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# 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.

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# 1 Scope

The present document establishes the minimum RF characteristics of RF repeater and network controlled repeater. For network controlled repeater (NCR), requirements for NCR-Fwd and NCR-MT apply. In this version of the specification mixed type NCR are not considered.

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# 2 References

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

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

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 38.104: "NR; Base Station (BS) radio transmission and reception".
- [3] 3GPP TR 25.942: "RF system scenarios".
- [4] Recommendation ITU-R SM.328: "Spectra and bandwidth of emissions".
- [5] ITU-R Recommendation SM.329: "Unwanted emissions in the spurious domain".
- [6] ITU-R Recommendation M.1545: "Measurement uncertainty as it applies to test limits for the terrestrial component of International Mobile Telecommunications – 2000".
- [7] 3GPP TS 38.115-1: "NR; Repeater conformance testing - Part 1: Conducted conformance testing".
- [8] 3GPP TS 38.115-2: "NR; Repeater conformance testing - Part 2: Radiated conformance testing".
- [9] ERC Recommendation 74-01, "Unwanted emissions in the spurious domain".
- [10] "Title 47 of the Code of Federal Regulations (CFR)", Federal Communications Commission.
- [11] Void
- [12] Void
- [13] 3GPP TS 38.101-1: "NR User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".
- [14] 3GPP TS 38.101-2: "NR User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".
- [15] Void
- [16] Void
- [17] Void
- [18] Void
- [19] Void
- [20] 3GPP TS 36.104: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception".

- [21] Void
- [22] 3GPP TS 38.174: "NR; Integrated Access and Backhaul (IAB) radio transmission and reception".
- [23] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".
- [24] 3GPP TS 38.213: "NR; Physical layer procedures for control".
- [25] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification".
- [26] 3GPP TS 38.211: "NR; Physical channels and modulation".
- [27] 3GPP TS 38.306: "NR; User Equipment (UE) radio access capabilities".
- [28] 3GPP TS 38.214: "NR; Physical layer procedures for data".
- [29] 3GPP TR 38.901: "Study on channel model for frequencies from 0.5 to 100 GHz".
- [30] 3GPP TR 38.101-4: "NR; User Equipment (UE) radio transmission and reception; Part 4: Performance requirements".
- [31] Commission Implementing Decision (EU) 2020/590 of 24 April 2020 amending Decision (EU) 2019/784 as regards an update of relevant technical conditions applicable to the 24,25-27,5 GHz frequency band.
- [32] ITU World Radiocommunication Conference 2023 (WRC-23) Final Acts, Resolution 220.
- [33] 3GPP TS 25.104: "Base Station (BS) radio transmission and reception (FDD)".

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## 3 Definitions of terms, symbols and abbreviations

### 3.1 Terms

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

**Antenna connector:** connector at the conducted interface of the *repeater type 1-C*

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

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

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

**Beam peak direction:** direction where the maximum EIRP is found

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

**directional requirement:** requirement which is applied in a specific direction within the *OTA coverage range*.

**Equivalent isotropic radiated power:** equivalent power radiated from an isotropic directivity device producing the same field intensity at a point of observation as the field intensity radiated in the direction of the same point of observation by the discussed device

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

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

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

**Maximum passband output power:** mean power level measured per *passband* at the *antenna connector*, during the *transmitter ON state* in a specified reference condition

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

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

**multi-band connector:** *Antenna Connector* for a *Multi-band repeater*.

**Multi-band repeater:** *Repeater Type 1-C* whose *antenna connector* is associated with a transmitter and/or receiver that is characterized by the ability to process two or more *passband(s)* in common active RF components simultaneously, where at least one *passband* is configured at a different operating band than the other *passband(s)* and where this different operating band is not a sub-band or superseding-band of another supported operating band

**NCR type 1-C:** NCR-MT or NCR-Fwd at FR1 with a *requirement set* consisting only of conducted requirements defined at individual antenna connectors.

**NCR type 1-H:** NCR-MT or NCR-Fwd operating at FR1 with a *requirement set* consisting of conducted requirements defined at individual TAB connectors and OTA requirements defined at RIB.

**NCR type 2-O:** NCR-MT or NCR-Fwd operating at FR2 with a *requirement set* consisting only of OTA requirements defined at the RIB.

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

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

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

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

**OTA peak directions set:** set(s) of *beam peak directions* within which certain OTA requirements are intended to be met, where all *OTA peak directions set(s)* are subsets of the *OTA coverage range*

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

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

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

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

**Rated passband output power:** mean power level associated with a *passband* the manufacturer has declared to be available at the *antenna connector*, during the *transmitter ON state* in a specified reference condition

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

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

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

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

**RF repeater type 1-C (RFR type 1-C):** Repeater operating at FR1 with a requirement set consisting only of conducted requirements defined at individual *antenna connectors*.

**RF repeater type 2-O (RFR type 2-O):** Repeater operating at FR2 with a requirement set consisting only of OTA requirements defined at the RIB

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

**single-band connector:** *Repeater type 1-C antenna connector* supporting operation either in a single *operating band* only, or in multiple *operating bands* but does not meet the conditions for a *multi-band connector*.

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

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

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

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

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

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

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

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

## 3.2 Symbols

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

|                                  |                                                                                                                                            |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| $BW_{\text{Config}}$             | Transmission bandwidth configuration, where $BW_{\text{Config}} = N_{\text{RB}} \times \text{SCS} \times 12$                               |
| $BW_{\text{Nominal}}$            | Nominal channel bandwidth                                                                                                                  |
| $BW_{\text{Passband}}$           | Passband bandwidth                                                                                                                         |
| $\Delta f$                       | Separation between the <i>passband edge</i> frequency and the nominal -3 dB point of the measuring filter closest to the carrier frequency |
| $\Delta f_{\text{max}}$          | $f_{\text{offset}_{\text{max}}}$ minus half of the bandwidth of the measuring filter                                                       |
| $\Delta f_{\text{OBUE}}$         | Maximum offset of the <i>operating band</i> unwanted emissions mask from the <i>operating band edge</i>                                    |
| $F_{\text{DL,low}}$              | The lowest frequency of the downlink <i>operating band</i>                                                                                 |
| $F_{\text{DL,high}}$             | The highest frequency of the downlink <i>operating band</i>                                                                                |
| $F_{\text{FBWhigh}}$             | Highest supported frequency within supported operating band, for which <i>fractional bandwidth</i> support was declared                    |
| $F_{\text{FBWlow}}$              | Lowest supported frequency within supported operating band, for which <i>fractional bandwidth</i> support was declared                     |
| $F_{\text{filter}}$              | Filter centre frequency                                                                                                                    |
| $F_{\text{offset,high}}$         | Frequency offset from $F_{\text{C,high}}$ to the upper <i>passband edge</i>                                                                |
| $F_{\text{offset,low}}$          | Frequency offset from $F_{\text{C,low}}$ to the lower <i>passband edge</i>                                                                 |
| $f_{\text{offset}}$              | Separation between the <i>passband edge</i> frequency and the centre of the measuring filter                                               |
| $f_{\text{offset}_{\text{max}}}$ | The offset to the frequency $\Delta f_{\text{OBUE}}$ outside the <i>operating band</i>                                                     |
| $F_{\text{step,X}}$              | Frequency steps for the OTA transmitter spurious emissions (Category B)                                                                    |
| $F_{\text{UL,low}}$              | The lowest frequency of the uplink <i>operating band</i>                                                                                   |
| $F_{\text{UL,high}}$             | The highest frequency of the uplink <i>operating band</i>                                                                                  |
| $P_{\text{EM,n50/n75,ind}}$      | Declared emission level for Band n50/n75; ind = a, b                                                                                       |
| $P_{\text{EM,n54,ind}}$          | Declared emission level for Band n54; ind = a, b, c, d, e, f                                                                               |
| $P_{\text{max,C,AC}}$            | Maximum carrier output power measured per <i>antenna connector</i>                                                                         |

|                                |                                                                                                                                                                    |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $P_{\text{rated,c,AC}}$        | The <i>rated carrier output power per antenna connector</i>                                                                                                        |
| $P_{\text{rated,c,sys}}$       | The sum of $P_{\text{rated,c,TABC}}$ for all <i>TAB connectors</i> for a single carrier                                                                            |
| $P_{\text{rated,c,TABC}}$      | The <i>rated carrier output power per TAB connector</i>                                                                                                            |
| $P_{\text{rated,p,AC}}$        | Rated passband output power per antenna connector                                                                                                                  |
| $P_{\text{rated,p,TABC}}$      | The <i>rated passband output power per TAB connector</i>                                                                                                           |
| $P_{\text{rated,t,AC}}$        | Rated total output power declared per antenna connector                                                                                                            |
| $P_{\text{rated,t,TABC}}$      | The <i>rated total output power</i> declared at <i>TAB connector</i> $P_{\text{rated,p,EIRP}}$ Rated passband EIRP output power                                    |
| $P_{\text{rated,p,TRP}}$       | Rated passband TRP output power declared per RIB                                                                                                                   |
| $P_{\text{rated,t,TRP}}$       | Rated total TRP output power declared per RIB                                                                                                                      |
| $P_{\text{in,p,AC}}$           | Input power intended to produce the maximum rated output power ( $P_{\text{rated,p,AC}}$ ) at the <i>antenna connector</i>                                         |
| $P_{\text{in,p,TABC}}$         | Input power intended to produce the maximum rated output power ( $P_{\text{rated,p,TABC}}$ ) at the <i>TAB connector</i>                                           |
| $P_{\text{in,p,EIRP}}$         | Input power intended to produce the maximum rated output power ( $P_{\text{rated,p,TRP}}$ ) at the RIB                                                             |
| $P_{\text{rated,out,FBWhigh}}$ | The rated output EIRP for the higher supported frequency range within supported <i>operating band</i> , for which <i>fractional bandwidth</i> support was declared |
| $P_{\text{rated,out,FBWlow}}$  | The rated output EIRP for the lower supported frequency range within supported <i>operating band</i> , for which <i>fractional bandwidth</i> support was declared  |
| $P_{\text{max,p,AC}}$          | <i>Maximum passband output power measured per antenna connector</i>                                                                                                |
| $P_{\text{max,p,TABC}}$        | The <i>maximum passband output power per TAB connector</i>                                                                                                         |
| $P_{\text{max,p,EIRP}}$        | <i>Maximum passband EIRP output power</i> when repeater is configured at the rated passband TRP output power ( $P_{\text{rated,p,TRP}}$ )                          |
| $P_{\text{max,p,TRP}}$         | <i>Maximum passband TRP output power</i> measured per RIB                                                                                                          |
| $W_{\text{gap}}$               | <i>Inter passband Bandwidth gap size</i>                                                                                                                           |

### 3.3 Abbreviations

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

|            |                                                                        |
|------------|------------------------------------------------------------------------|
| ACLR       | Adjacent Channel Leakage Ratio                                         |
| AoA        | Angle of Arrival                                                       |
| BFD        | Beam Failure Detection                                                 |
| BW         | Bandwidth                                                              |
| BWP        | Bandwidth Part                                                         |
| CACLR      | Cumulative ACLR                                                        |
| CBD        | Candidate Beam Detection                                               |
| CP-OFDM    | Cyclic Prefix-OFDM                                                     |
| CSI-RS     | Channel State Information - Reference Signal                           |
| DFT-s-OFDM | Discrete Fourier Transform-spread-OFDM                                 |
| DL         | Downlink                                                               |
| DMRS       | Demodulation Reference Signal                                          |
| EIRP       | Effective Isotropic Radiated Power                                     |
| EEIRP      | Expected EIRP                                                          |
| EVM        | Error Vector Magnitude                                                 |
| FBW        | Fractional Bandwidth                                                   |
| FR         | Frequency Range                                                        |
| FSS        | Fixed Satellite Service                                                |
| ITU-R      | Radiocommunication Sector of the International Telecommunication Union |
| LA         | Local Area                                                             |
| MR         | Medium Range                                                           |
| NCR        | Network Controlled Repeater                                            |
| NCR-MT     | NCR Mobile Termination                                                 |
| NCR-Fwd    | NCR Forward                                                            |
| NR         | New Radio                                                              |
| OBUE       | Operating Band Unwanted Emissions                                      |
| OOB        | Out-of-band                                                            |
| OTA        | Over-The-Air                                                           |
| QAM        | Quadrature Amplitude Modulation                                        |
| QCL        | Quasi Co-Location                                                      |

|        |                                                                                                                        |
|--------|------------------------------------------------------------------------------------------------------------------------|
| RF     | Radio Frequency                                                                                                        |
| RFR    | RF repeater                                                                                                            |
| RIB    | Radiated Interface Boundary                                                                                            |
| RLM    | Radio Link Monitoring                                                                                                  |
| RLM-RS | Reference Signal for RLM                                                                                               |
| RMSI   | Remaining Minimum System Information                                                                                   |
| RSRP   | Reference Signal Received Power                                                                                        |
| RX     | Receiver                                                                                                               |
| SA     | Standalone operation mode                                                                                              |
| SCS    | Sub-Carrier Spacing                                                                                                    |
| SMTC   | SSB-based Measurement Timing configurationSS-RSRP      Synchronization Signal based<br>Reference Signal Received Power |
| SSB    | Synchronization Signal Block                                                                                           |
| SSS    | Secondary Synchronization Signal                                                                                       |
| TCI    | Transmission Configuration Indicator                                                                                   |
| TRS    | Tracking Reference Signal                                                                                              |
| TX     | Transmitter                                                                                                            |
| TRP    | Total Radiated Power                                                                                                   |
| UL     | Uplink                                                                                                                 |
| WA     | Wide Area                                                                                                              |

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## 4 General

### 4.1 Relationship between Minimum Requirements and Test Requirements

Conformance to the present specification is demonstrated by fulfilling the test requirements specified in the conformance specification TS 38.115-1 [7] or TS 38.115-2 [8].

The minimum requirements given in this specification make no allowance for measurement uncertainty. The test specifications TS 38.115-1 [7] and TS 38.115-2 [8] define test tolerances. These test tolerances are individually calculated for each test. The test tolerances are used to relax the minimum requirements in this specification to create test requirements. For some requirements, including regulatory requirements, the test tolerance is set to zero.

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

The shared risk principle is defined in recommendation ITU-R M.1545 [6].

### 4.2 Conducted and radiated requirement reference points

#### 4.2.1 *RF repeater type 1-C*

For *RF Repeater type 1-C*, the requirements are applied at the repeater *antenna connector* (BS-side connector or UE-side connector) for downlink or uplink for the configuration in normal operating conditions.

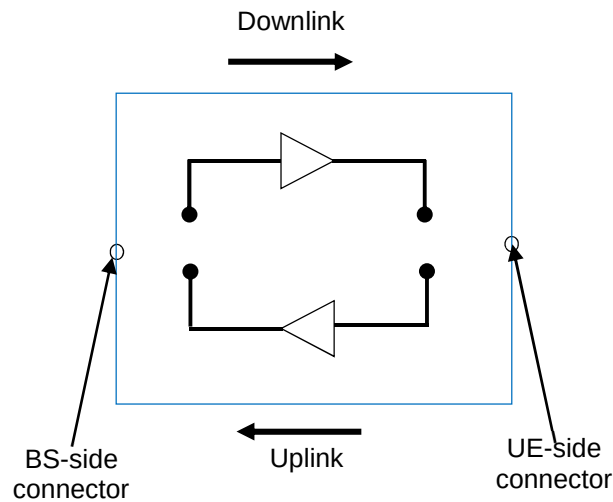


Figure 4.2.1-1: *RF repeater type 1-C* downlink and uplink interface

#### 4.2.1A NCR type 1-C

For *NCR type 1-C*, the NCR-Fwd RF requirements are applied at the NCR *antenna connector* (BS-side connector or UE-side connector) for downlink or uplink for the configuration in normal operating conditions.

For *NCR type 1-C*, the NCR-MT RF requirements are applied at the NCR *antenna connector* (BS-side connector) for the configuration in normal operating conditions.

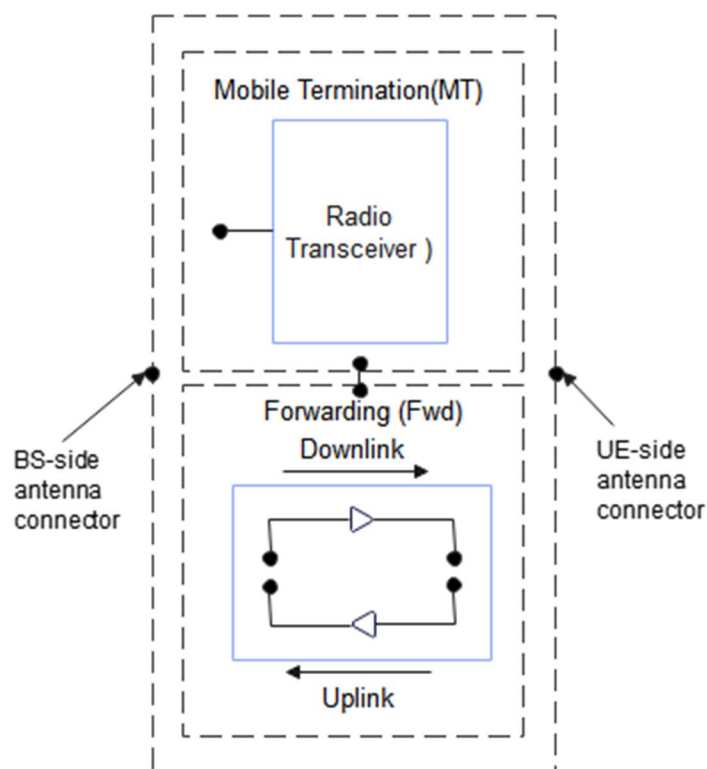


Figure 4.2.1-1A: Network controlled *Repeater type 1-C* downlink and uplink interface

NOTE 1: the NCR-MT and NCR-Fwd may have the same or separate antenna connectors.

### 4.2.1B Network controlled Repeater type 1-H

For *NCR type 1-H*, the requirements are defined for two points of reference, signified by radiated requirements and conducted requirements.

For *NCR type 1-H*, the NCR-Fwd conducted RF requirements are applied at the NCR individual or groups of *TAB connectors* at the *transceiver array boundary* (BS-side TAB connector or UE-side TAB connector) for downlink or uplink for the configuration in normal operating conditions.

For *NCR type 1-H*, the NCR-MT conducted RF requirements are applied at the NCR individual or groups of *TAB connectors* at the *transceiver array boundary* (BS-side TAB connector) for the configuration in normal operating conditions.

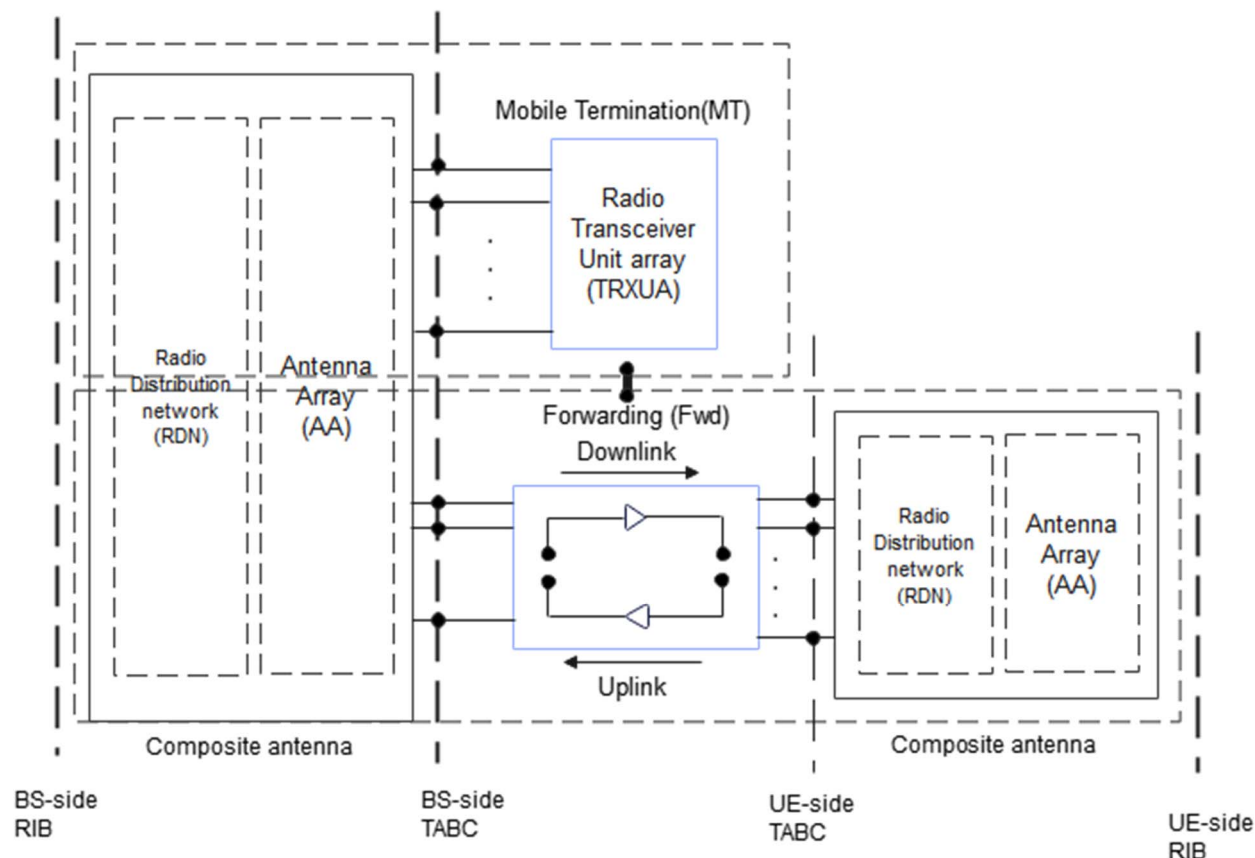


**Figure 4.2.1-1B: Network controlled Repeater type 1-H downlink and uplink interface**

NOTE 1: the NCR-MT and NCR-Fwd may have the same or separate TAB connectors.

### 4.2.2 Repeater type 2-O

For *RF repeater type 2-O*, the radiated characteristics are defined over the air (OTA), where the operating band specific radiated interface is referred to as the Radiated Interface Boundary (RIB). Radiated requirements are also referred to as OTA requirements. The (spatial) characteristics in which the OTA requirements apply are detailed for each requirement.

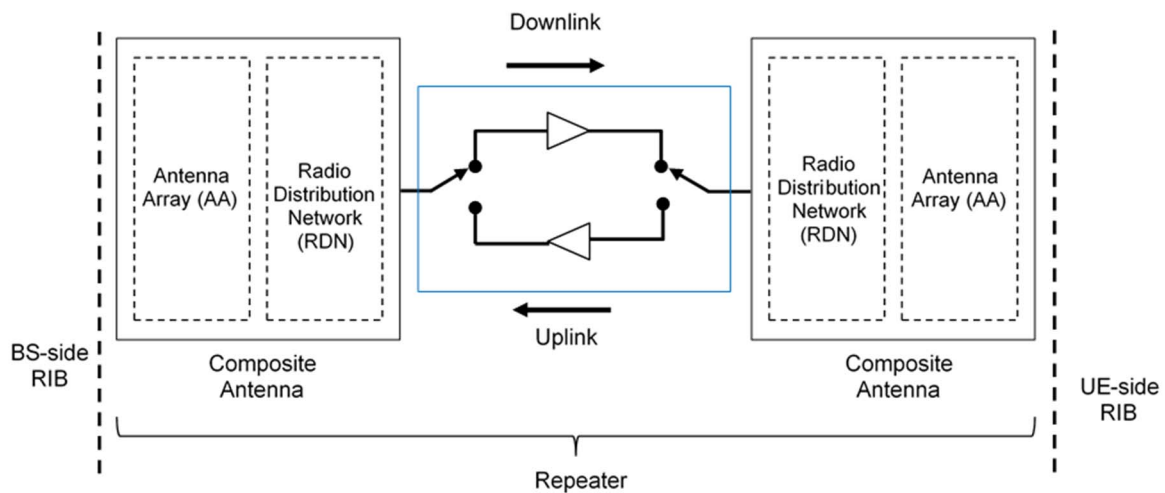


**Figure 4.2.2-1: Radiated reference points for *RF repeater type 2-O***

#### 4.2.2A Network controlled Repeater type 2-O

For *NCR type 2-O*, the radiated characteristics for NCR-Fwd and NCR-MT are defined over the air (OTA), where the operating band specific radiated interface is referred to as the Radiated Interface Boundary (RIB). Radiated requirements are also referred to as OTA requirements. The (spatial) characteristics in which the OTA requirements apply are detailed for each requirement.

For *NCR type 2-O*, the NCR-MT conducted RF requirements are applied at the BS side RIB for the configuration in normal operating conditions.



### 4.3.2 Repeater class for uplink

The requirements in this specification apply to uplink Wide Area repeaters and uplink Local Area repeaters unless otherwise stated. The associated deployment scenarios for each class are exactly the same for repeater with and without connectors.

For *RF repeater type 1-C* and *type 2-O*, repeater uplink classes are defined as indicated below:

- Wide Area repeaters are characterised by requirements derived from Macro Cell and/or Micro Cell scenarios.
- Local Area repeaters are characterised by requirements derived from Pico Cell and/or Micro Cell scenarios.

## 4.3A Network controlled repeater classes

### 4.3A.1 Network controlled repeater class for downlink

The requirements in this specification apply to downlink Wide Area NCR, downlink Medium Range NCR and downlink Local Area NCR unless otherwise stated. The associated deployment scenarios for each class are exactly the same for NCR with and without connectors.

For *NCR type 1-C*, *type 1-H* and *type 2-O*, NCR downlink classes are defined as indicated below:

- Wide Area NCR are characterised by requirements derived from Macro Cell scenarios with a NCR to UE minimum distance along the ground equal to 35 m.
- Medium Range NCR are characterised by requirements derived from Micro Cell scenarios with a NCR to UE minimum distance along the ground equal to 5 m.
- Local Area NCR are characterised by requirements derived from Pico Cell scenarios with a NCR to UE minimum distance along the ground equal to 2 m or from Femto Cell scenarios.
- Note: The requirements in this specification for LA NCR type 1-C apply to NCR type 1-C with declared output power less than or equal to LA rated output power limits as in table 6.2.1-1.

### 4.3A.2 Network controlled repeater class for uplink and MT

The requirements in this specification apply to uplink Wide Area NCR and uplink Local Area NCR unless otherwise stated. The associated deployment scenarios for each class are exactly the same for NCR with and without connectors.

For *NCR type 1-C*, *type 1-H* and *type 2-O*, NCR uplink classes and MT classes are defined as indicated below:

- Wide Area NCR are characterised by requirements derived from Macro Cell and/or Micro Cell scenarios.
- Local Area NCR are characterised by requirements derived from Pico Cell and/or Micro Cell scenarios.

## 4.4 Regional requirements

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

Table 4.4-1 lists all requirements in the present specification that may be applied differently in different regions.

Table 4.4-1: List of regional requirements

| Clause number           | Requirement                                                                                                 | Comments                                                                                                                                                                                                                             |
|-------------------------|-------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5.2                     | <i>Operating bands</i>                                                                                      | Some NR <i>operating bands</i> may be applied regionally.                                                                                                                                                                            |
| 6.2                     | Repeater output power                                                                                       | For Band n41 and n90 operation in Japan, additional output power limits shall be applied.                                                                                                                                            |
| 6.2.4,<br>7.3.4         | Repeater output power,<br>OTA repeater output power:<br>Additional requirements                             | These requirements may be applied regionally as additional repeater output power requirements.                                                                                                                                       |
| 6.5.2                   | Adjacent Channel Leakage<br>Power Ratio                                                                     | For Band n41 and n90 operation in Japan, absolute ACLR limits shall be applied to the sum of the absolute ACLR power over all <i>antenna connectors</i> for <i>repeater type 1-C</i> .                                               |
| 6.5.3.2,<br>7.5.3.2     | Operating band unwanted<br>emission,<br>OTA operating band unwanted<br>emissions                            | Category A or Category B operating band unwanted emissions limits may be applied regionally.                                                                                                                                         |
| 6.5.3.2.5.1             | Operating band unwanted<br>emission                                                                         | The repeater may have to comply with the additional requirements, when deployed in regions where those limits are applied, and under the conditions declared by the manufacturer.                                                    |
| 6.5.3.2.5.2             | Operating band unwanted<br>emission                                                                         | The repeater operating in Band n20 may have to comply with the additional requirements for protection of DTT, when deployed in certain regions.                                                                                      |
| 6.5.3.2                 | Operating band unwanted<br>emissions                                                                        | For Band n41 and n90 operation in Japan, the operating band unwanted emissions limits shall be applied to the sum of the emission power over all <i>antenna connectors</i> for <i>repeater type 1-C</i> .                            |
| 6.5.4.2.1,<br>7.5.4.2   | Tx spurious emissions,<br>OTA Tx spurious emissions                                                         | Category A or Category B spurious emission limits, as defined in ITU-R Recommendation SM.329 [5], may apply regionally.                                                                                                              |
| 6.5.4.2.2,<br>7.5.4.2.3 | Tx spurious emissions:<br>additional requirements,<br>OTA Tx spurious emissions:<br>additional requirements | These requirements may be applied for the protection of system operating in frequency ranges other than the repeater <i>operating band</i> .                                                                                         |
| 6.5.4.2                 | Transmitter spurious emissions                                                                              | For Band n41 and n90 operation in Japan, the sum of the spurious emissions over all <i>antenna connectors</i> for <i>repeater type 1-C</i> shall not exceed the <i>basic limits</i> .                                                |
| 6.5.5.1                 | Receiver spurious emissions                                                                                 | For Band n41 and n90 operation in Japan, the sum of receiver spurious emissions requirements over all <i>antenna connectors</i> for <i>repeater type 1-C</i> shall not exceed <i>minimum requirements</i> defined in clause 6.5.5.2. |
| 6.7.2                   | Input intermodulation                                                                                       | Interfering signal positions that are partially or completely outside of any downlink <i>operating band</i> of the repeater are not excluded from the requirement in Japan in Band n77, n78, n79.                                    |
| 6.8                     | Output intermodulation                                                                                      | For Band n41 and n90 operation in Japan, the repeater may have to comply with the additional requirements, when deployed in certain regions.                                                                                         |

## 4.5 Applicability of requirements

In Table 4.5-1, the requirement applicability for each requirement set is defined. For each requirement, the applicable requirement clause in the specification is identified. Requirements not included in a requirement set is marked not applicable (NA).

Table 4.5-1: Requirement set applicability

| Requirement                                         | Requirement set                                   |                             |                            |                            |                                                        |                            |  |      |    |
|-----------------------------------------------------|---------------------------------------------------|-----------------------------|----------------------------|----------------------------|--------------------------------------------------------|----------------------------|--|------|----|
|                                                     | <i>RFR<br/>type 1-C,<br/>NCR-Fwd<br/>type 1-C</i> | <i>NCR-Fwd<br/>type 1-H</i> | <i>NCR-MT<br/>type 1-C</i> | <i>NCR-MT<br/>type 1-H</i> | <i>RFR<br/>type 2-O,<br/>NCR-<br/>Fwd<br/>type 2-O</i> | <i>NCR-MT<br/>type 2-O</i> |  |      |    |
| Repeater output power                               | 6.2                                               | 6.2                         | NA                         | NA                         | NA                                                     | NA                         |  |      |    |
| Frequency stability                                 | 6.3                                               | 6.3                         |                            |                            |                                                        |                            |  |      |    |
| Out of band gain                                    | 6.4                                               | 6.4                         |                            |                            |                                                        |                            |  |      |    |
| Unwanted emissions                                  | 6.5                                               | 6.5                         |                            |                            |                                                        |                            |  |      |    |
| Repeater Error Vector Magnitude                     | 6.6                                               | 6.6                         |                            |                            |                                                        |                            |  |      |    |
| Input intermodulation                               | 6.7                                               | 6.7                         |                            |                            |                                                        |                            |  |      |    |
| Output intermodulation                              | 6.8                                               | 6.8                         |                            |                            |                                                        |                            |  |      |    |
| Adjacent Channel Rejection Ratio (ACRR)             | 6.9                                               | 6.9                         |                            |                            |                                                        |                            |  |      |    |
| Transmit ON/OFF power                               | 6.10                                              | 6.10                        |                            |                            |                                                        |                            |  |      |    |
| Repeater output power for NCR-MT                    | NA                                                | NA                          | 6.2.3.2                    | 6.2.3.2                    |                                                        |                            |  |      |    |
| Output power dynamics for NCR-MT                    |                                                   |                             | 6.11                       | 6.11                       |                                                        |                            |  |      |    |
| Transmit signal quality for NCR-MT                  |                                                   |                             | 6.12                       | 6.12                       |                                                        |                            |  |      |    |
| Unwanted emissions for NCR-MT                       |                                                   |                             | 6.5                        | 6.5                        |                                                        |                            |  |      |    |
| Transmit intermodulation for NCR-MT                 |                                                   |                             | 6.13                       | 6.13                       |                                                        |                            |  |      |    |
| Diversity characteristics for NCR-MT                |                                                   |                             | 6.15                       | 6.15                       |                                                        |                            |  |      |    |
| Reference sensitivity for NCR-MT                    |                                                   |                             | 6.16                       | 6.16                       |                                                        |                            |  |      |    |
| Maximum input level for NCR-MT                      |                                                   |                             | 6.17                       | 6.17                       |                                                        |                            |  |      |    |
| Adjacent channel selectivity for NCR-MT             |                                                   |                             | 6.18                       | 6.18                       |                                                        |                            |  |      |    |
| Blocking characteristics for NCR-MT                 |                                                   |                             | 6.19                       | 6.19                       |                                                        |                            |  |      |    |
| Spurious response for NCR-MT                        |                                                   |                             | 6.20                       | 6.20                       |                                                        |                            |  |      |    |
| Receiver intermodulation characteristics for NCR-MT |                                                   |                             | 6.21                       | 6.21                       |                                                        |                            |  |      |    |
| Receiver spurious emissions for NCR-MT              |                                                   |                             | 6.22                       | 6.22                       |                                                        |                            |  |      |    |
| Performance requirements for NCR-MT                 |                                                   |                             | 8                          | 8                          |                                                        |                            |  |      |    |
| OTA Repeater output power                           |                                                   | 7.2                         | NA                         | NA                         | 7.2                                                    |                            |  |      |    |
| OTA frequency stability                             |                                                   |                             |                            |                            | 7.3                                                    |                            |  |      |    |
| OTA out of band gain                                |                                                   |                             |                            |                            | 7.4                                                    |                            |  |      |    |
| OTA unwanted emissions                              |                                                   |                             |                            |                            | 7.5                                                    |                            |  |      |    |
| OTA Repeater Error Vector Magnitude                 |                                                   |                             |                            |                            | 7.6                                                    |                            |  |      |    |
| OTA input intermodulation                           |                                                   |                             |                            |                            | 7.7                                                    |                            |  |      |    |
| OTA Adjacent Channel Rejection Ratio (ACRR)         |                                                   |                             |                            |                            | 7.8                                                    |                            |  |      |    |
| OTA transmit ON/OFF power                           |                                                   |                             |                            |                            | 7.9                                                    |                            |  |      |    |
| OTA repeater output power for NCR-MT                |                                                   |                             |                            | NA                         | 7.2                                                    | NA                         |  | 7.2  |    |
| OTA output power dynamics for NCR-MT                |                                                   |                             |                            |                            | NA                                                     |                            |  | 7.10 |    |
| OTA transmit signal quality for NCR-MT              |                                                   |                             |                            |                            |                                                        |                            |  | 7.11 |    |
| OTA unwanted emissions for NCR-MT                   |                                                   |                             |                            |                            |                                                        |                            |  | 7.5  |    |
| OTA diversity characteristics for NCR-MT            |                                                   |                             |                            |                            |                                                        |                            |  | 7.12 |    |
| OTA reference sensitivity for NCR-MT                |                                                   | 7.13                        |                            |                            |                                                        |                            |  |      |    |
| OTA maximum input level for NCR-MT                  |                                                   | 7.14                        |                            |                            |                                                        |                            |  |      |    |
| OTA adjacent channel selectivity for NCR-MT         |                                                   | 7.15                        |                            |                            |                                                        |                            |  |      |    |
| OTA blocking characteristics for NCR-MT             |                                                   | 7.16                        |                            |                            |                                                        |                            |  |      |    |
| OTA receiver spurious emissions for NCR-MT          |                                                   | 7.17                        |                            |                            |                                                        |                            |  |      |    |
| OTA spatial emission                                |                                                   | 7.18                        |                            |                            |                                                        |                            |  | 7.18 | NA |
| Radiated performance requirements for NCR-MT        |                                                   |                             |                            |                            |                                                        |                            |  |      | 9  |

Table 4.5-1a: Void

Table 4.5-1b: Void

## 4.6 Requirements for contiguous and *non-contiguous spectrum*

A spectrum allocation where a repeater operates can either be contiguous or non-contiguous. Unless otherwise stated, the requirements in the present specification apply for repeater configured for both contiguous spectrum operation and non-contiguous spectrum operation.

For repeater operation in non-contiguous spectrum, some requirements apply at the repeater *passband* edges. For each such requirement, it is stated how the limits apply relative to the repeater *gap between passbands* and the *Inter-passband gap* respectively.

For NCR operation in non-contiguous spectrum, some requirements apply at the NCR-Fwd *passband* edges or NCR-MT carrier edges. For each such requirement, it is stated how the limits apply relative to the NCR *gap between passbands* and the *Inter-passband gap* respectively.

## 4.7 Requirements for repeater capable of multi-band operation

For multi-band connector or multi-band RIB, the RF requirements in clauses 6 and 7 apply separately to each supported operating band unless otherwise stated. For some requirements, it is explicitly stated that specific additions or exclusions to the requirement apply at multi-band connector(s), and multi-band RIB(s) as detailed in the requirement clause. For repeater or NCR capable of multi-band operation, various structures in terms of combinations of different downlink and uplink implementations (multi-band or single band) with mapping to one or more *antenna connectors* for *repeater type 1-C*, *NCR type 1-C*, *type 1-H* in different ways are possible. For multi-band connector(s) the exclusions or provisions for multi-band apply. For single-band connector(s), the following applies:

- Single-band transmitter spurious emissions, *operating band* unwanted emissions, ACLR, output intermodulation, ACRR and receiver spurious emissions requirements apply to this *connector* that is mapped to single-band.
- If the repeater or NCR is configured for single-band operation, single-band requirements shall apply to this *antenna connector* configured for single-band operation and no exclusions or provisions for multi-band capable repeater or NCR are applicable. Single-band requirements are tested separately at the *antenna connector* configured for single-band operation, with all other *antenna connectors* terminated.

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# 5 Operating bands

## 5.1 General

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

NOTE: Other *operating bands* may be considered in future releases.

Requirements throughout the RF specifications are in many cases defined separately for different frequency ranges (FR). The frequency ranges in which NR can operate according to the present version of the specification are identified as described in table 5.1-1.

**Table 5.1-1: Definition of frequency ranges**

| Frequency range designation |       | Corresponding frequency range |
|-----------------------------|-------|-------------------------------|
| FR1                         |       | 410 MHz – 7125 MHz            |
| FR2                         | FR2-1 | 24250 MHz – 52600 MHz         |
|                             | FR2-2 | 52600 MHz – 71000 MHz         |

Whenever FR2 is referred, both FR2-1 and FR2-2 frequency sub-ranges shall be applied, unless otherwise stated.

## 5.2 Operating bands

Repeater is designed to operate in the *operating bands* in FR1 and FR2-1 defined in TS 38.104 [2] except the operating bands n46, n96 and n102.

## 5.3 Channel arrangement

### 5.3.1 Channel raster

#### 5.3.1.1 NR-ARFCN and channel raster

For repeater and NCR-Fwd, the NR-ARFCN and channel raster is the same as specified for BS in TS 38.104 [2], subclause 5.4.2.1.

For NCR-MT, the NR-ARFCN and channel raster is the same as specified for UE in TS 38.101-1 [13] for FR1 in subclause 5.4.2.1 and in TS 38.101-2 [14] for FR2-1 in subclause 5.4.2.1.

#### 5.3.1.2 Channel raster entries for each *operating band*

For repeater and NCR-Fwd, the channel raster entries for NR bands for FR1 and FR2-1 defined in TS 38.104 [2] are the same as specified for BS in TS38.104 [2], clause 5.4.2.3.

For NCR-MT, the channel raster entries for NR bands for FR1 are the same as specified for UE in TS 38.101-1 [13] in subclause 5.4.2.3 and for NR bands for FR2-1 are the same as specified for UE in TS 38.101-2 [14] in subclause 5.4.2.3.

#### 5.3.1.3 Channel raster to resource element mapping

For NCR-MT, the channel raster to resource element mapping is the same as specified for UE in TS 38.101-1 [13] for FR1 in subclause 5.4.2.2 and in TS 38.101-2 [14] for FR2 in subclause 5.4.2.2.

## 5.3.2 Synchronization raster

### 5.3.2.1 Synchronization raster and numbering

For repeater and NCR-Fwd, the synchronization raster and numbering are the same as specified for BS in TS38.104 [2], clause 5.4.3.1.

For NCR-MT, the synchronization raster and numbering are the same as specified for UE in subclause 5.4.3.1 in TS 38.101-1 [13] for FR1 in subclause 5.4.3.1 and in subclause 5.4.3.1 in TS 38.101-2 [14] for FR2-1 in subclause 5.4.3.1.

### 5.3.2.2 Synchronization raster entries for each operating band

For repeater and NCR-Fwd, the synchronization raster entries for NR bands for FR1 and FR2-1 defined in TS38.104 [2] are the same as specified for BS in TS38.104 [2], clause 5.4.3.3.

For NCR-MT, the synchronization raster entries for NR bands for FR1 in Table 5.2-1 are the same as specified for UE in TS 38.101-1 [13] in subclause 5.4.3.3 and for NR bands for FR2-1 are the same as specified for UE in TS 38.101-2 [14] in subclause 5.4.3.3.

### 5.3.2.3 Synchronization raster to synchronization block resource element mapping

For NCR-MT, the synchronization raster to synchronization block resource element mapping is the same as specified for UE in TS 38.101-1 [13] for FR1 in subclause 5.4.3.2 and in TS 38.101-2 [14] for FR2-1 in subclause 5.4.3.2.

### 5.3.3 Channel spacing

For NCR-MT, the channel spacing is the same as specified for UE in TS 38.101-1 [13] for FR1 in subclause 5.4.1 and in TS 38.101-2 [14] for FR2-1 in subclause 5.4.1.

### 5.3.4 TX–RX frequency separation

The default TX channel (carrier centre frequency) to RX channel (carrier centre frequency) separation for operating bands is specified in Table 5.3.4-1.

**Table 5.3.4-1: NCR-MT TX-RX frequency separation**

| NR Operating Band                                                                                                                                                                                                                                                                                                                                                                                                    | TX – RX<br>carrier centre frequency<br>separation                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| n1                                                                                                                                                                                                                                                                                                                                                                                                                   | 190 MHz                                                                        |
| n2                                                                                                                                                                                                                                                                                                                                                                                                                   | 80 MHz                                                                         |
| n3                                                                                                                                                                                                                                                                                                                                                                                                                   | 95 MHz                                                                         |
| n5                                                                                                                                                                                                                                                                                                                                                                                                                   | 45 MHz                                                                         |
| n7                                                                                                                                                                                                                                                                                                                                                                                                                   | 120 MHz                                                                        |
| n8                                                                                                                                                                                                                                                                                                                                                                                                                   | 45 MHz                                                                         |
| n12                                                                                                                                                                                                                                                                                                                                                                                                                  | 30 MHz                                                                         |
| n13                                                                                                                                                                                                                                                                                                                                                                                                                  | -31 MHz                                                                        |
| n14                                                                                                                                                                                                                                                                                                                                                                                                                  | -30 MHz                                                                        |
| n18                                                                                                                                                                                                                                                                                                                                                                                                                  | 45 MHz                                                                         |
| n20                                                                                                                                                                                                                                                                                                                                                                                                                  | -41 MHz                                                                        |
| n24                                                                                                                                                                                                                                                                                                                                                                                                                  | -101.5, -120.5 MHz                                                             |
| n25                                                                                                                                                                                                                                                                                                                                                                                                                  | 80 MHz                                                                         |
| n26                                                                                                                                                                                                                                                                                                                                                                                                                  | 45 MHz                                                                         |
| n28                                                                                                                                                                                                                                                                                                                                                                                                                  | 55 MHz                                                                         |
| n30                                                                                                                                                                                                                                                                                                                                                                                                                  | 45 MHz                                                                         |
| n65                                                                                                                                                                                                                                                                                                                                                                                                                  | 190 MHz                                                                        |
| n66                                                                                                                                                                                                                                                                                                                                                                                                                  | 400 MHz                                                                        |
| n68                                                                                                                                                                                                                                                                                                                                                                                                                  | 55 MHz                                                                         |
| n70                                                                                                                                                                                                                                                                                                                                                                                                                  | 300 MHz                                                                        |
| n71                                                                                                                                                                                                                                                                                                                                                                                                                  | -46 MHz                                                                        |
| n74                                                                                                                                                                                                                                                                                                                                                                                                                  | 48 MHz                                                                         |
| n85                                                                                                                                                                                                                                                                                                                                                                                                                  | 30 MHz                                                                         |
| n87                                                                                                                                                                                                                                                                                                                                                                                                                  | 10MHz                                                                          |
| n88                                                                                                                                                                                                                                                                                                                                                                                                                  | 10MHz                                                                          |
| n91                                                                                                                                                                                                                                                                                                                                                                                                                  | 570 MHz – 595 MHz<br>(NOTE 2)                                                  |
| n92                                                                                                                                                                                                                                                                                                                                                                                                                  | 575 MHz – 680 MHz ( $\mu = 0$ )<br>580 MHz – 675 MHz ( $\mu = 1$ )<br>(NOTE 2) |
| n93                                                                                                                                                                                                                                                                                                                                                                                                                  | 517 MHz – 547 MHz<br>(NOTE 2)                                                  |
| n94                                                                                                                                                                                                                                                                                                                                                                                                                  | 522 MHz – 632 MHz ( $\mu = 0$ )<br>527 MHz – 627 MHz ( $\mu = 1$ )<br>(NOTE 2) |
| n100                                                                                                                                                                                                                                                                                                                                                                                                                 | 45 MHz                                                                         |
| n105                                                                                                                                                                                                                                                                                                                                                                                                                 | -51 MHz                                                                        |
| n110                                                                                                                                                                                                                                                                                                                                                                                                                 | 42 MHz                                                                         |
| NOTE 1: Void                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                |
| NOTE 2: The range of TX-RX frequency separation given paired UL and DL channel bandwidths $BW_{UL}$ and $BW_{DL}$ is given by the respective lower and upper limit $F_{DL\_low} - F_{UL\_high} + 0.5(BW_{DL} + BW_{UL})$ and $F_{DL\_high} - F_{UL\_low} - 0.5(BW_{DL} + BW_{UL})$ . The UL and DL channel bandwidth combinations specified in Clause 5.4 depend on the subcarrier spacing configuration $\mu$ [21]. |                                                                                |

## 5.4 NCR-MT channel bandwidth

### 5.4.1 General

The NCR-MT supports a single NR RF carrier per passband in the uplink or downlink in this release. From a BS perspective, different NCR-MT channel bandwidths may be supported within the same spectrum for transmitting to and receiving from NCR-MT connected to the BS. Transmission of multiple carriers to different NCR-MT within the BS channel bandwidth can be supported.

NOTE: 7 MHz channel bandwidth is not supported in the present version of the specification.

From a NCR-MT perspective, the NCR-MT per passband is configured with one carrier and NCR-MT is configured with one or more BWPs. The NCR-MT does not need to be aware of the BS channel bandwidth or how the BS allocates bandwidth to different NCR-MT.

The placement of the NCR-MT channel bandwidth is flexible but can only be completely within the BS channel bandwidth.

The relationship between the NCR-MT channel bandwidth, the guardband and the transmission bandwidth configuration is shown in Figure 5.4.1-1.

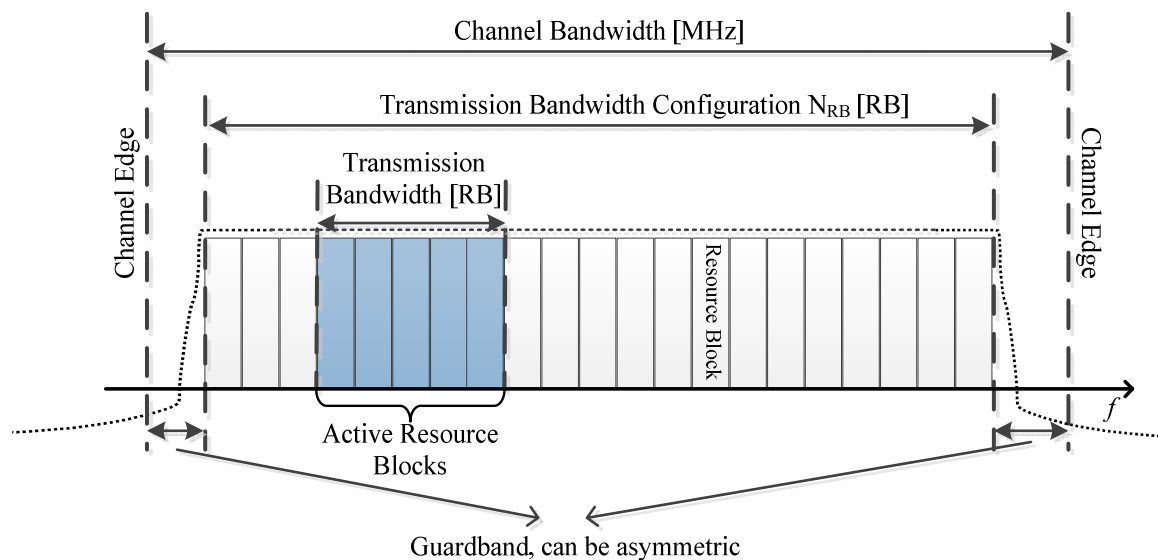


**Figure 5.4.1-1: Definition of channel bandwidth and transmission bandwidth configuration for one NR channel**

### 5.4.2 Transmission bandwidth configuration

For NCR-MT, the transmission bandwidth configuration is the same as specified for UE in TS 38.101-1 [13] for FR1 in subclause 5.3.2 and in TS 38.101-2 [14] for FR2-1 in subclause 5.3.2.

### 5.4.3 Minimum guardband and transmission bandwidth configuration

For NCR-MT, the minimum guardband and transmission bandwidth configuration is the same as specified for UE in TS38.101-1 [13] for FR1 and in TS 38.101-2 [14] for FR2-1 in subclause 5.3.3.

### 5.4.4 RB alignment

For NCR-MT, the RB alignment is the same as specified for UE in TS38.101-1 [13] for FR1 in subclause 5.3.4 and in TS 38.101-2 [14] for FR2-1 in subclause 5.3.4

### 5.4.5 NCR-MT channel bandwidth per operating band

For NCR-MT, the channel bandwidth for NR bands for FR1 in Table 5.2-1 is the same as specified for UE in TS38.101-1 [13] in subclause 5.3.5 and is the same as specified for UE in TS38.101-2 [14] in subclause 5.3.5.

---

## 6 Conducted characteristics

### 6.1 General

Clause 6 includes the conducted characteristics for both transmitter and receiver.

For conducted transmitter characteristics:

Unless otherwise stated, the conducted transmitter characteristics are specified at:

- Antenna connector for repeater type 1-C and *NCR type 1-C* (including Fwd and MT interfaces) configuration,
- *TAB connector* for *NCR type 1-H* (including Fwd and MT interfaces) in normal operating conditions.

Requirements apply in both DL and UL unless otherwise stated or declared.

For the DL the *antenna connector* or the *TAB connector* on the BS side is the input and the *antenna connector* or the *TAB connector* on the UE side is the output.

For the UL the *antenna connector* or the *TAB connector* on the UE side is the input and the *antenna connector* or the *TAB connector* on the BS side is the output.

All requirements are defined for normal conditions, unless otherwise stated.

For conducted receiver characteristics:

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

Unless otherwise stated, the following arrangements apply for conducted receiver characteristics requirements in clause 6:

- Requirements apply during the receive period.
- Requirements shall be met for any transmitter setting.
- Throughput requirements defined for the conducted receiver characteristics do not assume HARQ retransmissions.
- For ACS, blocking and intermodulation characteristics, the negative offsets of the interfering signal apply relative to the lower *passband* edge or *inter-passband gap*, and the positive offsets of the interfering signal apply relative to the upper *passband* edge or *inter-passband gap*.

NOTE: In normal operating condition the NCR-MT in TDD operation is configured to TX OFF power during *receive period*.

### 6.2 Repeater output power

#### 6.2.1 General

The repeater conducted output power requirement is at the *antenna connector*.

The *rated passband output power* of the *RF repeater type 1-C* and *NCR-Fwd type 1-C* shall be as specified in table 6.2.1-1 and table 6.2.1-2.

**Table 6.2.1-1: RF repeater type 1-C and NCR-FWD type 1-C DL transmission classes rated output power limits for repeater classes**

| Repeater class                                                                                                               | $P_{\text{rated,p,AC}}$            |
|------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| Wide Area repeater                                                                                                           | Note 1                             |
| Medium Range repeater                                                                                                        | $\leq 38 \text{ dBm} + X$ , Note 2 |
| Local Area repeater                                                                                                          | $\leq 24 \text{ dBm} + X$ , Note 2 |
| NOTE 1: There is no upper limit for the $P_{\text{rated,p,AC}}$ <i>rated passband output power</i> of the Wide Area repeater |                                    |
| NOTE 2: $X = 10 \cdot \log(\text{ceil}(\text{passband bandwidth}/20\text{MHz}))$                                             |                                    |

**Table 6.2.1-2: RF repeater type 1-C and NCR-Fwd type 1-C UL transmission classes rated output power limits for repeater classes**

| Repeater class                                                                                                                | $P_{\text{rated,p,AC}}$            |
|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| Wide Area repeater                                                                                                            | Note 1                             |
| Local Area repeater                                                                                                           | $\leq 24 \text{ dBm} + X$ , Note 2 |
| NOTE 1: There is no upper limit for the $P_{\text{rated,p,AC}}$ <i>rated passband output power</i> of the Wide Area repeater. |                                    |
| NOTE 2: $X = 10 \cdot \log(\text{ceil}(\text{passband bandwidth}/20\text{MHz}))$                                              |                                    |

The *rated passband output power* of the *NCR-Fwd 1-H* shall be as specified in table 6.2.1-3 and table 6.2.1-4.

**Table 6.2.1-3: NCR-Fwd 1-H DL rated output power limits for NCR classes**

| Repeater class                                                                                                          | $P_{\text{rated,c,sys}}$                                            | $P_{\text{rated,c,TABC}}$          |
|-------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|------------------------------------|
| Wide Area NCR                                                                                                           | (Note 1)                                                            | (Note 1)                           |
| Medium Range NCR                                                                                                        | $\leq 38 \text{ dBm} + 10\log(N_{\text{TXU,counted}}) + X$ (NOTE 2) | $\leq 38 \text{ dBm} + X$ (NOTE 2) |
| Local Area NCR                                                                                                          | $\leq 24 \text{ dBm} + 10\log(N_{\text{TXU,counted}}) + X$ (NOTE 2) | $\leq 24 \text{ dBm} + X$ (NOTE 2) |
| NOTE 1: There is no upper limit for the $P_{\text{rated,c,sys}}$ or $P_{\text{rated,c,TABC}}$ of the Wide Area NCR-Fwd. |                                                                     |                                    |
| NOTE 2: $X = 10 \cdot \log(\text{ceil}(\text{passband bandwidth}/20\text{MHz}))$                                        |                                                                     |                                    |

**Table 6.2.1-4: NCR-Fwd 1-H UL rated output power limits for NCR classes**

| Repeater class                                                                                                                       | $P_{\text{rated,c,sys}}$                                               | $P_{\text{rated,c,TABC}}$          |
|--------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|------------------------------------|
| Wide Area NCR                                                                                                                        | (Note 1)                                                               | (Note 1)                           |
| Local Area NCR                                                                                                                       | $\leq 24 \text{ dBm} + 10\log(N_{\text{TXU,counted}}) + X$ (NOTE 2, 3) | $\leq 24 \text{ dBm} + X$ (NOTE 2) |
| NOTE 1: There is no upper limit for the $P_{\text{rated,c,sys}}$ or $P_{\text{rated,c,TABC}}$ of the Wide Area NCR.                  |                                                                        |                                    |
| NOTE 2: $X = 10 \cdot \log(\text{ceil}(\text{passband bandwidth}/20\text{MHz}))$                                                     |                                                                        |                                    |
| NOTE 3: For joint transmission of NCR-Fwd and NCR-MT, $P_{\text{rated,c,sys}}$ shall apply to the total power of NCR-Fwd and NCR-MT. |                                                                        |                                    |

## 6.2.2 Minimum requirement for RF repeater

The requirements shall apply with NR signals in the *passband* of the repeater at:

The lowest input power ( $P_{\text{in,p,AC}}$ ) that produces the *rated passband output power* ( $P_{\text{rated,p,AC}}$ ).

Up to:

The lowest input power ( $P_{\text{in,p,AC}}$ ) that produces the *rated passband output power* ( $P_{\text{rated,p,AC}}$ ), plus 10dB

In normal conditions, the measured output power,  $P_{\text{max,p,AC}}$  shall remain within +2 dB and -2 dB of the *rated passband output power*  $P_{\text{rated,p,AC}}$ , declared by the manufacturer.

In extreme conditions, the measured output power,  $P_{\max,p,AC}$  shall remain within +2.5 dB and -2.5 dB of the *rated passband output power*  $P_{\text{rated},p,AC}$ , declared by the manufacturer.

## 6.2.3 Minimum requirement for NCR

### 6.2.3.1 Minimum requirement for NCR-Fwd

#### 6.2.3.1.1 Minimum requirement for NCR-Fwd type 1-C

The requirements shall apply with NR signals in the *passband* of the NCR-Fwd at:

The lowest input power ( $P_{\text{in},p,AC}$ ) that produces the *rated passband output power* ( $P_{\text{rated},p,AC}$ ).

Up to:

The lowest input power ( $P_{\text{in},p,AC}$ ) that produces the *rated passband output power* ( $P_{\text{rated},p,AC}$ ), plus 10dB

In normal conditions, the measured output power,  $P_{\max,p,AC}$  shall remain within +2 dB and -2 dB of the *rated passband output power*  $P_{\text{rated},p,AC}$ , declared by the manufacturer.

In extreme conditions, the measured output power,  $P_{\max,p,AC}$  shall remain within +2.5 dB and -2.5 dB of the *rated passband output power*  $P_{\text{rated},p,AC}$ , declared by the manufacturer.

#### 6.2.3.1.2 Minimum requirement for NCR-Fwd type 1-H

The requirements shall apply with NR signals in the *passband* of the NCR-Fwd at:

The lowest input power ( $P_{\text{in},p,TABC}$ ) that produces the *rated passband output power* ( $P_{\text{rated},p,TABC}$ ).

Up to:

The lowest input power ( $P_{\text{in},p,TABC}$ ) that produces the *rated passband output power* ( $P_{\text{rated},p,TABC}$ ), plus 10dB

In normal conditions, the measured output power,  $P_{\max,p,TABC}$  shall remain within +2 dB and -2 dB of the *rated passband output power*  $P_{\text{rated},p,TABC}$ , declared by the manufacturer.

In extreme conditions, the measured output power,  $P_{\max,p,TABC}$  shall remain within +2.5 dB and -2.5 dB of the *rated passband output power*  $P_{\text{rated},p,TABC}$ , declared by the manufacturer.

### 6.2.3.2 Minimum requirement for NCR-MT

#### 6.2.3.2.1 General

The NCR-MT conducted output power requirement is at *antenna connector* for *NCR-MT type 1-C*, or at *TAB connector* for *NCR-MT type 1-H*.

The *rated carrier output power* of the *NCR-MT type 1-C* shall be as specified in table 6.2.3.2.1-1.

**Table 6.2.3.2.1-1: NCR-MT type 1-C UL transmission classes rated output power limits**

| Repeater class                                                                                                   | $P_{\text{rated},c,AC}$ |
|------------------------------------------------------------------------------------------------------------------|-------------------------|
| Wide Area NCR-MT                                                                                                 | (Note)                  |
| Local Area NCR-MT                                                                                                | $\leq 24$ dBm           |
| NOTE: There is no upper limit for the $P_{\text{rated},c,AC}$ <i>rated output power</i> of the Wide Area NCR-MT. |                         |

The *rated carrier output power* of the *NCR-MT type 1-H* shall be as specified in table 6.2.3.2.1-2.

**Table 6.2.3.2.1-2: NCR-MT type 1-H UL transmission classes rated output power limits**

| Repeater class                                                                                                     | $P_{\text{rated,c,sys}}$                               | $P_{\text{rated,c,TABC}}$ |
|--------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|---------------------------|
| Wide Area NCR-MT                                                                                                   | (Note 1)                                               | (Note 1)                  |
| Local Area NCR-MT <sup>2,3</sup>                                                                                   | $\leq 24 \text{ dBm} + 10\log(N_{\text{TXU,counted}})$ | $\leq 24 \text{ dBm}$     |
| NOTE 1: There is no upper limit for the $P_{\text{rated,c,AC}}$ <i>rated output power</i> of the Wide Area NCR-MT. |                                                        |                           |
| NOTE 2: LA MT cannot exceed highest power class for that band as specified in TS 38.101-1.                         |                                                        |                           |
| NOTE 3: $N_{\text{TXU,counted}} = \min(N_{\text{TXU,active}}, 4)$                                                  |                                                        |                           |

#### 6.2.3.2.2 Minimum requirement for NCR-MT type 1-C and NCR-MT type 1-H

In normal conditions,  $P_{\text{max,c,AC}}$  shall remain within +2 dB and -2 dB of the *rated carrier output power*  $P_{\text{rated,c,AC}}$ , declared by the manufacturer.

In extreme conditions,  $P_{\text{max,c,AC}}$  shall remain within +2.5 dB and -2.5 dB of the *rated carrier output power*  $P_{\text{rated,c,AC}}$ , declared by the manufacturer.

## 6.3 Frequency stability

### 6.3.1 General

Frequency stability is the ability to maintain the same frequency on the output signal with respect to the input signal.

### 6.3.2 Minimum requirement for RF repeater

The frequency deviation of the output signal with respect to the input signal shall be no more than  $\pm 0,01$  PPM.

### 6.3.3 Minimum requirement for NCR

#### 6.3.3.1 Minimum requirement for NCR-Fwd

##### 6.3.3.1.1 Minimum requirement for NCR-Fwd type 1-C

The frequency deviation of the output signal with respect to the input signal shall be no more than  $\pm 0,01$  PPM.

##### 6.3.3.1.2 Minimum requirement for NCR-Fwd type 1-H

The frequency deviation of the output signal with respect to the input signal between corresponding input/output TAB connectors shall be no more than  $\pm 0,01$  PPM.

## 6.4 Out of band gain

### 6.4.1 General

Out of band gain refers to the gain of the repeater outside the *passband*.

The intended use of a repeater in a system is to amplify the in-band signals and not to amplify signals outside of the *passband*.

In the intended application of the repeater, the out of band gain is less than lowest expected the coupling loss to the nearest source of emissions.

## 6.4.2 Minimum requirement for RF repeater

The gain outside the *passband* shall not exceed the maximum level specified in table 6.4.2-1 or table 6.4.2-2, where:

- $f_{\text{offset\_CW}}$  is the offset between the outer channel edge frequency of the outer channel in the *passband* and a CW signal.

**Table 6.4.2-1: Out of band gain limits 1 for bands below 2496 MHz**

| Frequency offset, $f_{\text{offset\_CW}}$     | Maximum gain |
|-----------------------------------------------|--------------|
| $0,2 \leq f_{\text{offset\_CW}} < 1,0$ MHz    | 60 dB        |
| $1,0 \leq f_{\text{offset\_CW}} < 5,0$ MHz    | 45 dB        |
| $5,0 \leq f_{\text{offset\_CW}} < 10,0$ MHz   | 45 dB        |
| $10,0 \text{ MHz} \leq f_{\text{offset\_CW}}$ | 35 dB        |

**Table 6.4.2-2: Out of band gain limits 1 for bands above 2496 MHz**

| Frequency offset, $f_{\text{offset\_CW}}$  | Maximum gain |
|--------------------------------------------|--------------|
| $[0,2] < f_{\text{offset\_CW}} < 4,0$ MHz  | 60 dB        |
| $4,0 < f_{\text{offset\_CW}} < 15,0$ MHz   | 45 dB        |
| $15,0 \text{ MHz} < f_{\text{offset\_CW}}$ | 35 dB        |

## 6.4.3 Minimum requirement for NCR

### 6.4.3.1 Minimum requirement for NCR-Fwd

#### 6.4.3.1.1 Minimum requirement for NCR-Fwd type 1-C

The gain between the input antenna connector and output antenna connector outside the *passband* shall not exceed the maximum level specified in table 6.4.2-1 or table 6.4.2-2

#### 6.4.3.1.2 Minimum requirement for NCR-Fwd type 1-H

The gain defined between corresponding input/output TAB connectors outside the *passband* shall not exceed the maximum level specified in table 6.4.2-1 or table 6.4.2-2.

## 6.5 Unwanted emissions

### 6.5.1 General

Unwanted emissions consist of out-of-band emissions and spurious emissions according to ITU definitions [5]. In ITU terminology, out of band emissions are unwanted emissions immediately outside the channel bandwidth resulting from the modulation process and non-linearity in the transmitter but excluding spurious emissions. Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emission, intermodulation products and frequency conversion products, but exclude out of band emissions.

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

The maximum offset of the *operating band* unwanted emissions mask from the *operating band* edge is  $\Delta f_{\text{OBUE}}$ . The Operating band unwanted emissions define all unwanted emissions in each supported downlink *operating band* of *repeater type 1-C* DL and uplink *operating band* of *repeater type 1-C* UL, plus the frequency ranges  $\Delta f_{\text{OBUE}}$  above and  $\Delta f_{\text{OBUE}}$  below each band. Unwanted emissions outside of this frequency range are limited by a spurious emissions requirement.

The values of  $\Delta f_{\text{OBUE}}$  are defined in tables 6.5.1-1 and 6.5.1-2 for the NR *operating bands*.

**Table 6.5.1-1: Maximum offset of OBUE outside the downlink *operating band* of repeater type 1-C, NCR-Fwd type 1-C and NCR-Fwd type 1-H DL**

| Repeater or NCR type                   | Operating band characteristics                                                     | $\Delta f_{\text{OBUE}}$ (MHz) |
|----------------------------------------|------------------------------------------------------------------------------------|--------------------------------|
| NCR-Fwd type 1-H                       | $F_{\text{DL,high}} - F_{\text{DL,low}} < 100 \text{ MHz}$                         | 10                             |
|                                        | $100 \text{ MHz} \leq F_{\text{DL,high}} - F_{\text{DL,low}} \leq 900 \text{ MHz}$ | 40                             |
|                                        |                                                                                    |                                |
| Repeater type 1-C and NCR-Fwd type 1-C | $F_{\text{DL,high}} - F_{\text{DL,low}} \leq 200 \text{ MHz}$                      | 10                             |
|                                        | $200 \text{ MHz} < F_{\text{DL,high}} - F_{\text{DL,low}} \leq 900 \text{ MHz}$    | 40                             |

**Table 6.5.1-2: Maximum offset of OBUE outside the uplink *operating band* of repeater 1-C UL**

| Repeater or NCR type                   | Operating band characteristics                                                     | $\Delta f_{\text{OBUE}}$ (MHz) |
|----------------------------------------|------------------------------------------------------------------------------------|--------------------------------|
| NCR-Fwd type 1-H                       | $F_{\text{DL,high}} - F_{\text{DL,low}} < 100 \text{ MHz}$                         | 10                             |
|                                        | $100 \text{ MHz} \leq F_{\text{DL,high}} - F_{\text{DL,low}} \leq 900 \text{ MHz}$ | 40                             |
|                                        |                                                                                    |                                |
| Repeater type 1-C and NCR-Fwd type 1-C | $F_{\text{DL,high}} - F_{\text{DL,low}} \leq 200 \text{ MHz}$                      | 10                             |
|                                        | $200 \text{ MHz} < F_{\text{DL,high}} - F_{\text{DL,low}} \leq 900 \text{ MHz}$    | 40                             |

For *NCR-Fwd type 1-H* the unwanted emission requirements are applied per the *TAB connector TX min cell groups* for all the configurations supported by the repeater. The *basic limits* and corresponding emissions scaling are defined in each relevant clause.

There is no co-location unwanted emission requirement for LA NCR-Fwd type 1-C and repeaters type 1-C deployed in Femto cell scenario.

## 6.5.2 Adjacent Channel Leakage Power Ratio

### 6.5.2.1 General

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

The requirements shall apply outside the *repeater type 1-C passband* whatever the type of transmitter considered (single carrier or multi-carrier) and for all transmission modes foreseen by the manufacturer's specification.

For a *repeater* operating in *non-contiguous spectrum*, the ACLR requirement in clause 6.5.2.2 shall apply in *Gaps between passbands* for the frequency ranges defined in table 6.5.2.2-3, while the CACLR requirement in clause 6.5.2.2 shall apply in *gaps between passbands* for the frequency ranges defined in table 6.5.2.2-4.

For a *multi-band connector*, the ACLR requirement in clause 6.5.2.2 shall apply in *inter-passband gaps* for the frequency ranges defined in table 6.5.2.2-3, while the CACLR requirement in clause 6.5.2.2 shall apply in *inter-passband gaps* for the frequency ranges defined in table 6.5.2.2-4.

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

### 6.5.2.2 Limits and *basic limits*

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

For DL (all repeater classes), and for UL for WA class, either the ACLR (CACLR) absolute *basic limits* in table 6.5.2.2-2, 6.5.2.2-5 or else the relevant the ACLR (CACLR) *limits* in table 6.5.2.2-1, 6.5.2.2-3 or 6.5.2.2-4, whichever is less stringent, shall apply for each *antenna connector*. For UL for LA class, the ACLR (CACLR) and *basic limits* in table 6.5.2.2-1a, 6.5.2.2-3 or 6.5.2.2-4a shall apply.

**Table 6.5.2.2-1: ACLR limit for DL (all repeater classes) and for UL for Wide Area class**

| nominal channel bandwidth $BW_{\text{Nominal}}$ (MHz) (NOTE 5)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Repeater type 1-C adjacent channel centre frequency offset below or above the passband edge | Assumed adjacent channel carrier (informative) | Filter on the adjacent channel frequency and corresponding filter bandwidth | ACLR limit              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|------------------------------------------------|-----------------------------------------------------------------------------|-------------------------|
| 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | $BW_{\text{Nominal}}/2$                                                                     | NR of same BW (Note 2)                         | Square ( $BW_{\text{Config}}$ )                                             | 45 dB<br>38 dB (Note 4) |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | $1.5 \times BW_{\text{Nominal}}$                                                            | NR of same BW (Note 2)                         | Square ( $BW_{\text{Config}}$ )                                             | 45 dB<br>38 dB (Note 4) |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 2.5 MHz                                                                                     | 5 MHz E-UTRA                                   | Square (4.5 MHz)                                                            | 45 dB (Note 3)          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 7.5 MHz                                                                                     | 5 MHz E-UTRA                                   | Square (4.5 MHz)                                                            | 45 dB (Note 3)          |
| <p>NOTE 1: <math>BW_{\text{Nominal}}</math> is the <i>nominal channel bandwidth</i>. <math>BW_{\text{Config}}</math> is the <i>transmission bandwidth configuration</i> assumed for the adjacent channel.</p> <p>NOTE 2: With SCS that provides largest <i>transmission bandwidth configuration</i> (<math>BW_{\text{Config}}</math>).</p> <p>NOTE 3: The requirements are applicable when the band is also defined for E-UTRA or UTRA.</p> <p>NOTE 4: For repeater operating in band n104, ACLR requirement 38 dB applies. For repeater operating in other bands, ACLR requirement 45 dB applies.</p> <p>NOTE 5: For simultaneous NCR-Fwd and NCR-MT transmission, if the NCR-MT carrier is within the passband then the nominal channel bandwidth shall be calculated based on the the bandwidth between the lower edge of the passband and the lower edge of the NCR-MT carrier for lower side, or between the upper edge of the passband and the upper edge of the NCR-MT carrier for upper side. If the NCT-MT carrier is adjacent to the passband then ACLR requirement for NCR-MT based on NCR-MT channel bandwidth shall be applied for the NCR-MT carrier side and the nominal channel bandwidth calculated with the passband bandwidth shall be used for the passband side. If the NCR-MT carrier is not adjacent to the passband then CACLR shall be applied in the gap between the passband and the NCR-MT carrier.</p> |                                                                                             |                                                |                                                                             |                         |

Table 6.5.2.2-1a: ACLR limit for UL for Local Area

| nominal channel bandwidth $BW_{\text{Nominal}}$ (MHz) (NOTE 4)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Repeater type 1-C adjacent channel centre frequency offset below or above the passband edge | Assumed adjacent channel carrier (informative) | Filter on the adjacent channel frequency and corresponding filter bandwidth | ACLR limit |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|------------------------------------------------|-----------------------------------------------------------------------------|------------|
| 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | $BW_{\text{Nominal}}/2$                                                                     | NR of same BW (Note 2)                         | Square ( $BW_{\text{Config}}$ )                                             | 31 dB      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | $1.5 \times BW_{\text{Nominal}}$                                                            | NR of same BW (Note 2)                         | Square ( $BW_{\text{Config}}$ )                                             | 31 dB      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 2.5 MHz                                                                                     | 5 MHz E-UTRA                                   | Square (4.5 MHz)                                                            | 31 dB      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 7.5 MHz                                                                                     | 5 MHz E-UTRA                                   | Square (4.5 MHz)                                                            | 31 dB      |
| <p>NOTE 1: <math>BW_{\text{Nominal}}</math> is the <i>nominal channel bandwidth</i>. <math>BW_{\text{Config}}</math> is the <i>transmission bandwidth configuration</i> assumed for the adjacent channel.</p> <p>NOTE 2: With SCS that provides the largest <i>transmission bandwidth configuration</i> (<math>BW_{\text{Config}}</math>).</p> <p>NOTE 3: The requirements are applicable when the band is also defined for E-UTRA or UTRA.</p> <p>NOTE 4: For simultaneous NCR-Fwd and NCR-MT transmission, if the NCR-MT carrier is within the passband then the nominal channel bandwidth shall be calculated based on the the bandwidth between the lower edge of the passband and the lower edge of the NCR-MT carrier for lower side, or between the upper edge of the passband and the upper edge of the NCR-MT carrier for upper side. If the NCT-MT carrier is adjacent to the passband then ACLR requirement for NCR-MT based on NCR-MT channel bandwidth shall be applied for the NCR-MT carrier side and the nominal channel bandwidth calculated with the passband bandwidth shall be used for the passband side. If the NCR-MT carrier is not adjacent to the passband then CACLR shall be applied in the gap between the passband and the NCR-MT carrier.</p> |                                                                                             |                                                |                                                                             |            |

The ACLR absolute *basic limit* is specified in table 6.5.2.2-2 and is applicable for both contiguous spectrum, non-contiguous spectrum and multiple bands

Table 6.5.2.2-2: ACLR absolute *basic* limits for DL and UL for WA class, for DL for MR class and for DL for LA class

| Repeater category / class      | ACLR absolute basic limit |
|--------------------------------|---------------------------|
| Category A Wide Area DL and UL | -13 dBm/MHz               |
| Category B Wide Area DL and UL | -15 dBm/MHz               |
| Medium Range DL                | -25 dBm/MHz               |
| Local Area DL                  | -32 dBm/MHz               |

**Table 6.5.2.2-3: ACLR limit in non-contiguous spectrum or multiple bands for DL (all repeater classes) and for UL for Wide Area class**

| nominal channel bandwidth<br>$BW_{\text{Nominal}}$ (MHz)<br>(NOTE 6)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Gap between passbands or inter-passband gap size ( $W_{\text{gap}}$ ) where the limit applies (MHz) | Repeater type 1-C adjacent channel centre frequency offset below or above the passband edge (inside the gap) | Assumed adjacent channel carrier | Filter on the adjacent channel frequency and corresponding filter bandwidth | ACLR limit              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------------|-------------------------|
| 5, 10, 15, 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | $W_{\text{gap}} \geq 15$ (Note 3)<br>$W_{\text{gap}} \geq 45$ (Note 4)                              | 2.5 MHz                                                                                                      | 5 MHz NR (Note 2)                | Square ( $BW_{\text{Config}}$ )                                             | 45 dB<br>38 dB (Note 5) |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | $W_{\text{gap}} \geq 20$ (Note 3)<br>$W_{\text{gap}} \geq 50$ (Note 4)                              | 7.5 MHz                                                                                                      | 5 MHz NR (Note 2)                | Square ( $BW_{\text{Config}}$ )                                             | 45 dB<br>38 dB (Note 5) |
| 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | $W_{\text{gap}} \geq 60$ (Note 4)<br>$W_{\text{gap}} \geq 30$ (Note 3)                              | 10 MHz                                                                                                       | 20 MHz NR (Note 2)               | Square ( $BW_{\text{Config}}$ )                                             | 45 dB<br>38 dB (Note 5) |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | $W_{\text{gap}} \geq 80$ (Note 4)<br>$W_{\text{gap}} \geq 50$ (Note 3)                              | 30 MHz                                                                                                       | 20 MHz NR (Note 2)               | Square ( $BW_{\text{Config}}$ )                                             | 45 dB<br>38 dB (Note 5) |
| <p>NOTE 1: <math>BW_{\text{Nominal}}</math> is the <i>nominal channel bandwidth</i>. <math>BW_{\text{Config}}</math> is the <i>transmission bandwidth configuration</i> assumed for the adjacent channel.</p> <p>NOTE 2: With SCS that provides the largest <i>transmission bandwidth configuration</i> (<math>BW_{\text{Config}}</math>).</p> <p>NOTE 3: Applicable in case the <i>repeater type 1-C nominal channel bandwidth</i> at the other edge of the gap is <math>\leq 20</math> MHz.</p> <p>NOTE 4: Applicable in case the <i>repeater type 1-C nominal channel bandwidth</i> at the other edge of the gap is <math>&gt; 20</math> MHz.</p> <p>NOTE 5: For repeater operating in band n104, ACLR requirement 38 dB applies. For repeater operating in other bands, ACLR requirement 45 dB applies.</p> <p>NOTE 6: For simultaneous NCR-Fwd and NCR-MT transmission, if the NCR-MT carrier is within the passband then the nominal channel bandwidth shall be calculated based on the the bandwidth between the lower edge of the passband and the lower edge of the NCR-MT carrier for lower side, or between the upper edge of the passband and the upper edge of the NCR-MT carrier for upper side. If the NCT-MT carrier is adjacent to the passband then ACLR requirement for NCR-MT based on NCR-MT channel bandwidth shall be applied for the NCR-MT carrier side and the nominal channel bandwidth calculated with the passband bandwidth shall be used for the passband side. If the NCR-MT carrier is not adjacent to the passband then CACLR shall be applied in the gap between the passband and the NCR-MT carrier.</p> |                                                                                                     |                                                                                                              |                                  |                                                                             |                         |

**Table 6.5.2.2-3a: ACLR limit in non-contiguous spectrum or multiple bands for UL for Local Area class**

| nominal channel bandwidth<br>$BW_{\text{Nominal}}$ (MHz)<br>(NOTE 5)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Sub-block or inter-passband gap size ( $W_{\text{gap}}$ ) where the limit applies (MHz) | Repeater type 1-C adjacent channel centre frequency offset below or above the passband edge (inside the gap) | Assumed adjacent channel carrier | Filter on the adjacent channel frequency and corresponding filter bandwidth | ACLR limit |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------------|------------|
| 5, 10, 15, 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | $W_{\text{gap}} \geq 15$ (Note 3)<br>$W_{\text{gap}} \geq 45$ (Note 4)                  | 2.5 MHz                                                                                                      | 5 MHz NR (Note 2)                | Square ( $BW_{\text{Config}}$ )                                             | 31 dB      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $W_{\text{gap}} \geq 20$ (Note 3)<br>$W_{\text{gap}} \geq 50$ (Note 4)                  | 7.5 MHz                                                                                                      | 5 MHz NR (Note 2)                | Square ( $BW_{\text{Config}}$ )                                             | 31 dB      |
| 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | $W_{\text{gap}} \geq 60$ (Note 4)<br>$W_{\text{gap}} \geq 30$ (Note 3)                  | 10 MHz                                                                                                       | 20 MHz NR (Note 2)               | Square ( $BW_{\text{Config}}$ )                                             | 31 dB      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $W_{\text{gap}} \geq 80$ (Note 4)<br>$W_{\text{gap}} \geq 50$ (Note 3)                  | 30 MHz                                                                                                       | 20 MHz NR (Note 2)               | Square ( $BW_{\text{Config}}$ )                                             | 31 dB      |
| <p>NOTE 1: <math>BW_{\text{Config}}</math> is the <i>transmission bandwidth configuration</i> assumed for the adjacent channel.</p> <p>NOTE 2: With SCS that provides the largest <i>transmission bandwidth configuration</i> (<math>BW_{\text{Config}}</math>).</p> <p>NOTE 3: Applicable in case the <i>repeater type 1-C nominal channel bandwidth</i> at the other edge of the gap is <math>\leq 20</math> MHz.</p> <p>NOTE 4: Applicable in case the <i>repeater type 1-C nominal channel bandwidth</i> at the other edge of the gap is <math>&gt; 20</math> MHz.</p> <p>NOTE 5: For simultaneous NCR-Fwd and NCR-MT transmission, if the NCR-MT carrier is within the passband then the nominal channel bandwidth shall be calculated based on the the bandwidth between the lower edge of the passband and the lower edge of the NCR-MT carrier for lower side, or between the upper edge of the passband and the upper edge of the NCR-MT carrier for upper side. If the NCT-MT carrier is adjacent to the passband then ACLR requirement for NCR-MT based on NCR-MT channel bandwidth shall be applied for the NCR-MT carrier side and the nominal channel bandwidth calculated with the passband bandwidth shall be used for the passband side. If the NCR-MT carrier is not adjacent to the passband then CACLR shall be applied in the gap between the passband and the NCR-MT carrier.</p> |                                                                                         |                                                                                                              |                                  |                                                                             |            |

The Cumulative Adjacent Channel Leakage power Ratio (CACLR) in a *gap between passbands* or the *inter-passband gap* is the ratio of:

- the sum of the filtered mean power centred on the assigned channel frequencies for the two carriers adjacent to each side of the *gap between passbands* or the *inter-passband gap*, and
- the filtered mean power centred on a frequency channel adjacent to one of the respective *repeater type 1-C passband edges*.

The assumed filter for the adjacent channel frequency is defined in table 6.5.3.2-4 and the filters on the assigned channels are defined in table 6.5.2.2-6.

CACLR shall also be applied in case NCR-Fwd and NCR-MT transmit simultaneously in uplink and the NCR-Fwd passband and NCR-MT carrier are not contiguous. In this case, the gap between the NCR-Fwd passband and the NCR-MT carrier shall be considered in the same manner as a *gap between passbands*.

For operation in *non-contiguous spectrum* or multiple bands, the CACLR for NR carriers located on either side of the *gap between passbands* or the *inter-passband gap* shall be higher than the value specified in table 6.5.2.2-4.

Table 6.5.2.2-4: CACLR limit for DL (all repeater classes) and for UL for Wide Area class

| nominal channel bandwidth<br>$BW_{\text{Nominal}}$<br>(MHz)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Gap between passbands or inter-passband gap size ( $W_{\text{gap}}$ ) where the limit applies (MHz) | adjacent channel centre frequency offset below or above the passband edge (inside the gap) | Assumed adjacent channel carrier | Filter on the adjacent channel frequency and corresponding filter bandwidth | CACLR limit             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------------|-------------------------|
| 5, 10, 15, 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | $5 \leq W_{\text{gap}} < 15$ (Note 3)<br>$5 \leq W_{\text{gap}} < 45$ (Note 4)                      | 2.5 MHz                                                                                    | 5 MHz NR (Note 2)                | Square ( $BW_{\text{Config}}$ )                                             | 45 dB<br>38 dB (Note 5) |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | $10 < W_{\text{gap}} < 20$ (Note 3)<br>$10 \leq W_{\text{gap}} < 50$ (Note 4)                       | 7.5 MHz                                                                                    | 5 MHz NR (Note 2)                | Square ( $BW_{\text{Config}}$ )                                             | 45 dB<br>38 dB (Note 5) |
| 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | $20 \leq W_{\text{gap}} < 60$ (Note 4)<br>$20 \leq W_{\text{gap}} < 30$ (Note 3)                    | 10 MHz                                                                                     | 20 MHz NR (Note 2)               | Square ( $BW_{\text{Config}}$ )                                             | 45 dB<br>38 dB (Note 5) |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | $40 < W_{\text{gap}} < 80$ (Note 4)<br>$40 \leq W_{\text{gap}} < 50$ (Note 3)                       | 30 MHz                                                                                     | 20 MHz NR (Note 2)               | Square ( $BW_{\text{Config}}$ )                                             | 45 dB<br>38 dB (Note 5) |
| NOTE 1: $BW_{\text{Config}}$ is the <i>transmission bandwidth configuration</i> assumed for the adjacent channel.<br>NOTE 2: With SCS that provides the largest <i>transmission bandwidth configuration</i> ( $BW_{\text{Config}}$ ).<br>NOTE 3: Applicable in case the <i>nominal channel bandwidth</i> at the other edge of the gap is $\leq 20$ MHz.<br>NOTE 4: Applicable in case the <i>nominal channel bandwidth</i> at the other edge of the gap is $> 20$ MHz.<br>NOTE 5: For repeater operating in band n104, ACLR requirement 38 dB applies. For repeater operating in other bands, ACLR requirement 45 dB applies. |                                                                                                     |                                                                                            |                                  |                                                                             |                         |

The CACLR shall be higher than the value specified in table 6.5.2.2-4a for UL Local Area.

Table 6.5.2.2-4a: CACLR limit for UL for Local Area

| nominal channel bandwidth<br>$BW_{\text{Nominal}}$<br>(MHz)                                                                                                                                                                                                                                                                                                                                                                                                            | Gap between passbands or inter-passband gap size ( $W_{\text{gap}}$ ) where the limit applies (MHz) | adjacent channel centre frequency offset below or above the passband edge (inside the gap) | Assumed adjacent channel carrier | Filter on the adjacent channel frequency and corresponding filter bandwidth | CACLR limit |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------------|-------------|
| 5, 10, 15, 20                                                                                                                                                                                                                                                                                                                                                                                                                                                          | $5 \leq W_{\text{gap}} < 15$ (Note 3)<br>$5 \leq W_{\text{gap}} < 45$ (Note 4)                      | 2.5 MHz                                                                                    | 5 MHz NR (Note 2)                | Square ( $BW_{\text{Config}}$ )                                             | 31 dB       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | $10 < W_{\text{gap}} < 20$ (Note 3)<br>$10 \leq W_{\text{gap}} < 50$ (Note 4)                       | 7.5 MHz                                                                                    | 5 MHz NR (Note 2)                | Square ( $BW_{\text{Config}}$ )                                             | 31 dB       |
| 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100                                                                                                                                                                                                                                                                                                                                                                                                                            | $20 \leq W_{\text{gap}} < 60$ (Note 4)<br>$20 \leq W_{\text{gap}} < 30$ (Note 3)                    | 10 MHz                                                                                     | 20 MHz NR (Note 2)               | Square ( $BW_{\text{Config}}$ )                                             | 31 dB       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | $40 < W_{\text{gap}} < 80$ (Note 4)<br>$40 \leq W_{\text{gap}} < 50$ (Note 3)                       | 30 MHz                                                                                     | 20 MHz NR (Note 2)               | Square ( $BW_{\text{Config}}$ )                                             | 31 dB       |
| NOTE 1: $BW_{\text{Config}}$ is the <i>transmission bandwidth configuration</i> assumed for the adjacent channel.<br>NOTE 2: With SCS that provides the largest <i>transmission bandwidth configuration</i> ( $BW_{\text{Config}}$ ).<br>NOTE 3: Applicable in case the <i>nominal channel bandwidth</i> at the other edge of the gap is $\leq 20$ MHz.<br>NOTE 4: Applicable in case the <i>nominal channel bandwidth</i> at the other edge of the gap is $> 20$ MHz. |                                                                                                     |                                                                                            |                                  |                                                                             |             |

The CACLR absolute *minimum requirement* is specified in table 6.5.2.2-5.

**Table 6.5.2.2-5: CACLR absolute basic *limit* for DL and UL for WA class, for DL for MR class and for DL for LA class**

| <b>Repeater category / class</b> | <b>CACLR absolute basic <i>limit</i></b> |
|----------------------------------|------------------------------------------|
| Category A Wide Area DL and UL   | -13 dBm/MHz                              |
| Category B Wide Area DL and UL   | -15 dBm/MHz                              |
| Medium Range DL                  | -25 dBm/MHz                              |
| Local Area DL                    | -32 dBm/MHz                              |

**Table 6.5.2.2-6: Filter parameters for the assigned channel**

| <b>RAT of the carrier adjacent to the gap between passbands or inter-passband gap</b> | <b>Filter on the assigned channel frequency and corresponding filter bandwidth</b>       |
|---------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| NR                                                                                    | NR of same BW with SCS that provides largest <i>transmission bandwidth configuration</i> |

### 6.5.2.3 Minimum requirement for *RF repeater*

The ACLR (CACLR) absolute *basic limits* or the ACLR (CACLR) *limits*, whichever is less stringent, shall apply for each *antenna connector*.

For Band n41 and n90 operation in Japan, absolute ACLR limits shall be applied to the sum of the absolute ACLR power over all *antenna connectors* for *repeater type 1-C*.

### 6.5.2.4 Minimum requirement for *NCR*

#### 6.5.2.4.1 Minimum requirements for NCR-Fwd

##### 6.5.2.4.1.1 Minimum requirements for NCR-Fwd type 1-C

The ACLR (CACLR) absolute *basic limits* or the ACLR (CACLR) *limits*, whichever is less stringent, shall apply for each *antenna connector*.

For Band n41 and n90 operation in Japan, absolute ACLR limits shall be applied to the sum of the absolute ACLR power over all *antenna connectors* for *NCR-Fwd type 1-C*.

##### 6.5.2.4.1.2 Minimum requirement for *NCR-Fwd type 1-H*

The ACLR (CACLR) absolute *basic limits* + X (where  $X = 10\log_{10}(N_{\text{TXU, counted per cell}})$  for DL and for WA UL and  $X=0$  for LA UL) or the ACLR (CACLR) *limits*, whichever is less stringent, shall apply for each *TAB connector TX min cell group*. For joint transmission of NCR-Fwd and NCR-MT in uplink, the limits shall apply to the sum of emissions from both NCR-Fwd and NCR-MT.

NOTE: Conformance to the *NCR-Fwd type 1-H* ACLR requirement can be demonstrated by meeting at least one of the following criteria as determined by the manufacturer:

- 1) The ratio of the sum of the filtered mean power measured on each *TAB connector* in the *TAB connector TX min cell group* at the assigned channel frequency to the sum of the filtered mean power measured on each *TAB connector* in the *TAB connector TX min cell group* at the adjacent channel frequency shall be greater than or equal to the ACLR *basic limit* of the NCR-Fwd. This shall apply for each *TAB connector TX min cell group*.

Or

- 2) The ratio of the filtered mean power at the *TAB connector* centred on the assigned channel frequency to the filtered mean power at this *TAB connector* centred on the adjacent channel frequency shall be greater than or equal to the ACLR *basic limit* of the NCR-Fwd for every *TAB connector* in the *TAB connector TX min cell group*, for each *TAB connector TX min cell group*.

In case the ACLR (CACLR) absolute *basic limit* of NCR-Fwd type 1-H are applied, the conformance can be demonstrated by meeting at least one of the following criteria as determined by the manufacturer:

- 1) The sum of the filtered mean power measured on each TAB connector in the TAB connector TX min cell group at the adjacent channel frequency shall be less than or equal to the ACLR (CACLR) absolute *basic limit* + X of the NCR-Fwd. This shall apply to each TAB connector TX min cell group.

Or

- 2) The filtered mean power at each TAB connector centred on the adjacent channel frequency shall be less than or equal to the ACLR (CACLR) absolute *basic limit* + X of the NCR-Fwd scaled by  $X - 10\log_{10}(n)$  for every TAB connector in the TAB connector TX min cell group, for each TAB connector TX min cell group, where  $n$  is the number of TAB connectors in the TAB connector TX min cell group.

#### 6.5.2.4.2 Minimum requirement for NCR-MT

##### 6.5.2.4.2.1 Minimum requirements for NCR-MT type 1-C

For WA NCR-MT type 1-C, the BS ACLR basic requirements specified in clause 6.6.3 and 6.6.4 in TS 38.104 apply.

For LA NCR-MT type 1-C, the UE ACLR requirements specified in clause 6.5.2.5 in TS 38.101-1 apply.

For simultaneous transmission the limits apply for sum of NCR-MT transmission and NCR-Fwd transmission

##### 6.5.2.4.2.2 Minimum requirements for NCR-MT type 1-H

Limits for NCR-MT type 1-H apply to the sum of emissions across all TAB connectors.

For WA NCR-MT type 1-H, the repeater relative ACLR requirements specified in clause 6.6.3 and 6.6.4 in TS 38.104 apply. For Absolute ACLR requirements, the following scaling factor should be added on top of NCR-MT type 1-C basic limit requirements.

$$10\log(N_{\text{TXU,counted}}), \text{ where } N_{\text{TXU,counted}} = \min(N_{\text{TXU,active}}, 8)$$

For LA NCR-MT type 1-H, the UE ACLR requirements specified in clause 6.5.2.5 in TS 38.101-1 apply.

For simultaneous transmission the limits apply for sum of NCR-MT transmission and NCR-Fwd transmission.

### 6.5.3 Operating band unwanted emissions

#### 6.5.3.1 General

Unless otherwise stated, the operating band unwanted emission (OBUE) *basic limits* for DL are defined from  $\Delta f_{\text{OBUE}}$  below the lowest frequency of each supported downlink *operating band* up to  $\Delta f_{\text{OBUE}}$  above the highest frequency of each supported downlink *operating band*. The values of  $\Delta f_{\text{OBUE}}$  are defined in table 6.5.1-1 for the NR *operating bands*.

Unless otherwise stated, the operating band unwanted emission (OBUE) *basic limits* for UL are defined from  $\Delta f_{\text{OBUE}}$  below the lowest frequency of each supported uplink *operating band* up to  $\Delta f_{\text{OBUE}}$  above the highest frequency of each supported uplink *operating band*. The values of  $\Delta f_{\text{OBUE}}$  are defined in table 6.5.1-2 for the NR *operating bands*.

The requirements shall apply whatever the type of transmitter considered and for all transmission modes foreseen by the manufacturer's specification. In addition, for *repeater* operating in *non-contiguous spectrum*, the *basic limits* apply inside any *gap between passbands*. In addition, for a *repeater* operating in multiple bands, the *basic limits* apply inside any *inter-passband gap*.

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

- $\Delta f$  is the separation between the *passband edge* frequency and the nominal -3dB point of the measuring filter closest to the carrier frequency.
- $f_{\text{offset}}$  is the separation between the *passband edge* frequency and the centre of the measuring filter.

- $f_{\text{offset}_{\text{max}}}$  is the offset to the frequency  $\Delta f_{\text{OBUE}}$  outside the downlink *operating band* of *repeater type 1-C DL* and uplink *operating band* of *repeater type 1-C UL*, where  $\Delta f_{\text{OBUE}}$  is defined in tables 6.5.1-1 and 6.5.1-2.
- $\Delta f_{\text{max}}$  is equal to  $f_{\text{offset}_{\text{max}}}$  minus half of the bandwidth of the measuring filter.

For a *multi-band connector* of UL, the operating band unwanted emission basic limits apply also in a supported uplink *operating band* without any carrier transmitted, in the case where there are carrier(s) transmitted in another supported uplink *operating band*. In this case, no cumulative *basic limit* is applied in the *inter-band gap* between a supported uplink *operating band* with carrier(s) transmitted and a supported uplink *operating band* without any carrier transmitted and

- $\Delta f$  is the separation between the *repeater type 1-C passband edge* frequency and the nominal -3 dB point of the measuring filter closest to the *repeater type 1-C passband edge*.
- $f_{\text{offset}}$  is the separation from the *repeater type 1-C passband edge* frequency to the centre of the measuring filter.
- $f_{\text{offset}_{\text{max}}}$  is equal to the *inter-passband gap* minus half of the bandwidth of the measuring filter.
- $\Delta f_{\text{max}}$  is equal to  $f_{\text{offset}_{\text{max}}}$  minus half of the bandwidth of the measuring filter.

For a *multi-band connector* of DL, the operating band unwanted emission basic limits apply also in a supported downlink *operating band* without any carrier transmitted, in the case where there are carrier(s) transmitted in another supported downlink *operating band*. In this case, no cumulative *basic limit* is applied in the *inter-band gap* between a supported downlink *operating band* with carrier(s) transmitted and a supported downlink *operating band* without any carrier transmitted and

- In case the *inter-band gap* between a supported downlink *operating band* with carrier(s) transmitted and a supported downlink *operating band* without any carrier transmitted is less than  $2 \cdot \Delta f_{\text{OBUE}}$ ,  $f_{\text{offset}_{\text{max}}}$  shall be the offset to the frequency  $\Delta f_{\text{OBUE}}$  MHz outside the outermost edges of the two supported downlink *operating bands* and the operating band unwanted emission minimum requirement of the band where there are carriers transmitted, as defined in the tables of the present clause, shall apply across both downlink bands.
- In other cases, the operating band unwanted emission *basic limit* of the band where there are carriers transmitted, as defined in the tables of the present clause for the largest frequency offset ( $\Delta f_{\text{max}}$ ), shall apply from  $\Delta f_{\text{OBUE}}$  MHz below the lowest frequency, up to  $\Delta f_{\text{OBUE}}$  MHz above the highest frequency of the supported downlink *operating band* without any carrier transmitted.

For a *multi-band connector* of UL, the operating band unwanted emission limits apply also in a supported uplink *operating band* without any carrier transmitted, in the case where there are carrier(s) transmitted in another supported uplink *operating band*. In this case, no cumulative *basic limit* is applied in the *inter-band gap* between a supported uplink *operating band* with carrier(s) transmitted and a supported uplink *operating band* without any carrier transmitted and

- In case the *inter-band gap* between a supported uplink *operating band* with carrier(s) transmitted and a supported uplink *operating band* without any carrier transmitted is less than  $2 \cdot \Delta f_{\text{OBUE}}$ ,  $f_{\text{offset}_{\text{max}}}$  shall be the offset to the frequency  $\Delta f_{\text{OBUE}}$  MHz outside the outermost edges of the two supported uplink *operating bands* and the operating band unwanted emission *basic limit* of the band where there are carriers transmitted, as defined in the tables of the present clause, shall apply across both uplink bands.
- In other cases, the operating band unwanted emission basic limits of the band where there are carriers transmitted, as defined in the tables of the present clause for the largest frequency offset ( $\Delta f_{\text{max}}$ ), shall apply from  $\Delta f_{\text{OBUE}}$  MHz below the lowest frequency, up to  $\Delta f_{\text{OBUE}}$  MHz above the highest frequency of the supported uplink *operating band* without any carrier transmitted.

In addition, inside any *gap between passbands* for a *single-band connector* operating in *non-contiguous spectrum*, a combined basic limit shall be applied which is the cumulative sum of the basic limit specified for the adjacent *sub-blocks* on each side of the *gap between passbands*. The basic limit for each *sub-block* is specified in clauses 6.5.3.2.1 to 6.5.3.2.4 below, where in this case:

- $\Delta f$  is the separation between the *sub-block edge* frequency and the nominal -3 dB point of the measuring filter closest to the *sub-block edge*.
- $f_{\text{offset}}$  is the separation between the *sub-block edge* frequency and the centre of the measuring filter.

- $f_{\text{offset}_{\text{max}}}$  is equal to the *gap between passbands* bandwidth minus half of the bandwidth of the measuring filter.
- $\Delta f_{\text{max}}$  is equal to  $f_{\text{offset}_{\text{max}}}$  minus half of the bandwidth of the measuring filter.

For Wide Area *repeater type 1-C*, the basic limits of either clause 6.5.3.2.1 (Category A limits) or clause 6.5.3.2.2 (Category B limits) shall apply.

For Medium Range *repeater type 1-C*, the basic limits in clause 6.5.3.2.3 shall apply (Category A and B).

For Local Area *repeater type 1-C*, the basic limits of clause 6.5.3.2.4 shall apply (Category A and B).

The application of either Category A or Category B basic limits shall be the same as for Transmitter spurious emissions in clause 6.5.4.

In addition to, for the part of passband where there is no input signal at DL input port, the basic limits in Table 6.5.2.2-2 shall apply. In addition to, for the part of passband where there is no input signal at UL input port, the basic limits in clause 6.5.3.2.6 shall apply.

## 6.5.3.2 Basic limits

### 6.5.3.2.1 basic limits for Wide Area repeater type 1-C (Category A)

For repeater operating in Bands n5, n8, n12, n13, n14, n18, n26, n28, n29, n31, n68, n71, n72, n85, n87, n88, basic limits are specified in table 6.5.3.2.1-1.

**Table 6.5.3.2.1-1: Wide Area operating band unwanted emission basic limits (NR bands below 1 GHz) for Category A**

| Frequency offset of measurement filter -3dB point, $\Delta f$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                        | Basic limits (Notes 1, 2)                                                                                  | Measurement bandwidth |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 5 \text{ MHz}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | $0.05 \text{ MHz} \leq f_{\text{offset}} < 5.05 \text{ MHz}$                                        | $-7 \text{ dBm} - \frac{7}{5} \cdot \left( \frac{f_{\text{offset}}}{\text{MHz}} - 0.05 \right) \text{ dB}$ | 100 kHz               |
| $5 \text{ MHz} \leq \Delta f < \min(10 \text{ MHz}, \Delta f_{\text{max}})$                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | $5.05 \text{ MHz} \leq f_{\text{offset}} < \min(10.05 \text{ MHz}, f_{\text{offset}_{\text{max}}})$ | -14 dBm                                                                                                    | 100 kHz               |
| $10 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | $10.05 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$                         | -13 dBm (Note 3)                                                                                           | 100 kHz               |
| NOTE 1: For a <i>repeater</i> supporting <i>non-contiguous spectrum</i> operation within any <i>operating band</i> , the emission basic limits within <i>gaps between passbands</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i> . Exception is $\Delta f \geq 10 \text{ MHz}$ from both adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i> , where the emission limits within <i>gaps between passbands</i> shall be -13 dBm/1 MHz. |                                                                                                     |                                                                                                            |                       |
| NOTE 2: For a <i>multi-band connector</i> with <i>inter-passband gap</i> $< 2 \cdot \Delta f_{\text{OBUe}}$ the emission basic limits within the <i>inter-passband gaps</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> or <i>passband</i> on each side of the <i>inter-passband gap</i> , where the contribution from the far-end <i>sub-block</i> or <i>passband</i> shall be scaled according to the <i>measurement bandwidth</i> of the near-end <i>sub-block</i> or <i>passband</i> .                    |                                                                                                     |                                                                                                            |                       |
| NOTE 3: The basic limit is not applicable when $\Delta f_{\text{max}} < 10 \text{ MHz}$ .                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                     |                                                                                                            |                       |

For repeater operating in Bands n1, n2, n3, n7, n24, n25, n30, n34, n38, n39, n40, n41, n48, n50, n54, n65, n66, n70, n74, n75, n77, n78, n79, n90, n92, n94, n109, n110 basic limits are specified in table 6.5.3.2.1-2.

**Table 6.5.3.2.1-2: Wide Area operating band unwanted emission basic limits (NR bands above 1 GHz) for Category A**

| Frequency offset of measurement filter -3dB point, $\Delta f$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                        | Basic limit (Notes 1, 2)                                                                                   | Measurement bandwidth |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 5 \text{ MHz}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | $0.05 \text{ MHz} \leq f_{\text{offset}} < 5.05 \text{ MHz}$                                        | $-7 \text{ dBm} - \frac{7}{5} \cdot \left( \frac{f_{\text{offset}}}{\text{MHz}} - 0.05 \right) \text{ dB}$ | 100 kHz               |
| $5 \text{ MHz} \leq \Delta f < \min(10 \text{ MHz}, \Delta f_{\text{max}})$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | $5.05 \text{ MHz} \leq f_{\text{offset}} < \min(10.05 \text{ MHz}, f_{\text{offset}_{\text{max}}})$ | -14 dBm                                                                                                    | 100 kHz               |
| $10 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | $10.5 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$                          | -13 dBm (Note 3)                                                                                           | 1MHz                  |
| <p>NOTE 1: For a <i>repeater</i> supporting <i>non-contiguous spectrum</i> operation within any <i>operating band</i>, the emission basic limits within <i>gaps between passbands</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i>, where the contribution from the far-end <i>sub-block</i> shall be scaled according to the <i>measurement bandwidth</i> of the near-end <i>sub-block</i>. Exception is <math>\Delta f \geq 10 \text{ MHz}</math> from both adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i>, where the emission basic limits within <i>gaps between passbands</i> shall be -13 dBm/1 MHz.</p> <p>NOTE 2: For a <i>multi-band connector</i> with <i>inter-passband gap</i> <math>&lt; 2 \cdot \Delta f_{\text{OBU}}</math> the emission basic limits within the <i>inter-passband gaps</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> or <i>passband</i> on each side of the <i>inter-passband gap</i>, where the contribution from the far-end <i>sub-block</i> or <i>passband</i> shall be scaled according to the <i>measurement bandwidth</i> of the near-end <i>sub-block</i> or <i>passband</i>.</p> <p>NOTE 3: The basic limit is not applicable when <math>\Delta f_{\text{max}} &lt; 10 \text{ MHz}</math>.</p> |                                                                                                     |                                                                                                            |                       |

### 6.5.3.2.2 Basic limit for Wide Area repeater type 1-C (Category B)

For Category B Operating band unwanted emissions, there are two options for the *basic limits* that may be applied regionally. Either the *basic limits* in clause 6.5.3.2.2.1 or clause 6.5.3.2.2.2 shall be applied.

#### 6.5.3.2.2.1 Category B basic limits (Option 1)

For *repeater type 1-C* operating in Bands n5, n8, n12, n20, n26, n28, n29, n31, n67, n68, n71, n72, n85, n87, n88, the basic limits are specified in table 6.5.3.2.2.1-1:

**Table 6.5.3.2.2.1-1: Wide Area operating band unwanted emission basic limits (NR bands below 1 GHz) for Category B**

| Frequency offset of measurement filter -3dB point, $\Delta f$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                        | Basic limit (Notes 1, 2)                                                                                   | Measurement bandwidth |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 5 \text{ MHz}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | $0.05 \text{ MHz} \leq f_{\text{offset}} < 5.05 \text{ MHz}$                                        | $-7 \text{ dBm} - \frac{7}{5} \cdot \left( \frac{f_{\text{offset}}}{\text{MHz}} - 0.05 \right) \text{ dB}$ | 100 kHz               |
| $5 \text{ MHz} \leq \Delta f < \min(10 \text{ MHz}, \Delta f_{\text{max}})$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $5.05 \text{ MHz} \leq f_{\text{offset}} < \min(10.05 \text{ MHz}, f_{\text{offset}_{\text{max}}})$ | -14 dBm                                                                                                    | 100 kHz               |
| $10 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | $10.05 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$                         | -16 dBm (Note 3)                                                                                           | 100 kHz               |
| <p>NOTE 1: For a <i>repeater</i> supporting <i>non-contiguous spectrum</i> operation within any <i>operating band</i>, the emission basic limits within <i>gaps between passbands</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i>. Exception is <math>\Delta f \geq 10 \text{ MHz}</math> from both adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i>, where the emission basic limits within <i>gaps between passbands</i> shall be -15 dBm/1 MHz.</p> <p>NOTE 2: For a <i>multi-band connector</i> with <i>inter-passband gap</i> <math>&lt; 2 \cdot \Delta f_{\text{OBU}}</math> the emission basic limits within the <i>inter-passband gaps</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> or <i>passband</i> on each side of the <i>inter-passband gap</i>.</p> <p>NOTE 3: The <i>basic limit</i> is not applicable when <math>\Delta f_{\text{max}} &lt; 10 \text{ MHz}</math>.</p> |                                                                                                     |                                                                                                            |                       |

For *repeater* operating in Bands n1, n2, n3, n7, n25, n34, n38, n39, n40, n41, n48, n50, n65, n66, n70, n75, n77, n78, n79, n90, n92, n94, n109 basic limits are specified in table 6.5.3.2.2.1-2.

**Table 6.5.3.2.2.1-2: Wide Area repeater type 1-C operating band unwanted emission basic limits for Category B**

| Frequency offset of measurement filter -3dB point, $\Delta f$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                        | Basic limits (Notes 1, 2)                                                                                  | Measurement bandwidth |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 5 \text{ MHz}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $0.05 \text{ MHz} \leq f_{\text{offset}} < 5.05 \text{ MHz}$                                        | $-7 \text{ dBm} - \frac{7}{5} \cdot \left( \frac{f_{\text{offset}}}{\text{MHz}} - 0.05 \right) \text{ dB}$ | 100 kHz               |
| $5 \text{ MHz} \leq \Delta f < \min(10 \text{ MHz}, \Delta f_{\text{max}})$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | $5.05 \text{ MHz} \leq f_{\text{offset}} < \min(10.05 \text{ MHz}, f_{\text{offset}_{\text{max}}})$ | -14 dBm                                                                                                    | 100 kHz               |
| $10 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | $10.5 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$                          | -15 dBm (Note 3)                                                                                           | 1MHz                  |
| <p>NOTE 1: For a <i>repeater</i> supporting <i>non-contiguous spectrum</i> operation within any <i>operating band</i>, the emission basic limits within <i>gaps between passbands</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i>, where the contribution from the far-end <i>sub-block</i> shall be scaled according to the <i>measurement bandwidth</i> of the near-end <i>sub-block</i>. Exception is <math>\Delta f \geq 10 \text{ MHz}</math> from both adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i>, where the emission basic limits within <i>gaps between passbands</i> shall be -15 dBm/1 MHz.</p> <p>NOTE 2: For a <i>multi-band connector</i> with <i>inter-passband gap</i> <math>&lt; 2 \cdot \Delta f_{\text{OBUE}}</math> the emission basic limits within the <i>inter-passband gaps</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> or <i>passband</i> on each side of the <i>inter-passband gap</i>, where the contribution from the far-end <i>sub-block</i> or <i>passband</i> shall be scaled according to the <i>measurement bandwidth</i> of the near-end <i>sub-block</i> or <i>passband</i>.</p> <p>NOTE 3: The basic limit is not applicable when <math>\Delta f_{\text{max}} &lt; 10 \text{ MHz}</math>.</p> |                                                                                                     |                                                                                                            |                       |

For *repeater type 1-C* operating in Band n104, the *basic limits* are specified in tables 6.5.3.2.2.1-2a:

**Table 6.5.3.2.2.1-2a: Wide Area operating band unwanted emission basic limits for band n104 for Category B**

| Frequency offset of measurement filter -3dB point, $\Delta f$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                         | Basic limits                                                                                     | Measurement bandwidth |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 20 \text{ MHz}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | $0.05 \text{ MHz} \leq f_{\text{offset}} < 20.05 \text{ MHz}$                                        | $-7 \text{ dBm} - \frac{7}{20} \cdot \left( \frac{f_{\text{offset}}}{\text{MHz}} - 0.05 \right)$ | 100 kHz               |
| $20 \text{ MHz} \leq \Delta f < \min(40 \text{ MHz}, \Delta f_{\text{max}})$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | $20.05 \text{ MHz} \leq f_{\text{offset}} < \min(40.05 \text{ MHz}, f_{\text{offset}_{\text{max}}})$ | -14 dBm                                                                                          | 100 kHz               |
| $40 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | $40.5 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$                           | -15 dBm (Note 3)                                                                                 | 1MHz                  |
| <p>NOTE 1: For a <i>repeater</i> supporting <i>non-contiguous spectrum</i> operation within any <i>operating band</i>, the emission basic limits within <i>gaps between passbands</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> on each side of the <i>gap between passband</i>, where the contribution from the far-end <i>sub-block</i> shall be scaled according to the <i>measurement bandwidth</i> of the near-end <i>sub-block</i>. Exception is <math>\Delta f \geq 40 \text{ MHz}</math> from both adjacent <i>sub-blocks</i> on each side of the <i>gap between passband</i>, where the emission basic limits within <i>gaps between passbands</i> shall be -15 dBm/1 MHz.</p> <p>NOTE 2: For a <i>multi-band connector</i> with <i>inter-passband gap</i> <math>&lt; 2 \cdot \Delta f_{\text{OBUE}}</math> the emission basic limits within the <i>inter-passband gaps</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> or <i>passband</i> on each side of the <i>inter-passband gap</i>, where the contribution from the far-end <i>sub-block</i> or <i>passband</i> shall be scaled according to the <i>measurement bandwidth</i> of the near-end <i>sub-block</i> or <i>passband</i>.</p> <p>NOTE 3: The <i>basic limit</i> is not applicable when <math>\Delta f_{\text{max}} &lt; 40 \text{ MHz}</math>.</p> |                                                                                                      |                                                                                                  |                       |

## 6.5.3.2.2.2 Category B basic limits (Option 2)

The basic limits in this clause are intended for Europe and may be applied regionally for *repeater type 1-C* operating in bands n1, n3, n7, n8, n38, n65.

For a *repeater type 1-C* operating in bands n1, n3, n7, n8, n38 or n65, *basic limits* are specified in Table 6.5.3.2.2.2-1:

**Table 6.5.3.2.2-1: For a *repeater type 1-C* operating in bands n1, n3, n7, n8, n38 or n65, basic limits are specified in Table 6.5.3.2.2-1:**

| Frequency offset of measurement filter -3dB point, $\Delta f$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                      | Basic limits (Notes 1, 2)                                                                           | Measurement bandwidth |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 0.2 \text{ MHz}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | $0.015 \text{ MHz} \leq f_{\text{offset}} < 0.215 \text{ MHz}$                                    | -14 dBm                                                                                             | 30 kHz                |
| $0.2 \text{ MHz} \leq \Delta f < 1 \text{ MHz}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | $0.215 \text{ MHz} \leq f_{\text{offset}} < 1.015 \text{ MHz}$                                    | $-14 \text{ dBm} - 15 \cdot \left( \frac{f_{\text{offset}}}{\text{MHz}} - 0.215 \right) \text{ dB}$ | 30 kHz                |
| (Note 4)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | $1.015 \text{ MHz} \leq f_{\text{offset}} < 1.5 \text{ MHz}$                                      | -26 dBm                                                                                             | 30 kHz                |
| $1 \text{ MHz} \leq \Delta f \leq \min(10 \text{ MHz}, \Delta f_{\text{max}})$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | $1.5 \text{ MHz} \leq f_{\text{offset}} < \min(10.5 \text{ MHz}, f_{\text{offset}_{\text{max}}})$ | -13 dBm                                                                                             | 1 MHz                 |
| $10 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | $10.5 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$                        | -15 dBm (Note 3)                                                                                    | 1 MHz                 |
| NOTE 1: For a <i>repeater</i> supporting <i>non-contiguous spectrum</i> operation within any <i>operating band</i> , the emission basic limits within <i>gaps between passbands</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i> , where the contribution from the far-end <i>sub-block</i> shall be scaled according to the <i>measurement bandwidth</i> of the near-end <i>sub-block</i> . Exception is $\Delta f \geq 10 \text{ MHz}$ from both adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i> , where the emission basic limits within <i>gaps between passbands</i> shall be -15 dBm/1 MHz. |                                                                                                   |                                                                                                     |                       |
| NOTE 2: For a <i>multi-band connector</i> with <i>inter-passband gap</i> $< 2 \cdot \Delta f_{\text{OBUe}}$ the emission limits within the <i>inter-passband gaps</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> or <i>passband</i> on each side of the <i>inter-passband gap</i> , where the contribution from the far-end <i>sub-block</i> or <i>passband</i> shall be scaled according to the <i>measurement bandwidth</i> of the near-end <i>sub-block</i> or <i>passband</i> .                                                                                                                                                                                          |                                                                                                   |                                                                                                     |                       |
| NOTE 3: The <i>basic limit</i> is not applicable when $\Delta f_{\text{max}} < 10 \text{ MHz}$ .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                   |                                                                                                     |                       |
| NOTE 4: This frequency range ensures that the range of values of $f_{\text{offset}}$ is continuous.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                   |                                                                                                     |                       |

## 6.5.3.2.3 Basic limits for Medium Range repeater type 1-C (Category A and B) for DL

For Medium Range *repeater* for DL, *basic limits* are specified in table 6.5.3.2.3-1 and table 6.5.3.2.3-2.

For the tables in this clause for *repeater*,  $P_{\text{rated},x} = P_{\text{rated},p,AC} - 10 \cdot \log(\text{ceil}(BW_{\text{passband}}/20 \text{ MHz}))$

**Table 6.5.3.2.3-1: Medium Range *repeater operating band* unwanted emission *basic limits*,  $31 < P_{\text{rated},x} \leq 38 \text{ dBm}$**

| Frequency offset of measurement filter -3dB point, $\Delta f$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                        | Basic limits (Notes 1, 2)                                                                                                | Measurement bandwidth |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 5 \text{ MHz}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | $0.05 \text{ MHz} \leq f_{\text{offset}} < 5.05 \text{ MHz}$                                        | $P_{\text{rated},x} - 53 \text{ dB} - \frac{7}{5} \left( \frac{f_{\text{offset}}}{\text{MHz}} - 0.05 \right) \text{ dB}$ | 100 kHz               |
| $5 \text{ MHz} \leq \Delta f < \min(10 \text{ MHz}, \Delta f_{\text{max}})$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | $5.05 \text{ MHz} \leq f_{\text{offset}} < \min(10.05 \text{ MHz}, f_{\text{offset}_{\text{max}}})$ | $P_{\text{rated},x} - 60 \text{ dB}$                                                                                     | 100 kHz               |
| $10 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | $10.05 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$                         | $\text{Min}(P_{\text{rated},x} - 60 \text{ dB}, -25 \text{ dBm})$ (Note 3)                                               | 100 kHz               |
| NOTE 1: For a <i>repeater</i> DL supporting <i>non-contiguous spectrum</i> operation within any <i>operating band</i> the emission basic limits within <i>gaps between passbands</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i> . Exception is $\Delta f \geq 10 \text{ MHz}$ from both adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i> , where the emission basic limits within <i>gaps between passbands</i> shall be $\text{Min}(P_{\text{rated},x} - 60 \text{ dB}, -25 \text{ dBm})/100 \text{ kHz}$ . |                                                                                                     |                                                                                                                          |                       |
| NOTE 2: For a <i>multi-band connector</i> with <i>inter-passband gap</i> $< 2 \cdot \Delta f_{\text{OBUe}}$ the emission basic limits within the <i>inter-passband gaps</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> or <i>passband</i> on each side of the <i>inter-passband gap</i> .                                                                                                                                                                                                                                                                                                |                                                                                                     |                                                                                                                          |                       |
| NOTE 3: The <i>basic limit</i> is not applicable when $\Delta f_{\text{max}} < 10 \text{ MHz}$ .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                     |                                                                                                                          |                       |

For *repeater* operating in Band n104, the limits are specified in Table 6.5.3.2.3-1a and Table 6.5.3.2.3-2a.

**Table 6.5.3.2.3-1a. Medium Range *repeater* operating band unwanted emission *basic* limits for band n104,  $31 < P_{\text{rated},x} \leq 38$  dBm**

| Frequency offset of measurement filter -3dB point, $\Delta f$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                         | Basic limits (Notes 1, 2)                                                                                      | Measurement bandwidth |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 20 \text{ MHz}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | $0.05 \text{ MHz} \leq f_{\text{offset}} < 20.05 \text{ MHz}$                                        | $P_{\text{rated},x} - 53 \text{ dB} - \frac{7}{20} \left( \frac{f_{\text{offset}}}{\text{MHz}} - 0.05 \right)$ | 100 kHz               |
| $20 \text{ MHz} \leq \Delta f < \min(40 \text{ MHz}, \Delta f_{\text{max}})$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | $20.05 \text{ MHz} \leq f_{\text{offset}} < \min(40.05 \text{ MHz}, f_{\text{offset}_{\text{max}}})$ | $P_{\text{rated},x} - 60 \text{ dB}$                                                                           | 100 kHz               |
| $40 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | $40.05 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$                          | $\text{Min}(P_{\text{rated},x} - 60 \text{ dB}, -25 \text{ dBm})$ (Note 3)                                     | 100 kHz               |
| NOTE 1: For a <i>repeater</i> DL supporting <i>non-contiguous spectrum</i> operation within any <i>operating band</i> the emission basic limits within <i>gaps between passbands</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> on each side of the <i>gap between passband</i> . Exception is $\Delta f \geq 40 \text{ MHz}$ from both adjacent <i>sub-blocks</i> on each side of the <i>gap between passband</i> , where the emission basic limits within <i>gaps between passbands</i> shall be $\text{Min}(P_{\text{rated},x} - 60 \text{ dB}, -25 \text{ dBm})/100 \text{ kHz}$ . |                                                                                                      |                                                                                                                |                       |
| NOTE 2: For a <i>multi-band connector</i> with <i>inter-passband gap</i> $< 2 \cdot \Delta f_{\text{OBUe}}$ the emission basic limits within the <i>inter-passband gaps</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> or <i>passband</i> on each side of the <i>inter-passband gap</i> .                                                                                                                                                                                                                                                                                              |                                                                                                      |                                                                                                                |                       |
| NOTE 3: The <i>basic limit</i> is not applicable when $\Delta f_{\text{max}} < 40 \text{ MHz}$ .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                      |                                                                                                                |                       |

**Table 6.5.3.2.3-2: Medium Range *repeater* operating band unwanted emission *basic* limits,  $P_{\text{rated},x} \leq 31$  dBm**

| Frequency offset of measurement filter -3dB point, $\Delta f$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                        | Basic limits (Notes 1, 2)                                                                             | Measurement bandwidth |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 5 \text{ MHz}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | $0.05 \text{ MHz} \leq f_{\text{offset}} < 5.05 \text{ MHz}$                                        | $-22 \text{ dBm} - \frac{7}{5} \left( \frac{f_{\text{offset}}}{\text{MHz}} - 0.05 \right) \text{ dB}$ | 100 kHz               |
| $5 \text{ MHz} \leq \Delta f < \min(10 \text{ MHz}, \Delta f_{\text{max}})$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | $5.05 \text{ MHz} \leq f_{\text{offset}} < \min(10.05 \text{ MHz}, f_{\text{offset}_{\text{max}}})$ | -29 dBm                                                                                               | 100 kHz               |
| $10 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | $10.05 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$                         | -29 dBm (Note 3)                                                                                      | 100 kHz               |
| NOTE 1: For a <i>repeater</i> DL supporting <i>non-contiguous spectrum</i> operation within any <i>operating band</i> the emission basic limits within <i>gaps between passbands</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i> . Exception is $\Delta f \geq 10 \text{ MHz}$ from both adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i> , where the emission basic limits within <i>gaps between passbands</i> shall be -29 dBm/100 kHz. |                                                                                                     |                                                                                                       |                       |
| NOTE 2: For a <i>multi-band connector</i> with <i>inter-passband gap</i> $< 2 \cdot \Delta f_{\text{OBUe}}$ the emission basic limits within the <i>inter-passband gaps</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> or <i>passband</i> on each side of the <i>inter-passband gap</i> .                                                                                                                                                                                                                             |                                                                                                     |                                                                                                       |                       |
| NOTE 3: The <i>basic limit</i> is not applicable when $\Delta f_{\text{max}} < 10 \text{ MHz}$ .                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                     |                                                                                                       |                       |

**Table 6.5.3.2.3-2a. Medium Range repeater operating band unwanted emission basic limits for band 104,  $P_{\text{rated},x} \leq 31$  dBm**

| Frequency offset of measurement filter -3dB point, $\Delta f$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                         | basic limits (Notes 1, 2)                                                                   | Measurement bandwidth |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 20 \text{ MHz}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | $0.05 \text{ MHz} \leq f_{\text{offset}} < 20.05 \text{ MHz}$                                        | $-22 \text{ dBm} - \frac{7}{20} \left( \frac{f_{\text{offset}}}{\text{MHz}} - 0.05 \right)$ | 100 kHz               |
| $20 \text{ MHz} \leq \Delta f < \min(40 \text{ MHz}, \Delta f_{\text{max}})$                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | $20.05 \text{ MHz} \leq f_{\text{offset}} < \min(40.05 \text{ MHz}, f_{\text{offset}_{\text{max}}})$ | -29 dBm                                                                                     | 100 kHz               |
| $40 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | $40.05 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$                          | -29 dBm                                                                                     | 100 kHz               |
| NOTE 1: For a <i>repeater</i> DL supporting <i>non-contiguous spectrum</i> operation within any <i>operating band</i> the emission basic limits within <i>gaps between passbands</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> on each side of the <i>gap between passband</i> . Exception is $f \geq 40 \text{ MHz}$ from both adjacent <i>sub-blocks</i> on each side of the <i>gap between passband</i> , where the emission basic limits within <i>gaps between passbands</i> shall be -29dBm/100kHz. |                                                                                                      |                                                                                             |                       |
| NOTE 2: For a <i>multi-band connector</i> with <i>inter-passband gap</i> $< 2 \cdot \Delta f_{\text{OBUe}}$ the emission basic limits within the <i>inter-passband gaps</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> or <i>passband</i> on each side of the <i>inter-passband gap</i> .                                                                                                                                                                                                                  |                                                                                                      |                                                                                             |                       |
| NOTE 3: The <i>basic limit</i> is not applicable when $\Delta f_{\text{max}} < 40 \text{ MHz}$ .                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                      |                                                                                             |                       |

#### 6.5.3.2.4 Basic limits for Local Area repeater type 1-C (Category A and B)

For Local Area, *basic limits* are specified in table 6.5.3.2.4-1.

**Table 6.5.3.2.4-1: Local Area repeater operating band unwanted emission basic limits**

| Frequency offset of measurement filter -3dB point, $\Delta f$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                        | Basic limits (Notes 1, 2)                                                                             | Measurement bandwidth |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 5 \text{ MHz}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | $0.05 \text{ MHz} \leq f_{\text{offset}} < 5.05 \text{ MHz}$                                        | $-30 \text{ dBm} - \frac{7}{5} \left( \frac{f_{\text{offset}}}{\text{MHz}} - 0.05 \right) \text{ dB}$ | 100 kHz               |
| $5 \text{ MHz} \leq \Delta f < \min(10 \text{ MHz}, \Delta f_{\text{max}})$                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | $5.05 \text{ MHz} \leq f_{\text{offset}} < \min(10.05 \text{ MHz}, f_{\text{offset}_{\text{max}}})$ | -37 dBm                                                                                               | 100 kHz               |
| $10 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $10.05 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$                         | -37 dBm (Note 10)                                                                                     | 100 kHz               |
| NOTE 1: For a <i>repeater</i> supporting <i>non-contiguous spectrum</i> operation within any <i>operating band</i> the emission basic limits within <i>gaps between passbands</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i> . Exception is $f \geq 10 \text{ MHz}$ from both adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i> , where the emission basic limits within <i>gaps between passbands</i> shall be -37dBm/100kHz. |                                                                                                     |                                                                                                       |                       |
| NOTE 2: For a <i>multi-band connector</i> with <i>inter-passband gap</i> $< 2 \cdot \Delta f_{\text{OBUe}}$ the emission basic limits within the <i>inter-passband gaps</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> or <i>passband</i> on each side of the <i>inter-passband gap</i> .                                                                                                                                                                                                                 |                                                                                                     |                                                                                                       |                       |
| NOTE 3: The <i>basic limit</i> is not applicable when $\Delta f_{\text{max}} < 10 \text{ MHz}$ .                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                     |                                                                                                       |                       |

For *repeater* operating in Band n104, *basic limits* are specified in Table 6.5.3.2.4-1a.

**Table 6.5.3.2.4-1a. Local Area repeater operating band unwanted emission *basic* limits for band n104**

| Frequency offset of measurement filter -3dB point, $\Delta f$                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                         | Basic limits (Notes 1, 2)                                                                 | Measurement bandwidth |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 20 \text{ MHz}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | $0.05 \text{ MHz} \leq f_{\text{offset}} < 20.05 \text{ MHz}$                                        | $-30\text{dBm} - \frac{7}{20} \left( \frac{f_{\text{offset}}}{\text{MHz}} - 0.05 \right)$ | 100 kHz               |
| $20 \text{ MHz} \leq \Delta f < \min(40 \text{ MHz}, \Delta f_{\text{max}})$                                                                                                                                                                                                                                                                                                                                                                                                                                    | $20.05 \text{ MHz} \leq f_{\text{offset}} < \min(40.05 \text{ MHz}, f_{\text{offset}_{\text{max}}})$ | -37 dBm                                                                                   | 100 kHz               |
| $40 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$                                                                                                                                                                                                                                                                                                                                                                                                                                                       | $40.05 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$                          | -37 dBm                                                                                   | 100 kHz               |
| NOTE 1: For a repeater supporting <i>non-contiguous spectrum</i> operation within any <i>operating band</i> the emission basic limits within <i>sub-block gaps</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> on each side of the <i>sub-block gap</i> . Exception is $\Delta f \geq 40\text{MHz}$ from both adjacent <i>sub-blocks</i> on each side of the <i>sub-block gap</i> , where the emission basic limits within <i>sub-block gaps</i> shall be -37dBm/100kHz. |                                                                                                      |                                                                                           |                       |
| NOTE 2: For a <i>multi-band connector</i> with <i>Inter RF Bandwidth gap</i> $< 2 \cdot \Delta f_{\text{OBUe}}$ the emission basic limits within the <i>Inter RF Bandwidth gaps</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> or RF Bandwidth on each side of the <i>Inter RF Bandwidth gap</i>                                                                                                                                                                        |                                                                                                      |                                                                                           |                       |
| NOTE 3: The basic limit is not applicable when $\Delta f_{\text{max}} < 40 \text{ MHz}$ .                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                      |                                                                                           |                       |

### 6.5.3.2.5 Additional *basic* limits

#### 6.5.3.2.5.1 Limits in FCC Title 47

In addition to the basic limits in clauses 6.5.3.2.1, 6.5.3.2.2, 6.5.3.2.3 and 6.5.3.2.4, the *repeater type 1-C* may have to comply with the applicable emission basic limits established by FCC Title 47 [10], when deployed in regions where those limits are applied, and under the conditions declared by the manufacturer.

#### 6.5.3.2.5.2 Protection of DTT

In certain regions the following basic limit may apply for protection of DTT. For *repeater type 1-C* operating in Band n20, the level of emissions in the band 470-790 MHz, measured in an 8 MHz filter bandwidth on centre frequencies  $F_{\text{filter}}$  according to table 6.5.3.2.5.2-1, a basic limit  $P_{\text{EM},N}$  is declared by the manufacturer. This basic limit applies in the frequency range 470-790 MHz even though part of the range falls in the spurious domain.

**Table 6.5.3.2.5.2-1: Declared emissions *basic limit* for protection of DTT**

| Filter centre frequency, $F_{\text{filter}}$                                 | Measurement bandwidth | Declared emission <i>basic limit</i> (dBm) |
|------------------------------------------------------------------------------|-----------------------|--------------------------------------------|
| $F_{\text{filter}} = 8 \cdot N + 306 \text{ (MHz)}$ ;<br>$21 \leq N \leq 60$ | 8 MHz                 | $P_{\text{EM},N}$                          |

Note: The regional requirement is defined in terms of EIRP (effective isotropic radiated power), which is dependent on both the repeater emissions at the *antenna connector* and the deployment (including antenna gain and feeder loss). The requirement defined above provides the characteristics of the repeater needed to verify compliance with the regional requirement. Compliance with the regional requirement can be determined using the method outlined in TS 36.104 [20], annex F.

### 6.5.3.2.6 Basic limit inside passband with no UL input signal

The requirement is defined as a function of frequency offset from the edge of some part of passband with non-zero input signal. The requirement is measured as the ratio of the repeater output power in a zero-input basic unit to the repeater output power in a non-zero input basic unit. Basic unit equal to 360KHz.

The average of the basic limits over 10 sub-frames shall not exceed the values specified in Table 6.5.3.2.6-1.

Table 6.5.3.2.6-1: Basic limits inside passband with no UL input signal

| Parameter description                                                                                                                                                                                                                                                                                            | Unit | Basic Limit (NOTE 1)                                                                                                                                                                |                                              | Applicable Frequencies                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|----------------------------------------|
| General                                                                                                                                                                                                                                                                                                          | dB   | $max\{-25 - 10 \cdot \log_{10}(N_{RB}/L_{CRB}),$<br>$20 \cdot \log_{10} EVM - 3 - 5 \cdot ( \Delta_{RB}  - 1)/L_{CRB},$<br>$-57dBm + 10 \log_{10}(SCS/15kHz) - \overline{P_{RB}}\}$ |                                              | Any zero-input basic unit (NOTE 2)     |
| IQ Image                                                                                                                                                                                                                                                                                                         | dB   | -28                                                                                                                                                                                 | Image frequencies when output power > 10 dBm | Image frequencies (NOTES 2, 3)         |
|                                                                                                                                                                                                                                                                                                                  |      | -25                                                                                                                                                                                 | Image frequencies when output power ≤ 10 dBm |                                        |
| Carrier leakage                                                                                                                                                                                                                                                                                                  | dBc  | -28                                                                                                                                                                                 | Output power > 10 dBm                        | Carrier leakage frequency (NOTES 4, 5) |
|                                                                                                                                                                                                                                                                                                                  |      | -25                                                                                                                                                                                 | 0 dBm ≤ Output power ≤ 10 dBm                |                                        |
|                                                                                                                                                                                                                                                                                                                  |      | -20                                                                                                                                                                                 | -30 dBm ≤ Output power < 0 dBm               |                                        |
|                                                                                                                                                                                                                                                                                                                  |      | -10                                                                                                                                                                                 | -40 dBm ≤ Output power < -30 dBm             |                                        |
| NOTE 1: requirement is evaluated in each zero-input basic unit. For each such basic unit, the minimum requirement is calculated as the higher of $\overline{P_{RB}}$ - 30 dB and the power sum of all limit values (General, IQ Image or Carrier leakage) that apply. $\overline{P_{RB}}$ is defined in NOTE 10. |      |                                                                                                                                                                                     |                                              |                                        |
| NOTE 2: The measurement bandwidth is one basic unit and the limit is expressed as a ratio of measured power in one zero-input basic unit to the measured average power per non-zero input basic unit, where the averaging is done across all non-zero input parts of the passband.                               |      |                                                                                                                                                                                     |                                              |                                        |
| NOTE 3: The applicable frequencies for this limit are those that are enclosed in the reflection of the non-zero input part of passband, based on symmetry with respect to the carrier leakage frequency, but excluding any non-zero input basic units.                                                           |      |                                                                                                                                                                                     |                                              |                                        |
| NOTE 4: The measurement bandwidth is 1 basic unit and the limit is expressed as a ratio of measured power in one zero-input basic unit to the measured total power in all non-zero input basic units                                                                                                             |      |                                                                                                                                                                                     |                                              |                                        |
| NOTE 5: The applicable frequencies are those that are enclosed either in the basic unit containing the carrier leakage frequency, or in the two basic units immediately adjacent to the carrier leakage frequency but excluding any non-zero input basic units.                                                  |      |                                                                                                                                                                                     |                                              |                                        |
| NOTE 6: $L_{CRB}$ is the $floor\left(\frac{BW_{passband}}{basic\ unit}\right)$ .                                                                                                                                                                                                                                 |      |                                                                                                                                                                                     |                                              |                                        |
| NOTE 7: $N_{RB}$ is the $floor\left(\frac{bandwidth\ of\ non-zero\ input\ signal}{basic\ unit}\right)$ .                                                                                                                                                                                                         |      |                                                                                                                                                                                     |                                              |                                        |
| NOTE 8: $EVM$ is the limit specified in Table 6.6.2.2-1 for the modulation format used in the non-zero input basic units..                                                                                                                                                                                       |      |                                                                                                                                                                                     |                                              |                                        |
| NOTE 9: $\Delta_{RB}$ is the starting frequency offset between the end of nearest non-zero input basic unit and the measured zero-input basic unit (e.g. $\Delta_{RB} = 1$ or $\Delta_{RB} = -1$ for the first zero-input basic unit outside of the non-zero input part of passband).                            |      |                                                                                                                                                                                     |                                              |                                        |
| NOTE 10: $\overline{P_{RB}}$ is an average of the transmitted power over 10 sub-frames normalized by the number of non-zero input basic units, measured in dBm.                                                                                                                                                  |      |                                                                                                                                                                                     |                                              |                                        |

### 6.5.3.3 Minimum requirement for NCR

#### 6.5.3.3.1 Minimum requirement for NCR-Fwd

##### 6.5.3.3.1.1 Minimum requirement for NCR-Fwd type 1-C

The operating band unwanted emissions for *NCR-Fwd type 1-C* for each *antenna connector* shall be below the applicable *basic limits* defined in clause 6.5.3.2.

For Band n41 and n90 operation in Japan, the operating band unwanted emissions limits shall be applied to the sum of the emission power over all *antenna connectors* for *NCR-Fwd type 1-C*.

For joint transmission of NCR-Fwd and NCR-MT in the uplink, the operating band unwanted emissions limits shall apply to the total emissions from both the NCR-Fwd and NCR-MT.

##### 6.5.3.3.1.2 Minimum requirement for *NCR-Fwd type 1-H*

The operating band unwanted emissions requirements for *NCR-Fwd type 1-H* are that for each *TAB connector TX min cell group* and each applicable *basic limit* in clause 6.5.3.2, the power summation emissions at the *TAB connectors* of

the *TAB connector TX min cell group* shall not exceed a limit specified as the *basic limit* + *X*, where  $X = 10\log_{10}(N_{\text{TXU,counted}})$  for DL and for UL WA and  $X=0$  for UL LA.

For joint transmission of NCR-Fwd and NCR-MT in the uplink, the operating band unwanted emissions limits shall apply to the total emissions from both the NCR-Fwd and NCR-MT.

NOTE: Conformance to the *NCR-Fwd type 1-H* spurious emission requirement can be demonstrated by meeting at least one of the following criteria as determined by the manufacturer:

1) The sum of the emissions power measured on each *TAB connector* in the *TAB connector TX min cell group* shall be less than or equal to the limit as defined in this clause for the respective frequency span.

Or

2) The unwanted emissions power at each *TAB connector* shall be less than or equal to the *NCR-Fwd type 1-H* limit as defined in this clause for the respective frequency span, scaled by  $-10\log_{10}(n)$ , where *n* is the number of *TAB connectors* in the *TAB connector TX min cell group*.

### 6.5.3.3.2 Minimum requirement for NCR-MT

#### 6.5.3.3.2.1 Minimum requirements for NCR-MT type 1-C

For LA NCR-MT type 1-C, regardless of simultaneous transmission with NCR- Fwd is transmitting, the UE spectrum emission mask requirements specified in clause 6.5.2 in TS 38.101-1 applies .

For WA NCR-MT type 1-C, regardless of simultaneous transmission between NCR-MT and NCR-Fwd, the BS requirements specified in clause 6.6.4 in TS 38.104 apply.

For simultaneous transmission the limits apply for sum of NCR-MT transmission and NCR-Fwd transmission.

#### 6.5.3.3.2.2 Minimum requirements for NCR-MT type 1-H

Limits for NCR-MT type 1-H apply to the sum of emissions across all *TAB connectors*.

For LA NCR-MT type 1-H, regardless of simultaneous transmission with NCR- Fwd is transmitting, the UE spectrum emission mask requirements specified in clause 6.5.2 in TS 38.101-1 applies without scaling factor allowed.

For WA NCR-MT type 1-H, the repeater basic requirements specified in clause 6.6.4 in TS 38.104 relaxed with following scaling factor apply.

$$10\log(N_{\text{TXU,counted}}), \text{ where } N_{\text{TXU,counted}} = \min(N_{\text{TXU,active}}, 8)$$

For simultaneous transmission the limits apply for sum of NCR-MT transmission and NCR-Fwd transmission.

## 6.5.4 Transmitter spurious emissions

### 6.5.4.1 General

The transmitter spurious emission limits shall apply from 9 kHz to 12.75 GHz, excluding

- the frequency range from  $\Delta f_{\text{OBUE}}$  below the lowest frequency of each supported downlink *operating band*, up to  $\Delta f_{\text{OBUE}}$  above the highest frequency of each supported downlink *operating band*, where the  $\Delta f_{\text{OBUE}}$  is defined in table 6.5.1-1 for downlink, or
- the frequency range from  $\Delta f_{\text{OBUE}}$  below the lowest frequency of each supported uplink *operating band*, up to  $\Delta f_{\text{OBUE}}$  above the highest frequency of each supported uplink *operating band*, where the  $\Delta f_{\text{OBUE}}$  is defined in table 6.5.1-2 for uplink

For some *operating bands*, the upper limit is higher than 12.75 GHz in order to comply with the 5<sup>th</sup> harmonic limit of the downlink *operating band*, as specified in ITU-R recommendation SM.329 [5].

For a *multi-band connector*, for each supported *operating band* together with  $\Delta f_{\text{OBUE}}$  around the band is excluded from the transmitter spurious emissions requirement.

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

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

For Band n41 and n90 operation in Japan, the sum of the spurious emissions over all *antenna connectors* for *Repeater type 1-C* shall not exceed the *minimum requirements* defined in clause 6.5.5.2.

## 6.5.4.2 Basic limits

### 6.5.4.2.1 General transmitter spurious emissions *basic limits*

The *basic limits* of either table 6.5.4.2.1-1, table 6.5.4.2.1-2 (Category A limits) or table 6.5.4.2.1-3 (Category B limits) shall apply. The application of either Category A or Category B limits shall be the same as for operating band unwanted emissions in clause 6.5.3.

**Table 6.5.4.2.1-1: General transmitter spurious emission *basic limits* for DL in FR1, Category A**

| Spurious frequency range                                                                                                                                                                                               | Basic limit | Measurement bandwidth | Notes                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----------------------|------------------------|
| 9 kHz – 150 kHz                                                                                                                                                                                                        | -13 dBm     | 1 kHz                 | Note 1                 |
| 150 kHz – 30 MHz                                                                                                                                                                                                       |             | 10 kHz                | Note 1                 |
| 30 MHz – 1 GHz                                                                                                                                                                                                         |             | 100 kHz               | Note 1                 |
| 1 GHz – 12.75 GHz                                                                                                                                                                                                      |             | 1 MHz                 | Note 1, Note 2         |
| 12.75 GHz – 5 <sup>th</sup> harmonic of the upper frequency edge of the DL <i>operating band</i> in GHz                                                                                                                |             | 1 MHz                 | Note 1, Note 2, Note 3 |
| NOTE 1: <i>Measurement bandwidths</i> as in ITU-R SM.329 [5], s4.1.                                                                                                                                                    |             |                       |                        |
| NOTE 2: Upper frequency as in ITU-R SM.329 [5], s2.5 table 1.                                                                                                                                                          |             |                       |                        |
| NOTE 3: For DL, this spurious frequency range applies only for <i>operating bands</i> for which the 5 <sup>th</sup> harmonic of the upper frequency edge of the DL <i>operating band</i> is reaching beyond 12.75 GHz. |             |                       |                        |

**Table 6.5.4.2.1-2: General transmitter spurious emission *basic limits* for UL in FR1, Category A**

| Spurious frequency range                                                                                                                                                                                               | Basic limits | Measurement bandwidth | Notes                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------|------------------------|
| 9 kHz – 150 kHz                                                                                                                                                                                                        | -36 dBm      | 1 kHz                 | Note 1                 |
| 150 kHz – 30 MHz                                                                                                                                                                                                       |              | 10 kHz                | Note 1                 |
| 30 MHz – 1 GHz                                                                                                                                                                                                         |              | 100 kHz               | Note 1                 |
| 1 GHz – 12.75 GHz                                                                                                                                                                                                      | -30 dBm      | 1 MHz                 | Note 1, Note 2         |
| 12.75 GHz – 5 <sup>th</sup> harmonic of the upper frequency edge of the UL <i>operating band</i> in GHz                                                                                                                |              | 1 MHz                 | Note 1, Note 2, Note 3 |
| NOTE 1: <i>Measurement bandwidths</i> as in ITU-R SM.329 [5], s4.1.                                                                                                                                                    |              |                       |                        |
| NOTE 2: Upper frequency as in ITU-R SM.329 [5], s2.5 table 1.                                                                                                                                                          |              |                       |                        |
| NOTE 3: For UL, this spurious frequency range applies only for <i>operating bands</i> for which the 5 <sup>th</sup> harmonic of the upper frequency edge of the UL <i>operating band</i> is reaching beyond 12.75 GHz. |              |                       |                        |

**Table 6.5.4.2.1-3: General transmitter spurious emission *basic limits* in FR1, Category B**

| Spurious frequency range                                                                                                                                                                                               | <i>basic limits</i> | <i>Measurement bandwidth</i> | Notes                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------------|------------------------|
| 9 kHz – 150 kHz                                                                                                                                                                                                        | -36 dBm             | 1 kHz                        | Note 1                 |
| 150 kHz – 30 MHz                                                                                                                                                                                                       |                     | 10 kHz                       | Note 1                 |
| 30 MHz – 1 GHz                                                                                                                                                                                                         |                     | 100 kHz                      | Note 1                 |
| 1 GHz – 12.75 GHz                                                                                                                                                                                                      | -30 dBm             | 1 MHz                        | Note 1, Note 2         |
| 12.75 GHz – 5 <sup>th</sup> harmonic of the upper frequency edge of the <i>operating band</i> in GHz                                                                                                                   |                     | 1 MHz                        | Note 1, Note 2, Note 3 |
| NOTE 1: <i>Measurement bandwidths</i> as in ITU-R SM.329 [5], s4.1.                                                                                                                                                    |                     |                              |                        |
| NOTE 2: Upper frequency as in ITU-R SM.329 [5], s2.5 table 1.                                                                                                                                                          |                     |                              |                        |
| NOTE 3: For DL, this spurious frequency range applies only for <i>operating bands</i> for which the 5 <sup>th</sup> harmonic of the upper frequency edge of the DL <i>operating band</i> is reaching beyond 12.75 GHz. |                     |                              |                        |
| For UL, this spurious frequency range applies only for <i>operating bands</i> for which the 5 <sup>th</sup> harmonic of the upper frequency edge of the UL <i>operating band</i> is reaching beyond 12.75 GHz.         |                     |                              |                        |

#### 6.5.4.2.2 Additional spurious emissions *basic limits*

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

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

The spurious emission *basic limits* are provided in table 6.5.4.2.2-1 where requirements for co-existence with the system type listed in the first column apply for *repeater type 1-C*. For a *multi-band connector*, the exclusions and conditions in table 6.5.4.2.2-1 apply for each supported *operating band*.

**Table 6.5.4.2.2-1: Repeater type 1-C spurious emissions basic limits for co-existence with systems operating in other frequency bands**

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

NOTE 1: As defined in the scope for spurious emissions in this clause, except for the cases where the noted basic limits apply to a repeater operating in Band n28, Band n29, or Band n67, the co-existence requirements in table 6.5.4.2.3 -1 do not apply for the  $\Delta f_{\text{OBUE}}$  frequency range immediately outside the downlink *operating band* (see table 5.2-1). Emission limits for this excluded frequency range may be covered by local or regional requirements.

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

NOTE 3: For unsynchronized operation, special co-existence requirements may apply that are not covered by the 3GPP specifications.

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

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

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

NOTE 7: Does not apply for co-existence with standalone downlink bands (SDO) defined in TS 36.104 [20], table 5.5-1.

NOTE 8: Frequency range of UTRA, E-UTRA and NR bands, as described in TS 25.104 [33] clause 5.2, TS 36.104 [20] clause 5.5 and TS 38.104 [2] clause 5.2, respectively.

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

The following requirement may be applied for the protection of PHS. This requirement is also applicable at specified frequencies falling between  $\Delta f_{\text{OBUE}}$  below the lowest repeater transmitter frequency of the downlink *operating band* and  $\Delta f_{\text{OBUE}}$  above the highest repeater transmitter frequency of the downlink *operating band*.  $\Delta f_{\text{OBUE}}$  is defined in clause 6.5.1.

The spurious emission *basic limit* for this requirement are:

**Table 6.5.4.2.3-2: Repeater spurious emissions basic limit for repeater for co-existence with PHS for DL**

| Frequency range     | <i>basic limit</i> | <i>Measurement Bandwidth</i> | Note                                                                          |
|---------------------|--------------------|------------------------------|-------------------------------------------------------------------------------|
| 1884.5 – 1915.7 MHz | -41 dBm            | 300 kHz                      | Applicable when co-existence with PHS system operating in 1884.5 – 1915.7 MHz |

In certain regions, the following requirement may apply to repeater operating in Band n50 and n75 within the 1432 – 1452 MHz, and in Band n51 and Band n76. The *basic limit* are specified in Table 6.5.4.2.3-4. This requirement is also applicable at the frequency range from  $\Delta f_{\text{OBUE}}$  below the lowest frequency of the repeater downlink *operating band* up to  $\Delta f_{\text{OBUE}}$  above the highest frequency of the repeater downlink *operating band*.

**Table 6.5.4.2.3-4: Additional operating band unwanted emission basic limit for repeater operating in Band n50 and n75 within 1432 – 1452 MHz, and in Band n51 and n76**

| Filter centre frequency, $F_{\text{filter}}$ | <i>basic limit</i> | <i>Measurement Bandwidth</i> |
|----------------------------------------------|--------------------|------------------------------|
| $F_{\text{filter}} = 1413.5 \text{ MHz}$     | -42 dBm            | 27 MHz                       |

In certain regions, the following requirement may apply to repeater operating in NR Band n50 and n75 within 1492-1517 MHz and in Band n74 within 1492-1518 MHz. The maximum level of emissions, measured on centre frequencies  $F_{\text{filter}}$  with filter bandwidth according to Table 6.5.4.2.3-5, shall be defined according to the *basic limits*  $P_{\text{EM},n50/n75,a}$  nor  $P_{\text{EM},n50/n75,b}$  declared by the manufacturer.

**Table 6.5.4.2.3-5: Operating band n50, n74 and n75 declared emission above 1518 MHz**

| Filter centre frequency, $F_{\text{filter}}$                        | Declared <i>basic limits</i> (dBm) | <i>Measurement bandwidth</i> |
|---------------------------------------------------------------------|------------------------------------|------------------------------|
| $1518.5 \text{ MHz} \leq F_{\text{filter}} \leq 1519.5 \text{ MHz}$ | $P_{\text{EM}, n50/n75, a}$        | 1 MHz                        |
| $1520.5 \text{ MHz} \leq F_{\text{filter}} \leq 1558.5 \text{ MHz}$ | $P_{\text{EM}, n50/n75, b}$        | 1 MHz                        |

In certain regions, the following requirement shall be applied to repeater operating in Band n13 and n14 to ensure that appropriate interference protection is provided to 700 MHz public safety operations. This requirement is also applicable at the frequency range from 10 MHz below the lowest frequency of the repeater downlink operating band up to 10 MHz above the highest frequency of the repeater downlink operating band.

The power of any spurious emission shall not exceed:

**Table 6.5.4.2.3-6: Repeater spurious emissions basic limits for protection of 700 MHz public safety operations**

| Operating Band | Frequency range | <i>Basic limit</i> | <i>Measurement Bandwidth</i> |
|----------------|-----------------|--------------------|------------------------------|
| n13            | 763 - 775 MHz   | -46 dBm            | 6.25 kHz                     |
| n13            | 793 - 805 MHz   | -46 dBm            | 6.25 kHz                     |
| n14            | 769 - 775 MHz   | -46 dBm            | 6.25 kHz                     |
| n14            | 799 - 805 MHz   | -46 dBm            | 6.25 kHz                     |

In certain regions, the following requirement may apply to repeater operating in Band n30. This requirement is also applicable at the frequency range from 10 MHz below the lowest frequency of the repeater downlink operating band up to 10 MHz above the highest frequency of the repeater downlink operating band.

The power of any spurious emission shall not exceed:

**Table 6.5.4.2.3-7: Additional repeater spurious emissions basic limits for Band n30**

| Frequency range   | <i>basic limits</i> | <i>Measurement Bandwidth</i> | Note |
|-------------------|---------------------|------------------------------|------|
| 2200 – 2345 MHz   | -45 dBm             | 1 MHz                        |      |
| 2362.5 – 2365 MHz | -25 dBm             | 1 MHz                        |      |
| 2365 – 2367.5 MHz | -40 dBm             | 1 MHz                        |      |
| 2367.5 – 2370 MHz | -42 dBm             | 1 MHz                        |      |
| 2370 – 2395 MHz   | -45 dBm             | 1 MHz                        |      |

The following requirement may apply to repeater operating in Band n48 in certain regions. The power of any spurious emission shall not exceed:

**Table 6.5.4.2.3-8: Additional repeater spurious emissions basic limits for Band n48**

| Frequency range                            | <i>Basic limits</i> | <i>Measurement Bandwidth (NOTE)</i> | Note                                                     |
|--------------------------------------------|---------------------|-------------------------------------|----------------------------------------------------------|
| 3530 MHz – 3720 MHz                        | -25 dBm             | 1 MHz                               | Applicable 10 MHz from the assigned <i>passband edge</i> |
| 3100 MHz – 3530 MHz<br>3720 MHz – 4200 MHz | -40 dBm             | 1 MHz                               |                                                          |

NOTE: 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.

NOTE: The regional requirement, included in [12], is defined in terms of EIRP, which is dependent on both the repeater emissions at the *antenna connector* and the deployment (including antenna gain and feeder loss). The requirement defined above provides the characteristics of the base station needed to verify compliance with the regional requirement. The assessment of the EIRP level is described in Annex F.

The following requirement shall be applied to repeater operating in Band n26 to ensure that appropriate interference protection is provided to 800 MHz public safety operations. This requirement is also applicable at the frequency range from 10 MHz below the lowest frequency of the repeater downlink operating band up to 10 MHz above the highest frequency of the repeater downlink operating band.

The power of any spurious emission shall not exceed:

**Table 6.5.4.2.3-9: Repeater spurious emissions basic limits for protection of 800 MHz public safety operations**

| Operating Band | Frequency range | Basic limit | Measurement Bandwidth | Note                                                           |
|----------------|-----------------|-------------|-----------------------|----------------------------------------------------------------|
| n26            | 851 - 859 MHz   | -13 dBm     | 100 kHz               | Applicable for offsets > 37.5kHz from the <i>passband</i> edge |

The following requirement may apply to Repeater for Band n41 and n90 operation in Japan. This requirement is also applicable at the frequency range from  $\Delta f_{\text{OBUE}}$  below the lowest frequency of the Repeater downlink operating band up to  $\Delta f_{\text{OBUE}}$  above the highest frequency of the Repeater downlink operating band.

The power of any spurious emission shall not exceed:

**Table 6.5.4.2.3-10: Additional repeater spurious emissions basic limit for Band n41 and n90**

| Frequency range                                                             | Basic limit | Measurement Bandwidth |
|-----------------------------------------------------------------------------|-------------|-----------------------|
| 2505 MHz – 2535 MHz                                                         | -42 dBm     | 1 MHz                 |
| NOTE: This requirement applies for carriers allocated within 2545-2645 MHz. |             |                       |

The following requirement may apply to repeater operating in 3.45-3.55 GHz in Band n77 in certain regions. Basic limits are specified in table 6.5.4.2.3-11.

**Table 6.5.4.2.3-11: Additional repeater spurious emissions basic limits for Band n77**

| Channel bandwidth [MHz] | Frequency range [MHz]      | Filter centre frequency, $F_{\text{filter}}$ [MHz]                                   | Basic limit [dBm] | Measurement bandwidth [MHz] |
|-------------------------|----------------------------|--------------------------------------------------------------------------------------|-------------------|-----------------------------|
| All                     | 3430 – 3440<br>3560 – 3570 | $3430.5 \leq F_{\text{filter}} < 3439.5$<br>$3560.5 \leq F_{\text{filter}} < 3569.5$ | -25               | 1                           |
| All                     | $\leq 3430$<br>$> 3570$    | $F_{\text{filter}} < 3429.5$<br>$3570.5 \leq F_{\text{filter}}$                      | -40               | 1                           |

NOTE: 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.

The following requirement may also apply to repeater operating in Band n54 in certain regions. The level of emissions in the 1541 – 1650 MHz band, measured in measurement bandwidth according to Table 6.5.4.2.3-12 shall not exceed the maximum emission levels  $P_{\text{EM},n54,a}$ ,  $P_{\text{EM},n54,b}$ ,  $P_{\text{EM},n54,c}$ ,  $P_{\text{EM},n54,d}$ ,  $P_{\text{EM},n54,e}$  and  $P_{\text{EM},n54,f}$  declared by the manufacturer.

**Table 6.5.4.2.3-12: Declared Band n54 emissions basic limits for protection of the 1541-1650 MHz band**

| Operating Band | Frequency range | Declared emission level (dBW)<br>(Measurement bandwidth = 1 MHz) | Declared emission level (dBW) of<br>discrete emissions<br>of less than 700 Hz<br>bandwidth<br>(Measurement bandwidth = 1 kHz) | Declared emission level (dBW) of<br>discrete emissions<br>of less than 2 kHz<br>bandwidth<br>(Measurement bandwidth = 1 kHz) |
|----------------|-----------------|------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| n54            | 1541 - 1559 MHz | $P_{EM,n54,a}$                                                   |                                                                                                                               | $P_{EM,n54,f}$                                                                                                               |
|                | 1559 - 1610 MHz | $P_{EM,n54,b}$                                                   | $P_{EM,n54,d}$                                                                                                                |                                                                                                                              |
|                | 1610 - 1650 MHz | $P_{EM,n54,c}$                                                   | $P_{EM,n54,e}$                                                                                                                |                                                                                                                              |

Note: The regional requirements specified in attachment to the FCC reference document, 0007135419 are defined in terms of EIRP (effective isotropic radiated power), which is dependent on both the repeater emissions at the antenna connector and the deployment (including antenna gain and feeder loss). The EIRP level is calculated using:  $P_{EIRP} = P_E + G_{ant}$  where  $P_E$  denotes the repeater unwanted emission level at the antenna connector,  $G_{ant}$  equals the repeater antenna gain minus feeder loss. The requirement defined above provides the characteristics of the base station needed to verify compliance with the regional requirement.

#### 6.5.4.2.3 Co-location with base stations and repeater Nodes

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

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

The *basic limits* are in table 6.5.4.2.3-1. Requirements for co-location with a system type listed in the second column apply, depending on the declared class. For a *multi-band connector*, the exclusions and conditions in table 6.5.4.2.3-1 shall apply for each supported *operating band*.

**Table 6.5.4.2.3-1: Spurious emissions minimum requirements for co-location with BS, IAB-Node or repeater-Node**

| Frequency range of uplink operating band of the repeater to co-locate with (MHz)<br>(Note 3) | System type to co-locate with | Basic limits (dBm/100kHz) |                |                |
|----------------------------------------------------------------------------------------------|-------------------------------|---------------------------|----------------|----------------|
|                                                                                              |                               | WA<br>repeater            | MR<br>repeater | LA<br>repeater |
| 824 - 849                                                                                    | GSM850 or CDMA850             | -98                       | -91            | -70            |
| 876 - 915                                                                                    | GSM900                        | -98                       | -91            | -70            |
| 1710 - 1785                                                                                  | DCS1800                       | -98                       | -91            | -80            |
| 1850 - 1910                                                                                  | PCS1900                       | -98                       | -91            | -80            |
| n51/51, n91, n93                                                                             | NR or E-UTRA                  | N/A                       | N/A            | -88            |
| n46/46, n53/53                                                                               | NR or E-UTRA                  | N/A                       | -91            | -88            |
| n100, n101                                                                                   | NR                            | -96                       | N/A            | N/A            |
| n96, n102                                                                                    | NR                            | N/A                       | -90            | -87            |
| n104                                                                                         | NR                            | -95                       | -90            | -87            |
| Other operating band                                                                         | UTRA, E-UTRA or NR            | -96                       | -91            | -88            |

NOTE 1: As defined in the scope for spurious emissions in this clause, the co-location requirements in table 6.5.4.2.4-1 do not apply for the frequency range extending  $\Delta f_{OBUE}$  immediately outside the transmit frequency range. The current state-of-the-art technology does not allow a single generic solution for co-location with other system on adjacent frequencies for 30dB antenna to antenna minimum coupling loss. However, there are certain site-engineering solutions that can be used. These techniques are addressed in TR 25.942 [3].

NOTE 2: Table 6.5.4.2.3-1 assumes that two *operating bands*, where the corresponding transmit and receive frequency ranges in table 5.2-1 would be overlapping, are not deployed in the same geographical area. For such a case of operation with overlapping frequency arrangements in the same geographical area, special co-location requirements may apply that are not covered by the 3GPP specifications.

NOTE 3: Frequency range of UTRA, E-UTRA and NR bands, as described in TS 25.104 [33] clause 5.2, TS 36.104 [20] clause 5.5 and TS 38.104 [2] clause 5.2, respectively.

### 6.5.4.3 Minimum requirement for *RF repeater*

The Tx spurious emissions for *repeater type 1-C* for each *antenna connector* shall not exceed the *basic limits* specified in clause 6.5.4.2.

For Band n41 and n90 operation in Japan, the sum of the spurious emissions over all *antenna connectors* for *repeater type 1-C* shall not exceed the *basic limits* defined in clause 6.6.4.2.

### 6.5.4.4 Minimum requirement for *NCR*

#### 6.5.4.4.1 Minimum requirement for NCR-Fwd

##### 6.5.4.4.1.1 Minimum requirement for NCR-Fwd type 1-C

The Tx spurious emissions for *NCR-Fwd type 1-C* for each *antenna connector* shall not exceed the *basic limits* specified in clause 6.5.4.2.

For Band n41 and n90 operation in Japan, the sum of the spurious emissions over all *antenna connectors* for *NCR-Fwd type 1-C* shall not exceed the *basic limits* defined in clause 6.6.5.2.

For joint transmission of NCR-Fwd and NCR-MT in the uplink, the spurious emissions limits shall apply to the total emissions from both the NCR-Fwd and NCR-MT.

##### 6.5.4.4.1.2 Minimum requirement for NCR-Fwd type 1-H

The Tx spurious emissions requirements for *NCR-Fwd type 1-H* are that for each *TAB connector TX min cell group* and each applicable *basic limit* in clause 6.5.4.2, the power summation emissions at the *TAB connectors* of the *TAB connectors* of the *TAB connector TX min cell group* shall not exceed a limit specified as the *basic limit* + X, where  $X = 10\log_{10}(N_{\text{TXU, counted per cell}})$  for DL and for WA UL and  $X=0$  for LA UL, unless stated differently in regional regulation.

NOTE: Conformance to the *NCR-Fwd type 1-H* spurious emission requirement can be demonstrated by meeting at least one of the following criteria as determined by the manufacturer:

1) The sum of the emissions power measured on each *TAB connector* in the *TAB connector TX min cell group* shall be less than or equal to the limit as defined in this clause for the respective frequency span.

Or

2) The unwanted emissions power at each *TAB connector* shall be less than or equal to the *NCR-Fwd type 1-H* limit as defined in this clause for the respective frequency span, scaled by  $-10\log_{10}(n)$ , where  $n$  is the number of *TAB connectors* in the *TAB connector TX min cell group*.

For joint transmission of NCR-Fwd and NCR-MT in the uplink, the spurious emissions limits shall apply to the total emissions from both the NCR-Fwd and NCR-MT.

#### 6.5.4.4.2 Minimum requirement for NCR-MT

##### 6.5.4.4.2.1 Minimum requirements for NCR-MT type 1-C

When NCR-MT and NCR-Fwd are not transmitting simultaneously, the requirements in clause 6.6.4 of TS 38.104 applies for WA NCR-MT type 1-C and the requirements in clause 6.5.3 in TS 38.101-1 applies for LA NCR-MT type 1-C.

When NCR-MT and NCR-Fwd are transmitting simultaneously, the requirements in clause 6.5.3 in TS 38.101-1 applies for LA NCR-MT type 1-C for sum of NCR-MT transmission and NCR-Fwd transmission.

#### 6.5.4.4.2.2 Minimum requirements for NCR-MT type 1-H

Limits for NCR-MT type 1-H apply to the sum of emissions across all TAB connectors.

When WA NCR-MT and NCR-Fwd are not transmitting simultaneously, the requirements in clause 6.6.4 of TS 38.104 relaxed with the following scaling factor applies for WA NCR-MT type 1-H.

$$10\log(N_{\text{TXU,counted}}), \text{ where } N_{\text{TXU,counted}} = \min(N_{\text{TXU,active}}, 8)$$

When WA NCR-MT and NCR-Fwd are transmitting simultaneously, the requirements in clause 6.6.4 of TS 38.104 relaxed with the following scaling factor applies for the sum of NCR-MT transmission and NCR-Fwd transmission.

When LA NCR-MT and NCR-Fwd are not transmitting simultaneously, the requirements in clause 6.5.3 in TS 38.101-1 applies for LA NCR-MT type 1-H without scaling factor allowed for the sum of the spurious emissions.

When NCR-MT and NCR-Fwd are transmitting simultaneously, the requirements in clause 6.5.3 in TS 38.101-1 applies for sum of NCR-MT transmission and NCR-Fwd transmission.

## 6.5.5 Receiver spurious emissions

### 6.5.5.1 General

The receiver spurious emissions power is the power of emissions generated or amplified in a receiver unit that appear at the *antenna connector*. The requirements only apply to *repeater type 1-C* for TDD operation.

For each *antenna connectors* on BS-side and UE-side supporting both RX and TX in TDD, the requirements apply during the *transmitter OFF state*. For *antenna connectors* both BS-side and UE-side in FDD, the RX spurious emissions requirements are superseded by the TX spurious emissions requirements, as specified in clause 6.5.4.

For *multi-band connectors* that both transmit and receive in *operating band* supporting TDD, RX spurious emissions requirements are applicable during the *TX OFF state*, and are subject to exclusion zones in each supported *operating band*.

For Band n41 and n90 operation in Japan, the sum of receiver spurious emissions requirements over all *antenna connectors* for *repeater type 1-C* shall not exceed *minimum requirements* defined in clause 6.5.5.2.

### 6.5.5.2 Basic limits

The receiver spurious emissions requirements, *basic limits* are provided in table 6.5.5.2-1.

**Table 6.5.5.2-1: Repeater receiver spurious emissions *basic limits***

| Spurious frequency range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Basic limits | Measurement bandwidth | Note                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------|--------------------------------|
| 30 MHz – 1 GHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | -57 dBm      | 100 kHz               | Note 1                         |
| 1 GHz – 12.75 GHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | -47 dBm      | 1 MHz                 | Note 1, Note 2                 |
| 12.75 GHz – 5 <sup>th</sup> harmonic of the upper frequency edge of the UL <i>operating band</i> in GHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | -47 dBm      | 1 MHz                 | Note 1, Note 2, Note 3, Note 5 |
| 12.75 GHz - 26 GHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | -47 dBm      | 1 MHz                 | Note 1, Note 2, Note 6         |
| NOTE 1: <i>Measurement bandwidths</i> as in ITU-R SM.329 [5], s4.1.<br>NOTE 2: Upper frequency as in ITU-R SM.329 [5], s2.5 table 1.<br>NOTE 3: This spurious frequency range applies only for <i>operating bands</i> for which the 5 <sup>th</sup> harmonic of the upper frequency edge of the UL <i>operating band</i> is reaching beyond 12.75 GHz.<br>NOTE 4: The frequency range from $\Delta f_{\text{OBUE}}$ below the lowest frequency of the repeater transmitter <i>operating band</i> to $\Delta f_{\text{OBUE}}$ above the highest frequency of the repeater transmitter <i>operating band</i> may be excluded from the requirement. $\Delta f_{\text{OBUE}}$ is defined in clause 6.5.1. For <i>multi-band connectors</i> , the exclusion applies for all supported <i>operating bands</i> .<br>NOTE 5: Does not apply for band n104.<br>NOTE 6: Applies only for band n104. |              |                       |                                |

### 6.5.5.3 Minimum requirement for *RF repeater*

The RX spurious emissions requirements for *repeater type 1-C* are that for each *antenna connector*, the power of emissions shall not exceed *basic limits* specified in table 6.5.5.2-1.

For Band n41 and n90 operation in Japan, the sum of RX spurious emissions requirements over all *antenna connectors* for *repeater type 1-C* shall not exceed *basic limits* specified in table 6.5.5.2-1.

### 6.5.5.4 Minimum requirement for *NCR*

#### 6.5.5.4.1 Minimum requirement for *NCR-Fwd*

##### 6.5.5.4.1.1 Minimum requirement for *NCR-Fwd type 1-C*

The RX spurious emissions requirements for *NCR-Fwd type 1-C* are that for each *antenna connector*, the power of emissions shall not exceed *basic limits* specified in table 6.5.5.2-1.

For Band n41 and n90 operation in Japan, the sum of RX spurious emissions requirements over all *antenna connectors* for *NCR-Fwd type 1-C* shall not exceed *basic limits* specified in table 6.5.5.2-1.

For joint reception of *NCR-Fwd* and *NCR-MT* in the uplink, the receiver spurious emissions limits shall apply to the total emissions from both the *NCR-Fwd* and *NCR-MT*.

##### 6.5.5.4.1.2 Minimum requirement for *NCR-Fwd type 1-H*

The RX spurious emissions requirements for *NCR-Fwd type 1-H* are that for each applicable *basic limit* specified in table 7.6.2-1 for each *TAB connector RX min cell group*, the power sum of emissions at respective *TAB connectors* shall not exceed the limits specified as the *basic limits* + X, where  $X = 10\log_{10}(N_{\text{RXU, counted per cell}})$  for DL and for WA UL and X=0 for LA UL, unless stated differently in regional regulation.

The RX spurious emission requirements are applied per the *TAB connector RX min cell group* for all the configurations supported by the repeater.

NOTE: Conformance to the repeater receiver spurious emissions requirement can be demonstrated by meeting at least one of the following criteria as determined by the manufacturer:

- 1) The sum of the spurious emissions power measured on each *TAB connector* in the *TAB connector RX min cell group* shall be less than or equal to the limit above for the respective frequency span.

Or

- 2) The spurious emissions power at each *TAB connector* shall be less than or equal to the limit as defined above for the respective frequency span, scaled by  $-10\log_{10}(n)$ , where  $n$  is the number of *TAB connectors* in the *TAB connector RX min cell group*.

For joint reception of NCR-Fwd and NCR-MT in the uplink, the receiver spurious emissions limits shall apply to the total emissions from both the NCR-Fwd and NCR-MT.

## 6.6 Repeater Error Vector Magnitude

### 6.6.1 Downlink repeater error vector magnitude

#### 6.6.1.1 General

The Repeater Error Vector Magnitude (EVM) is a measure of the difference between the symbols provided at the input of repeater and the measured signal symbols at the output of the repeater after the equalization by the measurement equipment. This difference is called the error vector. Details about how the repeater EVM is determined are the same as specified in TS 38.104 [2] Annex B for FR1. The repeater EVM result is defined as the square root of the ratio of the mean error vector power to the mean reference power expressed in percent.

The repeater EVM requirement is applicable for a repeater operating at an input power in the range from what is required to reach the maximum output power to the minimum power level in table 6.6.1.1-1.

**Table 6.6.1.1-1: Minimum input power for repeater EVM**

| Repeater DL class                                     | Minimum input power spectral density (dBm/MHz) |                     |
|-------------------------------------------------------|------------------------------------------------|---------------------|
|                                                       | QPSK, 16 QAM, 64QAM                            | 256QAM <sup>1</sup> |
| WA                                                    | -82                                            | -75                 |
| MR                                                    | -77                                            | -70                 |
| LA                                                    | -74                                            | -67                 |
| Note 1: support of 256QAM is based on the declaration |                                                |                     |

#### 6.6.1.2 Minimum requirement for *RF repeater*

The repeater EVM levels for different modulation schemes outlined in table 6.6.1.2-1 shall be met using the frame structure described in clause 6.6.1.3.

**Table 6.6.1.2-1: Repeater EVM requirements**

| Parameter                                              | Required repeater EVM |
|--------------------------------------------------------|-----------------------|
| QPSK, 16QAM, 64QAM                                     | 8 %                   |
| 256QAM                                                 | 3.5 % <sup>1</sup>    |
| Note 1: support of 256QAM is based on the declaration. |                       |

#### 6.6.1.2A Minimum requirement for *NCR*

##### 6.6.1.2A.1 Minimum requirement for NCR-Fwd

###### 6.6.1.2A.1.1 Minimum requirement for NCR-Fwd type 1-C

The NCR-Fwd EVM levels for different modulation schemes outlined in table 6.6.1.2-1 shall be met using the frame structure described in clause 6.6.1.3.

###### 6.6.1.2A.1.2 Minimum requirement for *NCR-Fwd type 1-H*

The NCR-Fwd EVM levels for different modulation schemes outlined in table 6.6.1.2-1 shall be met using the frame structure described in clause 6.6.1.3 between corresponding input/output TAB connectors.

### 6.6.1.3 Repeater EVM frame structure for measurement

The input signals for the repeater EVM requirement shall have the same frame structure as defined for the BS in TS 38.104 [2].

## 6.6.2 Uplink repeater error vector magnitude

### 6.6.2.1 General

The Repeater Error Vector Magnitude is a measure of the difference between the reference waveform provided at the input of repeater and the measured waveform at the output of the repeater. This difference is called the error vector. Details about how the repeater EVM is determined are the same as specified in TS 38.101-1 [13] Annex F for FR1. Before calculating the repeater EVM the measured waveform is corrected by the sample timing offset and RF frequency offset. Then the carrier leakage shall be removed from the measured waveform before calculating the repeater EVM.

The measured waveform is further equalised using the channel estimates subjected to the repeater EVM equaliser spectrum flatness requirement specified in TS 38.101-1 [13] clause 6.4.2.4. For DFT-s-OFDM waveforms, the repeater EVM result is defined after the front-end FFT and IDFT as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %. For CP-OFDM waveforms, the repeater EVM result is defined after the front-end FFT as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %.

The basic repeater EVM measurement interval in one slot in the time domain. The repeater EVM measurement interval is reduced by any symbols that contains an allowable power transient in the measurement interval, as defined in TS 38.101-1 [13] clause 6.3.3 for EVM for UE.

The repeater EVM requirement is applicable for a repeater operating at an input power in the range from what is required to reach the maximum output power to the minimum power level in table 6.6.2.1-1.

**Table 6.6.2.1-1: Minimum input power for repeater EVM**

| Repeater UL class                                     | Minimum input power spectral density (dBm/MHz) |                     |
|-------------------------------------------------------|------------------------------------------------|---------------------|
|                                                       | QPSK, 16 QAM, 64QAM                            | 256QAM <sup>1</sup> |
| WA                                                    | -82                                            | -75                 |
| LA                                                    | -74                                            | -67                 |
| Note 1: support of 256QAM is based on the declaration |                                                |                     |

### 6.6.2.2 Minimum requirement for *RF repeater*

The RMS average of the basic repeater EVM measurements over 10 subframes for the average repeater EVM case for the different modulation schemes shall not exceed the values specified in Table 6.6.2.2-1.

**Table 6.6.2.2-1: Requirements for Repeater Error Vector Magnitude**

| Parameter                                              | Unit | Average Repeater EVM Level |
|--------------------------------------------------------|------|----------------------------|
| QPSK, 16 QAM, 64QAM                                    | %    | 8                          |
| 256 QAM                                                | %    | 3.5 <sup>1</sup>           |
| Note 1: support of 256QAM is based on the declaration. |      |                            |

### 6.6.2.3 Minimum requirement for *NCR*

#### 6.6.2.3.1 Minimum requirement for NCR-Fwd

##### 6.6.2.3.1.1 Minimum requirement for NCR-Fwd type 1-C

The RMS average of the basic NCR-Fwd EVM measurements over 10 subframes for the average NCR-Fwd EVM case for the different modulation schemes shall not exceed the values specified in Table 6.6.2.2-1.

#### 6.6.2.3.1.2 Minimum requirement for *NCR-Fwd type 1-H*

The RMS average of the basic NCR-Fwd EVM measurements over 10 subframes for the average NCR-Fwd EVM case for the different modulation schemes shall not exceed the values specified in Table 6.6.2.2-1 between corresponding input/output TAB connectors.

## 6.7 Input intermodulation

### 6.7.1 General requirement

#### 6.7.1.1 General

The input intermodulation is a measure of the capability of the repeater to inhibit the generation of interference in the *passband*, in the presence of interfering signals on frequencies other than the *passband*.

The following requirement applies for interfering signals depending on the repeaters *passband*.

This requirement applies to the uplink and downlink of the repeater during the *transmitter ON state*.

There is no co-location input intermodulation requirement for LA 1-C repeaters deployed in Femto cell scenario.

#### 6.7.1.2 Minimum requirement for *RF repeater*

For the parameters specified in table 6.7.1.2-1, the power in the *passband* shall not increase with more than 10 dB at the output of the repeater as measured with 1 MHz measurement bandwidth, compared to the level obtained without interfering signals applied.

The core requirement is applicable for all frequency separation possibilities between the two interfering signals that cause the 3rd order intermodulation product to fall into the *passband*.

Table 6.7.1.2-1 specifies the parameters for two interfering signals, where:

- $f_1$  offset is the offset from the channel edge frequency of the first or last channel in the *passband* of the closer carrier.

**Table 6.7.1.2-1: Input intermodulation requirement**

| $f_1$ offset | Interfering Signal Levels | Type of signals | Measurement bandwidth |
|--------------|---------------------------|-----------------|-----------------------|
| 1 MHz        | -40 dBm                   | 2 CW carriers   | 1 MHz                 |

#### 6.7.1.3 Minimum requirement for *NCR*

##### 6.7.1.3.1 Minimum requirement for NCR-Fwd

###### 6.7.1.3.1.1 Minimum requirement for NCR-Fwd type 1-C

For the parameters specified in table 6.7.1.1-1, the power in the *passband* shall not increase with more than 10 dB at the output of the NCR-Fwd as measured with 1 MHz measurement bandwidth, compared to the level obtained without interfering signals applied.

The core requirement is applicable for all frequency separation possibilities between the two interfering signals that cause the 3rd order intermodulation product to fall into the *passband*.

Table 6.7.1.2-1 specifies the parameters for two interfering signals.

#### 6.7.1.3.1.2 Minimum requirement for *NCR-Fwd type 1-H*

For the parameters specified in table 6.7.1.1-1, considering corresponding input/output TAB connectors, the power in the *passband* shall not increase with more than 10 dB at the output of the NCR-Fwd as measured with 1 MHz measurement bandwidth, compared to the level obtained without interfering signals applied.

The core requirement is applicable for all frequency separation possibilities between the two interfering signals that cause the 3rd order intermodulation product to fall into the *passband*.

Table 6.7.1.2-1 specifies the parameters for two interfering signals.

### 6.7.2 Co-location with BS/repeater in other systems

#### 6.7.2.1 General

This additional input intermodulation requirement may be applied for the protection of repeater receivers when GSM, CDMA, UTRA, E-UTRA, NR BS or repeater operating in a different frequency band are co-located with a repeater.

The following requirement applies for interfering signals depending on the repeaters *passband*.

This requirement applies to the uplink and downlink of the repeater. If the BS side is declared to meet co-location requirements, then it should meet input intermodulation co-location requirements for the downlink. If the UE side is declared to meet co-location requirements, then it should meet input intermodulation co-location requirements for the uplink.

#### 6.7.2.2 Minimum requirement for *RF repeater*

For the parameters specified in table 6.7.2.2-1 for DL and 6.7.2.2-2 for UL, the power in the *passband* shall not increase with more than 10 dB at the output of the repeater as measured with 1MHz measurement bandwidth, compared to the level obtained without interfering signals applied.

The core requirement is applicable for all frequency separation possibilities between the two interfering signals that cause the 3rd order intermodulation product to fall into the *passband*.

**Table 6.7.2.2-1: input intermodulation requirement for RF repeater DL when co-located with BS/repeater in other frequency bands.**

| Frequency range of interfering signal                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Interfering signal mean power for repeater with WA UE side (dBm) | Interfering signal mean power for repeater with MR UE side(dBm) | Interfering signal mean power for repeater with LA UE side(dBm) | Type of interfering signals |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------|
| Frequency range of co-located BS's downlink operating band or located repeater's <i>passband</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                  | +16                                                              | +8                                                              | x (Note 1)                                                      | 2 CW carriers               |
| NOTE 1: x = -7 dBm for RF repeater co-located with Pico GSM850 or Pico CDMA850<br>x = -4 dBm for RF repeater co-located with Pico DCS1800 or Pico PCS1900<br>x = -6 dBm for RF repeater co-located with UTRA bands or E-UTRA bands or NR bands<br>NOTE 2: The requirement does not apply when the interfering signal falls within the <i>passband</i> .<br>NOTE 3: For unsynchronized base stations (except in band n46, n96, and n102) or repeaters, special co-location requirements may apply that are not covered by the 3GPP specifications. |                                                                  |                                                                 |                                                                 |                             |

**Table 6.7.2.2-2: input intermodulation requirement for RF Repeater UL when co-located with BS/repeater in other frequency bands.**

| Frequency range of interfering signal                                                                                                                                                                                                                                                           | Interfering signal mean power for repeater with WA BS side(dBm) | Interfering signal mean power for repeater with LA BS side(dBm) | Type of interfering signals |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------|
| Frequency range of co-located BS's downlink operating band or located repeater's <i>passband</i>                                                                                                                                                                                                | +16                                                             | $P_{\text{rated,p,AC}} - 30$                                    | 2 CW carriers               |
| NOTE 1: The requirement does not apply when the interfering signal falls within the <i>passband</i> .<br>NOTE 2: For unsynchronized base stations (except in band n46, n96, and n102) or repeaters, special co-location requirements may apply that are not covered by the 3GPP specifications. |                                                                 |                                                                 |                             |

### 6.7.2.3 Minimum requirement for NCR

#### 6.7.2.3.1 Minimum requirement for NCR-Fwd

##### 6.7.2.3.1.1 Minimum requirement for NCR-Fwd type 1-C

For the parameters specified in table 6.7.2.2-1 for DL and 6.7.2.2-2 for UL, the power in the *passband* shall not increase with more than 10 dB at the output of the NCR-Fwd as measured with 1MHz measurement bandwidth, compared to the level obtained without interfering signals applied.

The core requirement is applicable for all frequency separation possibilities between the two interfering signals that cause the 3rd order intermodulation product to fall into the *passband*.

##### 6.7.2.3.1.2 Minimum requirement for NCR-Fwd type 1-H

For the parameters specified in table 6.7.2.2-1 for DL and 6.7.2.2-2 for UL, considering corresponding input/output TAB connectors, the power in the *passband* shall not increase with more than 10 dB at the output of the NCR-Fwd as measured with 1MHz measurement bandwidth, compared to the level obtained without interfering signals applied.

The core requirement is applicable for all frequency separation possibilities between the two interfering signals that cause the 3rd order intermodulation product to fall into the *passband*.

### 6.7.3 Co-existence with other systems

#### 6.7.3.1 General

This input intermodulation existence requirement may be applied for the protection of RF repeater receivers when GSM, CDMA, UTRA, E-UTRA, NR BS or repeater operating in another frequency band co-exist with a RF repeater.

#### 6.7.3.2 Minimum requirement for RF repeater

For the parameters specified in table 6.7.3.2-1, the power in the *passband* shall not increase with more than 10 dB at the output of the repeater as measured with 1MHz measurement bandwidth, compared to the level obtained without interfering signals applied.

The core requirement is applicable for all frequency separation possibilities between the two interfering signals that cause the 3rd order intermodulation product to fall into the *passband*.

**Table 6.7.3.2-1: input intermodulation requirement for RF repeater when co-exist with BS/repeater in other non-overlapping frequency bands**

| Frequency range of interfering signal                                                                                                                                                                                                                                             | Interfering signal mean power (dBm) | Type of interfering signals | Measurement bandwidth |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|-----------------------------|-----------------------|
| Frequency range of co-existence system operating band                                                                                                                                                                                                                             | -15                                 | 2 CW carriers               | 1MHz                  |
| NOTE 1: All the interfering signals should be limited into the frequency ranges that are either X MHz higher than $F_{UL,high}$ or X MHz lower than $F_{UL,low}$ , where X equals to 20MHz when $F_{UL,high} - F_{UL,low}$ is not larger than 200MHz, otherwise X equals to 60MHz |                                     |                             |                       |

### 6.7.3.3 Minimum requirement for NCR

#### 6.7.3.3.1 Minimum requirement for NCR-Fwd

##### 6.7.3.3.1.1 Minimum requirement for NCR-Fwd type 1-C

For the parameters specified in table 6.7.3.2-1, the power in the *passband* shall not increase with more than 10 dB at the output of the NCR-Fwd as measured with 1MHz measurement bandwidth, compared to the level obtained without interfering signals applied.

The core requirement is applicable for all frequency separation possibilities between the two interfering signals that cause the 3rd order intermodulation product to fall into the *passband*.

##### 6.7.3.3.1.2 Minimum requirement for NCR-Fwd type 1-H

For the parameters specified in table 6.7.3.2-1, considering corresponding input/output TAB connectors, the power in the *passband* shall not increase with more than 10 dB at the output of the NCR-Fwd as measured with 1MHz measurement bandwidth, compared to the level obtained without interfering signals applied.

The core requirement is applicable for all frequency separation possibilities between the two interfering signals that cause the 3rd order intermodulation product to fall into the *passband*.

## 6.8 Output intermodulation

### 6.8.1 General

The output intermodulation requirement is a measure of the capability of the repeater to inhibit the generation of signals in its non-linear elements caused by presence of the wanted signal and an interfering signal reaching the repeater via the output port. The requirement shall apply during the *transmitter ON state* and the *transmitter transient period*.

The requirement shall apply to the uplink and downlink of the Repeater.

The output intermodulation level is the power of the intermodulation products when an interfering signal is injected into the *antenna connector*.

### 6.8.2 Minimum requirements for RF repeater

#### 6.8.2.1 Minimum requirements

The output intermodulation level is the power of the intermodulation products when an interfering signal is injected into the output port. The wanted signal *passband* shall be the maximum bandwidth supported by the repeater.

For *repeater type 1-C*, the wanted signal and interfering signal centre frequency is specified in table 6.8.2.1-1, where interfering signal level is *rated total output power* ( $P_{rated,t,AC}$ ) at *antenna connector* in the *passband* – 30 dB.

The unwanted emission with output intermodulation applied shall not exceed the corresponding uplink and downlink unwanted emission limits in clause 6.5 in the presence of an interfering signal according to table 6.8.2.1-1. The

measurement may be limited to frequencies on which third and fifth order intermodulation products appear, considering the width of these products.

**Table 6.8.2.1-1: Interfering and wanted signals for the output intermodulation requirement**

| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Value                                                                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wanted signal type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | NR signal, filling all supported <i>passbands</i> in the operating band and with sufficient carriers to fill each <i>passband</i> . Minimum defined SCS for the operating band |
| Interfering signal type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | NR signal, with the minimum SCS and channel bandwidth defined in the operating band in [2]                                                                                     |
| Interfering signal level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <i>Rated total output power</i> ( $P_{\text{rated,t,AC}}$ ) in the <i>passband</i> – 30 dB                                                                                     |
| Interfering signal centre frequency offset from the lower/upper edge of the wanted signal or edge of <i>sub-block</i> inside a <i>sub-block gap</i>                                                                                                                                                                                                                                                                                                                                                                             | $f_{\text{offset}} = \pm \text{minimum pass band} \left( n - \frac{1}{2} \right)$<br>, for $n=1, 2$ and $3$                                                                    |
| NOTE 1: Interfering signal positions that are partially or completely outside of any downlink operating band of the repeater are excluded from the requirement, unless the interfering signal positions fall within the frequency range of adjacent downlink operating bands in the same geographical area. In case that none of the interfering signal positions fall completely within the frequency range of the downlink operating band, TS 38.115-1 [7] provides further guidance regarding appropriate test requirements. |                                                                                                                                                                                |
| NOTE 2: In Japan, NOTE 1 is not applied in Band n77, n78, n79.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                |

### 6.8.2.2 Additional requirements

For repeater supporting Band n41 and n90 operation in Japan, the sum of output intermodulation level over all *antenna connectors* shall not exceed the unwanted emission limits in clauses 6.5 in the presence of an NR interfering signal according to table 6.8.2.2-1.

**Table 6.8.2.2-1 Interfering and wanted signals for the additional output intermodulation requirement for Band n41 and n90**

| Parameter                                                                                                             | Value                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| Wanted signal                                                                                                         | NR single (NOTE)                                                                           |
| Interfering signal type                                                                                               | NR signal of 10 MHz <i>passband bandwidth</i>                                              |
| Interfering signal level                                                                                              | <i>Rated total output power</i> ( $P_{\text{rated,t,AC}}$ ) in the <i>passband</i> – 30 dB |
| Interfering signal centre frequency offset from the lower/upper <i>passband</i> centre frequency of the wanted signal | $\pm 5$ MHz<br>$\pm 15$ MHz<br>$\pm 25$ MHz                                                |
| NOTE: This requirement applies for <i>passband</i> allocated within 2545-2645 MHz.                                    |                                                                                            |

## 6.8.3 Minimum requirements for NCR

### 6.8.3.1 Minimum requirements for NCR-Fwd

#### 6.8.3.1.1 Minimum requirements for NCR-Fwd type 1-C

The output intermodulation level is the power of the intermodulation products when an interfering signal is injected into the output port. The wanted signal *passband* shall be the maximum bandwidth supported by the NCR-Fwd.

For *NCR-Fwd type 1-C*, the wanted signal and interfering signal centre frequency is specified in table 6.8.2.1-1, where interfering signal level is *rated total output power* ( $P_{\text{rated,t,AC}}$ ) at *antenna connector* in the *passband* – 30 dB.

The unwanted emission with output intermodulation applied shall not exceed the corresponding uplink and downlink unwanted emission limits in clause 6.5 in the presence of an interfering signal according to table 6.8.2.1-1. The measurement may be limited to frequencies on which third and fifth order intermodulation products appear, considering the width of these products.

### 6.8.3.1.2 Additional requirements for NCR-Fwd type 1-C

For NCR supporting Band n41 and n90 operation in Japan, the sum of output intermodulation level over all *antenna connectors* shall not exceed the unwanted emission limits in clauses 6.5 in the presence of an NR interfering signal according to table 6.8.2.2-1.

### 6.8.3.1.3 Minimum requirements for NCR-Fwd type 1-H

The output intermodulation level is the power of the intermodulation products when an interfering signal is injected into the output port. The wanted signal *passband* shall be the maximum bandwidth supported by the NCR-Fwd.

For NCR-Fwd type 1-H, the wanted signal and interfering signal centre frequency is specified in table 6.8.2.1-1, where interfering signal level is *rated total output power* ( $P_{\text{rated,t,TABC}}$ ) at TAB connector in the *passband* – 30 dB.

The unwanted emission with output intermodulation applied shall not exceed the corresponding uplink and downlink unwanted emission limits in clause 6.5 in the presence of an interfering signal according to table 6.8.2.1-1. The measurement may be limited to frequencies on which third and fifth order intermodulation products appear, considering the width of these products.

### 6.8.3.1.4 Additional requirements for NCR-Fwd type 1-H

For NCR supporting Band n41 and n90 operation in Japan, the sum of output intermodulation level over all TAB connectors shall not exceed the unwanted emission limits in clauses 6.5 in the presence of an NR interfering signal according to table 6.8.2.2-1.

## 6.9 Adjacent Channel Rejection Ratio (ACRR)

### 6.9.1 General

Adjacent Channel Rejection Ratio (ACRR) is the ratio of the average gain over a carrier of the repeater in the *passband* to the average gain of the repeater over an adjacent channel outside the repeater *passband*. The carrier in the *passband* and in the adjacent channel shall be of the same type (reference carrier) with bandwidths as defined by *nominal channel bandwidth*.

The requirement shall apply to the uplink and downlink of the Repeater, where the donor link is maintained via antennas (wireless Repeater).

The requirement is differentiated between uplink and downlink.

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

### 6.9.2 Minimum Requirements for RF repeater

For a repeater operating at *passband* below 2496 MHz, the ACRR requirements in table 6.9.2-1 shall apply in downlink. ACRR for downlink shall be higher than the value specified in the Table 6.9.2-1.

**Table 6.9.2-1: Repeater Downlink ACRR below 2496MHz**

| Co-existence with other systems                                                                                 | Repeater Class        | Channel offset from frequency edge of <i>passband</i> (MHz) | ACRR limit     |
|-----------------------------------------------------------------------------------------------------------------|-----------------------|-------------------------------------------------------------|----------------|
| UTRA, E-UTRA, NR                                                                                                | Wide Area repeater    | $BW_{\text{Nominal}}/2$                                     | 45             |
|                                                                                                                 | Medium Range repeater | $BW_{\text{Nominal}}/2$                                     | 45             |
|                                                                                                                 | Local Area repeater   | $BW_{\text{Nominal}}/2$                                     | 33<br>(Note 1) |
| NOTE 1: This requirement does not applicable if the <i>passband</i> occupies the entire <i>operating band</i> . |                       |                                                             |                |

For a repeater operating at *passband* above 2496 MHz, the ACRR requirements in table 6.9.2-1a shall apply in downlink. ACRR for downlink shall be higher than the value specified in the Table 6.9.2-1a.

**Table 6.9.2-1a: Repeater Downlink ACRR above 2496 MHz**

| Co-existence with other systems                                                                                 | Repeater Class        | Channel offset from frequency edge of <i>passband</i> (MHz) | ACRR limit    |
|-----------------------------------------------------------------------------------------------------------------|-----------------------|-------------------------------------------------------------|---------------|
| UTRA, E-UTRA, NR                                                                                                | Wide Area repeater    | $BW_{\text{Nominal}}/2$                                     | 33dB          |
|                                                                                                                 | Medium Range repeater | $BW_{\text{Nominal}}/2$                                     | 33dB          |
|                                                                                                                 | Local Area repeater   | $BW_{\text{Nominal}}/2$                                     | 33dB (Note 1) |
| NOTE 1: This requirement does not applicable if the <i>passband</i> occupies the entire <i>operating band</i> . |                       |                                                             |               |

For a repeater operating at *passband* below 2496 MHz, the ACRR requirements in table 6.9.2-2 shall apply in uplink. ACRR for uplink shall be higher than the value specified in the Table 6.9.2-2.

**Table 6.9.2-2: Repeater Uplink ACRR below 2496 MHz**

| Co-existence with other systems                                                                                 | Repeater Class      | Channel offset from frequency edge of <i>passband</i> (MHz) | ACRR limit    |
|-----------------------------------------------------------------------------------------------------------------|---------------------|-------------------------------------------------------------|---------------|
| UTRA, E-UTRA, NR                                                                                                | Wide Area repeater  | $BW_{\text{Nominal}}/2$                                     | 33dB          |
|                                                                                                                 | Local Area repeater | $BW_{\text{Nominal}}/2$                                     | 33dB (Note 1) |
| NOTE 1: This requirement does not applicable if the <i>passband</i> occupies the entire <i>operating band</i> . |                     |                                                             |               |

For a repeater operating at *passband* above 2496 MHz, the ACRR requirements in table 6.9.2-2a shall apply in uplink. ACRR for uplink shall be higher than the value specified in the Table 6.9.2-2a.

**Table 6.9.2-2a: Repeater Uplink ACRR above 2496 MHz**

| Co-existence with other systems                                                                                                  | Repeater Class      | Channel offset from frequency edge of <i>passband</i> (MHz) | ACRR limit             |
|----------------------------------------------------------------------------------------------------------------------------------|---------------------|-------------------------------------------------------------|------------------------|
| UTRA, E-UTRA, NR                                                                                                                 | Wide Area repeater  | $BW_{\text{Nominal}}/2$                                     | 33dB                   |
|                                                                                                                                  | Local Area repeater | 5MHz                                                        | 20dBc (Note 1, Note 2) |
|                                                                                                                                  |                     | $BW_{\text{Nominal}}/2$                                     | 33dBc (Note 1)         |
| NOTE 1: This requirement does not applicable if the <i>passband</i> occupies the entire <i>operating band</i> .                  |                     |                                                             |                        |
| NOTE 2: In this case, the channel within the <i>passband</i> and the adjacent channel are assumed to have a bandwidth of 10 MHz. |                     |                                                             |                        |

## 6.9.3 Minimum Requirements for *NCR*

### 6.9.3.1 Minimum requirements for *NCR-Fwd*

#### 6.9.3.1.1 Minimum requirements for *NCR-Fwd* type 1-C

For a *NCR-Fwd* operating at *passband* below 2496 MHz, the ACRR requirements in table 6.9.2-1 shall apply in downlink. In normal conditions the ACRR for downlink shall be higher than the value specified in the Table 6.9.2-1.

For a *NCR-Fwd* operating at *passband* above 2496 MHz, the ACRR requirements in table 6.9.2-1a shall apply in downlink. In normal conditions the ACRR for downlink shall be higher than the value specified in the Table 6.9.2-1a.

For a *NCR-Fwd* operating at *passband* below 2496 MHz, the ACRR requirements in table 6.9.2-2 shall apply in uplink. In normal conditions the ACRR for uplink shall be higher than the value specified in the Table 6.9.2-2.

For a *NCR-Fwd* operating at *passband* above 2496 MHz, the ACRR requirements in table 6.9.2-2a shall apply in uplink. In normal conditions the ACRR for uplink shall be higher than the value specified in the Table 6.9.2-2a.

### 6.9.3.1.2 Minimum Requirements for *NCR-Fwd type 1-H*

For a NCR-Fwd operating at *passband* below 2496 MHz, the ACRR requirements in table 6.9.2-1 shall apply in downlink. In normal conditions the ACRR for downlink between corresponding input/output TAB connectors shall be higher than the value specified in the Table 6.9.2-1.

For a NCR-Fwd operating at *passband* above 2496 MHz, the ACRR requirements in table 6.9.2-1a shall apply in downlink. In normal conditions the ACRR for downlink between corresponding input/output TAB connectors shall be higher than the value specified in the Table 6.9.2-1a.

For a NCR-Fwd operating at *passband* below 2496 MHz, the ACRR requirements in table 6.9.2-2 shall apply in uplink. In normal conditions the ACRR for uplink between corresponding input/output TAB connectors shall be higher than the value specified in the Table 6.9.2-2.

For a NCR-Fwd operating at *passband* above 2496 MHz, the ACRR requirements in table 6.9.2-2a shall apply in uplink. In normal conditions the ACRR for uplink between corresponding input/output TAB connectors shall be higher than the value specified in the Table 6.9.2-2a.

## 6.10 Transmit ON/OFF power

### 6.10.1 Transmitter OFF power

#### 6.10.1.1 General

Transmit OFF power requirements apply only to TDD operation of the repeater. The requirement applies to both downlink and uplink of the repeater.

Transmitter OFF power is defined as the mean power measured over  $70/N$  us filtered with a square filter of bandwidth equal to the *passband bandwidth* of the repeater ( $BW_{\text{passband}}$ ) centred on the assigned channel frequency during the *transmitter OFF state*.  $N = \text{SCS}/15$ , where SCS is Sub Carrier Spacing in kHz of the input signal.

For *multi-band connectors* and for *single band connectors* supporting transmission in multiple *operating bands*, the requirement is only applicable during the *transmitter OFF state* in all supported *operating bands*.

#### 6.10.1.2 Minimum requirement for *RF repeater*

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

For *repeater type 1-C uplink*, the requirements for transmitter OFF power spectral density shall be less than -50dBm /  $(\text{SCS} \cdot (12 \cdot N_{\text{RB}} + 1) / 1000)$  MHz per *antenna connector*, where SCS is Sub Carrier Spacing in kHz.

#### 6.10.1.3 Minimum requirement for *NCR*

##### 6.10.1.3.1 Minimum requirement for NCR Fwd

###### 6.10.1.3.1.1 Minimum requirement for NCR-Fwd type 1-C

For *NCR-Fwd type 1-C downlink*, the requirements for transmitter OFF power spectral density shall be less than -85 dBm/MHz per *antenna connector*.

For *NCR-Fwd type 1-C uplink*, the requirements for transmitter OFF power spectral density shall be less than -50dBm /  $(\text{SCS} \cdot (12 \cdot N_{\text{RB}} + 1) / 1000)$  MHz per *antenna connector*, where SCS is Sub Carrier Spacing in kHz.

###### 6.10.1.3.1.2 Minimum requirement for *NCR-Fwd type 1-H*

For *NCR-Fwd type 1-H downlink*, the requirements for transmitter OFF power spectral density shall be less than -85 dBm/MHz per *TAB connector*.

For *NCR-Fwd type 1-H uplink*, the requirements for transmitter OFF power spectral density shall be less than -50dBm /  $(SCS \cdot (12 \cdot N_{RB} + 1) / 1000)$  MHz per *TAB connector*, where SCS is Sub Carrier Spacing in kHz.

## 6.10.2 Transmitter transient period

### 6.10.2.1 General

*Transmitter transient period* requirements apply only to TDD operation of the repeater. The requirement applies to both downlink and uplink of the repeater.

The *transmitter transient period* is the time period during which the transmitter is changing from the *transmitter OFF* state to the *transmitter ON* state or vice versa. The *transmitter transient period* is illustrated in figure 6.10.2.1-1.

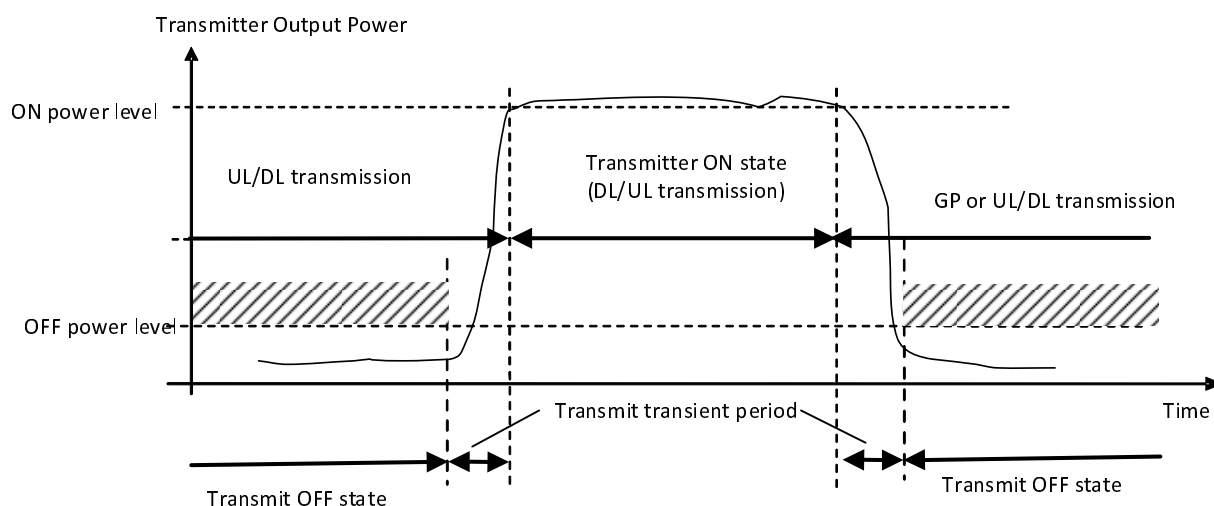


**Figure 6.10.2.1-1: Example of relations between transmitter ON state, transmitter OFF state and transmitter transient period**

For *repeater type 1-C* this requirement shall be applied at the *antenna connector* supporting transmission in the *operating band*. The beginning and end point of downlink and uplink bursts are referenced to the slot timing at the input.

### 6.10.2.2 Minimum requirement for *RF repeater*

For *repeater type 1-C*, the *transmitter transient period* shall be shorter than the values listed in the minimum requirement table 6.10.2.2-1.

**Table 6.10.2.2-1: Minimum requirement for the transmitter transient period for repeater type 1-C**

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

### 6.10.2.3 Minimum requirement for *NCR*

#### 6.10.2.3.1 Minimum requirement for *NCR-Fwd*

##### 6.10.2.3.1.1 Minimum requirement for *NCR-Fwd type 1-C*

For *NCR-Fwd type 1-C* this requirement shall be applied at the *antenna connector* supporting transmission in the *operating band*. The beginning and end point of downlink and uplink bursts are referenced to the slot timing at the input.

For *NCR-Fwd type 1-C*, the *transmitter transient period* shall be shorter than the values listed in the minimum requirement table 6.10.2.2-1.

#### 6.10.2.3.1.2 Minimum requirement for *NCR-Fwd type 1-H*

For *NCR-Fwd type 1-H* this requirement shall be applied at the *TAB connector* supporting transmission in the *operating band*. The beginning and end point of downlink and uplink bursts are referenced to the slot timing at the input.

For *NCR-Fwd type 1-H*, the *transmitter transient period* shall be shorter than the values listed in the minimum requirement table 6.10.2.2-1.

## 6.11 Output power dynamics for NCR-MT

### 6.11.1 General

Output power dynamics is specified in terms of: OFF power, ON/OFF time mask and power control requirements.

### 6.11.2 Transmit OFF power for NCR-MT

For WA NCR-MT type 1-C and NCR-MT type 1-H, the BS requirements specified in clause 6.4.1.2 in TS 38.104 [2] applies.

For LA NCR-MT type 1-C and NCR-MT type 1-H, the UE requirement specified in clause 6.3.2 in TS 38.101-1 [13] applies.

### 6.11.3 Transmit ON/OFF time mask for NCR-MT

For WA NCR-MT type 1-C and NCR-MT type 1-H, the BS requirements specified in clause 6.4.2.2 in TS 38.104 [2] applies.

For LA NCR-MT type 1-C and NCR-MT type 1-H, the UE requirements specified in clause 6.3.3 in TS 38.101-1 [13] applies.

### 6.11.4 Power control for NCR-MT

For WA NCR-MT, The IAB-MT requirements specified in clause 6.3.2 output dynamic range requirement, 6.3.3.1 relative power tolerance and 6.3.3.2 aggregated power tolerance requirements in TS 38.174 [22] applies.

For LA NCR-MT, The UE requirements specified in clause 6.3.4.3 of relative power tolerance and clause 6.3.4.4 of aggregate power tolerance in TS 38.101-1 [13] applies.

## 6.12 Transmit signal quality for NCR-MT

### 6.12.1 General

Transmit signal quality is specified in terms of: frequency error and transmit modulation quality requirements.

### 6.12.2 Frequency error requirements for NCR-MT

The IAB-MT requirements specified in clause 6.5.1.2 in TS 38.174 [22] apply to both NCR-MT type 1-C and NCR-MT type 1-H.

### 6.12.3 Transmit modulation quality

The IAB-MT requirements specified in clause 6.5.2.2 in TS 38.174 [22] apply to both NCR-MT type 1-C and NCR-MT type 1-H.

## 6.13 Transmit intermodulation for NCR-MT

### 6.13.1 General

The transmit intermodulation performance is a measure of the capability of the transmitter to inhibit the generation of signals in its non linear elements caused by presence of the wanted signal and an interfering signal reaching the transmitter via the antenna.

NCR-MT transmit intermodulation is defined by the ratio of the mean power of the wanted signal to the mean power of the intermodulation product when an interfering signal is added at a level below the wanted signal at each transmitter antenna port with the other antenna port(s) if any terminated.

### 6.13.2 Minimum requirements for NCR-MT

The Tx IMD requirement for IAB-MT specified in clause 6.7 of Rel-16 TS 38.174 [22] apply for WA and LA NCR-MT. The IM interference level is based on NCR-Fwd link.

## 6.14 Void

## 6.15 Diversity characteristics for NCR-MT

The Local Area NCR-MT is required to be equipped with a minimum of two Rx antenna ports in all operating bands except for the bands n7, n38, n41, n48, n77, n78, n79, n104 where the NCR-MT is required to be equipped with a minimum of four Rx antenna ports. This requirement applies when the band is used as a standalone band or as part of a band combination.

For the single carrier REFSENS requirements in Clause 6.16, the Local Area NCR-MT shall be verified with two Rx antenna ports in all supported frequency bands, additional requirements for four Rx ports shall be verified in operating bands where the NCR-MT is equipped with four Rx antenna ports.

For Rx requirements other than single carrier REFSENS in Clause 6.16, the NCR-MT shall be verified with four Rx antenna ports and skip two Rx antenna ports requirements in operating bands where the NCR-MT is equipped with four Rx antenna ports, otherwise, the NCR-MT shall be verified with two Rx antenna ports.

## 6.16 Reference sensitivity for NCR-MT

### 6.16.1 NCR-MT reference sensitivity level

#### 6.16.1.1 General

The reference sensitivity power level  $P_{\text{REFSENS}}$  is the minimum mean power received at the antenna connector for *NCR-MT type 1-C* or *TAB connector for NCR-MT type 1-H* at which a throughput requirement shall be met for a specified reference measurement channel.

#### 6.16.1.2 Minimum requirements for *NCR-MT type 1-C and 1-H*

The throughput shall be  $\geq 95\%$  of the maximum throughput of the reference measurement channel as specified in annex B.1.5.

The Wide Area NCR-MT reference sensitivity level is specified in table 6.16.1.2-1.

**Table 6.16.1.2-1: Wide Area NCR-MT reference sensitivity levels**

| NCR-MT channel bandwidth (MHz)                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Sub-carrier spacing (kHz) | Reference measurement channel | Reference sensitivity power level, $P_{\text{REFSENS}}$ (dBm) |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-------------------------------|---------------------------------------------------------------|
| 5,10,15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 15                        | G-FR1-A1-27 (Note 1)          | -101.5                                                        |
| 10, 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 30                        | G-FR1-A1-22 (Note 1)          | -102.0                                                        |
| 10, 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 60                        | G-FR1-A1-23 (Note 1)          | -99.0                                                         |
| 20, 25, 30, 35, 40, 45, 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 15                        | G-FR1-A1-24 (Note 1)          | -95.2                                                         |
| 20, 25, 30, 40, 50, 60, 70, 80, 90, 100                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 30                        | G-FR1-A1-25 (Note 1)          | -95.4                                                         |
| 20, 25, 30, 40, 50, 60, 70, 80, 90, 100                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 60                        | G-FR1-A1-26 (Note 1)          | -95.6                                                         |
| NOTE 1: $P_{\text{REFSENS}}$ is the power level of a single instance of the reference measurement channel. This requirement shall be met for each consecutive application of a single instance of the reference measurement channel mapped to disjoint frequency ranges with a width corresponding to the number of resource blocks of the reference measurement channel each, except for one instance that might overlap one other instance to cover the full <i>NCR-MT channel bandwidth</i> . |                           |                               |                                                               |

The Local Area NCR-MT reference sensitivity level is specified the same as specified in TS 38.101-1 [13] clause 7.3.

Referenced requirements applying to NB IoT are not applicable to the NCR-MT.

## 6.17 Maximum input level for NCR-MT

Maximum input level is defined as the maximum mean power received at the Local Area NCR-MT antenna port, at which the specified relative throughput shall meet or exceed the minimum requirements for the specified reference measurement channel. For Local Area NCR-MT, the throughput shall be  $\geq 95\%$  of the maximum throughput of the reference measurement channels as specified in 38.101-1 [13] Annex A.3.2 and Annex A.3.3 (with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1) with parameters specified in TS 38.101-1 [13] in Table 7.4-1.

## 6.18 Adjacent channel selectivity for NCR-MT

### 6.18.1 Adjacent Channel Selectivity (ACS)

#### 6.18.1.1 General

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

#### 6.18.1.2 Minimum requirement for *NCR-MT type 1-C* and *1-H*

The throughput shall be  $\geq 95\%$  of the maximum throughput of the reference measurement channel as specified in annex B.1.5. For Wide Area *NCR-MT type 1-C* and *type 1-H*, the requirement formulation and interferer levels for minimum requirement are the same as specified for Wide Area BS type 1-C and type 1-H in TS 38.104 [2], clause 7.4.1.2. The  $P_{\text{REFSENS}}$  used for wanted signal mean power in TS 38.104 [2] is specified in table 6.16.1.2-1 of TS 38.106.

For Local Area *NCR-MT type 1-C* and *type 1-H*, minimum requirement is the same as specified in TS 38.101-1 [13], clause 7.3.2.

#### 6.18.1.3 Void

## 6.19 Blocking characteristics for NCR-MT

### 6.19.1 General

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

### 6.19.2 Minimum requirement for NCR-MT type 1-C and 1-H

The throughput shall be  $\geq 95\%$  of the maximum throughput of the reference measurement channel as specified in annex B.1.5. For Wide Area *NCR-MT type 1-C* and *type 1-H*, the requirement formulation and interferer levels for minimum requirement are the same as specified for Wide Area BS type 1-C and type 1-H in TS 38.104 [2], clause 7.4.2.2. The  $P_{\text{REFSENS}}$  used for wanted signal mean power in TS 38.104 [2] is specified in table 6.16.1.2-1 of TS 38.106.

For Local Area *NCR-MT type 1-C* and *Type 1-H*, minimum requirement is the same as specified in TS 38.101-1 [13] clause 7.6.2.

#### 6.19.3 Void

## 6.20 Transmitter spurious response for NCR-MT

### 6.20.1 General

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

### 6.20.2 Minimum requirements for NCR-MT type 1-C and NCR-MT type 1-H

For Local Area *NCR-MT type 1-C* and *NCR-MT type 1-H*, minimum requirements are the same as specified in TS 38.101-1 [13], clause 7.7.

## 6.21 Receiver intermodulation characteristics for NCR-MT

### 6.21.1 General

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

### 6.21.2 Minimum requirement for NCR-MT type 1-C and 1-H

The throughput shall be  $\geq 95\%$  of the maximum throughput of the reference measurement channel as specified in annex B.1.5. For Wide Area *NCR-MT type 1-C* and *type 1-H*, the requirement formulation and interferer levels for minimum requirement are the same as specified for Wide Area BS type 1-C and type 1-H in TS 38.104 [2], clause 7.7.2. The  $P_{\text{REFSENS}}$  used for wanted signal mean power in TS 38.104 [2] is specified in table 6.16.1.2-1 of TS 38.106.

For Local Area *NCR-MT type 1-C* and *Type 1-H*, minimum requirement at antenna connector is the same as specified in TS 38.101-1 [13], clause 7.8.2.

### 6.21.3 Void

## 6.22 Receiver spurious emissions for NCR-MT

### 6.22.1 General

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

For *TAB connectors* supporting both RX and TX in TDD, the requirements apply during the *transmitter OFF period*.

For RX-only *multi-band connectors*, the spurious emissions requirements are subject to exclusion zones in each supported *operating band*. For *multi-band connectors* that both transmit and receive in *operating band* supporting TDD, RX spurious emissions requirements are applicable during the *TX OFF period*, and are subject to exclusion zones in each supported *operating band*.

For *NCR-MT type 1-H* manufacturer shall declare *TAB connector RX min cell groups*. Every *TAB connector* of *-NCR-MT type 1-H* supporting reception in an *operating band* shall map to one *TAB connector RX min cell group*, where mapping of *TAB connectors* to cells/beams is implementation dependent.

The number of active receiver units that are considered when calculating the conducted RX spurious emission limits ( $N_{RXU, \text{counted}}$ ) for Wide Area *NCR-MT type 1-H* is calculated as follows:

$$N_{RXU, \text{counted}} = \min(N_{RXU, \text{active}}, 8)$$

NOTE:  $N_{RXU, \text{active}}$  is the number of actually active receiver units.

### 6.22.2 Minimum requirements for *NCR-MT type 1-C* and *type 1-H*

The receiver spurious emissions requirements for *NCR-MT type 1-C* at the *antenna connector* and *NCR-MT type 1-H* are that for each *TAB connector*, the power of emissions shall not exceed the value specified in table 6.22.2-1.

**Table 6.22.2-1: *NCR-MT type 1-C* and *type 1-H* receiver spurious emissions minimum requirements**

| Spurious frequency range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Basic requirements | Measurement bandwidth | Note                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-----------------------|--------------------------------|
| 30 MHz – 1 GHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | -57 dBm            | 100 kHz               | Note 1                         |
| 1 GHz – 12.75 GHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | -47 dBm            | 1 MHz                 | Note 1, Note 2                 |
| 12.75 GHz – 5 <sup>th</sup> harmonic of the upper frequency edge of the UL <i>operating band</i> in GHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | -47 dBm            | 1 MHz                 | Note 1, Note 2, Note 3, Note 5 |
| 12.75 GHz - 26 GHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | -47 dBm            | 1 MHz                 | Note 1, Note 2, Note 6         |
| NOTE 1: <i>Measurement bandwidths</i> as in ITU-R SM.329 [5], s4.1.<br>NOTE 2: Upper frequency as in ITU-R SM.329 [5], s2.5 table 1.<br>NOTE 3: This spurious frequency range applies only for <i>operating bands</i> for which the 5 <sup>th</sup> harmonic of the upper frequency edge of the UL <i>operating band</i> is reaching beyond 12.75 GHz.<br>NOTE 4: The frequency range from $\Delta f_{\text{OBUE}}$ below the lowest frequency of the repeater transmitter <i>operating band</i> to $\Delta f_{\text{OBUE}}$ above the highest frequency of the repeater transmitter <i>operating band</i> may be excluded from the requirement. $\Delta f_{\text{OBUE}}$ is defined in clause 6.5.1. For <i>multi-band connectors</i> , the exclusion applies for all supported <i>operating bands</i> .<br>NOTE 5: Does not apply for band n104.<br>NOTE 6: Applies only for band n104. |                    |                       |                                |

## 7 Radiated characteristics

### 7.1 General

Clause 7 includes the radiated characteristics for both transmitter and receiver.

For radiated transmitter characteristics:

Radiated transmitter characteristics are specified at RIB for *repeater type 2-O*, *NCR-type 1-H* (including Fwd and MT interfaces), and *NCR type 2-O* (including Fwd and MT interfaces) including all its functional components active and for all foreseen modes of operation unless otherwise stated.

For radiated receiver characteristics:

Radiated receiver characteristics are specified at RIB for *NCR type 1-H* or *NCR type 2-O*, with full complement of transceivers for the configuration in normal operating condition.

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

- Requirements apply during the receive period.
- Requirements shall be met for any transmitter setting.
- Throughput requirements defined for the conducted receiver characteristics do not assume HARQ retransmissions.
- For ACS, blocking and intermodulation characteristics, the negative offsets of the interfering signal apply relative to the lower *passband* edge or *inter-passband gap*, and the positive offsets of the interfering signal apply relative to the upper *passband* edge or *inter-passband gap*.

NOTE 1: In normal operating condition the NCR-MT in TDD operation is configured to TX OFF power during *receive period*.

All requirements are defined for normal conditions, unless otherwise stated.

### 7.2 OTA output power

#### 7.2.1 General

*Repeater type 2-O*, *NCR-Fwd type 2-O* are declared to support one or more beams, as per manufacturer's declarations specified in TS 38.115-2 [8]. Radiated transmit power is defined as the EIRP level for a declared beam at a specific *beam peak direction*.

For each beam, the requirement is based on declaration of a beam identity, *reference beam direction pair*, beamwidth, *rated beam EIRP*, *OTA peak directions set*, the *beam direction pairs* at the maximum steering directions and their associated *rated beam EIRP* and beamwidth(s).

For a declared beam and *beam direction pair*, the *rated beam EIRP* level is the maximum power that the repeater is declared to radiate at the associated *beam peak direction*.

For each *beam peak direction* associated with a *beam direction pair* within the *OTA peak directions set*, a specific *rated beam EIRP* level may be claimed. Any claimed value shall be met within the accuracy requirement as described below. *Rated beam EIRP* is only required to be declared for the *beam direction pairs* subject to conformance testing as detailed in TS 38.115-2 [8].

NOTE 1: *OTA peak directions set* is set of *beam peak directions* for which the EIRP accuracy requirement is intended to be met. The *beam peak directions* are related to a corresponding contiguous range or discrete list of *beam centre directions* by the *beam direction pairs* included in the set.

NOTE 2: A *beam direction pair* is data set consisting of the *beam centre direction* and the related *beam peak direction*.

NOTE 3: A declared EIRP value is a value provided by the manufacturer for verification according to the conformance specification declaration requirements, whereas a claimed EIRP value is provided by the manufacturer to the equipment user for normal operation of the equipment and is not subject to formal conformance testing.

For *pass bands* where the supported *fractional bandwidth* (FBW) is larger than 6%, two rated beam EIRP may be declared by manufacturer:

- $P_{\text{rated,out,FBWlow}}$  for lower supported frequency range, and
- $P_{\text{rated,out,FBWhigh}}$  for higher supported frequency range.

For frequencies in between  $F_{\text{FBWlow}}$  and  $F_{\text{FBWhigh}}$  the rated beam EIRP is:

- $P_{\text{rated,out,FBWlow}}$ , for the output whose frequency is within frequency range  $F_{\text{FBWlow}} \leq f < (F_{\text{FBWlow}} + F_{\text{FBWhigh}}) / 2$ ,
- $P_{\text{rated,out,FBWhigh}}$ , for the output whose frequency is within frequency range  $(F_{\text{FBWlow}} + F_{\text{FBWhigh}}) / 2 \leq f \leq F_{\text{FBWhigh}}$ .

For *repeater type 2-O*, *NCR-Fwd type 2-O*, OTA repeater output power is also declared as a TRP radiated requirement, with the output power accuracy requirement defined at the RIB. TRP does not change with beamforming settings as long as the *beam peak direction* is within the *OTA peak directions set*. Thus, the TRP accuracy requirement shall be met for any beamforming setting for which the *beam peak direction* is within the *OTA peak directions set*.

There is no upper limit for the *rated TRP output power* and the *rated beam EIRP output power* of *repeater type 2-O* DL transmission.

The *repeater rated TRP output power* and the *rated beam EIRP output power* for *repeater type 2-O* UL transmission shall be within limits as specified in table 7.2.1-1.

**Table 7.2.1-1: Repeater rated TRP output power limits and rated EIRP output power limits for repeater type 2-O UL transmission**

| Repeater class                                                                                                                                | $P_{\text{rated,p,TRP}}$    | $P_{\text{rated,p,EIRP}}$   |
|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-----------------------------|
| Wide Area                                                                                                                                     | (note 1)                    | (note 1)                    |
| Local Area                                                                                                                                    | $\leq +35 + X$ dBm (Note 2) | $\leq +55 + X$ dBm (Note 2) |
| NOTE1: There is no upper limit for the $P_{\text{rated,p,TRP}}$ or $P_{\text{rated,p,EIRP}}$ of the <i>repeater type 2-O</i> UL transmission. |                             |                             |
| NOTE2: $X = 10 \cdot \log(\text{ceil}(\text{passband bandwidth}/100\text{MHz}))$                                                              |                             |                             |

There is no upper limit for the *rated TRP output power* and the *rated beam EIRP output power* of *NCR-Fwd type 2-O* DL transmission.

The *repeater rated TRP output power* and the *rated beam EIRP output power* for *NCR-Fwd type 2-O* UL transmission shall be within limits as specified in table 7.2.1-2.

**Table 7.2.1-2: Rated TRP output power limits and rated beam EIRP output power limits for NCR-Fwd type 2-O UL transmission**

| NCR-Fwd class                                                                                                                            | $P_{\text{rated,p,TRP}}$    | $P_{\text{rated,p,EIRP}}$   |
|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-----------------------------|
| Wide Area                                                                                                                                | (note 1)                    | (note 1)                    |
| Local Area                                                                                                                               | $\leq +35 + X$ dBm (Note 2) | $\leq +55 + X$ dBm (Note 2) |
| NOTE1: There is no upper limit for the $P_{\text{rated,p,TRP}}$ or $P_{\text{rated,p,EIRP}}$ of the <i>NCR type 2-O</i> UL transmission. |                             |                             |
| NOTE2: $X = 10 \cdot \log(\text{ceil}(\text{passband bandwidth}/100\text{MHz}))$                                                         |                             |                             |

## 7.2.2 Minimum requirement for RF repeater

The AoA of the input signal shall be the same as the reference direction for the *OTA peak directions set* when operating in the opposite DL/UL direction.

The requirements shall apply with NR signals in the *passband* of the repeater at:

The lowest input power ( $P_{p,in,EIRP}$ ) that produces the *rated passband TRP output power* ( $P_{rated,p,TRP}$ )

Up to:

The lowest input power ( $P_{p,in,EIRP}$ ) that produces the *rated passband TRP output power* ( $P_{rated,p,TRP}$ ), plus 10dB

In normal conditions, the measured output power,  $P_{max,p,EIRP}$  shall remain within +3.4 dB and -3.4 dB of the *rated beam EIRP output power*  $P_{rated,p,EIRP}$ , declared by the manufacturer.

In extreme conditions, the measured output power,  $P_{max,p,EIRP}$  shall remain within +4.5 dB and -4.5 dB of the *rated beam EIRP output power*  $P_{rated,p,EIRP}$ , declared by the manufacturer.

In normal conditions, the *repeater type 2-O maximum passband TRP output power*,  $P_{max,p,TRP}$  measured at the RIB shall remain within  $\pm 3$  dB of the *rated passband TRP output power*  $P_{rated,p,TRP}$ , as declared by the manufacturer.

## 7.2.3 Minimum requirement for NCR

### 7.2.3.1 Minimum requirement for NCR-MT

#### 7.2.3.1.1 Minimum requirement for NCR-MT type 1-H

For NCR-MT type 1-H, the IAB requirement specified in clause 9.2.2 in TS 38.174 [22] apply.

#### 7.2.3.1.2 Minimum requirement for NCR-MT type 2-O

For NCR-MT type 2-O, the IAB requirement specified in clause 9.2.3 in TS 38.174 [22] apply.

### 7.2.3.2 Minimum requirement for NCR-Fwd

#### 7.2.3.2.1 Minimum requirement for NCR-Fwd type 2-O

The AoA of the input signal shall be within the *Gain REFSENS RoAoA*.

The requirements shall apply with NR signals in the *passband* of the NCR-Fwd at:

- The lowest input power ( $P_{p,in,EIRP}$ ) that produces the *rated passband TRP output power* ( $P_{rated,p,TRP}$ )

Up to:

- The lowest input power ( $P_{p,in,EIRP}$ ) that produces the *rated passband TRP output power* ( $P_{rated,p,TRP}$ ), plus 10dB

In normal conditions, the measured output power,  $P_{max,p,EIRP}$  shall remain within +3.4 dB and -3.4 dB of the *rated beam EIRP output power*  $P_{rated,p,EIRP}$ , declared by the manufacturer.

In extreme conditions, the measured output power,  $P_{max,p,EIRP}$  shall remain within +4.5 dB and -4.5 dB of the *rated beam EIRP output power*  $P_{rated,p,EIRP}$ , declared by the manufacturer.

In normal conditions, the *repeater type 2-O maximum passband TRP output power*,  $P_{max,p,TRP}$  measured at the RIB shall remain within  $\pm 3$  dB of the *rated passband TRP output power*  $P_{rated,p,TRP}$ , as declared by the manufacturer.

## 7.3 OTA frequency stability

### 7.3.1 General

Frequency stability is the ability to maintain the same frequency on the output signal with respect to the input signal.

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

### 7.3.2 Minimum requirement for RF repeater

The frequency deviation of the output signal with respect to the input signal shall be no more than  $\pm 0,01$  PPM.

### 7.3.3 Minimum requirement for NCR

#### 7.3.3.1 Minimum requirement for NCR-Fwd

##### 7.3.3.1.1 Minimum requirement for NCR-Fwd type 2-O

The frequency deviation of the output signal with respect to the input signal shall be no more than  $\pm 0,01$  PPM.

## 7.4 OTA out of band gain

### 7.4.1 General

Out of band gain refers to the gain of the repeater outside the *passband*.

The requirement is based on the ratio of TRP output power to directional input power.

The intended use of a repeater in a system is to amplify the in-band signals and not to amplify signals outside of the *passband*.

In the intended application of the repeater, the out of band gain is less than lowest expected the coupling loss to the nearest source of emissions.

### 7.4.2 Minimum requirement for RF repeater

The gain outside the *passband* shall not exceed the maximum level specified in table 7.4.2-1, where:

- $f\_offset\_CW$  is the offset between the outer channel edge frequency of the outer channel in the *passband* and a CW signal.

**Table 7.4.2-1: Out of band gain limits 1**

| Frequency offset, $f\_offset\_CW$                                                        | Maximum gain |
|------------------------------------------------------------------------------------------|--------------|
| $0.1 * \text{Minimum}\{400\text{MHz}, \text{passband BW}\} \leq f\_offset\_CW < 150$ MHz | 68 dB        |
| $150 \text{ MHz} \leq f\_offset\_CW < 400 \text{ MHz}$                                   | 55 dB        |
| $400 \text{ MHz} \leq f\_offset\_CW < f\_offset\_max$                                    | 35 dB        |

### 7.4.3 Minimum requirement for NCR

#### 7.4.3.1 Minimum requirement for NCR-Fwd

##### 7.4.3.1.1 Minimum requirement for NCR-Fwd type 2-O

The gain outside the *passband* shall not exceed the maximum level specified in Table 7.4.2-1.

## 7.5 OTA unwanted emissions

### 7.5.1 General

Unwanted emissions consist of so-called out-of-band emissions and spurious emissions according to ITU definitions ITU-R SM.329 [5]. In ITU terminology, out of band emissions are unwanted emissions immediately outside the *passband* resulting from the modulation process and non-linearity in the transmitter but excluding spurious emissions. Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emission, intermodulation products and frequency conversion products, but exclude out of band emissions.

The OTA out-of-band emissions requirement for the *repeater type 2-O* transmitter is specified both in terms of Adjacent Channel Leakage power Ratio (ACLR) and operating band unwanted emissions (OBUE). OTA Unwanted emissions outside of this frequency range are limited by an OTA spurious emissions requirement.

The maximum offset of the operating band unwanted emissions mask from the *operating band* edge is  $\Delta f_{\text{OBUE}}$ . The value of  $\Delta f_{\text{OBUE}}$  are defined in table 7.5.1-1 and 7.5.1-2 for *repeater type 2-O* for NR *operating bands*.

**Table 7.5.1-1: Maximum offset  $\Delta f_{\text{OBUE}}$  outside the downlink operating band for repeater type 2-O and NCR-Fwd type 2-O DL**

| Repeater type                         | Operating band characteristics                         | $\Delta f_{\text{OBUE}}$ (MHz) |
|---------------------------------------|--------------------------------------------------------|--------------------------------|
| Repeater type 2-O<br>NCR-Fwd type 2-O | $F_{\text{DL,high}} - F_{\text{DL,low}} \leq 4000$ MHz | 1500                           |

**Table 7.5.1-2: Maximum offset  $\Delta f_{\text{OBUE}}$  outside the downlink operating band for repeater type 2-O and NCR-Fwd type 2-O UL**

| Repeater type                          | Operating band characteristics                         | $\Delta f_{\text{OBUE}}$ (MHz) |
|----------------------------------------|--------------------------------------------------------|--------------------------------|
| Repeater type 2-O,<br>NCR-Fwd type 2-O | $F_{\text{UL,high}} - F_{\text{UL,low}} \leq 4000$ MHz | 1500                           |

The unwanted emission requirements are applied per cell for all the configurations. Requirements for OTA unwanted emissions are captured using TRP, *directional requirements* or co-location requirements as described per requirement.

If the NCR supports simultaneous NCR-MT and NCR-Fwd transmission, then the unwanted emissions requirements should be defined on the total emissions from NCR-MT and NCR-Fwd.

### 7.5.2 OTA Adjacent Channel Leakage Power Ratio (ACLR)

#### 7.5.2.1 General

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

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

#### 7.5.2.2 Minimum requirement for *RF repeater*

The OTA ACLR limit is specified in table 7.5.2.2-1 for DL and UL for Wide Area class and DL for Local Area class.

The OTA ACLR limit is specified in table 7.5.2.2-1a for UL for Local Area class.

The OTA ACLR absolute limit is specified in table 7.5.2.2-2.

Either the OTA ACLR (CACLR) absolute limit in table 7.5.2.2-2 or 7.5.2.2-5 or the relevant ACLR (CACLR) limit in table 7.5.2.2-1, 7.5.2.2-1a, 7.5.2.2-3, 7.5.2.2-3a, 7.5.2.2-4 or 7.5.2.2-4a, whichever is less stringent, shall apply.

For a RIB operating in *non-contiguous spectrum*, the OTA ACLR requirement in table 7.5.2.2-3 shall apply in *gaps between passbands* for the frequency ranges defined in the table, while the OTA CACLR requirement in table 7.5.2.2-4 shall apply in *gaps between passbands* for the frequency ranges defined in the table.

The CACLR in a *gap between passbands* is the ratio of:

- a) the sum of the filtered mean power centred on the assigned channel frequencies for the two carriers adjacent to each side of the *gap between passbands*, and
- b) the filtered mean power centred on a frequency channel adjacent to one of the respective *passband* edges.

The assumed filter for the adjacent channel frequency is defined in table 7.5.2.2-4 and the filters on the assigned channels are defined in table 7.5.2.2-6.

For operation in *non-contiguous spectrum*, the CACLR for NR carriers located on either side of the *gap between passbands* shall be higher than the value specified in table 7.5.2.2-4.

**Table 7.5.2.2-1: Repeater type 2-O ACLR limit for DL and UL for WA class and DL for LA class**

| Repeater nominal channel bandwidth<br>$BW_{\text{Nominal}}$<br>(MHz)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Repeater adjacent channel centre frequency offset below or above the passband edge | Assumed adjacent channel carrier | Filter on the adjacent channel frequency and corresponding filter bandwidth | ACLR limit (dB)            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------------|----------------------------|
| 50, 100, 200, 400                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $BW_{\text{Nominal}}/2$                                                            | NR of same BW<br>(Note 2)        | Square<br>( $BW_{\text{Config}}$ )                                          | 28 (Note 3)<br>26 (Note 4) |
| NOTE 1: $BW_{\text{Nominal}}$ is the <i>nominal channel bandwidth</i> . $BW_{\text{Config}}$ is the <i>transmission bandwidth configuration</i> assumed for the adjacent channel.<br>NOTE 2: With SCS that provides the largest <i>transmission bandwidth configuration</i> ( $BW_{\text{Config}}$ ).<br>NOTE 3: Applicable to bands defined within the frequency spectrum range of 24.25 – 33.4 GHz<br>NOTE 4: Applicable to bands defined within the frequency spectrum range of 37 – 52.6 GHz<br>NOTE 5: For simultaneous NCR-Fwd and NCR-MT transmission, if the NCR-MT carrier is within the passband then the nominal channel bandwidth shall be calculated based on the the bandwidth between the lower edge of the passband and the lower edge of the NCR-MT carrier for lower side, or between the upper edge of the passband and the upper edge of the NCR-MT carrier for upper side. If the NCT-MT carrier is adjacent to the passband then ACLR requirement for NCR-MT based on NCR-MT channel bandwidth shall be applied for the NCR-MT carrier side and the nominal channel bandwidth calculated with the passband bandwidth shall be used for the passband side. If the NCR-MT carrier is not adjacent to the passband then CACLR shall be applied in the gap between the passband and the NCR-MT carrier. |                                                                                    |                                  |                                                                             |                            |

**Table 7.5.2.2-1a: Repeater type 2-O ACLR limit for UL LA class**

| Repeater nominal channel bandwidth<br>$BW_{\text{Nominal}}$<br>(MHz)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Repeater adjacent channel centre frequency offset below or above the passband edge | Assumed adjacent channel carrier | Filter on the adjacent channel frequency and corresponding filter bandwidth | ACLR limit (dB)            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------------|----------------------------|
| 50, 100, 200, 400                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | $BW_{\text{Nominal}}/2$                                                            | NR of same BW<br>(Note 2)        | Square<br>( $BW_{\text{Config}}$ )                                          | 17 (Note 3)<br>16 (Note 4) |
| NOTE 1: $BW_{\text{Nominal}}$ is the <i>nominal channel bandwidth</i> . $BW_{\text{Config}}$ is the <i>transmission bandwidth configuration</i> assumed for the adjacent channel.<br>NOTE 2: With SCS that provides the largest <i>transmission bandwidth configuration</i> ( $BW_{\text{Config}}$ ).<br>NOTE 3: Applicable to bands defined within the frequency spectrum range of 24.25 – 33.4 GHz<br>NOTE 4: Applicable to bands defined within the frequency spectrum range of 37 – 52.6 GHz<br>NOTE 5: For simultaneous NCR-Fwd and NCR-MT transmission, if the NCR-MT carrier is within the passband then the nominal channel bandwidth shall be calculated based on the the bandwidth between the lower edge of the passband and the lower edge of the NCR-MT carrier for lower side, or between the upper edge of the passband and the upper edge of the NCR-MT carrier for upper side. If the NCT-MT carrier is adjacent to the passband then ACLR requirement for NCR-MT based on NCR-MT channel bandwidth shall be applied for the NCR-MT carrier side and the nominal channel bandwidth calculated with the passband bandwidth shall be used for the passband side. If the NCR-MT carrier is not adjacent to the passband then CACLR shall be applied in the gap between the passband and the NCR-MT carrier. |                                                                                    |                                  |                                                                             |                            |

**Table 7.5.2.2-2: Repeater type 2-O ACLR absolute limit**

| Repeater class      | ACLR absolute limit |
|---------------------|---------------------|
| Wide area DL and UL | -13 dBm/MHz         |
| Medium range DL     | -20 dBm/MHz         |
| Local area DL       | -20 dBm/MHz         |

**Table 7.5.2.2-3: Repeater type 2-O ACLR limit in non-contiguous spectrum for DL and UL for WA class and DL for LA class**

| Repeater nominal channel bandwidth<br>$BW_{\text{Nominal}}$ (MHz) | Gap between passbands size ( $W_{\text{gap}}$ ) where the limit applies (MHz) | Repeater adjacent channel centre frequency offset below or above the passband edge (inside the gap) | Assumed adjacent channel carrier | Filter on the adjacent channel frequency and corresponding filter bandwidth | ACLR limit                 |
|-------------------------------------------------------------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------------|----------------------------|
| 50, 100, 200, 400                                                 | $W_{\text{gap}} \geq 100$ (Note 5)<br>$W_{\text{gap}} \geq 250$ (Note 6)      | 25 MHz                                                                                              | 50 MHz NR (Note 2)               | Square ( $BW_{\text{Config}}$ )                                             | 28 (Note 3)<br>26 (Note 4) |
| 50, 100, 200, 400                                                 | $W_{\text{gap}} \geq 400$ (Note 6)<br>$W_{\text{gap}} \geq 250$ (Note 5)      | 100 MHz                                                                                             | 200 MHz NR (Note 2)              | Square ( $BW_{\text{Config}}$ )                                             | 28 (Note 3)<br>26 (Note 4) |

NOTE 1:  $BW_{\text{Nominal}}$  is the *nominal channel bandwidth*.  $BW_{\text{Config}}$  is the *transmission bandwidth configuration* assumed for the adjacent channel.

NOTE 2: With SCS that provides the largest *transmission bandwidth configuration* ( $BW_{\text{Config}}$ ).

NOTE 3: Applicable to bands defined within the frequency spectrum range of 24.25 – 33.4 GHz.

NOTE 4: Applicable to bands defined within the frequency spectrum range of 37 – 52.6 GHz.

NOTE 5: Applicable in case the *repeater type 2-O nominal channel bandwidth* at the other edge of the gap is  $\leq 100$  MHz.

NOTE 6: Applicable in case the *repeater type 2-O nominal channel bandwidth* at the other edge of the gap is  $> 100$  MHz.

**Table 7.5.2.2-3a: Repeater type 2-O ACLR limit in non-contiguous spectrum for UL for LA class**

| Repeater nominal channel bandwidth<br>$BW_{\text{Nominal}}$ (MHz) | Gap between passbands size ( $W_{\text{gap}}$ ) where the limit applies (MHz) | Repeater adjacent channel centre frequency offset below or above the passband edge (inside the gap) | Assumed adjacent channel carrier | Filter on the adjacent channel frequency and corresponding filter bandwidth | ACLR limit                 |
|-------------------------------------------------------------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------------|----------------------------|
| 50, 100, 200, 400                                                 | $W_{\text{gap}} \geq 100$ (Note 5)<br>$W_{\text{gap}} \geq 250$ (Note 6)      | 25 MHz                                                                                              | 50 MHz NR (Note 2)               | Square ( $BW_{\text{Config}}$ )                                             | 17 (Note 3)<br>16 (Note 4) |
| 50, 100, 200, 400                                                 | $W_{\text{gap}} \geq 400$ (Note 6)<br>$W_{\text{gap}} \geq 250$ (Note 5)      | 100 MHz                                                                                             | 200 MHz NR (Note 2)              | Square ( $BW_{\text{Config}}$ )                                             | 17 (Note 3)<br>16 (Note 4) |

NOTE 1:  $BW_{\text{Config}}$  is the *transmission bandwidth configuration* assumed for the adjacent channel.

NOTE 2: With SCS that provides the largest *transmission bandwidth configuration* ( $BW_{\text{Config}}$ ).

NOTE 3: Applicable to bands defined within the frequency spectrum range of 24.25 – 33.4 GHz.

NOTE 4: Applicable to bands defined within the frequency spectrum range of 37 – 52.6 GHz.

NOTE 5: Applicable in case the *repeater type 2-O nominal channel bandwidth* at the other edge of the gap is  $\leq 100$  MHz.

NOTE 6: Applicable in case the *repeater type 2-O nominal channel bandwidth* at the other edge of the gap is  $> 100$  MHz.

**Table 7.5.2.2-4: Repeater type 2-O CACLR limit in non-contiguous spectrum for DL and UL for WA class and DL for LA class**

| Repeater nominal channel bandwidth<br>$BW_{\text{Nominal}}$ (MHz) | Gap between passbands size ( $W_{\text{gap}}$ ) where the limit applies (MHz)        | Repeater adjacent channel centre frequency offset below or above the passband edge (inside the gap) | Assumed adjacent channel carrier | Filter on the adjacent channel frequency and corresponding filter bandwidth | CACLR limit                |
|-------------------------------------------------------------------|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------------|----------------------------|
| 50, 100, 200, 400                                                 | $50 \leq W_{\text{gap}} < 100$ (Note 5)<br>$50 \leq W_{\text{gap}} < 250$ (Note 6)   | 25 MHz                                                                                              | 50 MHz NR (Note 2)               | Square ( $BW_{\text{Config}}$ )                                             | 28 (Note 3)<br>26 (Note 4) |
| 50, 100, 200, 400                                                 | $200 \leq W_{\text{gap}} < 400$ (Note 6)<br>$200 \leq W_{\text{gap}} < 250$ (Note 5) | 100 MHz                                                                                             | 200 MHz NR (Note 2)              | Square ( $BW_{\text{Config}}$ )                                             | 28 (Note 3)<br>26 (Note 4) |

NOTE 1:  $BW_{\text{Config}}$  is the *transmission bandwidth configuration* assumed for the adjacent channel.  
NOTE 2: With SCS that provides the largest *transmission bandwidth configuration* ( $BW_{\text{Config}}$ ).  
NOTE 3: Applicable to bands defined within the frequency spectrum range of 24.25 – 33.4 GHz.  
NOTE 4: Applicable to bands defined within the frequency spectrum range of 37 – 52.6 GHz.  
NOTE 5: Applicable in case the *repeater type 2-O nominal channel bandwidth* at the other edge of the gap is  $\leq 100$  MHz.  
NOTE 6: Applicable in case the *repeater type 2-O nominal channel bandwidth* at the other edge of the gap is  $> 100$  MHz.

**Table 7.5.2.2-4a: Repeater type 2-O CACLR limit in non-contiguous spectrum for UL for LA class**

| Repeater nominal channel bandwidth<br>$BW_{\text{Nominal}}$ (MHz) | Gap between passbands size ( $W_{\text{gap}}$ ) where the limit applies (MHz)        | Repeater adjacent channel centre frequency offset below or above the passband edge (inside the gap) | Assumed adjacent channel carrier | Filter on the adjacent channel frequency and corresponding filter bandwidth | CACLR limit                |
|-------------------------------------------------------------------|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------------|----------------------------|
| 50, 100, 200, 400                                                 | $50 \leq W_{\text{gap}} < 100$ (Note 5)<br>$50 \leq W_{\text{gap}} < 250$ (Note 6)   | 25 MHz                                                                                              | 50 MHz NR (Note 2)               | Square ( $BW_{\text{Config}}$ )                                             | 17 (Note 3)<br>16 (Note 4) |
| 50, 100, 200, 400                                                 | $200 \leq W_{\text{gap}} < 400$ (Note 6)<br>$200 \leq W_{\text{gap}} < 250$ (Note 5) | 100 MHz                                                                                             | 200 MHz NR (Note 2)              | Square ( $BW_{\text{Config}}$ )                                             | 17 (Note 3)<br>16 (Note 4) |

NOTE 1:  $BW_{\text{Config}}$  is the *transmission bandwidth configuration* assumed for the adjacent channel.  
NOTE 2: With SCS that provides the largest *transmission bandwidth configuration* ( $BW_{\text{Config}}$ ).  
NOTE 3: Applicable to bands defined within the frequency spectrum range of 24.25 – 33.4 GHz.  
NOTE 4: Applicable to bands defined within the frequency spectrum range of 37 – 52.6 GHz.  
NOTE 5: Applicable in case the *repeater type 2-O nominal channel bandwidth* at the other edge of the gap is  $\leq 100$  MHz.  
NOTE 6: Applicable in case the *repeater type 2-O nominal channel bandwidth* at the other edge of the gap is  $> 100$  MHz.

**Table 7.5.2.2-5: Repeater type 2-O CACLR absolute limit**

| Repeater class      | CACLR absolute limit |
|---------------------|----------------------|
| Wide area DL and UL | -13 dBm/MHz          |
| Medium range DL     | -20 dBm/MHz          |
| Local area DL       | -20 dBm/MHz          |

**Table 7.5.2.2-6: Filter parameters for the assigned channel**

| RAT of the carrier adjacent to the gap between passbands | Filter on the assigned channel frequency and corresponding filter bandwidth              |
|----------------------------------------------------------|------------------------------------------------------------------------------------------|
| NR                                                       | NR of same BW with SCS that provides largest <i>transmission bandwidth configuration</i> |

### 7.5.2.3 Minimum requirement for NCR

#### 7.5.2.3.1 Minimum requirement for NCR-Fwd

##### 7.5.2.3.1.1 Minimum requirement for NCR-Fwd *type 2-O*

The requirements in clause 7.5.2.2 apply for NCR-Fwd *type 2-O*. The limits apply to the sum of emissions from NCR-MT and NCR-FWD when transmitting simultaneously.

#### 7.5.2.3.2 Minimum requirement for NCR-MT

##### 7.5.2.3.2.1 Minimum requirement for NCR-MT *type 2-O*

For WA NCR-MT *type 2-O*, the BS ACLR requirements specified in clause 9.7.3.3 in TS 38.104 apply.

For LA NCR-MT *type 2-O*, the UE ACLR requirements specified in clause 6.5.2.3 in TS 38.101-2 apply.

For simultaneous transmission the limits apply for sum of NCR-MT transmission and NCR-Fwd transmission

## 7.5.3 OTA operating band unwanted emissions

### 7.5.3.1 General

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

In addition to, for the part of passband where there is no input signal, -13dBm/MHz shall apply for all classes DL and UL.

### 7.5.3.2 Minimum requirement for RF repeater

#### 7.5.3.2.1 General

The requirements of either clause 7.5.3.2.2 (Category A limits) or clause 7.5.3.2.3 (Category B limits) shall apply. The application of either Category A or Category B limits shall be the same as for General OTA transmitter spurious emissions requirements (*repeater type 2-O*) in clause 7.5.3.3.2. In addition, the limits in clause 7.5.3.2.4 may also apply.

Out-of-band emissions in FR2 are limited by OTA operating band unwanted emission limits.

For *repeater type 2-O*, unless otherwise stated, the OTA operating band unwanted emission limits in FR2 are defined from  $\Delta f_{\text{OBUE}}$  below the lowest frequency of each supported downlink *operating band* up to  $\Delta f_{\text{OBUE}}$  above the highest frequency of each supported downlink *operating band*.

The values of  $\Delta f_{\text{OBUE}}$  are defined in table 7.5.1-1 and 7.5.1-2 for the NR *operating bands*.

The requirements shall apply whatever the type of transmitter considered and for all transmission modes foreseen by the manufacturer's specification. For a *RIB* operating in contiguous CA, the requirements apply to the frequencies ( $\Delta f_{\text{OBUE}}$ ) starting from the edge of the *passband*. In addition, for a *RIB* operating in *non-contiguous spectrum*, the requirements apply inside any *gap between passbands*.

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

- $\Delta f$  is the separation between the *passband* edge frequency and the nominal -3dB point of the measuring filter closest to the *passband* edge.
- $f_{\text{offset}}$  is the separation between the *passband* edge frequency and the centre of the measuring filter.
- $f_{\text{offset}_{\text{max}}}$  is the offset to the frequency  $\Delta f_{\text{OBUE}}$  outside the downlink *operating band*, where  $\Delta f_{\text{OBUE}}$  is defined in table 7.5.1-1 and 7.5.1-2..

- $\Delta f_{\max}$  is equal to  $f_{\text{offset}_{\max}}$  minus half of the bandwidth of the measuring filter.

In addition, inside any *gap between passbands* for a *RIB* operating in *non-contiguous spectrum*, emissions shall not exceed the cumulative sum of the limits specified for the adjacent *sub-blocks* on each side of the *gap between passbands*. The limit for each *sub-block* is specified in clauses 7.5.3.2.2 and 7.5.3.2.3 below, where in this case:

- $\Delta f$  is the separation between the *sub-block* edge frequency and the nominal -3 dB point of the measuring filter closest to the *sub-block* edge.
- $f_{\text{offset}}$  is the separation between the *sub-block* edge frequency and the centre of the measuring filter.
- $f_{\text{offset}_{\max}}$  is equal to the *gap between passbands* bandwidth minus half of the bandwidth of the measuring filter.
- $\Delta f_{\max}$  is equal to  $f_{\text{offset}_{\max}}$  minus half of the bandwidth of the measuring filter.

#### 7.5.3.2.2 OTA operating band unwanted emission limits (Category A)

*Repeater type 2-O* unwanted emissions shall not exceed the maximum levels specified in tables 7.5.3.2.2-1 and 7.5.3.2.2-2.

**Table 7.5.3.2.2-1: OBUE limits applicable in the frequency range 24.25 – 33.4 GHz**

| Frequency offset of measurement filter -3B point, $\Delta f$                                                                                                                                                                                                               | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                                  | Limit                                                                  | Measurement bandwidth |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 0.1 \cdot \text{BW}_{\text{contiguous}}$                                                                                                                                                                                                    | $0.5 \text{ MHz} \leq f_{\text{offset}} < 0.1 \cdot \text{BW}_{\text{contiguous}} + 0.5 \text{ MHz}$          | Min(-5 dBm, Max( $P_{\text{rated,t,TRP}} - 35 \text{ dB}$ , -12 dBm))  | 1 MHz                 |
| $0.1 \cdot \text{BW}_{\text{contiguous}} \leq \Delta f < \Delta f_{\max}$                                                                                                                                                                                                  | $0.1 \cdot \text{BW}_{\text{contiguous}} + 0.5 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\max}}$ | Min(-13 dBm, Max( $P_{\text{rated,t,TRP}} - 43 \text{ dB}$ , -20 dBm)) | 1 MHz                 |
| NOTE 1: For <i>non-contiguous spectrum</i> operation within any <i>operating band</i> the limit within <i>gaps between passbands</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i> . |                                                                                                               |                                                                        |                       |

**Table 7.5.3.2.2-2: OBUE limits applicable in the frequency range 37 – 52.6 GHz**

| Frequency offset of measurement filter -3B point, $\Delta f$                                                                                                                                                                                                               | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                                  | Limit                                                                  | Measurement bandwidth |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 0.1 \cdot \text{BW}_{\text{contiguous}}$                                                                                                                                                                                                    | $0.5 \text{ MHz} \leq f_{\text{offset}} < 0.1 \cdot \text{BW}_{\text{contiguous}} + 0.5 \text{ MHz}$          | Min(-5 dBm, Max( $P_{\text{rated,t,TRP}} - 33 \text{ dB}$ , -12 dBm))  | 1 MHz                 |
| $0.1 \cdot \text{BW}_{\text{contiguous}} \leq \Delta f < \Delta f_{\max}$                                                                                                                                                                                                  | $0.1 \cdot \text{BW}_{\text{contiguous}} + 0.5 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\max}}$ | Min(-13 dBm, Max( $P_{\text{rated,t,TRP}} - 41 \text{ dB}$ , -20 dBm)) | 1 MHz                 |
| NOTE 1: For <i>non-contiguous spectrum</i> operation within any <i>operating band</i> the limit within <i>gaps between passbands</i> is calculated as a cumulative sum of contributions from adjacent <i>sub-blocks</i> on each side of the <i>gap between passbands</i> . |                                                                                                               |                                                                        |                       |

### 7.5.3.2.3 OTA operating band unwanted emission limits (Category B)

Repeater type 2-O unwanted emissions shall not exceed the maximum levels specified in table 7.5.3.2.3-1 or 7.5.3.2.3-2.

**Table 7.5.3.2.3-1: OBUE limits applicable in the frequency range 24.25 – 33.4 GHz**

| Frequency offset of measurement filter -3 dB point, $\Delta f$                                                                                                                                                                                               | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                                               | Limit                                                                  | Measurement bandwidth |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 0.1 \cdot \text{BW}_{\text{contiguous}}$                                                                                                                                                                                      | $0.5 \text{ MHz} \leq f_{\text{offset}} < 0.1 \cdot \text{BW}_{\text{contiguous}} + 0.5 \text{ MHz}$                       | Min(-5 dBm, Max( $P_{\text{rated,t,TRP}} - 35 \text{ dB}$ , -12 dBm))  | 1 MHz                 |
| $0.1 \cdot \text{BW}_{\text{contiguous}} \leq \Delta f < \Delta f_{\text{B}}$                                                                                                                                                                                | $0.1 \cdot \text{BW}_{\text{contiguous}} + 0.5 \text{ MHz} \leq f_{\text{offset}} < \Delta f_{\text{B}} + 0.5 \text{ MHz}$ | Min(-13 dBm, Max( $P_{\text{rated,t,TRP}} - 43 \text{ dB}$ , -20 dBm)) | 1 MHz                 |
| $\Delta f_{\text{B}} \leq \Delta f < \Delta f_{\text{max}}$                                                                                                                                                                                                  | $\Delta f_{\text{B}} + 5 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$                              | Min(-5 dBm, Max( $P_{\text{rated,t,TRP}} - 33 \text{ dB}$ , -10 dBm))  | 10 MHz                |
| NOTE 1: For non-contiguous spectrum operation within any <i>operating band</i> the limit within gaps between <i>passbands</i> is calculated as a cumulative sum of contributions from adjacent sub-blocks on each side of the gap between <i>passbands</i> . |                                                                                                                            |                                                                        |                       |
| NOTE 2: $\Delta f_{\text{B}} = 2 \cdot \text{BW}_{\text{contiguous}}$ when $\text{BW}_{\text{contiguous}} \leq 500 \text{ MHz}$ , otherwise $\Delta f_{\text{B}} = \text{BW}_{\text{contiguous}} + 500 \text{ MHz}$ .                                        |                                                                                                                            |                                                                        |                       |

**Table 7.5.3.2.3-2: OBUE limits applicable in the frequency range 37 – 52.6 GHz**

| Frequency offset of measurement filter -3 dB point, $\Delta f$                                                                                                                                                                                               | Frequency offset of measurement filter centre frequency, $f_{\text{offset}}$                                               | Limit                                                                  | Measurement bandwidth |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|-----------------------|
| $0 \text{ MHz} \leq \Delta f < 0.1 \cdot \text{BW}_{\text{contiguous}}$                                                                                                                                                                                      | $0.5 \text{ MHz} \leq f_{\text{offset}} < 0.1 \cdot \text{BW}_{\text{contiguous}} + 0.5 \text{ MHz}$                       | Min(-5 dBm, Max( $P_{\text{rated,t,TRP}} - 33 \text{ dB}$ , -12 dBm))  | 1 MHz                 |
| $0.1 \cdot \text{BW}_{\text{contiguous}} \leq \Delta f < \Delta f_{\text{B}}$                                                                                                                                                                                | $0.1 \cdot \text{BW}_{\text{contiguous}} + 0.5 \text{ MHz} \leq f_{\text{offset}} < \Delta f_{\text{B}} + 0.5 \text{ MHz}$ | Min(-13 dBm, Max( $P_{\text{rated,t,TRP}} - 41 \text{ dB}$ , -20 dBm)) | 1 MHz                 |
| $\Delta f_{\text{B}} \leq \Delta f < \Delta f_{\text{max}}$                                                                                                                                                                                                  | $\Delta f_{\text{B}} + 5 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$                              | Min(-5 dBm, Max( $P_{\text{rated,t,TRP}} - 31 \text{ dB}$ , -10 dBm))  | 10 MHz                |
| NOTE 1: For non-contiguous spectrum operation within any <i>operating band</i> the limit within gaps between <i>passbands</i> is calculated as a cumulative sum of contributions from adjacent sub-blocks on each side of the gap between <i>passbands</i> . |                                                                                                                            |                                                                        |                       |
| NOTE 2: $\Delta f_{\text{B}} = 2 \cdot \text{BW}_{\text{contiguous}}$ when $\text{BW}_{\text{contiguous}} \leq 500 \text{ MHz}$ , otherwise $\Delta f_{\text{B}} = \text{BW}_{\text{contiguous}} + 500 \text{ MHz}$ .                                        |                                                                                                                            |                                                                        |                       |

### 7.5.3.2.4 Additional OTA operating band unwanted emission requirements

#### 7.5.3.2.4.1 Protection of Earth Exploration Satellite Service

For repeater operating in the frequency range 24.25 – 27.5 GHz, the power of unwanted emission shall not exceed the limits in table 7.5.3.2.4.1-1 for DL and in table 7.5.3.2.4.1-2.

**Table 7.5.3.2.4.1-1: OBUE limits for protection of Earth Exploration Satellite Service for DL**

| Frequency range                                                                                                                                | Limit           | Measurement Bandwidth |
|------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------|
| 23.6 – 24 GHz                                                                                                                                  | -3 dBm (Note 1) | 200 MHz               |
| 23.6 – 24 GHz                                                                                                                                  | -9 dBm (Note 2) | 200 MHz               |
| NOTE 1: This limit applies to repeater brought into use on or before 1 September 2027 in countries not adopting EU Decision 2020/590 [31].     |                 |                       |
| NOTE 2: This limit applies to repeater brought into use after 1 September 2027 or to repeater in countries adopting EU Decision 2020/590 [31]. |                 |                       |

**Table 7.5.3.2.4.1-2: OBUE limits for protection of Earth Exploration Satellite Service for UL**

| Frequency range | Limit | Measurement Bandwidth |
|-----------------|-------|-----------------------|
| 23.6 – 24 GHz   | 1 dBm | 200 MHz               |

### 7.5.3.3 Minimum requirement for NCR

#### 7.5.3.3.1 Minimum requirement for NCR-Fwd

##### 7.5.3.3.1.1 Minimum requirement for NCR-Fwd *type 2-O*

The requirements in clause 7.5.3.2 apply for NCR-Fwd *type 2-O*. The limits apply to the sum of emissions from NCR-MT and NCR-Fwd when transmitting simultaneously.

#### 7.5.3.3.2 Minimum requirement for NCR-MT

##### 7.5.3.3.2.1 Minimum requirement for NCR-MT *type 2-O*

For Wide Area *NCR-MT type 2-O*, the BS OBUE requirements specified in clause 9.7.4.3 in TS 38.104 [2] apply.

For Local Area *NCR-MT type 2-O*, the UE SEM requirements specified in clause 6.5.2.1 in TS 38.101-2 [14] apply.

## 7.5.4 OTA transmitter spurious emissions

### 7.5.4.1 General

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

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

#### 7.5.4.2 Minimum requirement for *RF repeater*

##### 7.5.4.2.1 General

For *repeater type 2-O*, the OTA transmitter spurious emission limits apply from 30 MHz to 2<sup>nd</sup> harmonic of the upper frequency edge of the downlink *operating band*, excluding the frequency range from  $\Delta f_{\text{OBUE}}$  below the lowest frequency of the downlink *operating band*, up to  $\Delta f_{\text{OBUE}}$  above the highest frequency of the downlink *operating band*, where the  $\Delta f_{\text{OBUE}}$  is defined in table 7.5.1-1 and 7.5.1-2.

### 7.5.4.2.2 General OTA transmitter spurious emissions requirements

#### 7.5.4.2.2.1 General

The requirements of either clause 7.5.4.2.2.2 (Category A limits) or clause 7.5.4.2.2.3 (Category B limits) shall apply. The application of either Category A or Category B limits shall be the same as for Operating band unwanted emissions in clause 7.5.3.

#### 7.5.4.2.2.2 OTA transmitter spurious emissions (Category A)

The power of any spurious emission shall not exceed the limits in table 7.5.4.2.2.2-1.

**Table 7.5.4.2.2.2-1: Repeater radiated Tx spurious emission limits in FR2**

| Frequency range                                                                                                 | Limit   | Measurement Bandwidth | Note           |
|-----------------------------------------------------------------------------------------------------------------|---------|-----------------------|----------------|
| 30 MHz – 1 GHz                                                                                                  | -13 dBm | 100 kHz               | Note 1         |
| 1 GHz – 2 <sup>nd</sup> harmonic of the upper frequency edge of the <i>operating band</i>                       |         | 1 MHz                 | Note 1, Note 2 |
| NOTE 1: Bandwidth as in ITU-R SM.329 [5], s4.1<br>NOTE 2: Upper frequency as in ITU-R SM.329 [5], s2.5 table 1. |         |                       |                |

#### 7.5.4.2.2.3 OTA transmitter spurious emissions (Category B)

The power of any spurious emission shall not exceed the limits in table 7.5.4.2.2.3-1.

**Table 7.5.4.2.2.3-1: Repeater radiated Tx spurious emission limits in FR2 (Category B)**

| Frequency range (Note 4)                                                                                              | Limit   | Measurement Bandwidth | Note           |
|-----------------------------------------------------------------------------------------------------------------------|---------|-----------------------|----------------|
| 30 MHz ↔ 1 GHz                                                                                                        | -36 dBm | 100 kHz               | Note 1         |
| 1 GHz ↔ 18 GHz                                                                                                        | -30 dBm | 1 MHz                 | Note 1         |
| 18 GHz ↔ $F_{\text{step},1}$                                                                                          | -20 dBm | 10 MHz                | Note 2         |
| $F_{\text{step},1} \leftrightarrow F_{\text{step},2}$                                                                 | -15 dBm | 10 MHz                | Note 2         |
| $F_{\text{step},2} \leftrightarrow F_{\text{step},3}$                                                                 | -10 dBm | 10 MHz                | Note 2         |
| $F_{\text{step},4} \leftrightarrow F_{\text{step},5}$                                                                 | -10 dBm | 10 MHz                | Note 2         |
| $F_{\text{step},5} \leftrightarrow F_{\text{step},6}$                                                                 | -15 dBm | 10 MHz                | Note 2         |
| $F_{\text{step},6} \leftrightarrow$ 2 <sup>nd</sup> harmonic of the upper frequency edge of the <i>operating band</i> | -20 dBm | 10 MHz                | Note 2, Note 3 |
| NOTE 1: Bandwidth as in ITU-R SM.329 [5], s4.1                                                                        |         |                       |                |
| NOTE 2: Limit and bandwidth as in ERC Recommendation 74-01 [9], Annex 2.                                              |         |                       |                |
| NOTE 3: Upper frequency as in ITU-R SM.329 [5], s2.5 table 1.                                                         |         |                       |                |
| NOTE 4: The step frequencies $F_{\text{step},X}$ are defined in Table 7.5.4.2.2.3-2.                                  |         |                       |                |

**Table 7.5.4.2.2.3-2: Step frequencies for defining the Repeater radiated Tx spurious emission limits in FR2 (Category B)**

| Operating band                                                                                                                 | $F_{\text{step},1}$ (GHz) | $F_{\text{step},2}$ (GHz) | $F_{\text{step},3}$ (GHz) (Note 2) | $F_{\text{step},4}$ (GHz) (Note 2) | $F_{\text{step},5}$ (GHz) | $F_{\text{step},6}$ (GHz) |
|--------------------------------------------------------------------------------------------------------------------------------|---------------------------|---------------------------|------------------------------------|------------------------------------|---------------------------|---------------------------|
| n257                                                                                                                           | 18                        | 23.5                      | 25                                 | 31                                 | 32.5                      | 41.5                      |
| n258                                                                                                                           | 18                        | 21                        | 22.75                              | 29                                 | 30.75                     | 40.5                      |
| n259                                                                                                                           | 23.5                      | 35.5                      | 38                                 | 45                                 | 47.5                      | 59.5                      |
| n263                                                                                                                           | 18                        | 43                        | 53.5                               | 74.5                               | 85                        | 127                       |
| NOTE 1: $F_{\text{step},X}$ are based on ERC Recommendation 74-01 [9], Annex 2.                                                |                           |                           |                                    |                                    |                           |                           |
| NOTE 2: $F_{\text{step},3}$ and $F_{\text{step},4}$ are aligned with the values for $\Delta f_{\text{OBUE}}$ in table 7.5.1-1. |                           |                           |                                    |                                    |                           |                           |

### 7.5.4.2.3 Additional OTA transmitter spurious emissions requirements

These requirements may be applied for the protection of systems operating in frequency ranges other than the repeater-Node. The limits may apply as an optional protection of such systems that are deployed in the same geographical area as the repeater-Node, or they may be set by local or regional regulation as a mandatory requirement for an NR *operating band*. It is in some cases not stated in the present document whether a requirement is mandatory or under what exact circumstances that a limit applies, since this is set by local or regional regulation. An overview of regional requirements in the present document is given in clause 4.4.

#### 7.5.4.2.3.1 Limits for protection of Earth Exploration Satellite Service

For repeater operating in the frequency range 24.25 – 27.5 GHz, the power of any spurious emissions shall not exceed the limits in Table 7.5.4.2.3.1-1 and Table 7.5.4.2.3.1-2.

**Table 7.5.4.2.3.1-1: Limits for protection of Earth Exploration Satellite Service for DL**

| Frequency range                                                                                                                                | Limit  | Measurement Bandwidth | Note   |
|------------------------------------------------------------------------------------------------------------------------------------------------|--------|-----------------------|--------|
| 23.6 – 24 GHz                                                                                                                                  | -3 dBm | 200 MHz               | Note 1 |
| 23.6 – 24 GHz                                                                                                                                  | -9 dBm | 200 MHz               | Note 2 |
| NOTE 1: This limit applies to Repeater brought into use on or before 1 September 2027 in countries not adopting EU Decision 2020/590 [31].     |        |                       |        |
| NOTE 2: This limit applies to Repeater brought into use after 1 September 2027 or to repeater in countries adopting EU Decision 2020/590 [31]. |        |                       |        |

**Table 7.5.4.2.3.1-2: OBUE limits for protection of Earth Exploration Satellite Service for UL**

| Frequency range | Limit | Measurement Bandwidth |
|-----------------|-------|-----------------------|
| 23.6 – 24 GHz   | 1 dBm | 200 MHz               |

### 7.5.4.3 Minimum requirement for NCR

#### 7.5.4.3.1 Minimum requirement for NCR-Fwd

##### 7.5.4.3.1.1 Minimum requirement for NCR-Fwd type 2-O

The requirements in clause 7.5.4.2 apply. The limits apply to the sum of emissions from NCR-MT and NCR-Fwd when transmitting simultaneously.

#### 7.5.4.3.2 Minimum requirement for NCR-MT

##### 7.5.4.3.2.1 Minimum requirement for NCR-MT Type 2-O

For Wide Area *NCR-MT type 2-O*, the OTA TX spurious emission requirements are as defined in clause 7.5.4.2.

For Local Area *NCR-MT type 2-O*, the OTA TX spurious emission requirements defined for NR UE in clause 6.5.3 in TS 38.101-2 [14] apply.

## 7.5.5 OTA receiver spurious emissions

### 7.5.5.1 General

The OTA RX spurious emission is the power of the emissions radiated from the antenna array from a receiver unit.

The metric used to capture OTA receiver spurious emissions is *total radiated power* (TRP), with the requirement defined at the RIB.

For a RIB operating in FDD, OTA RX spurious emissions requirement do not apply as they are superseded by the OTA TX spurious emissions requirement. This is due to the fact that TX and RX spurious emissions cannot be distinguished in OTA domain.

For a RIB operating in TDD, the OTA RX spurious emissions requirement shall apply during the *transmitter OFF state* only.

For *multi-band RIB*, the OTA RX spurious emissions requirements are subject to exclusion zones in each supported *operating band*.

### 7.5.5.2 Minimum requirement for *RF repeater*

For the *Repeater type 2-O*, the power of any RX spurious emission shall not exceed the limits in table 7.5.5.2-1.

**7.5.5.2-1: OTA receiver spurious emission limits for *Repeater type 2-O***

| Spurious frequency range (Note 4)                                                                                                                                                                                                                                                                                                   | Limit (Note 5) | Measurement Bandwidth | Note           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-----------------------|----------------|
| 30 MHz ↔ 1 GHz                                                                                                                                                                                                                                                                                                                      | -36 dBm        | 100 kHz               | Note 1         |
| 1 GHz ↔ 18 GHz                                                                                                                                                                                                                                                                                                                      | -30 dBm        | 1 MHz                 | Note 1         |
| 18 GHz ↔ $F_{\text{step},1}$                                                                                                                                                                                                                                                                                                        | -20 dBm        | 10 MHz                | Note 2         |
| $F_{\text{step},1}$ ↔ $F_{\text{step},2}$                                                                                                                                                                                                                                                                                           | -15 dBm        | 10 MHz                | Note 2         |
| $F_{\text{step},2}$ ↔ $F_{\text{step},3}$                                                                                                                                                                                                                                                                                           | -10 dBm        | 10 MHz                | Note 2         |
| $F_{\text{step},4}$ ↔ $F_{\text{step},5}$                                                                                                                                                                                                                                                                                           | -10 dBm        | 10 MHz                | Note 2         |
| $F_{\text{step},5}$ ↔ $F_{\text{step},6}$                                                                                                                                                                                                                                                                                           | -15 dBm        | 10 MHz                | Note 2         |
| $F_{\text{step},6}$ ↔ 2 <sup>nd</sup> harmonic of the upper frequency edge of the UL <i>operating band</i>                                                                                                                                                                                                                          | -20 dBm        | 10 MHz                | Note 2, Note 3 |
| NOTE 1: Bandwidth as in ITU-R SM.329 [5], s4.1.<br>NOTE 2: Limit and bandwidth as in ERC Recommendation 74-01 [9], Annex 2.<br>NOTE 3: Upper frequency as in ITU-R SM.329 [5], s2.5 table 1.<br>NOTE 4: The step frequencies $F_{\text{step},X}$ are defined in table 7.5.5.3-2.<br>NOTE 5: Additional limits may apply regionally. |                |                       |                |

**Table 7.5.5.2-2: Step frequencies for defining the OTA receiver spurious emission limits for *Repeater type 2-O***

| Operating band | $F_{\text{step},1}$ (GHz) | $F_{\text{step},2}$ (GHz) | $F_{\text{step},3}$ (GHz) | $F_{\text{step},4}$ (GHz) | $F_{\text{step},5}$ (GHz) | $F_{\text{step},6}$ (GHz) |
|----------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| n257           | 18                        | 23.5                      | 25                        | 31                        | 32.5                      | 41.5                      |
| n258           | 18                        | 21                        | 22.75                     | 29                        | 30.75                     | 40.5                      |
| n259           | 23.5                      | 35.5                      | 38                        | 45                        | 47.5                      | 59.5                      |
| n260           | 25                        | 34                        | 35.5                      | 41.5                      | 43                        | 52                        |
| n261           | 18                        | 25.5                      | 26.0                      | 29.85                     | 30.35                     | 38.35                     |
| n262           | 37.2                      | 45.2                      | 45.7                      | 49.7                      | 50.2                      | 58.2                      |
| n263           | 18                        | 43                        | 53.5                      | 74.5                      | 85                        | 127                       |

In addition to the requirements in Table 7.5.5.2-1, the requirement for protection of EESS for *RF repeater* operating in frequency range 24.25 – 27.5 GHz in clause 7.5.4.2.3.1 may be applied.

### 7.5.5.3 Minimum requirement for *NCR*

#### 7.5.5.3.1 Minimum requirement for NCR-Fwd

##### 7.5.5.3.1.1 Minimum requirement for *NCR-Fwd type 2-O*

The requirements in clause 7.5.5.2 apply.

The receiver spurious emissions limits shall apply to the total emissions from both the NCR-Fwd and NCR-MT.

## 7.6 OTA Repeater Error Vector Magnitude

### 7.6.1 Downlink repeater error vector magnitude

#### 7.6.1.1 General

The Repeater Error Vector Magnitude (EVM) is a measure of the difference between the symbols provided at the input of the repeater and the measured signal symbols at the output of the repeater after the equalization by the measurement equipment. This difference is called the error vector. Details about how the repeater EVM is determined are same as specified in TS 38.104 [2] Annex C for FR2. The repeater EVM result is defined as the square root of the ratio of the mean error vector power to the mean reference power expressed in percent.

For repeater type 2-O, OTA modulation quality requirement is defined as a *directional requirement* at the RIB and shall be met within the *OTA coverage range* on the transmit side and the AoA of the incident wave of the received signal is in the reference direction at the receive side.

For NCR-Fwd type 2-O, OTA modulation quality requirement is defined as a directional requirement at the RIB and shall be met within the OTA coverage range on the transmit side and the AoA of the incident wave of the received signal is within the OTA REFSSENS RoAoA at the receive side.

The repeater EVM requirement is applicable when the repeater is operating with an input power level within the range from what is required to reach the rated beam EIRP output power ( $P_{\text{rated,p,EIRP}}$ ) to the minimum power levels in table 7.6.1.1-1.

**Table 7.6.1.1-1: Minimum input power for repeater EVM for repeater type 2-O and NCR-Fwd type 2-O**

| Repeater class    | Minimum input power (dBm/MHz)                 |                    |                     |                    |                    |                     |
|-------------------|-----------------------------------------------|--------------------|---------------------|--------------------|--------------------|---------------------|
|                   | 24.25 – 33.4 GHz                              |                    |                     | 37 – 52.6 GHz      |                    |                     |
|                   | Up to 16 QAM                                  | 64QAM <sup>1</sup> | 256QAM <sup>2</sup> | Up to 16 QAM       | 64QAM <sup>1</sup> | 256QAM <sup>2</sup> |
| <b>WA, MR, LA</b> | -77- $G_{RX\_ANT}$                            | -73- $G_{RX\_ANT}$ | -66- $G_{RX\_ANT}$  | -75- $G_{RX\_ANT}$ | -71- $G_{RX\_ANT}$ | -64- $G_{RX\_ANT}$  |
| Note 1:           | support of 64QAM is based on the declaration  |                    |                     |                    |                    |                     |
| Note 2:           | support of 256QAM is based on the declaration |                    |                     |                    |                    |                     |

Where  $G_{RX\_ANT}$  is the gain of the receive side antennas and is estimated based on the 3dB gain RoAoA and a formula,  $G_{RX\_ANT} = 44.1 - 10 \cdot \log_{10}(\text{BeW}_{\theta, \text{REFSENS}} \cdot \text{BeW}_{\phi, \text{REFSENS}})$  dB.

#### 7.6.1.2 Minimum requirement for repeater

The repeater EVM levels for different modulation schemes outlined in table 7.6.1.2-1 shall be met using the frame structure described in clause 7.6.1.3.

**Table 7.6.1.2-1: Repeater EVM requirements**

| Parameter   | Required repeater EVM                          |
|-------------|------------------------------------------------|
| Up to 16QAM | 12.5%                                          |
| 64QAM       | 8 % <sup>1</sup>                               |
| 256QAM      | 3.5 % <sup>2</sup>                             |
| Note 1:     | support of 64QAM is based on the declaration   |
| Note 2:     | support of 256QAM is based on the declaration. |

## 7.6.1.2A Minimum requirement for NCR

### 7.6.1.2A.1 Minimum requirement for NCR-Fwd

#### 7.6.1.2A.1.1 Minimum requirement for NCR-Fwd type 2-O

The requirements in clause 7.6.1.2 apply for NCR-Fwd type 2-O.

## 7.6.1.3 Repeater EVM frame structure for measurement

The input signals for the repeater EVM requirement shall have the same frame structure as defined for the BS in TS 38.104 [2].

## 7.6.2 Uplink repeater error vector magnitude

### 7.6.2.1 General

The Repeater Error Vector Magnitude is a measure of the difference between the reference waveform provided at the input of the repeater and the measured waveform at the output of the repeater. This difference is called the error vector. Details about how the repeater EVM is determined are the same as specified in TS 38.101-2 [14] Annex F for FR2. Before calculating the repeater EVM, the measured waveform is corrected by the sample timing offset and RF frequency offset. Then the carrier leakage shall be removed from the measured waveform before calculating the repeater EVM.

The measured waveform is further equalised using the channel estimates subjected to the EVM equaliser spectrum flatness requirement specified in TS 38.101-2 [14] clauses 6.4.2.4 and 6.4.2.5. For DFT-s-OFDM waveforms, the repeater EVM result is defined after the front-end FFT and IDFT as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %. For CP-OFDM waveforms, the repeater EVM result is defined after the front-end FFT as the square root of the ratio of the mean error vector power to the mean reference power expressed as a %.

The basic repeater EVM measurement interval is one slot in the time domain. The repeater EVM measurement interval is reduced by any symbols that contains an allowable power transient in the measurement interval as defined in TS 38.101-2 [14] clause 6.3.3.

All the parameters defined in clause 7.6.2 are defined using the measurement methodology specified in TS 38.101-2 [14] Annex F.

For *repeater type 2-O*, OTA modulation quality requirement is defined as a *directional requirement* at the RIB and shall be met within the *OTA coverage range* on the transmit side and the AoA of the incident wave of the received signal is in the reference direction at the receive side.

For *NCR-Fwd type 2-O*, OTA modulation quality requirement is defined as a directional requirement at the RIB and shall be met within the OTA coverage range on the transmit side and the AoA of the incident wave of the received signal is within the OTA REFSENS RoAoA at the receive side.

The repeater EVM requirement is applicable when the repeater is operating with an input power level within the range from what is required to reach the rated beam EIRP output power ( $P_{\text{rated,p,EIRP}}$ ) to the minimum input power levels in table 7.6.2.1-1.

**Table 7.6.2.1-1: Minimum input power for repeater EVM for repeater type 2-O and NCR-Fwd type 2-O**

| Repeater class                                       | Minimum input power (dBm/MHz) |                           |                           |                           |
|------------------------------------------------------|-------------------------------|---------------------------|---------------------------|---------------------------|
|                                                      | 24.25 – 33.4 GHz              |                           | 37 – 52.6 GHz             |                           |
|                                                      | Up to 16 QAM                  | 64QAM <sup>1</sup>        | Up to 16 QAM              | 64QAM <sup>1</sup>        |
| WA, LA                                               | -77- $G_{\text{RX\_ANT}}$     | -73- $G_{\text{RX\_ANT}}$ | -75- $G_{\text{RX\_ANT}}$ | -71- $G_{\text{RX\_ANT}}$ |
| Note 1: support of 64QAM is based on the declaration |                               |                           |                           |                           |

Where  $G_{\text{RX\_ANT}}$  is the gain of the receive side antennas and is estimated based on the 3dB gain RoAoA and a formula,  $G_{\text{RX\_ANT}} = 44.1 - 10 \cdot \log_{10}(\text{BeW}_{\theta, \text{REFSENS}} \cdot \text{BeW}_{\phi, \text{REFSENS}})$  dB.

### 7.6.2.2 Minimum requirement for RF repeater

The RMS average of the basic repeater EVM measurements over 10 subframes for the average repeater EVM case, for the different modulation schemes shall not exceed the values specified in Table 7.6.2.2-1.

**Table 7.6.2.2-1: Minimum requirements for repeater error vector magnitude**

| Parameter                                            | Unit | Average repeater EVM level |
|------------------------------------------------------|------|----------------------------|
| Up to 16 QAM                                         | %    | 12.5                       |
| 64 QAM                                               | %    | 8 <sup>1</sup>             |
| Note 1: support of 64QAM is based on the declaration |      |                            |

### 7.6.2.3 Minimum requirement for NCR

#### 7.6.2.3.1 Minimum requirement for NCR-Fwd

##### 7.6.2.3.1.1 Minimum requirement for *NCR-Fwd type 2-O*

The requirements in clause 7.6.2.2 apply for *NCR-Fwd type 2-O*.

## 7.7 OTA input intermodulation

### 7.7.1 General

The input intermodulation is a measure of the capability of the repeater to inhibit the generation of interference in the *passband*, in the presence of interfering signals on frequencies other than the *passband*. The requirement is defined as a directional requirement.

The requirement shall apply at the RIB when the AoA of the incident wave of a received signal and the interfering signal are from the same direction:

The interfering signals apply to each supported polarization, under the assumption of polarization match.

The following requirement applies for interfering signals depending on the repeaters *passband*.

This requirement applies to the uplink and downlink of the repeater during the *transmitter ON state*.

When GSM, CDMA, UTRA, E-UTRA, NR BS or repeater operating in a different frequency band are co-located with a NCR, additional input intermodulation co-location requirement may be applied for the protection of RF repeater or NCR receivers. This requirement applies to the uplink and downlink of the repeater. If the BS side is declared to meet co-location requirements, then it should meet input intermodulation co-location requirements for the downlink. If the UE side is declared to meet co-location requirements, then it should meet input intermodulation co-location requirements for the uplink.

When GSM, CDMA, UTRA, E-UTRA, NR BS or repeater operating in another frequency band co-exist with a NCR, additional input intermodulation co-existence requirement may be applied for the protection of NR repeater or NCR receivers.

### 7.7.2 Minimum requirement for RF repeater

For the parameters specified in table 7.7.2-1, the power in the *passband* shall not increase with more than 10 dB at the output of the repeater as measured with 1 MHz measurement bandwidth, compared to the level obtained without interfering signals applied.

The core requirement is applicable for all frequency separation possibilities between the two interfering signals that cause the 3rd order intermodulation product to fall into the whole *passband*.

Table 7.7.2-1 specifies the parameters for two interfering signals, where:

- $f_1$  offset is the offset from the channel edge frequency of the first or last channel in the *passband* of the closer carrier.
- $G_{RX\_ANT}$  is the gain of the receive side antennas and is calculated from EIRP and TRP declaration.

**Table 7.7.2-1: Input intermodulation requirement**

| $f_1$ offset | Interfering Signal Levels | Type of signals | Measurement bandwidth |
|--------------|---------------------------|-----------------|-----------------------|
| 1 MHz        | -53dBm – $G_{RX\_ANT}$    | 2 CW carriers   | 1 MHz                 |

### 7.7.3 Minimum requirement for NCR

#### 7.7.3.1 Minimum requirement for NCR-Fwd

##### 7.7.3.1.1 Minimum requirement for NCR-Fwd type 2-O

The requirements in clause 7.7.2 apply for NCR-Fwd type 2-O.

## 7.8 OTA Adjacent Channel Rejection Ratio (ACRR)

### 7.8.1 General

OTA Adjacent Channel Rejection Ratio (ACRR) is the ratio of the average gain over a carrier of the repeater in the *passband* to the average gain of the repeater over an adjacent channel outside the repeater *passband*. The requirement shall apply to the uplink and downlink of the Repeater. The bandwidth of the channel inside the *passband* and the adjacent channel shall be of the same type (reference carrier) with bandwidths as defined by *nominal channel bandwidth*.

The requirement is differentiated between downlink and uplink.

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

The ACRR is a ratio of gain in the adjacent channel to gain in the wanted channel. The gain in each case is defined as the ratio of TRP output power to directional input power.

### 7.8.2 Minimum Requirements for RF repeater

The requirement shall apply at the RIB when the AoA of the incident wave of a received signal in the *passband* and a received signal on an adjacent channel outside repeater *passband* is from the same direction and are the same as the TX reference direction for the opposite DL/UL setting.

For a repeater operating at *passband* operating in FR2, the ACRR requirements in table 7.8.2-1 shall apply in downlink. ACRR for downlink shall be higher than the value specified in the Table 7.8.2-1.

**Table 7.8.2-1: Repeater Downlink ACRR**

| Co-existence with other systems                                                                                 | Repeater Class        | Channel offset from frequency edge of <i>passband</i> (MHz) | ACRR limit (dB)                   |
|-----------------------------------------------------------------------------------------------------------------|-----------------------|-------------------------------------------------------------|-----------------------------------|
| NR                                                                                                              | Wide Area repeater    | $BW_{Nominal}/2$                                            | 28 (Note 2)<br>26 (Note 3)        |
|                                                                                                                 | Medium Range repeater | $BW_{Nominal}/2$                                            | 28 (Note 2)<br>26 (Note 3)        |
|                                                                                                                 | Local Area repeater   | $BW_{Nominal}/2$                                            | 28 (Notes 1, 2)<br>26 (Note 1, 3) |
| NOTE 1: This requirement does not applicable if the <i>passband</i> occupies the entire <i>operating band</i> . |                       |                                                             |                                   |
| NOTE 2: Applicable to bands defined within the frequency spectrum range of 24.25 – 33.4 GHz.                    |                       |                                                             |                                   |
| NOTE 3: Applicable to bands defined within the frequency spectrum range of 37 – 52.6 GHz                        |                       |                                                             |                                   |

For a repeater operating at *passband* operating in FR2, the ACRR requirements in table 7.8.2-2 shall apply in uplink. ACRR for uplink shall be higher than the value specified in the Table 7.8.2-2.

**Table 7.8.2-2: Repeater Uplink ACRR**

| Co-existence with other systems                                                                                 | Repeater Class      | Channel offset from frequency edge of <i>passband</i> (MHz) | ACRR limit (dB)                  |
|-----------------------------------------------------------------------------------------------------------------|---------------------|-------------------------------------------------------------|----------------------------------|
| NR                                                                                                              | Wide Area repeater  | $BW_{\text{Nominal}}/2$                                     | 28 (Note 2)<br>26 (Note 3)       |
|                                                                                                                 | Local Area repeater | $BW_{\text{Nominal}}/2$                                     | 17 (Note 1, 2)<br>16 (Note 1, 3) |
| NOTE 1: This requirement does not applicable if the <i>passband</i> occupies the entire <i>operating band</i> . |                     |                                                             |                                  |
| NOTE 2: Applicable to bands defined within the frequency spectrum range of 24.25 – 33.4 GHz.                    |                     |                                                             |                                  |
| NOTE 3: Applicable to bands defined within the frequency spectrum range of 37 – 52.6 GHz                        |                     |                                                             |                                  |

## 7.8.3 Minimum Requirements for NCR

### 7.8.3.1 Minimum Requirements for NCR-Fwd

#### 7.8.3.1.1 Minimum Requirements for NCR-Fwd type 2-O

The requirement shall apply at the RIB when the AoA of the incident wave of a received signal in the *passband* and a received signal on an adjacent channel outside repeater *passband* is from the same direction and are the same as the TX reference direction for the opposite DL/UL setting.

For *NCR-Fwd type 2-O* operating at *passband* operating in FR2, the ACRR requirements in table 7.8.3.1.1-1 shall apply in downlink. In normal conditions the ACRR for downlink shall be higher than the value specified in the Table 7.8.3.1.1-1.

**Table 7.8.3.1.1-1: NCR-Fwd type 2-O Downlink ACRR**

| Co-existence with other systems                                                                               | Repeater Class        | Channel offset from frequency edge of <i>passband</i> (MHz) | ACRR limit (dB)                   |
|---------------------------------------------------------------------------------------------------------------|-----------------------|-------------------------------------------------------------|-----------------------------------|
| NR                                                                                                            | Wide Area repeater    | $BW_{\text{Nominal}}/2$                                     | 28 (Note 2)<br>26 (Note 3)        |
|                                                                                                               | Medium Range repeater | $BW_{\text{Nominal}}/2$                                     | 28 (Note 2)<br>26 (Note 3)        |
|                                                                                                               | Local Area repeater   | $BW_{\text{Nominal}}/2$                                     | 28 (Notes 1, 2)<br>26 (Note 1, 3) |
| NOTE 1: This requirement is not applicable if the <i>passband</i> occupies the entire <i>operating band</i> . |                       |                                                             |                                   |
| NOTE 2: Applicable to bands defined within the frequency spectrum range of 24.25 – 33.4 GHz.                  |                       |                                                             |                                   |
| NOTE 3: Applicable to bands defined within the frequency spectrum range of 37 – 52.6 GHz                      |                       |                                                             |                                   |

For *NCR-Fwd type 2-O* operating at *passband* operating in FR2, the ACRR requirements in table 7.8.3.1.1-2 shall apply in uplink. In normal conditions the ACRR for uplink shall be higher than the value specified in the Table 7.8.3.1.1-2.

**Table 7.8.3.1.1-2: NCR-Fwd type 2-O Uplink ACRR**

| Co-existence with other systems                                                                               | Repeater Class      | Channel offset from frequency edge of <i>passband</i> (MHz) | ACRR limit (dB)                  |
|---------------------------------------------------------------------------------------------------------------|---------------------|-------------------------------------------------------------|----------------------------------|
| NR                                                                                                            | Wide Area repeater  | $BW_{\text{Nominal}}/2$                                     | 28 (Note 2)<br>26 (Note 3)       |
|                                                                                                               | Local Area repeater | $BW_{\text{Nominal}}/2$                                     | 17 (Note 1, 2)<br>16 (Note 1, 3) |
| NOTE 1: This requirement is not applicable if the <i>passband</i> occupies the entire <i>operating band</i> . |                     |                                                             |                                  |
| NOTE 2: Applicable to bands defined within the frequency spectrum range of 24.25 – 33.4 GHz.                  |                     |                                                             |                                  |
| NOTE 3: Applicable to bands defined within the frequency spectrum range of 37 – 52.6 GHz                      |                     |                                                             |                                  |

## 7.9 OTA transmit ON/OFF power

### 7.9.1 General

OTA transmit ON/OFF power requirements apply only to TDD operation of repeater. The requirements apply to both downlink and uplink of the repeater.

### 7.9.2 OTA transmitter OFF power

#### 7.9.2.1 General

OTA transmitter OFF power is defined as the mean power measured over  $70/N$   $\mu$ s filtered with a square filter of bandwidth equal to the *passband bandwidth* of the repeater ( $BW_{\text{passband}}$ ) centred on the assigned channel frequency during the *transmitter OFF state*.  $N = \text{SCS}/15$ , where SCS is Sub Carrier Spacing in kHz of the input signal. For *repeater type 2-O* and *NCR-Fwd type 2-O*, the OTA transmitter OFF power is defined as TRP.

#### 7.9.2.2 Minimum requirement for RF repeater

The OTA transmitter OFF TRP spectral density for *repeater type 2-O* shall be less than -36 dBm/MHz.

#### 7.9.2.3 Minimum requirement for NCR

##### 7.9.2.3.1 Minimum requirement for NCR-Fwd

###### 7.9.2.3.1.1 Minimum requirement for NCR-Fwd *type 2-O*

The requirements in clause 7.9.2.2 apply for NCR-Fwd *type 2-O*.

##### 7.9.2.3.2 Minimum requirement for NCR-MT

###### 7.9.2.3.2.1 Minimum requirement for NCR-MT *type 2-O*

For Wide Area NCR-MT *type 2-O*, the OTA transmitter OFF TRP spectral density for shall be less than -36 dBm/MHz. For Local Area *NCR-MT type 2-O*, the transmit OFF power shall not exceed the values specified in Tables 7.9.2.3.2.1-1 for each operating band supported. The requirement is verified with the test metric of TRP (Link=TX beam peak direction, Meas=TRP grid).

**Table 7.9.2.3.2.1-1: Transmit OFF power for FR2-1**

| Operating band                     | Channel bandwidth / Transmit OFF power (dBm) / measurement bandwidth |           |            |            |
|------------------------------------|----------------------------------------------------------------------|-----------|------------|------------|
|                                    | 50 MHz                                                               | 100 MHz   | 200 MHz    | 400 MHz    |
| n257, n258, n259, n260, n261, n262 | -35                                                                  | -35       | -35        | -35        |
|                                    | 47.58 MHz                                                            | 95.16 MHz | 190.20 MHz | 380.28 MHz |

## 7.9.3 OTA transient period

### 7.9.3.1 General

The OTA *transmitter transient period* is the time period during which the transmitter is changing from the *transmitter OFF state* to the *transmitter ON state* or vice versa. The *transmitter transient period* is illustrated in figure 7.9.3.1-1.

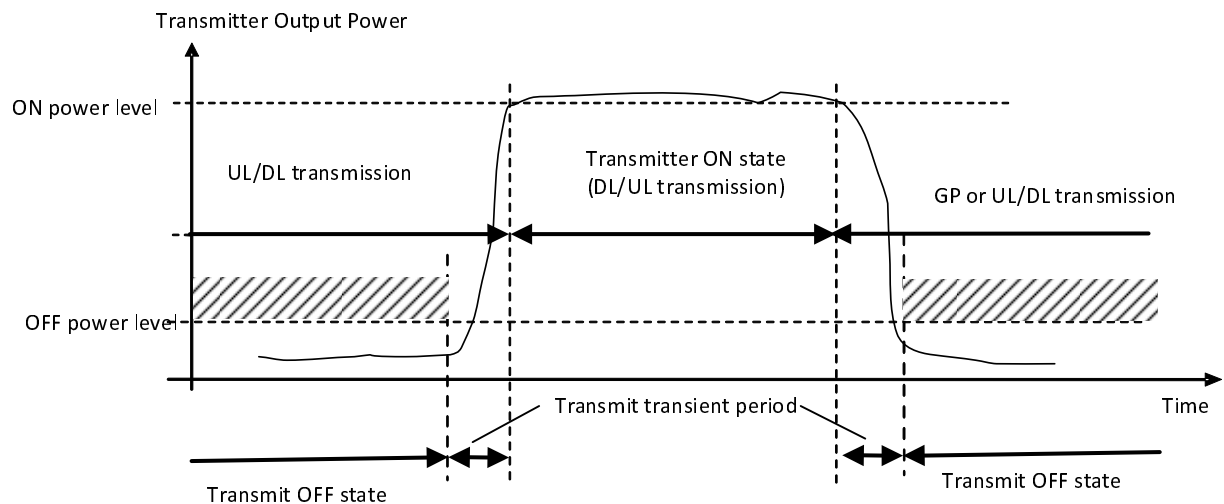


**Figure 7.9.3.1-1: Example of relations between transmitter *ON* state, transmitter *OFF* state and transmitter transient period**

This requirement shall be applied at each RIB supporting transmission in the *operating band*. The beginning and end point of downlink and uplink bursts are referenced to the slot timing at the input.

### 7.9.3.2 Minimum requirement for RF repeater

For *repeater type 2-O*, the *OTA transmitter transient period* shall be shorter than the values listed in the minimum requirement table 7.9.3.2-1.

**Table 7.9.3.2-1: Minimum requirement for the *OTA transmitter transient period* for *repeater type 2-O***

| Transition | Transient period length (µs) |
|------------|------------------------------|
| OFF to ON  | 3                            |
| ON to OFF  | 3                            |

### 7.9.3.3 Minimum requirement for NCR

#### 7.9.3.3.1 Minimum requirement for NCR-Fwd

##### 7.9.3.3.1.1 Minimum requirement for NCR-Fwd type 2-O

The requirements in clause 7.9.3.2 apply for NCR-Fwd type 2-O.

#### 7.9.3.3.2 Minimum requirement for NCR-MT

##### 7.9.3.3.2.1 Minimum requirement for NCR-MT type 2-O

For Wide Area NCR-MT type 2-O, the *OTA transmitter transient period* shall be shorter than the values listed in the minimum requirement table 7.9.3.3.2.1-1.

**Table 7.9.3.3.2.1-1: Minimum requirement for the OTA transmitter transient period for Wide Area NCR-MT type 2-O**

| Transition | Transient period length (µs) |
|------------|------------------------------|
| OFF to ON  | 3                            |
| ON to OFF  | 3                            |

For Local Area NCR-MT type 2-O, the requirement from TS 38.101-2 section 6.3.3.2 applies.

## 7.10 OTA output power dynamics for NCR-MT

### 7.10.1 General

### 7.10.2 Minimum requirement for NCR-MT

## 7.11 OTA transmit signal quality for NCR-MT

### 7.11.1 General

Transmit signal quality is specified in terms of: frequency error and transmit modulation quality requirements.

### 7.11.2 Frequency error requirements for NCR-MT

#### 7.11.2.1 Minimum requirement for NCR-MT type 2-O

For NCR-MT type 2-O, the requirements specified in clause 9.6.1.2.3 in TS 38.174 applies.

### 7.11.3 Transmit modulation quality

#### 7.11.3.1 Minimum requirement for NCR-MT type 2-O

For NCR-MT type 2-O, the requirements specified in clause 9.6.2.2.3 in TS 38.174 applies.

## 7.12 Diversity characteristics for NCR-MT

### 7.12.1 General

### 7.12.2 Minimum requirement for NCR-MT

The OTA diversity characteristic is specified the same as conducted diversity characteristic for FR1 NCR type 1-C, 1-H in sub-clause 6.13.

## 7.13 OTA reference sensitivity for NCR-MT

### 7.13.1 General

The reference sensitivity power level REFSENS is defined as the EIS level at the centre of the quiet zone in the RX beam peak direction, at which the throughput shall meet or exceed the requirements for the specified reference measurement channel.

## 7.13.2 Minimum requirement for NCR-MT type 2-O

The wide area NCR-MT reference sensitivity level is specified the same as the Wide Area IAB-MT reference sensitivity level requirement in TS 38.174 [22], subclause 10.3.3.3.

The local area NCR-MT reference sensitivity level is specified the same as reference sensitivity power level for power class 3 in TS 38.101-2 [14], subclause 7.3.2.3.

## 7.14 OTA maximum input level for NCR-MT

### 7.14.1 General

The maximum input level is defined as the maximum mean power, for which the throughput shall meet or exceed the minimum requirements for the specified reference measurement channel.

### 7.14.2 Minimum requirement for NCR-MT type 2-O

The local area NCR-MT maximum input power is specified the same as maximum input power in TS 38.101-2 [14], subclause 7.4.

## 7.15 OTA adjacent channel selectivity for NCR-MT

### 7.15.1 General

Adjacent Channel Selectivity (ACS) is a measure of a receiver's ability to receive a NR 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).

### 7.15.1 Minimum requirement for NCR-MT type 2-O

The wide area NCR-MT ACS requirement is specified the same as the Wide Area IAB-MT ACS requirement in TS 38.174 [22], subclause 10.5.1.4.

The local area NCR-MT reference sensitivity level is specified the same as ACS requirement in TS 38.101-2 [14], subclause 7.5.

## 7.16 OTA blocking characteristics for NCR-MT

### 7.16.1 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 occurs.

### 7.16.2 Minimum requirement for NCR-MT type 2-O

The wide area NCR-MT blocking requirement is specified the same as the Wide Area IAB-MT blocking requirement in TS 38.174 [22], subclause 10.5.2.4.

The local area NCR-MT blocking requirement is specified the same as blocking requirement in TS 38.101-2 [14], subclause 7.6.

## 7.17 OTA receiver spurious emissions for NCR-MT

### 7.17.1 General

The receiver spurious emissions power is the power of emissions generated or amplified in a receiver. The receiver spurious emissions power level is measured as TRP.

### 7.17.2 Minimum requirement for NCR-MT type 2-O

The wide area NCR-MT receiver spurious emission requirement is specified the same as the Wide Area IAB-MT receiver spurious emission requirement in TS 38.174 [22], subclause 10.7.3.2.

The local area NCR-MT receiver spurious emission requirement is specified the same as receiver spurious emission requirement in TS 38.101-2 [14], subclause 7.9.

## 7.18 OTA spatial emission

### 7.18.1 General

OTA spatial emission requirements are defined to set upper limits on radiated power in specific directions.

### 7.18.2 Protection of FSS UL

#### 7.18.2.1 General

This requirement shall be applied to NCR operating in band n104 to protect FSS (Earth-to-Space) satellite receiver.

The expected EIRP (EEIRP) is defined as the average value of the EIRP, with the averaging being performed:

- over azimuth angles from  $-180^\circ$  to  $+180^\circ$  with reference to NCR horizontal boresight, and
- over the specified angular ranges  $\theta_{HLi} \leq \theta < \theta_{HHi}$ , above the horizon, and
- over the supported beam directions.

#### 7.18.2.2 Minimum requirement for NCR type 1-H

For NCR type 1-H operating in band n104, the Expected EIRP (EEIRP) in the frequency range 6425 – 7075 MHz, shall not exceed the limits specified in table 7.18.2.2-1.

**Table 7.18.2.2-1: EEIRP limits as function of elevation above horizon**

| Bin number<br><i>i</i>                                                 | Elevation angular range<br>$\theta_{HLi} \leq \theta < \theta_{HHi}$ (Degrees) | EEIRP limit<br>(dBm/MHz) |
|------------------------------------------------------------------------|--------------------------------------------------------------------------------|--------------------------|
| 1                                                                      | $0 \leq \theta < 5$                                                            | 27                       |
| 2                                                                      | $5 \leq \theta < 10$                                                           | 23                       |
| 3                                                                      | $10 \leq \theta < 15$                                                          | 19                       |
| 4                                                                      | $15 \leq \theta < 20$                                                          | 18                       |
| 5                                                                      | $20 \leq \theta < 30$                                                          | 16                       |
| 6                                                                      | $30 \leq \theta < 60$                                                          | 15                       |
| 7                                                                      | $60 \leq \theta < 90$                                                          | 15                       |
| NOTE 1: The requirement shall apply to all supported mechanical tilts. |                                                                                |                          |
| NOTE 2: The requirement is defined based on [32].                      |                                                                                |                          |

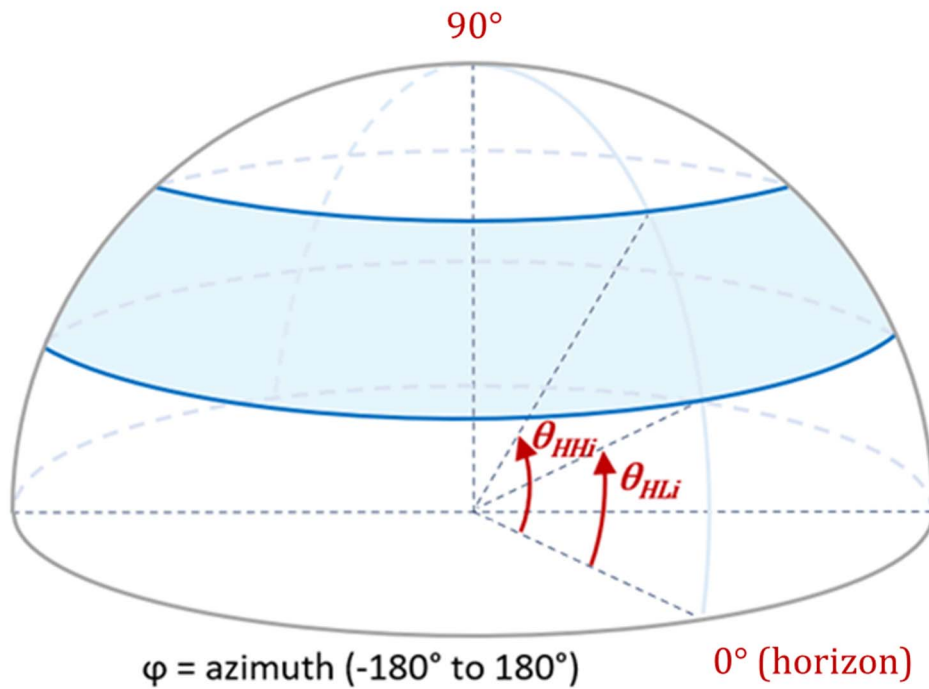


Figure 7.18.2.2-1: Definitions of  $\theta_{HLi}$  and  $\theta_{HHi}$  angles.

## 8 Conducted performance requirements

### 8.1 General

Conducted performance requirements specify the ability of the *NCR-MT type 1-C* to correctly demodulate signals in various conditions and configurations. Conducted performance requirements are specified at the *TAB connector(s)* (for *NCR-MT type 1-C*).

Conducted performance requirements for the NCR-MT are specified for the fixed reference channels defined in Annex B and the propagation conditions in Annex C. The requirements only apply to those FRCs that are supported by the NCR-MT.

The SNR used in this clause is specified based on a single carrier and defined as:

$$\text{SNR} = S / N$$

Where:

$S$  is the total signal energy in the slot on a single *TAB connector* (for *NCR-MT type 1-C*).

$N$  is the noise energy in a bandwidth corresponding to the transmission bandwidth over the duration of a slot on a single *TAB connector* (for *NCR-MT type 1-C*).

## 8.2 Demodulation performance requirements

### 8.2.1 Performance requirements for PDSCH

#### 8.2.1.1 2Rx requirements

##### 8.2.1.1.1 FDD

The performance requirements are specified in Table 8.2.1.1.1-1 and Table 8.2.1.1.1-2, with the addition of test parameters in Table 8.2.1.1.1-1.

The required throughput is expressed as a fraction of maximum throughput for the FRCs listed in Annex B.

**Table: 8.2.1.1.1-1 Test parameters for testing PDSCH**

| Parameter                                  |                                           | Value                                                                                                                                                                |
|--------------------------------------------|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cyclic prefix                              |                                           | Normal                                                                                                                                                               |
| Duplex mode                                |                                           | FDD                                                                                                                                                                  |
| HARQ                                       | Maximum number of HARQ transmissions      | 4 for Test 1-1 and 1-2<br>1 for Test 2-1 and 2-2                                                                                                                     |
|                                            | RV sequence                               | 0, 2, 3, 1                                                                                                                                                           |
| DM-RS                                      | DM-RS configuration type                  | 1                                                                                                                                                                    |
|                                            | DM-RS duration                            | single-symbol DM-RS                                                                                                                                                  |
|                                            | DM-RS position ( $l_0$ )                  | 2                                                                                                                                                                    |
|                                            | Additional DM-RS position                 | pos1                                                                                                                                                                 |
|                                            | Number of DM-RS CDM group(s) without data | 1                                                                                                                                                                    |
|                                            | DM-RS port(s)                             | {1000}                                                                                                                                                               |
|                                            | DM-RS sequence generation                 | $N_{ID}^0=0$                                                                                                                                                         |
| Time domain resource assignment            | PDSCH mapping type                        | A                                                                                                                                                                    |
|                                            | Start symbol                              | 2                                                                                                                                                                    |
|                                            | Allocation length                         | 12                                                                                                                                                                   |
| Frequency domain resource assignment       | RB assignment                             | Full applicable test bandwidth                                                                                                                                       |
| PT-RS configuration                        |                                           | Not configured                                                                                                                                                       |
| PRB bundling size                          |                                           | 2                                                                                                                                                                    |
| VRB-to-PRB mapping type                    |                                           | Not interleaved                                                                                                                                                      |
| PDSCH & PDSCH DMRS Precoding configuration |                                           | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1, i_2$ combination, and with PRB bundling granularity |

##### 8.2.1.1.1.1 Minimum requirements

**Table 8.2.1.1.1-1: Minimum requirements for PDSCH Type A with Rank 1**

| Test number | FRC (Annex B)   | Bandwidth (MHz) / Subcarrier spacing (kHz) | Propagation conditions (Annex C) | Antenna configuration | Fraction of maximum throughput (%) | SNR (dB) |
|-------------|-----------------|--------------------------------------------|----------------------------------|-----------------------|------------------------------------|----------|
| 1-1         | M-FR1-NCR.1.1-1 | 10/15                                      | TDLA30-10                        | 2x2, ULA Low          | 70                                 | -0.9     |
| 1-2         | M-FR1-NCR.1.1-3 | 10/15                                      | TDLA30-10                        | 2x2, ULA Low          | 70                                 | 6.8      |

**Table 8.2.1.1.1-2: Minimum requirements for PDSCH Type A with Rank 1**

| Test number | FRC (Annex B)   | Bandwidth (MHz) / Subcarrier spacing (kHz) | Propagation conditions (Annex C) | Antenna configuration | Fraction of maximum BLER (%) | SNR (dB) |
|-------------|-----------------|--------------------------------------------|----------------------------------|-----------------------|------------------------------|----------|
| 2-1         | M-FR1-NCR.1.1-1 | 10/15                                      | TDLA30-10                        | 2x2, ULA Low          | 1                            | 5.0      |
| 2-2         | M-FR1-NCR.1.1-3 | 10/15                                      | TDLA30-10                        | 2x2, ULA Low          | 1                            | 13.0     |

### 8.2.1.1.2 TDD

The performance requirements are specified in Table 8.2.1.1.2.1-1 and Table 8.2.1.1.2.1-2, with the addition of test parameters in Table 8.2.1.1.1-1.

The required throughput is expressed as a fraction of maximum throughput for the FRCs listed in Annex B.

**Table: 8.2.1.1.1-1 Test parameters for testing PDSCH**

| Parameter                                                                          |                                           | Value                                                                                                                                                                |
|------------------------------------------------------------------------------------|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cyclic prefix                                                                      |                                           | Normal                                                                                                                                                               |
| Default TDD UL-DL pattern (Note 1)                                                 |                                           | 7D1S2U, S=6D:4G:4U                                                                                                                                                   |
| HARQ                                                                               | Maximum number of HARQ transmissions      | 4 for Test 1-1 and 1-2<br>1 for Test 2-1 and 2-2                                                                                                                     |
|                                                                                    | RV sequence                               | 0, 2, 3, 1                                                                                                                                                           |
| DM-RS                                                                              | DM-RS configuration type                  | 1                                                                                                                                                                    |
|                                                                                    | DM-RS duration                            | single-symbol DM-RS                                                                                                                                                  |
|                                                                                    | DM-RS position ( $l_0$ )                  | 2                                                                                                                                                                    |
|                                                                                    | Additional DM-RS position                 | pos1                                                                                                                                                                 |
|                                                                                    | Number of DM-RS CDM group(s) without data | 1                                                                                                                                                                    |
|                                                                                    | DM-RS port(s)                             | {1000}                                                                                                                                                               |
|                                                                                    | DM-RS sequence generation                 | $N_{ID}^0=0$                                                                                                                                                         |
| Time domain resource assignment                                                    | PDSCH mapping type                        | A                                                                                                                                                                    |
|                                                                                    | Start symbol                              | 2                                                                                                                                                                    |
|                                                                                    | Allocation length                         | 12                                                                                                                                                                   |
| Frequency domain resource assignment                                               | RB assignment                             | Full applicable test bandwidth                                                                                                                                       |
| PT-RS configuration                                                                |                                           | Not configured                                                                                                                                                       |
| PRB bundling size                                                                  |                                           | 2                                                                                                                                                                    |
| VRB-to-PRB mapping type                                                            |                                           | Not interleaved                                                                                                                                                      |
| PDSCH & PDSCH DMRS Precoding configuration                                         |                                           | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1, i_2$ combination, and with PRB bundling granularity |
| Note 1: The same requirements are applicable to TDD with different UL-DL patterns. |                                           |                                                                                                                                                                      |

#### 8.2.1.1.2.1 Minimum requirements

**Table 8.2.1.1.2.1-1: Minimum requirements for PDSCH Type A with Rank 1**

| Test number | FRC (Annex B)   | Bandwidth (MHz) / Subcarrier spacing (kHz) | Propagation conditions (Annex C) | Antenna configuration | Fraction of maximum throughput (%) | SNR (dB) |
|-------------|-----------------|--------------------------------------------|----------------------------------|-----------------------|------------------------------------|----------|
| 1-1         | M-FR1-NCR.1.1-2 | 40/30                                      | TDLA30-10                        | 2x2, ULA Low          | 70                                 | -1.0     |
| 1-2         | M-FR1-NCR.1.1-4 | 40/30                                      | TDLA30-10                        | 2x2, ULA Low          | 70                                 | 6.8      |

**Table 8.2.1.1.2.1-2: Minimum requirements for PDSCH Type A with Rank 1**

| Test number | FRC (Annex B)   | Bandwidth (MHz) / Subcarrier spacing (kHz) | Propagation conditions (Annex C) | Antenna configuration | Fraction of maximum BLER (%) | SNR (dB) |
|-------------|-----------------|--------------------------------------------|----------------------------------|-----------------------|------------------------------|----------|
| 2-1         | M-FR1-NCR.1.1-2 | 40/30                                      | TDLA30-10                        | 2x2, ULA Low          | 1                            | 4.3      |
| 2-2         | M-FR1-NCR.1.1-4 | 40/30                                      | TDLA30-10                        | 2x2, ULA Low          | 1                            | 12       |

## 8.2.1.2 4Rx requirements

### 8.2.1.2.1 FDD

The performance requirements are specified in Table 8.2.1.2.1.1-1 and Table 8.2.1.2.1.1-2, with the addition of test parameters in Table 8.2.1.2.1-1.

The required throughput is expressed as a fraction of maximum throughput for the FRCs listed in Annex B.

**Table: 8.2.1.2.1-1 Test parameters for testing PDSCH**

| Parameter                                  |                                           | Value                                                                                                                                                                |
|--------------------------------------------|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cyclic prefix                              |                                           | Normal                                                                                                                                                               |
| Duplex mode                                |                                           | FDD                                                                                                                                                                  |
| HARQ                                       | Maximum number of HARQ transmissions      | 4 for Test 1-1 and 1-2<br>1 for Test 2-1 and 2-2                                                                                                                     |
|                                            | RV sequence                               | 0, 2, 3, 1                                                                                                                                                           |
| DM-RS                                      | DM-RS configuration type                  | 1                                                                                                                                                                    |
|                                            | DM-RS duration                            | single-symbol DM-RS                                                                                                                                                  |
|                                            | DM-RS position ( $l_0$ )                  | 2                                                                                                                                                                    |
|                                            | Additional DM-RS position                 | pos1                                                                                                                                                                 |
|                                            | Number of DM-RS CDM group(s) without data | 1                                                                                                                                                                    |
|                                            | DM-RS port(s)                             | {1000}                                                                                                                                                               |
|                                            | DM-RS sequence generation                 | $N_{ID}^0=0$                                                                                                                                                         |
| Time domain resource assignment            | PDSCH mapping type                        | A                                                                                                                                                                    |
|                                            | Start symbol                              | 2                                                                                                                                                                    |
|                                            | Allocation length                         | 12                                                                                                                                                                   |
| Frequency domain resource assignment       | RB assignment                             | Full applicable test bandwidth                                                                                                                                       |
| PT-RS configuration                        |                                           | Not configured                                                                                                                                                       |
| PRB bundling size                          |                                           | 2                                                                                                                                                                    |
| VRB-to-PRB mapping type                    |                                           | Not interleaved                                                                                                                                                      |
| PDSCH & PDSCH DMRS Precoding configuration |                                           | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1, i_2$ combination, and with PRB bundling granularity |

#### 8.2.1.2.1.1 Minimum requirements

**Table 8.2.1.2.1.1-1: Minimum requirements for PDSCH Type A with Rank 1**

| Test number | FRC (Annex B)   | Bandwidth (MHz) / Subcarrier spacing (kHz) | Propagation conditions (Annex C) | Antenna configuration | Fraction of maximum throughput (%) | SNR (dB) |
|-------------|-----------------|--------------------------------------------|----------------------------------|-----------------------|------------------------------------|----------|
| 1-1         | M-FR1-NCR.1.1-1 | 10/15                                      | TDLA30-10                        | 2x4, ULA Low          | 70                                 | -3.9     |
| 1-2         | M-FR1-NCR.1.1-3 | 10/15                                      | TDLA30-10                        | 2x4, ULA Low          | 70                                 | 3.5      |

**Table 8.2.1.2.1.1-2: Minimum requirements for PDSCH Type A with Rank 1**

| Test number | FRC (Annex B)   | Bandwidth (MHz) / Subcarrier spacing (kHz) | Propagation conditions (Annex C) | Antenna configuration | Fraction of maximum BLER (%) | SNR (dB) |
|-------------|-----------------|--------------------------------------------|----------------------------------|-----------------------|------------------------------|----------|
| 2-1         | M-FR1-NCR.1.1-1 | 10/15                                      | TDLA30-10                        | 2x4, ULA Low          | 1                            | 0.2      |
| 2-2         | M-FR1-NCR.1.1-3 | 10/15                                      | TDLA30-10                        | 2x4, ULA Low          | 1                            | 7.7      |

### 8.2.1.2.2 TDD

The performance requirements are specified in Table 8.2.1.2.2.1-1 and Table 8.2.1.2.2.1-2, with the addition of test parameters in Table 8.2.1.2.2-1.

The required throughput is expressed as a fraction of maximum throughput for the FRCs listed in annex B.

**Table: 8.2.1.2.2-1 Test parameters for testing PDSCH**

| Parameter                                                                          |                                           | Value                                                                                                                                                                |
|------------------------------------------------------------------------------------|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cyclic prefix                                                                      |                                           | Normal                                                                                                                                                               |
| Default TDD UL-DL pattern (Note 1)                                                 |                                           | 7D1S2U, S=6D:4G:4U                                                                                                                                                   |
| HARQ                                                                               | Maximum number of HARQ transmissions      | 4 for Test 1-1 and 1-2<br>1 for Test 2-1 and 2-2                                                                                                                     |
|                                                                                    | RV sequence                               | 0, 2, 3, 1                                                                                                                                                           |
| DM-RS                                                                              | DM-RS configuration type                  | 1                                                                                                                                                                    |
|                                                                                    | DM-RS duration                            | single-symbol DM-RS                                                                                                                                                  |
|                                                                                    | DM-RS position ( $l_0$ )                  | 2                                                                                                                                                                    |
|                                                                                    | Additional DM-RS position                 | pos1                                                                                                                                                                 |
|                                                                                    | Number of DM-RS CDM group(s) without data | 1                                                                                                                                                                    |
|                                                                                    | DM-RS port(s)                             | {1000} for Rank 1 tests                                                                                                                                              |
|                                                                                    | DM-RS sequence generation                 | $N_{ID}^0=0$                                                                                                                                                         |
| Time domain resource assignment                                                    | PDSCH mapping type                        | A                                                                                                                                                                    |
|                                                                                    | Start symbol                              | 2                                                                                                                                                                    |
|                                                                                    | Allocation length                         | 12                                                                                                                                                                   |
| Frequency domain resource assignment                                               | RB assignment                             | Full applicable test bandwidth                                                                                                                                       |
| PT-RS configuration                                                                |                                           | Not configured                                                                                                                                                       |
| PRB bundling size                                                                  |                                           | 2                                                                                                                                                                    |
| VRB-to-PRB mapping type                                                            |                                           | Not interleaved                                                                                                                                                      |
| PDSCH & PDSCH DMRS Precoding configuration                                         |                                           | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1, i_2$ combination, and with PRB bundling granularity |
| Note 1: The same requirements are applicable to TDD with different UL-DL patterns. |                                           |                                                                                                                                                                      |

#### 8.2.1.2.2.1 Minimum requirements

**Table 8.2.1.2.2.1-1: Minimum requirements for PDSCH Type A with Rank 1**

| Test number | FRC (Annex B)   | Bandwidth (MHz) / Subcarrier spacing (kHz) | Propagation conditions (Annex C) | Antenna configuration | Fraction of maximum throughput (%) | SNR (dB) |
|-------------|-----------------|--------------------------------------------|----------------------------------|-----------------------|------------------------------------|----------|
| 1-1         | M-FR1-NCR.1.1-2 | 40/30                                      | TDLA30-10                        | 2x4, ULA Low          | 70                                 | -3.9     |
| 1-2         | M-FR1-NCR.1.1-4 | 40/30                                      | TDLA30-10                        | 2x4, ULA Low          | 70                                 | 3.6      |

**Table 8.2.1.2.2.1-2: Minimum requirements for PDSCH Type A with Rank 1**

| Test number | FRC (Annex B)   | Bandwidth (MHz) / Subcarrier spacing (kHz) | Propagation conditions (Annex C) | Antenna configuration | Fraction of maximum BLER (%) | SNR (dB) |
|-------------|-----------------|--------------------------------------------|----------------------------------|-----------------------|------------------------------|----------|
| 2-1         | M-FR1-NCR.1.1-2 | 40/30                                      | TDLA30-10                        | 2x4, ULA Low          | 1                            | -0.5     |
| 2-2         | M-FR1-NCR.1.1-4 | 40/30                                      | TDLA30-10                        | 2x4, ULA Low          | 1                            | 7.1      |

## 8.2.2 Performance requirements for PDCCH

The receiver characteristics of the PDCCH are determined by the probability of miss-detection of the Downlink Scheduling Grant (Pm-dsg).

### 8.2.2.1 2Rx requirements

#### 8.2.2.1.1 FDD

The parameters specified in Table 8.2.2.1.1-1 are valid for all FDD tests unless otherwise stated.

**Table: 8.2.2.1.1-1 Test parameters for testing PDCCH**

| Parameter                                                   | Value                                                                                                                                                                                      |
|-------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cyclic prefix                                               | Normal                                                                                                                                                                                     |
| DM-RS sequence generation                                   | NID=0                                                                                                                                                                                      |
| Frequency domain resource allocation for CORESET            | Start from RB = 0 with contiguous RB allocation                                                                                                                                            |
| CCE to REG mapping type                                     | Not-Interleaved                                                                                                                                                                            |
| Interleaver size                                            | 3                                                                                                                                                                                          |
| REG bundle size                                             | 6 for test with 1Tx and 2Tx                                                                                                                                                                |
| Shift Index                                                 | 0                                                                                                                                                                                          |
| Slots for PDCCH monitoring                                  | Each slot                                                                                                                                                                                  |
| Number of PDCCH candidates for the tested aggregation level | 1                                                                                                                                                                                          |
| PDCCH Precoding configuration                               | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i1, i2 combination with REG bundling granularity for number of Tx larger than 1 |

#### 8.2.2.1.1.1 1Tx requirements

For the parameters specified in Table 8.2.2.1.1-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 8.2.2.1.1.1-1.

**Table 8.2.2.1.1.1-1: Minimum performance for PDCCH with 15 kHz SCS**

| Test number | Bandwidth (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value |          |
|-------------|-----------------|------------|------------------|-------------------|-------------------|-----------------------|----------------------------------------------|-----------------|----------|
|             |                 |            |                  |                   |                   |                       |                                              | Pm-dsg (%)      | SNR (dB) |
| 1-1         | 10              | 24         | 2                | 2                 | M-FR1-NCR.1.2-1   | TDLA30-10             | 1x2 Low                                      | 1               | 8.1      |
| 1-2         | 10              | 48         | 2                | 4                 | M-FR1-NCR.1.2-2   | TDLA30-10             | 1x2 Low                                      | 1               | 5.5      |

#### 8.2.2.1.1.2 2Tx requirements

For the parameters specified in Table 8.2.2.1.1-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 8.2.2.1.1.2-1.

**Table 8.2.2.1.1.2-1: Minimum performance for PDCCH with 15 kHz SCS**

| Test number | Bandwidth (MHz) | CORE SET RB | CORE SET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value |          |
|-------------|-----------------|-------------|-------------------|-------------------|-------------------|-----------------------|----------------------------------------------|-----------------|----------|
|             |                 |             |                   |                   |                   |                       |                                              | Pm-dsg (%)      | SNR (dB) |
| 1-1         | 10              | 48          | 1                 | 8                 | M-FR1-NCR.1.2-3   | TDLA30-10             | 2x2 Low                                      | 1               | -0.2     |

### 8.2.2.1.2 TDD

The parameters specified in Table 8.2.2.1.2-1 are valid for all TDD tests unless otherwise stated.

**Table: 8.2.2.1.2-1 Test parameters for testing PDCCH**

| Parameter                                                                          | Value                                                                                                                                                                                          |
|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cyclic prefix                                                                      | Normal                                                                                                                                                                                         |
| Default TDD UL-DL pattern (Note 1)                                                 | 7D1S2U, S=6D:4G:4U                                                                                                                                                                             |
| DM-RS sequence generation                                                          | $N_{ID}=0$                                                                                                                                                                                     |
| Frequency domain resource allocation for CORESET                                   | Start from RB = 0 with contiguous RB allocation                                                                                                                                                |
| CCE to REG mapping type                                                            | Interleaved                                                                                                                                                                                    |
| Interleaver size                                                                   | 3                                                                                                                                                                                              |
| REG bundle size                                                                    | 2 for test with 1Tx<br>6 for test with 2Tx                                                                                                                                                     |
| Shift Index                                                                        | 0                                                                                                                                                                                              |
| Slots for PDCCH monitoring                                                         | Each slot                                                                                                                                                                                      |
| Number of PDCCH candidates for the tested aggregation level                        | 1                                                                                                                                                                                              |
| PDCCH Precoding configuration                                                      | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1, i_2$ combination with REG bundling granularity for number of Tx larger than 1 |
| Note 1: The same requirements are applicable to TDD with different UL-DL patterns. |                                                                                                                                                                                                |

#### 8.2.2.1.2.1 1Tx requirements

For the parameters specified in Table 8.2.2.1.2-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 8.2.2.1.2.1-1.

**Table 8.2.2.1.2.1-1: Minimum performance for PDCCH with 30 kHz SCS**

| Test number | Bandwidth (MHz) | CORE SET RB | CORE SET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value |          |
|-------------|-----------------|-------------|-------------------|-------------------|-------------------|-----------------------|----------------------------------------------|-----------------|----------|
|             |                 |             |                   |                   |                   |                       |                                              | Pm-dsg (%)      | SNR (dB) |
| 1-1         | 40              | 102         | 1                 | 2                 | M-FR1-NCR.1.2-4   | TDLA30-10             | 1x2 Low                                      | 1               | 7.0      |
| 1-2         | 40              | 102         | 1                 | 4                 | M-FR1-NCR.1.2-5   | TDLA30-10             | 1x2 Low                                      | 1               | 4.9      |

#### 8.2.2.1.2.2 2Tx requirements

For the parameters specified in Table 8.2.2.1.2-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 8.2.2.1.2.2-1.

**Table 8.2.2.1.2.2-1: Minimum performance for PDCCH with 30 kHz SCS**

| Test number | Bandwidth (MHz) | CORE SET RB | CORE SET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value |          |
|-------------|-----------------|-------------|-------------------|-------------------|-------------------|-----------------------|----------------------------------------------|-----------------|----------|
|             |                 |             |                   |                   |                   |                       |                                              | Pm-dsg (%)      | SNR (dB) |
| 1-1         | 40              | 90          | 1                 | 8                 | M-FR1-NCR.1.2-6   | TDLA30-10             | 2x2 Low                                      | 1               | -0.7     |

## 8.2.2.2 4Rx requirements

### 8.2.2.2.1 FDD

The parameters specified in Table 8.2.2.2.1-1 are valid for all FDD tests unless otherwise stated.

**Table: 8.2.2.2.1-1 Test parameters for testing PDCCH**

| Parameter                                                   | Value                                                                                                                                                                                      |
|-------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cyclic prefix                                               | Normal                                                                                                                                                                                     |
| DM-RS sequence generation                                   | NID=0                                                                                                                                                                                      |
| Frequency domain resource allocation for CORESET            | Start from RB = 0 with contiguous RB allocation                                                                                                                                            |
| CCE to REG mapping type                                     | Not-Interleaved                                                                                                                                                                            |
| Interleaver size                                            | 3                                                                                                                                                                                          |
| REG bundle size                                             | 6 for test with 1Tx and 2Tx                                                                                                                                                                |
| Shift Index                                                 | 0                                                                                                                                                                                          |
| Slots for PDCCH monitoring                                  | Each slot                                                                                                                                                                                  |
| Number of PDCCH candidates for the tested aggregation level | 1                                                                                                                                                                                          |
| PDCCH Precoding configuration                               | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i1, i2 combination with REG bundling granularity for number of Tx larger than 1 |

#### 8.2.2.2.1.1 1Tx requirements

For the parameters specified in Table 8.2.2.2.1-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 8.2.2.2.1.1-1.

**Table 8.2.2.2.1.1-1: Minimum performance for PDCCH with 15 kHz SCS**

| Test number | Bandwidth (MHz) | CORE SET RB | CORE SET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value |          |
|-------------|-----------------|-------------|-------------------|-------------------|-------------------|-----------------------|----------------------------------------------|-----------------|----------|
|             |                 |             |                   |                   |                   |                       |                                              | Pm-dsg (%)      | SNR (dB) |
| 1-1         | 10              | 24          | 2                 | 2                 | M-FR1-NCR.1.2-1   | TDLA30-10             | 1x4 Low                                      | 1               | 2.2      |
| 1-2         | 10              | 48          | 2                 | 4                 | M-FR1-NCR.1.2-2   | TDLA30-10             | 1x4 Low                                      | 1               | 0.2      |

#### 8.2.2.2.1.2 2Tx requirements

For the parameters specified in Table 8.2.2.2.1-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 8.2.2.2.1.2-1.

**Table 8.2.2.2.1.2-1: Minimum performance for PDCCH with 15 kHz SCS**

| Test number | Bandwidth (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value |          |
|-------------|-----------------|------------|------------------|-------------------|-------------------|-----------------------|----------------------------------------------|-----------------|----------|
|             |                 |            |                  |                   |                   |                       |                                              | Pm-dsg (%)      | SNR (dB) |
| 1-1         | 10              | 48         | 2                | 8                 | M-FR1-NCR.1.2-3   | TDLA30-10             | 2x4 Low                                      | 1               | -2.5     |

#### 8.2.2.2.2 TDD

The parameters specified in Table 8.2.2.2.2-1 are valid for all TDD tests unless otherwise stated.

**Table: 8.2.2.2.2-1 Test parameters for testing PDCCH**

| Parameter                                                                          | Value                                                                                                                                                                                          |
|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cyclic prefix                                                                      | Normal                                                                                                                                                                                         |
| Default TDD UL-DL pattern (Note 1)                                                 | 7D1S2U, S=6D:4G:4U                                                                                                                                                                             |
| DM-RS sequence generation                                                          | $N_{ID}=0$                                                                                                                                                                                     |
| Frequency domain resource allocation for CORESET                                   | Start from RB = 0 with contiguous RB allocation                                                                                                                                                |
| CCE to REG mapping type                                                            | Interleaved                                                                                                                                                                                    |
| Interleaver size                                                                   | 3                                                                                                                                                                                              |
| REG bundle size                                                                    | 2 for test with 1Tx<br>6 for test with 2Tx                                                                                                                                                     |
| Shift Index                                                                        | 0                                                                                                                                                                                              |
| Slots for PDCCH monitoring                                                         | Each slot                                                                                                                                                                                      |
| Number of PDCCH candidates for the tested aggregation level                        | 1                                                                                                                                                                                              |
| PDCCH Precoding configuration                                                      | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1, i_2$ combination with REG bundling granularity for number of Tx larger than 1 |
| Note 1: The same requirements are applicable to TDD with different UL-DL patterns. |                                                                                                                                                                                                |

#### 8.2.2.2.2.1 1Tx requirements

For the parameters specified in Table 8.2.2.2.2-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 8.2.2.2.2.1-1.

**Table 8.2.2.2.2.1-1: Minimum performance for PDCCH with 30 kHz SCS**

| Test number | Bandwidth (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value |          |
|-------------|-----------------|------------|------------------|-------------------|-------------------|-----------------------|----------------------------------------------|-----------------|----------|
|             |                 |            |                  |                   |                   |                       |                                              | Pm-dsg (%)      | SNR (dB) |
| 1-1         | 40              | 102        | 1                | 2                 | M-FR1-NCR.1.2-4   | TDLA30-10             | 1x4 Low                                      | 1               | 2.1      |
| 1-2         | 40              | 102        | 1                | 4                 | M-FR1-NCR.1.2-5   | TDLA30-10             | 1x4 Low                                      | 1               | 0.7      |

#### 8.2.2.2.2.2 2Tx requirements

For the parameters specified in Table 8.2.2.2.2-1, the average probability of a missed downlink scheduling grant (Pm-dsg) shall be below the specified value in Table 8.2.2.2.2.2-1.

Table 8.2.2.2.2.2-1: Minimum performance for PDCCH with 30 kHz SCS

| Test number | Bandwidth (MHz) | CORESET RB | CORESET duration | Aggregation level | Reference Channel | Propagation Condition | Antenna configuration and correlation Matrix | Reference value |          |
|-------------|-----------------|------------|------------------|-------------------|-------------------|-----------------------|----------------------------------------------|-----------------|----------|
|             |                 |            |                  |                   |                   |                       |                                              | Pm-dsg (%)      | SNR (dB) |
| 1-1         | 40              | 90         | 1                | 8                 | M-FR1-NCR.1.2-6   | TDLA30-10             | 2x4 Low                                      | 1               | -4.1     |

8.2.3 Channel Quality Indicator (CQI) reporting requirements

8.2.3.1 General

This clause includes conducted requirements for the reporting of channel quality indicator (CQI) .

The reporting accuracy of the channel quality indicator (CQI) under frequency non-selective conditions is determined by the reporting variance and the BLER performance using the transport format indicated by the reported CQI median. The purpose is to verify that the reported CQI values are in accordance with the CQI definition given in TS 38.214 [28]. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

8.2.3.2 2Rx requirements

8.2.3.2.1 FDD

8.2.3.2.1.1 Test parameters

Parameters specified in Table 8.2.3.2.1.1-1 are applied for all test cases in clause 8.2.3.2.1 unless otherwise stated.

Table 8.2.3.2.1.1-1: Test parameters for testing CQI reporting

| Parameter                                  |                                                                     | Unit | Test 1                                       |   | Test 2 |    |
|--------------------------------------------|---------------------------------------------------------------------|------|----------------------------------------------|---|--------|----|
| Bandwidth                                  |                                                                     | MHz  | 10                                           |   |        |    |
| Duplex Mode                                |                                                                     |      | FDD                                          |   |        |    |
| Subcarrier spacing                         |                                                                     | kHz  | 15                                           |   |        |    |
| SNR                                        |                                                                     | dB   | 8                                            | 9 | 14     | 15 |
| Propagation channel                        |                                                                     |      | AWGN                                         |   |        |    |
| Antenna configuration                      |                                                                     |      | 2×2 with static channel specified in Annex C |   |        |    |
| Beamforming Model                          |                                                                     |      | TBD                                          |   |        |    |
| NZP CSI-RS for CSI acquisition             | CSI-RS resource Type                                                |      | Periodic                                     |   |        |    |
|                                            | Number of CSI-RS ports (X)                                          |      | 2                                            |   |        |    |
|                                            | CDM Type                                                            |      | FD-CDM2                                      |   |        |    |
|                                            | Density (ρ)                                                         |      | 1                                            |   |        |    |
|                                            | First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> ) |      | Row 3,(6)                                    |   |        |    |
|                                            | First OFDM symbol in the PRB used for CSI-RS (l <sub>0</sub> )      |      | 13                                           |   |        |    |
|                                            | NZP CSI-RS-timeConfig periodicity and offset                        | slot | 5/1                                          |   |        |    |
| ReportConfigType                           |                                                                     |      | Periodic                                     |   |        |    |
| CQI-table                                  |                                                                     |      | Table 2                                      |   |        |    |
| reportQuantity                             |                                                                     |      | cri-RI-PMI-CQI                               |   |        |    |
| timeRestrictionForChannelMeasurements      |                                                                     |      | Not configured                               |   |        |    |
| timeRestrictionForInterferenceMeasurements |                                                                     |      | Not configured                               |   |        |    |
| cqi-FormatIndicator                        |                                                                     |      | Wideband                                     |   |        |    |
| pmi-FormatIndicator                        |                                                                     |      | Wideband                                     |   |        |    |
| Sub-band Size                              |                                                                     | RB   | 8                                            |   |        |    |
| Csi-ReportingBand                          |                                                                     |      | 1111111                                      |   |        |    |
| CSI-Report periodicity and offset          |                                                                     | slot | 5/0                                          |   |        |    |
| aperiodicTriggeringOffset                  |                                                                     |      | Not configured                               |   |        |    |
| Codebook configuration                     | Codebook Type                                                       |      | type1-SinglePanel                            |   |        |    |
|                                            | Codebook Mode                                                       |      | 1                                            |   |        |    |
|                                            | (CodebookConfig-N1,CodebookConfig-N2)                               |      | Not configured                               |   |        |    |
|                                            | CodebookSubsetRestriction                                           |      | 010000                                       |   |        |    |
|                                            | RI Restriction                                                      |      | N/A                                          |   |        |    |
| Physical channel for CSI report            |                                                                     |      | PUCCH                                        |   |        |    |
| CQI/RI/PMI delay                           |                                                                     | ms   | 8                                            |   |        |    |
| Maximum number of HARQ transmission        |                                                                     |      | 1                                            |   |        |    |
| Measurement channel                        |                                                                     |      | M-FR1-NCR.1.3-1                              |   |        |    |

## 8.2.3.2.1.2 Minimum requirements

For the parameters specified in Table 8.2.3.2.1.1-1, the minimum requirements are specified by the following:

- The reported CQI value according to the reference channel shall be in the range of  $\pm 1$  of the reported median more than 90% of the time.
- If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

## 8.2.3.2.2 TDD

## 8.2.3.2.2.1 Test parameters

Parameters specified in Table 8.2.3.2.2.1-1 are applied for all test cases in clause 8.2.3.2.2.1 unless otherwise stated.

**Table 8.2.3.2.2.1-1: Test parameters for testing CQI reporting**

| Parameter                                                                                                                                                         |                                                                             | Unit | Test 1                                       |   | Test 2 |    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|------|----------------------------------------------|---|--------|----|
| Bandwidth                                                                                                                                                         |                                                                             | MHz  | 40                                           |   |        |    |
| Subcarrier spacing                                                                                                                                                |                                                                             | kHz  | 30                                           |   |        |    |
| Duplex Mode                                                                                                                                                       |                                                                             |      | TDD                                          |   |        |    |
| TDD UL-DL pattern (Note 1)                                                                                                                                        |                                                                             |      | 7D1S2U, S=6D:4G:4U                           |   |        |    |
| SNR                                                                                                                                                               |                                                                             | dB   | 8                                            | 9 | 14     | 15 |
| Propagation channel                                                                                                                                               |                                                                             |      | AWGN                                         |   |        |    |
| Antenna configuration                                                                                                                                             |                                                                             |      | 2×2 with static channel specified in Annex C |   |        |    |
| Beamforming Model                                                                                                                                                 |                                                                             |      | TBD                                          |   |        |    |
| NZP CSI-RS for CSI acquisition                                                                                                                                    | CSI-RS resource Type                                                        |      | Periodic                                     |   |        |    |
|                                                                                                                                                                   | Number of CSI-RS ports ( <i>X</i> )                                         |      | 2                                            |   |        |    |
|                                                                                                                                                                   | CDM Type                                                                    |      | FD-CDM2                                      |   |        |    |
|                                                                                                                                                                   | Density ( <i>ρ</i> )                                                        |      | 1                                            |   |        |    |
|                                                                                                                                                                   | First subcarrier index in the PRB used for CSI-RS ( <i>k</i> <sub>0</sub> ) |      | Row 3,(6,-)                                  |   |        |    |
|                                                                                                                                                                   | First OFDM symbol in the PRB used for CSI-RS ( <i>l</i> <sub>0</sub> )      |      | 13                                           |   |        |    |
|                                                                                                                                                                   | NZP CSI-RS-timeConfig periodicity and offset                                | slot | 10/1                                         |   |        |    |
| ReportConfigType                                                                                                                                                  |                                                                             |      | Periodic                                     |   |        |    |
| CQI-table                                                                                                                                                         |                                                                             |      | Table 2                                      |   |        |    |
| reportQuantity                                                                                                                                                    |                                                                             |      | cri-RI-PMI-CQI                               |   |        |    |
| timeRestrictionForChannelMeasurements                                                                                                                             |                                                                             |      | Not configured                               |   |        |    |
| timeRestrictionForInterferenceMeasurements                                                                                                                        |                                                                             |      | Not configured                               |   |        |    |
| cqi-FormatIndicator                                                                                                                                               |                                                                             |      | Wideband                                     |   |        |    |
| pmi-FormatIndicator                                                                                                                                               |                                                                             |      | Wideband                                     |   |        |    |
| Sub-band Size                                                                                                                                                     |                                                                             | RB   | 16                                           |   |        |    |
| Csi-ReportingBand                                                                                                                                                 |                                                                             |      | 1111111                                      |   |        |    |
| CSI-Report periodicity and offset                                                                                                                                 |                                                                             | slot | 10/9                                         |   |        |    |
| aperiodicTriggeringOffset                                                                                                                                         |                                                                             |      | Not configured                               |   |        |    |
| Codebook configuration                                                                                                                                            | Codebook Type                                                               |      | type1-SinglePanel                            |   |        |    |
|                                                                                                                                                                   | Codebook Mode                                                               |      | 1                                            |   |        |    |
|                                                                                                                                                                   | (CodebookConfig-N1,CodebookConfig-N2)                                       |      | Not configured                               |   |        |    |
|                                                                                                                                                                   | CodebookSubsetRestriction                                                   |      | 010000                                       |   |        |    |
|                                                                                                                                                                   | RI Restriction                                                              |      | N/A                                          |   |        |    |
| Physical channel for CSI report                                                                                                                                   |                                                                             |      | PUCCH                                        |   |        |    |
| CQI/RI/PMI delay                                                                                                                                                  |                                                                             | ms   | 9.5                                          |   |        |    |
| Maximum number of HARQ transmission                                                                                                                               |                                                                             |      | 1                                            |   |        |    |
| Measurement channel                                                                                                                                               |                                                                             |      | M-FR1-NCR.1.3-2                              |   |        |    |
| Note 1: The same requirements are applicable for TDD with different UL-DL pattern.                                                                                |                                                                             |      |                                              |   |        |    |
| Note 2: SSB, TRS, CSI-RS, and/or other unspecified test parameters with respect to TS 38.101-4 [30] are left up to test implementation, if transmitted or needed. |                                                                             |      |                                              |   |        |    |

## 8.2.3.2.2.2 Minimum requirements

For the parameters specified in Table 8.2.3.2.2.1-1, the minimum requirements are specified by the following:

- The reported CQI value according to the reference channel shall be in the range of  $\pm 1$  of the reported median more than 90% of the time.
- If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

### 8.2.3.3 4Rx requiremnets

#### 8.2.3.3.1 FDD

##### 8.2.3.3.1.1 Test parameters

Parameters specified in Table 8.2.3.3.1.1-1 are applied for all test cases in clause 8.2.3.3.1.1 unless otherwise stated.

**Table 8.2.3.3.1.1-1: Test parameters for testing CQI reporting**

| Parameter                                  |                                                                     | Unit | Test 1                                       |   | Test 2 |    |
|--------------------------------------------|---------------------------------------------------------------------|------|----------------------------------------------|---|--------|----|
| Bandwidth                                  |                                                                     | MHz  | 10                                           |   |        |    |
| Subcarrier spacing                         |                                                                     | kHz  | 15                                           |   |        |    |
| Duplex Mode                                |                                                                     |      | FDD                                          |   |        |    |
| SNR                                        |                                                                     | dB   | 5                                            | 6 | 11     | 12 |
| Propagation channel                        |                                                                     |      | AWGN                                         |   |        |    |
| Antenna configuration                      |                                                                     |      | 2×4 with static channel specified in Annex C |   |        |    |
| Beamforming Model                          |                                                                     |      | TBD                                          |   |        |    |
| NZP CSI-RS for CSI acquisition             | CSI-RS resource Type                                                |      | Periodic                                     |   |        |    |
|                                            | Number of CSI-RS ports (X)                                          |      | 2                                            |   |        |    |
|                                            | CDM Type                                                            |      | FD-CDM2                                      |   |        |    |
|                                            | Density (ρ)                                                         |      | 1                                            |   |        |    |
|                                            | First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> ) |      | Row 3,(6)                                    |   |        |    |
|                                            | First OFDM symbol in the PRB used for CSI-RS (l <sub>0</sub> )      |      | 13                                           |   |        |    |
|                                            | NZP CSI-RS-timeConfig periodicity and offset                        | slot | 5/1                                          |   |        |    |
| ReportConfigType                           |                                                                     |      | Periodic                                     |   |        |    |
| CQI-table                                  |                                                                     |      | Table 2                                      |   |        |    |
| reportQuantity                             |                                                                     |      | cri-RI-PMI-CQI                               |   |        |    |
| timeRestrictionForChannelMeasurements      |                                                                     |      | Not configured                               |   |        |    |
| timeRestrictionForInterferenceMeasurements |                                                                     |      | Not configured                               |   |        |    |
| cqi-FormatIndicator                        |                                                                     |      | Wideband                                     |   |        |    |
| pmi-FormatIndicator                        |                                                                     |      | Wideband                                     |   |        |    |
| Sub-band Size                              |                                                                     | RB   | 8                                            |   |        |    |
| csi-ReportingBand                          |                                                                     |      | 1111111                                      |   |        |    |
| CSI-Report periodicity and offset          |                                                                     | slot | 5/0                                          |   |        |    |
| aperiodicTriggeringOffset                  |                                                                     |      | Not configured                               |   |        |    |
| Codebook configuration                     | Codebook Type                                                       |      | type1-SinglePanel                            |   |        |    |
|                                            | Codebook Mode                                                       |      | 1                                            |   |        |    |
|                                            | (CodebookConfig-N1,CodebookConfig-N2)                               |      | Not configured                               |   |        |    |
|                                            | CodebookSubsetRestriction                                           |      | 010000                                       |   |        |    |
|                                            | RI Restriction                                                      |      | N/A                                          |   |        |    |
| Physical channel for CSI report            |                                                                     |      | PUCCH                                        |   |        |    |
| CQI/RI/PMI delay                           |                                                                     | ms   | 8                                            |   |        |    |
| Maximum number of HARQ transmission        |                                                                     |      | 1                                            |   |        |    |
| Measurement channel                        |                                                                     |      | M-FR1-NCR.1.3-1                              |   |        |    |

##### 8.2.3.3.1.2 Minimum requirements

For the parameters specified in Table 8.2.3.3.1.1-1, the minimum requirements are specified by the following:

- The reported CQI value according to the reference channel shall be in the range of  $\pm 1$  of the reported median more than 90 % of the time.

- b) If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

### 8.2.3.3.2 TDD

#### 8.2.3.3.2.1 Test parameters

Parameters specified in Table 8.2.3.3.2.1 -1 are applied for all test cases in clause 8.2.3.3.2.1 unless otherwise stated.

**Table 8.2.3.3.2.1 -1: Test parameters for testing CQI reporting**

| Parameter                                                                                                                                                         |                                                                     | Unit | Test 1                                       |   | Test 2 |    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|------|----------------------------------------------|---|--------|----|
| Bandwidth                                                                                                                                                         |                                                                     | MHz  | 40                                           |   |        |    |
| Subcarrier spacing                                                                                                                                                |                                                                     | kHz  | 30                                           |   |        |    |
| Duplex Mode                                                                                                                                                       |                                                                     |      | TDD                                          |   |        |    |
| TDD UL-DL pattern (Note 1)                                                                                                                                        |                                                                     |      | 7D1S2U, S=6D:4G:4U                           |   |        |    |
| SNR                                                                                                                                                               |                                                                     | dB   | 5                                            | 6 | 11     | 12 |
| Propagation channel                                                                                                                                               |                                                                     |      | AWGN                                         |   |        |    |
| Antenna configuration                                                                                                                                             |                                                                     |      | 2×4 with static channel specified in Annex C |   |        |    |
| Beamforming Model                                                                                                                                                 |                                                                     |      | TBD                                          |   |        |    |
| NZP CSI-RS for CSI acquisition                                                                                                                                    | CSI-RS resource Type                                                |      | Periodic                                     |   |        |    |
|                                                                                                                                                                   | Number of CSI-RS ports (X)                                          |      | 2                                            |   |        |    |
|                                                                                                                                                                   | CDM Type                                                            |      | FD-CDM2                                      |   |        |    |
|                                                                                                                                                                   | Density (ρ)                                                         |      | 1                                            |   |        |    |
|                                                                                                                                                                   | First subcarrier index in the PRB used for CSI-RS (k <sub>0</sub> ) |      | Row 3,(6,-)                                  |   |        |    |
|                                                                                                                                                                   | First OFDM symbol in the PRB used for CSI-RS (l <sub>0</sub> )      |      | 13                                           |   |        |    |
|                                                                                                                                                                   | NZP CSI-RS-timeConfig periodicity and offset                        | slot | 10/1                                         |   |        |    |
| ReportConfigType                                                                                                                                                  |                                                                     |      | Periodic                                     |   |        |    |
| CQI-table                                                                                                                                                         |                                                                     |      | Table 2                                      |   |        |    |
| reportQuantity                                                                                                                                                    |                                                                     |      | cri-RI-PMI-CQI                               |   |        |    |
| timeRestrictionForChannelMeasurements                                                                                                                             |                                                                     |      | Not configured                               |   |        |    |
| timeRestrictionForInterferenceMeasurements                                                                                                                        |                                                                     |      | Not configured                               |   |        |    |
| cqi-FormatIndicator                                                                                                                                               |                                                                     |      | Wideband                                     |   |        |    |
| pmi-FormatIndicator                                                                                                                                               |                                                                     |      | Wideband                                     |   |        |    |
| Sub-band Size                                                                                                                                                     |                                                                     | RB   | 16                                           |   |        |    |
| Csi-ReportingBand                                                                                                                                                 |                                                                     |      | 1111111                                      |   |        |    |
| CSI-Report periodicity and offset                                                                                                                                 |                                                                     | slot | 10/9                                         |   |        |    |
| aperiodicTriggeringOffset                                                                                                                                         |                                                                     |      | Not configured                               |   |        |    |
| Codebook configuration                                                                                                                                            | Codebook Type                                                       |      | type1-SinglePanel                            |   |        |    |
|                                                                                                                                                                   | Codebook Mode                                                       |      | 1                                            |   |        |    |
|                                                                                                                                                                   | (CodebookConfig-N1,CodebookConfig-N2)                               |      | Not configured                               |   |        |    |
|                                                                                                                                                                   | CodebookSubsetRestriction                                           |      | 010000                                       |   |        |    |
| RI Restriction                                                                                                                                                    |                                                                     |      | N/A                                          |   |        |    |
| Physical channel for CSI report                                                                                                                                   |                                                                     |      | PUCCH                                        |   |        |    |
| CQI/RI/PMI delay                                                                                                                                                  |                                                                     | ms   | 9.5                                          |   |        |    |
| Maximum number of HARQ transmission                                                                                                                               |                                                                     |      | 1                                            |   |        |    |
| Measurement channel                                                                                                                                               |                                                                     |      | M-FR1-NCR.1.3-2                              |   |        |    |
| Note 1: The same requirements are applicable for TDD with different UL-DL pattern.                                                                                |                                                                     |      |                                              |   |        |    |
| Note 2: SSB, TRS, CSI-RS, and/or other unspecified test parameters with respect to TS 38.101-4 [30] are left up to test implementation, if transmitted or needed. |                                                                     |      |                                              |   |        |    |

#### 8.2.3.3.2.2 Minimum requirements

For the parameters specified in Table 8.2.3.3.2.1 -1-1, the minimum requirements are specified by the following:

- a) The reported CQI value according to the reference channel shall be in the range of  $\pm 1$  of the reported median more than 90% of the time.
- b) If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

## 9 Radiated performance requirements

### 9.1 General

Radiated performance requirements specify the ability of the *NCR-MT type 2-O* to correctly demodulate radiated signals in various conditions and configurations. Radiated performance requirements are specified at the RIB.

Radiated performance requirements for the NCR-MT are specified for the fixed reference channels defined in annex B and the propagation conditions in annex C.

The radiated performance requirements for the *NCR-MT type 2-O* are limited to two OTA *demodulation branches* as described in clause 9.2. Conformance requirements can only be tested for 1 or 2 *demodulation branches* depending on the number of polarizations supported by the NCR-MT, with the required SNR applied separately per polarization.

NOTE 1: The NCR-MT can support more than 2 *demodulation branches*, however OTA conformance testing can only be performed for 1 or 2 *demodulation branches*.

Radiated performance requirements apply for a single carrier only.

Whenever the "RX antennas" term is used for the radiated performance requirements description, it shall refer to the *demodulation branches* (i.e. not physical antennas of the antenna array).

The SNR used in this clause is specified based on a single carrier and defined as:

$$\text{SNR} = S / N$$

Where:

S is the total signal energy in a slot on a RIB.

N is the noise energy in a bandwidth corresponding to the *transmission bandwidth* over the duration of a slot on a RIB

Radiated performance requirements are only specified for up to 2 *demodulation branches*.

### 9.2 OTA demodulation branches

If the *NCR-MT type 2-O* uses polarization diversity and has the ability to maintain isolation between the signals for each of the *demodulation branches*, then radiated performance requirements can be tested for up to two *demodulation branches* (i.e. 1RX or 2RX test setups). When tested for two *demodulation branches*, each demodulation branch maps to one polarization.

If the *NCR-MT type 2-O* does not use polarization diversity then radiated performance requirements can only be tested for a single *demodulation branch* (i.e. 1RX test setup).

## 9.3 Demodulation performance requirements

### 9.3.1 Performance requirements for NCR type 2-O

#### 9.3.1.1 Performance requirements for PDSCH

##### 9.3.1.1.1 General

The performance requirement of PDSCH is determined by (i) a minimum required throughput for a given SNR and (ii) a minimum SNR at which 1% first transmission BLER is achieved. The required throughput is expressed as a fraction of maximum throughput for the FRCs listed in annex B. The throughput requirements assume HARQ retransmissions whereas the 1% BLER requirements are based on the first transmission only.

**Table: 9.3.1.1.1-1 Test parameters for PDSCH testing**

| Parameter                                                                                                                                                         |                                           | Value                                                                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cyclic prefix                                                                                                                                                     |                                           | Normal                                                                                                                                                               |
| Default TDD UL-DL pattern (Note 1)                                                                                                                                |                                           | 3D1S1U, S=10D:2G:2U                                                                                                                                                  |
| HARQ                                                                                                                                                              | Maximum number of HARQ transmissions      | 4                                                                                                                                                                    |
|                                                                                                                                                                   | RV sequence                               | 0, 2, 3, 1                                                                                                                                                           |
| DM-RS                                                                                                                                                             | DM-RS configuration type                  | 1                                                                                                                                                                    |
|                                                                                                                                                                   | DM-RS duration                            | single-symbol DM-RS                                                                                                                                                  |
|                                                                                                                                                                   | DM-RS position ( $l_0$ )                  | 2                                                                                                                                                                    |
|                                                                                                                                                                   | Additional DM-RS position                 | pos1                                                                                                                                                                 |
|                                                                                                                                                                   | Number of DM-RS CDM group(s) without data | 1                                                                                                                                                                    |
|                                                                                                                                                                   | DM-RS port(s)                             | {1000} for Rank 1 tests<br>{1000-1001} for Rank 2 tests                                                                                                              |
|                                                                                                                                                                   | DM-RS sequence generation                 | $N_{ID}^0=0$                                                                                                                                                         |
| Time domain resource assignment                                                                                                                                   | PDSCH mapping type                        | A                                                                                                                                                                    |
|                                                                                                                                                                   | Start symbol                              | 1                                                                                                                                                                    |
|                                                                                                                                                                   | Allocation length                         | 13                                                                                                                                                                   |
| Frequency domain resource assignment                                                                                                                              | RB assignment                             | Full applicable test bandwidth                                                                                                                                       |
| PT-RS configuration                                                                                                                                               | Frequency density ( $K_{PT-RS}$ )         | 2                                                                                                                                                                    |
|                                                                                                                                                                   | Time density ( $L_{PT-RS}$ )              | 1                                                                                                                                                                    |
| PRB bundling size                                                                                                                                                 |                                           | 2                                                                                                                                                                    |
| VRB-to-PRB mapping type                                                                                                                                           |                                           | Not interleaved                                                                                                                                                      |
| PDSCH & PDSCH DMRS Precoding configuration                                                                                                                        |                                           | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable $i_1, i_2$ combination, and with PRB bundling granularity |
| Note 1: The same requirements are applicable to TDD with different UL-DL patterns.                                                                                |                                           |                                                                                                                                                                      |
| Note 2: SSB, TRS, CSI-RS, and/or other unspecified test parameters with respect to TS 38.101-4 [30] are left up to test implementation, if transmitted or needed. |                                           |                                                                                                                                                                      |

##### 9.3.1.1.2 Minimum requirements

The throughput shall be equal to or larger than the fraction of maximum throughput, and also meet the 1<sup>st</sup> transmission BLER 1% for the FRCs stated in table 9.3.1.1.2-1 at the given respective SNR with the test parameters stated in Tabl9.3.1.1.1-1.

**Table 9.3.1.2-1: Minimum requirements for PDSCH with 100 MHz Channel Bandwidth, 120 kHz SCS**

| Case number | Bandwidth (MHz) | FRC           | SCS (kHz) | Propagation condition | Antenna configuration | 70% throughput (dB) | 1% BLER (dB) |
|-------------|-----------------|---------------|-----------|-----------------------|-----------------------|---------------------|--------------|
| 1           | 100             | M-FR2-B.1.1-1 | 120       | TDLA30-75             | 2x2                   | -0.9                | 2.8          |

### 9.3.1.2 Performance requirements for PDCCH

#### 9.3.1.2.1 General

The receiver characteristics of the PDCCH are determined by the probability of miss-detection of the Downlink Scheduling Grant (Pm-dsg).

**Table: 9.3.1.2.1-1 Test parameters for testing PDCCH**

| Parameter                                                                                                                                                        | Value                                                                                                                                                                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cyclic prefix                                                                                                                                                    | Normal                                                                                                                                                                                     |
| Default TDD UL-DL pattern (Note 1)                                                                                                                               | 3D1S1U, S=10D:2G:2U                                                                                                                                                                        |
| DM-RS sequence generation                                                                                                                                        | NID=0                                                                                                                                                                                      |
| Frequency domain resource allocation for CORESET                                                                                                                 | Start from RB = 0 with contiguous RB allocation                                                                                                                                            |
| CCE to REG mapping type                                                                                                                                          | Interleaved                                                                                                                                                                                |
| Interleaver size                                                                                                                                                 | 2 for test with Aggregation level 4<br>3 for others                                                                                                                                        |
| REG bundle size                                                                                                                                                  | 6 for test with Aggregation level 4<br>2 for others                                                                                                                                        |
| Shift Index                                                                                                                                                      | 0                                                                                                                                                                                          |
| Slots for PDCCH monitoring                                                                                                                                       | Each slot                                                                                                                                                                                  |
| Number of PDCCH candidates for the tested aggregation level                                                                                                      | 1                                                                                                                                                                                          |
| PDCCH Precoding configuration                                                                                                                                    | Single Panel Type I, Random precoder selection updated per slot, with equal probability of each applicable i1, i2 combination with REG bundling granularity for number of Tx larger than 1 |
| Note 1: The same requirements are applicable to TDD with different UL-DL patterns.                                                                               |                                                                                                                                                                                            |
| Note 2: SSB, TRS, CSI-RS, and/or other unspecified test parameters with respect to TS 38.101-4 [30] are left up to test implementation, if transmitted or needed |                                                                                                                                                                                            |

#### 9.3.1.2.2 Minimum requirements

The Pm-dsg shall be equal to or smaller than 1%, for the cases stated in Table 9.3.1.2.2-1 at the given SNR with the test parameters stated in Table 9.3.1.2.1-1.

**Table 9.3.1.2.2-1: Minimum requirements for PDCCH, 100 MHz Channel Bandwidth, 120 kHz SCS**

| Antenna configuration | CORESET RB | CORESET duration | Aggregation level | FRC (Annex A)   | Propagation conditions and correlation matrix (Annex I) | Pm-dsg (%) | SNR (dB) |
|-----------------------|------------|------------------|-------------------|-----------------|---------------------------------------------------------|------------|----------|
| 1x2                   | 60         | 1                | 2                 | M-FR2-NCR.1.2-1 | TDLA30-75, ULA Low                                      | 1          | 6.4      |
| 1x2                   | 60         | 1                | 4                 | M-FR2-NCR.1.2-2 | TDLA30-75, ULA Low                                      | 1          | 2.9      |
| 2x2                   | 60         | 1                | 8                 | M-FR2-NCR.1.2-3 | TDLA30-75, ULA Low                                      | 1          | 0.1      |

## 9.4 CSI reporting requirements

### 9.4.1 Performance requirements for NCR-MT type 2-O

#### 9.4.1.1 General

This clause includes radiated requirements for the reporting of channel state information (CSI).

#### 9.4.1.2 Common test parameters

Parameters specified in Table 9.4.1.2-1 are applied for all test cases in this clause unless otherwise stated.

Table 9.4.1.2-1: Test parameters for CSI test cases

| Parameter                                                                                                                                                 |                                                                                  | Unit | Value                                                                                                                                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| PDSCH transmission scheme                                                                                                                                 |                                                                                  |      | Transmission scheme 1                                                                                                                            |
| Duplex Mode                                                                                                                                               |                                                                                  |      | TDD                                                                                                                                              |
| PTRS <i>epr</i> -Ratio                                                                                                                                    |                                                                                  |      | 0                                                                                                                                                |
| Actual carrier configuration                                                                                                                              | Offset between Point A and the lowest usable subcarrier on this carrier (Note 3) | RBs  | 0                                                                                                                                                |
|                                                                                                                                                           | Subcarrier spacing                                                               | kHz  | 120                                                                                                                                              |
| DL BWP configuration #1                                                                                                                                   | Cyclic prefix                                                                    |      | Normal                                                                                                                                           |
|                                                                                                                                                           | RB offset                                                                        | RBs  | 0                                                                                                                                                |
|                                                                                                                                                           | Number of contiguous PRB                                                         | PRBs | Maximum transmission bandwidth configuration as specified in clause 5.3.2 of TS 38.101-2 [4] for tested channel bandwidth and subcarrier spacing |
|                                                                                                                                                           | Active DL BWP index                                                              |      | 1                                                                                                                                                |
| PDSCH configuration                                                                                                                                       | Mapping type                                                                     |      | Type A                                                                                                                                           |
|                                                                                                                                                           | $k_0$                                                                            |      | 0                                                                                                                                                |
|                                                                                                                                                           | Starting symbol (S)                                                              |      | 2                                                                                                                                                |
|                                                                                                                                                           | Length (L)                                                                       |      | 12                                                                                                                                               |
|                                                                                                                                                           | PDSCH aggregation factor                                                         |      | 1                                                                                                                                                |
|                                                                                                                                                           | PRB bundling type                                                                |      | Static                                                                                                                                           |
|                                                                                                                                                           | PRB bundling size                                                                |      | 2                                                                                                                                                |
|                                                                                                                                                           | Resource allocation type                                                         |      | Type 0                                                                                                                                           |
|                                                                                                                                                           | RBG size                                                                         |      | Config2                                                                                                                                          |
|                                                                                                                                                           | VRB-to-PRB mapping type                                                          |      | Non-interleaved                                                                                                                                  |
|                                                                                                                                                           | VRB-to-PRB mapping interleaver bundle size                                       |      | N/A                                                                                                                                              |
| PDSCH DMRS configuration                                                                                                                                  | DMRS Type                                                                        |      | Type 1                                                                                                                                           |
|                                                                                                                                                           | Number of additional DMRS                                                        |      | 1                                                                                                                                                |
|                                                                                                                                                           | DMRS ports indexes                                                               |      | {1000} for Rank1<br>{1000,1001} for Rank2                                                                                                        |
|                                                                                                                                                           | Maximum number of OFDM symbols for DL front loaded DMRS                          |      | 1                                                                                                                                                |
|                                                                                                                                                           | Number of PDSCH DMRS CDM group(s) without data                                   |      | 2                                                                                                                                                |
| PTRS configuration                                                                                                                                        | Frequency density ( $K_{PT-RS}$ )                                                |      | 2                                                                                                                                                |
|                                                                                                                                                           | Time density ( $L_{PT-RS}$ )                                                     |      | 1                                                                                                                                                |
|                                                                                                                                                           | Resource Element Offset                                                          |      | 2                                                                                                                                                |
| NZP CSI-RS for CSI acquisition                                                                                                                            | Frequency Occupation                                                             |      | Start PRB 0<br>Number of PRB = BWP size                                                                                                          |
| Redundancy version coding sequence                                                                                                                        |                                                                                  |      | {0,2,3,1}                                                                                                                                        |
| Physical signals, channels mapping and precoding                                                                                                          |                                                                                  |      | As specified in Annex C.3.1                                                                                                                      |
| Note 1: PDSCH is scheduled only on full DL slots without CSI-RS resource and TRS allocated.                                                               |                                                                                  |      |                                                                                                                                                  |
| Note 2: Point A coincides with minimum guard band as specified in Table 5.3.3-1 from TS 38.101-2 [4] for tested channel bandwidth and subcarrier spacing. |                                                                                  |      |                                                                                                                                                  |

### 9.4.1.3 Reporting of Channel Quality Indicator (CQI)

#### 9.4.1.3.1 General

The reporting accuracy of the channel quality indicator (CQI) under frequency non-selective conditions is determined by the reporting variance and the BLER performance using the transport format indicated by the reported CQI median. The purpose is to verify that the reported CQI values are in accordance with the CQI definition given in TS 38.214 [11]. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

**Table 9.4.1.3.1-1: Test parameters**

| Parameter                           |                                                                                                                                                                                                                             | Unit | Test 1                                         |   | Test 2 |    |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------------------------------------------|---|--------|----|
| Bandwidth                           |                                                                                                                                                                                                                             | MHz  | 100                                            |   |        |    |
| Subcarrier spacing                  |                                                                                                                                                                                                                             | kHz  | 120                                            |   |        |    |
| Duplex Mode                         |                                                                                                                                                                                                                             |      | TDD                                            |   |        |    |
| Default TDD UL-DL pattern (Note 1)  |                                                                                                                                                                                                                             |      | 3D1S1U                                         |   |        |    |
| Special Slot Configuration          |                                                                                                                                                                                                                             |      | 10D+2G+2U                                      |   |        |    |
| SNR <sub>BB</sub>                   |                                                                                                                                                                                                                             | dB   | 8                                              | 9 | 14     | 15 |
| Propagation channel                 |                                                                                                                                                                                                                             |      | AWGN                                           |   |        |    |
| Antenna configuration               |                                                                                                                                                                                                                             |      | 2×2 with static channel specified in Annex I.1 |   |        |    |
| Beamforming Model                   |                                                                                                                                                                                                                             |      | As specified in Annex I.3.1                    |   |        |    |
| NZP CSI-RS for CSI acquisition      | CSI-RS resource Type                                                                                                                                                                                                        |      | Periodic                                       |   |        |    |
|                                     | Number of CSI-RS ports ( $X$ )                                                                                                                                                                                              |      | 2                                              |   |        |    |
|                                     | CDM Type                                                                                                                                                                                                                    |      | fd-CDM2                                        |   |        |    |
|                                     | Density ( $\rho$ )                                                                                                                                                                                                          |      | 1                                              |   |        |    |
|                                     | First subcarrier index in the PRB used for CSI-RS ( $k_0, k_1$ )                                                                                                                                                            |      | 6                                              |   |        |    |
|                                     | First OFDM symbol in the PRB used for CSI-RS ( $l_0, l_1$ )                                                                                                                                                                 |      | 13                                             |   |        |    |
|                                     | NZP CSI-RS-timeConfig periodicity and offset                                                                                                                                                                                | slot | 5/1                                            |   |        |    |
| ReportConfigType                    |                                                                                                                                                                                                                             |      | Periodic                                       |   |        |    |
| CQI-table                           |                                                                                                                                                                                                                             |      | Table 1                                        |   |        |    |
| reportQuantity                      |                                                                                                                                                                                                                             |      | cri-RI-PMI-CQI                                 |   |        |    |
| cqi-FormatIndicator                 |                                                                                                                                                                                                                             |      | Wideband                                       |   |        |    |
| pmi-FormatIndicator                 |                                                                                                                                                                                                                             |      | Wideband                                       |   |        |    |
| Sub-band Size                       |                                                                                                                                                                                                                             | RB   | 8                                              |   |        |    |
| csi-ReportingBand                   |                                                                                                                                                                                                                             |      | 11111111                                       |   |        |    |
| CSI-Report periodicity and offset   |                                                                                                                                                                                                                             | slot | 5/4                                            |   |        |    |
| Codebook configuration              | Codebook Type                                                                                                                                                                                                               |      | type1-SinglePanel                              |   |        |    |
|                                     | Codebook Mode                                                                                                                                                                                                               |      | 1                                              |   |        |    |
|                                     | (CodebookConfig-N1,CodebookConfig-N2)                                                                                                                                                                                       |      | Not configured                                 |   |        |    |
|                                     | CodebookSubsetRestriction                                                                                                                                                                                                   |      | 010000                                         |   |        |    |
|                                     | RI Restriction                                                                                                                                                                                                              |      | N/A                                            |   |        |    |
| CQI/RI/PMI delay                    |                                                                                                                                                                                                                             | ms   | 1.75                                           |   |        |    |
| Maximum number of HARQ transmission |                                                                                                                                                                                                                             |      | 1                                              |   |        |    |
| Measurement channel                 |                                                                                                                                                                                                                             |      | M-FR2-NCR.1.3-1                                |   |        |    |
| Note 1:                             | The same requirements are applicable to with different UL-DL patterns.                                                                                                                                                      |      |                                                |   |        |    |
| Note 2:                             | SSB, TRS, CSI-RS, and/or other unspecified test parameters with respect to TS 38.101-4 [30] are left up to test implementation, if transmitted or needed.                                                                   |      |                                                |   |        |    |
| Note 3:                             | If the NCR-MT reports in an available uplink reporting instance at slot #n based on CQI estimation at a downlink slot not later than slot#(n-4), this reported CQI cannot be applied at the gNB downlink before slot#(n+4). |      |                                                |   |        |    |

#### 9.4.1.3.2 Minimum requirements

For the parameters specified in Table 9.4.1.3.1-1, and using the downlink physical channels specified in Annex B, the minimum requirements are specified by the following:

- a) The reported CQI value according to the reference channel shall be in the range of  $\pm 1$  of the reported median more than 90% of the time.
- b) If the PDSCH BLER using the transport format indicated by median CQI is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI is greater than 0.1, then the BLER using transport format indicated by (median CQI-1) shall be less than or equal to 0.1.

## 10 NCR-MT RRC\_CONNECTED state mobility

### 10.1 RRC Connection Mobility Control for NCR-MT

#### 10.1.1 SA: RRC Re-establishment

##### 10.1.1.1 Introduction

This clause contains requirements on the NCR-MT regarding RRC connection re-establishment procedure. The requirements in this clause are applicable only for local area (LA) NCR-MT.

RRC connection re-establishment is initiated when an NCR-MT in RRC\_CONNECTED state loses RRC connection due to any of failure cases, including radio link failure, handover failure, and RRC connection reconfiguration failure. The RRC connection re-establishment procedure is specified in clause 5.3.7 of TS 38.331 [23].

The requirements in this clause are applicable for RRC connection re-establishment to NR cell.

##### 10.1.1.2 Requirements

In RRC\_CONNECTED state the NCR-MT shall be capable of sending *RRCReestablishmentRequest* message within  $T_{\text{re-establish\_delay}}$  seconds from the moment it detects a loss in RRC connection. The total RRC connection delay ( $T_{\text{re-establish\_delay}}$ ) shall be less than:

$$T_{\text{re-establish\_delay}} = T_{\text{NCR-MT\_re-establish\_delay}} + T_{\text{UL\_grant}}$$

$T_{\text{UL\_grant}}$ : It is the time required to acquire and process uplink grant from the target PCell. The uplink grant is required to transmit *RRCReestablishmentRequest* message.

The NCR-MT re-establishment delay ( $T_{\text{NCR-MT\_re-establish\_delay}}$ ) is specified in clause 10.1.1.2.1.

##### 10.1.1.2.1 NCR-MT Re-establishment delay requirement

The NCR-MT re-establishment delay ( $T_{\text{NCR-MT\_re-establish\_delay}}$ ) is the time between the moments when any of the conditions requiring RRC re-establishment as defined in clause 5.3.7 in TS 38.331 [23] is detected by the NCR-MT and when the NCR-MT sends PRACH to the target PCell. The NCR-MT re-establishment delay ( $T_{\text{NCR-MT\_re-establish\_delay}}$ ) requirement shall be less than:

$$T_{\text{NCR-MT\_re-establish\_delay}} = 400 \text{ ms} + T_{\text{identify\_intra\_NR}} + \sum_{i=1}^{N_{\text{freq}}-1} T_{\text{identify\_inter\_NR},i} + T_{\text{SI-NR}} + T_{\text{PRACH}}$$

The intra-frequency target NR cell shall be considered detectable if each relevant SSB can satisfy that:

- the conditions of SSB\_RP and SSB  $\hat{E}_s/\text{Iot}$  according to Annex TBD for the LA NCR-MT class and NCR type are fulfilled.

The inter-frequency target NR cell shall be considered detectable when for each relevant SSB:

- the conditions of SSB\_RP and SSB  $\hat{E}_s/\text{Iot}$  according to Annex TBD for the LA NCR-MT class and NCR type are fulfilled.

$T_{\text{identify\_intra\_NR}}$ : It is the time to identify the target intra-frequency NR cell and it depends on whether the target NR cell is known cell or unknown cell and on the frequency range (FR) of the target NR cell. If the NCR-MT is not configured with intra-frequency NR carrier for RRC re-establishment then  $T_{\text{identify\_intra\_NR}}=0$ ; otherwise  $T_{\text{identify\_intra\_NR}}$  shall not exceed the values defined in Table 10.1.1.2.1-1.

$T_{\text{identify\_inter\_NR},i}$ : It is the time to identify the target inter-frequency NR cell on inter-frequency carrier  $i$  configured for RRC re-establishment and it depends on whether the target NR cell is known cell or unknown cell and on the frequency range (FR) of the target NR cell.  $T_{\text{identify\_inter\_NR},i}$  shall not exceed the values defined in Table 10.1.1.2.1-2.

$T_{\text{SMTC}}$ : It is the periodicity of the SMTC occasion configured for the intra-frequency carrier. If the NCR-MT has been provided with higher layer signaling of *smtc2* [23] then  $T_{\text{SMTC}}$  follows *smtc1* or *smtc2* according to the physical cell ID of the target cell.

$T_{\text{SMTC},i}$ : It is the periodicity of the SMTC occasion configured for the inter-frequency carrier  $i$ . If the NCR-MT is not provided with SMTC configuration then the NCR-MT may assume that the target SSB periodicity is no larger than 20 ms.

$T_{\text{SI-NR}}$ : It is the time required for receiving all the relevant system information according to the reception procedure and the RRC procedure delay of system information blocks defined in TS 38.331 [23] for the target NR cell.

$T_{\text{PRACH}}$ : It is the delay uncertainty in acquiring the first available PRACH occasion in the target NR cell.  $T_{\text{PRACH}}$  can be up to the summation of SSB to PRACH occasion association period and 10 ms. SSB to PRACH occasion associated period is defined in clause 14 of TS 38.213 [24].

$N_{\text{freq}}$ : It is the total number of NR frequencies to be monitored for RRC re-establishment;  $N_{\text{freq}} = 1$  if the target intra-frequency NR cell is known, else  $N_{\text{freq}} = 2$  and  $T_{\text{identify\_intra\_NR}} = 0$  if the target inter-frequency NR cell is known.

There is no requirement if the target cell does not contain the NCR-MT context or if the SSB transmission periodicity is larger than 20 ms.

In the requirement defined in the below tables, the target FR1 cell is known if it has been meeting the relevant cell identification requirement during the last 5 seconds otherwise it is unknown.

**Table 10.1.1.2.1-1: Time to identify target NR cell for RRC connection re-establishment to NR intra-frequency cell**

| Serving cell SSB $\hat{E}_s/\text{lot}$ (dB)                                                                                                                                     | Frequency range (FR) of target NR cell | $T_{\text{identify\_intra\_NR}}$ [ms]       |                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|---------------------------------------------|----------------------------------------------|
|                                                                                                                                                                                  |                                        | Known NR cell                               | Unknown NR cell                              |
| $\geq -8$                                                                                                                                                                        | FR1                                    | MAX (1600 ms, $40 \times T_{\text{SMTC}}$ ) | MAX (6400 ms, $80 \times T_{\text{SMTC}}$ )  |
| $\geq -8$                                                                                                                                                                        | FR2-1                                  | N/A                                         | MAX (8000 ms, $640 \times T_{\text{SMTC}}$ ) |
| $< -8$                                                                                                                                                                           | FR1                                    | N/A                                         | 6400 <sup>Note1</sup>                        |
| $< -8$                                                                                                                                                                           | FR2-1                                  | N/A                                         | 28160 <sup>Note1</sup>                       |
| Note 1: The NCR-MT is not required to successfully identify a cell on any NR frequency layer when $T_{\text{SMTC}} > 20$ ms and serving cell SSB $\hat{E}_s/\text{lot} < -8$ dB. |                                        |                                             |                                              |

**Table 10.1.1.2.1-2: Time to identify target NR cell for RRC connection re-establishment to NR inter-frequency cell**

| Serving cell SSB $\hat{E}_s/\text{lot}$ (dB)                                                                                                                                       | Frequency range (FR) of target NR cell | $T_{\text{identify\_inter\_NR},i}$ [ms]       |                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|-----------------------------------------------|------------------------------------------------|
|                                                                                                                                                                                    |                                        | Known NR cell                                 | Unknown NR cell                                |
| $\geq -8$                                                                                                                                                                          | FR1                                    | MAX (1600 ms, $48 \times T_{\text{SMTC},i}$ ) | MAX (6400 ms, $104 \times T_{\text{SMTC},i}$ ) |
| $\geq -8$                                                                                                                                                                          | FR2-1                                  | N/A                                           | MAX (8000 ms, $832 \times T_{\text{SMTC},i}$ ) |
| $< -8$                                                                                                                                                                             | FR1                                    | N/A                                           | 6400 <sup>Note1</sup>                          |
| $< -8$                                                                                                                                                                             | FR2-1                                  | N/A                                           | 32000 <sup>Note1</sup>                         |
| Note 1: The NCR-MT is not required to successfully identify a cell on any NR frequency layer when $T_{\text{SMTC},i} > 20$ ms and serving cell SSB $\hat{E}_s/\text{lot} < -8$ dB. |                                        |                                               |                                                |

## 10.1.2 Random access

### 10.1.2.1 Introduction

This clause contains requirements on the NCR-MT regarding random access procedure. The random access procedure is initiated to establish uplink time synchronization for a NCR-MT which either has not acquired or has lost its uplink synchronization, or to convey NCR-MT's request Other SI, or for beam failure recovery. The random access is specified in clause 8 of TS 38.213 [24] and the control of the RACH transmission is specified in clause 5.1 of TS 38.321 [25].

The requirements in this clause apply for LA NCR-MT.

### 10.1.2.2 Requirements for 4-step RA type

The NCR-MT shall have capability to calculate PRACH transmission power according to the PRACH power formula defined in clause 7.4 of TS 38.213 [24] and apply this power level at the first preamble or additional preambles. The absolute power applied to the first preamble shall have an accuracy as specified in Table TBA for FR1 and in Table TBA for FR2-1. The relative power applied to additional preambles shall have an accuracy as specified in Table TBA for FR1 and clause TBA for FR2-1.

The NCR-MT shall indicate a random access problem to upper layers if the maximum number of preamble transmission counter has been reached for the random access procedure on PCell as specified in clause 5.1.4 in TS 38.321 [25].

The requirements in this clause apply for NCR-MT in SA operation mode.

#### 10.1.2.2.1 Contention based random access

##### 10.1.2.2.1.1 Correct behaviour when transmitting Random Access Preamble

With the NCR-MT selected SSB with SS-RSRP above *rsrp-ThresholdSSB*, NCR-MT shall have the capability to select a Random Access Preamble randomly with equal probability from the Random Access Preambles associated with the selected SSB if the association between Random Access Preambles and SSB is configured, as specified in clause 5.1.2 in TS 38.321 [25].

With the NCR-MT selected SSB with SS-RSRP above *rsrp-ThresholdSSB*, NCR-MT shall have the capability to transmit Random Access Preamble on the next available PRACH occasion from the PRACH occasions corresponding to the selected SSB permitted by the restrictions given by the *ra-ssb-OccasionMaskIndex* if configured, if the association between PRACH occasions and SSBs is configured, and PRACH occasion shall be randomly selected with equal probability amongst the selected SSB associated PRACH occasions occurring simultaneously but on different subcarriers, as specified in clause 5.1.2 in TS 38.321 [25].

##### 10.1.2.2.1.2 Correct behaviour when receiving Random Access Response

The NCR-MT may stop monitoring for Random Access Response(s) and shall transmit the msg3 if the Random Access Response contains a Random Access Preamble identifier corresponding to the transmitted Random Access Preamble.

The NCR-MT shall again perform the Random Access Resource selection procedure defined in clause 5.1.2 in TS 38.321 [25], and transmit with the calculated PRACH transmission power when the backoff time expires if all received Random Access Responses contain Random Access Preamble identifiers that do not match the transmitted Random Access Preamble.

##### 10.1.2.2.1.3 Correct behaviour when not receiving Random Access Response

The NCR-MT shall again perform the Random Access Resource selection procedure defined in clause 5.1.2 in TS 38.321 [25], and transmit with the calculated PRACH transmission power when the backoff time expires if no Random Access Response is received within the RA Response window defined in clause 5.1.4 in TS 38.321 [25].

##### 10.1.2.2.1.4 Correct behaviour when receiving an UL grant for msg3 retransmission

The NCR-MT shall re-transmit the msg3 upon the reception of an UL grant for msg3 retransmission.

#### 10.1.2.2.1.5 SA: Correct behaviour when receiving a message over Temporary C-RNTI

The NCR-MT shall send ACK if the Contention Resolution is successful.

The NCR-MT shall again perform the Random Access Resource selection procedure defined in clause 5.1.2 in TS 38.321 [25], and transmit with the calculated PRACH transmission power when the backoff time expires unless the received message includes a NCR-MT Contention Resolution Identity MAC control element and the NCR-MT Contention Resolution Identity included in the MAC control element matches the CCCH SDU transmitted in the uplink message.

#### 10.1.2.2.1.6 Correct behaviour when contention Resolution timer expires

The NCR-MT shall re-select a preamble and transmit with the calculated PRACH transmission power when the backoff time expires if the Contention Resolution Timer expires.

### 10.1.2.2.2 Non-Contention based random access

#### 10.1.2.2.2.1 Correct behaviour when transmitting Random Access Preamble

If the contention-free Random Access Resources and the contention-free PRACH occasions associated with SSBs is configured, with the NCR-MT selected SSB with SS-RSRP above *rsrp-ThresholdSSB* amongst the associated SSBs, NCR-MT shall have the capability to select the Random Access Preamble corresponding to the selected SSB, and to transmit Random Access Preamble on the next available PRACH occasion from the PRACH occasions corresponding to the selected SSB permitted by the restrictions given by the *ra-ssb-OccasionMaskIndex* if configured, and PRACH occasion shall be randomly selected with equal probability amongst the selected SSB associated PRACH occasions occurring simultaneously but on different subcarriers, as specified in clause 5.1.2 in TS 38.321 [25].

If the contention-free Random Access Resources and the contention-free PRACH occasions associated with CSI-RSs is configured, with the NCR-MT selected CSI-RS with CSI-RSRP above *rsrp-ThresholdCSI-RS* amongst the associated CSI-RSs, NCR-MT shall have the capability to select the Random Access Preamble corresponding to the selected CSI-RS, and to transmit Random Access Preamble on the next available PRACH occasion from the PRACH occasions in *ra-OccasionList* corresponding to the selected CSI-RS, and PRACH occasion shall be randomly selected with equal probability amongst the selected CSI-RS associated PRACH occasions occurring simultaneously but on different subcarriers, as specified in clause 5.1.2 in TS 38.321 [25].

If the random access procedure is initialized for beam failure recovery and if the contention-free Random Access Resources and the contention-free PRACH occasions for beam failure recovery request associated with any of the SSBs and/or CSI-RSs is configured, NCR-MT shall have the capability to select the Random Access Preamble corresponding to the selected SSB with SS-RSRP above *rsrp-ThresholdSSB* amongst the associated SSBs or the selected CSI-RS with CSI-RSRP above *rsrp-ThresholdCSI-RS* amongst the associated CSI-RSs, and to transmit Random Access Preamble on the next available PRACH occasion from the PRACH occasions corresponding to the selected SSB permitted by the restrictions given by the *ra-ssb-OccasionMaskIndex* if configured, or from the PRACH occasions in *ra-OccasionList* corresponding to the selected CSI-RS, and PRACH occasion shall be randomly selected with equal probability amongst the selected SSB associated PRACH occasions or the selected CSI-RS associated PRACH occasions occurring simultaneously but on different subcarriers, as specified in clause 5.1.2 in TS 38.321 [25].

#### 10.1.2.2.2.2 Correct behaviour when receiving Random Access Response

The NCR-MT may stop monitoring for Random Access Response(s), if the Random Access Response contains a Random Access Preamble identifier corresponding to the transmitted Random Access Preamble, unless the random access procedure is initialized for Other SI request from NCR-MT.

The NCR-MT may stop monitoring for Random Access Response(s) and shall monitor the Other SI transmission if the Random Access Response only contains a Random Access Preamble identifier which is corresponding to the transmitted Random Access Preamble and the random access procedure is initialized for SI request from NCR-MT, as specified in clause 5.1.4 in TS 38.321 [25].

The NCR-MT may stop monitoring for Random Access Response(s), if the contention-free Random Access Preamble for beam failure recovery request was transmitted and if the PDCCCH addressed to NCR-MT's C-RNTI is received, as specified in clause 5.1.4 in TS 38.321 [25].

The NCR-MT shall again perform the Random Access Resource selection procedure defined in clause 5.1.2 in TS 38.321 [25] for the next available PRACH occasion, and transmit the preamble with the calculated PRACH transmission power if all received Random Access Responses contain Random Access Preamble identifiers that do not match the transmitted Random Access Preamble.

#### 10.1.2.2.3 Correct behaviour when not receiving Random Access Response

The NCR-MT shall again perform the Random Access Resource selection procedure defined in clause 5.1.2 in TS 38.321 [25] for the next available PRACH occasion, and transmit the preamble with the calculated PRACH transmission power, if no Random Access Response is received within the RA Response window configured in *RACH-ConfigCommon* or if no PDCCH addressed to NCR-MT's C-RNTI is received within the RA Response window configured in *BeamFailureRecoveryConfig*, as defined in clause 5.1.4 in TS 38.321 [25].

## 10.2 Timing

### 10.2.1 NCR-MT transmit timing

#### 10.2.1.1 Introduction

The NCR-MT shall have capability to follow the frame timing change of the reference cell in connected state. The uplink frame transmission takes place  $(N_{TA} + N_{TA\ offset}) \times T_c$  before the reception of the first detected path (in time) of the corresponding downlink frame from the reference cell. NCR-MT shall use the PCell as the reference cell for deriving the NCR-MT transmit timing. NCR-MT initial transmit timing accuracy, gradual timing adjustment requirements are defined in the following requirements.

#### 10.2.1.2 Requirements

The requirements in clause 10.2.1.2 apply for both wide area and local area NCR-MT as defined in clause 4.3A.2.

The NCR-MT initial transmission timing error shall be less than or equal to  $\pm T_e$  where the timing error limit value  $T_e$  is specified in Table 10.2.1.2-1. This requirement applies for PUCCH, PUSCH and SRS or it is the PRACH transmission.

The NCR-MT shall meet the  $T_e$  requirement for an initial transmission provided that at least one SSB is available at the NCR-MT during the last 160 ms. The reference point for the NCR-MT initial transmit timing control requirement shall be the downlink timing of the reference cell minus  $(N_{TA} + N_{TA\ offset}) \times T_c$ . The downlink timing is defined as the time when the first path (in time) of the corresponding downlink frame used by the NCR-MT to determine downlink timing is received from the reference cell at the NCR-MT antenna.  $N_{TA}$  for PRACH is defined as 0.

$(N_{TA} + N_{TA\ offset}) \times T_c$  (in  $T_c$  units) for other channels is the difference between NCR-MT transmission timing and the downlink timing immediately after when the last timing advance in clause 10.2.2 was applied.  $N_{TA}$  for other channels is not changed until next timing advance is received. The value of  $N_{TA\ offset}$  depends on the duplex mode of the cell in which the uplink transmission takes place and the frequency range (FR).  $N_{TA\ offset}$  is defined in Table 10.2.1.2-2.

**Table 10.2.1.2-1:  $T_e$  Timing Error Limit**

| Frequency Range                                                           | SCS of SSB signals ( kHz) | SCS of uplink signals ( kHz) | T <sub>e</sub>        |
|---------------------------------------------------------------------------|---------------------------|------------------------------|-----------------------|
| 1                                                                         | 15                        | 15                           | 12*64*T <sub>c</sub>  |
|                                                                           |                           | 30                           | 10*64*T <sub>c</sub>  |
|                                                                           |                           | 60                           | 10*64*T <sub>c</sub>  |
|                                                                           | 30                        | 15                           | 8*64*T <sub>c</sub>   |
|                                                                           |                           | 30                           | 8*64*T <sub>c</sub>   |
|                                                                           |                           | 60                           | 7*64*T <sub>c</sub>   |
| 2-1                                                                       | 120                       | 60                           | 3.5*64*T <sub>c</sub> |
|                                                                           |                           | 120                          | 3.5*64*T <sub>c</sub> |
|                                                                           | 240                       | 60                           | 3*64*T <sub>c</sub>   |
|                                                                           |                           | 120                          | 3*64*T <sub>c</sub>   |
| Note 1: T <sub>c</sub> is the basic timing unit defined in TS 38.211 [26] |                           |                              |                       |

**Table 10.2.1.2-2: The Value of  $N_{TA\ offset}$** 

| Frequency range and band of cell used for uplink transmission                                                                                                                                                                                                           | $N_{TA\ offset}$ (Unit: $T_c$ ) |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| FR1 TDD band without LTE-NR coexistence case                                                                                                                                                                                                                            | 25600 (Note 1)                  |
| FR1 TDD band with LTE-NR coexistence case                                                                                                                                                                                                                               | 39936 (Note 1)                  |
| FR2-1                                                                                                                                                                                                                                                                   | 13792                           |
| Note 1: The NCR-MT identifies $N_{TA\ offset}$ based on the information n-TimingAdvanceOffset as specified in TS 38.331 [23]. If NCR-MT is not provided with the information n-TimingAdvanceOffset, the default value of $N_{TA\ offset}$ is set as 25600 for FR1 band. |                                 |

When it is the transmission for PUCCH, PUSCH and SRS transmission, the NCR-MT shall be capable of changing the transmission timing according to the received downlink frame of the reference cell except when the timing advance in clause 10.2.3 is applied.

#### 10.2.1.2.1 Gradual timing adjustment

The requirements in this clause apply for NCR-MT belonging to local area NCR-MT class as defined in clause 4.3A.2.

When the transmission timing error between the NCR-MT and the reference timing exceeds  $\pm T_e$  then the NCR-MT is required to adjust its timing to within  $\pm T_e$ . The reference timing shall be  $(N_{TA} + N_{TA\ offset}) \times T_c$  before the downlink timing of the reference cell. All adjustments made to the NCR-MT uplink timing shall follow these rules:

- 1) The maximum amount of the magnitude of the timing change in one adjustment shall be  $T_q$ .
- 2) The minimum aggregate adjustment rate shall be  $T_p$  per second.
- 3) The maximum aggregate adjustment rate shall be  $T_q$  per 200 ms.

where the maximum autonomous time adjustment step  $T_q$  and the aggregate adjustment rate  $T_p$  are specified in Table 10.2.1.2.1-1.

**Table 10.2.1.2.1-1:  $T_q$  Maximum Autonomous Time Adjustment Step and  $T_p$  Minimum Aggregate Adjustment rate**

| Frequency Range                                                 | SCS of uplink signals (kHz) | $T_q$                    | $T_p$                    |
|-----------------------------------------------------------------|-----------------------------|--------------------------|--------------------------|
| 1                                                               | 15                          | $5.5 \cdot 64 \cdot T_c$ | $5.5 \cdot 64 \cdot T_c$ |
|                                                                 | 30                          | $5.5 \cdot 64 \cdot T_c$ | $5.5 \cdot 64 \cdot T_c$ |
|                                                                 | 60                          | $5.5 \cdot 64 \cdot T_c$ | $5.5 \cdot 64 \cdot T_c$ |
| 2-1                                                             | 60                          | $2.5 \cdot 64 \cdot T_c$ | $2.5 \cdot 64 \cdot T_c$ |
|                                                                 | 120                         | $2.5 \cdot 64 \cdot T_c$ | $2.5 \cdot 64 \cdot T_c$ |
| NOTE: $T_c$ is the basic timing unit defined in TS 38.211 [26]. |                             |                          |                          |

## 10.2.2 NCR-MT timer accuracy

### 10.2.2.1 Introduction

NCR-MT timers are used in different protocol entities to control the NCR-MT behaviour.

The requirements in clause 10.2.2 apply for NCR-MT belonging to local area NCR-MT class as defined in clause 4.3A.2.

### 10.2.2.2 Requirements

For NCR-MT timers specified in TS 38.331 [23], the NCR-MT shall comply with the timer accuracies according to Table 10.2.2.2-1.

The requirements are only related to the actual timing measurements internally in the NCR-MT. They do not include the following:

- Inaccuracy in the start and stop conditions of a timer (e.g. NCR-MT reaction time to detect that start and stop conditions of a timer is fulfilled), or
- Inaccuracies due to restrictions in observability of start and stop conditions of an NCR-MT timer (e.g. slot alignment when NCR-MT sends messages at timer expiry).

**Table 10.2.2.2-1**

| Timer value [s]      | Accuracy    |
|----------------------|-------------|
| timer value < 4      | $\pm 0.1s$  |
| timer value $\geq 4$ | $\pm 2.5\%$ |

## 10.2.3 NCR-MT timing advance

### 10.2.3.1 Introduction

The timing advance is initiated from gNB to NCR-MT, with MAC message that implies the adjustment of the timing advance, as defined in clause 5.2 of TS 38.321 [25]. The time advance adjustment requirement for both wide area and local area NCR-MT as defined in clause 4.3A.2.

### 10.2.3.2 Requirements

#### 10.2.3.2.1 Timing Advance adjustment delay

NCR-MT shall adjust the timing of its uplink transmission timing at time slot  $n+k+1$  for a timing advance command received in time slot  $n$ , and the value of  $k$  is defined in clause 4.2 in TS 38.213 [24]. The same requirement applies also when NCR-MT is not able to transmit a configured uplink transmission due to the channel assessment procedure.

#### 10.2.3.2.2 Timing Advance adjustment accuracy

The NCR-MT shall adjust the timing of its transmissions with a relative accuracy better than or equal to the NCR-MT Timing Advance adjustment accuracy requirement in Table 10.2.3.2.2-1, to the signalled timing advance value compared to the timing of preceding uplink transmission. The timing advance command step is defined in TS 38.213 [24].

**Table 10.2.3.2.2-1: NCR-MT Timing Advance adjustment accuracy**

| UL Sub Carrier Spacing(kHz)                                     | 15            | 30            | 60            | 120          |
|-----------------------------------------------------------------|---------------|---------------|---------------|--------------|
| NCR-MT Timing Advance adjustment accuracy                       | $\pm 256 T_c$ | $\pm 256 T_c$ | $\pm 128 T_c$ | $\pm 32 T_c$ |
| NOTE: $T_c$ is the basic timing unit defined in TS 38.211 [26]. |               |               |               |              |

## 10.3 Signalling Characteristics for NCR-MT

### 10.3.1 Radio Link Monitoring

#### 10.3.1.1 Introduction

The requirements in clause 10.3.1 apply for radio link monitoring of local area NCR-MT class as defined in clause 4.3A.2 on:

- PCell in SA NR,

The NCR-MT shall monitor the downlink radio link quality based on the reference signal configured as RLM-RS resource(s) in order to detect the downlink radio link quality of the PCell as specified in TS 38.213 [24]. The configured RLM-RS resources can be all SSBs, or all CSI-RSs, or a mix of SSBs and CSI-RSs. NCR-MT is not required to perform RLM outside the active DL BWP.

On each RLM-RS resource, the NCR-MT shall estimate the downlink radio link quality and compare it to the thresholds  $Q_{out}$  and  $Q_{in}$  for the purpose of monitoring downlink radio link quality of the cell.

The threshold  $Q_{out}$  is defined as the level at which the downlink radio link cannot be reliably received and shall correspond to the out-of-sync block error rate ( $BLER_{out}$ ) as defined in Table 10.3.1-1. For SSB based radio link monitoring,  $Q_{out\_SSB}$  is derived based on the hypothetical PDCCH transmission parameters listed in Table 10.3.1.2.1-1. For CSI-RS based radio link monitoring,  $Q_{out\_CSI-RS}$  is derived based on the hypothetical PDCCH transmission parameters listed in Table 10.3.1.3.1-1.

The threshold  $Q_{in}$  is defined as the level at which the downlink radio link quality can be received with significantly higher reliability than at  $Q_{out}$  and shall correspond to the in-sync block error rate ( $BLER_{in}$ ) as defined in Table 10.3.1-1. For SSB based radio link monitoring,  $Q_{in\_SSB}$  is derived based on the hypothetical PDCCH transmission parameters listed in Table 10.3.1.2.1-2. For CSI-RS based radio link monitoring,  $Q_{in\_CSI-RS}$  is derived based on the hypothetical PDCCH transmission parameters listed in Table 10.3.1.3.1-2.

The out-of-sync block error rate ( $BLER_{out}$ ) and in-sync block error rate ( $BLER_{in}$ ) are determined from the network configuration via parameter *rlmInSyncOutOfSyncThreshold* signalled by higher layers. When NCR-MT is not configured with *rlmInSyncOutOfSyncThreshold* from the network, NCR-MT determines out-of-sync and in-sync block error rates from Configuration #0 in Table 10.3.1-1 by default. All requirements in clause 10.3.1 are applicable for BLER Configuration #0 in Table 10.3.1-1.

**Table 10.3.1-1: Out-of-sync and in-sync block error rates**

| Configuration | $BLER_{out}$ | $BLER_{in}$ |
|---------------|--------------|-------------|
| 0             | 10%          | 2%          |

NCR-MT shall be able to monitor up to  $N_{RLM}$  RLM-RS resources of the same or different types in each corresponding carrier frequency range, depending on a maximum number  $L_{max}$  of SSBs per half frame according to TS 38.213 [24], where  $N_{RLM}$  is specified in Table 10.3.1-2 according TS 38.213 [24], and meet the requirements as specified in clause 10.3.1. NCR-MT is not required to meet the requirements in clause 10.3.1 if RLM-RS is not configured and no TCI state for PDCCH is activated.

**Table 10.3.1-2: Maximum number of RLM-RS resources  $N_{\text{RLM}}$** 

| Carrier frequency range of PCell  | $L_{\text{max}}$ | Maximum number of RLM-RS resources, $N_{\text{RLM}}$ |
|-----------------------------------|------------------|------------------------------------------------------|
| FR1, $\leq 3$ GHz <sup>Note</sup> | 4                | 2                                                    |
| FR1, $> 3$ GHz <sup>Note</sup>    | 8                | 4                                                    |
| FR2-1                             | 64               | 8                                                    |

### 10.3.1.2 Requirements for SSB based radio link monitoring

#### 10.3.1.2.1 Introduction

The requirements in this clause apply for each SSB based RLM-RS resource configured for PCell, provided that the SSB configured for RLM is actually transmitted within NCR-MT active DL BWP during the entire evaluation period specified in clause 10.3.1.2.2.

**Table 10.3.1.2.1-1: PDCCH transmission parameters for out-of-sync evaluation**

| Attribute                                                        | Value for BLER Configuration #0 |
|------------------------------------------------------------------|---------------------------------|
| DCI format                                                       | 1-0                             |
| Number of control OFDM symbols                                   | 2                               |
| Aggregation level (CCE)                                          | 8                               |
| Ratio of hypothetical PDCCH RE energy to average SSS RE energy   | 4dB                             |
| Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | 4dB                             |
| Bandwidth (PRBs)                                                 | 24                              |
| Sub-carrier spacing (kHz)                                        | SCS of the active DL BWP        |
| DMRS precoder granularity                                        | REG bundle size                 |
| REG bundle size                                                  | 6                               |
| CP length                                                        | Normal                          |
| Mapping from REG to CCE                                          | Distributed                     |

**Table 10.3.1.2.1-2: PDCCH transmission parameters for in-sync evaluation**

| Attribute                                                        | Value for BLER Configuration #0 |
|------------------------------------------------------------------|---------------------------------|
| DCI payload size                                                 | 1-0                             |
| Number of control OFDM symbols                                   | 2                               |
| Aggregation level (CCE)                                          | 4                               |
| Ratio of hypothetical PDCCH RE energy to average SSS RE energy   | 0dB                             |
| Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | 0dB                             |
| Bandwidth (PRBs)                                                 | 24                              |
| Sub-carrier spacing (kHz)                                        | SCS of the active DL BWP        |
| DMRS precoder granularity                                        | REG bundle size                 |
| REG bundle size                                                  | 6                               |
| CP length                                                        | Normal                          |
| Mapping from REG to CCE                                          | Distributed                     |

#### 10.3.1.2.2 Minimum requirement

NCR-MT shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last  $T_{\text{Evaluate\_out\_SSB}}$  [ms] period becomes worse than the threshold  $Q_{\text{out\_SSB}}$  within  $T_{\text{Evaluate\_out\_SSB}}$  [ms] evaluation period.

NCR-MT shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last  $T_{\text{Evaluate\_in\_SSB}}$  [ms] period becomes better than the threshold  $Q_{\text{in\_SSB}}$  within  $T_{\text{Evaluate\_in\_SSB}}$  [ms] evaluation period.

$T_{\text{Evaluate\_out\_SSB}}$  and  $T_{\text{Evaluate\_in\_SSB}}$  are defined in Table 10.3.1.2.2-1 for FR1 with scaling factor  $K_1 = 5$ .

$T_{\text{Evaluate\_out\_SSB}}$  and  $T_{\text{Evaluate\_in\_SSB}}$  are defined in Table 10.3.1.2.2-2 for FR2-1 with scaling factor  $N=8$  and  $K_2 = 3$ .

For FR1,

- $P = 1$

For FR2-1,

- $P=1$ , when the RLM-RS resource is not overlapped with SMTC occasion.
- $P = \frac{1}{1 - \frac{T_{\text{SSB}}}{T_{\text{SMTCperiod}}}}$ , when the RLM-RS resource is partially overlapped with SMTC occasion ( $T_{\text{SSB}} < T_{\text{SMTCperiod}}$ ).
- $P = 3$ , when RLM-RS resource is fully overlapped with SMTC period ( $T_{\text{SSB}} = T_{\text{SMTCperiod}}$ ).

If the high layer in TS 38.331 [23] signaling of  $\text{smc}_2$  is present,  $T_{\text{SMTCperiod}}$  follows  $\text{smc}_2$ ; Otherwise  $T_{\text{SMTCperiod}}$  follow  $\text{smc}_1$ .

Longer evaluation period would be expected if the combination of RLM-RS resource and SMTC occasion configurations does not meet previous conditions.

**Table 10.3.1.2.2-1: Evaluation period  $T_{\text{Evaluate\_out\_SSB}}$  and  $T_{\text{Evaluate\_in\_SSB}}$  for FR1**

| Configuration                                                            | $T_{\text{Evaluate\_out\_SSB}}$ (ms)                                                    | $T_{\text{Evaluate\_in\_SSB}}$ (ms)                                                    |
|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| no DRX                                                                   | $\text{Max}(200 \times K_1, \text{Ceil}(10 \times P \times K_1) \times T_{\text{SSB}})$ | $\text{Max}(100 \times K_1, \text{Ceil}(5 \times P \times K_1) \times T_{\text{SSB}})$ |
| NOTE: $T_{\text{SSB}}$ is the periodicity of the SSB configured for RLM. |                                                                                         |                                                                                        |

**Table 10.3.1.2.2-2: Evaluation period  $T_{\text{Evaluate\_out\_SSB}}$  and  $T_{\text{Evaluate\_in\_SSB}}$  for FR2-1**

| Configuration                                                            | $T_{\text{Evaluate\_out\_SSB}}$ (ms)                                                             | $T_{\text{Evaluate\_in\_SSB}}$ (ms)                                                             |
|--------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| no DRX                                                                   | $\text{Max}(200 \times K_2, \text{Ceil}(10 \times P \times N \times K_2) \times T_{\text{SSB}})$ | $\text{Max}(100 \times K_2, \text{Ceil}(5 \times P \times N \times K_2) \times T_{\text{SSB}})$ |
| NOTE: $T_{\text{SSB}}$ is the periodicity of the SSB configured for RLM. |                                                                                                  |                                                                                                 |

### 10.3.1.2.3 Measurement restrictions for SSB based RLM

The NCR-MT is required to be capable of measuring SSB for RLM without measurement gaps. The NCR-MT is required to perform the SSB measurements with measurement restrictions as described in the following scenarios.

For FR1, when the SSB for RLM is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, NCR-MT shall be able to measure the SSB for RLM without any restriction;
- If SSB and CSI-RS have different SCS,
  - If NCR-MT supports *simultaneousRxDataSSB-DiffNumerology*, NCR-MT shall be able to measure the SSB for RLM without any restriction;
  - If NCR-MT does not support *simultaneousRxDataSSB-DiffNumerology*, NCR-MT is required to measure one of but not both SSB for RLM and CSI-RS. Longer measurement period for SSB based RLM is expected, and no requirements are defined.

For FR2-1, when the SSB for RLM measurement on one CC is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, NCR-MT is required to measure

one of but not both SSB for RLM and CSI-RS. Longer measurement period for SSB based RLM is expected, and no requirements are defined.

### 10.3.1.3 Requirements for CSI-RS based radio link monitoring

#### 10.3.1.3.1 Introduction

The requirements in this clause apply for each CSI-RS based RLM-RS resource configured for PCell, provided that the CSI-RS configured for RLM is actually transmitted within NCR-MT active DL BWP during the entire evaluation period specified in clause 10.3.1.3.2. NCR-MT is not expected to perform radio link monitoring measurements on the CSI-RS configured as RLM-RS if the CSI-RS is not in the active TCI state of any CORESET configured in the NCR-MT active BWP.

**Table 10.3.1.3.1-1: PDCCH transmission parameters for out-of-sync evaluation**

| Attribute                                                           | Value for BLER Configuration #0 |
|---------------------------------------------------------------------|---------------------------------|
| DCI format                                                          | 1-0                             |
| Number of control OFDM symbols                                      | 2                               |
| Aggregation level (CCE)                                             | 8                               |
| Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy   | 4dB                             |
| Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy | 4dB                             |
| Bandwidth (PRBs)                                                    | 48                              |
| Sub-carrier spacing (kHz)                                           | SCS of the active DL BWP        |
| DMRS precoder granularity                                           | REG bundle size                 |
| REG bundle size                                                     | 6                               |
| CP length                                                           | Normal                          |
| Mapping from REG to CCE                                             | Distributed                     |

**Table 10.3.1.3.1-2: PDCCH transmission parameters for in-sync evaluation**

| Attribute                                                           | Value for BLER Configuration #0 |
|---------------------------------------------------------------------|---------------------------------|
| DCI payload size                                                    | 1-0                             |
| Number of control OFDM symbols                                      | 2                               |
| Aggregation level (CCE)                                             | 4                               |
| Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy   | 0dB                             |
| Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy | 0dB                             |
| Bandwidth (PRBs)                                                    | 48                              |
| Sub-carrier spacing (kHz)                                           | SCS of the active DL BWP        |
| DMRS precoder granularity                                           | REG bundle size                 |
| REG bundle size                                                     | 6                               |
| CP length                                                           | Normal                          |
| Mapping from REG to CCE                                             | Distributed                     |

#### 10.3.1.3.2 Minimum requirement

NCR-MT shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last  $T_{\text{Evaluate\_out\_CSI-RS}}$  [ms] period becomes worse than the threshold  $Q_{\text{out\_CSI-RS}}$  within  $T_{\text{Evaluate\_out\_CSI-RS}}$  [ms] evaluation period.

NCR-MT shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last  $T_{\text{Evaluate\_in\_CSI-RS}}$  [ms] period becomes better than the threshold  $Q_{\text{in\_CSI-RS}}$  within  $T_{\text{Evaluate\_in\_CSI-RS}}$  [ms] evaluation period.

- $T_{\text{Evaluate\_out\_CSI-RS}}$  and  $T_{\text{Evaluate\_in\_CSI-RS}}$  are defined in Table 10.3.1.3.2-1 for FR1 with scaling factor  $K_1 = 5$ .
- $T_{\text{Evaluate\_out\_CSI-RS}}$  and  $T_{\text{Evaluate\_in\_CSI-RS}}$  are defined in Table 10.3.1.3.2-2 for FR2-1 with scaling factor  $K_2 = 3$ .

The requirements of  $T_{\text{Evaluate\_out\_CSI-RS}}$  and  $T_{\text{Evaluate\_in\_CSI-RS}}$  apply provided that the CSI-RS for RLM is not in a resource set configured with repetition ON. The requirements do not apply when the CSI-RS resource in the active TCI state of CORESET is the same CSI-RS resource for RLM and the TCI state information of the CSI-RS resource is not given, wherein the TCI state information means QCL Type-D to SSB for L1-RSRP or CSI-RS with repetition ON.

For FR1,

- $P=1$ .

For FR2-1,

- $P=1$ , when the RLM-RS resource is not overlapped with SMTC occasion.
- $P = \frac{1}{1 - \frac{T_{\text{CSI-RS}}}{T_{\text{SMTCperiod}}}}$ , when the RLM-RS resource is partially overlapped with SMTC occasion ( $T_{\text{CSI-RS}} < T_{\text{SMTCperiod}}$ ).
- $P = 3$ , when the RLM-RS resource is fully overlapped with SMTC occasion ( $T_{\text{CSI-RS}} = T_{\text{SMTCperiod}}$ ).

If the high layer in TS 38.331 [23] signaling of  $\text{smtc}_2$  is present,  $T_{\text{SMTCperiod}}$  follows  $\text{smtc}_2$ ; Otherwise  $T_{\text{SMTCperiod}}$  follow  $\text{smtc}_1$ .

NOTE: The overlap between CSI-RS for RLM and SMTC means that CSI-RS based RLM is within the SMTC window duration.

Longer evaluation period would be expected if the combination of RLM-RS resource and SMTC occasion configurations does not meet previous conditions.

The values of  $M_{\text{out}}$  and  $M_{\text{in}}$  used in Table 10.3.1.3.2-1 and Table 10.3.1.3.2-2 are defined as:

- $M_{\text{out}} = 20$  and  $M_{\text{in}} = 10$ , if the CSI-RS resource configured for RLM is transmitted with higher layer CSI-RS parameter *density* [8, clause 7.4.1] set to 3 and over the bandwidth  $\geq 24$  PRBs.

**Table 10.3.1.3.2-1: Evaluation period  $T_{\text{Evaluate\_out\_CSI-RS}}$  and  $T_{\text{Evaluate\_in\_CSI-RS}}$  for FR1**

| Configuration                                                                                                                                                                             | $T_{\text{Evaluate\_out\_CSI-RS}}$ (ms)                                                                | $T_{\text{Evaluate\_in\_CSI-RS}}$ (ms)                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| no DRX                                                                                                                                                                                    | $\text{Max}(200 \times K_1, \text{Ceil}(M_{\text{out}} \times P \times K_1) \times T_{\text{CSI-RS}})$ | $\text{Max}(100 \times K_1, \text{Ceil}(M_{\text{in}} \times P \times K_1) \times T_{\text{CSI-RS}})$ |
| NOTE: $T_{\text{CSI-RS}}$ is the periodicity of the CSI-RS resource configured for RLM. The requirements in this table apply for $T_{\text{CSI-RS}}$ equal to 5 ms, 10ms, 20 ms or 40 ms. |                                                                                                        |                                                                                                       |

**Table 10.3.1.3.2-2: Evaluation period  $T_{\text{Evaluate\_out\_CSI-RS}}$  and  $T_{\text{Evaluate\_in\_CSI-RS}}$  for FR2-1**

| Configuration                                                                                                                                                                              | $T_{\text{Evaluate\_out\_CSI-RS}}$ (ms)                                                                | $T_{\text{Evaluate\_in\_CSI-RS}}$ (ms)                                                                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| no DRX                                                                                                                                                                                     | $\text{Max}(200 \times K_2, \text{Ceil}(M_{\text{out}} \times P \times K_2) \times T_{\text{CSI-RS}})$ | $\text{Max}(100 \times K_2, \text{Ceil}(M_{\text{in}} \times P \times K_2) \times T_{\text{CSI-RS}})$ |
| NOTE: $T_{\text{CSI-RS}}$ is the periodicity of the CSI-RS resource configured for RLM. The requirements in this table apply for $T_{\text{CSI-RS}}$ equal to 5 ms, 10 ms, 20 ms or 40 ms. |                                                                                                        |                                                                                                       |

### 10.3.1.3.3 Measurement restrictions for CSI-RS based RLM

The NCR-MT is required to be capable of measuring CSI-RS for RLM without measurement gaps. The NCR-MT is required to perform the CSI-RS measurements with measurement restrictions as described in the following clauses.

For both FR1 and FR2-1, when the CSI-RS for RLM is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, NCR-MT is not required to receive CSI-RS for RLM in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD, or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for RLM, the NCR-MT shall be able to perform CSI-RS measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for RLM, the NCR-MT shall be able to perform CSI-RS measurement with restrictions according to its capabilities:

- If the NCR-MT supports *simultaneousRxDataSSB-DiffNumerology* the NCR-MT shall be able to perform CSI-RS for RLM measurement without restrictions.
- If the NCR-MT does not support *simultaneousRxDataSSB-DiffNumerology*, NCR-MT is required to measure one of but not both CSI-RS for RLM and SSB. Longer measurement period for CSI-RS based RLM is expected, and no requirements are defined.

For FR1, when the CSI-RS for RLM is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, NCR-MT shall be able to measure the CSI-RS for RLM without any restriction.

For FR2-1, when the CSI-RS for RLM measurement on one CC is in the same OFDM symbol as SSB for RLM, BFD, or L1-RSRP measurement on the same CC or different CCs in the same band, or in the same symbol as SSB for CBD measurement on the same CC or different CCs in the same band when beam failure is detected, NCR-MT is required to measure one of but not both CSI-RS for RLM and SSB. Longer measurement period for CSI-RS based RLM is expected, and no requirements are defined.

For FR2-1, when the CSI-RS for RLM measurement on one CC is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band,

- In the following cases, NCR-MT is required to measure one of but not both CSI-RS for RLM and the other CSI-RS. Longer measurement period for CSI-RS based RLM is expected, and no requirements are defined.
  - The CSI-RS for RLM or the other CSI-RS in a resource set configured with repetition ON, or
  - The other CSI-RS is configured in q1 and beam failure is detected, or
  - The two CSI-RS-es are not QCL-ed w.r.t. QCL-TypeD, or the QCL information is not known to NCR-MT,
- Otherwise, NCR-MT shall be able to measure the CSI-RS for RLM without any restriction.

#### 10.3.1.4 Minimum requirement for NCR-MT turning off the transmitter

The transmitter power of the NCR-MT in the monitored cell shall be turned off within 40ms after expiry of T310 timer as specified in TS 38.331 [23].

#### 10.3.1.5 Minimum requirement for L1 indication

When the downlink radio link quality on all the configured RLM-RS resources is worse than  $Q_{\text{out, layer 1}}$  of the NCR-MT shall send an out-of-sync indication for the cell to the higher layers. A layer 3 filter shall be applied to the out-of-sync indications as specified in TS 38.331 [23].

When the downlink radio link quality on at least one of the configured RLM-RS resources is better than  $Q_{\text{in, layer 1}}$  of the NCR-MT shall send an in-sync indication for the cell to the higher layers. A layer 3 filter shall be applied to the in-sync indications as specified in TS 38.331 [23].

The out-of-sync and in-sync evaluations for the configured RLM-RS resources shall be performed as specified in clause 5 [25]. Two successive indications from layer 1 shall be separated by at least  $T_{\text{Indication\_interval}}$ .

$T_{\text{Indication\_interval}}$  is  $\max(10\text{ms}, T_{\text{RLM-RS,M}})$ , where  $T_{\text{RLM-RS,M}}$  is the shortest periodicity of all configured RLM-RS resources for the monitored cell, which corresponds to  $T_{\text{SSB}}$  specified in clause 10.3.1.2 if the RLM-RS resource is SSB, or  $T_{\text{CSI-RS}}$  specified in clause 10.3.1.3 if the RLM-RS resource is CSI-RS.

### 10.3.1.6 Scheduling availability of NCR-MT during radio link monitoring

When the reference signal to be measured for RLM has different subcarrier spacing than PDSCH/PDCCH or is on frequency range 2, there are restrictions on the scheduling availability as described in the following clauses.

#### 10.3.1.6.1 Scheduling availability of NCR-MT performing radio link monitoring with a same subcarrier spacing as PDSCH/PDCCH on FR1

There are no scheduling restrictions due to radio link monitoring performed with a same subcarrier spacing as PDSCH/PDCCH on FR1.

#### 10.3.1.6.2 Scheduling availability of NCR-MT performing radio link monitoring with a different subcarrier spacing than PDSCH/PDCCH on FR1

For NCR-MTs which support *simultaneousRxDataSSB-DiffNumerology* [27] there are no restrictions on scheduling availability due to radio link monitoring based on SSB as RLM-RS. For NCR-MTs which do not support *simultaneousRxDataSSB-DiffNumerology* [27] the following restrictions apply due to radio link monitoring based on SSB as RLM-RS.

- The NCR-MT is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on SSB symbols to be measured for radio link monitoring.

#### 10.3.1.6.3 Scheduling availability of NCR-MT performing radio link monitoring on FR2-1

The following scheduling restriction applies due to radio link monitoring on an FR2-1 serving PCell .

- If the RLM-RS is CSI-RS which is type-D QCLed with active TCI state for PDCCH or PDSCH, and the CSI-RS is not in a CSI-RS resource set with repetition ON,
  - There are no scheduling restrictions due to radio link monitoring based on the CSI-RS.
- Otherwise
  - The NCR-MT is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on RLM-RS symbols to be measured for radio link monitoring.

For FR2-1, if following conditions are met,

- NCR-MT has been notified about system information update through paging,
- The gap between NCR-MT's reception of PDCCH that NCR-MT monitors in the Type2-PDCCH CSS set and that notifies system information update, and the PDCCH that NCR-MT monitors in the Type0-PDCCH CSS set, is greater than 2 slots,

For the SSB for RLM and CORESET for RMSI scheduling multiplexing patterns 3, NCR-MT is expected to receive the PDCCH that NCR-MT monitors in the Type0-PDCCH CSS set, and the corresponding PDSCH, on SSB symbols to be measured for RLM; and

For the SSB for RLM and CORESET for RMSI scheduling multiplexing patterns 2, NCR-MT is expected to receive PDSCH that corresponds to the PDCCH that NCR-MT monitors in the Type0-PDCCH CSS set, on SSB symbols to be measured for RLM.

## 10.3.2 Link Recovery Procedure

### 10.3.2.1 Introduction

The local area NCR-MT as defined in clause 4.3A.2 shall assess the downlink radio link quality of a serving cell based on the reference signal in the set  $\bar{Q}$  as specified in TS 38.213 [24] in order to detect beam failure on:

- PCell in SA NR,

The RS resource configurations in the set  $\bar{q}_0$  on PCell can be periodic CSI-RS resources and/or SSBs. RS resource configuration in the set  $\bar{q}_0$  on SCell shall be periodic CSI-RS. NCR-MT is not required to perform beam failure detection outside the active DL BWP. NCR-MT is not required to meet the requirements in clause 10.3.2.2 and 10.3.2.3 if NCR-MT does not have set  $\bar{q}_0$ .

On each RS resource configuration in the set  $\bar{q}_0$ , the NCR-MT shall estimate the radio link quality and compare it to the threshold  $Q_{out\_LR}$  for the purpose of accessing downlink radio link quality of the serving cell beams.

The threshold  $Q_{out\_LR}$  is defined as the level at which the downlink radio level link of a given resource configuration on set  $\bar{q}_0$  cannot be reliably received and shall correspond to the  $BLER_{out} = 10\%$  block error rate of a hypothetical PDCCH transmission. For SSB based beam failure detection,  $Q_{out\_LR\_SSB}$  is derived based on the hypothetical PDCCH transmission parameters listed in Table 10.3.2.2.1. For CSI-RS based beam failure detection,  $Q_{out\_LR\_CSI-RS}$  is derived based on the hypothetical PDCCH transmission parameters listed in Table 10.3.2.3.1-1.

Upon request the NCR-MT shall deliver configuration indexes from the set  $\bar{q}_l$  as specified in TS 38.213 [24], to higher layers, and the corresponding L1-RSRP measurement provided that the measured L1-RSRP is equal to or better than the threshold  $Q_{in\_LR}$ , which is indicated by higher layer parameter *rsrp-ThresholdSSB*. The NCR-MT applies the  $Q_{in\_LR}$  threshold to the L1-RSRP measurement obtained from an SSB. The NCR-MT applies the  $Q_{in\_LR}$  threshold to the L1-RSRP measurement obtained for a CSI-RS resource after scaling a respective CSI-RS reception power with a value provided by higher layer parameter *powerControlOffsetSS*. The RS resource configurations in the set  $\bar{q}_l$  can be periodic CSI-RS resources or SSBs or both SSB and CSI-RS resources. NCR-MT is not required to perform candidate beam detection outside the active DL BWP.

## 10.3.2.2 Requirements for SSB based beam failure detection

### 10.3.2.2.1 Introduction

The requirements in this clause apply for each SSB resource in the set  $\bar{q}_0$  configured for a serving cell, provided that the SSB configured for beam failure detection is actually transmitted within the NCR-MT active DL BWP during the entire evaluation period specified in clause 10.3.2.2.2. The requirements in this clause could not be applicable if NCR-MT is required to perform beam failure detection on more than 1 serving cell per band.

**Table 10.3.2.2.1-1: PDCCH transmission parameters for beam failure instance**

| Attribute                                                        | Value for BLER                  |
|------------------------------------------------------------------|---------------------------------|
| DCI format                                                       | 1-0                             |
| Number of control OFDM symbols                                   | 2                               |
| Aggregation level (CCE)                                          | 8                               |
| Ratio of hypothetical PDCCH RE energy to average SSS RE energy   | 0dB                             |
| Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | 0dB                             |
| Bandwidth (PRBs)                                                 | 24                              |
| Sub-carrier spacing (kHz)                                        | Same as the SCS of RMSI CORESET |
| DMRS precoder granularity                                        | REG bundle size                 |
| REG bundle size                                                  | 6                               |
| CP length                                                        | Normal                          |
| Mapping from REG to CCE                                          | Distributed                     |

### 10.3.2.2.2 Minimum requirement

NCR-MT shall be able to evaluate whether the downlink radio link quality on the configured SSB resource in set  $\bar{q}_0$  estimated over the last  $T_{\text{Evaluate\_BFD\_SSB}}$  ms period becomes worse than the threshold  $Q_{\text{out\_LR\_SSB}}$  within  $T_{\text{Evaluate\_BFD\_SSB}}$  ms period.

The value of  $T_{\text{Evaluate\_BFD\_SSB}}$  is defined in Table 10.3.2.2.2-1 for FR1.

The value of  $T_{\text{Evaluate\_BFD\_SSB}}$  is defined in Table 10.3.2.2.2-2 for FR2-1 with scaling factor  $N=8$ .

For FR1,

- $P=1$ .

For FR2-1,

- $P=1$ , when the BFD-RS resource is not overlapped with SMTC occasion.
- $P = \frac{1}{1 - \frac{T_{\text{SSB}}}{T_{\text{SMTCperiod}}}}$ , when the BFD-RS resource is partially overlapped with SMTC occasion ( $T_{\text{SSB}} < T_{\text{SMTCperiod}}$ ).
- $P = 3$ , when the BFD-RS resource is fully overlapped with SMTC period ( $T_{\text{SSB}} = T_{\text{SMTCperiod}}$ ).

If the high layer in TS 38.331 [23] signaling of  $\text{smc}_2$  is present,  $T_{\text{SMTCperiod}}$  follows  $\text{smc}_2$ ; Otherwise  $T_{\text{SMTCperiod}}$  follow  $\text{smc}_1$ .

Longer evaluation period would be expected if the combination of BFD-RS resource and SMTC occasion does not meet pervious conditions.

**Table 10.3.2.2.2-1: Evaluation period  $T_{\text{Evaluate\_BFD\_SSB}}$  for FR1**

| Configuration                                                             | $T_{\text{Evaluate\_BFD\_SSB}}$ (ms)                            |
|---------------------------------------------------------------------------|-----------------------------------------------------------------|
| no DRX                                                                    | $\text{Max}(50, \text{Ceil}(5 \times P) \times T_{\text{SSB}})$ |
| Note: $T_{\text{SSB}}$ is the periodicity of SSB in the set $\bar{q}_0$ . |                                                                 |

**Table 10.3.2.2.2-2: Evaluation period  $T_{\text{Evaluate\_BFD\_SSB}}$  for FR2-1**

| Configuration                                                             | $T_{\text{Evaluate\_BFD\_SSB}}$ (ms)                                     |
|---------------------------------------------------------------------------|--------------------------------------------------------------------------|
| no DRX                                                                    | $\text{Max}(50, \text{Ceil}(5 \times P \times N) \times T_{\text{SSB}})$ |
| Note: $T_{\text{SSB}}$ is the periodicity of SSB in the set $\bar{q}_0$ . |                                                                          |

### 10.3.2.2.3 Measurement restriction for SSB based beam failure detection

The NCR-MT is required to be capable of measuring SSB for BFD without measurement gaps. The NCR-MT is required to perform the SSB measurements with measurement restrictions as described in the following scenarios.

For FR1, when the SSB for BFD measurement is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, NCR-MT shall be able to measure the SSB for BFD measurement without any restriction;
- If SSB and CSI-RS have different SCS,
  - If NCR-MT supports *simultaneousRxDataSSB-DiffNumerology*, NCR-MT shall be able to measure the SSB for BFD measurement without any restriction;
  - If NCR-MT does not support *simultaneousRxDataSSB-DiffNumerology*, NCR-MT is required to measure one of but not both SSB for BFD measurement and CSI-RS. Longer measurement period for SSB based BFD measurement is expected, and no requirements are defined.

For FR2-1, when the SSB for BFD measurement on one CC is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC in the same band, NCR-MT is required to measure one of but not both SSB for BFD measurement and CSI-RS. Longer measurement period for SSB based BFD measurement is expected, and no requirements are defined.

### 10.3.2.3 Requirements for CSI-RS based beam failure detection

#### 10.3.2.3.1 Introduction

The requirements in this clause apply for each CSI-RS resource in the set  $\bar{q}_0$  of resource configurations for a serving cell, provided that the CSI-RS resource(s) in set  $\bar{q}_0$  for beam failure detection are actually transmitted within the NCR-MT active DL BWP during the entire evaluation period specified in clause 10.3.2.3.2. NCR-MT is not expected to perform beam failure detection measurements on the CSI-RS configured for BFD if the CSI-RS is not QCL-ed, with QCL-TypeD when applicable, with the RS in the active TCI state of any CORESET configured in the NCR-MT active BWP. The requirements in this clause apply when NCR-MT is required to perform beam failure detection on no more than 1 serving cell per band.

**Table 10.3.2.3.1-1: PDCCH transmission parameters for beam failure instance**

| Attribute                                                           | Value for BLER           |
|---------------------------------------------------------------------|--------------------------|
| DCI format                                                          | 1-0                      |
| Number of control OFDM symbols                                      | 2                        |
| Aggregation level (CCE)                                             | 8                        |
| Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy   | 0dB                      |
| Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy | 0dB                      |
| Bandwidth (PRBs)                                                    | 48                       |
| Sub-carrier spacing (kHz)                                           | SCS of the active DL BWP |
| DMRS precoder granularity                                           | REG bundle size          |
| REG bundle size                                                     | 6                        |
| CP length                                                           | Normal                   |
| Mapping from REG to CCE                                             | Distributed              |

#### 10.3.2.3.2 Minimum requirement

NCR-MT shall be able to evaluate whether the downlink radio link quality on the CSI-RS resource in set  $\bar{q}_0$  estimated over the last  $T_{\text{Evaluate\_BFD\_CSI-RS}}$  ms period becomes worse than the threshold  $Q_{\text{out\_LR\_CSI-RS}}$  within  $T_{\text{Evaluate\_BFD\_CSI-RS}}$  ms period.

The value of  $T_{\text{Evaluate\_BFD\_CSI-RS}}$  is defined in Table 10.3.2.3.2-1 for FR1.

The value of  $T_{\text{Evaluate\_BFD\_CSI-RS}}$  is defined in Table 10.3.2.3.2-2 for FR2-1 with  $N=1$ .

The requirements of  $T_{\text{Evaluate\_BFD\_CSI-RS}}$  apply provided that the CSI-RS for BFD is not in a resource set configured with repetition ON. The requirements shall not apply when the CSI-RS resource in the active TCI state of CORESET is the same CSI-RS resource for BFD and the TCI state information of the CSI-RS resource is not given, wherein the TCI state information means QCL Type-D to SSB for L1-RSRP or CSI-RS with repetition ON.

For FR1,

- $P = 1$ .

For FR2-1,

- $P = 1$ , when the BFD-RS resource is not overlapped with SMTC occasion.

- $P = \frac{1}{1 - \frac{T_{\text{CSI-RS}}}{T_{\text{SMTCperiod}}}}$ , when the BFD-RS resource is partially overlapped with SMTC occasion ( $T_{\text{CSI-RS}} < T_{\text{SMTCperiod}}$ ).
- $P = P_{\text{sharing factor}}$ , when BFD-RS resource is fully overlapped with SMTC occasion ( $T_{\text{CSI-RS}} = T_{\text{SMTCperiod}}$ ).
- $P_{\text{sharing factor}} = 3$ .

If the high layer in TS 38.331 [23] signaling of  $\text{smtc}_2$  is present,  $T_{\text{SMTCperiod}}$  follows  $\text{smtc}_2$ ; Otherwise  $T_{\text{SMTCperiod}}$  follow  $\text{smtc}_1$ .

NOTE: The overlap between CSI-RS for BFD and SMTC means that CSI-RS for BFD is within the SMTC window duration.

Longer evaluation period would be expected if the combination of the BFD-RS resource and SMTC occasion configurations does not meet pervious conditions.

The values of  $M_{\text{BFD}}$  used in Table 10.3.2.3.2-1 and Table 10.3.2.3.2-2 are defined as

- $M_{\text{BFD}} = 10$ , if the CSI-RS resource(s) in set  $\bar{q}_0$  used for BFD is transmitted with Density = 3.

**Table 10.3.2.3.2-1: Evaluation period  $T_{\text{Evaluate\_BFD\_CSI-RS}}$  for FR1**

| Configuration                                                                            | $T_{\text{Evaluate\_BFD\_CSI-RS}}$ (ms)                              |
|------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| no DRX                                                                                   | $\text{Max}(50, [M_{\text{BFD}} \times P] \times T_{\text{CSI-RS}})$ |
| Note: $T_{\text{CSI-RS}}$ is the periodicity of CSI-RS resource in the set $\bar{q}_0$ . |                                                                      |

**Table 10.3.2.3.2-2: Evaluation period  $T_{\text{Evaluate\_BFD\_CSI-RS}}$  for FR2-1**

| Configuration                                                                            | $T_{\text{Evaluate\_BFD\_CSI-RS}}$ (ms)                                       |
|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| no DRX                                                                                   | $\text{Max}(50, [M_{\text{BFD}} \times P \times N] \times T_{\text{CSI-RS}})$ |
| Note: $T_{\text{CSI-RS}}$ is the periodicity of CSI-RS resource in the set $\bar{q}_0$ . |                                                                               |

### 10.3.2.3.3 Measurement restrictions for CSI-RS based beam failure detection

The NCR-MT is required to be capable of measuring CSI-RS for BFD without measurement gaps. The NCR-MT is required to perform the CSI-RS measurements with measurement restrictions as described in the following scenarios.

For both FR1 and FR2-1, when the CSI-RS for BFD measurement is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, NCR-MT is not required to receive CSI-RS for BFD measurement in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for BFD measurement, the NCR-MT shall be able to perform CSI-RS measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for BFD measurement, the NCR-MT shall be able to perform CSI-RS measurement with restrictions according to its capabilities:

- If the NCR-MT supports *simultaneousRxDataSSB-DiffNumerology* the NCR-MT shall be able to perform CSI-RS measurement without restrictions.
- If the NCR-MT does not support *simultaneousRxDataSSB-DiffNumerology*, NCR-MT is required to measure one of but not both CSI-RS for BFD measurement and SSB. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.

For FR1, when the CSI-RS for BFD measurement is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, NCR-MT shall be able to measure the CSI-RS for BFD measurement without any restriction.

For FR2-1, when the CSI-RS for BFD measurement on one CC is in the same OFDM symbol as SSB for RLM, BFD or L1-RSRP measurement on the same CC in the same band, or in the same symbol as SSB for CBD measurement on the same CC in the same band when beam failure is detected, NCR-MT is required to measure one of but not both CSI-RS for BFD measurement and SSB. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.

For FR2-1, when the CSI-RS for BFD measurement on one CC is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC in the same band,

- In the following cases, NCR-MT is required to measure one of but not both CSI-RS for BFD measurement and the other CSI-RS. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.
  - The CSI-RS for BFD measurement or the other CSI-RS in a resource set configured with repetition ON, or
  - The other CSI-RS is configured in set  $\bar{q}_1$  and beam failure is detected, or
  - The two CSI-RS-es are not QCL-ed w.r.t. QCL-TypeD, or the QCL information is not known to NCR-MT,
- Otherwise, NCR-MT shall be able to measure the CSI-RS for BFD measurement without any restriction.

#### 10.3.2.4 Minimum requirement for L1 indication

When the radio link quality on all the RS resources in set  $\bar{q}_0$  is worse than  $Q_{out\_LR, layer\ 1}$  of the NCR-MT shall send a beam failure instance indication to the higher layers. A layer 3 filter may be applied to the beam failure instance indications as specified in TS 38.331 [23].

The beam failure instance evaluation for the RS resources in set  $\bar{q}_0$  shall be performed as specified in clause 6 in TS 38.213 [24]. Two successive indications from layer 1 shall be separated by at least  $T_{indication\_interval\_BFD}$ .

$T_{indication\_interval\_BFD}$  is  $\max(2ms, T_{SSB-RS,M})$  or  $\max(2ms, T_{CSI-RS,M})$ , where  $T_{SSB-RS,M}$  and  $T_{CSI-RS,M}$  is the shortest periodicity of all RS resources in set  $\bar{q}_0$  for the accessed cell, corresponding to either the shortest periodicity of the SSB in the set  $\bar{q}_0$  or CSI-RS resource in the set  $\bar{q}_0$ .

#### 10.3.2.5 Requirements for SSB based candidate beam detection

##### 10.3.2.5.1 Introduction

The requirements in this clause apply for each SSB resource in the set  $\bar{q}_1$  configured for a serving cell, provided that the SSBs configured for candidate beam detection are actually transmitted within NCR-MT active DL BWP during the entire evaluation period specified in clause 10.3.2.5.2.

##### 10.3.2.5.2 Minimum requirement

Upon request the NCR-MT shall be able to evaluate whether the L1-RSRP measured on the configured SSB resource in set  $\bar{q}_1$  estimated over the last  $T_{Evaluate\_CBD\_SSB}$  ms period becomes better than the threshold  $Q_{in\_LR}$  provided SSB<sub>RP</sub> and SSB  $\hat{E}_s/I_{ot}$  are according to Annex Table in B.2.4.1 [23] for a corresponding band.

The NCR-MT shall monitor the configured SSB resources using the evaluation period in table 10.3.2.5.2-1 and 10.3.2.5.2-2 which is applicable to the non-DRX mode only.

The value of  $T_{Evaluate\_CBD\_SSB}$  is defined in Table 10.3.2.5.2-1 for FR1.

The value of  $T_{Evaluate\_CBD\_SSB}$  is defined in Table 10.3.2.5.2-2 for FR2-1 with scaling factor  $N=8$ .

Where,

For FR1,

- $P = 1$ .

For FR2-1,

- $P=1$ , when the candidate beam detection RS resource is not overlapped with SMTC occasion.
- $P = \frac{1}{1 - \frac{T_{SSB}}{T_{SMTCperiod}}}$ , when candidate beam detection RS is partially overlapped with SMTC occasion ( $T_{SSB} < T_{SMTCperiod}$ ).
- $P = 3$ , when candidate beam detection RS is fully overlapped with SMTC period ( $T_{SSB} = T_{SMTCperiod}$ ).

If the high layer in TS 38.331 [23] signaling of  $smc2$  is present,  $T_{SMTCperiod}$  follows  $smc2$ ; Otherwise  $T_{SMTCperiod}$  follow  $smc1$ .

Longer evaluation period would be expected if the combination of CBD-RS resource and SMTC occasion configurations does not meet pervious conditions.

**Table 10.3.2.5.2-1: Evaluation period  $T_{Evaluate\_CBD\_SSB}$  for FR1**

| Configuration                                                      | $T_{Evaluate\_CBD\_SSB}$ (ms)     |
|--------------------------------------------------------------------|-----------------------------------|
| non-DRX                                                            | $Ceil(3 \times P) \times T_{SSB}$ |
| Note: $T_{SSB}$ is the periodicity of SSB in the set $\bar{q}_l$ . |                                   |

**Table 10.3.2.5.2-2: Evaluation period  $T_{Evaluate\_CBD\_SSB}$  for FR2-1**

| Configuration                                                      | $T_{Evaluate\_CBD\_SSB}$ (ms)              |
|--------------------------------------------------------------------|--------------------------------------------|
| non-DRX                                                            | $Ceil(3 \times P \times N) \times T_{SSB}$ |
| Note: $T_{SSB}$ is the periodicity of SSB in the set $\bar{q}_l$ . |                                            |

### 10.3.2.5.3 Measurement restriction for SSB based candidate beam detection

For FR1, when the SSB for CBD measurement is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, NCR-MT shall be able to measure the SSB for CBD measurement without any restrictions;
- If SSB and CSI-RS have different SCS-es,
  - If NCR-MT supports *simultaneousRxDataSSB-DiffNumerology*, NCR-MT shall be able to measure the SSB for CBD measurement without any restriction;
  - If NCR-MT does not support *simultaneousRxDataSSB-DiffNumerology*, NCR-MT is required to measure one of but not both SSB for CBD measurement and CSI-RS. Longer measurement period for SSB based CBD measurement is expected, and no requirements are defined.

For FR2-1, when the SSB for CBD measurement on one CC is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC in the same band, NCR-MT is required to measure one of but not both SSB for CBD measurement and CSI-RS. Longer measurement period for SSB based CBD measurement is expected, and no requirements are defined.

### 10.3.2.6 Requirements for CSI-RS based candidate beam detection

#### 10.3.2.6.1 Introduction

The requirements in this clause apply for each CSI-RS resource in the set  $\bar{q}_l$  configured for a serving cell, provided that the CSI-RS resources configured for candidate beam detection are actually transmitted within NCR-MT active DL BWP during the entire evaluation period specified in clause 10.3.2.6.2.

#### 10.3.2.6.2 Minimum requirement

Upon request the NCR-MT shall be able to evaluate whether the L1-RSRP measured on the configured CSI-RS resource in set  $\bar{q}_l$  estimated over the last  $T_{\text{Evaluate\_CBD\_CSI-RS}}$  [ms] period becomes better than the threshold  $Q_{\text{in\_LR}}$  within  $T_{\text{Evaluate\_CBD\_CSI-RS}}$  [ms] period provided CSI-RS  $\hat{E}_s/\text{Iot}$  is according to Annex Table in B.2.4.2 [23] for a corresponding band.

The NCR-MT shall monitor the configured CSI-RS resources using the evaluation period in table 10.3.2.6.2-1 and 10.3.2.6.2-2 which is applicable to the non-DRX mode only.

The value of  $T_{\text{Evaluate\_CBD\_CSI-RS}}$  is defined in Table 10.3.2.6.2-1 for FR1.

The value of  $T_{\text{Evaluate\_CBD\_CSI-RS}}$  is defined in Table 10.3.2.6.2-2 for FR2-1 with scaling factor  $N=8$ .

For FR1,

- $P = 1$ .

For FR2-1,

- $P = 1$ , when candidate beam detection RS is not overlapped with SMTC occasion.
- $P = \frac{1}{1 + \frac{T_{\text{CSI-RS}}}{T_{\text{SMTCperiod}}}}$ , when candidate beam detection RS is partially overlapped with SMTC occasion ( $T_{\text{CSI-RS}} < T_{\text{SMTCperiod}}$ ).
- $P = 3$ , when candidate beam detection RS is fully overlapped with SMTC occasion ( $T_{\text{CSI-RS}} = T_{\text{SMTCperiod}}$ ).

If the high layer in TS 38.331 [23] signaling of  $\text{smtc}_2$  is present,  $T_{\text{SMTCperiod}}$  follows  $\text{smtc}_2$ ; Otherwise  $T_{\text{SMTCperiod}}$  follow  $\text{smtc}_1$ .

Longer evaluation period would be expected if the CSI-RS is on the same OFDM symbols with RLM, BFD, BM-RS, or other CBD-RS, according to the measurement restrictions defined in clause 10.3.2.6.3.

The values of  $M_{\text{CBD}}$  used in Table 10.3.2.6.2-1 and Table 10.3.2.6.2-2 are defined as

- $M_{\text{CBD}} = 3$ , if the CSI-RS resource configured in the set  $\bar{q}_l$  is transmitted with Density = 3.

**Table 10.3.2.6.2-1: Evaluation period  $T_{\text{Evaluate\_CBD\_CSI-RS}}$  for FR1**

| Configuration                                                                            | $T_{\text{Evaluate\_CBD\_CSI-RS}}$ (ms)                                         |
|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| non-DRX                                                                                  | $\text{Max}(25, \text{Ceil}(M_{\text{CBD}} \times P) \times T_{\text{CSI-RS}})$ |
| Note: $T_{\text{CSI-RS}}$ is the periodicity of CSI-RS resource in the set $\bar{q}_l$ . |                                                                                 |

**Table 10.3.2.6.2-2: Evaluation period  $T_{\text{Evaluate\_CBD\_CSI-RS}}$  for FR2-1**

| Configuration                                                                            | $T_{\text{Evaluate\_CBD\_CSI-RS}}$ (ms)                                                  |
|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| non-DRX                                                                                  | $\text{Max}(25, \text{Ceil}(M_{\text{CBD}} \times P \times N) \times T_{\text{CSI-RS}})$ |
| Note: $T_{\text{CSI-RS}}$ is the periodicity of CSI-RS resource in the set $\bar{q}_l$ . |                                                                                          |

### 10.3.2.6.3 Measurement restriction for CSI-RS based candidate beam detection

For both FR1 and FR2-1, when the CSI-RS for CBD measurement is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, NCR-MT is not required to receive CSI-RS for CBD measurement in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for CBD measurement, the NCR-MT shall be able to perform CSI-RS based CBD measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for CBD measurement, the NCR-MT shall be able to perform CSI-RS based CBD measurement with restrictions according to its capabilities:

- If the NCR-MT supports *simultaneousRxDataSSB-DiffNumerology* the NCR-MT shall be able to perform CSI-RS based CBD measurement for without restrictions.
- If the NCR-MT does not support *simultaneousRxDataSSB-DiffNumerology*, NCR-MT is required to measure one of but not both CSI-RS for CBD measurement and SSB. Longer measurement period for CSI-RS based CBD measurement is expected, and no requirements are defined.

For FR1, when the CSI-RS for CBD measurement is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, NCR-MT shall be able to measure the CSI-RS for CBD measurement without any restriction.

For FR2-1, when the CSI-RS for CBD measurement on one CC is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement on the same CC in the same band, NCR-MT is required to measure one of but not both CSI-RS for CBD measurement and SSB. Longer evaluation period for CSI-RS based CBD measurement is expected, and no requirements are defined.

For FR2-1, when the CSI-RS for CBD measurement on one CC is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC in the same band, NCR-MT is required to measure one of but not both CSI-RS for CBD measurement and the other CSI-RS. Longer evaluation period for CSI-RS based CBD measurement is expected, and no requirements are defined.

### 10.3.2.7 Scheduling availability of NCR-MT during beam failure detection

Scheduling availability restrictions when the NCR-MT is performing beam failure detection are described in the following clauses.

#### 10.3.2.7.1 Scheduling availability of NCR-MT performing beam failure detection with a same subcarrier spacing as PDSCH/PDCCH on FR1

There are no scheduling restrictions due to beam failure detection performed on SSB and CSI-RS configured for BFD with the same SCS as PDSCH or PDCCH in FR1.

#### 10.3.2.7.2 Scheduling availability of NCR-MT performing beam failure detection with a different subcarrier spacing than PDSCH/PDCCH on FR1

For NCR-MTs which support *simultaneousRxDataSSB-DiffNumerology* [27] there are no restrictions on scheduling availability due to beam failure detection when SSB is configured as BFD. For NCR-MTs which do not support *simultaneousRxDataSSB-DiffNumerology* [27] the following restrictions apply due to beam failure detection when SSB is configured as BFD.

- The NCR-MT is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on SSB symbols to be measured for beam failure detection.

#### 10.3.2.7.3 Scheduling availability of NCR-MT performing beam failure detection on FR2-1

The following scheduling restriction applies due to beam failure detection.

- For the case where no RSs are provided for BFD, or when CSI-RS is configured for BFD is explicitly configured and is type-D QCLed with active TCI state for PDCCH or PDSCH, and the CSI-RS is not in a CSI-RS resource set with repetition ON.
- There are no scheduling restrictions due to beam failure detection performed based on the CSI-RS.
- Otherwise
  - The NCR-MT is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on BFD-RS resource symbols to be measured for beam failure detection.

For FR2-1, if following conditions are met,

- NCR-MT has been notified about system information update through paging,
- The gap between NCR-MT's reception of PDCCH that NCR-MT monitors in the Type2-PDCCH CSS set and that notifies system information update, and the PDCCH that NCR-MT monitors in the Type0-PDCCH CSS set, is greater than 2 slots,

For the SSB and CORESET for RMSI scheduling multiplexing patterns 3, NCR-MT is expected to receive the PDCCH that NCR-MT monitors in the Type0-PDCCH CSS set, and the corresponding PDSCH, on SSB symbols to be measured for BFD measurement; and

For the SSB and CORESET for RMSI scheduling multiplexing patterns 2, NCR-MT is expected to receive PDSCH that corresponds to the PDCCH that NCR-MT monitors in the Type0-PDCCH CSS set, on SSB symbols to be measured for BFD measurement.

### 10.3.2.8 Scheduling availability of NCR-MT during candidate beam detection

Scheduling availability restrictions when the NCR-MT is performing L1-RSRP measurement for candidate beam detection are described in the following clauses.

#### 10.3.2.8.1 Scheduling availability of NCR-MT performing L1-RSRP measurement with a same subcarrier spacing as PDSCH/PDCCH on FR1

There are no scheduling restrictions due to L1-RSRP measurement performed on SSB and CSI-RS configured as link recovery detection resource with the same SCS as PDSCH or PDCCH in FR1.

#### 10.3.2.8.2 Scheduling availability of NCR-MT performing L1-RSRP measurement with a different subcarrier spacing than PDSCH/PDCCH on FR1

For NCR-MTs which support *simultaneousRxDataSSB-DiffNumerology* [27] there are no restrictions on scheduling availability due to L1-RSRP measurement based on SSB as link recovery detection resource. For NCR-MTs which do not support *simultaneousRxDataSSB-DiffNumerology* [27] the following restrictions apply due to L1-RSRP measurement based on SSB configured as link recovery detection resource.

- The NCR-MT is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH, TRS, CSI-RS for tracking or CSI-RS for CQI on SSB symbols to be measured for L1-RSRP.

#### 10.3.2.8.3 Scheduling availability of NCR-MT performing L1-RSRP measurement on FR2-1

The following scheduling restriction applies due to candidate beam detection

- The NCR-MT is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH, CSI-RS for tracking or CSI-RS for CQI on reference symbols to be measured for candidate beam detection.

For FR2-1, if following conditions are met,

- NCR-MT has been notified about system information update through paging,

- The gap between NCR-MT's reception of PDCCH that NCR-MT monitors in the Type2-PDCCH CSS set and that notifies system information update, and the PDCCH that NCR-MT monitors in the Type0-PDCCH CSS set, is greater than 2 slots,

For the SSB and CORESET for RMSI scheduling multiplexing patterns 3, NCR-MT is expected to receive the PDCCH that NCR-MT monitors in the Type0-PDCCH CSS set, and the corresponding PDSCH, on SSB symbols to be measured for CBD measurement; and

For the SSB and CORESET for RMSI scheduling multiplexing patterns 2, NCR-MT is expected to receive PDSCH that corresponds to the PDCCH that NCR-MT monitors in the Type0-PDCCH CSS set, on SSB symbols to be measured for CBD measurement.

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## Annex A: Void

## Annex B (normative): NCR-MT Reference measurement channels

### B.1 NCR-MT Demodulation Performance Fixed Reference Channels

#### B.1.1 Fixed Reference Channels for PDSCH performance requirements

The parameters for the reference measurement channels are specified in table B.1.1-1 for FR1 PDSCH performance requirements.

The parameters for the reference measurement channels are specified in table B.1.1-2 for FR2-1 PDSCH performance requirements.

**Table B.1.1-1: FRC parameters for FR1 PDSCH performance requirements, 1 transmission layer**

| Parameter                           | Unit | Value               |                     |                     |                     |
|-------------------------------------|------|---------------------|---------------------|---------------------|---------------------|
| Reference channel                   |      | M-FR1-<br>NCR.1.1-1 | M-FR1-<br>NCR.1.1-2 | M-FR1-<br>NCR.1.1-3 | M-FR1-<br>NCR.1.1-4 |
| Channel bandwidth                   | MHz  | 10                  | 40                  | 10                  | 40                  |
| Subcarrier spacing                  | kHz  | 15                  | 30                  | 15                  | 30                  |
| Allocated resource blocks           | PRBs | 52                  | 106                 | 52                  | 106                 |
| Number of consecutive PDSCH symbols |      | 12                  | 12                  | 12                  | 12                  |
| MCS table                           |      | 64QAM               | 64QAM               | 64QAM               | 64QAM               |
| MCS index                           |      | 4                   | 4                   | 13                  | 13                  |
| Modulation                          |      | QPSK                | QPSK                | 16QAM               | 16QAM               |
| Target Coding Rate                  |      | 0.30                | 0.30                | 0.48                | 0.48                |
| Number of MIMO layers               |      | 1                   | 1                   | 1                   | 1                   |
| Number of DMRS REs                  |      | 12                  | 12                  | 12                  | 12                  |
| Overhead for TBS determination      |      | 0                   | 0                   | 0                   | 0                   |
| Information Bit Payload per Slot    |      | 4096                | 8456                | 13064               | 26632               |
| Transport block CRC per Slot        |      | 24                  | 24                  | 24                  | 24                  |
| Number of Code Blocks per Slot      |      | 1                   | 2                   | 2                   | 4                   |
| Binary Channel Bits Per Slot        |      | 13728               | 27984               | 27456               | 55968               |

**Table B.1.1-2: FRC parameters for FR2-1 PDSCH performance requirements, 1 transmission layer**

| Parameter                           | Unit | Value           |
|-------------------------------------|------|-----------------|
| Reference channel                   |      | M-FR2-NCR.1.1-1 |
| Channel bandwidth                   | MHz  | 100             |
| Subcarrier spacing                  | kHz  | 120             |
| Allocated resource blocks           | PRBs | 66              |
| Number of consecutive PDSCH symbols |      | 13              |
| MCS table                           |      | 64QAM           |
| MCS index                           |      | 4               |
| Modulation                          |      | QPSK            |
| Target Coding Rate                  |      | 0.30            |
| Number of MIMO layers               |      | 1               |
| Number of DMRS REs                  |      | 12              |
| Overhead for TBS determination      |      | 6               |
| Information Bit Payload per Slot    |      | 5504            |
| Transport block CRC per Slot        |      | 24              |
| Number of Code Blocks per Slot      |      | 1               |
| Binary Channel Bits Per Slot        |      | 18282           |

## B.1.2 Fixed Reference Channels for PDCCH performance requirements

The parameters for the reference measurement channels are specified in table B.1.2-1 for FR1 PDCCH performance requirements.

The parameters for the reference measurement channels are specified in table B.1.2-2 for FR2-1 PDCCH performance requirements.

**Table B.1.2-1: FR1 PDCCH Reference Channels**

| Parameter                           | Unit | Value           |                 |                 |                 |                 |                 |
|-------------------------------------|------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Reference channel                   |      | M-FR1-NCR.1.2-1 | M-FR1-NCR.1.2-2 | M-FR1-NCR.1.2-3 | M-FR1-NCR.1.2-4 | M-FR1-NCR.1.2-5 | M-FR1-NCR.1.2-6 |
| Subcarrier spacing                  | kHz  | 15              | 15              | 15              | 30              | 30              | 30              |
| CORESET frequency domain allocation |      | 24              | 48              | 48              | 102             | 102             | 90              |
| CORESET time domain allocation      |      | 2               | 2               | 1               | 1               | 1               | 1               |
| Aggregation level                   |      | 2               | 4               | 8               | 2               | 4               | 8               |
| DCI Format                          |      | 1_0             | 1_1             | 1_1             | 1_0             | 1_1             | 1_1             |
| Payload (without CRC)               | Bits | 39              | 52              | 52              | 41              | 53              | 53              |

**Table B.1.2-2: FR2-1 PDCCH Reference Channels**

| Parameter                           | Unit | Value           |                 |                 |
|-------------------------------------|------|-----------------|-----------------|-----------------|
| Reference channel                   |      | M-FR2-NCR.1.2-1 | M-FR2-NCR.1.2-2 | M-FR2-NCR.1.2-3 |
| Subcarrier spacing                  | kHz  | 120             | 120             | 120             |
| CORESET frequency domain allocation |      | 60              | 60              | 60              |
| CORESET time domain allocation      |      | 1               | 1               | 1               |
| Aggregation level                   |      | 2               | 4               | 8               |
| DCI Format                          |      | 1_0             | 1_1             | 1_1             |
| Payload (without CRC)               | Bits | 40              | 56              | 56              |

## B.1.3 Fixed Reference Channels for CSI reporting performance

This clause defines the DL signal applicable to the reporting of channel status information.

Tables in this clause specifies the mapping of CQI index to Information Bit payload, which complies with the CQI definition specified in clause 5.2.2.1 of TS 38.214 [11] and with MCS definition specified in clause 5.1.3 of TS 38.214 [11].

**Table B.1.3-1: Fixed Reference Channels for FR1 CSI reporting with CQI table 2 and MCS table 2**

| Reference channel                         |                     |           |            | M-FR1-NCR.1.3-1                  | M-FR1-NCR.1.3-2 |
|-------------------------------------------|---------------------|-----------|------------|----------------------------------|-----------------|
| Number of allocated PDSCH resource blocks |                     |           |            | 52                               | 106             |
| Number of consecutive PDSCH symbols       |                     |           |            | 12                               | 12              |
| Number of PDSCH MIMO layers               |                     |           |            | 1                                | 2               |
| Number of DMRS REs (Note 1)               |                     |           |            | 24                               | 24              |
| Overhead for TBS determination            |                     |           |            | 0                                | 0               |
| Available RE-s for PDSCH                  |                     |           |            | 6240                             | 12720           |
| CQI index                                 | Spectral efficiency | MCS index | Modulation | Information Bit Payload per Slot |                 |
| 0                                         | 0.1523              | 0         | QPSK       | N/A                              | N/A             |
| 1                                         | 0.3770              | 1         | QPSK       | 1480                             | 2976            |
| 2                                         | 0.8770              | 3         |            | 2408                             | 4744            |
| 3                                         | 1.4766              | 5         |            | 5504                             | 11016           |
| 4                                         | 1.9141              | 7         |            | 9224                             | 18960           |
| 5                                         | 2.4063              | 9         | 16QAM      | 12040                            | 24576           |
| 6                                         | 2.7305              | 11        |            | 15112                            | 30728           |
| 7                                         | 3.3223              | 13        |            | 16896                            | 34816           |
| 8                                         | 3.9023              | 15        |            | 20496                            | 42016           |
| 9                                         | 4.5234              | 17        | 64QAM      | 24576                            | 49176           |
| 10                                        | 5.1152              | 19        |            | 28168                            | 57376           |
| 11                                        | 5.5547              | 21        |            | 31752                            | 65576           |
| 12                                        | 6.2266              | 23        |            | 34816                            | 69672           |
| 13                                        | 6.9141              | 25        | 256QAM     | 38936                            | 79896           |
| 14                                        | 7.4063              | 27        |            | 43032                            | 88064           |
| 15                                        |                     |           |            | 46104                            | 94248           |

NOTE 1: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data  
NOTE 2: PDSCH is only scheduled on slots which are full DL

**Table B.1.3-2: Fixed Reference Channels for FR2-1 CSI reporting with CQI table 1 and MCS table 1**

| Reference channel                         |                     |           |            | M-FR2-NCR.1.3-1                  |
|-------------------------------------------|---------------------|-----------|------------|----------------------------------|
| Number of allocated PDSCH resource blocks |                     |           |            | 66                               |
| Number of consecutive PDSCH symbols       |                     |           |            | 12                               |
| Number of PDSCH MIMO layers               |                     |           |            | 1                                |
| Number of DMRS REs (Note 1)               |                     |           |            | 24                               |
| Overhead for TBS determination            |                     |           |            | 6                                |
| Available RE-s for PDSCH                  |                     |           |            | 7590                             |
| CQI index                                 | Spectral efficiency | MCS index | Modulation | Information Bit Payload per Slot |
| 0                                         | 0.1523              | 0         | QPSK       | N/A                              |
| 1                                         | 0.2344              | 0         | QPSK       | 1800                             |
| 2                                         | 0.3770              | 2         |            | 1800                             |
| 3                                         | 0.6016              | 4         |            | 2856                             |
| 4                                         | 0.8770              | 6         |            | 4480                             |
| 5                                         | 1.1758              | 8         |            | 6528                             |
| 6                                         | 1.4766              | 11        | 16QAM      | 8712                             |
| 7                                         | 1.9141              | 13        |            | 11016                            |
| 8                                         | 2.4063              | 15        |            | 14343                            |
| 9                                         | 2.7305              | 18        | 64QAM      | 17928                            |
| 10                                        | 3.3223              | 20        |            | 20496                            |
| 11                                        | 3.9023              | 22        |            | 25104                            |
| 12                                        | 4.5234              | 24        |            | 29192                            |
| 13                                        | 5.1152              | 26        |            | 33816                            |
| 14                                        | 5.5547              | 28        |            | 38936                            |
| 15                                        |                     |           |            | 42016                            |

NOTE 1: Number of DMRS REs includes the overhead of the DM-RS CDM groups without data  
NOTE 2: PDSCH is only scheduled on slots which are full DL

## B.2 Fixed Reference Channels for reference sensitivity level, ACS, in-band blocking, out-of-band blocking and receiver intermodulation (QPSK, $R=1/3$ )

The parameters for the FR1 WA NCR-MT reference measurement channels are specified in tables B.2-1 for FR1 reference sensitivity level, ACS, in-band blocking, out-of-band blocking, receiver intermodulation.

**Table B.2-1: FRC parameters for FR1 reference sensitivity level for FR1 WA NCR-MT**

| Reference channel                                                                                                                                                               | G-FR1-A1-22 | G-FR1-A1-23 | G-FR1-A1-24 | G-FR1-A1-25 | G-FR1-A1-26 | G-FR1-A1-27 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Subcarrier spacing (kHz)                                                                                                                                                        | 30          | 60          | 15          | 30          | 60          | 15          |
| Allocated resource blocks                                                                                                                                                       | 11          | 11          | 106         | 51          | 24          | 25          |
| CP-OFDM Symbols per slot (Note 1)                                                                                                                                               | 9           | 9           | 9           | 9           | 9           | 9           |
| Modulation                                                                                                                                                                      | QPSK        | QPSK        | QPSK        | QPSK        | QPSK        | QPSK        |
| Code rate (Note 2)                                                                                                                                                              | 1/3         | 1/3         | 1/3         | 1/3         | 1/3         | 1/3         |
| NOTE 1: <i>DL-DMRS-config-type</i> = 1 with <i>DL-DMRS-max-len</i> = 1, <i>DL-DMRS-add-pos</i> = pos2 with $l_0 = 2$ , $l = 6$ and 9 as per Table 7.4.1.1.2-3 of TS 38.211 [3]. |             |             |             |             |             |             |
| NOTE 2: MCS index 4 and target coding rate = 308/1024 are adopted to calculate payload size for receiver sensitivity                                                            |             |             |             |             |             |             |

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## Annex C (normative): Propagation conditions

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### C.1 Static propagation condition

The propagation for the static performance measurement is an Additive White Gaussian Noise (AWGN) environment. No fading or multi-paths exist for this propagation model.

#### C.1.1 NCR-MT receiver with 2RX

For 1 port transmission the channel matrix is defined in the frequency domain by:

$$\mathbf{H} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}.$$

For 2 port transmission the channel matrix is defined in the frequency domain by:

$$\mathbf{H} = \begin{pmatrix} 1 & j \\ 1 & -j \end{pmatrix}.$$

#### C.1.2 NCR-MT Receiver with 4Rx

For 1 port transmission the channel matrix is defined in the frequency domain by

$$\mathbf{H} = \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}.$$

For 2 port transmission the channel matrix is defined in the frequency domain by

$$\mathbf{H} = \begin{bmatrix} 1 & j \\ 1 & -j \\ 1 & j \\ 1 & -j \end{bmatrix}.$$

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### C.2 Multi-path fading propagation conditions

#### C.2.1 General

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.
- Different models are used for FR1 (410 MHz - 7.125 GHz) and FR2 (24.25 GHz – 52.6 GHz).

## C.2.2 Delay profiles

### C.2.2.1 General

The delay profiles are simplified from the TR 38.901 [29] TDL models. The simplification steps are shown below for information. These steps are only used when new delay profiles are created. Otherwise, the delay profiles specified in C.2.2.1 can be used as such.

- Step 1: Use the original TDL model from TR 38.901 [29].
- Step 2: Re-order the taps in ascending delays.
- Step 3: Perform delay scaling according to the procedure described in clause 7.7.3 in TR 38.901 [29].
- Step 4: Apply the quantization to the delay resolution 5 ns. This is done simply by rounding the tap delays to the nearest multiple of the delay resolution.
- Step 5: If multiple taps are rounded to the same delay bin, merge them by calculating their linear power sum.
- Step 6: If there are more than 12 taps in the quantized model, merge the taps as follows:
  - Find the weakest tap from all taps (both merged and unmerged taps are considered):
    - If there are two or more taps having the same value and are the weakest, select the tap with the smallest delay as the weakest tap.
  - When the weakest tap is the first delay tap, merge taps as follows:
    - Update the power of the first delay tap as the linear power sum of the weakest tap and the second delay tap.
    - Remove the second delay tap.
  - When the weakest tap is the last delay tap, merge taps as follows:
    - Update the power of the last delay tap as the linear power sum of the second-to-last tap and the last tap.
    - Remove the second-to-last tap.
  - Otherwise:
    - For each side of the weakest tap, identify the neighbour tap that has the smaller delay difference to the weakest tap.
      - When the delay difference between the weakest tap and the identified neighbour tap on one side equals the delay difference between the weakest tap and the identified neighbour tap on the other side.
        - Select the neighbour tap that is weaker in power for merging.
      - Otherwise, select the neighbour tap that has smaller delay difference for merging.
    - To merge, the power of the merged tap is the linear sum of the power of the weakest tap and the selected tap.
    - When the selected tap is the first tap, the location of the merged tap is the location of the first tap. The weakest tap is removed.

- When the selected tap is the last tap, the location of the merged tap is the location of the last tap. The weakest tap is removed.
- Otherwise, the location of the merged tap is based on the average delay of the weakest tap and selected tap. If the average delay is on the sampling grid, the location of the merged tap is the average delay. Otherwise, the location of the merged tap is rounded towards the direction of the selected tap (e.g. 10 ns & 20 ns → 15 ns, 10 ns & 25 ns → 20 ns, if 25 ns had higher or equal power; 15 ns, if 10 ns had higher power). The weakest tap and the selected tap are removed.
- Repeat step 6 until the final number of taps is 12.
- Step 7: Round the amplitudes of taps to one decimal (e.g. -8.78 dB → -8.8 dB)
- Step 8: If the delay spread has slightly changed due to the tap merge, adjust the final delay spread by increasing or decreasing the power of the last tap so that the delay spread is corrected.
- Step 9: Re-normalize the highest tap to 0 dB.

NOTE 1: Some values of the delay profile created by the simplification steps may differ from the values in tables C.2.2.2-2, C.2.2.2-3, and C.2.1.1-4 for the corresponding model.

NOTE 2: For Step 5 and Step 6, the power values are expressed in the linear domain using 6 digits of precision. The operations are in the linear domain.

### C.2.2.2 Delay profiles for FR1

The delay profiles for FR1 are selected to be representative of low, medium and high delay spread environment. The resulting model parameters are specified in C.2.2.2-1 and the tapped delay line models are specified in tables C.2.2.2-2 ~ table C.2.2.2-4.

**Table C.2.2.2-1: Delay profiles for NR channel models**

| Model   | Number of channel taps | Delay spread (r.m.s.) | Maximum excess tap delay (span) | Delay resolution |
|---------|------------------------|-----------------------|---------------------------------|------------------|
| TDLA30  | 12                     | 30 ns                 | 290 ns                          | 5 ns             |
| TDLB100 | 12                     | 100 ns                | 480 ns                          | 5 ns             |
| TDLC300 | 12                     | 300 ns                | 2595 ns                         | 5 ns             |

**Table C.2.2.2-2: TDLA30 (DS = 30 ns)**

| Tap # | Delay (ns) | Power (dB) | Fading distribution |
|-------|------------|------------|---------------------|
| 1     | 0          | -15.5      | Rayleigh            |
| 2     | 10         | 0          |                     |
| 3     | 15         | -5.1       |                     |
| 4     | 20         | -5.1       |                     |
| 5     | 25         | -9.6       |                     |
| 6     | 50         | -8.2       |                     |
| 7     | 65         | -13.1      |                     |
| 8     | 75         | -11.5      |                     |
| 9     | 105        | -11.0      |                     |
| 10    | 135        | -16.2      |                     |
| 11    | 150        | -16.6      |                     |
| 12    | 290        | -26.2      |                     |

**Table C.2.2.2-3: TDLB100 (DS = 100ns)**

| Tap # | Delay (ns) | Power (dB) | Fading distribution |
|-------|------------|------------|---------------------|
| 1     | 0          | 0          | Rayleigh            |
| 2     | 10         | -2.2       |                     |
| 3     | 20         | -0.6       |                     |
| 4     | 30         | -0.6       |                     |
| 5     | 35         | -0.3       |                     |
| 6     | 45         | -1.2       |                     |
| 7     | 55         | -5.9       |                     |
| 8     | 120        | -2.2       |                     |
| 9     | 170        | -0.8       |                     |
| 10    | 245        | -6.3       |                     |
| 11    | 330        | -7.5       |                     |
| 12    | 480        | -7.1       |                     |

**Table C.2.2.2-4: TDLC300 (DS = 300 ns)**

| Tap # | Delay (ns) | Power (dB) | Fading distribution |
|-------|------------|------------|---------------------|
| 1     | 0          | -6.9       | Rayleigh            |
| 2     | 65         | 0          |                     |
| 3     | 70         | -7.7       |                     |
| 4     | 190        | -2.5       |                     |
| 5     | 195        | -2.4       |                     |
| 6     | 200        | -9.9       |                     |
| 7     | 240        | -8.0       |                     |
| 8     | 325        | -6.6       |                     |
| 9     | 520        | -7.1       |                     |
| 10    | 1045       | -13.0      |                     |
| 11    | 1510       | -14.2      |                     |
| 12    | 2595       | -16.0      |                     |

## C.2.3 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., TDLA<DS>-<Doppler>, TDLB<DS>-<Doppler> or TDLC<DS>-<Doppler> where '<DS>' indicates the desired delay spread and '<Doppler>' indicates the maximum Doppler frequency (Hz).

Table C.2.3-1 show the propagation conditions that are used for the performance measurements in multi-path fading environment for low, medium and high Doppler frequencies for FR1.

**Table C.2.3-1: Channel model parameters for FR1**

| Combination name | Model   | Maximum Doppler frequency |
|------------------|---------|---------------------------|
| TDLA30-5         | TDLA30  | 5 Hz                      |
| TDLA30-10        | TDLA30  | 10 Hz                     |
| TDLB100-400      | TDLB100 | 400 Hz                    |
| TDLC300-100      | TDLC300 | 100 Hz                    |

## C.2.4 MIMO channel correlation matrices

### C.2.4.1 General

The MIMO channel correlation matrices defined in annex C.2.4 apply for the antenna configuration using uniform linear arrays at both gNB and NCR-MT and for the antenna configuration using cross polarized antennas.

## C.2.4.2 MIMO correlation matrices using Uniform Linear Array

### C.2.4.2.1 General

The MIMO channel correlation matrices defined in annex C.2.4.2 apply for the antenna configuration using uniform linear array (ULA) at both gNB and NCR-MT.

### C.2.4.2.2 Definition of MIMO correlation matrices

Table C.2.4.2.2-1 defines the correlation matrix for the gNB.

**Table C.2.4.2.2-1: gNB correlation matrix**

|                                                              | gNB correlation                                                      |
|--------------------------------------------------------------|----------------------------------------------------------------------|
| One antenna                                                  | $R_{gNB} = 1$                                                        |
| Two antennas                                                 | $R_{gNB} = \begin{pmatrix} 1 & \alpha \\ \alpha^* & 1 \end{pmatrix}$ |
| NOTE: The matrix applies to the gNB for NCR-MT requirements. |                                                                      |

Table C.2.4.2.2-2 defines the correlation matrix for the NCR-MT:

**Table C.2.4.2.2-2: NCR-MT correlation matrix**

|                                                                                 | NCR-MT correlation                                                                                                                                                                                                           |
|---------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Two antennas                                                                    | $R_{UE} = \begin{pmatrix} 1 & \beta \\ \beta^* & 1 \end{pmatrix}$                                                                                                                                                            |
| Four antennas                                                                   | $R_{UE} = \begin{pmatrix} 1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9*} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9*} & \beta^{1/9*} & 1 & \beta^{1/9} \\ \beta^* & \beta^{4/9*} & \beta^{1/9*} & 1 \end{pmatrix}$ |
| NOTE: The correlation matrix $R_{UE}$ applies to NCR-MT for NCR-MT requirements |                                                                                                                                                                                                                              |

Table C.2.4.2.2-3 defines the channel spatial correlation matrix  $R_{\text{spat}}$ . The parameters,  $\alpha$  and  $\beta$  in table C.2.4.2.2-3 defines the spatial correlation between the antennas at the gNB and NCR-MT respectively.

**Table C.2.4.2.2-3:  $R_{\text{spat}}$  correlation matrices**

|                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1x2 case                                                                                                                                                                                | $R_{\text{spat}} = R_{\text{UE}} = \begin{bmatrix} 1 & \beta \\ \beta^* & 1 \end{bmatrix}$                                                                                                                                                                                                                                                                                      |
| 1x4 case                                                                                                                                                                                | $R_{\text{spat}} = R_{\text{UE}} = \begin{bmatrix} 1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9*} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9*} & \beta^{1/9*} & 1 & \beta^{1/9} \\ \beta^* & \beta^{4/9*} & \beta^{1/9*} & 1 \end{bmatrix}$                                                                                                                           |
| 2x2 case                                                                                                                                                                                | $R_{\text{spat}} = R_{\text{gNB}} \otimes R_{\text{UE}} = \begin{bmatrix} 1 & \alpha \\ \alpha^* & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta \\ \beta^* & 1 \end{bmatrix} = \begin{bmatrix} 1 & \beta & \alpha & \alpha\beta \\ \beta^* & 1 & \alpha\beta^* & \alpha \\ \alpha^* & \alpha^*\beta & 1 & \beta \\ \alpha^*\beta^* & \alpha^* & \beta^* & 1 \end{bmatrix}$ |
| 2x4 case                                                                                                                                                                                | $R_{\text{spat}} = R_{\text{gNB}} \otimes R_{\text{UE}} = \begin{bmatrix} 1 & \alpha \\ \alpha^* & 1 \end{bmatrix} \otimes \begin{bmatrix} 1 & \beta^{1/9} & \beta^{4/9} & \beta \\ \beta^{1/9*} & 1 & \beta^{1/9} & \beta^{4/9} \\ \beta^{4/9*} & \beta^{1/9*} & 1 & \beta^{1/9} \\ \beta^* & \beta^{4/9*} & \beta^{1/9*} & 1 \end{bmatrix}$                                   |
| NOTE 1: $R_{\text{gNB}}$ refers to the correlation matrix of gNB for NCR-MT requirements.<br>NOTE 2: $R_{\text{UE}}$ refers to the correlation matrix of NCR-MT for NCR-MT requirements |                                                                                                                                                                                                                                                                                                                                                                                 |

For cases with more antennas at either gNB or NCR-MT or both, the channel spatial correlation matrix can still be expressed as the Kronecker product of  $R_{\text{gNB}}$  and  $R_{\text{UE}}$  according to  $R_{\text{spat}} = R_{\text{gNB}} \otimes R_{\text{UE}}$ .

### C.2.4.2.3 MIMO correlation matrices at high, medium and low level

The  $\alpha$  and  $\beta$  for different correlation types are given in table C.2.4.2.3-1.

**Table C.2.4.2.3-1: Correlation for high, medium and low level**

| Low correlation |         | Medium correlation |         | High correlation |         |
|-----------------|---------|--------------------|---------|------------------|---------|
| $\alpha$        | $\beta$ | $\alpha$           | $\beta$ | $\alpha$         | $\beta$ |
| 0               | 0       | 0.3                | 0.9     | 0.9              | 0.9     |

The correlation matrices for high, medium and low correlation are defined in table C.2.4.2.3-2, C.2.4.2.3-3 and C.2.4.2.3-4 as below.

The values in table C.2.4.2.3-2 have been adjusted for the 2x4 high correlation case to ensure the correlation matrix is positive semi-definite after round-off to 4 digit precision. This is done using the equation:

$$\mathbf{R}_{\text{high}} = [\mathbf{R}_{\text{spatial}} + a\mathbf{I}_n] / (1 + a)$$

Where the value "a" is a scaling factor such that the smallest value is used to obtain a positive semi-definite result. For the 2x4 high correlation case, a = 0.00010.

Table C.2.4.2.3-2: MIMO correlation matrices for high correlation

|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1x2 case | $R_{high} = \begin{pmatrix} 1 & 0.9 \\ 0.9 & 1 \end{pmatrix}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 2x2 case | $R_{high} = \begin{pmatrix} 1 & 0.9 & 0.9 & 0.81 \\ 0.9 & 1 & 0.81 & 0.9 \\ 0.9 & 0.81 & 1 & 0.9 \\ 0.81 & 0.9 & 0.9 & 1 \end{pmatrix}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 2x4 case | $R_{high} = \begin{bmatrix} 1.0000 & 0.9883 & 0.9542 & 0.8999 & 0.8999 & 0.8894 & 0.8587 & 0.8099 \\ 0.9883 & 1.0000 & 0.9883 & 0.9542 & 0.8894 & 0.8999 & 0.8894 & 0.8587 \\ 0.9542 & 0.9883 & 1.0000 & 0.9883 & 0.8587 & 0.8894 & 0.8999 & 0.8894 \\ 0.8999 & 0.9542 & 0.9883 & 1.0000 & 0.8099 & 0.8587 & 0.8894 & 0.8999 \\ 0.8999 & 0.8894 & 0.8587 & 0.8099 & 1.0000 & 0.9883 & 0.9542 & 0.8999 \\ 0.8894 & 0.8999 & 0.8894 & 0.8587 & 0.9883 & 1.0000 & 0.9883 & 0.9542 \\ 0.8587 & 0.8894 & 0.8999 & 0.8894 & 0.9542 & 0.9883 & 1.0000 & 0.9883 \\ 0.8099 & 0.8587 & 0.8894 & 0.8999 & 0.8999 & 0.9542 & 0.9883 & 1.0000 \end{bmatrix}$ |

Table C.2.4.2.3-3: MIMO correlation matrices for medium correlation

|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1x2 case | [N/A]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 2x2 case | $R_{medium} = \begin{pmatrix} 1.0000 & 0.9000 & 0.3000 & 0.2700 \\ 0.9000 & 1.0000 & 0.2700 & 0.3000 \\ 0.3000 & 0.2700 & 1.0000 & 0.9000 \\ 0.2700 & 0.3000 & 0.9000 & 1.0000 \end{pmatrix}$                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 2x4 case | $R_{medium} = \begin{pmatrix} 1.0000 & 0.9884 & 0.9543 & 0.9000 & 0.3000 & 0.2965 & 0.2863 & 0.2700 \\ 0.9884 & 1.0000 & 0.9884 & 0.9543 & 0.2965 & 0.3000 & 0.2965 & 0.2863 \\ 0.9543 & 0.9884 & 1.0000 & 0.9884 & 0.2863 & 0.2965 & 0.3000 & 0.2965 \\ 0.9000 & 0.9543 & 0.9884 & 1.0000 & 0.2700 & 0.2863 & 0.2965 & 0.3000 \\ 0.3000 & 0.2965 & 0.2863 & 0.2700 & 1.0000 & 0.9884 & 0.9543 & 0.9000 \\ 0.2965 & 0.3000 & 0.2965 & 0.2863 & 0.9884 & 1.0000 & 0.9884 & 0.9543 \\ 0.2863 & 0.2965 & 0.3000 & 0.2965 & 0.9543 & 0.9884 & 1.0000 & 0.9884 \\ 0.2700 & 0.2863 & 0.2965 & 0.3000 & 0.9000 & 0.9543 & 0.9884 & 1.0000 \end{pmatrix}$ |

Table C.2.4.2.3-4: MIMO correlation matrices for low correlation

|          |                          |
|----------|--------------------------|
| 1x2 case | $R_{low} = \mathbf{I}_2$ |
| 1x4 case | $R_{low} = \mathbf{I}_4$ |
| 2x2 case | $R_{low} = \mathbf{I}_4$ |
| 2x4 case | $R_{low} = \mathbf{I}_8$ |

In table C.2.4.2.3-4,  $\mathbf{I}_d$  is a  $d \times d$  identity matrix.

NOTE: For completeness, the correlation matrices were defined for high, medium and low correlation but performance requirements exist only for low correlation.

### C.2.4.3 Multi-antenna channel models using cross polarized antennas

#### C.2.4.3.1 General

The MIMO channel correlation matrices defined in annex C.2.4.3 apply to two cases as presented below:

- One TX antenna and multiple RX antennas case, with cross polarized antennas used at gNB
- Multiple TX antennas and multiple RX antennas case, with cross polarized antennas used at both NCR-MT and gNB

The cross-polarized antenna elements with +/-45 degrees polarization slant angles are deployed at gNB. For one TX antenna case, antenna element with +90 degree polarization slant angle is deployed at NCR-MT. For multiple TX antennas case, cross-polarized antenna elements with +90/0 degrees polarization slant angles are deployed at NCR-MT.

For the cross-polarized antennas, the N antennas are labelled such that antennas for one polarization are listed from 1 to N/2 and antennas for the other polarization are listed from N/2+1 to N, where N is the number of TX or RX antennas.

### C.2.4.3.2 Definition of MIMO correlation matrices using cross polarized antennas

For the channel spatial correlation matrix, the following is used:

$$R_{\text{spat}} = P_{UL} (R_{UE} \otimes \Gamma_{UL} \otimes R_{gNB}) P_{UL}^T$$

Where

- $R_{UE}$  is the spatial correlation matrix at the NCR-MT (NCR-MT requirements) with same polarization,
- $R_{gNB}$  is the spatial correlation matrix at the gNB (NCR-MT requirements) with same polarization,
- $\Gamma_{UL}$  is a polarization correlation matrix,
- $P_{UL}$  is a permutation matrix, and
- $(\bullet)^T$  denotes transpose.

Table C.2.4.3.2-1 defines the polarization correlation matrix.

**Table C.2.4.3.2-1: Polarization correlation matrix**

|                                 | One TX antenna                                                           | Multiple TX antennas                                                                                                                 |
|---------------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Polarization correlation matrix | $\Gamma_{UL} = \begin{bmatrix} 1 & -\gamma \\ -\gamma & 1 \end{bmatrix}$ | $\Gamma_{UL} = \begin{bmatrix} 1 & -\gamma & 0 & 0 \\ -\gamma & 1 & 0 & 0 \\ 0 & 0 & 1 & \gamma \\ 0 & 0 & \gamma & 1 \end{bmatrix}$ |

The matrix  $P_{UL}$  is defined as

$$P_{UL}(a,b) = \begin{cases} 1 & \text{for } a = (j-1)Nr + i \text{ and } b = 2(j-1)Nr + i, \quad i = 1, \dots, Nr, j = 1, \dots, \lceil Nt/2 \rceil \\ 1 & \text{for } a = (j-1)Nr + i \text{ and } b = 2(j - Nt/2)Nr - Nr + i, \quad i = 1, \dots, Nr, j = \lceil Nt/2 \rceil + 1, \dots, Nt \\ 0 & \text{otherwise} \end{cases}$$

where  $Nt$  and  $Nr$  is the number of TX and RX antennas respectively, and  $\lceil \bullet \rceil$  is the ceiling operator.

The matrix  $P_{UL}$  is used to map the spatial correlation coefficients in accordance with the antenna element labelling system described in C.2.4.3.

### C.2.4.3.3 Spatial correlation matrices at NCR-MT and gNB sides

#### C.2.4.3.3.1 Spatial correlation matrices at NCR-MT side

In this subclause,  $R_{UE}$  refers to an NCR-MT for NCR-MT requirements.

For 2-antenna receiver using one pair of cross-polarized antenna elements,  $R_{UE} = 1$ .

For 4-antenna receiver using two pairs of cross-polarized antenna elements,  $R_{UE} = \begin{pmatrix} 1 & \beta \\ \beta^* & 1 \end{pmatrix}$ .

#### C.2.4.3.3.2 Spatial correlation matrices at gNB side

In this subclause,  $R_{gNB}$  refers to a gNB for NCR-MT requirements.

For 1-antenna transmitter,  $R_{gNB} = 1$ .

For 2-antenna transmitter using one pair of cross-polarized antenna elements,  $R_{gNB} = 1$ .

#### C.2.4.3.4 MIMO correlation matrices using cross polarized antennas

The values for parameters  $\alpha$ ,  $\beta$  and  $\gamma$  for low spatial correlation are given in table C.2.4.3.4-1.

**Table C.2.4.3.4-1: Values for parameters  $\alpha$ ,  $\beta$  and  $\gamma$**

| Low spatial correlation                                                                                                                                                                                                    |         |          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|----------|
| $\alpha$                                                                                                                                                                                                                   | $\beta$ | $\gamma$ |
| 0                                                                                                                                                                                                                          | 0       | 0        |
| NOTE 1: Value of $\alpha$ applies when more than one pair of cross-polarized antenna elements at gNB side.<br>NOTE 2: Value of $\beta$ applies when more than one pair of cross-polarized antenna elements at NCR-MT side. |         |          |

#### C.2.4.3.5 Beam steering approach

For the 2D cross-polarized antenna array at gNB, given the channel spatial correlation matrix in C.2.4.3.2, C.2.4.3.3 and C.2.4.3.4, the corresponding random channel matrix  $H$  can be calculated. The signal model for the  $k$ -th slot is denoted as

$$y = H D_{\theta_{k,1}, \theta_{k,2}} W x + n$$

And the steering matrix is further expressed as following:

$$D_{\theta_{k,1}, \theta_{k,2}} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \otimes (D_{\theta_{k,1}}(N_1) \otimes D_{\theta_{k,2}}(N_2))$$

where

- $H$  is the  $N_r \times N_t$  channel matrix per subcarrier.
- $D_{\theta_{k,1}, \theta_{k,2}}$  is the steering matrix,
- $D_{\theta_{k,1}}(N_1)$  is the steering matrix in first dimension with same polarization,
- $D_{\theta_{k,2}}(N_2)$  is the steering matrix in second dimension with same polarization,
- $N_1$  is the number of antenna elements in first dimension with same polarization,
- $N_2$  is the number of antenna elements in second dimension with same polarization,
- For antenna array with only one direction, number of antenna element in second direction  $N_2$  equals 1.

For 1 antenna element with the same polarization in one direction,

$$D_{\theta_{k,i}}(1)=1$$

For 2 antenna elements with the same polarization in one direction,

$$D_{\theta_{k,i}}(2)=\begin{bmatrix} 1 & 0 \\ 0 & e^{j3\theta_{k,i}} \end{bmatrix}$$

where the index  $i=1,2$  stands for first dimension and second dimension respectively.

- $\theta_{k,i}$  controls the phase variation in first dimension and second dimension respectively, and the phase for k-th subframe is denoted by  $\theta_{k,i}=\theta_{0,i}+\Delta\theta k$ , where  $\theta_{0,i}$  is the random start value with the uniform distribution, i.e.,  $\theta_{0,i} \in [0,2\pi]$ ,  $\Delta\theta$  is the step of phase variation, which is defined in Table C.2.4.3.5-1, and k is the linear increment of  $2^{-\mu}$  for every slot throughout the simulation, the index  $i=1,2$  stands for first dimension and second dimension respectively.
- $W$  is the precoding matrix for  $N_t$  transmission antennas,
- $y$  is the received signal,  $x$  is the transmitted signal, and  $n$  is AWGN.
- $\mu$  corresponds to subcarrier spacing configuration,  $\Delta f = 2^{\mu} \cdot 15[\text{kHz}]$

For the 1D cross-polarized antenna array at gNB, the corresponding random channel matrix  $H$  can be calculated by letting  $N_2=1$ , i.e.,

$$D_{\theta_{k,1}}=\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \otimes D_{\theta_{k,1}}(N_1)$$

**Table C.2.4.3.5-1: The step of phase variation**

| Variation Step | Value (rad/ms)          |
|----------------|-------------------------|
| $\Delta\theta$ | $1.2566 \times 10^{-3}$ |

## C.3 Physical signals, channels mapping and precoding

### C.3.1 General

Unless otherwise stated, the transmission on antenna port(s)  $p = p_0, p_0 + 1, \dots, p_0 + N_p - 1$  is defined by using a precoder matrix  $W(i)$  of size  $N_{ANT} \times N_p$ , where  $N_{ANT}$  is the number of physical transmit antenna elements configured per test,  $N_p$  is the number of ports for a reference signal or physical channel configured per test, and  $p_0$  is the first port for that reference signal or physical channel as defined in clauses 7.3 and 7.4 in TS 38.211 [21]. This precoder takes as an input a block of signals for antenna port(s)  $p = p_0, p_0 + 1, \dots, p_0 + N_p - 1$ ,  $y^{(p)}(i) =$

$[y^{(p_0)}(i) \ y^{(p_0+1)}(i) \ \dots \ y^{(p_0+N_p-1)}(i)]^T$ ,  $i = 0, 1, \dots, M_{\text{symb}}^{\text{ap}} - 1$ , with  $M_{\text{symb}}^{\text{ap}}$  being the number of modulation symbols per antenna port including the reference signal symbols, and generates a block of signals  $y_{bf}^{(q)}(i) =$

$[y_{bf}^{(0)}(i) \ y_{bf}^{(1)}(i) \ \dots \ y_{bf}^{(N_{ANT}-1)}(i)]^T$  the elements of which are to be mapped onto the frequency-time index pair  $(k, l)$  as per the test configuration but transmitted on different physical antenna elements:

$$y_{bf}^{(q)}(i) = W(i)y^{(p)}(i)$$

For Clause 8.2.3 and 9.4.1, the transmission of PDCCH and PDCCH DMRS on antenna port  $p = p_0$  is defined by using a precoder matrix  $W(i)$  of size  $2 \times 1$ . This precoder takes as an input a block of signals for antenna port(s)  $p = p_0$ ,

$y^{(p)}(i) = y^{(p_0)}(i)$  and generates a block of signals  $y_{bf}^{(q)}(i) = \left[ y_{bf}^{(0)}(i) \ y_{bf}^{(\frac{N_{ANT}}{2})}(i) \right]^T$  the elements of which are to be

mapped onto the frequency-time index pair  $(k, l)$  as per the test configuration but transmitted on different physical antenna elements:

$$y_{bf}^{(q)}(i) = W(i)y^{(p)}(i)$$

The precoder matrix  $W(i)$  is specific to the test case configuration.  $W(i)$  is defined in Clause 5.2.2.2 of TS 38.214 [28].

The transmission on PT-RS antenna port is associated (using same precoder) with the lowest indexed DM-RS antenna port among the DM-RS antenna ports assigned for the PDSCH.

The physical antenna elements are identified by indices  $j = 0, 1, \dots, N_{ANT} - 1$ , where  $N_{ANT}$  is the number of physical antenna elements configured per test.

Modulation symbols  $y^{(p)}(i)$  with  $p \in \{4000\}$  (i.e. PSS, SSS, PBCH and DM-RS for PBCH) are directly mapped to first physical antenna element.

Modulation symbols  $a_{k,l}$  for CSI-RS resources which configured for tracking with one port are directly mapped to first physical antenna element.

Modulation symbols  $a_{k,l}$  for CSI-RS resources which configured for beam refinement with one port are directly mapped to first physical antenna element.

Modulation symbols  $a_{k,l}^{(p)}$  for NZP CSI-RS which configured for CSI acquisition with

$p \in \{p_0, p_0 + 1, \dots, p_0 + N_{CSI} - 1\}$  are mapped to the physical antenna index  $j = p - p_0$  where  $N_{CSI}$  is the number of NZP CSI-RS ports configured per test.

---

Annex D: Void

Annex E: Void

Annex F: Void

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## Annex G (normative): NCR-MT RRM Testing

The test cases defined in this Annex are to verify the minimum requirements defined in clause 12. The conducted tests are performed for NCR type 1-H, and the over the air (OTA) tests are performed for NCR type 2-O, where the conducted and radiated reference points and the NCR type are defined in clause 4.3. For the test cases for NCR-MT, the DU part is disabled during the testing. The test cases apply for Local-area NCR-MT classes, where the NCR-MT classes are defined in clause 4.4.

The test configurations and procedures are defined in following clauses and in each test cases. The test requirements are derived using the corresponding configuration parameters as example. The actual NCR-MT RRM test can be conducted by any set of configuration parameters which are left to implementations and manufacturer declarations and the corresponding test requirements shall be based on the actual configuration parameters used in the test. For example, TDD pattern and related configurations shall be configurable and left for implementation and declaration including:

- DL/UL scheduling related configuration
- PRACH configuration
- SRS configuration
- SSB configuration
- CSI-RS configuration
- BWP configuration
- SMTC configuration
- TCI state configuration
- Antenna configuration
- AoA configuration

## G.1 NCR-MT RRM test configurations

### G.1.1 Reference measurement channels

#### G.1.1.1 PDSCH

##### G.1.1.1.1 TDD

**Table G.1.1.1.1-1: PDSCH Reference Measurement Channels for SCS=15kHz**

| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Unit  | Value         |  |  |  |  |  |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|---------------|--|--|--|--|--|--|
| Reference channel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |       | SR.1.1<br>TDD |  |  |  |  |  |  |
| Channel bandwidth                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | MHz   | 10            |  |  |  |  |  |  |
| Number of transmitter antennas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       | 1             |  |  |  |  |  |  |
| Allocated resource blocks for PDSCH <sup>Note 1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       | 24            |  |  |  |  |  |  |
| Allocated slots per Radio Frame                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |               |  |  |  |  |  |  |
| Radio frame containing SSB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | slots | Note 5        |  |  |  |  |  |  |
| Radio frame not containing SSB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | slots | 4             |  |  |  |  |  |  |
| MCS table                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       | 64QAM         |  |  |  |  |  |  |
| MCS index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       | 4             |  |  |  |  |  |  |
| Modulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       | QPSK          |  |  |  |  |  |  |
| Target Coding Rate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       | 1/3           |  |  |  |  |  |  |
| Number of control symbols                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       | 2             |  |  |  |  |  |  |
| PDSCH mapping type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       | Type A        |  |  |  |  |  |  |
| Information Bit Payload                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |               |  |  |  |  |  |  |
| For slots with RMSI <sup>Note 2</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | bits  | 1608          |  |  |  |  |  |  |
| For slots without RMSI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | bits  | 1864          |  |  |  |  |  |  |
| Number of Code Blocks per slot                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       | 1             |  |  |  |  |  |  |
| Binary Channel Bits Per slot                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |       |               |  |  |  |  |  |  |
| For slots with RMSI <sup>Note 2, Note 4</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | bits  | 5184          |  |  |  |  |  |  |
| For slots without RMSI <sup>Note 6</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | bits  | 6048          |  |  |  |  |  |  |
| <p>Note 1: Allocated outside the SMTC duration in time and in resource blocks which do not overlap with the resource blocks allocated for SS/PBCH block.</p> <p>Note 2: PDSCH is scheduled on the slots with RMSI.</p> <p>Note 3: If necessary the information bit payload size can be adjusted to facilitate the test implementation. The payload sizes are defined in TS 38.213 [3].</p> <p>Note 4: Derived based on the PDSCH DMRS assumption: dmrs-TypeA-Position=2, dmrs-Type=1, dmrs-AdditionalPositions=2, maxLength=1, Antenna port index: 1000, and Number of PDSCH DMRS CDM group(s) without data: 2.</p> <p>Note 5: PDSCH is not scheduled in slots containing SSB according to the SSB configuration used in the test. SSB configurations are defined in clause G.1.5.</p> <p>Note 6: Derived based on the PDSCH DMRS assumption: dmrs-TypeA-Position=2, dmrs-Type=1, dmrs-AdditionalPositions=2, maxLength=1, Antenna port index: 1000, and Number of PDSCH DMRS CDM group(s) without data: 1.</p> |       |               |  |  |  |  |  |  |

**Table G.1.1.1.1-2: PDSCH Reference Measurement Channels for SCS=30kHz**

| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Unit  | Value         |  |  |  |  |  |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|---------------|--|--|--|--|--|--|
| Reference channel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |       | SR.2.1<br>TDD |  |  |  |  |  |  |
| Channel bandwidth                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | MHz   | 40            |  |  |  |  |  |  |
| Number of transmitter antennas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       | 1             |  |  |  |  |  |  |
| Allocated resource blocks for PDSCH <sup>Note 1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       | 24            |  |  |  |  |  |  |
| Allocated slots per Radio Frame                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |               |  |  |  |  |  |  |
| Radio frame containing SSB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | slots | Note 5        |  |  |  |  |  |  |
| Radio frame not containing SSB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | slots | 10            |  |  |  |  |  |  |
| MCS table                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       | 64QAM         |  |  |  |  |  |  |
| MCS index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       | 4             |  |  |  |  |  |  |
| Modulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       | QPSK          |  |  |  |  |  |  |
| Target Coding Rate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       | 1/3           |  |  |  |  |  |  |
| Number of control symbols                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       | 2             |  |  |  |  |  |  |
| PDSCH mapping type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       | Type A        |  |  |  |  |  |  |
| Information Bit Payload                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |               |  |  |  |  |  |  |
| For slots with RMSI <sup>Note 2</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | bits  | 1608          |  |  |  |  |  |  |
| For slots without RMSI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | bits  | 1864          |  |  |  |  |  |  |
| Number of Code Blocks per slot                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       | 1             |  |  |  |  |  |  |
| Binary Channel Bits Per slot                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |       |               |  |  |  |  |  |  |
| For slots with RMSI <sup>Note 2, Note 4</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | bits  | 5184          |  |  |  |  |  |  |
| For slots without RMSI <sup>Note 6</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | bits  | 6048          |  |  |  |  |  |  |
| <p>Note 1: Allocated outside the SMTC duration in time and in resource blocks which do not overlap with the resource blocks allocated for SS/PBCH block.</p> <p>Note 2: PDSCH is scheduled on the slots with RMSI.</p> <p>Note 3: If necessary the information bit payload size can be adjusted to facilitate the test implementation. The payload sizes are defined in TS 38.213 [3].</p> <p>Note 4: Derived based on the PDSCH DMRS assumption: dmrs-TypeA-Position=2, dmrs-Type=1, dmrs-AdditionalPositions=2, maxLength=1, Antenna port index: 1000, and Number of PDSCH DMRS CDM group(s) without data: 2.</p> <p>Note 5: PDSCH is not scheduled in slots containing SSB according to the SSB configuration used in the test. SSB configurations are defined in clause G.1.5.</p> <p>Note 6: Derived based on the PDSCH DMRS assumption: dmrs-TypeA-Position=2, dmrs-Type=1, dmrs-AdditionalPositions=2, maxLength=1, Antenna port index: 1000, and Number of PDSCH DMRS CDM group(s) without data: 1.</p> |       |               |  |  |  |  |  |  |

**Table G.1.1.1.1-3: PDSCH Reference Measurement Channels for SCS=120kHz**

| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Unit  | Value         |  |  |  |  |  |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|---------------|--|--|--|--|--|--|
| Reference channel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       | SR.3.1<br>TDD |  |  |  |  |  |  |
| Channel bandwidth                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | MHz   | 100           |  |  |  |  |  |  |
| Number of transmitter antennas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       | 1             |  |  |  |  |  |  |
| Allocated resource blocks for PDSCH <sup>Note 1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       | 24            |  |  |  |  |  |  |
| Allocated slots per Radio Frame                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |               |  |  |  |  |  |  |
| Radio frame containing SSB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | slots | Note 5        |  |  |  |  |  |  |
| Radio frame not containing SSB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | slots | 48            |  |  |  |  |  |  |
| MCS table                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       | 64QAM         |  |  |  |  |  |  |
| MCS index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       | 4             |  |  |  |  |  |  |
| Modulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       | QPSK          |  |  |  |  |  |  |
| Target Coding Rate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |       | 1/3           |  |  |  |  |  |  |
| Number of control symbols                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       | 2             |  |  |  |  |  |  |
| PDSCH mapping type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |       | Type A        |  |  |  |  |  |  |
| Information Bit Payload                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |       |               |  |  |  |  |  |  |
| For slots with RMSI <sup>Note 2</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | bits  | 1608          |  |  |  |  |  |  |
| For slots without RMSI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | bits  | 1864          |  |  |  |  |  |  |
| Number of Code Blocks per slot                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       | 1             |  |  |  |  |  |  |
| Binary Channel Bits Per slot                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |               |  |  |  |  |  |  |
| For slots with RMSI <sup>Note 2, Note 4</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | bits  | 5184          |  |  |  |  |  |  |
| For slots without RMSI <sup>Note 6</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | bits  | 6048          |  |  |  |  |  |  |
| <p>Note 1: Allocated outside the SMTC duration in time and in resource blocks which do not overlap with the resource blocks allocated for SS/PBCH block</p> <p>Note 2: PDSCH is scheduled on the slots with RMSI.</p> <p>Note 3: If necessary the information bit payload size can be adjusted to facilitate the test implementation. The payload sizes are defined in TS 38.213 [3].</p> <p>Note 4: Derived based on the PDSCH DMRS assumption: dmrs-TypeA-Position=2, dmrs-Type=1, dmrs-AdditionalPositions=2, maxLength=1, Antenna port index: 1000, and Number of PDSCH DMRS CDM group(s) without data: 2.</p> <p>Note 5: PDSCH is not scheduled in slots containing SSB according to the SSB configuration used in the test. SSB configurations are defined in clause G.1.5.</p> <p>Note 6: Derived based on the PDSCH DMRS assumption: dmrs-TypeA-Position=2, dmrs-Type=1, dmrs-AdditionalPositions=2, maxLength=1, Antenna port index: 1000, and Number of PDSCH DMRS CDM group(s) without data: 1.</p> |       |               |  |  |  |  |  |  |

## G.1.1.1.2 FDD

Table G.1.1.1.2-1: PDSCH Reference Measurement Channels for SCS=15kHz

| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Unit  | Value         |  |  |  |  |  |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|---------------|--|--|--|--|--|--|
| Reference channel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       | SR.1.1<br>FDD |  |  |  |  |  |  |
| Channel bandwidth                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | MHz   | 10            |  |  |  |  |  |  |
| Number of transmitter antennas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       | 1             |  |  |  |  |  |  |
| Allocated resource blocks for PDSCH <sup>Note 1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       | 24            |  |  |  |  |  |  |
| Allocated slots per Radio Frame                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       | 10            |  |  |  |  |  |  |
| Radio frame containing SSB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | slots | Note 5        |  |  |  |  |  |  |
| Radio frame not containing SSB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | slots | 10            |  |  |  |  |  |  |
| MCS index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |       | 4             |  |  |  |  |  |  |
| Modulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       | QPSK          |  |  |  |  |  |  |
| Target Coding Rate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       | 1/3           |  |  |  |  |  |  |
| Number of control symbols                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |       | 2             |  |  |  |  |  |  |
| PDSCH mapping type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       | Type A        |  |  |  |  |  |  |
| Information Bit Payload                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |               |  |  |  |  |  |  |
| For slots with RMSI <sup>Note 2</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | bits  | 1864          |  |  |  |  |  |  |
| Number of Code Blocks per slot                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       | 1             |  |  |  |  |  |  |
| Binary Channel Bits Per slot                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |               |  |  |  |  |  |  |
| For slots with RMSI <sup>Note 2, Note 4</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | bits  | 6048          |  |  |  |  |  |  |
| <p>Note 1: Allocated outside the SMTC duration in time and in resource blocks which do not overlap with the resource blocks allocated for SS/PBCH block.</p> <p>Note 2: PDSCH is scheduled on the slots with RMSI.</p> <p>Note 3: If necessary the information bit payload size can be adjusted to facilitate the test implementation. The payload sizes are defined in TS 38.213 [3].</p> <p>Note 4: Derived based on the PDSCH DMRS assumption: dmrs-TypeA-Position=2, dmrs-Type=1, dmrs-AdditionalPositions=2, maxLength=1, Antenna port index: 1000, and Number of PDSCH DMRS CDM group(s) without data: 1.</p> <p>Note 5: PDSCH is not scheduled in slots containing SSB according to the SSB configuration used in the test. SSB configurations are defined in clause A.3.10.</p> |       |               |  |  |  |  |  |  |

## G.1.1.2 CORESET for RMSI scheduling

### G.1.1.2.1 TDD

**Table G.1.1.2.1-1: RMSI CORESET Reference Channel for TDD with SCS=15KHz**

| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Unit    | Value         |  |  |  |  |  |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------------|--|--|--|--|--|--|
| Reference channel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |         | CR.1.1<br>TDD |  |  |  |  |  |  |
| Channel bandwidth                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | MHz     | 10            |  |  |  |  |  |  |
| Subcarrier spacing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | kHz     | 15            |  |  |  |  |  |  |
| Allocated resource blocks<br>for RMSI CORESET <small>Note 7</small>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |         | 24            |  |  |  |  |  |  |
| SSB and RMSI CORESET<br>multiplexing configuration<br><small>Note 7</small>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |         | Pattern 1     |  |  |  |  |  |  |
| Offset between SSB and<br>RMSI CORESET <small>Note 3, 7</small>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | RB      | 0 (Note 8)    |  |  |  |  |  |  |
| Configuration of PDCCH<br>monitoring occasions for<br>RMSI CORESET <small>Note 4</small>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         | Index 4       |  |  |  |  |  |  |
| Number of transmitter<br>antennas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |         | 1             |  |  |  |  |  |  |
| Duration of RMSI<br>CORESET <small>Note 7</small>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | symbols | 2             |  |  |  |  |  |  |
| DCI Format <small>Note 1</small>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |         | Note 2        |  |  |  |  |  |  |
| Aggregation level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | CCE     | 8             |  |  |  |  |  |  |
| DMRS precoder<br>granularity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         | 6             |  |  |  |  |  |  |
| REG bundle size                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         | 6             |  |  |  |  |  |  |
| Mapping from REG to<br>CCE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         | Distributed   |  |  |  |  |  |  |
| Cell ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |         | Note 5        |  |  |  |  |  |  |
| Payload (without CRC)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | bits    | Note 6        |  |  |  |  |  |  |
| <p>Note 1: DCI formats are defined in TS 38.212.</p> <p>Note 2: DCI format shall depend upon the test configuration.</p> <p>Note 3: The offset is defined with respect to the subcarrier spacing of the CORESET from the smallest RB index of RMSI CORESET to the smallest RB index of the common RB overlapping with the first RB of the SS/PBCH block.</p> <p>Note 4: The configuration of PDCCH monitoring occasions for RMSI CORESET is defined in Table 13-11 in TS 38.213 [3].</p> <p>Note 5: Cell ID shall depend upon the test configuration.</p> <p>Note 6: Payload size shall depend upon the test configuration.</p> <p>Note 7: The configuration of set of resource blocks and slot symbols of control resource set for Type0-PDCCH search space corresponds to index 0 in Table 13-1 in TS 38.213 [3].</p> <p>Note 8: Other values can be used to align with GSCN [13] as long as SSB does not overlap the RMC.</p> |         |               |  |  |  |  |  |  |

**Table G.1.1.2.1-2: RMSI CORESET Reference Channel for TDD with SCS=30KHz**

| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Unit    | Value         |  |  |  |  |  |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------------|--|--|--|--|--|--|
| Reference channel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |         | CR.2.1<br>TDD |  |  |  |  |  |  |
| Channel bandwidth                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | MHz     | 40            |  |  |  |  |  |  |
| Subcarrier spacing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | kHz     | 30            |  |  |  |  |  |  |
| Allocated resource blocks<br>for RMSI CORESET <sup>Note 7</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         | 24            |  |  |  |  |  |  |
| SSB and RMSI CORESET<br>multiplexing configuration<br><sup>Note 7</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |         | Pattern 1     |  |  |  |  |  |  |
| Offset between SSB and<br>RMSI CORESET <sup>Note 3, 7</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | RB      | 0 (Note 8)    |  |  |  |  |  |  |
| Configuration of PDCCH<br>monitoring occasions for<br>RMSI CORESET <sup>Note 4</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         | Index 4       |  |  |  |  |  |  |
| Number of transmitter<br>antennas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |         | 1             |  |  |  |  |  |  |
| Duration of RMSI<br>CORESET <sup>Note 7</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | symbols | 2             |  |  |  |  |  |  |
| DCI Format <sup>Note 1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         | Note 2        |  |  |  |  |  |  |
| Aggregation level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | CCE     | 8             |  |  |  |  |  |  |
| DMRS precoder<br>granularity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         | 6             |  |  |  |  |  |  |
| REG bundle size                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         | 6             |  |  |  |  |  |  |
| Mapping from REG to<br>CCE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         | Distributed   |  |  |  |  |  |  |
| Cell ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |         | Note 5        |  |  |  |  |  |  |
| Payload (without CRC)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | bits    | Note 6        |  |  |  |  |  |  |
| <p>Note 1: DCI formats are defined in TS 38.212.</p> <p>Note 2: DCI format shall depend upon the test configuration.</p> <p>Note 3: The offset is defined with respect to the subcarrier spacing of the CORESET from the smallest RB index of RMSI CORESET to the smallest RB index of the common RB overlapping with the first RB of the SS/PBCH block.</p> <p>Note 4: The configuration of PDCCH monitoring occasions for RMSI CORESET is defined in Table 13-11 in TS 38.213 [3].</p> <p>Note 5: Cell ID shall depend upon the test configuration.</p> <p>Note 6: Payload size shall depend upon the test configuration.</p> <p>Note 7: The configuration of set of resource blocks and slot symbols of control resource set for Type0-PDCCH search space corresponds to index 0 in Table 13-6 in TS 38.213 [3].</p> <p>Note 8: Other values can be used to align with GSCN [13] as long as SSB does not overlap the RMC.</p> |         |               |  |  |  |  |  |  |

**Table G.1.1.2.1-3: RMSI CORESET Reference Channel for TDD with SCS=120KHz**

| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Unit    | Value         |  |  |  |  |  |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------------|--|--|--|--|--|--|
| Reference channel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |         | CR.3.1<br>TDD |  |  |  |  |  |  |
| Channel bandwidth                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | MHz     | 100           |  |  |  |  |  |  |
| Subcarrier spacing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | kHz     | 120           |  |  |  |  |  |  |
| Allocated resource blocks<br>for RMSI CORESET <sup>Note 7</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         | 24            |  |  |  |  |  |  |
| SSB and RMSI CORESET<br>multiplexing configuration<br><sup>Note 7</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |         | Pattern 1     |  |  |  |  |  |  |
| Offset between SSB and<br>RMSI CORESET <sup>Note 3, 7</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | RB      | 0 (Note 8)    |  |  |  |  |  |  |
| Configuration of PDCCH<br>monitoring occasions for<br>RMSI CORESET <sup>Note 4</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         | Index 4       |  |  |  |  |  |  |
| Number of transmitter<br>antennas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |         | 1             |  |  |  |  |  |  |
| Duration of RMSI<br>CORESET <sup>Note 7</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | symbols | 2             |  |  |  |  |  |  |
| DCI Format <sup>Note 1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         | Note 2        |  |  |  |  |  |  |
| Aggregation level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | CCE     | 8             |  |  |  |  |  |  |
| DMRS precoder<br>granularity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |         | 6             |  |  |  |  |  |  |
| REG bundle size                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         | 6             |  |  |  |  |  |  |
| Mapping from REG to<br>CCE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         | Distributed   |  |  |  |  |  |  |
| Cell ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |         | Note 5        |  |  |  |  |  |  |
| Payload (without CRC)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | bits    | Note 6        |  |  |  |  |  |  |
| <p>Note 1: DCI formats are defined in TS 38.212.</p> <p>Note 2: DCI format shall depend upon the test configuration.</p> <p>Note 3: The offset is defined with respect to the subcarrier spacing of the CORESET from the smallest RB index of RMSI CORESET to the smallest RB index of the common RB overlapping with the first RB of the SS/PBCH block.</p> <p>Note 4: The configuration of PDCCH monitoring occasions for RMSI CORESET is defined in Table 13-12 in TS 38.213 [3].</p> <p>Note 5: Cell ID shall depend upon the test configuration.</p> <p>Note 6: Payload size shall depend upon the test configuration.</p> <p>Note 7: The configuration of set of resource blocks and slot symbols of control resource set for Type0-PDCCH search space corresponds to index 0 in Table 13-8 in TS 38.213 [3].</p> <p>Note 8: Other values can be used to align with GSCN [13] as long as SSB does not overlap the RMC.</p> |         |               |  |  |  |  |  |  |

## G.1.1.2.2 FDD

Table G.1.1.2.2-1: RMSI CORESET Reference Channel for FDD with SCS=15KHz

| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Unit    | Value         |  |  |  |  |  |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------------|--|--|--|--|--|--|
| Reference channel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |         | CR.1.1<br>FDD |  |  |  |  |  |  |
| Channel bandwidth                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | MHz     | 10            |  |  |  |  |  |  |
| Subcarrier spacing for RMSI CORESET                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | kHz     | 15            |  |  |  |  |  |  |
| Allocated resource blocks for RMSI CORESET <sup>Note 7</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |         | 24            |  |  |  |  |  |  |
| Subcarrier spacing for SSB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | kHz     | 15            |  |  |  |  |  |  |
| SSB and RMSI CORESET multiplexing configuration <sup>Note 7</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |         | Pattern 1     |  |  |  |  |  |  |
| Offset between SSB and RMSI CORESET <sup>Note 3, 7</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | RB      | 0 (Note8)     |  |  |  |  |  |  |
| Configuration of PDCCH monitoring occasions for RMSI CORESET <sup>Note 4</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         | Index 4       |  |  |  |  |  |  |
| Number of transmitter antennas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |         | 1             |  |  |  |  |  |  |
| Duration of RMSI CORESET <sup>Note 7</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | symbols | 2             |  |  |  |  |  |  |
| DCI Format <sup>Note 1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |         | Note 2        |  |  |  |  |  |  |
| Aggregation level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | CCE     | 8             |  |  |  |  |  |  |
| DMRS precoder granularity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |         | 6             |  |  |  |  |  |  |
| REG bundle size                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |         | 6             |  |  |  |  |  |  |
| Mapping from REG to CCE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         | Distributed   |  |  |  |  |  |  |
| Cell ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         | Note 5        |  |  |  |  |  |  |
| Payload (without CRC)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | bits    | Note 6        |  |  |  |  |  |  |
| <p>Note 1: DCI formats are defined in TS 38.212.</p> <p>Note 2: DCI format shall depend upon the test configuration.</p> <p>Note 3: The offset is defined with respect to the subcarrier spacing of the CORESET from the smallest RB index of RMSI CORESET to the smallest RB index of the common RB overlapping with the first RB of the SS/PBCH block.</p> <p>Note 4: The configuration of PDCCH monitoring occasions for RMSI CORESET is defined in Table 13-11 in TS 38.213 [3].</p> <p>Note 5: Cell ID shall depend upon the test configuration.</p> <p>Note 6: Payload size shall depend upon the test configuration.</p> <p>Note 7: The configuration of set of resource blocks and slot symbols of control resource set for Type0-PDCCH search space corresponds to index 0 in Table 13-1 in TS 38.213 [3]</p> <p>Note 8: Other values can be used to align with GSCN [13] as long as SSB does not overlap the RMC.</p> |         |               |  |  |  |  |  |  |

### G.1.1.3 CORESET for RMC scheduling

#### G.1.1.3.1 TDD

**Table G.1.1.3.1-1: Control Channel RMC for TDD with SCS=15KHz**

| Parameter                                                                       | Unit    | Value                            |                                  |  |  |  |  |  |
|---------------------------------------------------------------------------------|---------|----------------------------------|----------------------------------|--|--|--|--|--|
| Reference channel                                                               |         | CCR.1.1<br>TDD                   | CCR.1.2<br>TDD                   |  |  |  |  |  |
| Subcarrier spacing                                                              | kHz     | 15                               | 15                               |  |  |  |  |  |
| Allocated resource blocks<br>for CORESET <small>Note 3</small>                  |         | 24                               | 18                               |  |  |  |  |  |
| Number of transmitter<br>antennas                                               |         | 1                                | 1                                |  |  |  |  |  |
| Duration of CORESET                                                             | symbols | 2                                | 2                                |  |  |  |  |  |
| REG bundle size                                                                 |         | 6                                | 6                                |  |  |  |  |  |
| DMRS precoder<br>granularity                                                    |         | Same as<br>REG<br>bundle<br>size | Same as<br>REG<br>bundle<br>size |  |  |  |  |  |
| CCE to REG mapping                                                              |         | Interleaved                      | Interleaved                      |  |  |  |  |  |
| Interleave n <sub>shift</sub>                                                   |         | 0                                | 0                                |  |  |  |  |  |
| Interleave size                                                                 |         | 2                                | 2                                |  |  |  |  |  |
| Beamforming Pre-Coder                                                           |         | N/A                              | N/A                              |  |  |  |  |  |
| Aggregation level                                                               | CCE     | 8                                | 4                                |  |  |  |  |  |
| DCI formats                                                                     |         | Note 1                           | Note 1                           |  |  |  |  |  |
| Payload size (without<br>CRC)                                                   | bits    | Note 2                           | Note 2                           |  |  |  |  |  |
| Note 1: DCI format shall depend upon the test configuration.                    |         |                                  |                                  |  |  |  |  |  |
| Note 2: Payload size shall depend upon the test configuration                   |         |                                  |                                  |  |  |  |  |  |
| Note 3: Allocated in the resource blocks where the associated RMC is scheduled. |         |                                  |                                  |  |  |  |  |  |

**Table G.1.1.3.1-2: Control Channel RMC for TDD with SCS=30KHz**

| Parameter                                                                            | Unit    | Value                            |  |  |  |  |  |  |
|--------------------------------------------------------------------------------------|---------|----------------------------------|--|--|--|--|--|--|
| Reference channel                                                                    |         | CCR.2.1<br>TDD                   |  |  |  |  |  |  |
| Subcarrier spacing                                                                   | kHz     | 30                               |  |  |  |  |  |  |
| Allocated resource blocks<br>for CORESET <small>Note 3</small>                       |         | 24                               |  |  |  |  |  |  |
| Number of transmitter<br>antennas                                                    |         | 1                                |  |  |  |  |  |  |
| Duration of CORESET                                                                  | symbols | 2                                |  |  |  |  |  |  |
| REG bundle size                                                                      |         | 6                                |  |  |  |  |  |  |
| DMRS precoder<br>granularity                                                         |         | Same as<br>REG<br>bundle<br>size |  |  |  |  |  |  |
| CCE to REG mapping                                                                   |         | Interleaved                      |  |  |  |  |  |  |
| Interleave n <sub>shift</sub>                                                        |         | 0                                |  |  |  |  |  |  |
| Interleave size                                                                      |         | 2                                |  |  |  |  |  |  |
| Beamforming Pre-Coder                                                                |         | N/A                              |  |  |  |  |  |  |
| Aggregation level                                                                    | CCE     | 8                                |  |  |  |  |  |  |
| DCI formats                                                                          |         | Note 1                           |  |  |  |  |  |  |
| Payload size (without<br>CRC)                                                        | bits    | Note 2                           |  |  |  |  |  |  |
| Note 1: DCI format shall depend upon the test configuration.                         |         |                                  |  |  |  |  |  |  |
| Note 2: Payload size shall depend upon the test configuration.                       |         |                                  |  |  |  |  |  |  |
| Note 3: Allocated in the same resource blocks where the associated RMC is scheduled. |         |                                  |  |  |  |  |  |  |

**Table G.1.1.3.1-3: Control Channel RMC for TDD with SCS=120KHz**

| Parameter                                                                                  | Unit | Value                            |                                  |                                  |  |  |  |  |
|--------------------------------------------------------------------------------------------|------|----------------------------------|----------------------------------|----------------------------------|--|--|--|--|
| Reference channel                                                                          |      | CCR.3.1<br>TDD                   | CCR.3.2<br>TDD                   | CCR.3.3<br>TDD                   |  |  |  |  |
| Subcarrier spacing                                                                         | kHz  | 120                              | 120                              | 120                              |  |  |  |  |
| Allocated resource blocks for<br>CORESET <small>Note 3</small>                             |      | 24                               | 24                               | 24                               |  |  |  |  |
| Number of transmitter antennas                                                             |      | 1                                | 1                                | 1                                |  |  |  |  |
| monitoringSlotPeriodicityAndOffset                                                         |      | sl160<br>0                       | sl160<br>0                       | sl160<br>80                      |  |  |  |  |
| monitoringSymbolsWithinSlot                                                                |      | 1100000<br>0000000               | 0011000<br>0000000               | 1100000<br>0000000               |  |  |  |  |
| Duration of CORESET                                                                        | slot | 1                                | 1                                | 1                                |  |  |  |  |
| REG bundle size                                                                            |      | 6                                | 6                                | 6                                |  |  |  |  |
| DMRS precoder granularity                                                                  |      | Same as<br>REG<br>bundle<br>size | Same as<br>REG<br>bundle<br>size | Same as<br>REG<br>bundle<br>size |  |  |  |  |
| CCE to REG mapping                                                                         |      | Interleaved                      | Interleaved                      | Interleaved                      |  |  |  |  |
| Interleave n <sub>shift</sub>                                                              |      | 0                                | 0                                | 0                                |  |  |  |  |
| Interleave size                                                                            |      | 2                                | 2                                | 2                                |  |  |  |  |
| Beamforming Pre-Coder                                                                      |      | N/A                              | N/A                              | N/A                              |  |  |  |  |
| Aggregation level                                                                          | CCE  | 8                                | 8                                | 8                                |  |  |  |  |
| DCI formats                                                                                |      | Note 1                           | Note 1                           | Note 1                           |  |  |  |  |
| Payload size (without CRC)                                                                 | bits | Note 2                           | Note 2                           | Note 2                           |  |  |  |  |
| Note 1: DCI format shall depend upon the test configuration.                               |      |                                  |                                  |                                  |  |  |  |  |
| Note 2: Payload size shall depend upon the test configuration.                             |      |                                  |                                  |                                  |  |  |  |  |
| Note 3: Allocated in the same resource blocks where the associated PDSCH RMC is scheduled. |      |                                  |                                  |                                  |  |  |  |  |

**G.1.1.3.2 FDD****Table G.1.1.3.2-1: Control Channel RMC for FDD with SCS=15KHz**

| Parameter                                                                       | Unit    | Value                         |                               |  |  |  |  |  |
|---------------------------------------------------------------------------------|---------|-------------------------------|-------------------------------|--|--|--|--|--|
| Reference channel                                                               |         | CCR.1.1<br>FDD                | CCR.1.2<br>FDD                |  |  |  |  |  |
| Channel bandwidth                                                               | MHz     | 10                            | 10                            |  |  |  |  |  |
| Subcarrier spacing                                                              | kHz     | 15                            | 15                            |  |  |  |  |  |
| Allocated resource<br>blocks for CORESET<br><small>Note 3</small>               |         | 24                            | 18                            |  |  |  |  |  |
| Number of transmitter<br>antennas                                               |         | 1                             | 1                             |  |  |  |  |  |
| Duration of CORESET                                                             | symbols | 2                             | 2                             |  |  |  |  |  |
| REG bundle size                                                                 |         | 6                             | 6                             |  |  |  |  |  |
| DMRS precoder<br>granularity                                                    |         | Same as<br>REG<br>bundle size | Same as<br>REG<br>bundle size |  |  |  |  |  |
| CCE to REG mapping                                                              |         | Interleaved                   | Interleaved                   |  |  |  |  |  |
| Interleave n <sub>shift</sub>                                                   |         | 0                             | 0                             |  |  |  |  |  |
| Interleave size                                                                 |         | 2                             | 2                             |  |  |  |  |  |
| Beamforming Pre-<br>Coder                                                       |         | N/A                           | N/A                           |  |  |  |  |  |
| Aggregation level                                                               | CCE     | 4                             | 2                             |  |  |  |  |  |
| DCI formats                                                                     |         | Note 1                        | Note 1                        |  |  |  |  |  |
| Payload size (without<br>CRC)                                                   | bits    | Note 2                        | Note 2                        |  |  |  |  |  |
| Note 1: DCI format shall depend upon the test configuration.                    |         |                               |                               |  |  |  |  |  |
| Note 2: Payload size shall depend upon the test configuration                   |         |                               |                               |  |  |  |  |  |
| Note 3: Allocated in the resource blocks where the associated RMC is scheduled. |         |                               |                               |  |  |  |  |  |

## G.1.2 OFDMA channel noise generator (OCNG)

### G.1.2.1 Generic OFDMA Channel Noise Generator (OCNG)

The OCNG pattern is used in a test for modelling allocations of unused resources in the channel bandwidth to virtual NCR-MTs (which are not under test). The OCNG pattern comprises PDCCH and PDSCH transmissions to the virtual NCR-MTs.

#### G.1.2.1.1 OCNG pattern 1: Generic OCNG pattern for all unused REs

**Table G.1.2.1.1-1: OP.1: Generic OCNG pattern for all unused REs**

| OCNG Parameters                                                                                                                          | Control Region            | Data Region                                    |
|------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|------------------------------------------------|
| Resource allocation                                                                                                                      | Unused REs (Note 1)       | Unused REs (Note 2)                            |
| Channel                                                                                                                                  | PDCCH                     | PDSCH                                          |
| Contents                                                                                                                                 | Virtual NCR-MT IDs        | Uncorrelated pseudo random QPSK modulated data |
| Antenna transmission scheme                                                                                                              | Same as used in PDCCH RMC | Same as used in PDSCH RMC                      |
| Subcarrier spacing                                                                                                                       | Same as used in PDCCH RMC | Same as used in PDSCH RMC                      |
| Aggregation level                                                                                                                        | Same as used in PDCCH RMC | N/A                                            |
| Code rate                                                                                                                                | Same as used in PDCCH RMC | Same as used in PDSCH RMC                      |
| Transmit Power                                                                                                                           | Same as used in PDCCH RMC | Same as used in PDSCH RMC                      |
| CP length                                                                                                                                | Same as used in PDCCH RMC | Same as used in PDSCH RMC                      |
| Note 1: REs not used in the active CORESETs where PDCCH is scheduled for the NCR-MT under test.                                          |                           |                                                |
| Note 2: REs not allocated to any physical channels, CORESET, SSB or any other reference signal within the channel bandwidth of the cell. |                           |                                                |

#### G.1.2.1.2 OCNG pattern 2: Generic OCNG pattern for all unused REs for 2AoA setup

**Table G.1.2.1.2-1: OP.2: Generic OCNG pattern for all unused REs for 2AoA setup**

| OCNG Parameters                                                                                                                          | Control Region                                                                                                                       | Data Region                                                                                                                          |
|------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Probe                                                                                                                                    | Transmitting the serving beam                                                                                                        |                                                                                                                                      |
| Resource allocation                                                                                                                      | Unused REs (Note 1) in the symbols where SSB/CSI-RS are not transmitted from both the serving beam probe and non-serving beam probe. | Unused REs (Note 2) in the symbols where SSB/CSI-RS are not transmitted from both the serving beam probe and non-serving beam probe. |
| Channel                                                                                                                                  | PDCCH                                                                                                                                | PDSCH                                                                                                                                |
| Contents                                                                                                                                 | Virtual NCR-MT IDs                                                                                                                   | Uncorrelated pseudo random QPSK modulated data                                                                                       |
| Antenna transmission scheme                                                                                                              | Same as used in PDCCH RMC                                                                                                            | Same as used in PDSCH RMC                                                                                                            |
| Subcarrier spacing                                                                                                                       | Same as used in PDCCH RMC                                                                                                            | Same as used in PDSCH RMC                                                                                                            |
| Aggregation level                                                                                                                        | Same as used in PDCCH RMC                                                                                                            | N/A                                                                                                                                  |
| Code rate                                                                                                                                | Same as used in PDCCH RMC                                                                                                            | Same as used in PDSCH RMC                                                                                                            |
| Transmit Power                                                                                                                           | Same as used in PDCCH RMC                                                                                                            | Same as used in PDSCH RMC                                                                                                            |
| CP length                                                                                                                                | Same as used in PDCCH RMC                                                                                                            | Same as used in PDSCH RMC                                                                                                            |
| Note 1: REs not used in the active CORESETs where PDCCH is scheduled for the NCR-MT under test.                                          |                                                                                                                                      |                                                                                                                                      |
| Note 2: REs not allocated to any physical channels, CORESET, SSB or any other reference signal within the channel bandwidth of the cell. |                                                                                                                                      |                                                                                                                                      |
| Note 3: No OCNG is transmitted from the probe transmitting non-serving beam.                                                             |                                                                                                                                      |                                                                                                                                      |

### G.1.2.1.3 OCNG pattern 3: Generic OCNG pattern for unused REs in the same bandwidth as PDSCH RMC

**Table G.1.2.1.3-1: OP.3: Generic OCNG pattern for unused REs in the same BW as RMC**

| OCNG Parameters                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Control Region            | Data Region                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|------------------------------------------------|
| Resource allocation                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Unused REs (Note 1)       | Unused REs (Note 2)                            |
| Channel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | PDCCH                     | PDSCH                                          |
| Contents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Virtual NCR-MT IDs        | Uncorrelated pseudo random QPSK modulated data |
| Antenna transmission scheme                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Same as used in PDCCH RMC | Same as used in PDSCH RMC                      |
| Subcarrier spacing                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Same as used in PDCCH RMC | Same as used in PDSCH RMC                      |
| Aggregation level                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Same as used in PDCCH RMC | N/A                                            |
| Code rate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Same as used in PDCCH RMC | Same as used in PDSCH RMC                      |
| Transmit Power                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Same as used in PDCCH RMC | Same as used in PDSCH RMC                      |
| CP length                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Same as used in PDCCH RMC | Same as used in PDSCH RMC                      |
| Note 1: REs not used in the active CORESETs where PDCCH is scheduled for the NCR-MT under test. REs for OCNG shall not be allocated outside the allocated bandwidth of the PDSCH RMC of the serving cell.<br>Note 2: REs not allocated to any physical channels, CORESET, SSB or any other reference signal within the allocated bandwidth of the PDSCH RMC of the serving cell. REs for OCNG shall not be allocated outside the allocated bandwidth of the PDSCH RMC of the serving cell. |                           |                                                |

### G.1.2.1.4 OCNG pattern 4: Generic OCNG pattern for all unused REs outside SSB slot(s)

**Table G.1.2.1.4-1: OP.4: Generic OCNG pattern for all unused REs outside SSB slot(s)**

| OCNG Parameters                                                                                                                                                                                                                                                                                                                                                                                                                 | Control Region            | Data Region                                    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|------------------------------------------------|
| Resource allocation                                                                                                                                                                                                                                                                                                                                                                                                             | Unused REs (Note 1)       | Unused REs (Note 2)                            |
| Channel                                                                                                                                                                                                                                                                                                                                                                                                                         | PDCCH                     | PDSCH                                          |
| Contents                                                                                                                                                                                                                                                                                                                                                                                                                        | Virtual NCR-MT IDs        | Uncorrelated pseudo random QPSK modulated data |
| Antenna transmission scheme                                                                                                                                                                                                                                                                                                                                                                                                     | Same as used in PDCCH RMC | Same as used in PDSCH RMC                      |
| Subcarrier spacing                                                                                                                                                                                                                                                                                                                                                                                                              | Same as used in PDCCH RMC | Same as used in PDSCH RMC                      |
| Aggregation level                                                                                                                                                                                                                                                                                                                                                                                                               | Same as used in PDCCH RMC | N/A                                            |
| Code rate                                                                                                                                                                                                                                                                                                                                                                                                                       | Same as used in PDCCH RMC | Same as used in PDSCH RMC                      |
| Transmit Power                                                                                                                                                                                                                                                                                                                                                                                                                  | Same as used in PDCCH RMC | Same as used in PDSCH RMC                      |
| CP length                                                                                                                                                                                                                                                                                                                                                                                                                       | Same as used in PDCCH RMC | Same as used in PDSCH RMC                      |
| Note 1: REs not used in the active CORESETs where PDCCH is scheduled for the NCR-MT under test. REs for OCNG shall not be allocated in the slot(s) containing SSB of the respective cell.<br>Note 2: REs not allocated to any physical channels, CORESET, SSB or any other reference signal within the channel bandwidth of the cell. REs for OCNG shall not be allocated in the slot(s) containing SSB of the respective cell. |                           |                                                |

## G.1.3 Antenna configurations

### G.1.3.1 Antenna configurations for FR1

Unless otherwise specified, NR TDD cells in all RRM Test cases in AWGN propagation condition are configured with Antenna Configuration [1x2].

#### G.1.3.1.1 Antenna connection for 4 Rx capable NCR-MT

##### G.1.3.1.1.1 Introduction

All tests for FR1 are specified for NCR-MTs supporting 2RX. In this clause, the antenna connection method for applying 2RX tests to NCR-MTs supporting 4RX antenna ports is specified. No tests are currently specified for FR1

which are applicable only to 4RX antenna ports, so 4RX capable NCR-MTs are always tested by reusing tests which were originally specified for 2RX NCR-MTs.

### G.1.3.1.1.2 Principle of testing

#### G.1.3.1.1.2.1 Single carrier tests

For 4RX capable NCR-MTs supporting at least one 2RX band, the, all single carrier tests specified for FR1 except those in G.2.3 shall be tested on any band where 2RX is supported with the antenna connection specified in clause G.1.3.1.1.2.2.

For 4RX capable NCR-MT which do not support any 2RX band, all tests specified for FR1 shall be tested using the antenna connection specified in clause G.1.3.1.1.2.3. For radio link monitoring tests, the SNR levels are modified according to table G.1.3.1.1.2.1-1 and table G.1.3.1.1.2.1-2. For beam failure detection and link recovery tests, the SNR levels are modified according to table G.1.3.1.1.2.1-3.

**Table G.1.3.1.1.2.1-1: Modified parameters for RLM out of sync testing with 4 RX antenna connection**

| Test case | SNR during T3 (dB) |        |        |        |
|-----------|--------------------|--------|--------|--------|
|           | Test 1             | Test 2 | Test 3 | Test 4 |
| G.2.3.1.1 | -18                | N/A    | N/A    | N/A    |
| G.2.3.1.3 | -18                | N/A    | N/A    | N/A    |
| G.2.3.1.5 | -18                | N/A    | N/A    | N/A    |
| G.2.3.1.7 | -18                | N/A    | N/A    | N/A    |

**Table G.1.3.1.1.2.1-2: Modified parameters for RLM in sync single carrier testing with 4 RX antenna connection**

| Test case | SNR during T3 (dB) |        | SNR during T4 (dB) |        |
|-----------|--------------------|--------|--------------------|--------|
|           | Test 1             | Test 2 | Test 1             | Test 2 |
| G.2.3.1.2 | -18                | N/A    | -8                 | N/A    |
| G.2.3.1.4 | -18                | N/A    | -8                 | N/A    |
| G.2.3.1.6 | -18                | N/A    | -8                 | N/A    |
| G.2.3.1.8 | -18                | N/A    | -8                 | N/A    |

**Table G.1.3.1.1.2.1-3: Modified parameters for Beam Failure Detection and Link Recovery testing with 4 RX antenna connection**

| Test case | SNR for RS in set $q_0$ during T3, T4 and T5 (dB) |
|-----------|---------------------------------------------------|
|           | Test 1                                            |
| G.2.3.2.1 | -15                                               |
| G.2.3.2.2 | -15                                               |
| G.2.3.2.3 | -15                                               |
| G.2.3.2.4 | -15                                               |

#### G.1.3.1.1.2.2 Antenna connection for bands where 2RX is supported

For bands where 2RX is supported, it is left to declaration and AP configuration to decide which 2 of the 4 Rx ports are connected with data source from tester. The remaining 2 Rx ports shall be connected with zero input. No test parameters or requirements are modified.

#### G.1.3.1.1.2.3 Antenna connection for bands where 4RX is supported

For bands where 4RX is supported, all 4 RX antennas are connected with data source from tester. The Tester provide independent noise and fading (low correlation) for each antenna port. Except for the modifications to radio link monitoring thresholds described in clauses G.1.3.1.1.2.1 and G.1.3.1.1.2.2, no test parameters or requirements are modified.

### G.1.3.2 Antenna configurations for FR2

Unless otherwise specified, the default Downlink Antenna Configuration for NR FR2 cells is 1x2.

In case of Downlink Antenna Configuration 2x2 for NR FR2 cells, unless otherwise specified, the downlink signal is transmitted over the two polarizations (V and H) of the dual polarized antenna of the test equipment.

## G.1.4 BWP configurations

### G.1.4.1 Introduction

This clause provides the typical BWP configurations used for RRM test cases defined in Annex G. For downlink BWP, both initial BWP and dedicated BWP configurations are specified in clause G.1.4.2 and for uplink BWP, both initial BWP and dedicated BWP configurations are specified in clause G.1.4.3.

### G.1.4.2 Downlink BWP configurations

#### G.1.4.2.1 Initial BWP

**Table G.1.4.2.1-1: Downlink BWP patterns for initial BWP configuration**

| BWP Parameters                                                                                                                                                                                 | Unit | Values                                  |                                                        |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----------------------------------------|--------------------------------------------------------|--|
| Reference BWP                                                                                                                                                                                  |      | DLBWP.0.1                               | DLBWP.0.2                                              |  |
| Starting PRB index                                                                                                                                                                             |      | 0                                       | RB <sub>a</sub> <sup>Note 1</sup>                      |  |
| Bandwidth                                                                                                                                                                                      | RB   | Same as RF channel defined in each test | same as RMSI CORESET (CORESET #0) defined in each test |  |
| Note 1: RB <sub>a</sub> is the lowest PRB index to guarantee the BWP including SSB PRB index (RB <sub>J</sub> , RB <sub>J+1</sub> ,..., RB <sub>J+19</sub> ) which is defined in Clause G.1.5. |      |                                         |                                                        |  |

#### G.1.4.2.2 Dedicated BWP

**Table G.1.4.2.2-1: Downlink BWP patterns for dedicated BWP configuration**

| BWP Parameters                                                                                                                                                                                                 | Unit | Values                                  |                                                                   |                                                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----------------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------------|
| Reference BWP                                                                                                                                                                                                  |      | DLBWP.1.1                               | DLBWP.1.2                                                         | DLBWP.1.3                                                         |
| Starting PRB index                                                                                                                                                                                             |      | 0                                       | RB <sub>b</sub> <sup>Note 1</sup>                                 | RB <sub>a</sub> <sup>Note 2</sup>                                 |
| Bandwidth                                                                                                                                                                                                      | RB   | Same as RF channel defined in each test | 25 for SCS = 15KHz,<br>51 for SCS = 30KHz,<br>32 for SCS = 120KHz | 25 for SCS = 15KHz,<br>51 for SCS = 30KHz,<br>32 for SCS = 120KHz |
| Note 1: RB <sub>b</sub> is the lowest PRB index to guarantee the BWP not fully overlapped with SSB PRB index (RB <sub>J</sub> , RB <sub>J+1</sub> ,..., RB <sub>J+19</sub> ) which is defined in Clause G.1.5. |      |                                         |                                                                   |                                                                   |
| Note 2: RB <sub>a</sub> is the lowest PRB index to guarantee the BWP including SSB PRB index (RB <sub>J</sub> , RB <sub>J+1</sub> ,..., RB <sub>J+19</sub> ) which is defined in Clause G.1.5.                 |      |                                         |                                                                   |                                                                   |

### G.1.4.3 Uplink BWP configurations

#### G.1.4.3.1 Initial BWP

**Table G.1.4.3.1-1: Uplink BWP patterns for initial BWP configuration**

| BWP Parameters                                                                                    | Unit | Values                                  |                                                        |  |
|---------------------------------------------------------------------------------------------------|------|-----------------------------------------|--------------------------------------------------------|--|
| Reference BWP                                                                                     |      | ULBWP.0.1                               | ULBWP.0.2                                              |  |
| Starting PRB index                                                                                |      | 0                                       | RB <sub>a</sub> <sup>Note 1</sup>                      |  |
| Bandwidth                                                                                         | RB   | Same as RF channel defined in each test | same as RMSI CORESET (CORESET #0) defined in each test |  |
| Note 1: RB <sub>a</sub> is same as RB <sub>a</sub> for DLBWP.0.2 as defined in Table G.1.4.2.1-1. |      |                                         |                                                        |  |

#### G.1.4.3.2 Dedicated BWP

**Table G.1.4.3.2-1: Uplink BWP patterns for dedicated BWP configuration**

| BWP Parameters                                                                                    | Unit | Values                                  |                                                                   |                                                                   |
|---------------------------------------------------------------------------------------------------|------|-----------------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------------|
| Reference BWP                                                                                     |      | ULBWP.1.1                               | ULBWP.1.2                                                         | ULBWP.1.3                                                         |
| Starting PRB index                                                                                |      | 0                                       | RB <sub>b</sub> <sup>Note 1</sup>                                 | RB <sub>a</sub> <sup>Note 2</sup>                                 |
| Bandwidth                                                                                         | RB   | Same as RF channel defined in each test | 25 for SCS = 15KHz,<br>51 for SCS = 30KHz,<br>32 for SCS = 120KHz | 25 for SCS = 15KHz,<br>51 for SCS = 30KHz,<br>32 for SCS = 120KHz |
| Note 1: RB <sub>b</sub> is same as RB <sub>b</sub> for DLBWP.1.2 as defined in Table G.1.4.2.2-1. |      |                                         |                                                                   |                                                                   |
| Note 2: RB <sub>a</sub> is same as RB <sub>a</sub> for DLBWP.1.3 as defined in Table G.1.4.2.2-1. |      |                                         |                                                                   |                                                                   |

### G.1.5 SSB Configurations

#### G.1.5.1 SSB Configurations for FR1

##### G.1.5.1.1 SSB pattern 1 in FR1: SSB allocation for SSB SCS=15 kHz

**Table G.1.5.1.1-1: SSB.1 FR1: SSB Pattern 1 for SSB SCS=15 kHz in 10 MHz channel**

| SSB Parameters                                                                                                                                                           | Values                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| SSB SCS                                                                                                                                                                  | 15 kHz                                                                             |
| SSB periodicity (T <sub>SSB</sub> )                                                                                                                                      | 20 ms                                                                              |
| Number of SSBs per SS-burst                                                                                                                                              | 1                                                                                  |
| SS/PBCH block index                                                                                                                                                      | 0                                                                                  |
| Symbol numbers containing SSB <sup>Note 2</sup>                                                                                                                          | 2-5                                                                                |
| Slot numbers containing SSB <sup>Note 2</sup>                                                                                                                            | 0                                                                                  |
| SFN containing SSB                                                                                                                                                       | SFN mod<br>(max(T <sub>SSB</sub> ,10ms)/10ms) = 0                                  |
| RB numbers containing SSB within channel BW                                                                                                                              | (RB <sub>J</sub> , RB <sub>J+1</sub> , ..., RB <sub>J+19</sub> ) <sup>Note 1</sup> |
| Note 1: RBs containing SSB can be configured in any frequency location within the cell bandwidth according to the allowed synchronization raster defined in clause 5.4.3 |                                                                                    |
| Note 2: These values have been derived from other parameters for information purposes (as per TS 38.213 [3]). They are not settable parameters themselves.               |                                                                                    |

## G.1.5.1.2 SSB pattern 2 in FR1: SSB allocation for SSB SCS=30 kHz

Table G.1.5.1.2-1: SSB.2 FR1: SSB Pattern 2 for SSB SCS=30 kHz

| SSB Parameters                                  |                                                                                                                                                                  | Values                                                      |
|-------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| SSB SCS                                         |                                                                                                                                                                  | 30 kHz                                                      |
| SSB periodicity ( $T_{SSB}$ )                   |                                                                                                                                                                  | 20 ms                                                       |
| Number of SSBs per SS-burst                     |                                                                                                                                                                  | 1                                                           |
| SS/PBCH block index                             |                                                                                                                                                                  | 0                                                           |
| Symbol numbers containing SSB <sup>Note 3</sup> |                                                                                                                                                                  | 4-7 or 2-5 <sup>Note 2</sup>                                |
| Slot numbers containing SSB <sup>Note 3</sup>   |                                                                                                                                                                  | 0                                                           |
| SFN containing SSB                              |                                                                                                                                                                  | SFN mod<br>( $\max(T_{SSB}, 10\text{ms})/10\text{ms}$ ) = 0 |
| RB numbers containing SSB within channel BW     |                                                                                                                                                                  | $(RB_J, RB_{J+1}, \dots, RB_{J+19})$ <sup>Note 1</sup>      |
| Note 1:                                         | RBs containing SSB can be configured in any frequency location within the cell bandwidth according to the allowed synchronization raster defined in clause 5.4.3 |                                                             |
| Note 2:                                         | Symbols 4-7 is chosen, if the SSB pattern Case B should be used for the current band as define in clause 5.4.3]; Otherwise, symbol 2-5 is chosen.                |                                                             |
| Note 3:                                         | These values have been derived from other parameters for information purposes (as per TS 38.213 [3]). They are not settable parameters themselves                |                                                             |

## G.1.5.1.3 SSB pattern 3 in FR1: SSB allocation for SSB SCS=15 kHz

Table G.1.5.1.3-1: SSB.3 FR1: SSB Pattern 3 for SSB SCS=15 kHz

| SSB Parameters                                                                                                                                                           |  | Values                                                                            |      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----------------------------------------------------------------------------------|------|
| SSB SCS                                                                                                                                                                  |  | 15 kHz                                                                            |      |
| SSB periodicity (T <sub>SSB</sub> )                                                                                                                                      |  | 20 ms                                                                             |      |
| Number of SSBs per SS-burst                                                                                                                                              |  | 2                                                                                 |      |
| SS/PBCH block index                                                                                                                                                      |  | 0                                                                                 | 1    |
| Symbol numbers containing SSB <sup>Note 2</sup>                                                                                                                          |  | 2-5                                                                               | 8-11 |
| Slot numbers containing SSB <sup>Note 2</sup>                                                                                                                            |  | 0                                                                                 | 0    |
| SFN containing SSB                                                                                                                                                       |  | SFN mod<br>(max(T <sub>SSB</sub> ,10ms)/10ms) = 0                                 |      |
| RB numbers containing SSB within channel BW                                                                                                                              |  | (RB <sub>J</sub> , RB <sub>J+1</sub> ,..., RB <sub>J+19</sub> ) <sup>Note 1</sup> |      |
| Note 1: RBs containing SSB can be configured in any frequency location within the cell bandwidth according to the allowed synchronization raster defined in clause 5.4.3 |  |                                                                                   |      |
| Note 2: These values have been derived from other parameters for information purposes (as per TS 38.213 [3]). They are not settable parameters themselves.               |  |                                                                                   |      |

## G.1.5.1.4 SSB pattern 4 in FR1: SSB allocation for SSB SCS=30 kHz

Table G.1.5.1.4-1: SSB.4 FR1: SSB Pattern 4 for SSB SCS=30 kHz

| SSB Parameters                                  |                                                                                                                                                                   | Values                                                                            |      |
|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------|
| SSB SCS                                         |                                                                                                                                                                   | 30 kHz                                                                            |      |
| SSB periodicity ( $T_{SSB}$ )                   |                                                                                                                                                                   | 20 ms                                                                             |      |
| Number of SSBs per SS-burst                     |                                                                                                                                                                   | 2                                                                                 |      |
| SS/PBCH block index                             |                                                                                                                                                                   | 0                                                                                 | 1    |
| Symbol numbers containing SSB <sup>Note 3</sup> |                                                                                                                                                                   | 4-7 or 2-5 <sup>Note 2</sup>                                                      | 8-11 |
| Slot numbers containing SSB <sup>Note 3</sup>   |                                                                                                                                                                   | 0                                                                                 | 0    |
| SFN containing SSB                              |                                                                                                                                                                   | SFN mod<br>(max( $T_{SSB}$ ,10ms)/10ms) = 0                                       |      |
| RB numbers containing SSB within channel BW     |                                                                                                                                                                   | (RB <sub>J</sub> , RB <sub>J+1</sub> ,..., RB <sub>J+19</sub> ) <sup>Note 1</sup> |      |
| Note 1:                                         | RBs containing SSB can be configured in any frequency location within the cell bandwidth according to the allowed synchronization raster defined in clause 5.4.3. |                                                                                   |      |
| Note 2:                                         | Symbols 4-7 is chosen, if the SSB pattern Case B should be used for the current band as defined in clause 5.4.3; Otherwise, symbol 2-5 is chosen.                 |                                                                                   |      |
| Note 3:                                         | These values have been derived from other parameters for information purposes (as per TS 38.213 [3]). They are not settable parameters themselves.                |                                                                                   |      |

## G.1.5.1.5 SSB pattern 5 in FR1: SSB allocation for SSB SCS=15 kHz starting from odd SFN

Table G.1.5.1.5-1: SSB.5 FR1: SSB Pattern 5 for SSB SCS=15 kHz

| SSB Parameters                                                                                                                                                            | Values                                                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| SSB SCS                                                                                                                                                                   | 15 kHz                                                 |
| SSB periodicity ( $T_{SSB}$ )                                                                                                                                             | 20 ms                                                  |
| Number of SSBs per SS-burst                                                                                                                                               | 1                                                      |
| SS/PBCH block index                                                                                                                                                       | 0                                                      |
| Symbol numbers containing SSB <sup>Note 2</sup>                                                                                                                           | 2-5                                                    |
| Slot numbers containing SSB <sup>Note 2</sup>                                                                                                                             | 0                                                      |
| SFN containing SSB                                                                                                                                                        | SFN mod $(\max(T_{SSB}, 10\text{ms})/10\text{ms}) = 1$ |
| RB numbers containing SSB within channel BW                                                                                                                               | $(RB_J, RB_{J+1}, \dots, RB_{J+19})^{\text{Note 1}}$   |
| Note 1: RBs containing SSB can be configured in any frequency location within the cell bandwidth according to the allowed synchronization raster defined in clause 5.4.3. |                                                        |
| Note 2: These values have been derived from other parameters for information purposes (as per TS 38.213 [3]). They are not settable parameters themselves.                |                                                        |

### G.1.5.1.6 SSB pattern 6 in FR1: SSB allocation for SSB SCS=30 kHz starting from odd SFN

**Table G.1.5.1.6-1: SSB.6 FR1: SSB Pattern 6 for SSB SCS=30 kHz**

| SSB Parameters                                                                                                                                                           | Values                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| SSB SCS                                                                                                                                                                  | 30 kHz                                                 |
| SSB periodicity ( $T_{SSB}$ )                                                                                                                                            | 20 ms                                                  |
| Number of SSBs per SS-burst                                                                                                                                              | 1                                                      |
| SS/PBCH block index                                                                                                                                                      | 0                                                      |
| Symbol numbers containing SSB <sup>Note 3</sup>                                                                                                                          | 4-7 or 2-5 <sup>Note 2</sup>                           |
| Slot numbers containing SSB <sup>Note 3</sup>                                                                                                                            | 0                                                      |
| SFN containing SSB                                                                                                                                                       | SFN mod $(\max(T_{SSB}, 10\text{ms})/10\text{ms}) = 1$ |
| RB numbers containing SSB within channel BW                                                                                                                              | $(RB_J, RB_{J+1}, \dots, RB_{J+19})^{\text{Note 1}}$   |
| Note 1: RBs containing SSB can be configured in any frequency location within the cell bandwidth according to the allowed synchronization raster defined in clause 5.4.3 |                                                        |
| Note 2: Symbols 4-7 is chosen, if the SSB pattern Case B should be used for the current band as defined in clause 5.4.3; Otherwise, symbol 2-5 is chosen.                |                                                        |
| Note 3: These values have been derived from other parameters for information purposes (as per TS 38.213 [3]). They are not settable parameters themselves.               |                                                        |

## G.1.5.2 SSB Configurations for FR2

### G.1.5.2.1 SSB pattern 1 in FR2: SSB allocation for SSB SCS=120 kHz

**Table G.1.5.2.1-1: SSB.1 FR2: SSB Pattern 1 for SSB SCS = 120 kHz with 2 SSBs per SS-burst**

| SSB Parameters                                   |                                                                                                                                                                   | Values                                                                            |      |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------|
| SSB SCS                                          |                                                                                                                                                                   | 120 kHz                                                                           |      |
| SSB periodicity ( $T_{SSB}$ )                    |                                                                                                                                                                   | 20 ms                                                                             |      |
| Number of SSBs per SS-burst                      |                                                                                                                                                                   | 2                                                                                 |      |
| SS/PBCH block index                              |                                                                                                                                                                   | 0                                                                                 | 1    |
| Symbol numbers containing SSBs <sup>Note 2</sup> |                                                                                                                                                                   | 4-7                                                                               | 8-11 |
| Slot numbers containing SSB <sup>Note 2</sup>    |                                                                                                                                                                   | 0                                                                                 | 0    |
| SFN containing SSB                               |                                                                                                                                                                   | SFN mod<br>(max( $T_{SSB}$ ,10ms)/10ms) = 0                                       |      |
| RB numbers containing SSBs within channel BW     |                                                                                                                                                                   | (RB <sub>J</sub> , RB <sub>J+1</sub> ,..., RB <sub>J+19</sub> ) <sup>Note 1</sup> |      |
| Note 1:                                          | RBs containing SSB can be configured in any frequency location within the cell bandwidth according to the allowed synchronization raster defined in clause 5.4.3. |                                                                                   |      |
| Note 2:                                          | These values have been derived from other parameters for information purposes (as per TS 38.213 [3]). They are not settable parameters themselves.                |                                                                                   |      |

## G.1.5.2.2 SSB pattern 2 in FR2: SSB allocation for SSB SCS=240 kHz

Table G.1.5.2.2-1: SSB.2 FR2: SSB Pattern 2 for SSB SCS = 240 kHz with 2 SSBs per SS-burst

| SSB Parameters                                   |                                                                                                                                                                   | Values                                                      |            |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|------------|
| SSB SCS                                          |                                                                                                                                                                   | 240 kHz                                                     |            |
| SSB periodicity ( $T_{SSB}$ )                    |                                                                                                                                                                   | 20 ms                                                       |            |
| Number of SSBs per SS-burst                      |                                                                                                                                                                   | 2                                                           |            |
| SS/PBCH block index                              |                                                                                                                                                                   | 0                                                           | 1          |
| Symbol numbers containing SSBs <sup>Note 2</sup> |                                                                                                                                                                   | 8-11                                                        | 12-13, 0-1 |
| Slot numbers containing SSB <sup>Note 2</sup>    |                                                                                                                                                                   | 0                                                           | 0, 1       |
| SFN containing SSB                               |                                                                                                                                                                   | SFN mod<br>( $\max(T_{SSB}, 10\text{ms})/10\text{ms}$ ) = 0 |            |
| RB numbers containing SSBs within channel BW     |                                                                                                                                                                   | $(RB_J, RB_{J+1}, \dots, RB_{J+39})$ <sup>Note 1</sup>      |            |
| Note 1:                                          | RBs containing SSB can be configured in any frequency location within the cell bandwidth according to the allowed synchronization raster defined in clause 5.4.3. |                                                             |            |
| Note 2:                                          | These values have been derived from other parameters for information purposes (as per TS 38.213 [3]). They are not settable parameters themselves.                |                                                             |            |

## G.1.5.2.3 SSB pattern 3 in FR2: SSB allocation for SSB SCS=120 kHz

Table G.1.5.2.3-1: SSB.3 FR2: SSB Pattern 3 for SSB SCS = 120 kHz with 1 SSB per SS-burst

| SSB Parameters                                   |                                                                                                                                                                   | Values                                                   |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|
| SSB SCS                                          |                                                                                                                                                                   | 120 kHz                                                  |
| SSB periodicity ( $T_{SSB}$ )                    |                                                                                                                                                                   | 20 ms                                                    |
| Number of SSBs per SS-burst                      |                                                                                                                                                                   | 1                                                        |
| SS/PBCH block index                              |                                                                                                                                                                   | 0                                                        |
| Symbol numbers containing SSBs <sup>Note 2</sup> |                                                                                                                                                                   | 4-7                                                      |
| Slot numbers containing SSB <sup>Note 2</sup>    |                                                                                                                                                                   | 0                                                        |
| SFN containing SSB                               |                                                                                                                                                                   | SFN mod<br>(max( $T_{SSB}$ ,10ms)/10ms) = 0              |
| RB numbers containing SSBs within channel BW     |                                                                                                                                                                   | ( $RB_J, RB_{J+1}, \dots, RB_{J+19}$ ) <sup>Note 1</sup> |
| Note 1:                                          | RBs containing SSB can be configured in any frequency location within the cell bandwidth according to the allowed synchronization raster defined in clause 5.4.3. |                                                          |
| Note 2:                                          | These values have been derived from other parameters for information purposes (as per TS 38.213 [3]). They are not settable parameters themselves.                |                                                          |

## G.1.5.2.4 SSB pattern 4 in FR2: SSB allocation for SSB SCS=240 kHz

Table G.1.5.2.4-1: SSB.4 FR2: SSB Pattern 4 for SSB SCS = 240 kHz with 1 SSB per SS-burst

| SSB Parameters                                   |                                                                                                                                                                   | Values                                                      |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| SSB SCS                                          |                                                                                                                                                                   | 240 kHz                                                     |
| SSB periodicity ( $T_{SSB}$ )                    |                                                                                                                                                                   | 20 ms                                                       |
| Number of SSBs per SS-burst                      |                                                                                                                                                                   | 1                                                           |
| SS/PBCH block index                              |                                                                                                                                                                   | 0                                                           |
| Symbol numbers containing SSBs <sup>Note 2</sup> |                                                                                                                                                                   | 8-11                                                        |
| Slot numbers containing SSB <sup>Note 2</sup>    |                                                                                                                                                                   | 0                                                           |
| SFN containing SSB                               |                                                                                                                                                                   | SFN mod<br>( $\max(T_{SSB}, 10\text{ms})/10\text{ms}$ ) = 0 |
| RB numbers containing SSBs within channel BW     |                                                                                                                                                                   | ( $RB_J, RB_{J+1}, \dots, RB_{J+39}$ ) <sup>Note 1</sup>    |
| Note 1:                                          | RBs containing SSB can be configured in any frequency location within the cell bandwidth according to the allowed synchronization raster defined in clause 5.4.3. |                                                             |
| Note 2:                                          | These values have been derived from other parameters for information purposes (as per TS 38.213 [3]). They are not settable parameters themselves.                |                                                             |

## G.1.5.2.5 SSB pattern 5 in FR2: SSB allocation for SSB SCS=120 kHz

Table G.1.5.2.5-1: SSB.5 FR2: SSB Pattern 5 for SSB SCS = 120 kHz with 2 SSBs per SS-burst

| SSB Parameters                                   |                                                                                                                                                                   | Values                                                                             |     |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-----|
| SSB SCS                                          |                                                                                                                                                                   | 120 kHz                                                                            |     |
| SSB periodicity ( $T_{SSB}$ )                    |                                                                                                                                                                   | 20 ms                                                                              |     |
| Number of SSBs per SS-burst                      |                                                                                                                                                                   | 2                                                                                  |     |
| SS/PBCH block index                              |                                                                                                                                                                   | 2                                                                                  | 3   |
| Symbol numbers containing SSBs <sup>Note 2</sup> |                                                                                                                                                                   | 2-5                                                                                | 6-9 |
| Slot numbers containing SSB <sup>Note 2</sup>    |                                                                                                                                                                   | 1                                                                                  | 1   |
| SFN containing SSB                               |                                                                                                                                                                   | SFN mod<br>( $\max(T_{SSB}, 10\text{ms})/10\text{ms}$ ) = 0                        |     |
| RB numbers containing SSBs within channel BW     |                                                                                                                                                                   | (RB <sub>J</sub> , RB <sub>J+1</sub> , ..., RB <sub>J+19</sub> ) <sup>Note 1</sup> |     |
| Note 1:                                          | RBs containing SSB can be configured in any frequency location within the cell bandwidth according to the allowed synchronization raster defined in clause 5.4.3. |                                                                                    |     |
| Note 2:                                          | These values have been derived from other parameters for information purposes (as per TS 38.213 [3]). They are not settable parameters themselves.                |                                                                                    |     |

## G.1.5.2.6 SSB pattern 6 in FR2: SSB allocation for SSB SCS=240 kHz

Table G.1.5.2.6-1: SSB.6 FR2: SSB Pattern 6 for SSB SCS = 240 kHz with 2 SSBs per SS-burst

| SSB Parameters                                   |                                                                                                                                                                   | Values                                                      |     |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|-----|
| SSB SCS                                          |                                                                                                                                                                   | 240 kHz                                                     |     |
| SSB periodicity ( $T_{SSB}$ )                    |                                                                                                                                                                   | 20 ms                                                       |     |
| Number of SSBs per SS-burst                      |                                                                                                                                                                   | 2                                                           |     |
| SS/PBCH block index                              |                                                                                                                                                                   | 2                                                           | 3   |
| Symbol numbers containing SSBs <sup>Note 2</sup> |                                                                                                                                                                   | 2-5                                                         | 6-9 |
| Slot numbers containing SSB <sup>Note 2</sup>    |                                                                                                                                                                   | 1                                                           | 1   |
| SFN containing SSB                               |                                                                                                                                                                   | SFN mod<br>( $\max(T_{SSB}, 10\text{ms})/10\text{ms}$ ) = 0 |     |
| RB numbers containing SSBs within channel BW     |                                                                                                                                                                   | $(RB_J, RB_{J+1}, \dots, RB_{J+39})$ <sup>Note 1</sup>      |     |
| Note 1:                                          | RBs containing SSB can be configured in any frequency location within the cell bandwidth according to the allowed synchronization raster defined in clause 5.4.3. |                                                             |     |
| Note 2:                                          | These values have been derived from other parameters for information purposes (as per TS 38.213 [3]). They are not settable parameters themselves.                |                                                             |     |

## G.1.5.2.7 SSB pattern 7 in FR2: SSB allocation for SSB SCS=120 kHz

Table G.1.5.2.7-1: SSB.7 FR2: SSB Pattern 7 for SSB SCS = 120 kHz with 1 SSB per SS-burst

| SSB Parameters                                                                                                                                                            | Values                                                                             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| SSB SCS                                                                                                                                                                   | 120 kHz                                                                            |
| SSB periodicity ( $T_{SSB}$ )                                                                                                                                             | 20 ms                                                                              |
| Number of SSBs per SS-burst                                                                                                                                               | 1                                                                                  |
| SS/PBCH block index                                                                                                                                                       | 1                                                                                  |
| Symbol numbers containing SSBs <sup>Note 2</sup>                                                                                                                          | 8-11                                                                               |
| Slot numbers containing SSB <sup>Note 2</sup>                                                                                                                             | 0                                                                                  |
| SFN containing SSB                                                                                                                                                        | SFN mod<br>( $\max(T_{SSB}, 10\text{ms})/10\text{ms}$ ) = 0                        |
| RB numbers containing SSBs within channel BW                                                                                                                              | (RB <sub>J</sub> , RB <sub>J+1</sub> , ..., RB <sub>J+19</sub> ) <sup>Note 1</sup> |
| Note 1: RBs containing SSB can be configured in any frequency location within the cell bandwidth according to the allowed synchronization raster defined in clause 5.4.3. |                                                                                    |
| Note 2: These values have been derived from other parameters for information purposes (as per TS 38.213 [3]). They are not settable parameters themselves.                |                                                                                    |

### G.1.5.2.8 SSB pattern 8 in FR2: SSB allocation for SSB SCS=240 kHz

**Table G.1.5.2.8-1: SSB.8 FR2: SSB Pattern 8 for SSB SCS = 240 kHz with 1 SSB per SS-burst**

| SSB Parameters                                   |                                                                                                                                                                   | Values                                                                             |     |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-----|
| SSB SCS                                          |                                                                                                                                                                   | 240 kHz                                                                            |     |
| SSB periodicity ( $T_{SSB}$ )                    |                                                                                                                                                                   | 20 ms                                                                              |     |
| Number of SSBs per SS-burst                      |                                                                                                                                                                   | 1                                                                                  |     |
| SS/PBCH block index                              |                                                                                                                                                                   | 1                                                                                  |     |
| Symbol numbers containing SSBs <sup>Note 2</sup> |                                                                                                                                                                   | 12-13                                                                              | 0-1 |
| Slot numbers containing SSB <sup>Note 2</sup>    |                                                                                                                                                                   | 0                                                                                  | 1   |
| SFN containing SSB                               |                                                                                                                                                                   | SFN mod<br>( $\max(T_{SSB}, 10\text{ms})/10\text{ms}$ ) = 0                        |     |
| RB numbers containing SSBs within channel BW     |                                                                                                                                                                   | (RB <sub>J</sub> , RB <sub>J+1</sub> , ..., RB <sub>J+39</sub> ) <sup>Note 1</sup> |     |
| Note 1:                                          | RBs containing SSB can be configured in any frequency location within the cell bandwidth according to the allowed synchronization raster defined in clause 5.4.3. |                                                                                    |     |
| Note 2:                                          | These values have been derived from other parameters for information purposes (as per TS 38.213 [3]). They are not settable parameters themselves.                |                                                                                    |     |

## G.1.6 SMTC Configurations

### G.1.6.1 SMTC pattern 1: SMTC period = 20 ms with SMTC duration = 1 ms

**Table G.1.6.1-1: SMTC.1: SMTC Pattern 1 for SMTC period = 20 ms and duration = 1 ms**

| SMTC Parameters  | Values |
|------------------|--------|
| SMTC periodicity | 20 ms  |
| SMTC offset      | 0 ms   |
| SMTC duration    | 1 ms   |

### G.1.6.2 SMTC pattern 2: SMTC period = 20 ms with SMTC duration = 5 ms

**Table G.1.6.2-1: SMTC.2: SMTC Pattern 2 for SMTC period = 20 ms and duration = 5 ms**

| SMTC Parameters  | Values |
|------------------|--------|
| SMTC periodicity | 20 ms  |
| SMTC offset      | 0 ms   |
| SMTC duration    | 5 ms   |

### G.1.6.3 SMTC pattern 3: SMTC period = 160 ms with SMTC duration = 1 ms

**Table G.1.6.3-1: SMTC.3: SMTC Pattern 3 for SMTC period = 20 ms and duration = 5 ms**

| SMTC Parameters  | Values |
|------------------|--------|
| SMTC periodicity | 160 ms |
| SMTC offset      | 0 ms   |
| SMTC duration    | 1 ms   |

#### G.1.6.4 SMTC pattern 4: SMTC period = 20 ms with SMTC duration = 1 ms

**Table G.1.6.4-1: SMTC.4: SMTC Pattern 4 for SMTC period = 20 ms and duration = 1 ms**

| SMTC Parameters  | Values |
|------------------|--------|
| SMTC periodicity | 20 ms  |
| SMTC offset      | 10 ms  |
| SMTC duration    | 1 ms   |

#### G.1.6.5 SMTC pattern 5: SMTC period = 20 ms with SMTC duration = 5 ms

**Table G.1.6.4-1: SMTC.5: SMTC Pattern 5 for SMTC period = 20 ms and duration = 5 ms**

| SMTC Parameters  | Values |
|------------------|--------|
| SMTC periodicity | 20 ms  |
| SMTC offset      | 10 ms  |
| SMTC duration    | 5 ms   |

## G.1.7 CSI-RS configurations

### G.1.7.1 TDD

**Table G.1.7.1-1: CSI-RS Reference Measurement Channels for SCS=15kHz**

|                                                                                                                                                                                                | CSI-RS.1.1 TDD    | CSI-RS.1.2 TDD     | CSI-RS.1.3 TDD     | CSI-RS.1.4 TDD    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------------|--------------------|-------------------|
| Resource Type                                                                                                                                                                                  | periodic          | periodic           | aperiodic          | aperiodic         |
| <b>Resource Set Config</b>                                                                                                                                                                     |                   |                    |                    |                   |
| nzp-CSI-ResourceSetId                                                                                                                                                                          | 0                 | 0                  | 0                  | 0                 |
| repetition                                                                                                                                                                                     | n.a.              | off                | off                | on                |
| aperiodicTriggeringOffset                                                                                                                                                                      | n.a.              | n.a.               | 0                  | 0                 |
| trs-Info                                                                                                                                                                                       | n.a.              | n.a.               | n.a.               | n.a.              |
| <b>Resource Config</b>                                                                                                                                                                         |                   |                    |                    |                   |
| nzp-CSI-RS-ResourceId                                                                                                                                                                          | 0 for resource #0 | 10 for resource #0 | 20 for resource #0 | 0 for resource #0 |
|                                                                                                                                                                                                |                   |                    |                    | 1 for resource #1 |
|                                                                                                                                                                                                |                   |                    |                    | 2 for resource #2 |
|                                                                                                                                                                                                |                   |                    |                    | 3 for resource #3 |
|                                                                                                                                                                                                |                   | 11 for resource #1 | 21 for resource #1 | 4 for resource #4 |
|                                                                                                                                                                                                |                   |                    |                    | 5 for resource #5 |
|                                                                                                                                                                                                |                   |                    |                    | 6 for resource #6 |
|                                                                                                                                                                                                |                   |                    |                    | 7 for resource #7 |
| powerControlOffset                                                                                                                                                                             | 0                 | 0                  | 0                  | 0                 |
| powerControlOffsetSS                                                                                                                                                                           | db0               | db0                | db0                | db0               |
| scramblingID                                                                                                                                                                                   | 0                 | 0                  | 0                  | 0                 |
| Period (slots)                                                                                                                                                                                 | slot5             | slot10             | n.a.               | n.a.              |
| qcl-InfoPeriodicCSI-RS                                                                                                                                                                         | TCI.State.0       | TCI.State.0        | n.a.               | n.a.              |
|                                                                                                                                                                                                |                   | TCI.State.1        |                    |                   |
| frequencyDomainAllocation                                                                                                                                                                      | 000001            | 000001             | 000001             | 000001            |
| nrofPorts                                                                                                                                                                                      | 2                 | 1                  | 1                  | 1                 |
| firstOFDMSymbolInTimeDomain                                                                                                                                                                    | 4 for resource #0 | 6 for resource #0  | 6 for resource #0  | 0 for resource #0 |
|                                                                                                                                                                                                |                   |                    |                    | 1 for resource #1 |
|                                                                                                                                                                                                |                   |                    |                    | 2 for resource #2 |
|                                                                                                                                                                                                |                   |                    |                    | 3 for resource #3 |
|                                                                                                                                                                                                |                   | 10 for resource #1 | 10 for resource #1 | 4 for resource #4 |
|                                                                                                                                                                                                |                   |                    |                    | 5 for resource #5 |
|                                                                                                                                                                                                |                   |                    |                    | 6 for resource #6 |
|                                                                                                                                                                                                |                   |                    |                    | 7 for resource #7 |
| cdm-Type                                                                                                                                                                                       | FD-CDM2           | noCDM              | noCDM              | noCDM             |
| density                                                                                                                                                                                        | 1                 | 3                  | 3                  | 3                 |
| startingRB                                                                                                                                                                                     | 0                 | 0                  | 0                  | 0                 |
| nrofRBs                                                                                                                                                                                        | 276 (Note 1)      | 276 (Note 1)       | 276 (Note 1)       | 276 (Note 1)      |
| Note 1: If the configured value of PRBs is larger than the width of the corresponding BWP relevant for the test case, the Test Equipment shall implement CSI-RS only in the width of that BWP. |                   |                    |                    |                   |

Table G.1.7.1-2: CSI-RS Reference Measurement Channels for SCS=30kHz

|                                                                                                                                                                                                | CSI-RS.2.1 TDD    | CSI-RS.2.2 TDD     | CSI-RS.2.3 TDD     | CSI-RS.2.4 TDD    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------------|--------------------|-------------------|
| Resource Type                                                                                                                                                                                  | periodic          | periodic           | aperiodic          | aperiodic         |
| <b>Resource Set Config</b>                                                                                                                                                                     |                   |                    |                    |                   |
| nzp-CSI-ResourceSetId                                                                                                                                                                          | 0                 | 0                  | 0                  | 0                 |
| repetition                                                                                                                                                                                     | n.a.              | off                | off                | on                |
| aperiodicTriggeringOffset                                                                                                                                                                      | n.a.              | n.a.               | 0                  | 0                 |
| trs-Info                                                                                                                                                                                       | n.a.              | n.a.               | n.a.               | n.a.              |
| <b>Resource Config</b>                                                                                                                                                                         |                   |                    |                    |                   |
| nzp-CSI-RS-ResourceId                                                                                                                                                                          | 0 for resource #0 | 10 for resource #0 | 20 for resource #0 | 0 for resource #0 |
|                                                                                                                                                                                                |                   |                    |                    | 1 for resource #1 |
|                                                                                                                                                                                                |                   |                    |                    | 2 for resource #2 |
|                                                                                                                                                                                                |                   |                    |                    | 3 for resource #3 |
|                                                                                                                                                                                                |                   | 11 for resource #1 | 21 for resource #1 | 4 for resource #4 |
|                                                                                                                                                                                                |                   |                    |                    | 5 for resource #5 |
|                                                                                                                                                                                                |                   |                    |                    | 6 for resource #6 |
|                                                                                                                                                                                                |                   |                    |                    | 7 for resource #7 |
| powerControlOffset                                                                                                                                                                             | 0                 | 0                  | 0                  | 0                 |
| powerControlOffsetSS                                                                                                                                                                           | db0               | db0                | db0                | db0               |
| scramblingID                                                                                                                                                                                   | 0                 | 0                  | 0                  | 0                 |
| Period (slots)                                                                                                                                                                                 | slot10            | slot20             | n.a.               | n.a.              |
| qcl-InfoPeriodicCSI-RS                                                                                                                                                                         | TCI.State.0       | TCI.State.0        | n.a.               | n.a.              |
|                                                                                                                                                                                                |                   | TCI.State.1        |                    |                   |
| frequencyDomainAllocation                                                                                                                                                                      | 000001            | 000001             | 000001             | 000001            |
| nrofPorts                                                                                                                                                                                      | 2                 | 1                  | 1                  | 1                 |
| firstOFDMSymbolInTimeDomain                                                                                                                                                                    | 4 for resource #0 | 6 for resource #0  | 6 for resource #0  | 0 for resource #0 |
|                                                                                                                                                                                                |                   |                    |                    | 1 for resource #1 |
|                                                                                                                                                                                                |                   |                    |                    | 2 for resource #2 |
|                                                                                                                                                                                                |                   |                    |                    | 3 for resource #3 |
|                                                                                                                                                                                                |                   | 10 for resource #1 | 10 for resource #1 | 4 for resource #4 |
|                                                                                                                                                                                                |                   |                    |                    | 5 for resource #5 |
|                                                                                                                                                                                                |                   |                    |                    | 6 for resource #6 |
|                                                                                                                                                                                                |                   |                    |                    | 7 for resource #7 |
| cdm-Type                                                                                                                                                                                       | FD-CDM2           | noCDM              | noCDM              | noCDM             |
| density                                                                                                                                                                                        | 1                 | 3                  | 3                  | 3                 |
| startingRB                                                                                                                                                                                     | 0                 | 0                  | 0                  | 0                 |
| nrofRBs                                                                                                                                                                                        | 276 (Note 1)      | 276 (Note 1)       | 276 (Note 1)       | 276 (Note 1)      |
| Note 1: If the configured value of PRBs is larger than the width of the corresponding BWP relevant for the test case, the Test Equipment shall implement CSI-RS only in the width of that BWP. |                   |                    |                    |                   |

Table G.1.7.1-3: CSI-RS Reference Measurement Channels for SCS=120kHz

|                                                                                                                                                                                                | CSI-RS.3.1 TDD    | CSI-RS.3.2 TDD     | CSI-RS.3.3 TDD     | CSI-RS.3.4 TDD    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------------|--------------------|-------------------|
| Resource Type                                                                                                                                                                                  | periodic          | periodic           | aperiodic          | aperiodic         |
| <b>Resource Set Config</b>                                                                                                                                                                     |                   |                    |                    |                   |
| nzp-CSI-ResourceSetId                                                                                                                                                                          | 0                 | 0                  | 0                  | 0                 |
| repetition                                                                                                                                                                                     | n.a.              | off                | off                | on                |
| aperiodicTriggeringOffset                                                                                                                                                                      | n.a.              | n.a.               | 4                  | 4                 |
| trs-Info                                                                                                                                                                                       | n.a.              | n.a.               | n.a.               | n.a.              |
| <b>Resource Config</b>                                                                                                                                                                         |                   |                    |                    |                   |
| nzp-CSI-RS-ResourceId                                                                                                                                                                          | 0 for resource #0 | 10 for resource #0 | 20 for resource #0 | 0 for resource #0 |
|                                                                                                                                                                                                |                   |                    |                    | 1 for resource #1 |
|                                                                                                                                                                                                |                   |                    |                    | 2 for resource #2 |
|                                                                                                                                                                                                |                   |                    |                    | 3 for resource #3 |
|                                                                                                                                                                                                |                   | 11 for resource #1 | 21 for resource #1 | 4 for resource #4 |
|                                                                                                                                                                                                |                   |                    |                    | 5 for resource #5 |
|                                                                                                                                                                                                |                   |                    |                    | 6 for resource #6 |
|                                                                                                                                                                                                |                   |                    |                    | 7 for resource #7 |
| powerControlOffset                                                                                                                                                                             | 0                 | 0                  | 0                  | 0                 |
| powerControlOffsetSS                                                                                                                                                                           | db0               | db0                | db0                | db0               |
| scramblingID                                                                                                                                                                                   | 0                 | 0                  | 0                  | 0                 |
| Period (slots)                                                                                                                                                                                 | slot40            | slot80             | n.a.               | n.a.              |
| qcl-InfoPeriodicCSI-RS                                                                                                                                                                         | TCI.State.0       | TCI.State.0        | n.a.               | n.a.              |
|                                                                                                                                                                                                |                   | TCI.State.1        |                    |                   |
| frequencyDomainAllocation                                                                                                                                                                      | 000001            | 000001             | 000001             | 000001            |
| nrofPorts                                                                                                                                                                                      | 1                 | 1                  | 1                  | 1                 |
| firstOFDMSymbolInTimeDomain                                                                                                                                                                    | 4 for resource #0 | 6 for resource #0  | 6 for resource #0  | 0 for resource #0 |
|                                                                                                                                                                                                |                   |                    |                    | 1 for resource #1 |
|                                                                                                                                                                                                |                   |                    |                    | 2 for resource #2 |
|                                                                                                                                                                                                |                   |                    |                    | 3 for resource #3 |
|                                                                                                                                                                                                |                   | 10 for resource #1 | 10 for resource #1 | 4 for resource #4 |
|                                                                                                                                                                                                |                   |                    |                    | 5 for resource #5 |
|                                                                                                                                                                                                |                   |                    |                    | 6 for resource #6 |
|                                                                                                                                                                                                |                   |                    |                    | 7 for resource #7 |
| cdm-Type                                                                                                                                                                                       | FD-CDM2           | noCDM              | noCDM              | noCDM             |
| density                                                                                                                                                                                        | 1                 | 3                  | 3                  | 3                 |
| startingRB                                                                                                                                                                                     | 0                 | 0                  | 0                  | 0                 |
| nrofRBs                                                                                                                                                                                        | 276 (Note 1)      | 276 (Note 1)       | 276 (Note 1)       | 276 (Note 1)      |
| Note 1: If the configured value of PRBs is larger than the width of the corresponding BWP relevant for the test case, the Test Equipment shall implement CSI-RS only in the width of that BWP. |                   |                    |                    |                   |

## G.1.7.2 FDD

Table G.1.7.2-1: CSI-RS Reference Measurement Channels for SCS=15kHz

|                            | CSI-RS.1.1 FDD    | CSI-RS.1.2 FDD     | CSI-RS.1.3 FDD     | CSI-RS.1.4 FDD     |
|----------------------------|-------------------|--------------------|--------------------|--------------------|
| Resource Type              | periodic          | periodic           | aperiodic          | aperiodic          |
| <b>Resource Set Config</b> |                   |                    |                    |                    |
| nzp-CSI-ResourceSetId      | 0                 | 0                  | 0                  | 0                  |
| repetition                 | n.a.              | off                | off                | on                 |
| aperiodicTriggeringOffset  | n.a.              | n.a.               | 6                  | 6                  |
| trs-Info                   | n.a.              | n.a.               | n.a.               | n.a.               |
| <b>Resource Config</b>     |                   |                    |                    |                    |
| nzp-CSI-RS-ResourceId      | 0 for resource #0 | 10 for resource #0 | 20 for resource #0 | 30 for resource #0 |
|                            |                   |                    |                    | 31 for resource #1 |
|                            |                   |                    |                    | 32 for resource #2 |
|                            |                   |                    |                    | 33 for resource #3 |
|                            |                   | 11 for resource #1 | 21 for resource #1 | 34 for resource #4 |
|                            |                   |                    |                    | 35 for resource #5 |

|                             |                   |                    |                    |                    |
|-----------------------------|-------------------|--------------------|--------------------|--------------------|
|                             |                   |                    |                    | 36 for resource #6 |
|                             |                   |                    |                    | 37 for resource #7 |
| powerControlOffset          | 0                 | 0                  | 0                  | 0                  |
| powerControlOffsetSS        | db0               | db0                | db0                | db0                |
| scramblingID                | 0                 | 0                  | 0                  | 0                  |
| Period (slots)              | slot5             | slot10             | n.a.               | n.a.               |
| Offset                      | 1                 | 1                  | n.a.               | n.a.               |
| qcl-InfoPeriodicCSI-RS      | TCI.State.0       | TCI.State.0        | n.a.               | n.a.               |
|                             |                   | TCI.State.1        |                    |                    |
| frequencyDomainAllocation   | 000001            | 000001             | 000001             | 000001             |
| nrofPorts                   | 2                 | 1                  | 1                  | 1                  |
| firstOFDMSymbolInTimeDomain | 5 for resource #0 | 6 for resource #0  | 6 for resource #0  | 0 for resource #0  |
|                             |                   |                    |                    | 1 for resource #1  |
|                             |                   |                    |                    | 2 for resource #2  |
|                             |                   |                    |                    | 3 for resource #3  |
|                             |                   | 10 for resource #1 | 10 for resource #1 | 4 for resource #4  |
|                             |                   |                    |                    | 5 for resource #5  |
|                             |                   |                    |                    | 6 for resource #6  |
|                             |                   |                    |                    | 7 for resource #7  |
| cdm-Type                    | FD-CDM2           | noCDM              | noCDM              | noCDM              |
| density                     | 1                 | 3                  | 3                  | 3                  |
| startingRB                  | 0                 | 0                  | 0                  | 0                  |
| nrofRBs                     | 276               | 276                | 276                | 276                |

## G.1.8 Angle of Arrival (AoA) for FR2 RRM test cases

This clause specifies the AoA setups for FR2 RRM test cases. The applicable AoA setup is defined in each test case.

### G.1.8.1 Setup 1: Single AoA

There is only one active probe in the test. The DL signals, and noise if applicable, transmitted from the probe, are aligned to AoA based upon the declaration.

### G.1.8.2 Setup 2: 2 AoAs

There are 2 active probes in the test. The DL signals, and noise if applicable, transmitted from the two active probes, align to AoAs based upon the declaration.

## G.1.9 TCI State Configuration

### G.1.9.1 Introduction

This clause provides the configurations for TCI states towards either SSB or CSI-RS. The TCI states defined in this clause are configured in each test when applicable to indicate that certain DL signals are QCL'ed with the referenceSignal configured in the TCI states.

## G.1.9.2 TCI states

**Table G.1.9.2-1: TCI States**

| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | TCI.State.0 | TCI.State.1 | TCI.State.2                                        | TCI.State.3                                        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------|----------------------------------------------------|----------------------------------------------------|
| tcid-StateId                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Id0         | Id1         | Id2                                                | Id3                                                |
| qcl-Type1                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | typeC       | typeC       | typeA                                              | typeA                                              |
| qcl-Type2 <sup>Note1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                        | typeD       | typeD       | typeD                                              | typeD                                              |
| referenceSignal                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | SSB0        | SSB1        | Resource #4 in TRS resource set 1 <sup>Note3</sup> | Resource #4 in TRS resource set 2 <sup>Note3</sup> |
| <p>Note 1: qcl-Type2 of typeD only where applicable. For RRM test cases, this will be only in FR2</p> <p>Note 2: referenceSignal configurations towards which the TCI states are configured are defined in a test-specific manner.</p> <p>Note 3: Reference TRS resource sets are defined in G.1.10, and the applicable TRS resource set(s) are specified in each test case. When a single TRS resource set is configured in a test case, it is considered as resource set 1.</p> |             |             |                                                    |                                                    |

## G.1.10 Configurations of CSI-RS for tracking

### G.1.10.1 Configuration of CSI-RS for tracking for FR1

#### G.1.10.1.2 TDD

**Table G.1.10.1.2-1: CSI-RS for tracking for SCS=15kHz**

| Parameter                                                                                    | Unit  | Value                                                                          |
|----------------------------------------------------------------------------------------------|-------|--------------------------------------------------------------------------------|
| Reference channel                                                                            |       | TRS.1.1 TDD                                                                    |
| Bandwidth                                                                                    |       | BW of Active BWP <sup>Note 1</sup>                                             |
| SCS                                                                                          | kHz   | 15                                                                             |
| First subcarrier index in the PRB used for CSI-RS                                            |       | $k_0=0$ for CSI-RS resource 1,2,3,4                                            |
| First OFDM symbol in the slot used for CSI-RS                                                |       | $l_0 = 5$ for CSI-RS resource 1 and 3<br>$l_0 = 9$ for CSI-RS resource 2 and 4 |
| Number of CSI-RS ports (X)                                                                   |       | 1 for CSI-RS resource 1,2,3,4                                                  |
| CDM Type                                                                                     |       | 'No CDM' for CSI-RS resource 1,2,3,4                                           |
| Density ( $\rho$ )                                                                           |       | 3 for CSI-RS resource 1,2,3,4                                                  |
| CSI-RS periodicity                                                                           | slots | 20 for CSI-RS resource 1,2,3,4                                                 |
| EPRE ratio to SSS                                                                            | dB    | -3 <sup>Note 2</sup>                                                           |
| TCI state                                                                                    |       | TCI.State.0                                                                    |
| Note: BW of TRS is configured same as the BW size of NCR-MT active BWP in the RRM test cases |       |                                                                                |

**Table G.1.10.1.2-2: CSI-RS for tracking for SCS=30kHz**

| Parameter                                                                                      | Unit  | Value                                                                          |
|------------------------------------------------------------------------------------------------|-------|--------------------------------------------------------------------------------|
| Reference channel                                                                              |       | TRS.1.2 TDD                                                                    |
| Bandwidth                                                                                      |       | BW of Active BWP <sup>Note 1</sup>                                             |
| SCS                                                                                            | kHz   | 30                                                                             |
| First subcarrier index in the PRB used for CSI-RS                                              |       | $k_0=0$ for CSI-RS resource 1,2,3,4                                            |
| First OFDM symbol in the slot used for CSI-RS                                                  |       | $l_0 = 5$ for CSI-RS resource 1 and 3<br>$l_0 = 9$ for CSI-RS resource 2 and 4 |
| Number of CSI-RS ports (X)                                                                     |       | 1 for CSI-RS resource 1,2,3,4                                                  |
| CDM Type                                                                                       |       | 'No CDM' for CSI-RS resource 1,2,3,4                                           |
| Density ( $\rho$ )                                                                             |       | 3 for CSI-RS resource 1,2,3,4                                                  |
| CSI-RS periodicity                                                                             | slots | 40 for CSI-RS resource 1,2,3,4                                                 |
| EPRE ratio to SSS                                                                              | dB    | -3 <sup>Note 2</sup>                                                           |
| TCI state                                                                                      |       | TCI.State.0                                                                    |
| Note 1: BW of TRS is configured same as the BW size of NCR-MT active BWP in the RRM test cases |       |                                                                                |
| Note 2: Unless otherwise specified in the test case                                            |       |                                                                                |

## G.1.10.1.3 FDD

Table G.1.10.1.3-1: CSI-RS for tracking for SCS=15kHz

| Parameter                                                                                  | Unit  | Value                                                                          |
|--------------------------------------------------------------------------------------------|-------|--------------------------------------------------------------------------------|
| Reference channel                                                                          |       | TRS.1.1 FDD                                                                    |
| Bandwidth                                                                                  |       | BW of Active BWP <sup>Note 1</sup>                                             |
| SCS                                                                                        | kHz   | 15                                                                             |
| First subcarrier index in the PRB used for CSI-RS                                          |       | $k_0=0$ for CSI-RS resource 1,2,3,4                                            |
| First OFDM symbol in the slot used for CSI-RS                                              |       | $l_0 = 5$ for CSI-RS resource 1 and 3<br>$l_0 = 9$ for CSI-RS resource 2 and 4 |
| Number of CSI-RS ports (X)                                                                 |       | 1 for CSI-RS resource 1,2,3,4                                                  |
| CDM Type                                                                                   |       | 'No CDM' for CSI-RS resource 1,2,3,4                                           |
| Density ( $\rho$ )                                                                         |       | 3 for CSI-RS resource 1,2,3,4                                                  |
| CSI-RS periodicity                                                                         | slots | 20 for CSI-RS resource 1,2,3,4                                                 |
| CSI-RS offset                                                                              | slots | 10 for CSI-RS resource 1 and 2<br>11 for CSI-RS resource 3 and 4               |
| EPRE ratio to SSS                                                                          | dB    | -3 <sup>Note 2</sup>                                                           |
| TCI state                                                                                  |       | TCI.State.0                                                                    |
| Note 1: BW of TRS is configured same as the BW size of UE active BWP in the RRM test cases |       |                                                                                |
| Note 2: Unless otherwise specified in the test case                                        |       |                                                                                |

Table G.1.10.1.3-2: CSI-RS for tracking for SCS=30kHz

| Parameter                                                                                  | Unit  | Value                                                                          |
|--------------------------------------------------------------------------------------------|-------|--------------------------------------------------------------------------------|
| Reference channel                                                                          |       | TRS.1.2 FDD                                                                    |
| Bandwidth                                                                                  |       | BW of Active BWP <sup>Note 1</sup>                                             |
| SCS                                                                                        | kHz   | 30                                                                             |
| First subcarrier index in the PRB used for CSI-RS                                          |       | $k_0=0$ for CSI-RS resource 1,2,3,4                                            |
| First OFDM symbol in the slot used for CSI-RS                                              |       | $l_0 = 5$ for CSI-RS resource 1 and 3<br>$l_0 = 9$ for CSI-RS resource 2 and 4 |
| Number of CSI-RS ports (X)                                                                 |       | 1 for CSI-RS resource 1,2,3,4                                                  |
| CDM Type                                                                                   |       | 'No CDM' for CSI-RS resource 1,2,3,4                                           |
| Density ( $\rho$ )                                                                         |       | 3 for CSI-RS resource 1,2,3,4                                                  |
| CSI-RS periodicity                                                                         | slots | 40 for CSI-RS resource 1,2,3,4                                                 |
| CSI-RS offset                                                                              | slots | 20 for CSI-RS resource 1 and 2<br>21 for CSI-RS resource 3 and 4               |
| EPRE ratio to SSS                                                                          | dB    | -3 <sup>Note 2</sup>                                                           |
| TCI state                                                                                  |       | TCI.State.0                                                                    |
| Note 1: BW of TRS is configured same as the BW size of UE active BWP in the RRM test cases |       |                                                                                |
| Note 2: Unless otherwise specified in the test case                                        |       |                                                                                |

## G.1.10.2 Configuration of CSI-RS for tracking for FR2

### G.1.10.2.1 TDD

**Table G.1.10.2.1-1: CSI-RS for tracking for SCS=120kHz Set 1**

| Parameter                                                                                                                                                                                                                                                                  | Unit  | Value                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------------------------------------------------------------------------------|
| Reference channel                                                                                                                                                                                                                                                          |       | TRS.2.1 TDD                                                                    |
| Bandwidth                                                                                                                                                                                                                                                                  |       | BW of Active BWP <sup>Note 1,3</sup>                                           |
| SCS                                                                                                                                                                                                                                                                        | kHz   | 120                                                                            |
| First subcarrier index in the PRB used for CSI-RS                                                                                                                                                                                                                          |       | $k_0=0$ for CSI-RS resource 1,2,3,4                                            |
| First OFDM symbol in the slot used for CSI-RS                                                                                                                                                                                                                              |       | $l_0 = 1$ for CSI-RS resource 1 and 3<br>$l_0 = 5$ for CSI-RS resource 2 and 4 |
| Number of CSI-RS ports (X)                                                                                                                                                                                                                                                 |       | 1 for CSI-RS resource 1,2,3,4                                                  |
| CDM Type                                                                                                                                                                                                                                                                   |       | 'No CDM' for CSI-RS resource 1,2,3,4                                           |
| Density ( $\rho$ )                                                                                                                                                                                                                                                         |       | 3 for CSI-RS resource 1,2,3,4                                                  |
| CSI-RS periodicity                                                                                                                                                                                                                                                         | slots | 80 for CSI-RS resource 1,2,3,4                                                 |
| EPRE ratio to SSS                                                                                                                                                                                                                                                          | dB    | -3 <sup>Note 2</sup>                                                           |
| TCI state                                                                                                                                                                                                                                                                  |       | TCI.State.0                                                                    |
| Note 1: BW of TRS is configured same as the BW size of NCR-MT active BWP in the RRM test cases<br>Note 2: Unless otherwise specified in the test case<br>Note 3: If active BWP is larger than 52RBs, BW of TRS is configured as 52RBs. Otherwise, same as active BWP size. |       |                                                                                |

**Table G.1.10.2.1-2: CSI-RS for tracking for SCS=120kHz Set 2**

| Parameter                                                                                                                                                                                                                                                                  | Unit  | Value                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------------------------------------------------------------------------------|
| Reference channel                                                                                                                                                                                                                                                          |       | TRS.2.2 TDD                                                                    |
| Bandwidth                                                                                                                                                                                                                                                                  |       | BW of Active BWP <sup>Note 1,3</sup>                                           |
| SCS                                                                                                                                                                                                                                                                        | kHz   | 120                                                                            |
| First subcarrier index in the PRB used for CSI-RS                                                                                                                                                                                                                          |       | $k_0=0$ for CSI-RS resource 1,2,3,4                                            |
| First OFDM symbol in the slot used for CSI-RS                                                                                                                                                                                                                              |       | $l_0 = 2$ for CSI-RS resource 1 and 3<br>$l_0 = 6$ for CSI-RS resource 2 and 4 |
| Number of CSI-RS ports (X)                                                                                                                                                                                                                                                 |       | 1 for CSI-RS resource 1,2,3,4                                                  |
| CDM Type                                                                                                                                                                                                                                                                   |       | 'No CDM' for CSI-RS resource 1,2,3,4                                           |
| Density ( $\rho$ )                                                                                                                                                                                                                                                         |       | 3 for CSI-RS resource 1,2,3,4                                                  |
| CSI-RS periodicity                                                                                                                                                                                                                                                         | slots | 80 for CSI-RS resource 1,2,3,4                                                 |
| EPRE ratio to SSS                                                                                                                                                                                                                                                          | dB    | -3 <sup>Note 2</sup>                                                           |
| TCI state                                                                                                                                                                                                                                                                  |       | TCI.State.1                                                                    |
| Note 1: BW of TRS is configured same as the BW size of NCR-MT active BWP in the RRM test cases<br>Note 2: Unless otherwise specified in the test case<br>Note 3: If active BWP is larger than 52RBs, BW of TRS is configured as 52RBs. Otherwise, same as active BWP size. |       |                                                                                |

## G.2 NCR-MT RRM test cases

### G.2.1 RRC\_CONNECTED state mobility for NCR-MTs

#### G.2.1.1 RRC Connection Mobility Control

##### G.2.1.1.2 RRC Re-establishment for LA NCR-MT

##### G.2.1.1.1.1 Inter-frequency RRC Re-establishment in FR1 for LA NCR-MT

##### G.2.1.1.1.1.1 Test Purpose and Environment

The purpose is to verify that the NR inter-frequency RRC re-establishment delay in FR1 to an unknown target cell is within the specified limits. These tests will verify the requirements in clause 10.1.1. This test case is applicable only for local area NCR-MT and for NCR type 1-H.

The test parameters are given in table G.2.1.1.1.1.1-1, table G.2.1.1.1.1.1-2 and table G.2.1.1.1.1.1-3 below. The test consists of 3 successive time periods, with time duration of T1, T2 and T3 respectively. At the start of time period T2, cell 1, which is the active cell, becomes inactive. The time period T3 starts after the occurrence of the radio link failure. During T1, the NCR-MT shall be configured with the carrier frequency of cell 2 (with RF Channel Number #2) to ensure that the NCR-MT has the context of the carrier frequency of cell 2 by the end of T1.

**Table G.2.1.1.1.1.1-1: Supported test configurations**

| Configuration                                                                               | Description of serving cell                       | Description of target cell                        |
|---------------------------------------------------------------------------------------------|---------------------------------------------------|---------------------------------------------------|
| 1                                                                                           | 15 kHz SSB SCS, 10 MHz bandwidth, TDD duplex mode | 15 kHz SSB SCS, 10 MHz bandwidth, TDD duplex mode |
| 2                                                                                           | 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode | 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode |
| 3                                                                                           | 15 kHz SSB SCS, 10 MHz bandwidth, FDD duplex mode | 15 kHz SSB SCS, 10 MHz bandwidth, FDD duplex mode |
| Note: The NCR-MT is only required to be tested in one of the supported test configurations. |                                                   |                                                   |

**Table G.2.1.1.1.1-2: General test parameters for NR inter-frequency RRC Re-establishment test case in FR1**

| Parameter                  |                 | Unit | Test configuration | Value                     | Comment                                                       |
|----------------------------|-----------------|------|--------------------|---------------------------|---------------------------------------------------------------|
| Initial condition          | Active cell     |      | 1, 2               | Cell1                     |                                                               |
|                            | Neighbour cells |      | 1, 2               | Cell2                     |                                                               |
| Final condition            | Active cell     |      | 1, 2               | Cell2                     |                                                               |
| RF Channel Number          |                 |      | 1, 2               | 1, 2                      |                                                               |
| Time offset between cells  |                 |      | 1, 2               | 3 $\mu$ s                 | Synchronous cells                                             |
| N310                       |                 | -    | 1, 2               | 1                         | Maximum consecutive out-of-sync indications from lower layers |
| N311                       |                 | -    | 1, 2               | 1                         | Minimum consecutive in-sync indications from lower layers     |
| T310                       |                 | ms   | 1, 2               | 0                         | Radio link failure timer; T310 is disabled                    |
| T311                       |                 | ms   | 1, 2               | 30000                     | RRC re-establishment timer                                    |
| Access Barring Information |                 | -    | 1, 2               | Not Sent                  | No additional delays in random access procedure.              |
| SSB configuration          |                 |      | 1                  | SSB.1 FR1                 |                                                               |
|                            |                 |      | 2                  | SSB.2 FR1                 |                                                               |
| SMTC configuration         |                 |      | 1                  | SMTC pattern 1            |                                                               |
|                            |                 |      | 2                  | SMTC pattern 1            |                                                               |
| DRX cycle length           |                 | s    | 1, 2               | OFF                       |                                                               |
| PRACH configuration        |                 |      | 1, 2               | FR1 PRACH configuration 1 | TBD                                                           |
| T1                         |                 | s    | 1, 2               | 20                        |                                                               |
| T2                         |                 | ms   | 1, 2               | 1000                      | Time for the NCR-MT to detect RLF                             |
| T3                         |                 | s    | 1, 2               | 20                        |                                                               |

**Table G.2.1.1.1.1-3: Cell specific test parameters for NR inter-frequency RRC Re-establishment test case in FR1**

| Parameter                                                                                                                                                                                                              | Unit          | Test configuration | Cell 1              |           |           | Cell 2              |           |            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------|---------------------|-----------|-----------|---------------------|-----------|------------|
|                                                                                                                                                                                                                        |               |                    | T1                  | T2        | T3        | T1                  | T2        | T3         |
| RF Channel Number                                                                                                                                                                                                      |               | 1, 2               | 1                   |           |           | 2                   |           |            |
| TDD configuration                                                                                                                                                                                                      |               | 1                  | TDDConf.1.1         |           |           | TDDConf.1.1         |           |            |
|                                                                                                                                                                                                                        |               | 2                  | TDDConf.2.1         |           |           | TDDConf.2.1         |           |            |
| PDSCH RMC configuration                                                                                                                                                                                                |               | 1                  | SR.1.1 FDD          |           |           | N/A                 |           |            |
|                                                                                                                                                                                                                        |               | 2                  | SR.1.1 TDD          |           |           |                     |           |            |
|                                                                                                                                                                                                                        |               | 3                  | SR.1.1 FDD          |           |           |                     |           |            |
| RMSI CORESET RMC configuration                                                                                                                                                                                         |               | 1                  | CR.1.1 TDD          |           |           | CR.1.1 TDD          |           |            |
|                                                                                                                                                                                                                        |               | 2                  | CR.2.1 TDD          |           |           | CR.2.1 TDD          |           |            |
|                                                                                                                                                                                                                        |               | 3                  | CR.1.1 FDD          |           |           | CR.1.1 FDD          |           |            |
| Dedicated CORESET RMC configuration                                                                                                                                                                                    |               | 1                  | CCR.1.1 TDD         |           |           | CCR.1.1 TDD         |           |            |
|                                                                                                                                                                                                                        |               | 2                  | CCR.2.1 TDD         |           |           | CCR.2.1 TDD         |           |            |
|                                                                                                                                                                                                                        |               | 3                  | CCR.1.1 FDD         |           |           | CCR.1.1 FDD         |           |            |
| OCNG Pattern                                                                                                                                                                                                           |               | 1, 2               | OP.1 defined in TBD |           |           | OP.1 defined in TBD |           |            |
| TRS configuration                                                                                                                                                                                                      |               | 1                  | TRS.1.1 TDD         |           |           | N/A                 |           |            |
|                                                                                                                                                                                                                        |               | 2                  | TRS.1.2 TDD         |           |           |                     |           |            |
|                                                                                                                                                                                                                        |               | 3                  | TRS.1.1 FDD         |           |           |                     |           |            |
| Initial DL BWP configuration                                                                                                                                                                                           |               | 1, 2               | DLBWP.0             |           |           | DLBWP.0             |           |            |
| Initial UL BWP configuration                                                                                                                                                                                           |               | 1, 2               | ULBWP.0             |           |           | ULBWP.0             |           |            |
| Active DL BWP configuration                                                                                                                                                                                            |               | 1, 2               | DLBWP.1.1           | N/A       | N/A       | N/A                 | N/A       | DLBW P.1.1 |
| Active UL BWP configuration                                                                                                                                                                                            |               | 1, 2               | ULBWP.1.1           | N/A       | N/A       | N/A                 | N/A       | ULBW P.1.1 |
| RLM-RS                                                                                                                                                                                                                 |               | 1, 2               | SSB                 |           |           | SSB                 |           |            |
| $\hat{E}_s / I_{ot}$                                                                                                                                                                                                   | dB            | 1, 2               | 4                   | -infinity | -infinity | -infinity           | -infinity | 7          |
| $N_{oc}$ <sup>Note2</sup>                                                                                                                                                                                              | dBm/SCS       | 1                  | -98                 |           |           |                     |           |            |
|                                                                                                                                                                                                                        |               | 2                  | -95                 |           |           |                     |           |            |
| $N_{oc}$ <sup>Note2</sup>                                                                                                                                                                                              | dBm/15 kHz    | 1, 2               | -98                 |           |           |                     |           |            |
| $\hat{E}_s / N_{oc}$                                                                                                                                                                                                   | dB            | 1, 2               | 4                   | -infinity | -infinity | -infinity           | -infinity | 7          |
| SS-RSRP <sup>Note3</sup>                                                                                                                                                                                               | dBm/SCS       | 1                  | -94                 | -infinity | -infinity | -infinity           | -infinity | -91        |
|                                                                                                                                                                                                                        |               | 2                  | -91                 | -infinity | -infinity | -infinity           | -infinity | -88        |
| Io                                                                                                                                                                                                                     | dBm/9.36 MHz  | 1                  | -64.59              | -70.05    | -70.05    | -70.05              | -70.05    | -62.26     |
|                                                                                                                                                                                                                        | dBm/38.16 MHz | 2                  | -58.50              | -63.94    | -63.94    | -63.94              | -63.94    | -56.15     |
| Propagation Condition                                                                                                                                                                                                  |               | 1, 2               | AWGN                |           |           |                     |           |            |
| Note 1: OCNG shall be used such that both cells are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.                                                          |               |                    |                     |           |           |                     |           |            |
| Note 2: Interference from other cells and noise sources not specified in the test is assumed to be constant over subcarriers and time and shall be modelled as AWGN of appropriate power for $N_{oc}$ to be fulfilled. |               |                    |                     |           |           |                     |           |            |
| Note 3: SS-RSRP levels have been derived from other parameters for information purposes. They are not settable parameters themselves.                                                                                  |               |                    |                     |           |           |                     |           |            |

**G.2.1.1.1.1.2 Test Requirements**

The RRC re-establishment delay is defined as the time from the start of time period T3, to the moment when the NCR-MT starts to send PRACH preambles to cell 2 for sending the *RRCReestablishmentRequest* message to cell 2.

The RRC re-establishment delay to an unknown NR inter frequency cell shall be less than 14.5 s.

The rate of correct RRC re-establishments observed during repeated tests shall be at least 90%.

NOTE: The RRC re-establishment delay in the test is derived from the following expression:

$$T_{re-establish\_delay} = T_{NCR-MT\_re-establish\_delay} + T_{UL\_grant}$$

Where:

$T_{UL\_grant}$  = It is the time required to acquire and process uplink grant from the target cell. The PRACH reception is used as a trigger for the completion of the test; hence  $T_{UL\_grant}$  is not used.

$$T_{NCR-MT\_re-establish\_delay} = 400 \text{ ms} + T_{identify\_intra\_NR} + \sum_{i=1}^{N_{freq}-1} T_{identify\_inter\_NR,i} + T_{SI-NR} + T_{PRACH}$$

$$N_{freq} = 2$$

$$T_{identify\_intra\_NR} = 6400 \text{ ms}$$

$$T_{identify\_inter\_NR} = 6400 \text{ ms}$$

$T_{SI-NR} = 1280 \text{ ms}$ ; it is the time required for receiving all the relevant system information as defined in TS 38.331 for the target inter-frequency NR cell.

$T_{PRACH} = 15 \text{ ms}$ ; it is the additional delay caused by the random access procedure.

This gives a total of 14495 ms, allow 14.5 s in the test case.

#### G.2.1.1.1.2 Intra-frequency RRC Re-establishment in FR1 without serving cell timing for LA NCR-MT

##### G.2.1.1.1.2.1 Test Purpose and Environment

The purpose is to verify that the NR intra-frequency RRC re-establishment delay in FR1 without serving cell timing is within the specified limits. These tests will verify the requirements in clause 10.1.1. This test case is applicable only for local area NCR-MT and for NCR type 1-H.

The test parameters are given in table G.2.1.1.1.2.1-1, table G.2.1.1.1.2.1-2 and table G.2.1.1.1.2.1-3 below. The test consists of 3 successive time periods, with time duration of T1, T2 and T3 respectively. At the start of time period T2, cell 1, which is the active cell, is deactivated. The time period T3 starts after the occurrence of the radio link failure.

**Table G.2.1.1.1.2.1-1: Supported test configurations**

| Configuration                                                                               | Description                                       |
|---------------------------------------------------------------------------------------------|---------------------------------------------------|
| 1                                                                                           | 15 kHz SSB SCS, 10 MHz bandwidth, TDD duplex mode |
| 2                                                                                           | 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode |
| 3                                                                                           | 15 kHz SSB SCS, 10 MHz bandwidth, FDD duplex mode |
| Note: The NCR-MT is only required to be tested in one of the supported test configurations. |                                                   |

**Table G.2.1.1.1.2.1-2: General test parameters for NR intra-frequency RRC Re-establishment test case in FR1**

| Parameter                  |                 | Unit | Test configuration | Value                     | Comment                                                              |
|----------------------------|-----------------|------|--------------------|---------------------------|----------------------------------------------------------------------|
| Initial condition          | Active cell     |      | 1, 2               | Cell1                     |                                                                      |
|                            | Neighbour cells |      | 1, 2               | Cell2                     |                                                                      |
| Final condition            | Active cell     |      | 1, 2               | Cell2                     |                                                                      |
| RF Channel Number          |                 |      | 1, 2               | 1, 2                      |                                                                      |
| Time offset between cells  |                 |      | 1, 2               | 3 $\mu$ s                 | Synchronous cells                                                    |
| N310                       |                 | -    | 1, 2               | 1                         | Maximum consecutive out-of-sync indications from lower layers        |
| N311                       |                 | -    | 1, 2               | 1                         | Minimum consecutive in-sync indications from lower layers            |
| T310                       |                 | ms   | 1, 2               | 6000                      | Radio link failure timer configured by <i>RLF-TimersAndConstants</i> |
| T311                       |                 | ms   | 1, 2               | 15000                     | RRC re-establishment timer                                           |
| Access Barring Information |                 | -    | 1, 2               | Not Sent                  | No additional delays in random access procedure.                     |
| SSB configuration          |                 |      | 1                  | SSB.1 FR1                 |                                                                      |
|                            |                 |      | 2                  | SSB.2 FR1                 |                                                                      |
| SMTC configuration         |                 |      | 1                  | SMTC pattern 1            |                                                                      |
|                            |                 |      | 2                  | SMTC pattern 1            |                                                                      |
| DRX cycle length           |                 | s    | 1, 2               | OFF                       |                                                                      |
| PRACH configuration        |                 |      | 1, 2               | FR1 PRACH configuration 1 | TBD                                                                  |
| T1                         |                 | s    | 1, 2               | 10                        |                                                                      |
| T2                         |                 | s    | 1, 2               | 7                         | Time for the NCR-MT to detect RLF                                    |
| T3                         |                 | s    | 1, 2               | 10                        |                                                                      |

**Table G.2.1.1.2.1-3: Cell specific test parameters for NR intra-frequency RRC Re-establishment test case in FR1**

| Parameter                                                                                                                                                                                                              | Unit         | Test configuration | Cell 1              |           |           | Cell 2              |           |        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------|---------------------|-----------|-----------|---------------------|-----------|--------|
|                                                                                                                                                                                                                        |              |                    | T1                  | T2        | T3        | T1                  | T2        | T3     |
| TDD configuration                                                                                                                                                                                                      |              | 1                  | TDDConf.1.1         |           |           | TDDConf.1.1         |           |        |
|                                                                                                                                                                                                                        |              | 2                  | TDDConf.2.1         |           |           | TDDConf.2.1         |           |        |
| PDSCH RMC configuration                                                                                                                                                                                                |              | 1                  | SR.1.1 TDD          |           |           | N/A                 |           |        |
|                                                                                                                                                                                                                        |              | 2                  | SR.2.1 TDD          |           |           |                     |           |        |
|                                                                                                                                                                                                                        |              | 3                  | SR.1.1 FDD          |           |           |                     |           |        |
| RMSI CORESET RMC configuration                                                                                                                                                                                         |              | 1                  | CR.1.1 TDD          |           |           | CR.1.1 TDD          |           |        |
|                                                                                                                                                                                                                        |              | 2                  | CR.2.1 TDD          |           |           | CR.2.1 TDD          |           |        |
|                                                                                                                                                                                                                        |              | 3                  | CR.1.1 FDD          |           |           | CR.1.1 FDD          |           |        |
| Dedicated CORESET RMC configuration                                                                                                                                                                                    |              | 1                  | CCR.1.1 TDD         |           |           | CCR.1.1 TDD         |           |        |
|                                                                                                                                                                                                                        |              | 2                  | CCR.2.1 TDD         |           |           | CCR.2.1 TDD         |           |        |
|                                                                                                                                                                                                                        |              | 3                  | CCR.1.1 FDD         |           |           | CCR.1.1 FDD         |           |        |
| OCNG Pattern                                                                                                                                                                                                           |              | 1, 2               | OP.1 defined in TBD |           |           | OP.1 defined in TBD |           |        |
| Initial DL BWP configuration                                                                                                                                                                                           |              | 1, 2               | DLBWP.0.1           |           |           | DLBWP.0.1           |           |        |
| Initial UL BWP configuration                                                                                                                                                                                           |              | 1, 2               | ULBWP.0.1           |           |           | ULBWP.0.1           |           |        |
| RLM-RS                                                                                                                                                                                                                 |              | 1, 2               | SSB                 |           |           | SSB                 |           |        |
| $\hat{E}_s / I_{ot}$                                                                                                                                                                                                   | dB           | 1, 2               | 4                   | -infinity | -infinity | -infinity           | -infinity | 4      |
| $N_{oc}$ <sup>Note2</sup>                                                                                                                                                                                              | dBm/SCS      | 1                  | -98                 |           |           |                     |           |        |
|                                                                                                                                                                                                                        |              | 2                  | -95                 |           |           |                     |           |        |
| $N_{oc}$ <sup>Note2</sup>                                                                                                                                                                                              | dBm/15 kHz   | 1, 2               | -98                 |           |           |                     |           |        |
| $\hat{E}_s / N_{oc}$                                                                                                                                                                                                   | dB           | 1, 2               | 4                   | -infinity | -infinity | -infinity           | -infinity | 4      |
| SS-RSRP <sup>Note3</sup>                                                                                                                                                                                               | dBm/SCS      | 1                  | -94                 | -infinity | -infinity | -infinity           | -infinity | -94    |
|                                                                                                                                                                                                                        |              | 2                  | -91                 | -infinity | -infinity | -infinity           | -infinity | -91    |
| Io                                                                                                                                                                                                                     | dBm/9.36 MHz | 1                  | -64.59              | -infinity | -infinity | -infinity           | -infinity | -64.59 |
|                                                                                                                                                                                                                        | dBm/9.36 MHz | 2                  | -58.50              | -infinity | -infinity | -infinity           | -infinity | -58.50 |
| Propagation Condition                                                                                                                                                                                                  |              | 1, 2               | AWGN                |           |           |                     |           |        |
| Note 1: OCNG shall be used such that both cells are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.                                                          |              |                    |                     |           |           |                     |           |        |
| Note 2: Interference from other cells and noise sources not specified in the test is assumed to be constant over subcarriers and time and shall be modelled as AWGN of appropriate power for $N_{oc}$ to be fulfilled. |              |                    |                     |           |           |                     |           |        |
| Note 3: SS-RSRP levels have been derived from other parameters for information purposes. They are not settable parameters themselves.                                                                                  |              |                    |                     |           |           |                     |           |        |

**G.2.1.1.2.2 Test Requirements**

The RRC re-establishment delay is defined as the time from the start of time period T3, to the moment when the NCR-MT starts to send PRACH preambles to cell 2 for sending the *RRCReestablishmentRequest* message to cell 2.

The RRC re-establishment delay to an unknown NR intra frequency cell without serving cell timing shall be less than 8.1 s.

The rate of correct RRC re-establishments observed during repeated tests shall be at least 90%.

NOTE: The RRC re-establishment delay in the test is derived from the following expression:

$$T_{re-establish\_delay} = T_{NCR-MT\_re-establish\_delay} + T_{UL\_grant}$$

Where:

$T_{UL\_grant}$  = It is the time required to acquire and process uplink grant from the target cell. The PRACH reception is used as a trigger for the completion of the test; hence  $T_{UL\_grant}$  is not used.

$$T_{NCR-MT\_re-establish\_delay} = 400 \text{ ms} + T_{identify\_intra\_NR} + \sum_{i=1}^{N_{freq}-1} T_{identify\_inter\_NR,i} + T_{SI-NR} + T_{PRACH}$$

$$N_{freq} = 1$$

$$T_{identify\_intra\_NR} = 6400 \text{ ms}$$

$T_{SI-NR} = 1280 \text{ ms}$ ; it is the time required for receiving all the relevant system information as defined in TS 38.331 [2] for the target intra-frequency NR cell.

$T_{PRACH} = 15 \text{ ms}$ ; it is the additional delay caused by the random access procedure.

This gives a total of 8095 ms, allow 8.1 s in the test case.

### G.2.1.1.1.3 Inter-frequency RRC Re-establishment in FR2-1 for LA NCR-MT

#### G.2.1.1.1.3.1 Test Purpose and Environment

The purpose is to verify that the NR inter-frequency RRC re-establishment delay in FR2-1 without known target cell is within the specified limits. These tests will verify the requirements in clause 10.1.1. This test case is applicable only for local area NCR-MT and for NCR type 2-O.

The test parameters are given in table G.2.1.1.1.3.1-1, table G.2.1.1.1.3.1-2 and table G.2.1.1.1.3.1-3 below. The test consists of 3 successive time periods, with time duration of T1, T2 and T3 respectively. At the start of time period T2, cell 1, which is the active cell, becomes inactive. The time period T3 starts after the occurrence of the radio link failure. During T1, the NCR-MT shall be configured with the carrier frequency of cell 2 (with RF Channel Number #2) to ensure that the NCR-MT has the context of the carrier frequency of cell 2 by the end of T1.

**Table G.2.1.1.1.3.1-1: Supported test configurations**

| Configuration | Description                                            |
|---------------|--------------------------------------------------------|
| 1             | NR 120 kHz SSB SCS, 100 MHz bandwidth, TDD duplex mode |

**Table G.2.1.1.1.3.1-2: General test parameters for NR inter-frequency RRC Re-establishment test case in FR2-1**

| Parameter                  |                 | Unit | Test configuration | Value                       | Comment                                                       |
|----------------------------|-----------------|------|--------------------|-----------------------------|---------------------------------------------------------------|
| Initial condition          | Active cell     |      | 1                  | Cell1                       |                                                               |
|                            | Neighbour cells |      | 1                  | Cell2                       |                                                               |
| Final condition            | Active cell     |      | 1                  | Cell2                       |                                                               |
| RF Channel Number          |                 |      | 1                  | 1, 2                        |                                                               |
| Time offset between cells  |                 |      | 1                  | 3 $\mu$ s                   | Synchronous cells                                             |
| N310                       |                 | -    | 1                  | 1                           | Maximum consecutive out-of-sync indications from lower layers |
| N311                       |                 | -    | 1                  | 1                           | Minimum consecutive in-sync indications from lower layers     |
| T310                       |                 | ms   | 1                  | 0                           | Radio link failure timer; T310 is disabled                    |
| T311                       |                 | ms   | 1                  | 30000                       | RRC re-establishment timer                                    |
| Access Barring Information |                 | -    | 1                  | Not Sent                    | No additional delays in random access procedure.              |
| SSB configuration          |                 |      | 1                  | SSB.1 FR2-1                 |                                                               |
|                            |                 |      | 1                  | SMTC pattern 1              |                                                               |
| DRX cycle length           |                 | s    | 1                  | OFF                         |                                                               |
| PRACH configuration        |                 |      | 1                  | FR2-1 PRACH configuration 1 | Table TBD                                                     |
| T1                         |                 | s    | 1                  | 10                          |                                                               |
| T2                         |                 | ms   | 1                  | 4800                        | Time for the NCR-MT to detect RLF                             |
| T3                         |                 | s    | 1                  | 20                          |                                                               |

**Table G.2.1.1.3.1-3: Cell specific test parameters for NR inter-frequency RRC Re-establishment test case in FR2-1**

| Parameter                                                                                                                                                                                                              | Unit          | Test configuration | Cell 1                                 |           |           | Cell 2              |           |        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------|----------------------------------------|-----------|-----------|---------------------|-----------|--------|
|                                                                                                                                                                                                                        |               |                    | T1                                     | T2        | T3        | T1                  | T2        | T3     |
| AoA setup                                                                                                                                                                                                              |               | 1                  | Setup 2 as specified in clause G.1.8.2 |           |           |                     |           |        |
| TDD configuration                                                                                                                                                                                                      |               | 1                  | TDDConf.3.1                            |           |           | TDDConf.3.1         |           |        |
| PDSCH RMC configuration                                                                                                                                                                                                |               | 1                  | SR.3.1 TDD                             |           |           | N/A                 |           |        |
| RMSI CORESET RMC configuration                                                                                                                                                                                         |               | 1                  | CR.3.1 TDD                             |           |           | CR.3.1 TDD          |           |        |
| Dedicated CORESET RMC configuration                                                                                                                                                                                    |               | 1                  | CCR.3.1 TDD                            |           |           | CCR.3.1 TDD         |           |        |
| TRS configuration                                                                                                                                                                                                      |               | 1                  | TRS.2.1 TDD                            |           |           | N/A                 |           |        |
| PDSCH/PDCCH TCI state                                                                                                                                                                                                  |               | 1                  | TCI.State.2                            |           |           | N/A                 |           |        |
| OCNG Pattern                                                                                                                                                                                                           |               | 1                  | OP.1 defined in TBD                    |           |           | OP.1 defined in TBD |           |        |
| Initial DL BWP configuration                                                                                                                                                                                           |               | 1                  | DLBWP.0.1                              |           |           | DLBWP.0.1           |           |        |
| Initial UL BWP configuration                                                                                                                                                                                           |               | 1                  | ULBWP.0.1                              |           |           | ULBWP.0.1           |           |        |
| RLM-RS                                                                                                                                                                                                                 |               | 1                  | SSB                                    |           |           | SSB                 |           |        |
| $\hat{E}_s / I_{ot}$                                                                                                                                                                                                   | dB            | 1                  | 5                                      | -infinity | -infinity | -infinity           | -infinity | 8      |
| $N_{oc}$ <sup>Note2</sup>                                                                                                                                                                                              | dBm/15 kHz    | 1                  | -98                                    |           |           |                     |           |        |
| $N_{oc}$ <sup>Note2</sup>                                                                                                                                                                                              | dBm/SCS       | 1                  | -89                                    |           |           |                     |           |        |
| $\hat{E}_s / N_{oc}$                                                                                                                                                                                                   | dB            | 1                  | 5                                      | -infinity | -infinity | -infinity           | -infinity | 8      |
| SS-RSRP <sup>Note3</sup>                                                                                                                                                                                               | dBm/SCS       | 1                  | -84                                    | -infinity | -infinity | -infinity           | -infinity | -81    |
| Io                                                                                                                                                                                                                     | dBm/95.04 MHz | 1                  | -53.82                                 | -infinity | -infinity | -infinity           | -infinity | -51.37 |
| Propagation Condition                                                                                                                                                                                                  |               | 1                  | AWGN                                   |           |           |                     |           |        |
| Note 1: OCNG shall be used such that both cells are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.                                                          |               |                    |                                        |           |           |                     |           |        |
| Note 2: Interference from other cells and noise sources not specified in the test is assumed to be constant over subcarriers and time and shall be modelled as AWGN of appropriate power for $N_{oc}$ to be fulfilled. |               |                    |                                        |           |           |                     |           |        |
| Note 3: SS-RSRP levels have been derived from other parameters for information purposes. They are not settable parameters themselves.                                                                                  |               |                    |                                        |           |           |                     |           |        |
| Note 4: Void                                                                                                                                                                                                           |               |                    |                                        |           |           |                     |           |        |

**G.2.1.1.3.2 Test Requirements**

The RRC re-establishment delay is defined as the time from the start of time period T3, to the moment when the NCR-MT starts to send PRACH preambles to cell 2 for sending the *RRCReestablishmentRequest* message to cell 2.

The RRC re-establishment delay to an unknown NR inter frequency cell shall be less than 18 s.

The rate of correct RRC re-establishments observed during repeated tests shall be at least 90%.

NOTE: The RRC re-establishment delay in the test is derived from the following expression:

$$T_{re-establish\_delay} = T_{NCR-MT\_re-establish\_delay} + T_{UL\_grant}$$

Where:

$T_{UL\_grant}$  = It is the time required to acquire and process uplink grant from the target cell. The PRACH reception is used as a trigger for the completion of the test; hence  $T_{UL\_grant}$  is not used.

$$T_{NCR-MT\_re-establish\_delay} = 400 \text{ ms} + T_{identify\_intra\_NR} + \sum_{i=1}^{N_{freq}-1} T_{identify\_inter\_NR,i} + T_{SI-NR} + T_{PRACH}$$

$$N_{freq} = 2$$

$$T_{\text{identify\_intra\_NR}} = 8000 \text{ ms}$$

$$T_{\text{identify\_inter\_NR}} = 8000 \text{ ms}$$

$T_{SI-NR} = 1280 \text{ ms}$ ; it is the time required for receiving all the relevant system information as defined in TS 38.331 for the target inter-frequency NR cell.

$T_{\text{PRACH}} = 15 \text{ ms}$ ; it is the additional delay caused by the random access procedure.

This gives a total of 17695 ms, allow 18 s in the test case.

#### G.2.1.1.1.4 Intra-frequency RRC Re-establishment in FR2-1 without serving cell timing for LA NCR-MT

##### G.2.1.1.1.4.1 Test Purpose and Environment

The purpose is to verify that the NR intra-frequency RRC re-establishment delay in FR2-1 without serving cell timing is within the specified limits. These tests will verify the requirements in clause 10.1.1. This test case is applicable only for local area NCR-MT and for NCR type 2-O.

The test parameters are given in table G.2.1.1.1.4.1-1, table G.2.1.1.1.4.1-2 and table G.2.1.1.1.4.1-3 below. The test consists of 3 successive time periods, with time duration of T1, T2 and T3 respectively. At the start of time period T2, cell 1, which is the active cell, is deactivated. The time period T3 starts after the occurrence of the radio link failure.

**Table G.2.1.1.1.4.1-1: Supported test configurations**

| Configuration | Description                                         |
|---------------|-----------------------------------------------------|
| 1             | 120 kHz SSB SCS, 100 MHz bandwidth, TDD duplex mode |

**Table G.2.1.1.1.4.1-2: General test parameters for NR intra-frequency RRC Re-establishment test case in FR2-1**

| Parameter                  |                 | Unit | Test configuration | Value                       | Comment                                                              |
|----------------------------|-----------------|------|--------------------|-----------------------------|----------------------------------------------------------------------|
| Initial condition          | Active cell     |      | 1                  | Cell1                       |                                                                      |
|                            | Neighbour cells |      | 1                  | Cell2                       |                                                                      |
| Final condition            | Active cell     |      | 1                  | Cell2                       |                                                                      |
| RF Channel Number          |                 |      | 1                  | 1                           |                                                                      |
| Time offset between cells  |                 |      | 1                  | 3 $\mu\text{s}$             | Synchronous cells                                                    |
| N310                       |                 | -    | 1                  | 1                           | Maximum consecutive out-of-sync indications from lower layers        |
| N311                       |                 | -    | 1                  | 1                           | Minimum consecutive in-sync indications from lower layers            |
| T310                       |                 | ms   | 1                  | 6000                        | Radio link failure timer configured by <i>RLF-TimersAndConstants</i> |
| T311                       |                 | ms   | 1                  | 30000                       | RRC re-establishment timer                                           |
| Access Barring Information |                 | -    | 1                  | Not Sent                    | No additional delays in random access procedure.                     |
| SSB configuration          |                 |      | 1                  | SSB.1 FR2-1                 |                                                                      |
| SMTC configuration         |                 |      | 1                  | SMTC pattern 1              |                                                                      |
| DRX cycle length           |                 | s    | 1                  | OFF                         |                                                                      |
| PRACH configuration        |                 |      | 1                  | FR2-1 PRACH configuration 1 | Table TBD                                                            |
| T1                         |                 | s    | 1                  | 10                          |                                                                      |
| T2                         |                 | s    | 1                  | 10800                       | Time for the NCR-MT to detect RLF                                    |
| T3                         |                 | s    | 1                  | 30                          |                                                                      |

**Table G.2.1.1.4.1-3: Cell specific test parameters for NR intra-frequency RRC Re-establishment test case in FR2-1**

| Parameter                                                                                                                                                                                                              | Unit          | Test configuration | Cell 1                                 |           |           | Cell 2                 |           |        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------|----------------------------------------|-----------|-----------|------------------------|-----------|--------|
|                                                                                                                                                                                                                        |               |                    | T1                                     | T2        | T3        | T1                     | T2        | T3     |
| AoA setup                                                                                                                                                                                                              |               | 1                  | Setup 2 as specified in clause G.1.8.2 |           |           |                        |           |        |
| TDD configuration                                                                                                                                                                                                      |               | 1                  | TDDConf.3.1                            |           |           | TDDConf.3.1            |           |        |
|                                                                                                                                                                                                                        |               | 1                  | SR.3.1 TDD                             |           |           | N/A                    |           |        |
| RMSI CORESET RMC configuration                                                                                                                                                                                         |               | 1                  | CR.3.1 FDD                             |           |           | CR.3.1 FDD             |           |        |
| Dedicated CORESET RMC configuration                                                                                                                                                                                    |               | 1                  | CCR.3.1 FDD                            |           |           | CCR.3.1 FDD            |           |        |
| TRS configuration                                                                                                                                                                                                      |               | 1                  | TRS.2.1 TDD                            |           |           | N/A                    |           |        |
| TCI state                                                                                                                                                                                                              |               | 1                  | CSI-RS.Config.0                        |           |           | N/A                    |           |        |
| OCNG Pattern                                                                                                                                                                                                           |               | 1                  | OP.1 defined in TBD                    |           |           | OP.1 defined in TBD    |           |        |
| Initial DL BWP configuration                                                                                                                                                                                           |               | 1                  | DLBWP.0.1                              |           |           | DLBWP.0.1              |           |        |
| Initial UL BWP configuration                                                                                                                                                                                           |               | 1                  | ULBWP.0.1                              |           |           | ULBWP.0.1              |           |        |
| RLM-RS                                                                                                                                                                                                                 |               | 1                  | SSB                                    |           |           | SSB                    |           |        |
| AoA setup                                                                                                                                                                                                              |               | 1                  | Setup 1 defined in TBD                 |           |           | Setup 1 defined in TBD |           |        |
| $\hat{E}_s/I_{ot}$                                                                                                                                                                                                     | dB            | 1                  | 5                                      | -infinity | -infinity | -infinity              | -infinity | 5      |
| $N_{oc}$ <sup>Note2</sup>                                                                                                                                                                                              | dBm/SCS       | 1                  | -98                                    |           |           |                        |           |        |
| $N_{oc}$ <sup>Note2</sup>                                                                                                                                                                                              | dBm/15 kHz    | 1                  | -89                                    |           |           |                        |           |        |
| $\hat{E}_s/N_{oc}$                                                                                                                                                                                                     | dB            | 1                  | 5                                      | -infinity | -infinity | -infinity              | -infinity | 5      |
| SS-RSRP <sup>Note3</sup>                                                                                                                                                                                               | dBm/SCS       | 1                  | -93                                    | -infinity | -infinity | -infinity              | -infinity | -93    |
| Io                                                                                                                                                                                                                     | dBm/95.04 MHz | 1                  | -62.82                                 | -infinity | -infinity | -infinity              | -infinity | -62.82 |
| Propagation Condition                                                                                                                                                                                                  |               | 1                  | AWGN                                   |           |           |                        |           |        |
| Note 1: OCNG shall be used such that both cells are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.                                                          |               |                    |                                        |           |           |                        |           |        |
| Note 2: Interference from other cells and noise sources not specified in the test is assumed to be constant over subcarriers and time and shall be modelled as AWGN of appropriate power for $N_{oc}$ to be fulfilled. |               |                    |                                        |           |           |                        |           |        |
| Note 3: SS-RSRP levels have been derived from other parameters for information purposes. They are not settable parameters themselves.                                                                                  |               |                    |                                        |           |           |                        |           |        |
| Note 4: Void                                                                                                                                                                                                           |               |                    |                                        |           |           |                        |           |        |

**G.2.1.1.4.2 Test Requirements**

The RRC re-establishment delay is defined as the time from the start of time period T3, to the moment when the NCR-MT starts to send PRACH preambles to cell 2 for sending the *RRCReestablishmentRequest* message to cell 2.

The RRC re-establishment delay to an unknown NR intra frequency cell without serving cell timing shall be less than 30 s.

The rate of correct RRC re-establishments observed during repeated tests shall be at least 90%.

NOTE: The RRC re-establishment delay in the test is derived from the following expression:

$$T_{re-establish\_delay} = T_{NCR-MT\_re-establish\_delay} + T_{UL\_grant}$$

Where:

$T_{UL\_grant}$  = It is the time required to acquire and process uplink grant from the target cell. The PRACH reception is used as a trigger for the completion of the test; hence  $T_{UL\_grant}$  is not used.

$$T_{NCR-MT\_re-establish\_delay} = 400 \text{ ms} + T_{identify\_intra\_NR} + \sum_{i=1}^{N_{freq}-1} T_{identify\_inter\_NR,i} + T_{SI-NR} + T_{PRACH}$$

$$N_{freq} = 1$$

$$T_{\text{identify\_intra\_NR}} = 28160 \text{ ms}$$

$T_{SI-NR} = 1280 \text{ ms}$ ; it is the time required for receiving all the relevant system information as defined in TS 38.331 [2] for the target intra-frequency NR cell.

$T_{\text{PRACH}} = 15 \text{ ms}$ ; it is the additional delay caused by the random access procedure.

This gives a total of 29855 ms, allow 30 s in the test case.

## G.2.2 Timing

### G.2.2.1 Transmit timing

#### G.2.2.1.1 NR NCR-MT Transmit Timing Test for FR1

##### G.2.2.1.1.1 Test Purpose and environment

The purpose of this test is to verify that the NCR-MT can follow frame timing change of the connected gNodeB and that the NCR-MT initial transmit timing accuracy, maximum amount of timing change in one adjustment, minimum and maximum adjustment rate are within the specified limits. This test will verify the requirements in clause 10.2.1.2. Local area NCR-MT type 1-C and type 1-H shall be tested with this test.

Supported test configurations are shown in Table G.2.2.1.1.1-1.

**Table G.2.2.1.1.1-1: Supported test configurations for FR1 PCell**

| Configuration                                                                              | Description                                        |
|--------------------------------------------------------------------------------------------|----------------------------------------------------|
| 1                                                                                          | NR TDD, SSB SCS 15 kHz, data SCS 15 kHz, BW 10 MHz |
| 2                                                                                          | NR TDD, SSB SCS 30 kHz, data SCS 30 kHz, BW 40 MHz |
| Note: The NCR-MT is only required to be tested in one of the supported test configurations |                                                    |

For this test a single NR cell (Cell 1) is used. Table G.2.2.1.1.1-2 defines the parameters to be configured and strength of the transmitted signals. The transmit timing is verified by the NCR-MT transmitting SRS using the configuration defined in Table G.2.2.1.1.1-3.

**Table G.2.2.1.1-2: Cell Specific Test Parameters for UL Transmit Timing test**

| Parameter                                | Unit        | Config | Test1                       |
|------------------------------------------|-------------|--------|-----------------------------|
| SSB ARFCN                                |             | 1,2,3  | 1                           |
| TDD configuration                        |             | 1      | TDDConf.1.1                 |
|                                          |             | 2      | TDDConf.1.2                 |
| BW <sub>channel</sub>                    | MHz         | 1      | 10: N <sub>RB,c</sub> = 52  |
|                                          |             | 2      | 10: N <sub>RB,c</sub> = 52  |
|                                          |             | 3      | 40: N <sub>RB,c</sub> = 106 |
| Initial BWP Configuration                |             | 1,2,3  | DLBWP.0.1<br>ULBWP.0.1      |
| Dedicated BWP Configuration              |             | 1,2,3  | DLBWP.1.1<br>ULBWP.1.1      |
| DRX Cycle                                | ms          |        | N/A                         |
| PDSCH Reference measurement channel      |             | 1      | SR.1.1 TDD                  |
|                                          |             | 2      | SR.2.1 TDD                  |
| RMSI CORESET Reference Channel           |             | 1      | CR.1.1 TDD                  |
|                                          |             | 2      | CR.2.1 TDD                  |
| Dedicated CORESET Reference Channel      |             | 1      | CCR.1.1 TDD                 |
|                                          |             | 2      | CCR.2.1 TDD                 |
| OCNG Patterns                            |             | 1,2,3  | OP.1                        |
| SSB configuration                        |             | 1,2    | SSB.1 FR1                   |
|                                          |             | 3      | SSB.2 FR1                   |
| SMTc Configuration                       |             | 1,2    | SMTc.1                      |
|                                          |             | 3      | SMTc.2                      |
| TRS configuration                        |             | 1      | TRS.1.1 TDD                 |
|                                          |             | 2      | TRS.1.2 TDD                 |
| EPRE ratio of PSS to SSS                 | dB          | 1,2,3  | 0                           |
| EPRE ratio of PBCH DMRS to SSS           |             |        |                             |
| EPRE ratio of PBCH to PBCH DMRS          |             |        |                             |
| EPRE ratio of PDCCH DMRS to SSS          |             |        |                             |
| EPRE ratio of PDCCH to PDCCH DMRS        |             |        |                             |
| EPRE ratio of PDSCH DMRS to SSS          |             |        |                             |
| EPRE ratio of PDSCH to PDSCH             |             |        |                             |
| EPRE ratio of OCNG DMRS to SSS(Note 1)   |             |        |                             |
| EPRE ratio of OCNG to OCNG DMRS (Note 1) |             |        |                             |
| $N_{oc}^{Note2}$                         | dBm/15 kHz  | 1,2,3  | -98                         |
| $N_{oc}^{Note2}$                         | dBm/SCS     | 1,2    | -98                         |
|                                          |             | 3      | -95                         |
| $\hat{E}_s / I_{ot}$                     |             | 1,2,3  | 3                           |
| $\hat{E}_s / N_{oc}$                     |             | 1,2,3  | 3                           |
| SS-RSRP <sup>Note3</sup>                 | dBm/SCS     | 1,2    | -95                         |
|                                          |             | 3      | -92                         |
| I <sub>o</sub> <sup>Note3</sup>          | dBm/9.36MHz | 1,2    | -65.2                       |
|                                          | dBm/38.1MHz | 3      | -59.2                       |
| Propagation condition                    |             | 1,2,3  | AWGN                        |
| SRS Config                               |             | 1,2    | SRSCConf.1 <sup>Note5</sup> |
|                                          |             | 3      | SRSCConf.1 <sup>Note5</sup> |

|         |                                                                                                                                                                                                                |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Note 1: | OCNG shall be used such that the resources in Cell 1 are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.                                             |
| Note 2: | Interference from other cells and noise sources not specified in the test is assumed to be constant over subcarriers and time and shall be modelled as AWGN of appropriate power for $N_{oc}$ to be fulfilled. |
| Note 3: | SS-RSRP and $I_o$ levels have been derived from other parameters for information purposes. They are not settable parameters themselves.                                                                        |
| Note 4: | SS-RSRP minimum requirements are specified assuming independent interference and noise at each receiver antenna port.                                                                                          |
| Note 5: | SRS configs are given in Table G.2.2.1.1.1-3                                                                                                                                                                   |

**Table G.2.2.1.1.1-3: SRS Configuration for Timing Accuracy Test**

|                 | Field                            | SRSCnf.1                                                     | Comments           |
|-----------------|----------------------------------|--------------------------------------------------------------|--------------------|
| SRS-ResourceSet | srs-ResourceSetId                | 0                                                            |                    |
|                 | srs-ResourceList                 | 0                                                            |                    |
|                 | resourceType                     | Periodic                                                     |                    |
|                 | Usage                            | Codebook                                                     |                    |
| SRS-Resource    | SRS-ResourceId                   | 0                                                            |                    |
|                 | nrofSRS-Ports                    | Port1                                                        |                    |
|                 | transmissionComb                 | n2                                                           |                    |
|                 | combOffset-n2                    | 0                                                            |                    |
|                 | cyclicShift-n2                   | 0                                                            |                    |
|                 | resourceMapping startPosition    | 0                                                            |                    |
|                 | resourceMapping nrofSymbols      | n1                                                           |                    |
|                 | resourceMapping repetitionFactor | n1                                                           |                    |
|                 | freqDomainPosition               | 0                                                            |                    |
|                 | freqDomainShift                  | 0                                                            |                    |
|                 | freqHopping c-SRS                | 14 for test configuration 1,2<br>25 for test configuration 3 | Matches $N_{RB,c}$ |
|                 | freqHopping b-SRS                | 0                                                            |                    |
|                 | freqHopping b-hop                | 0                                                            |                    |
|                 | groupOrSequenceHopping           | Neither                                                      |                    |
|                 | resourceType                     | Periodic                                                     |                    |
|                 | periodicityAndOffset-p           | sl1, 0                                                       |                    |
|                 | sequenceId                       | 0                                                            | Any 10 bit number  |

### G.2.2.1.1.2 Test requirements

The test sequence shall be carried out in RRC\_CONNECTED for every test case.

Following will be the test sequence for this test

- 1) Setup NR PCell according to parameters given in Table G.2.2.1.1.1-1.
- 2) After connection set up with the cell, the test equipment will verify that the timing of the NR cell is within  $(N_{TA} + N_{TA\_offset}) \times T_c \pm T_e$  of the first path (in time) of DL SSB used by the NCR-MT to determine downlink timing is received from the reference cell at the NCR-MT antenna.
  - a. The  $N_{TA}$  offset value (in  $T_c$  units) is 25600
  - b. The  $T_e$  values depend on the DL and UL SCS for which the test is being run and are given in Table 10.2.1.2-1

- 3) The test system shall adjust the timing of the DL path by values given in Table G.2.2.1.1.2-1

**Table G.2.2.1.1.2-1: Adjustment Value for DL Timing**

| SCS of SSB signals (KHz) | Adjustment Value     |
|--------------------------|----------------------|
|                          | Test1                |
| 15                       | +64*64T <sub>c</sub> |
| 30                       | +32*64T <sub>c</sub> |

- 4) The test system shall verify that the adjustment step size and the adjustment rate shall be according to requirements specified in clause 10.2.1.2 Table 10.2.1.2.1-1 until the NCR-MT transmit timing offset is within  $(N_{TA} + N_{TA\_offset}) \times T_c \pm T_e$  respective to the first path (in time) of DL SSB used by the NCR-MT to determine downlink timing is received from the reference cell at the NCR-MT antenna.
- 5) The test system shall verify that the NCR-MT transmit timing offset stays within  $(N_{TA} + N_{TA\_offset}) \times T_c \pm T_e$  of the first path (in time) of DL SSB used by the NCR-MT to determine downlink timing is received from the reference cell at the NCR-MT antenna.

## G.2.2.1.2 NR NCR-MT Transmit Timing Test for FR2-1

### G.2.2.1.2.1 Test Purpose and environment

The purpose of this test is to verify that the NCR-MT can follow frame timing change of the connected gNodeB and that the NCR-MT initial transmit timing accuracy, maximum amount of timing change in one adjustment, minimum and maximum adjustment rate are within the specified limits. This test will verify the requirements in clause 10.2.1.2. Local area NCR-MT type 2-O shall be tested with this test.

Supported test configurations are shown in Table G.2.2.1.2.1-1.

**Table G.2.2.1.2.1-1: Supported test configurations for FR2-1 PCell**

| Configuration | Description                                           |
|---------------|-------------------------------------------------------|
| 1             | NR TDD, SSB SCS 240 kHz, data SCS 120 kHz, BW 100 MHz |

For this test a single NR cell is used. Tables G.2.2.1.2.1-2 and Tables G.2.2.1.2.1-2A define the parameters to be configured and strength of the transmitted signals. The transmit timing is verified by the NCR-MT transmitting SRS using the configuration defined in Table G.2.2.1.2.1-3.

Table G.2.2.1.2.1-2: Cell Specific Test Parameters for UL Transmit Timing test

| Parameter                                                                                                                                                                                                              | Unit | Config | Test1                       | Test2                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------|-----------------------------|---------------------------|
| SSB ARFCN                                                                                                                                                                                                              |      | 1      | Freq1                       | Freq1                     |
| BW <sub>channel</sub>                                                                                                                                                                                                  | MHz  | 1      | 100: N <sub>RB,C</sub> = 66 |                           |
| Initial BWP Configuration                                                                                                                                                                                              |      | 1      | DLBWP.0.1<br>ULBWP.0.1      |                           |
| Dedicated BWP Configuration                                                                                                                                                                                            |      | 1      | DLBWP.1.1<br>ULBWP.1.1      |                           |
| TRS Configuration                                                                                                                                                                                                      |      | 1      | TRS.2.1 TDD                 |                           |
| TCI State                                                                                                                                                                                                              |      | 1      | CSI-RS.Config.0             |                           |
| DRx Cycle                                                                                                                                                                                                              | ms   |        | N/A                         |                           |
| PDSCH Reference measurement channel                                                                                                                                                                                    |      | 1      | SR.3.1 TDD                  |                           |
| RMSI CORESET Reference Channel                                                                                                                                                                                         |      | 1      | CR.3.1 TDD                  |                           |
| Dedicated CORESET Reference Channel                                                                                                                                                                                    |      | 1      | CCR.3.1 TDD                 |                           |
| OCNG Patterns                                                                                                                                                                                                          |      | 1      | OP.1                        |                           |
| SSB Configuration                                                                                                                                                                                                      |      | 1      | SSB.4 FR2-1                 |                           |
| SMTC Configuration                                                                                                                                                                                                     |      | 1      | SMTC.1                      |                           |
| EPRE ratio of PSS to SSS                                                                                                                                                                                               | dB   | 1      | 0                           | 0                         |
| EPRE ratio of PBCH DMRS to SSS                                                                                                                                                                                         |      |        |                             |                           |
| EPRE ratio of PBCH to PBCH DMRS                                                                                                                                                                                        |      |        |                             |                           |
| EPRE ratio of PDCCH DMRS to SSS                                                                                                                                                                                        |      |        |                             |                           |
| EPRE ratio of PDCCH to PDCCH DMRS                                                                                                                                                                                      |      |        |                             |                           |
| EPRE ratio of PDSCH DMRS to SSS                                                                                                                                                                                        |      |        |                             |                           |
| EPRE ratio of PDSCH to PDSCH                                                                                                                                                                                           |      |        |                             |                           |
| EPRE ratio of OCNG DMRS to SSS(Note 1)                                                                                                                                                                                 |      |        |                             |                           |
| EPRE ratio of OCNG to OCNG DMRS (Note 1)                                                                                                                                                                               |      |        |                             |                           |
| Propagation condition                                                                                                                                                                                                  |      | 1      | AWGN                        |                           |
| SRS Config                                                                                                                                                                                                             |      | 1      | SRSCnf.1 <sup>Note5</sup>   | SRSCnf.2 <sup>Note5</sup> |
| Note 1: OCNG shall be used such that both cells are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.                                                          |      |        |                             |                           |
| Note 2: Interference from other cells and noise sources not specified in the test is assumed to be constant over subcarriers and time and shall be modelled as AWGN of appropriate power for $N_{oc}$ to be fulfilled. |      |        |                             |                           |
| Note 3: SS-RSRP and $I_o$ levels have been derived from other parameters for information purposes. They are not settable parameters themselves.                                                                        |      |        |                             |                           |
| Note 4: SS-RSRP minimum requirements are specified assuming independent interference and noise at each receiver antenna port.                                                                                          |      |        |                             |                           |
| Note 5: SRS confias are given in Table G.2.2.1.2.1-3                                                                                                                                                                   |      |        |                             |                           |

Table G.2.2.1.2.1-2A: OTA related test parameters

| Parameter                      | Unit                                                                                                                                                                                                           | Test 1                            | Test 2 |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|--------|
| Angle of arrival configuration |                                                                                                                                                                                                                | Setup 1 according to clause G.1.8 |        |
| $N_{oc}$ <sup>Note1</sup>      | dBm/15kHz <sup>Note4</sup>                                                                                                                                                                                     | -112                              |        |
| $N_{oc}$ <sup>Note1</sup>      | dBm/SCS <sup>Note3</sup>                                                                                                                                                                                       | -103                              |        |
| $\hat{E}_s/N_{oc}$             | dB                                                                                                                                                                                                             | 4                                 |        |
| SS-RSRP <sup>Note2</sup>       | dBm/SCS <sup>Note4</sup>                                                                                                                                                                                       | -99                               |        |
| $\hat{E}_s/I_{ot}$             | dB                                                                                                                                                                                                             | 4                                 |        |
| $I_o$ <sup>Note2</sup>         | dBm/95.04 MHz <sup>Note4</sup>                                                                                                                                                                                 | -68.5                             |        |
| Note 1:                        | Interference from other cells and noise sources not specified in the test is assumed to be constant over subcarriers and time and shall be modelled as AWGN of appropriate power for $N_{oc}$ to be fulfilled. |                                   |        |
| Note 2:                        | SS-RSRP and $I_o$ levels have been derived from other parameters for information purposes. They are not settable parameters themselves.                                                                        |                                   |        |
| Note 3:                        | SS-RSRP minimum requirements are specified assuming independent interference and noise at each receiver antenna port.                                                                                          |                                   |        |
| Note 4:                        | Equivalent power received by an antenna with 0dBi gain at the centre of the quiet zone                                                                                                                         |                                   |        |
| Note 5:                        | As observed with 0dBi gain antenna at the centre of the quiet zone                                                                                                                                             |                                   |        |

Table G.2.2.1.2.1-3: SRS Configuration for Timing Accuracy Test

|                 | Field                               | SRSCConf.1 | SRSCConf.2 | Comments           |
|-----------------|-------------------------------------|------------|------------|--------------------|
| SRS-ResourceSet | rsr-ResourceSetId                   | 0          | 0          |                    |
|                 | rsr-ResourceIdList                  | 0          | 0          |                    |
|                 | resourceType                        | Periodic   | Periodic   |                    |
|                 | Usage                               | Codebook   | Codebook   |                    |
| SRS-Resource    | SRS-ResourceId                      | 0          | 0          |                    |
|                 | nrofSRS-Ports                       | Port1      | Port1      |                    |
|                 | transmissionComb                    | n2         | n2         |                    |
|                 | combOffset-n2                       | 0          | 0          |                    |
|                 | cyclicShift-n2                      | 0          | 0          |                    |
|                 | resourceMapping<br>startPosition    | 0          | 0          |                    |
|                 | resourceMapping<br>nrofSymbols      | n1         | n1         |                    |
|                 | resourceMapping<br>repetitionFactor | n1         | n1         |                    |
|                 | freqDomainPosition                  | 0          | 0          |                    |
|                 | freqDomainShift                     | 0          | 0          |                    |
|                 | freqHopping<br>c-SRS                | 17         | 17         | Matches $N_{RB,c}$ |
|                 | freqHopping<br>b-SRS                | 0          | 0          |                    |
|                 | freqHopping<br>b-hop                | 0          | 0          |                    |
|                 | groupOrSequenceHopping              | Neither    | Neither    |                    |
|                 | resourceType                        | Periodic   | Periodic   |                    |
|                 | periodicityAndOffset-p              | sl1, 0     | sl2560, 4  |                    |
|                 | sequenceId                          | 0          | 0          | Any 10 bit number  |

### G.2.2.1.2.2 Test requirements

The test sequence shall be carried out in RRC\_CONNECTED for every test case.

Following will be the test sequence for this test:

- 1) Setup NR PCell according to parameters given in Table G.2.2.1.2.1-1.

- 2) After connection set up with the cell, the test equipment will verify that the timing of the NR cell is within  $(N_{TA} + N_{TA\_offset}) \times T_c \pm T_e$  of the first path (in time) of DL SSB used by the NCR-MT to determine downlink timing is received from the reference cell at the NCR-MT antenna.
  - a. The  $N_{TA}$  offset value (in  $T_c$  units) is 13792
  - b. The  $T_e$  values depend on the DL and UL SCS for which the test is being run and are given in Table 10.2.1.2-1
- 3) The test system shall adjust the timing of the DL path by values given in Table G.2.2.1.2.2-1

**Table G.2.2.1.2.2-1: Adjustment Value for DL Timing**

| SCS of SSB signals (kHz) | Adjustment Value   |                    |
|--------------------------|--------------------|--------------------|
|                          | Test1              | Test2              |
| 240                      | $+8 \times 64 T_c$ | $+4 \times 64 T_c$ |

- 4) The test system shall verify that the adjustment step size and the adjustment rate shall be according to requirements specified in clause 10.2.1.2 Table 10.2.1.2.1-1 until the NCR-MT transmit timing offset is within  $(N_{TA} + N_{TA\_offset}) \times T_c \pm T_e$  respective to the first path (in time) of DL SSB used by the NCR-MT to determine downlink timing is received from the reference cell at the NCR-MT antenna.
- 5) The test system shall verify that the NCR-MT transmit timing offset stays within  $(N_{TA} + N_{TA\_offset}) \times T_c \pm T_e$  of the first path (in time) of DL SSB used by the NCR-MT to determine downlink timing is received from the reference cell at the NCR-MT antenna.

## G.2.3 Signalling Characteristics for NCR MTs

### G.2.3.1 Radio link Monitoring

#### G.2.3.1.1 Radio Link Monitoring Out-of-sync Test for FR1 PCell configured with SSB-based RLM RS in non-DRX mode

##### G.2.3.1.1.1 Test Purpose and Environment

The purpose of this test is to verify that the NCR-MT properly detects the out of sync and in sync for the purpose of monitoring downlink radio link quality of the PCell. This test will partly verify the FR1 radio link monitoring requirements in clause 12.3.1.

In the test, NCR-MT is configured to perform RLM on SSB, with *detectionResource* included in *RadioLinkMonitoringRS* set to SSB#0 and SSB#1, and *purpose* set to 'rlf'. Supported test configurations are shown in table G.2.3.1.1.1-1. The test parameters are given in Tables G.2.3.1.1-2 and G.2.3.1.1-3 below. There is one cell (Cell 1), which is the active NR cell, in the test. The test consists of three successive time periods, with time duration of T1, T2 and T3 respectively. Figure G.2.3.1.1.1-1 shows the variation of the downlink SNR in the active cell to emulate out-of-sync and in-sync states. Prior to the start of the time duration T1, the NCR-MT shall be fully synchronized to Cell 1. The NCR-MT shall be configured for periodic CSI reporting with a reporting periodicity of 5 ms.

**Table G.2.3.1.1.1-1: Supported test configurations for FR1 PCell**

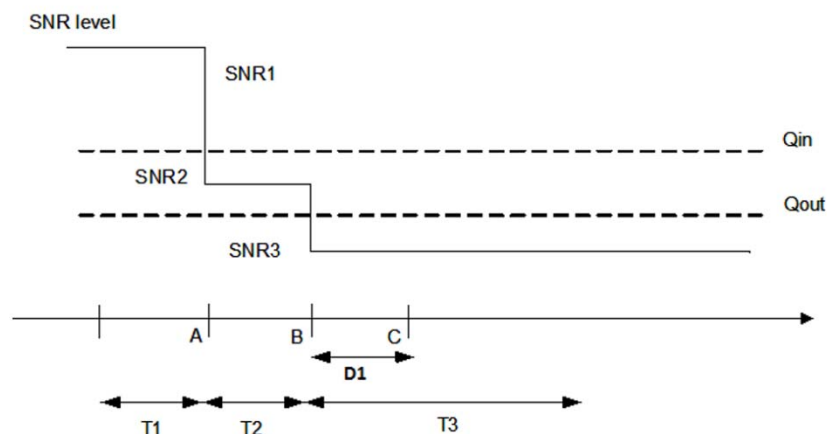
| Configuration                                                                                | Description                                     |
|----------------------------------------------------------------------------------------------|-------------------------------------------------|
| 1                                                                                            | TDD, SSB SCS 15 kHz, data SCS 15 kHz, BW 10 MHz |
| 2                                                                                            | TDD, SSB SCS 30 kHz, data SCS 30 kHz, BW 40 MHz |
| Note: The NCR-MT is only required to pass in one of the supported test configurations in FR1 |                                                 |

Table G.2.3.1.1.1-2: General test parameters for FR1 out-of-sync testing in non-DRX mode

| Parameter                                                                                   |                                                                  | Unit | Value                       |
|---------------------------------------------------------------------------------------------|------------------------------------------------------------------|------|-----------------------------|
|                                                                                             |                                                                  |      | Test 1                      |
| Active PCell                                                                                |                                                                  |      | Cell 1                      |
| RF Channel Number                                                                           |                                                                  |      | 1                           |
| Duplex mode                                                                                 | Config 1,2                                                       |      | TDD                         |
| BW <sub>channel</sub>                                                                       | Config 1                                                         | MHz  | 10: N <sub>RB,c</sub> = 52  |
|                                                                                             | Config 2                                                         |      | 40: N <sub>RB,c</sub> = 106 |
| DL initial BWP configuration                                                                | Config 1, 2                                                      |      | DLBWP.0.1                   |
| DL dedicated BWP configuration                                                              | Config 1, 2                                                      |      | DLBWP.1.1                   |
| UL initial BWP configuration                                                                | Config 1, 2                                                      |      | ULBWP.0.1                   |
| UL dedicated BWP configuration                                                              | Config 1, 2                                                      |      | ULBWP.1.1                   |
| TDD Configuration                                                                           | Config 1                                                         |      | TDDConf.1.1                 |
|                                                                                             | Config 2                                                         |      | TDDConf.2.1                 |
| CORESET Reference Channel                                                                   | Config 1                                                         |      | CR.1.1 TDD                  |
|                                                                                             | Config 2                                                         |      | CR.2.1 TDD                  |
| SSB Configuration                                                                           | Config 1                                                         |      | SSB.1 FR1                   |
|                                                                                             | Config 2                                                         |      | SSB.2 FR1                   |
| SMTTC Configuration                                                                         | Config 1                                                         |      | SMTTC.1                     |
|                                                                                             | Config 2                                                         |      | SMTTC.1                     |
| PDSCH/PDCCH subcarrier spacing                                                              | Config 1                                                         |      | 15 kHz                      |
|                                                                                             | Config 2                                                         |      | 30 kHz                      |
| PRACH Configuration                                                                         | Config 1                                                         |      | TBD                         |
|                                                                                             | Config 2                                                         |      | TBD                         |
| SSB index assigned as RLM RS                                                                |                                                                  |      | 0                           |
| OCNG parameters                                                                             |                                                                  |      | OP.1                        |
| CP length                                                                                   |                                                                  |      | Normal                      |
| Correlation Matrix and Antenna Configuration                                                |                                                                  |      | 2x2 Low                     |
| Out of sync transmission parameters                                                         | DCI format                                                       |      | 1-0                         |
|                                                                                             | Number of Control OFDM symbols                                   |      | 2                           |
|                                                                                             | Aggregation level                                                | CCE  | 8                           |
|                                                                                             | Ratio of hypothetical PDCCH RE energy to average SSS RE energy   | dB   | 4                           |
|                                                                                             | Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | dB   | 4                           |
|                                                                                             | DMRS precoder granularity                                        |      | REG bundle size             |
|                                                                                             | REG bundle size                                                  |      | 6                           |
|                                                                                             | DRX                                                              |      | OFF                         |
| Layer 3 filtering                                                                           |                                                                  |      | Enabled                     |
| T310 timer                                                                                  |                                                                  | ms   | 0                           |
| T311 timer                                                                                  |                                                                  | ms   | 1000                        |
| N310                                                                                        |                                                                  |      | 1                           |
| N311                                                                                        |                                                                  |      | 1                           |
| CSI-RS configuration for CSI reporting                                                      | Config 1                                                         |      | CSI-RS.1.1 TDD              |
|                                                                                             | Config 2                                                         |      | CSI-RS.2.1 TDD              |
| CSI-RS for tracking                                                                         | Config 1                                                         |      | TRS.1.1 TDD                 |
|                                                                                             | Config 2                                                         |      | TRS.1.2 TDD                 |
| T1                                                                                          |                                                                  | s    | 0.2                         |
| T2                                                                                          |                                                                  | s    | 1.08                        |
| T3                                                                                          |                                                                  | s    | 1.08                        |
| D1                                                                                          |                                                                  | s    | 1.04                        |
| Note 1: All configurations are assigned to the NCR-MT prior to the start of time period T1. |                                                                  |      |                             |
| Note 2: NCR-MT-specific PDCCH is not transmitted after T1 starts.                           |                                                                  |      |                             |

**Table G.2.3.1.1.1-3: Cell specific test parameters for FR1 (Cell 1) for out-of-sync radio link monitoring tests in non-DRX mode**

| Parameter                         |                                                                                                                                                                                                    | Unit    | Test 1            |    |     |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-------------------|----|-----|
|                                   |                                                                                                                                                                                                    |         | T1                | T2 | T3  |
| EPRE ratio of PDCCH DMRS to SSS   |                                                                                                                                                                                                    | dB      | 4                 |    |     |
| EPRE ratio of PDCCH to PDCCH DMRS |                                                                                                                                                                                                    | dB      | 0                 |    |     |
| EPRE ratio of PBCH DMRS to SSS    |                                                                                                                                                                                                    | dB      | 0                 |    |     |
| EPRE ratio of PBCH to PBCH DMRS   |                                                                                                                                                                                                    | dB      |                   |    |     |
| EPRE ratio of PSS to SSS          |                                                                                                                                                                                                    | dB      |                   |    |     |
| EPRE ratio of PDSCH DMRS to SSS   |                                                                                                                                                                                                    | dB      |                   |    |     |
| EPRE ratio of PDSCH to PDSCH DMRS |                                                                                                                                                                                                    | dB      |                   |    |     |
| EPRE ratio of OCNG DMRS to SSS    |                                                                                                                                                                                                    | dB      |                   |    |     |
| EPRE ratio of OCNG to OCNG DMRS   |                                                                                                                                                                                                    | dB      |                   |    |     |
| SNR on RLM-RS                     | Config 1                                                                                                                                                                                           | dB      | 1                 | -7 | -15 |
|                                   | Config 2                                                                                                                                                                                           |         | 1                 | -7 | -15 |
|                                   | Config 3                                                                                                                                                                                           |         | 1                 | -7 | -15 |
| SNR on other channels and signals | Config 1, 2, 3                                                                                                                                                                                     | dB      | 1                 |    |     |
| $N_{oc}$                          | Config 1                                                                                                                                                                                           | dBm/SCS | -98               |    |     |
|                                   | Config 2                                                                                                                                                                                           |         | -95               |    |     |
| Propagation condition             |                                                                                                                                                                                                    |         | TDL-C 300ns 100Hz |    |     |
| Note 1:                           | OCNG shall be used such that the resources in Cell 1 are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.                                 |         |                   |    |     |
| Note 2:                           | The signal contains PDCCH for NCR-MTs other than the device under test as part of OCNG.                                                                                                            |         |                   |    |     |
| Note 3:                           | SNR levels correspond to the signal to noise ratio over the SSS REs.                                                                                                                               |         |                   |    |     |
| Note 4:                           | The SNR in time periods T1, T2 and T3 is denoted as SNR1, SNR2 and SNR3 respectively in Figure G.2.3.1.1.1-1.                                                                                      |         |                   |    |     |
| Note 5:                           | The SNR values are specified for testing an NCR-MT which supports 2RX on at least one band. For testing of an NCR-MT which supports 4RX on all bands, the SNR during T3 is defined in clause G.1.3 |         |                   |    |     |

**Figure G.2.3.1.1.1-1: SNR variation for out-of-sync testing**

#### G.2.3.1.1.2 Test Requirements

The NCR-MT behaviour in each test during time durations T1, T2 and T3 shall be as follows:

During the period from time point A to time point B the NCR-MT shall transmit uplink signal at least in all uplink slots configured for CSI transmission according to the configured periodic CSI reporting.

The NCR-MT shall stop transmitting uplink signal no later than time point C (D1 second after the start of the time duration T3).

The rate of correct events observed during repeated tests shall be at least 90%.

G.2.3.1.2      Radio Link Monitoring In-sync Test for FR1 PCell configured with SSB-based RLM RS in non-DRX mode

G.2.3.1.2.1      Test Purpose and Environment

The purpose of this test is to verify that the NCR-MT properly detects the out of sync and in sync for the purpose of monitoring downlink radio link quality of the PCell. This test will partly verify the FR1 radio link monitoring requirements in clause 12.3.1.

In the test, NCR-MT is configured to perform RLM on SSB, with *detectionResource* included in *RadioLinkMonitoringRS* set to SSB#0 and SSB#1, and *purpose* set to ‘*rlf*’. Supported test configurations are shown in table G.2.3.1.2.1-1. The test parameters are given in Tables G.2.3.1.2.1-2, and G.2.3.1.2.1-3 below. There is one cell (Cell 1), which is the active cell, in the test. The test consists of five successive time periods, with time duration of T1, T2, T3, T4 and T5 respectively. Figure G.2.3.1.2.1-1 shows the variation of the downlink SNR in the active cell to emulate out-of-sync and in-sync states. Prior to the start of the time duration T1, the NCR-MT shall be fully synchronized to Cell 1. Prior to the start of the time duration T1, the NCR-MT shall be fully synchronized to Cell 1. The NCR-MT shall be configured for periodic CSI reporting with a reporting periodicity of 5 ms.

Table G.2.3.1.2.1-1: Supported test configurations for FR1 PCell

| Configuration                                                                                     | Description                                     |
|---------------------------------------------------------------------------------------------------|-------------------------------------------------|
| 1                                                                                                 | TDD, SSB SCS 15 kHz, data SCS 15 kHz, BW 10 MHz |
| 2                                                                                                 | TDD, SSB SCS 30 kHz, data SCS 30 kHz, BW 40 MHz |
| Note:      The NCR-MT is only required to pass in one of the supported test configurations in FR1 |                                                 |

Table G.2.3.1.2.1-2: General test parameters for FR1 in-sync testing in non-DRX mode

| Parameter                                    |                                                                  | Unit | Value                       |
|----------------------------------------------|------------------------------------------------------------------|------|-----------------------------|
|                                              |                                                                  |      | Test 1                      |
| Active PCell                                 |                                                                  |      | Cell 1                      |
| RF Channel Number                            |                                                                  |      | 1                           |
| Duplex mode                                  | Config 1, 2                                                      |      | TDD                         |
| BW <sub>channel</sub>                        | Config 1                                                         | MHz  | 10: N <sub>RB,c</sub> = 52  |
|                                              | Config 2                                                         |      | 40: N <sub>RB,c</sub> = 106 |
| DL initial BWP configuration                 | Config 1, 2                                                      |      | DLBWP.0.1                   |
| DL dedicated BWP configuration               | Config 1, 2                                                      |      | DLBWP.1.1                   |
| UL initial BWP configuration                 | Config 1, 2                                                      |      | ULBWP.0.1                   |
| UL dedicated BWP configuration               | Config 1, 2                                                      |      | ULBWP.1.1                   |
| TDD Configuration                            | Config 1                                                         |      | TDDConf.1.1                 |
|                                              | Config 2                                                         |      | TDDConf.2.1                 |
| CORESET Reference Channel                    | Config 1                                                         |      | CR.1.1 TDD                  |
|                                              | Config 2                                                         |      | CR.2.1 TDD                  |
| SSB Configuration                            | Config 1                                                         |      | SSB.1 FR1                   |
|                                              | Config 2                                                         |      | SSB.2 FR1                   |
| SMTC Configuration                           | Config 1,2                                                       |      | SMTC.1                      |
| PDSCH/PDCCH subcarrier spacing               | Config 1                                                         |      | 15 kHz                      |
|                                              | Config 2                                                         |      | 30 kHz                      |
| PRACH Configuration                          | Config 1                                                         |      | TBD                         |
|                                              | Config 2                                                         |      | TBD                         |
| SSB index assigned as RLM RS                 |                                                                  |      | 0                           |
| OCNG parameters                              |                                                                  |      | OP.1                        |
| CP length                                    |                                                                  |      | Normal                      |
| Correlation Matrix and Antenna Configuration |                                                                  |      | 2x2 Low                     |
| In sync transmission parameters              | DCI format                                                       |      | 1-0                         |
|                                              | Number of Control OFDM symbols                                   |      | 2                           |
|                                              | Aggregation level                                                | CCE  | 4                           |
|                                              | Ratio of hypothetical PDCCH RE energy to average SSS RE energy   | dB   | 0                           |
|                                              | Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | dB   | 0                           |
|                                              | DMRS precoder granularity                                        |      | REG bundle size             |
|                                              | REG bundle size                                                  |      | 6                           |
|                                              |                                                                  |      |                             |
| Out of sync transmission parameters          | DCI format                                                       |      | 1-0                         |
|                                              | Number of Control OFDM symbols                                   |      | 2                           |
|                                              | Aggregation level                                                | CCE  | 8                           |
|                                              | Ratio of hypothetical PDCCH RE energy to average SSS RE energy   | dB   | 4                           |
|                                              | Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | dB   | 4                           |
|                                              | DMRS precoder granularity                                        |      | REG bundle size             |
|                                              | REG bundle size                                                  |      | 6                           |
|                                              |                                                                  |      |                             |
| DRX                                          |                                                                  |      | OFF                         |
| Layer 3 filtering                            |                                                                  |      | Enabled                     |
| T310 timer                                   |                                                                  | ms   | 1000                        |
| T311 timer                                   |                                                                  | ms   | 1000                        |

|                                                                                             |          |                |
|---------------------------------------------------------------------------------------------|----------|----------------|
| N310                                                                                        |          | 1              |
| N311                                                                                        |          | 1              |
| CSI-RS configuration for CSI reporting                                                      | Config 1 | CSI-RS.1.1 TDD |
|                                                                                             | Config 2 | CSI-RS.2.1 TDD |
| CSI-RS for tracking                                                                         | Config 1 | TRS.1.1 TDD    |
|                                                                                             | Config 2 | TRS.1.2 TDD    |
| T1                                                                                          | s        | 0.2            |
| T2                                                                                          | s        | 0.2            |
| T3                                                                                          | s        | 1.04           |
| T4                                                                                          | s        | 0.2            |
| T5                                                                                          | s        | 2.02           |
| D1                                                                                          | s        | 1.98           |
| Note 1: All configurations are assigned to the NCR-MT prior to the start of time period T1. |          |                |
| Note 2: NCR-MT-specific PDCCH is not transmitted after T1 starts.                           |          |                |

**Table G.2.3.1.2.1-3: Cell specific test parameters for FR1 (Cell 1) for in-sync radio link monitoring tests in non-DRX mode**

| Parameter                         |                                                                                                                                                                                                                          | Unit | Test 1            |    |     |      |    |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------|----|-----|------|----|
|                                   |                                                                                                                                                                                                                          |      | T1                | T2 | T3  | T4   | T5 |
| EPRE ratio of PDCCH DMRS to SSS   |                                                                                                                                                                                                                          | dB   | 4                 |    |     |      |    |
| EPRE ratio of PDCCH to PDCCH DMRS |                                                                                                                                                                                                                          | dB   | 0                 |    |     |      |    |
| EPRE ratio of PBCH DMRS to SSS    |                                                                                                                                                                                                                          | dB   | 0                 |    |     |      |    |
| EPRE ratio of PBCH to PBCH DMRS   |                                                                                                                                                                                                                          | dB   |                   |    |     |      |    |
| EPRE ratio of PSS to SSS          |                                                                                                                                                                                                                          | dB   |                   |    |     |      |    |
| EPRE ratio of PDSCH DMRS to SSS   |                                                                                                                                                                                                                          | dB   |                   |    |     |      |    |
| EPRE ratio of PDSCH to PDSCH DMRS |                                                                                                                                                                                                                          | dB   |                   |    |     |      |    |
| EPRE ratio of OCNG DMRS to SSS    |                                                                                                                                                                                                                          | dB   |                   |    |     |      |    |
| EPRE ratio of OCNG to OCNG DMRS   |                                                                                                                                                                                                                          | dB   |                   |    |     |      |    |
| SNR on RLM-RS                     | Config 1                                                                                                                                                                                                                 | dB   | 1                 | -7 | -15 | -4.5 | 1  |
|                                   | Config 2                                                                                                                                                                                                                 |      | 1                 | -7 | -15 | -4.5 | 1  |
|                                   | Config 3                                                                                                                                                                                                                 |      | 1                 | -7 | -15 | -4.5 | 1  |
| SNR on other channels and signals | Config 1, 2, 3                                                                                                                                                                                                           | dB   | 1                 |    |     |      |    |
| $N_{oc}$                          | Config 1                                                                                                                                                                                                                 | dBm/ | -98               |    |     |      |    |
|                                   | Config 2                                                                                                                                                                                                                 | SCS  | -95               |    |     |      |    |
| Propagation condition             |                                                                                                                                                                                                                          |      | TDL-C 300ns 100Hz |    |     |      |    |
| Note 1:                           | OCNG shall be used such that the resources in Cell 1 are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.                                                       |      |                   |    |     |      |    |
| Note 2:                           | The signal contains PDCCH for NCR-MTs other than the device under test as part of OCNG.                                                                                                                                  |      |                   |    |     |      |    |
| Note 3:                           | SNR levels correspond to the signal to noise ratio over the SSS REs.                                                                                                                                                     |      |                   |    |     |      |    |
| Note 4:                           | The SNR in time periods T1, T2, T3, T4 and T5 is denoted as SNR1, SNR2, SNR3, SNR4 and SNR5 respectively in Figure G.2.3.1.2.1-1.                                                                                        |      |                   |    |     |      |    |
| Note 5:                           | The SNR values are specified for testing an NCR-MT which supports 2RX on at least one band. For testing of an NCR-MT which supports 4RX on all bands, the SNR during T3 and T4 is modified as specified in clause G.1.3. |      |                   |    |     |      |    |

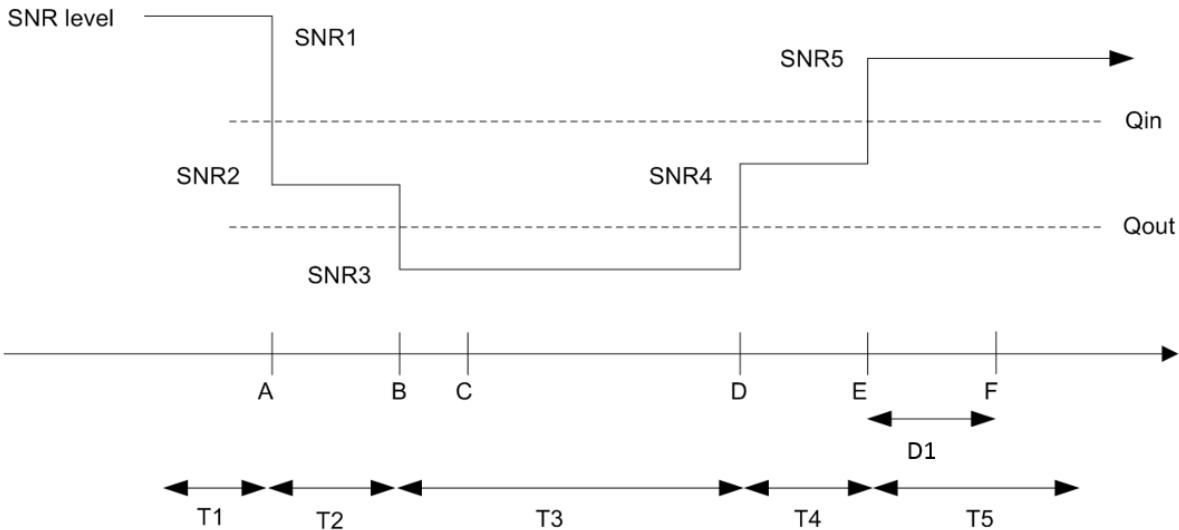


Figure G.2.3.1.2.1-1: SNR variation for in-sync testing

G.2.3.1.2.2 Test Requirements

The NCR-MT behaviour in each test during time durations T1, T2, T3, T4 and T5 shall be as follows:

During the period from time point A to time point F (D1 second after the start of time duration T5) the NCR-MT shall transmit uplink signal at least in all uplink slots configured for CSI transmission according to the configured periodic CSI reporting.

The rate of correct events observed during repeated tests shall be at least 90%.

G.2.3.1.3 Radio Link Monitoring Out-of-sync Test for FR2-1 PCell configured with SSB-based RLM RS in non-DRX mode

G.2.3.1.3.1 Test Purpose and Environment

The purpose of this test is to verify that the NCR-MT properly detects the out of sync and in sync for the purpose of monitoring downlink radio link quality of the PCell. This test will partly verify the FR2-1 radio link monitoring requirements in clause 12.3.1.

In the test, NCR-MT is configured to perform RLM on SSB, with *detectionResource* included in *RadioLinkMonitoringRS* set to SSB#0 and SSB#1, and *purpose* set to 'rlf'. Supported test configurations are shown in table G.2.3.1.3.1-1. The test parameters are given in Tables G.2.3.1.3.1-2 and G.2.3.1.3.1-3 below. There is one cell (Cell 1), which is the active NR cell, in the test. The test consists of three successive time periods, with time duration of T1, T2 and T3 respectively. Figure G.2.3.1.3.1-1 shows the variation of the downlink SNR in the active cell to emulate out-of-sync and in-sync states, and Figure G.2.3.1.3.1-2 shows the Time multiplexed downlink transmissions from each Angle of Arrival. Prior to the start of the time duration T1, the NCR-MT shall be fully synchronized to Cell 1. The NCR-MT shall be configured for periodic CSI reporting with a reporting periodicity of 5 ms.

Table G.2.3.1.3.1-1: Supported test configurations for FR2-1 PCell

| Configuration | Description                                       |
|---------------|---------------------------------------------------|
| 1             | TDD, SSB SCS 120 KHz, data SCS 120KHz, BW 100 MHz |

**Table G.2.3.1.3.1-2: General test parameters for FR2-1 out-of-sync testing in non-DRX mode**

| Parameter                                                                                   |                                                                  | Unit | Value                       |
|---------------------------------------------------------------------------------------------|------------------------------------------------------------------|------|-----------------------------|
|                                                                                             |                                                                  |      | <b>Test 1</b>               |
| Active PCell                                                                                |                                                                  |      | Cell 1                      |
| RF Channel Number                                                                           |                                                                  |      | 1                           |
| Duplex mode                                                                                 | Config 1                                                         |      | TDD                         |
| BW <sub>channel</sub>                                                                       | Config 1                                                         |      | 100: N <sub>RB,c</sub> = 66 |
| DL initial BWP configuration                                                                | Config 1                                                         |      | DLBWP.0.1                   |
| DL dedicated BWP configuration                                                              | Config 1                                                         |      | DLBWP.1.1                   |
| UL initial BWP configuration                                                                | Config 1                                                         |      | ULBWP.0.1                   |
| UL dedicated BWP configuration                                                              | Config 1                                                         |      | ULBWP.1.1                   |
| TDD Configuration                                                                           | Config 1                                                         |      | TDDConf.3.1                 |
| CORESET Reference Channel                                                                   | Config 1                                                         |      | CR.3.1 TDD                  |
| SSB Configuration                                                                           | Config 1                                                         |      | SSB.1 FR2                   |
| SMTc Configuration                                                                          | Config 1                                                         |      | SMTc.1                      |
| PDSCH/PDCCH subcarrier spacing                                                              | Config 1                                                         |      | 120 KHz                     |
| PRACH Configuration                                                                         | Config 1                                                         |      | TBD                         |
| SSB index assigned as RLM RS                                                                | Config 1                                                         |      | 0,1                         |
| OCNG parameters                                                                             |                                                                  |      | OP.2                        |
| CP length                                                                                   |                                                                  |      | Normal                      |
| Out of sync transmission parameters                                                         | DCI format                                                       |      | 1-0                         |
|                                                                                             | Number of Control OFDM symbols                                   |      | 2                           |
|                                                                                             | Aggregation level                                                | CCE  | 8                           |
|                                                                                             | Ratio of hypothetical PDCCH RE energy to average SSS RE energy   | dB   | 4                           |
|                                                                                             | Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | dB   | 4                           |
|                                                                                             | DMRS precoder granularity                                        |      | REG bundle size             |
| REG bundle size                                                                             |                                                                  |      | 6                           |
| DRX                                                                                         |                                                                  |      | OFF                         |
| Layer 3 filtering                                                                           |                                                                  |      | <i>Enabled</i>              |
| T310 timer                                                                                  |                                                                  | ms   | 0                           |
| T311 timer                                                                                  |                                                                  | ms   | 1000                        |
| N310                                                                                        |                                                                  |      | 1                           |
| N311                                                                                        |                                                                  |      | 1                           |
| CSI-RS for CSI reporting                                                                    | Config 1                                                         |      | CSI-RS.3.1 TDD              |
| TCI states for PDCCH/PDSCH                                                                  |                                                                  |      | TCI.State.2                 |
| CSI-RS for tracking                                                                         | Config 1                                                         |      | TRS.2.1 TDD                 |
| T1                                                                                          |                                                                  | s    | 0.2                         |
| T2                                                                                          |                                                                  | s    | 4.88                        |
| T3                                                                                          |                                                                  | s    | 4.88                        |
| D1                                                                                          |                                                                  | s    | 4.84                        |
| Note 1: All configurations are assigned to the NCR-MT prior to the start of time period T1. |                                                                  |      |                             |
| Note 2: NCR-MT-specific PDCCH is not transmitted after T1 starts.                           |                                                                  |      |                             |

**Table G.2.3.1.3.1-3: OTA related cell specific test parameters for FR2-1 (Cell 1) for out-of-sync radio link monitoring tests in non-DRX mode**

| Parameter | Unit | Test 1                                 |    |    |      |    |    |
|-----------|------|----------------------------------------|----|----|------|----|----|
|           |      | T1                                     | T2 | T3 | T1   | T2 | T3 |
| AoA setup |      | Setup 2 as specified in clause G.1.8.2 |    |    |      |    |    |
|           |      | AoA1                                   |    |    | AoA2 |    |    |

| Parameter                                                     |                                                                                                                                                                                                     | Unit      | Test 1                          |                      |     |                     |     |     |
|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------------------------------|----------------------|-----|---------------------|-----|-----|
|                                                               |                                                                                                                                                                                                     |           | T1                              | T2                   | T3  | T1                  | T2  | T3  |
| EPRE ratio of PDCCH DMRS to SSS                               |                                                                                                                                                                                                     | dB        | 4                               |                      |     | Not sent            |     |     |
| EPRE ratio of PDCCH to PDCCH DMRS                             |                                                                                                                                                                                                     | dB        | 0                               |                      |     |                     |     |     |
| EPRE ratio of PBCH DMRS to SSS                                |                                                                                                                                                                                                     | dB        |                                 |                      |     |                     |     |     |
| EPRE ratio of PBCH to PBCH DMRS                               |                                                                                                                                                                                                     | dB        |                                 |                      |     |                     |     |     |
| EPRE ratio of PSS to SSS                                      |                                                                                                                                                                                                     | dB        |                                 |                      |     |                     |     |     |
| EPRE ratio of PDSCH DMRS to SSS                               |                                                                                                                                                                                                     | dB        |                                 |                      |     |                     |     |     |
| EPRE ratio of PDSCH to PDSCH DMRS                             |                                                                                                                                                                                                     | dB        |                                 |                      |     |                     |     |     |
| EPRE ratio of OCNG DMRS to SSS                                |                                                                                                                                                                                                     | dB        |                                 |                      |     |                     |     |     |
| EPRE ratio of OCNG to OCNG DMRS                               |                                                                                                                                                                                                     | dB        |                                 |                      |     |                     |     |     |
| ssb-Index 0 SNR                                               | Config 1                                                                                                                                                                                            | dB        | 2 <sup>Note 6</sup>             | -6 <sup>Note 6</sup> | -15 |                     |     |     |
| ssb-Index 1 SNR                                               | Config 1                                                                                                                                                                                            |           | Not sent                        |                      |     | 2 <sup>Note 6</sup> | -15 | -15 |
| SNR on other channels and signals                             | Config 1                                                                                                                                                                                            | dB        | 2 <sup>Note 6</sup>             |                      |     | N/A                 |     |     |
| $N_{oc}$                                                      | Config 1                                                                                                                                                                                            | dBm/15kHz | -92.1                           |                      |     | -92.1               |     |     |
| Time multiplexing of the downlink transmissions from each AoA |                                                                                                                                                                                                     |           | Defined in Figure G.2.3.1.3.1-2 |                      |     |                     |     |     |
| Propagation condition                                         |                                                                                                                                                                                                     |           | TDL-A 30ns 75Hz                 |                      |     | TDL-A 30ns 75Hz     |     |     |
| Note 1:                                                       | OCNG shall be used such that the resources in Cell 1 are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.                                  |           |                                 |                      |     |                     |     |     |
| Note 2:                                                       | The signal contains PDCCH for NCR-MTs other than the device under test as part of OCNG.                                                                                                             |           |                                 |                      |     |                     |     |     |
| Note 3:                                                       | SNR levels correspond to the signal to noise ratio over the SSS REs.                                                                                                                                |           |                                 |                      |     |                     |     |     |
| Note 4:                                                       | The SNR values are specified for testing an NCR-MT which supports 2RX on at least one band. For testing of an NCR-MT which supports 4RX on all bands, the SNR during T3 is defined in clause G.1.3. |           |                                 |                      |     |                     |     |     |
| Note 5:                                                       | Void                                                                                                                                                                                                |           |                                 |                      |     |                     |     |     |
| Note 6:                                                       | This value allows up to 1dB degradation from applied SNR to NCR-MT baseband.                                                                                                                        |           |                                 |                      |     |                     |     |     |

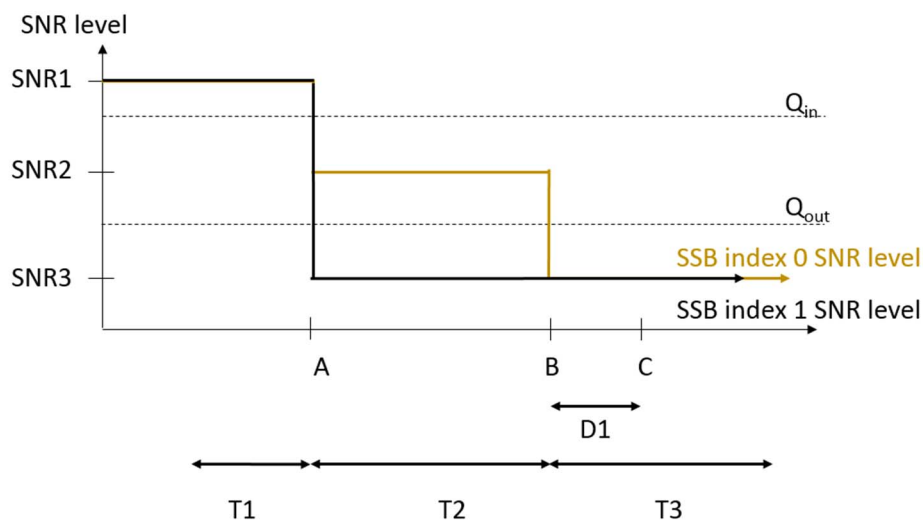


Figure G.2.3.1.3.1-1: SNR variation for out-of-sync testing

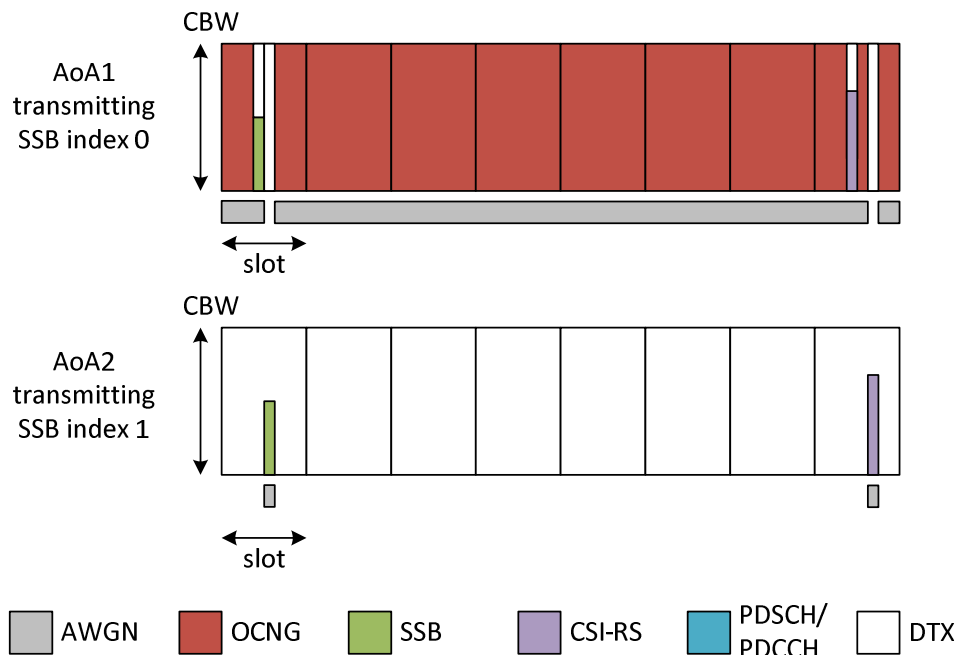


**Figure G.2.3.1.3.1-2: Time multiplexed downlink transmissions**

#### G.2.3.1.3.2 Test Requirements

The NCR-MT behavior in each test during time durations T1, T2 and T3 shall be as follows:

During the period from time point A to time point B the NCR-MT shall transmit uplink signal at least in all uplink slots configured for CSI transmission according to the configured periodic CSI reporting.

The NCR-MT shall stop transmitting uplink signal no later than time point C (D1 second after the start of the time duration T3).

The rate of correct events observed during repeated tests shall be at least 90%.

#### G.2.3.1.4 Radio Link Monitoring In-sync Test for FR2-1 PCell configured with SSB-based RLM RS in non-DRX mode

##### G.2.3.1.4.1 Test Purpose and Environment

The purpose of this test is to verify that the NCR-MT properly detects the out of sync and in sync for the purpose of monitoring downlink radio link quality of the PCell. This test will partly verify the FR2-1 radio link monitoring requirements in clause 12.3.1.

In the test, NCR-MT is configured to perform RLM on SSB, with *detectionResource* included in *RadioLinkMonitoringRS* set to SSB#0 and SSB#1, and *purpose* set to 'rlf'. Supported test configurations are shown in table G.2.3.1.4.1-1. The test parameters are given in Tables G.2.3.1.4.1-2, and G.2.3.1.4.1-3 below. There is one cell (Cell 1), which is the active cell, in the test. The test consists of five successive time periods, with time duration of T1, T2, T3, T4 and T5 respectively. Figure G.2.3.1.4.1-1 shows the variation of the downlink SNR in the active cell to emulate out-of-sync and in-sync states, and Figure G.2.3.1.4.1-2 shows the Time multiplexed downlink transmissions from each Angle of Arrival. Prior to the start of the time duration T1, the NCR-MT shall be fully synchronized to Cell 1. Prior to the start of the time duration T1, the NCR-MT shall be fully synchronized to Cell 1. The NCR-MT shall be configured for periodic CSI reporting with a reporting periodicity of 5 ms.

**Table G.2.3.1.4.1-1: Supported test configurations for FR2-1 PCell**

| Configuration | Description                                       |
|---------------|---------------------------------------------------|
| 1             | TDD, SSB SCS 120 KHz, data SCS 120KHz, BW 100 MHz |

**Table G.2.3.1.4.1-2: General test parameters for FR2-1 in-sync testing in non-DRX mode**

| Parameter                                                                                   |                                                                  | Unit | Value                       |
|---------------------------------------------------------------------------------------------|------------------------------------------------------------------|------|-----------------------------|
|                                                                                             |                                                                  |      | <b>Test 1</b>               |
| Active PCell                                                                                |                                                                  |      | Cell 1                      |
| RF Channel Number                                                                           |                                                                  |      | 1                           |
| Duplex mode                                                                                 | Config 1                                                         |      | TDD                         |
| BW <sub>channel</sub>                                                                       | Config 1                                                         |      | 100: N <sub>RB,c</sub> = 66 |
| DL initial BWP configuration                                                                | Config 1                                                         |      | DLBWP.0.1                   |
| DL dedicated BWP configuration                                                              | Config 1                                                         |      | DLBWP.1.1                   |
| UL initial BWP configuration                                                                | Config 1                                                         |      | ULBWP.0.1                   |
| UL dedicated BWP configuration                                                              | Config 1                                                         |      | ULBWP.1.1                   |
| TDD Configuration                                                                           | Config 1                                                         |      | TDDConf.3.1                 |
| CORESET Reference Channel                                                                   | Config 1                                                         |      | CR.3.1 TDD                  |
| SSB Configuration                                                                           | Config 1                                                         |      | SSB.1 FR2-1                 |
| SMTC Configuration                                                                          | Config 1                                                         |      | SMTC.3                      |
| PDSCH/PDCCH subcarrier spacing                                                              | Config 1                                                         |      | 120 KHz                     |
| PRACH Configuration                                                                         | Config 1                                                         |      | TBD                         |
| SSB index assigned as RLM RS                                                                | Config 1                                                         |      | 0,1                         |
| OCNG parameters                                                                             |                                                                  |      | OP.2                        |
| CP length                                                                                   |                                                                  |      | Normal                      |
| In sync transmission parameters                                                             | DCI format                                                       |      | 1-0                         |
|                                                                                             | Number of Control OFDM symbols                                   |      | 2                           |
|                                                                                             | Aggregation level                                                | CCE  | 4                           |
|                                                                                             | Ratio of hypothetical PDCCH RE energy to average SSS RE energy   | dB   | 0                           |
|                                                                                             | Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | dB   | 0                           |
|                                                                                             | DMRS precoder granularity                                        |      | REG bundle size             |
|                                                                                             | REG bundle size                                                  |      | 6                           |
| Out of sync transmission parameters                                                         | DCI format                                                       |      | 1-0                         |
|                                                                                             | Number of Control OFDM symbols                                   |      | 2                           |
|                                                                                             | Aggregation level                                                | CCE  | 8                           |
|                                                                                             | Ratio of hypothetical PDCCH RE energy to average SSS RE energy   | dB   | 4                           |
|                                                                                             | Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | dB   | 4                           |
|                                                                                             | DMRS precoder granularity                                        |      | REG bundle size             |
|                                                                                             | REG bundle size                                                  |      | 6                           |
| DRX                                                                                         |                                                                  |      | OFF                         |
| Layer 3 filtering                                                                           |                                                                  |      | <i>Enabled</i>              |
| T310 timer                                                                                  |                                                                  | ms   | 4000                        |
| T311 timer                                                                                  |                                                                  | ms   | 1000                        |
| N310                                                                                        |                                                                  |      | 1                           |
| N311                                                                                        |                                                                  |      | 1                           |
| CSI-RS for CSI reporting                                                                    | Config 1                                                         |      | CSI-RS.3.1 TDD              |
| TCI states for PDCCH/PDSCH                                                                  |                                                                  |      | TCI.State.2                 |
| CSI-RS for tracking                                                                         | Config 1                                                         |      | TRS.2.1 TDD                 |
| T1                                                                                          |                                                                  | s    | 0.2                         |
| T2                                                                                          |                                                                  | s    | 0.2                         |
| T3                                                                                          |                                                                  | s    | 4.84                        |
| T4                                                                                          |                                                                  | s    | 0.2                         |
| T5                                                                                          |                                                                  | s    | 7.84                        |
| D1                                                                                          |                                                                  | s    | 7.8                         |
| Note 1: All configurations are assigned to the NCR-MT prior to the start of time period T1. |                                                                  |      |                             |
| Note 2: NCR-MT-specific PDCCH is not transmitted after T1 starts.                           |                                                                  |      |                             |

**Table G.2.3.1.4.1-3: OTA related cell specific test parameters for FR2-1 (Cell 1) for in-sync radio link monitoring tests in non-DRX mode**

| Parameter                                                     |                                                                                                                                                                                                     | Unit      | Test 1                                 |                      |     |      |                     |                     |     |     |     |     |
|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|----------------------------------------|----------------------|-----|------|---------------------|---------------------|-----|-----|-----|-----|
|                                                               |                                                                                                                                                                                                     |           | T1                                     | T2                   | T3  | T4   | T5                  | T1                  | T2  | T3  | T4  | T5  |
| AoA setup                                                     |                                                                                                                                                                                                     |           | Setup 2 as specified in clause G.1.8.2 |                      |     |      |                     |                     |     |     |     |     |
|                                                               |                                                                                                                                                                                                     |           | AoA1                                   |                      |     |      |                     | AoA2                |     |     |     |     |
| EPRE ratio of PDCCH DMRS to SSS                               |                                                                                                                                                                                                     | dB        | 4                                      |                      |     |      |                     | Not sent            |     |     |     |     |
| EPRE ratio of PDCCH to PDCCH DMRS                             |                                                                                                                                                                                                     | dB        | 0                                      |                      |     |      |                     |                     |     |     |     |     |
| EPRE ratio of PBCH DMRS to SSS                                |                                                                                                                                                                                                     | dB        |                                        |                      |     |      |                     |                     |     |     |     |     |
| EPRE ratio of PBCH to PBCH DMRS                               |                                                                                                                                                                                                     | dB        |                                        |                      |     |      |                     |                     |     |     |     |     |
| EPRE ratio of PSS to SSS                                      |                                                                                                                                                                                                     | dB        |                                        |                      |     |      |                     |                     |     |     |     |     |
| EPRE ratio of PDSCH DMRS to SSS                               |                                                                                                                                                                                                     | dB        |                                        |                      |     |      |                     |                     |     |     |     |     |
| EPRE ratio of PDSCH to PDSCH DMRS                             |                                                                                                                                                                                                     | dB        |                                        |                      |     |      |                     |                     |     |     |     |     |
| EPRE ratio of OCNG DMRS to SSS                                |                                                                                                                                                                                                     | dB        |                                        |                      |     |      |                     |                     |     |     |     |     |
| EPRE ratio of OCNG to OCNG DMRS                               |                                                                                                                                                                                                     | dB        |                                        |                      |     |      |                     |                     |     |     |     |     |
| ssb-Index 0 SNR                                               | Config 1                                                                                                                                                                                            | dB        | 2 <sup>Note 6</sup>                    | -6 <sup>Note 6</sup> | -15 | -4.5 | 2 <sup>Note 6</sup> |                     |     |     |     |     |
| ssb-Index 1 SNR                                               | Config 1                                                                                                                                                                                            |           | Not sent                               |                      |     |      |                     | 2 <sup>Note 6</sup> | -15 | -15 | -15 | -15 |
| SNR on other channels and signals                             | Config 1                                                                                                                                                                                            | dB        | 2 <sup>Note 6</sup>                    |                      |     |      |                     | N/A                 |     |     |     |     |
| $N_{oc}$                                                      | Config 1                                                                                                                                                                                            | dBm/15kHz | -92.1                                  |                      |     |      |                     | -92.1               |     |     |     |     |
| Time multiplexing of the downlink transmissions from each AoA |                                                                                                                                                                                                     |           | Defined in Figure G.2.3.1.4.1-2        |                      |     |      |                     |                     |     |     |     |     |
| Propagation condition                                         |                                                                                                                                                                                                     |           | TDL-A 30ns 75Hz                        |                      |     |      |                     | TDL-A 30ns 75Hz     |     |     |     |     |
| Note 1:                                                       | OCNG shall be used such that the resources in Cell 1 are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.                                  |           |                                        |                      |     |      |                     |                     |     |     |     |     |
| Note 2:                                                       | The signal contains PDCCH for NCR-MTs other than the device under test as part of OCNG.                                                                                                             |           |                                        |                      |     |      |                     |                     |     |     |     |     |
| Note 3:                                                       | SNR levels correspond to the signal to noise ratio over the SSS REs.                                                                                                                                |           |                                        |                      |     |      |                     |                     |     |     |     |     |
| Note 4:                                                       | The SNR values are specified for testing an NCR-MT which supports 2RX on at least one band. For testing of an NCR-MT which supports 4RX on all bands, the SNR during T3 is defined in clause G.1.3. |           |                                        |                      |     |      |                     |                     |     |     |     |     |
| Note 5:                                                       | Void.                                                                                                                                                                                               |           |                                        |                      |     |      |                     |                     |     |     |     |     |
| Note 6:                                                       | This value allows up to 1dB degradation from applied SNR to NCR-MT baseband                                                                                                                         |           |                                        |                      |     |      |                     |                     |     |     |     |     |

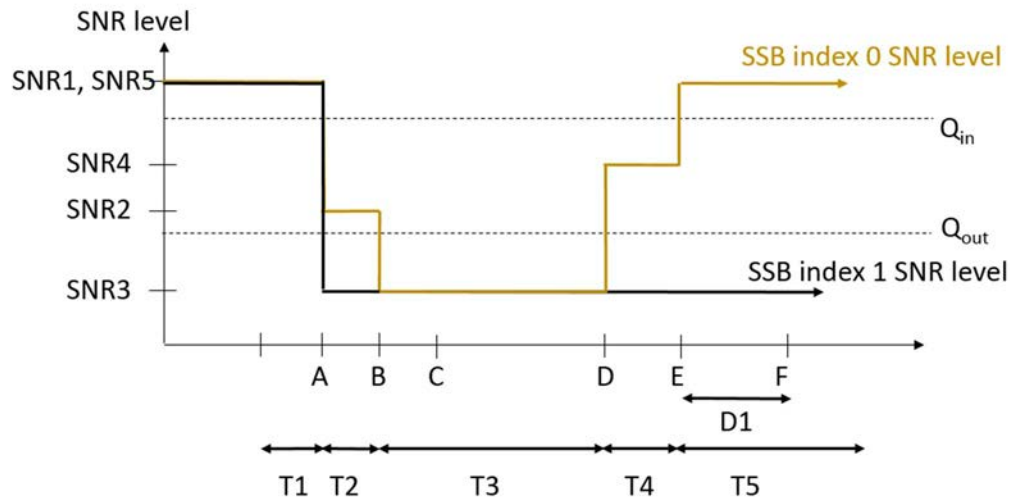


Figure G.2.3.1.4.1-1: SNR variation for in-sync testing

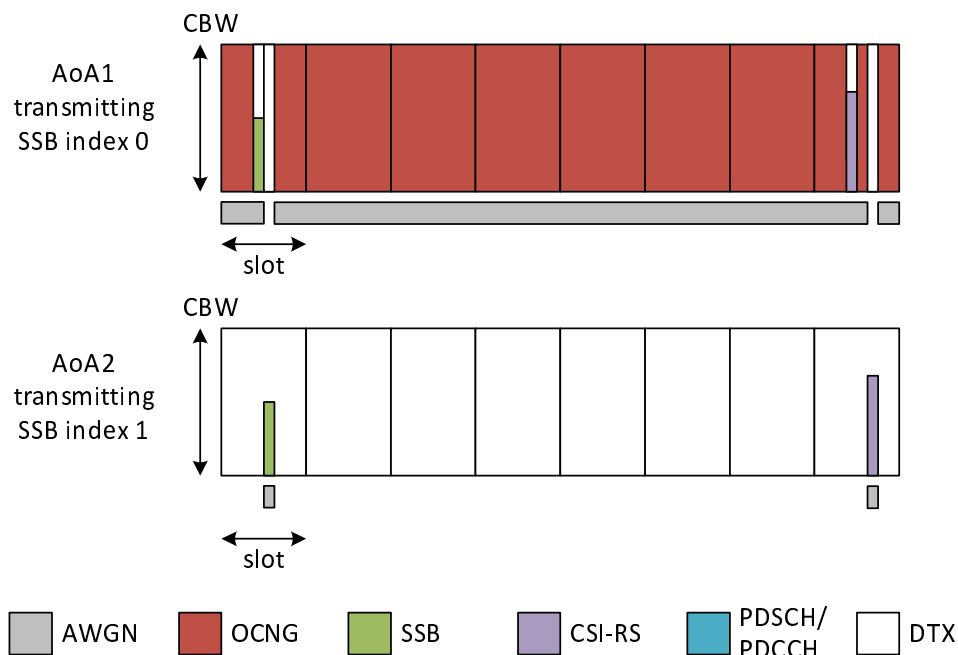


Figure G.2.3.1.4.1-2: Time multiplexed downlink transmissions

#### G.2.3.1.4.2 Test Requirements

The NCR-MT behaviour in each test during time durations T1, T2, T3, T4 and T5 shall be as follows:

During the period from time point A to time point F (D1 second after the start of time duration T5) the NCR-MT shall transmit uplink signal at least in all uplink slots configured for CSI transmission according to the configured periodic CSI reporting.

The rate of correct events observed during repeated tests shall be at least 90%.

### G.2.3.1.5 Radio Link Monitoring Out-of-sync Test for FR1 PCell configured with CSI-RS-based RLM in non-DRX mode

#### G.2.3.1.5.1 Test Purpose and Environment

The purpose of this test is to verify that the NCR-MT properly detects the out of sync for the purpose of monitoring downlink CSI-RS based radio link quality of the PCell. This test will partly verify the FR1 PCell CSI-RS Out-of-sync radio link monitoring requirements in clause 12.3.1.3. This test case is applicable only for local area NCR-MT and for NCR type 1-H.

The test parameters are given in Tables G.2.3.1.5.1-1, G.2.3.1.5.1-2 and G.2.3.1.5.1-3 below. There is one cell, cell 1 which is the PCell, in the test. The test consists of three successive time periods, with time duration of T1, T2 and T3 respectively. Figure G.2.3.1.5.1-1 shows the variation of the downlink SNR in the PCell to emulate out-of-sync and in-sync states. Prior to the start of the time duration T1, the NCR-MT shall be fully synchronized to cell 1. The NCR-MT shall be configured for periodic CSI reporting with a reporting periodicity defined in CSI-RS configuration. In the test, SSB0 is configured as the BFD-RS.

**Table G.2.3.1.5.1-1: Supported test configurations for FR1 PCell**

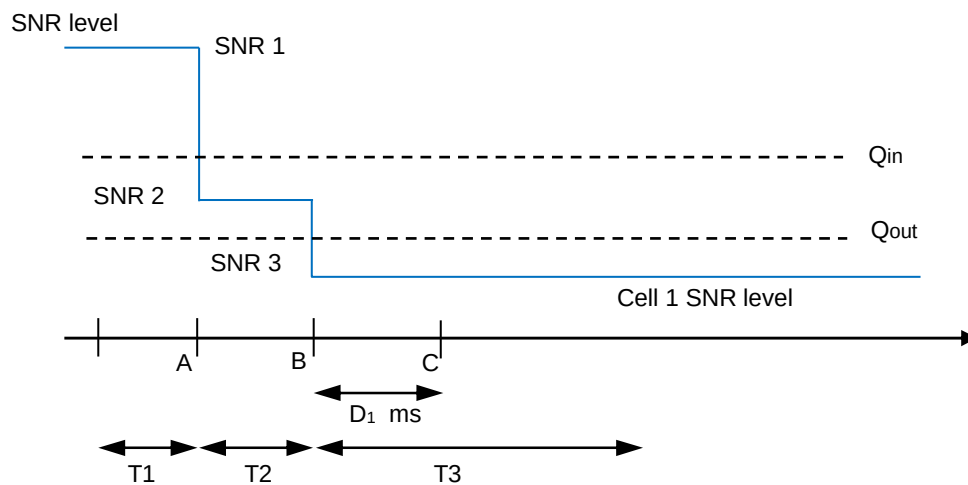
| Configuration                                                                                | Description                                       |
|----------------------------------------------------------------------------------------------|---------------------------------------------------|
| 1                                                                                            | TDD duplex mode, 15 kHz SSB SCS, 10 MHz bandwidth |
| 2                                                                                            | TDD duplex mode, 30 kHz SSB SCS, 40 MHz bandwidth |
| Note: The NCR-MT is only required to pass in one of the supported test configurations in FR1 |                                                   |

**Table G.2.3.1.5.1-2: General test parameters for FR1 PCell for CSI-RS out-of-sync testing in non-DRX**

| Parameter                                                         |                                                                     | Unit | NCR-MT<br>Test 1           |
|-------------------------------------------------------------------|---------------------------------------------------------------------|------|----------------------------|
| Active PCell                                                      |                                                                     |      | Cell 1                     |
| RF Channel Number                                                 |                                                                     |      | 1                          |
| Duplex mode                                                       | Config 1, 2                                                         |      | TDD                        |
| TDD Configuration                                                 | Config 1                                                            |      | TDDConf.1.1                |
|                                                                   | Config 2                                                            |      | TDDConf.2.1                |
| DL initial BWP configuration                                      | Config 1, 2                                                         |      | DLBWP.0.1                  |
| DL dedicated BWP configuration                                    | Config 1, 2                                                         |      | DLBWP.1.1                  |
| UL initial BWP configuration                                      | Config 1, 2                                                         |      | ULBWP.0.1                  |
| UL dedicated BWP configuration                                    | Config 1, 2                                                         |      | ULBWP.1.1                  |
| CORESET Reference Channel                                         | Config 1                                                            |      | CR.1.1 TDD                 |
|                                                                   | Config 2                                                            |      | CR.2.1 TDD                 |
| SSB Configuration                                                 | Config 1                                                            |      | SSB.1 FR1                  |
|                                                                   | Config 2                                                            |      | SSB.2 FR1                  |
| SMTC Configuration                                                | Config 1                                                            |      | SMTC.1                     |
|                                                                   | Config 2                                                            |      | SMTC.1                     |
| PDSCH/PDCCH subcarrier spacing                                    | Config 1                                                            |      | 15 kHz                     |
|                                                                   | Config 2                                                            |      | 30 kHz                     |
| TRS configuration                                                 | Config 1                                                            |      | TRS.1.1 TDD                |
|                                                                   | Config 2                                                            |      | TRS.1.2 TDD                |
| CSI-RS for RLM                                                    | Config 1                                                            |      | Resource #4 in TRS.1.1 TDD |
|                                                                   | Config 2                                                            |      | Resource #4 in TRS.1.2 TDD |
| TCI configuration for PDCCH/PDSCH                                 |                                                                     |      | TCI.State.2                |
| OCNG parameters                                                   |                                                                     |      | OP.1                       |
| CP length                                                         |                                                                     |      | Normal                     |
| Correlation Matrix and Antenna Configuration                      |                                                                     |      | 2x2 Low                    |
| Out of sync transmission parameters                               | DCI format                                                          |      | 1-0                        |
|                                                                   | Number of Control OFDM symbols                                      |      | 2                          |
|                                                                   | Aggregation level                                                   | CCE  | 8                          |
|                                                                   | Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy   | dB   | 4                          |
|                                                                   | Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy | dB   | 4                          |
|                                                                   | DMRS precoder granularity                                           |      | REG bundle size            |
|                                                                   | REG bundle size                                                     |      | 6                          |
| Layer 3 filtering                                                 |                                                                     |      | <i>Enabled</i>             |
| T310 timer                                                        |                                                                     | ms   | 0                          |
| T311 timer                                                        |                                                                     | ms   | 1000                       |
| N310                                                              |                                                                     |      | 1                          |
| N311                                                              |                                                                     |      | 1                          |
| CSI-RS configuration for CSI reporting                            | Config 1                                                            |      | CSI-RS.1.1 TDD             |
|                                                                   | Config 2                                                            |      | CSI-RS.2.1 TDD             |
| T1                                                                |                                                                     | s    | 0.2                        |
| T2                                                                |                                                                     | s    | 48                         |
| T3                                                                |                                                                     | s    | 0.48                       |
| D1                                                                |                                                                     | s    | 0.44                       |
| Note 1: NCR-MT-specific PDCCH is not transmitted after T1 starts. |                                                                     |      |                            |

**Table G.2.3.1.5.1-3: Cell specific test parameters for FR1 for CSI-RS out-of-sync radio link monitoring in non-DRX**

| Parameter                                                                                                                                                                                                      |             | Unit      | Test 1            |    |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----------|-------------------|----|-----|
|                                                                                                                                                                                                                |             |           | T1                | T2 | T3  |
| PDCCH_beta                                                                                                                                                                                                     |             | dB        | 4                 |    |     |
| PDCCH_DMRS_beta                                                                                                                                                                                                |             | dB        | 4                 |    |     |
| PBCH_beta                                                                                                                                                                                                      |             | dB        | 0                 |    |     |
| PSS_beta                                                                                                                                                                                                       |             | dB        |                   |    |     |
| SSS_beta                                                                                                                                                                                                       |             | dB        |                   |    |     |
| PDSCH_beta                                                                                                                                                                                                     |             | dB        |                   |    |     |
| OCNG_beta                                                                                                                                                                                                      |             | dB        |                   |    |     |
| SNR on RLM-RS                                                                                                                                                                                                  | Config 1, 2 | dB        | 1                 | -7 | -15 |
| SNR on other channels and signals                                                                                                                                                                              | Config 1, 2 | dB        | 1                 |    |     |
| $N_{oc}$                                                                                                                                                                                                       | Config 1, 2 | dBm/15kHz | -98               |    |     |
| Propagation condition                                                                                                                                                                                          |             |           | TDL-C 300ns 100Hz |    |     |
| Note 1: OCNG shall be used such that the resources in Cell 1 are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.                                     |             |           |                   |    |     |
| Note 2: The uplink resources for CSI reporting are assigned to the NCR-MT prior to the start of time period T1.                                                                                                |             |           |                   |    |     |
| Note 3: NZP CSI-RS resource set configuration for CSI reporting are assigned to the NCR-MT prior to the start of time period T1.                                                                               |             |           |                   |    |     |
| Note 4: The timers and layer 3 filtering related parameters are configured prior to the start of time period T1.                                                                                               |             |           |                   |    |     |
| Note 5: The signal contains PDCCH for NCR-MTs other than the device under test as part of OCNG.                                                                                                                |             |           |                   |    |     |
| Note 6: SNR levels correspond to the signal to noise ratio over the SSS REs.                                                                                                                                   |             |           |                   |    |     |
| Note 7: The SNR in time periods T1, T2 and T3 is denoted as SNR1, SNR2 and SNR3 respectively in figure G.2.3.1.5.1-1.                                                                                          |             |           |                   |    |     |
| Note 8: The SNR NCR-MTs are specified for testing a NCR-MT which supports 2RX on at least one band. For testing of NCR-MT which supports 4RX on all bands, the SNR during T3 is specified in clause G.1.3.1.1. |             |           |                   |    |     |

**Figure G.2.3.1.5.1-1: SNR variation for CSI-RS out-of-sync testing**

### G.2.3.1.5.2 Test Requirements

The NCR-MT behaviour during time durations T1, T2, and T3 shall be as follows:

During time durations T1, T2 and T3, the NCR-MT shall transmit uplink signal at least in all subframes configured for CSI transmission on Cell 1.

During the period from time point A to time point B the NCR-MT shall transmit uplink signal in Cell 1 at least in all uplink slots configured for CSI transmission according to the configured periodic CSI reporting for Cell 1.

The NCR-MT shall stop transmitting uplink signal in Cell 1 no later than time point C ( $D_1$  ms after the start of the time duration T3) on the PCell.

The rate of correct events observed during repeated tests shall be at least 90%.

G.2.3.1.6      Radio Link Monitoring In-sync Test for FR1 PCell configured with CSI-RS-based RLM in non-DRX mode

G.2.3.1.6.1      Test Purpose and Environment

The purpose of this test is to verify that the NCR-MT properly detects the in sync for the purpose of monitoring downlink CSI-RS based radio link quality of the PCell. This test will partly verify the FR1 PCell CSI-RS In-sync radio link monitoring requirements in clause 12.3.1.3. This test case is applicable only for local area NCR-MT and for NCR type 1-H.

The test parameters are given in Tables G.2.3.1.6.1-1, G.2.3.1.6.1-2, and G.2.3.1.6.1-3 below. There is one cells, cell 1 which is the PCell, in the test. The test consists of five successive time periods, with time duration of T1, T2, T3, T4 and T5 respectively. Figure G.2.3.1.6.1-1 shows the variation of the downlink SNR in the PCell to emulate out-of-sync and in-sync states. Prior to the start of the time duration T1, the NCR-MT shall be fully synchronized to cell 1. The NCR-MT shall be configured for periodic CSI reporting with a reporting periodicity defined in CSI-RS configuration. In the test, SSB0 is configured as the BFD-RS.

Table G.2.3.1.6.1-1: Supported test configurations for FR1 PCell

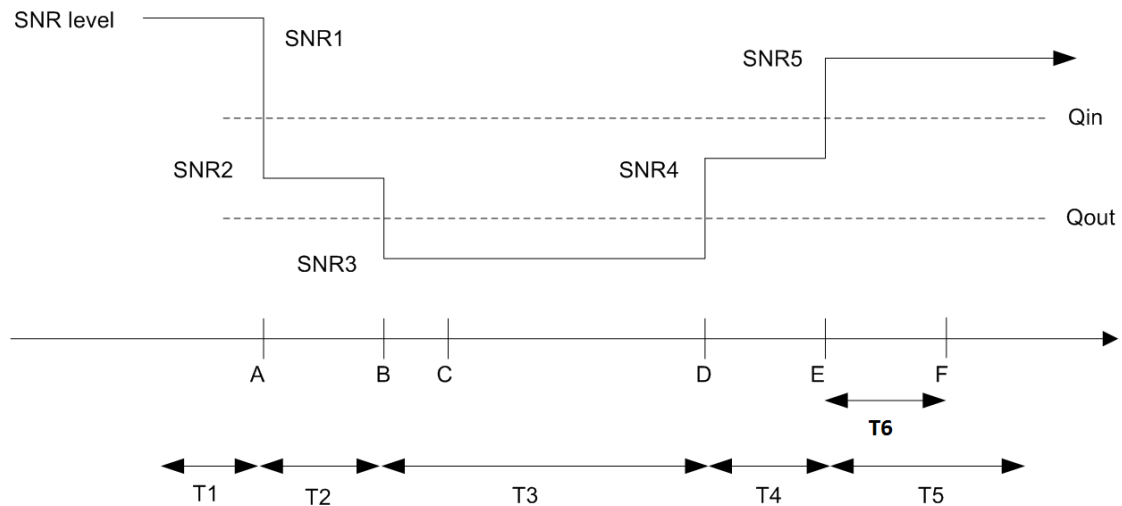
| Configuration                                                                                     | Description                                       |
|---------------------------------------------------------------------------------------------------|---------------------------------------------------|
| 1                                                                                                 | TDD duplex mode, 15 kHz SSB SCS, 10 MHz bandwidth |
| 2                                                                                                 | TDD duplex mode, 30kHz SSB SCS, 40 MHz bandwidth  |
| Note:      The NCR-MT is only required to pass in one of the supported test configurations in FR1 |                                                   |

**Table G.2.3.1.6.1-2: General test parameters for FR1 PCell for CSI-RS in-sync testing in non-DRX**

| Parameter                                                         |                                                                     | Unit | NCR-MT<br>Test 1           |
|-------------------------------------------------------------------|---------------------------------------------------------------------|------|----------------------------|
| Active PCell                                                      |                                                                     |      | Cell 1                     |
| RF Channel Number                                                 |                                                                     |      | 1                          |
| Duplex mode                                                       | Config 1, 2                                                         |      | TDD                        |
| TDD Configuration                                                 | Config 1                                                            |      | TDDConf.1.1                |
|                                                                   | Config 2                                                            |      | TDDConf.2.1                |
| DL initial BWP configuration                                      | Config 1, 2                                                         |      | DLBWP.0.1                  |
| DL dedicated BWP configuration                                    | Config 1, 2                                                         |      | DLBWP.1.1                  |
| UL initial BWP configuration                                      | Config 1, 2                                                         |      | ULBWP.0.1                  |
| UL dedicated BWP configuration                                    | Config 1, 2                                                         |      | ULBWP.1.1                  |
| CORESET Reference Channel                                         | Config 1                                                            |      | CR.1.1 TDD                 |
|                                                                   | Config 2                                                            |      | CR.2.1 TDD                 |
| SSB Configuration                                                 | Config 1                                                            |      | SSB.1 FR1                  |
|                                                                   | Config 2                                                            |      | SSB.2 FR1                  |
| SMTC Configuration                                                | Config 1, 2                                                         |      | SMTC.1                     |
| PDSCH/PDCCH subcarrier spacing                                    | Config 1                                                            |      | 15 kHz                     |
|                                                                   | Config 2                                                            |      | 30 kHz                     |
| TRS configuration                                                 | Config 1                                                            |      | TRS.1.1 TDD                |
|                                                                   | Config 2                                                            |      | TRS.1.2 TDD                |
| CSI-RS for RLM                                                    | Config 1                                                            |      | Resource #4 in TRS.1.1 TDD |
|                                                                   | Config 2                                                            |      | Resource #4 in TRS.1.2 TDD |
| TCI configuration for PDCCH/PDSCH                                 |                                                                     |      | TCI.State.2                |
| OCNG parameters                                                   |                                                                     |      | OP.1                       |
| CP length                                                         |                                                                     |      | Normal                     |
| Correlation Matrix and Antenna Configuration                      |                                                                     |      | 2x2 Low                    |
| Out of sync transmission parameters                               | DCI format                                                          |      | 1-0                        |
|                                                                   | Number of Control OFDM symbols                                      |      | 2                          |
|                                                                   | Aggregation level                                                   | CCE  | 8                          |
|                                                                   | Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy   | dB   | 4                          |
|                                                                   | Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy | dB   | 4                          |
|                                                                   | DMRS precoder granularity                                           |      | REG bundle size            |
|                                                                   | REG bundle size                                                     |      | 6                          |
| In sync transmission parameters                                   | DCI format                                                          |      | 1-0                        |
|                                                                   | Number of Control OFDM symbols                                      |      | 2                          |
|                                                                   | Aggregation level                                                   | CCE  | 4                          |
|                                                                   | Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy   | dB   | 0                          |
|                                                                   | Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy | dB   | 0                          |
|                                                                   | DMRS precoder granularity                                           |      | REG bundle size            |
|                                                                   | REG bundle size                                                     |      | 6                          |
| Layer 3 filtering                                                 |                                                                     |      | <i>Enabled</i>             |
| T310 timer                                                        |                                                                     | ms   | 1000                       |
| T311 timer                                                        |                                                                     | ms   | 1000                       |
| N310                                                              |                                                                     |      | 1                          |
| N311                                                              |                                                                     |      | 1                          |
| CSI-RS configuration for CSI reporting                            | Config 1                                                            |      | CSI-RS.1.1 TDD             |
|                                                                   | Config 2                                                            |      | CSI-RS.2.1 TDD             |
| T1                                                                |                                                                     | s    | 0.2                        |
| T2                                                                |                                                                     | s    | 0.2                        |
| T3                                                                |                                                                     | s    | 0.44                       |
| T4                                                                |                                                                     | s    | 0.2                        |
| T5                                                                |                                                                     | s    | 0.88                       |
| T6                                                                |                                                                     | s    | 0.84                       |
| Note 1: NCR-MT-specific PDCCH is not transmitted after T1 starts. |                                                                     |      |                            |

**Table G.2.3.1.6.1-3: Cell specific test parameters for FR1 for CSI-RS in-sync radio link monitoring in non-DRX**

| Parameter                                                                                                                                                                                                      |             | Unit      | Test 1            |    |     |      |    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----------|-------------------|----|-----|------|----|
|                                                                                                                                                                                                                |             |           | T1                | T2 | T3  | T4   | T5 |
| PDCCH_beta                                                                                                                                                                                                     |             | dB        | 4                 |    |     |      |    |
| PDCCH_DMRS_beta                                                                                                                                                                                                |             | dB        | 4                 |    |     |      |    |
| PBCH_beta                                                                                                                                                                                                      |             | dB        | 0                 |    |     |      |    |
| PSS_beta                                                                                                                                                                                                       |             | dB        |                   |    |     |      |    |
| SSS_beta                                                                                                                                                                                                       |             | dB        |                   |    |     |      |    |
| PDSCH_beta                                                                                                                                                                                                     |             | dB        |                   |    |     |      |    |
| OCNG_beta                                                                                                                                                                                                      |             | dB        |                   |    |     |      |    |
| SNR on RLM-RS                                                                                                                                                                                                  | Config 1, 2 | dB        | 1                 | -7 | -15 | -4.5 | 1  |
| SNR on other channels and signals                                                                                                                                                                              | Config 1, 2 | dB        | 1                 |    |     |      |    |
| $N_{oc}$                                                                                                                                                                                                       | Config 1, 2 | dBm/15kHz | -98               |    |     |      |    |
| Propagation condition                                                                                                                                                                                          |             |           | TDL-C 300ns 100Hz |    |     |      |    |
| Note 1: OCNG shall be used such that the resources in Cell 1 are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.                                     |             |           |                   |    |     |      |    |
| Note 2: The uplink resources for CSI reporting are assigned to the NCR-MT prior to the start of time period T1.                                                                                                |             |           |                   |    |     |      |    |
| Note 3: NZP CSI-RS resource set configuration for CSI reporting are assigned to the NCR-MT prior to the start of time period T1.                                                                               |             |           |                   |    |     |      |    |
| Note 4: The timers and layer 3 filtering related parameters are configured prior to the start of time period T1.                                                                                               |             |           |                   |    |     |      |    |
| Note 5: The signal contains PDCCH for NCR-MTs other than the device under test as part of OCNG.                                                                                                                |             |           |                   |    |     |      |    |
| Note 6: SNR levels correspond to the signal to noise ratio over the SSS REs.                                                                                                                                   |             |           |                   |    |     |      |    |
| Note 7: The SNR in time periods T1, T2, T3, T4 and T5 is denoted as SNR1, SNR2, SNR3, SNR4 and SNR5 respectively in figure G.2.3.1.6.1-1.                                                                      |             |           |                   |    |     |      |    |
| Note 8: The SNR NCR-MTs are specified for testing a NCR-MT which supports 2RX on at least one band. For testing of NCR-MT which supports 4RX on all bands, the SNR during T3 is specified in clause G.1.3.1.1. |             |           |                   |    |     |      |    |

**Figure G.2.3.1.6.1-1: SNR variation for CSI-RS in-sync testing**

### G.2.3.1.6.2 Test Requirements

The NCR-MT behaviour in each test during time durations T1, T2, T3, T4 and T5 shall be as follows:

During the period from time point A to time point F (T6 second after the start of time duration T5) the NCR-MT shall transmit uplink signal at least in all uplink slots configured for CSI transmission according to the configured periodic CSI reporting on the PCell.

The rate of correct events observed during repeated tests shall be at least 90%.

G.2.3.1.7      Radio Link Monitoring Out-of-sync Test for FR2-1 PCell configured with CSI-RS-based RLM in non-DRX mode

G.2.3.1.7.1      Test Purpose and Environment

The purpose of this test is to verify that the NCR-MT properly detects the out of sync for the purpose of monitoring downlink CSI-RS based radio link quality of the PCell. This test will partly verify the FR2-1 PCell CSI-RS Out-of-sync radio link monitoring requirements in clause 12.3.1.3. This test case is applicable only for local area NCR-MT and for NCR type 2-0.

The test parameters are given in Tables G.2.3.1.7.1-1, G.2.3.1.7.1-2 and G.2.3.1.7.1-3 below. There is one cell, cell 1 which is the PCell, in the test. The test consists of three successive time periods, with time duration of T1, T2 and T3 respectively. Figure G.2.3.1.7.1-1 shows the variation of the downlink SNR in the PCell to emulate out-of-sync and in-sync states. Prior to the start of the time duration T1, the NCR-MT shall be fully synchronized to cell 1. The NCR-MT shall be configured for periodic CSI reporting with a reporting periodicity of 10 ms. In the test, SSB0 and SSB1 are configured as BFD-RS.

**Table G.2.3.1.7.1-1: Supported test configurations for FR2-1 PCell**

| Configuration | Description                                         |
|---------------|-----------------------------------------------------|
| 1             | TDD duplex mode, 120 kHz SSB SCS, 100 MHz bandwidth |

**Table G.2.3.1.7.1-2: General test parameters for FR2-1 PCell for CSI-RS out-of-sync testing in non-DRX**

| Parameter                                                         |                                                                     | Unit | NCR-MT<br>Test 1                                         |
|-------------------------------------------------------------------|---------------------------------------------------------------------|------|----------------------------------------------------------|
| Active PCell                                                      |                                                                     |      | Cell 1                                                   |
| RF Channel Number                                                 |                                                                     |      | 1                                                        |
| Duplex mode                                                       | Config 1                                                            |      | TDD                                                      |
| TDD Configuration                                                 | Config 1                                                            |      | TDDConf.3.1                                              |
| DL initial BWP configuration                                      | Config 1                                                            |      | DLBWP.0.1                                                |
| DL dedicated BWP configuration                                    | Config 1                                                            |      | DLBWP.1.1                                                |
| UL initial BWP configuration                                      | Config 1                                                            |      | ULBWP.0.1                                                |
| UL dedicated BWP configuration                                    | Config 1                                                            |      | ULBWP.1.1                                                |
| CORESET Reference Channel                                         | Config 1                                                            |      | CCR.3.1 TDD<br>CCR.3.3 TDD                               |
| SSB Configuration                                                 | Config 1                                                            |      | SSB.1 FR2-1                                              |
| SMTC Configuration                                                | Config 1                                                            |      | SMTC.1                                                   |
| PDSCH/PDCCH subcarrier spacing                                    | Config 1                                                            |      | 120 KHz                                                  |
| CSI-RS for RLM                                                    | Config 1                                                            |      | Resource #4 in TRS.2.1 TDD<br>Resource #4 in TRS.2.2 TDD |
| TRS configuration                                                 |                                                                     |      | TRS.2.1 TDD<br>TRS.2.2 TDD                               |
| TCI configuration for PDCCH#1/PDSCH                               |                                                                     |      | TCI.State.2                                              |
| TCI configuration for PDCCH#2                                     |                                                                     |      | TCI.State.3                                              |
| OCNG parameters                                                   |                                                                     |      | OP.1                                                     |
| CP length                                                         |                                                                     |      | Normal                                                   |
| Out of sync transmission parameters                               | DCI format                                                          |      | 1-0                                                      |
|                                                                   | Number of Control OFDM symbols                                      |      | 2                                                        |
|                                                                   | Aggregation level                                                   | CCE  | 8                                                        |
|                                                                   | Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy   | dB   | 4                                                        |
|                                                                   | Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy | dB   | 4                                                        |
|                                                                   | DMRS precoder granularity                                           |      | REG bundle size                                          |
|                                                                   | REG bundle size                                                     |      | 6                                                        |
| Layer 3 filtering                                                 |                                                                     |      | <i>Enabled</i>                                           |
| T310 timer                                                        |                                                                     | ms   | 0                                                        |
| T311 timer                                                        |                                                                     | ms   | 1000                                                     |
| N310                                                              |                                                                     |      | 1                                                        |
| N311                                                              |                                                                     |      | 1                                                        |
| CSI-RS for CSI reporting                                          | Config 1                                                            |      | CSI-RS.3.1 TDD                                           |
| T1                                                                |                                                                     | s    | 0.2                                                      |
| T2                                                                |                                                                     | s    | 0.35                                                     |
| T3                                                                |                                                                     | s    | 0.35                                                     |
| D1                                                                |                                                                     | s    | 0.31                                                     |
| Note 1: NCR-MT-specific PDCCH is not transmitted after T1 starts. |                                                                     |      |                                                          |



During the period from time point A to time point B the NCR-MT shall transmit uplink signal in Cell 1 at least in all uplink slots configured for CSI transmission according to the configured periodic CSI reporting for Cell 1.

The NCR-MT shall stop transmitting uplink signal in Cell 1 no later than time point C ( $D_1$  second after the start of the time duration T3) on the PCell.

The rate of correct events observed during repeated tests shall be at least 90%.

### G.2.3.1.8 Radio Link Monitoring In-sync Test for FR2-1 PCell configured with CSI-RS-based RLM in non-DRX mode

#### G.2.3.1.8.1 Test Purpose and Environment

The purpose of this test is to verify that the NCR-MT properly detects the in sync for the purpose of monitoring downlink CSI-RS based radio link quality of the PCell. This test will partly verify the FR2 PCell CSI-RS In-sync radio link monitoring requirements in clause 12.3.1.3. This test case is applicable only for local area NCR-MT and for NCR type 2-O.

The test parameters are given in Tables G.2.3.1.8.1-1, G.2.3.1.8.1-2 and G.2.3.1.8.1-3 below. There is one cells, cell 1 which is the PCell, in the test. The test consists of five successive time periods, with time duration of T1, T2, T3, T4 and T5 respectively. Figure G.2.3.1.8.1-1 shows the variation of the downlink SNR in the PCell to emulate out-of-sync and in-sync states. Prior to the start of the time duration T1, the NCR-MT shall be fully synchronized to cell 1. The NCR-MT shall be configured for periodic CSI reporting with a reporting periodicity of 10 ms. In the test, SSB0 and SSB1 are configured as BFD-RS.

Table G.2.3.1.8.1-1: Supported test configurations for FR2-1 PCell

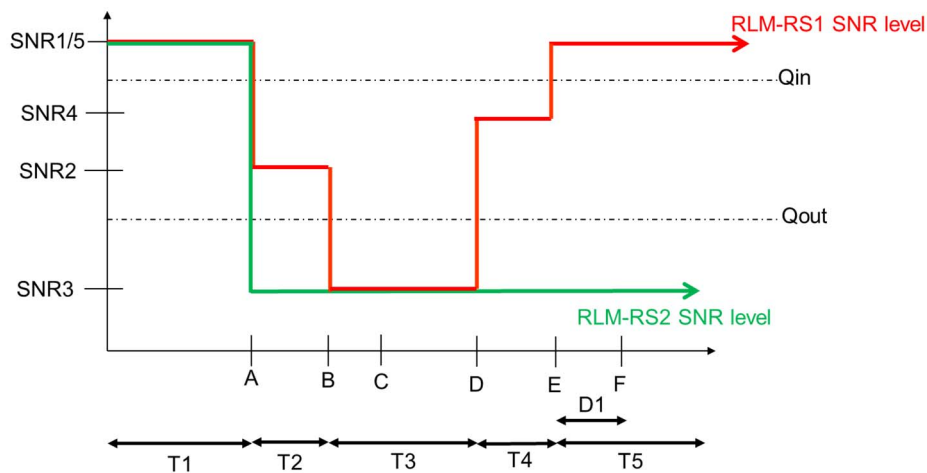
| Configuration | Description                                         |
|---------------|-----------------------------------------------------|
| 1             | TDD duplex mode, 120 kHz SSB SCS, 100 MHz bandwidth |

**Table G.2.3.1.8.1-2: General test parameters for FR2-1 PCell for CSI-RS in-sync testing in non-DRX**

| Parameter                                                         |                                                                     | Unit | NCR-MT<br>Test 1                                         |
|-------------------------------------------------------------------|---------------------------------------------------------------------|------|----------------------------------------------------------|
| Active PCell                                                      |                                                                     |      | Cell 1                                                   |
| RF Channel Number                                                 |                                                                     |      | 1                                                        |
| Duplex mode                                                       | Config 1                                                            |      | TDD                                                      |
| TDD Configuration                                                 | Config 1                                                            |      | TDDConf.3.1                                              |
| DL initial BWP configuration                                      | Config 1                                                            |      | DLBWP.0.1                                                |
| DL dedicated BWP configuration                                    | Config 1                                                            |      | DLBWP.1.1                                                |
| UL initial BWP configuration                                      | Config 1                                                            |      | ULBWP.0.1                                                |
| UL dedicated BWP configuration                                    | Config 1                                                            |      | ULBWP.1.1                                                |
| CORESET Reference Channel                                         | Config 1                                                            |      | CCR.3.1 TDD<br>CCR.3.3 TDD                               |
| SSB Configuration                                                 | Config 1                                                            |      | SSB.1 FR2-1                                              |
| SMTC Configuration                                                | Config 1                                                            |      | SMTC.1                                                   |
| PDSCH/PDCCH subcarrier spacing                                    | Config 1                                                            |      | 120 KHz                                                  |
| CSI-RS for RLM                                                    | Config 1                                                            |      | Resource #4 in TRS.2.1 TDD<br>Resource #4 in TRS.2.2 TDD |
| TRS configuration                                                 |                                                                     |      | TRS.2.1 TDD<br>TRS.2.2 TDD                               |
| TCI configuration for PDCCH#1/PDSCH                               |                                                                     |      | TCI.State.2                                              |
| TCI configuration for PDCCH#2                                     |                                                                     |      | TCI.State.3                                              |
| OCNG parameters                                                   |                                                                     |      | OP.1                                                     |
| CP length                                                         |                                                                     |      | Normal                                                   |
| Out of sync transmission parameters                               | DCI format                                                          |      | 1-0                                                      |
|                                                                   | Number of Control OFDM symbols                                      |      | 2                                                        |
|                                                                   | Aggregation level                                                   | CCE  | 8                                                        |
|                                                                   | Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy   | dB   | 4                                                        |
|                                                                   | Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy | dB   | 4                                                        |
|                                                                   | DMRS precoder granularity                                           |      | REG bundle size                                          |
|                                                                   | REG bundle size                                                     |      | 6                                                        |
|                                                                   | REG bundle size                                                     |      | 6                                                        |
| In sync transmission parameters                                   | DCI format                                                          |      | 1-0                                                      |
|                                                                   | Number of Control OFDM symbols                                      |      | 2                                                        |
|                                                                   | Aggregation level                                                   | CCE  | 4                                                        |
|                                                                   | Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy   | dB   | 0                                                        |
|                                                                   | Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy | dB   | 0                                                        |
|                                                                   | DMRS precoder granularity                                           |      | REG bundle size                                          |
|                                                                   | REG bundle size                                                     |      | 6                                                        |
|                                                                   | REG bundle size                                                     |      | 6                                                        |
| Layer 3 filtering                                                 |                                                                     |      | Enabled                                                  |
| T310 timer                                                        |                                                                     | ms   | 1000                                                     |
| T311 timer                                                        |                                                                     | ms   | 1000                                                     |
| N310                                                              |                                                                     |      | 1                                                        |
| N311                                                              |                                                                     |      | 1                                                        |
| CSI-RS for CSI reporting                                          | Config 1                                                            |      | CSI-RS.3.1 TDD                                           |
| T1                                                                |                                                                     | s    | 0.2                                                      |
| T2                                                                |                                                                     | s    | 0.2                                                      |
| T3                                                                |                                                                     | s    | 0.24                                                     |
| T4                                                                |                                                                     | s    | 0.2                                                      |
| T5                                                                |                                                                     | s    | 0.88                                                     |
| D1                                                                |                                                                     | s    | 0.84                                                     |
| Note 1: NCR-MT-specific PDCCH is not transmitted after T1 starts. |                                                                     |      |                                                          |

**Table G.2.3.1.8.1-3: Cell specific test parameters for FR2-1 for CSI-RS in-sync radio link monitoring in non-DRX**

| Parameter                                                                                                                                                                  |          | Unit      | Test 1                               |                      |     |      |                     |                     |     |     |     |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------|--------------------------------------|----------------------|-----|------|---------------------|---------------------|-----|-----|-----|-----|
|                                                                                                                                                                            |          |           | T1                                   | T2                   | T3  | T4   | T5                  | T1                  | T2  | T3  | T4  | T5  |
| AoA setup                                                                                                                                                                  |          |           | AoA setup as defined in clause G.1.8 |                      |     |      |                     |                     |     |     |     |     |
|                                                                                                                                                                            |          |           | AoA1                                 |                      |     |      |                     | AoA2                |     |     |     |     |
| Assumption for NCR-MT beams <sup>Note 8</sup>                                                                                                                              |          |           | Rough                                |                      |     |      |                     | Rough               |     |     |     |     |
| PDCCH_beta                                                                                                                                                                 |          | dB        | 4                                    |                      |     |      |                     | Not sent            |     |     |     |     |
| PDCCH_DMRS_beta                                                                                                                                                            |          | dB        | 4                                    |                      |     |      |                     |                     |     |     |     |     |
| PBCH_beta                                                                                                                                                                  |          | dB        | 0                                    |                      |     |      |                     |                     |     |     |     |     |
| PSS_beta                                                                                                                                                                   |          | dB        |                                      |                      |     |      |                     |                     |     |     |     |     |
| SSS_beta                                                                                                                                                                   |          | dB        |                                      |                      |     |      |                     |                     |     |     |     |     |
| PDSCH_beta                                                                                                                                                                 |          | dB        |                                      |                      |     |      |                     |                     |     |     |     |     |
| OCNG_beta                                                                                                                                                                  |          | dB        |                                      |                      |     |      |                     |                     |     |     |     |     |
| SNR on RLM-RS1                                                                                                                                                             | Config 1 | dB        | 2 <sup>Note 9</sup>                  | -6 <sup>Note 9</sup> | -15 | -4.5 | 2 <sup>Note 9</sup> |                     |     |     |     |     |
| SNR on RLM-RS2                                                                                                                                                             | Config 1 |           | Not sent                             |                      |     |      |                     | 2 <sup>Note 9</sup> | -14 | -15 | -15 | -14 |
| SNR on other channels and signals                                                                                                                                          | Config 1 | dB        | 2 <sup>Note 10</sup>                 |                      |     |      |                     | N/A                 |     |     |     |     |
| N <sub>oc</sub>                                                                                                                                                            | Config 1 | dBm/15KHz | -92.1                                |                      |     |      |                     | -92.1               |     |     |     |     |
| Propagation condition                                                                                                                                                      |          |           | TDL-C 300ns 100Hz                    |                      |     |      |                     | TDL-C 300ns 100Hz   |     |     |     |     |
| Note 1: OCNG shall be used such that the resources in Cell 1 are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols. |          |           |                                      |                      |     |      |                     |                     |     |     |     |     |
| Note 2: The uplink resources for CSI reporting are assigned to the NCR-MT prior to the start of time period T1.                                                            |          |           |                                      |                      |     |      |                     |                     |     |     |     |     |
| Note 3: NZP CSI-RS resource set configuration for CSI reporting are assigned to the NCR-MT prior to the start of time period T1.                                           |          |           |                                      |                      |     |      |                     |                     |     |     |     |     |
| Note 4: The timers and layer 3 filtering related parameters are configured prior to the start of time period T1.                                                           |          |           |                                      |                      |     |      |                     |                     |     |     |     |     |
| Note 5: The signal contains PDCCH for NCR-MTs other than the device under test as part of OCNG.                                                                            |          |           |                                      |                      |     |      |                     |                     |     |     |     |     |
| Note 6: SNR levels correspond to the signal to noise ratio over the SSS REs.                                                                                               |          |           |                                      |                      |     |      |                     |                     |     |     |     |     |
| Note 7: The SNR in time periods T1, T2, T3, T4 and T5 is denoted as SNR1, SNR2, SNR3, SNR4 and SNR5 respectively in figure G.2.3.1.8.1-1.                                  |          |           |                                      |                      |     |      |                     |                     |     |     |     |     |
| Note 8: Information about types of NCR-MT beam does not limit NCR-MT implementation or test system implementation.                                                         |          |           |                                      |                      |     |      |                     |                     |     |     |     |     |
| Note 9: This NCR-MT allows up to 1dB degradation from applied SNR to NCR-MT baseband.                                                                                      |          |           |                                      |                      |     |      |                     |                     |     |     |     |     |

**Figure G.2.3.1.8.1-1: SNR variation for CSI-RS in-sync testing**

### G.2.3.1.8.2 Test Requirements

The NCR-MT behaviour in each test during time durations T1, T2, T3, T4 and T5 shall be as follows:

During the period from time point A to time point F (D1 second after the start of time duration T5) the NCR-MT shall transmit uplink signal at least in all uplink slots configured for CSI transmission according to the configured periodic CSI reporting on the PCell.

The rate of correct events observed during repeated tests shall be at least 90%.

## G.2.3.2 Beam Failure Detection and Link Recovery Procedure

### G.2.3.2.1 Beam Failure Detection and Link Recovery Test for FR1 PCell configured with SSB-based BFD and LR

#### G.2.3.2.1.1 Test Purpose and Environment

The purpose of this test is to verify that the NCR-MT properly detects SSB-based beam failure in the set  $q_0$  configured for a serving cell and that the NCR-MT performs correct SSB-based link recovery based on beam candidate set  $q_1$ . The purpose is to test the downlink monitoring for beam failure detection within the NCR-MT's active DL BWP, during the evaluation period, and link recovery. This test will partly verify the SSB based beam failure detection and link recovery for an FR1 serving cell requirements in clause 12.3.2.

The test parameters are given in Tables G.2.3.2.1.1-1, G.2.3.2.1.1-2 and G.2.3.2.1.1-3 below. There is one cell, cell 1 which is the active cell, in the test. The test consists of five successive time periods, with time duration of T1, T2, T3, T4 and T5 respectively. Figure G.2.3.2.1.1-1 shows the variation of the downlink SNR of the SSB in set  $q_0$  in the active cell to emulate SSB based beam failure. Figure G.2.3.2.1.1-1 additionally shows the variation of the downlink L1-RSRP of the SSB in set  $q_1$  of the candidate beam used for link recovery. Prior to the start of the time duration T1, the NCR-MT shall be fully synchronized to cell 1. The NCR-MT shall be configured for periodic CSI reporting with a reporting periodicity of 2 ms. The NCR-MT is configured to perform inter-frequency measurements using GP ID #0 (40ms) in test 1.

**Table G.2.3.2.1.1-1: Supported test configurations for FR1 PCell**

| Configuration                                                                                | Description                                       |
|----------------------------------------------------------------------------------------------|---------------------------------------------------|
| 1                                                                                            | TDD duplex mode, 15 kHz SSB SCS, 10 MHz bandwidth |
| 2                                                                                            | TDD duplex mode, 30 kHz SSB SCS, 40 MHz bandwidth |
| 3                                                                                            | FDD duplex mode, 15 kHz SSB SCS, 10 MHz bandwidth |
| Note: The NCR-MT is only required to pass in one of the supported test configurations in FR1 |                                                   |

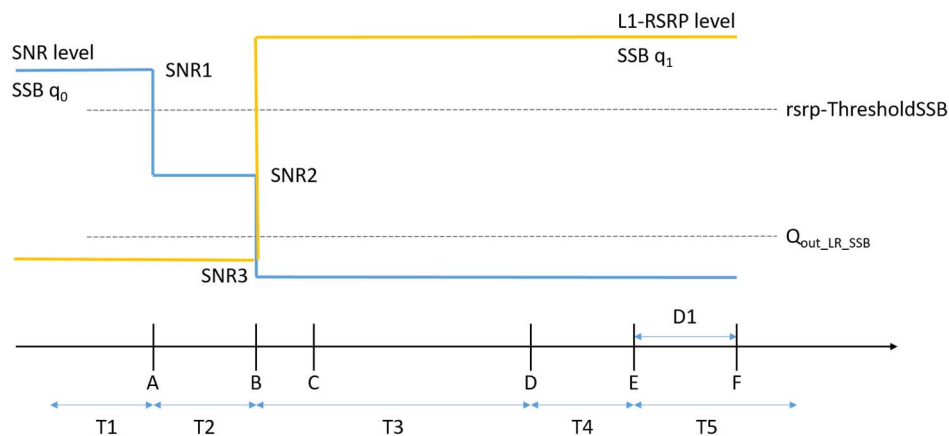
Table G.2.3.2.1.1-2: General test parameters for FR1 PCell for SSB-based beam failure detection and link recovery testing

| Parameter                                      |                                                                     | Unit        | Value           | Comment                                                                                 |
|------------------------------------------------|---------------------------------------------------------------------|-------------|-----------------|-----------------------------------------------------------------------------------------|
|                                                |                                                                     |             | Test 1          |                                                                                         |
| Active PSCell                                  |                                                                     |             | Cell 1          |                                                                                         |
| RF Channel Number                              |                                                                     |             | 1               |                                                                                         |
| Duplex mode                                    | Config 1, 2                                                         |             | TDD             |                                                                                         |
|                                                | Config 3                                                            |             | FDD             |                                                                                         |
| BWchannel                                      | Config 1                                                            | MHz         | 10: NRB,c = 52  |                                                                                         |
|                                                | Config 2                                                            |             | 40: NRB,c = 106 |                                                                                         |
| DL initial BWP configuration                   | Config 1, 2                                                         |             | DLBWP.0.1       |                                                                                         |
| DL dedicated BWP configuration                 | Config 1, 2                                                         |             | DLBWP.1.1       |                                                                                         |
| UL initial BWP configuration                   | Config 1, 2                                                         |             | ULBWP.0.1       |                                                                                         |
| UL dedicated BWP configuration                 | Config 1, 2                                                         |             | ULBWP.1.1       |                                                                                         |
| CORESET Reference Channel                      | Config 1                                                            |             | CR.1.1 TDD      |                                                                                         |
|                                                | Config 2                                                            |             | CR.2.1 TDD      |                                                                                         |
|                                                | Config 3                                                            |             | CR.1.1 FDD      |                                                                                         |
| SSB Configuration                              | Config 1                                                            |             | SSB.3 FR1       |                                                                                         |
|                                                | Config 2                                                            |             | SSB.4 FR1       |                                                                                         |
| SMTc Configuration                             | Config 1                                                            |             | SMTc.1          |                                                                                         |
|                                                | Config 2                                                            |             | SMTc.1          |                                                                                         |
| PDSCH/PDCCH subcarrier spacing                 | Config 1                                                            |             | 15 KHz          |                                                                                         |
|                                                | Config 2                                                            |             | 30 KHz          |                                                                                         |
| PRACH Configuration                            | Config 1                                                            |             | Table G.X       |                                                                                         |
|                                                | Config 2                                                            |             | Table G.X       |                                                                                         |
| SSB Index assigned as BFD RS (q <sub>0</sub> ) |                                                                     |             | 0               |                                                                                         |
| SSB Index assigned as CBD RS (q <sub>1</sub> ) |                                                                     |             | 1               |                                                                                         |
| OCNG parameters                                |                                                                     |             | OP.1            |                                                                                         |
| CP length                                      |                                                                     |             | Normal          |                                                                                         |
| Correlation Matrix and Antenna Configuration   |                                                                     |             | 2x2 Low         |                                                                                         |
| Beam failure detection transmission parameters | DCI format                                                          |             | 1-0             |                                                                                         |
|                                                | Number of Control OFDM symbols                                      |             | 2               |                                                                                         |
|                                                | Aggregation level                                                   | CCE         | 8               |                                                                                         |
|                                                | Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy   | dB          | 0               |                                                                                         |
|                                                | Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy | dB          | 0               |                                                                                         |
|                                                | DMRS precoder granularity                                           |             | REG bundle size |                                                                                         |
|                                                | REG bundle size                                                     |             | 6               |                                                                                         |
| rlmInSyncOutOfSyncThreshold                    |                                                                     |             | absent          | When the field is absent, the NCR-MT applies the value 0. (Table 8.1.1-1 of TS 38.133). |
| rsrp-ThresholdSSB                              | Config 1                                                            | dBm/SCS kHz | -98             | Threshold used for Q <sub>in_LR_SSB</sub>                                               |
|                                                | Config 2                                                            |             | -95             |                                                                                         |
| powerControlOffsetSS                           |                                                                     |             | db0             | Used for deriving rsrp-ThresholdCSI-RS                                                  |
| beamFailureInstanceMaxCount                    |                                                                     |             | n1              | see clause 5.17 of TS 38.321 [14]                                                       |
| beamFailureDetectionTimer                      |                                                                     |             | pbfd4           | see clause 5.17 of TS 38.321 [14]                                                       |

| Parameter                                                                                   |          | Unit | Value          | Comment                                                               |
|---------------------------------------------------------------------------------------------|----------|------|----------------|-----------------------------------------------------------------------|
|                                                                                             |          |      | <b>Test 1</b>  |                                                                       |
| CSI-RS configuration for CSI reporting                                                      | Config 1 |      | CSI-RS.1.1 TDD |                                                                       |
|                                                                                             | Config 2 |      | CSI-RS.2.1 TDD |                                                                       |
|                                                                                             | Config 3 |      | CSI-RS.1.1 FDD |                                                                       |
| CSI-RS for tracking                                                                         | Config 1 |      | TRS.1.1 TDD    |                                                                       |
|                                                                                             | Config 2 |      | TRS.1.2 TDD    |                                                                       |
|                                                                                             | Config 3 |      | TRS.1.1 FDD    |                                                                       |
| SSB Index assigned as RLM RS                                                                |          | 0, 1 |                |                                                                       |
| T310 Timer                                                                                  | ms       | 1000 |                |                                                                       |
| N310                                                                                        |          | 2    |                |                                                                       |
| T1                                                                                          |          | s    | 0.2            | During this time the the NCR-MT shall be fully synchronized to cell 1 |
| T2                                                                                          |          | s    | 0.37           |                                                                       |
| T3                                                                                          |          | s    | 0.24           |                                                                       |
| T4                                                                                          |          | s    | 0              |                                                                       |
| T5                                                                                          |          | s    | 0.17           |                                                                       |
| D1                                                                                          |          | s    | 0.13           |                                                                       |
| Note 1: All configurations are assigned to the NCR-MT prior to the start of time period T1. |          |      |                |                                                                       |
| Note 2: NCR-MT-specific PDCCH is not transmitted after T1 starts.                           |          |      |                |                                                                       |

**Table G.2.3.2.1.1-3: Cell specific test parameters for FR1 PCell for SSB-based beam failure detection and link recovery testing**

| Parameter                         |                                                                                                                                                                                                                 | Unit            | Test 1            |      |     |     |     |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------|------|-----|-----|-----|
|                                   |                                                                                                                                                                                                                 |                 | T1                | T2   | T3  | T4  | T5  |
| EPRE ratio of PDCCH DMRS to SSS   |                                                                                                                                                                                                                 | dB              | 0                 |      |     |     |     |
| EPRE ratio of PDCCH to PDCCH DMRS |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| EPRE ratio of PBCH DMRS to SSS    |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| EPRE ratio of PBCH to PBCH DMRS   |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| EPRE ratio of PSS to SSS          |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| EPRE ratio of PDSCH DMRS to SSS   |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| EPRE ratio of PDSCH to PDSCH DMRS |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| EPRE ratio of OCNG DMRS to SSS    |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| EPRE ratio of OCNG to OCNG DMRS   |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| SNR_SSB of set q <sub>0</sub>     | Config 1                                                                                                                                                                                                        | dB              | 5                 | -3   | -12 | -12 | -12 |
|                                   | Config 2                                                                                                                                                                                                        |                 | 5                 | -3   | -12 | -12 | -12 |
| SNR_SSB of set q <sub>1</sub>     | Config 1                                                                                                                                                                                                        | dB              | -10               | -10  | 10  | 10  | 10  |
|                                   | Config 2                                                                                                                                                                                                        |                 | -10               | -10  | 10  | 10  | 10  |
| SSB_RP of set q <sub>1</sub>      | Config 1                                                                                                                                                                                                        | dBm/S<br>CS kHz | -108              | -108 | -88 | -88 | -88 |
|                                   | Config 2                                                                                                                                                                                                        |                 | -105              | -105 | -85 | -85 | -85 |
| N <sub>oc</sub>                   | Config 1                                                                                                                                                                                                        | dBm/15<br>KHz   | -98               |      |     |     |     |
|                                   | Config 2                                                                                                                                                                                                        |                 | -98               |      |     |     |     |
| Propagation condition             |                                                                                                                                                                                                                 |                 | TDL-C 300ns 100Hz |      |     |     |     |
| Note 1:                           | OCNG shall be used such that the resources in Cell 1 are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.                                              |                 |                   |      |     |     |     |
| Note 2:                           | The uplink resources for CSI reporting are assigned to the NCR-MT prior to the start of time period T1.                                                                                                         |                 |                   |      |     |     |     |
| Note 3:                           | NZP CSI-RS resource set configuration for CSI reporting are assigned to the NCR-MT prior to the start of time period T1.                                                                                        |                 |                   |      |     |     |     |
| Note 4:                           | Void.                                                                                                                                                                                                           |                 |                   |      |     |     |     |
| Note 5:                           | The timers and layer 3 filtering related parameters are configured prior to the start of time period T1.                                                                                                        |                 |                   |      |     |     |     |
| Note 6:                           | The signal contains PDCCH for NCR-MTs other than the device under test as part of OCNG.                                                                                                                         |                 |                   |      |     |     |     |
| Note 7:                           | SNR levels correspond to the signal to noise ratio over the SSS REs.                                                                                                                                            |                 |                   |      |     |     |     |
| Note 8:                           | The SNR in time periods T1, T2, T3, T4 and T5 is denoted as SNR1, SNR2 and SNR3 respectively in figure G.2.3.2.1.1-1.                                                                                           |                 |                   |      |     |     |     |
| Note 9:                           | The SNR values are specified for testing a NCR-MT which supports 2RX on at least one band. For testing of a NCR-MT which supports 4RX on all bands, the SNR during T3 is modified as specified in clause G.1.3. |                 |                   |      |     |     |     |

**Figure G.2.3.2.1.1-1: SNR and L1-RSRP variation SSB for SSB-based beam failure detection and link recovery testing**

### G.2.3.2.1.2 Test Requirements

The NCR-MT behaviour during time durations T1, T2, T3, T4 and T5 shall be as follows:

During the time duration T1 and T2, the NCR-MT shall transmit uplink signal at least in all subframes configured for CSI transmission on Cell 1.

During the period from time point A to time point B the NCR-MT shall transmit uplink signal in Cell 1 in all uplink slots configured for CSI transmission according to the configured periodic CSI reporting for Cell 1.

During T3 the NCR-MT shall detect beam failure and initiate link recovery. During T4 and T5 the NCR-MT measures and evaluate beam candidate from beam candidate set  $q_1$ .

No later than time point F occurring no later than  $D1 = 120 + 10$  ms after the start of T5, the NCR-MT shall transmit preamble on a beam associated with the candidate beam set  $q_1$ . The NCR-MT shall not transmit preamble on a beam associated with the candidate beam set  $q_1$  earlier than time point B.

Test is concluded once the test equipment has received the initial preamble transmission from the NCR-MT. The rate of correct events observed during repeated tests shall be at least 90%.

### G.2.3.2.2 Beam Failure Detection and Link Recovery Test for FR2 PCell configured with SSB-based BFD and LR

#### G.2.3.2.2.1 Test Purpose and Environment

The purpose of this test is to verify that the NCR-MT properly detects SSB-based beam failure in the set  $q_0$  configured for a serving cell and that the NCR-MT performs correct SSB-based link recovery based on beam candidate set  $q_1$ . The purpose is to test the downlink monitoring for beam failure detection within the NCR-MT active DL BWP, during the evaluation period, and link recovery, when no DRX is used. This test will partly verify the SSB based beam failure detection and link recovery for an FR2 serving cell requirements in clause 12.3.2.2.

The test parameters are given in Tables G.2.3.2.2.1-1, G.2.3.2.2.1-2 and G.2.3.2.2.1-3 below. There is one cell, cell 1 which is the active cell, in the test. The test consists of five successive time periods, with time duration of T1, T2, T3, T4 and T5 respectively. Figure G.2.3.2.2.1-1 shows the variation of the downlink SNR of the SSB in set  $q_0$  in the active cell to emulate SSB based beam failure. Figure G.2.3.2.2.1-1 additionally shows the variation of the downlink L1-RSRP of the SSB in set  $q_1$  of the candidate beam used for link recovery. Prior to the start of the time duration T1, the NCR-MT shall be fully synchronized to cell 1. The NCR-MT shall be configured for periodic CSI reporting with a reporting periodicity of 2 ms. In the test, DRX configuration is not enabled.

**Table G.2.3.2.2.1-1: Supported test configurations for FR2 PCell**

| Configuration                                                                                | Description                                         |
|----------------------------------------------------------------------------------------------|-----------------------------------------------------|
| 1                                                                                            | TDD duplex mode, 120 kHz SSB SCS, 100 MHz bandwidth |
| 2                                                                                            | TDD duplex mode, 240 kHz SSB SCS, 100 MHz bandwidth |
| Note: The NCR-MT is only required to pass in one of the supported test configurations in FR2 |                                                     |

Table G.2.3.2.2.1-2: General test parameters for FR2 PCell for SSB-based beam failure detection and link recovery testing

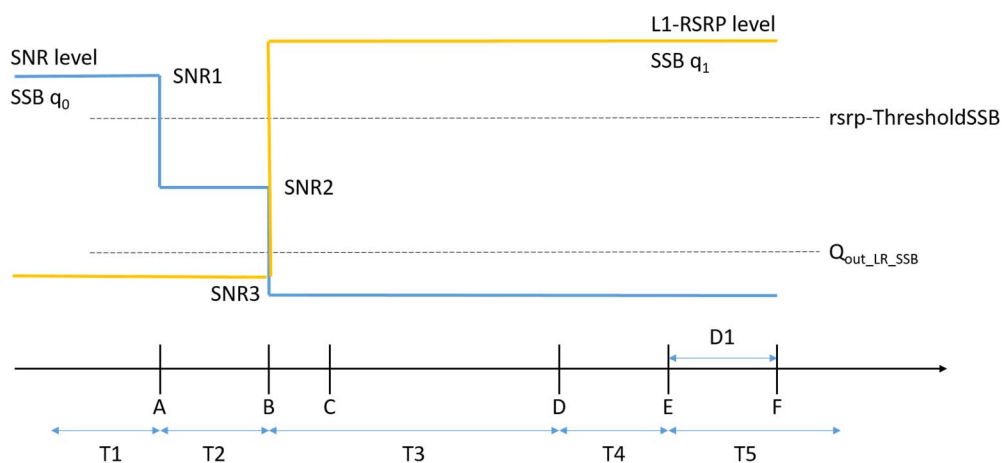
| Parameter                                      |                                                                     | Unit | Value                       | Comment                                                                                     |
|------------------------------------------------|---------------------------------------------------------------------|------|-----------------------------|---------------------------------------------------------------------------------------------|
|                                                |                                                                     |      | Test 1                      |                                                                                             |
| Active PCell                                   |                                                                     |      | Cell 1                      |                                                                                             |
| RF Channel Number                              |                                                                     |      | 1                           |                                                                                             |
| Duplex mode                                    | Config 1, 2                                                         |      | TDD                         |                                                                                             |
| BW <sub>channel</sub>                          | Config 1, 2                                                         |      | 100: N <sub>RB,c</sub> = 66 |                                                                                             |
| DL initial BWP configuration                   | Config 1, 2                                                         |      | DLBWP.0.1                   |                                                                                             |
| DL dedicated BWP configuration                 | Config 1, 2                                                         |      | DLBWP.1.1                   |                                                                                             |
| UL initial BWP configuration                   | Config 1, 2                                                         |      | ULBWP.0.1                   |                                                                                             |
| UL dedicated BWP configuration                 | Config 1, 2                                                         |      | ULBWP.1.1                   |                                                                                             |
| CORESET Reference Channel                      | Config 1, 2                                                         |      | CR. 3.1 TDD                 |                                                                                             |
| SSB Configuration                              | Config 1                                                            |      | SSB.1 FR2                   |                                                                                             |
|                                                | Config 2                                                            |      | SSB.2 FR2                   |                                                                                             |
| SMTC Configuration                             | Config 1, 2                                                         |      | SMTC.3                      |                                                                                             |
| PDSCH/PDCC H subcarrier spacing                | Config 1, 2                                                         |      | 120 KHz                     |                                                                                             |
| SSB index assigned as BFD RS (q <sub>0</sub> ) |                                                                     |      | 0                           |                                                                                             |
| SSB index assigned as CBD RS (q <sub>1</sub> ) |                                                                     |      | 1                           |                                                                                             |
| OCNG parameters                                |                                                                     |      | OP.1                        |                                                                                             |
| CP length                                      |                                                                     |      | Normal                      |                                                                                             |
| Beam failure detection transmission parameters | DCI format                                                          |      | 1-0                         |                                                                                             |
|                                                | Number of Control OFDM symbols                                      |      | 2                           |                                                                                             |
|                                                | Aggregation level                                                   | CCE  | 8                           |                                                                                             |
|                                                | Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy   | dB   | 0                           |                                                                                             |
|                                                | Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy | dB   | 0                           |                                                                                             |
|                                                | DMRS precoder granularity                                           |      | REG bundle size             |                                                                                             |
|                                                | REG bundle size                                                     |      | 6                           |                                                                                             |
| DRX                                            |                                                                     |      | OFF                         |                                                                                             |
| rlmInSyncOutOfSyncThreshold                    |                                                                     |      | absent                      | When the field is absent, the NCR-MT applies the value 0. (Table 8.1.1-1 in TS 38.133 [6]). |

| Parameter                                                                                   |                | Unit           | Value          | Comment                                                                           |
|---------------------------------------------------------------------------------------------|----------------|----------------|----------------|-----------------------------------------------------------------------------------|
|                                                                                             |                |                | Test 1         |                                                                                   |
| rsrp-ThresholdSSB                                                                           | Config 1       | dBm/SSB<br>SCS | -94.5          | Threshold used<br>for $Q_{in\_LR\_SSB}$                                           |
|                                                                                             | Config 2       |                | -91.5          |                                                                                   |
| powerControlOffsetSS                                                                        |                |                | db0            | Used for deriving<br>rsrp-ThresholdCSI-RS                                         |
| beamFailureInstanceMaxCount                                                                 |                |                | n1             | see clause 5.17 of<br>TS 38.321 [7]                                               |
| beamFailureDetectionTimer                                                                   |                |                | pbfd4          | see clause 5.17 of<br>TS 38.321 [7]                                               |
| CSI-RS configuration<br>for CSI reporting                                                   | Config<br>1, 2 |                | CSI-RS.3.1 TDD |                                                                                   |
| TCI states                                                                                  |                |                | TCI.State.0    |                                                                                   |
| CSI-RS for tracking                                                                         | Config<br>1, 2 |                | TRS.2.1 TDD    |                                                                                   |
| SSB index assigned as RLM RS                                                                |                |                | 0, 1           |                                                                                   |
| T310 Timer                                                                                  |                | ms             | 1000           |                                                                                   |
| N310                                                                                        |                |                | 2              |                                                                                   |
| T1                                                                                          |                | s              | 1              | During this time<br>the the NCR-MT<br>shall be fully<br>synchronized to<br>cell 1 |
| T2                                                                                          |                | s              | 2.61           |                                                                                   |
| T3                                                                                          |                | s              | 1.64           |                                                                                   |
| T4                                                                                          |                | s              | 0              |                                                                                   |
| T5                                                                                          |                | s              | 1.01           |                                                                                   |
| D1                                                                                          |                | s              | 0.97           |                                                                                   |
| Note 1: All configurations are assigned to the NCR-MT prior to the start of time period T1. |                |                |                |                                                                                   |
| Note 2: NCR-MT-specific PDCCH is not transmitted after T1 starts.                           |                |                |                |                                                                                   |

*Editor's note: An additional RS for RLM, different from BFD-RS at constant high SNR shall be configured as part of the test configuration.*

**Table G.2.3.2.2.1-3: Cell specific test parameters for FR2 PCell for SSB-based beam failure detection and link recovery testing**

| Parameter                         |                                                                                                                                                                    | Unit        | Test 1                    |        |       |       |       |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|---------------------------|--------|-------|-------|-------|
|                                   |                                                                                                                                                                    |             | T1                        | T2     | T3    | T4    | T5    |
| AoA setup                         |                                                                                                                                                                    |             | Setup 1 defined in G.1.18 |        |       |       |       |
| EPRE ratio of PDCCH DMRS to SSS   |                                                                                                                                                                    | dB          | 0                         |        |       |       |       |
| EPRE ratio of PDCCH to PDCCH DMRS |                                                                                                                                                                    | dB          |                           |        |       |       |       |
| EPRE ratio of PBCH DMRS to SSS    |                                                                                                                                                                    | dB          |                           |        |       |       |       |
| EPRE ratio of PBCH to PBCH DMRS   |                                                                                                                                                                    | dB          |                           |        |       |       |       |
| EPRE ratio of PSS to SSS          |                                                                                                                                                                    | dB          |                           |        |       |       |       |
| EPRE ratio of PDSCH DMRS to SSS   |                                                                                                                                                                    | dB          |                           |        |       |       |       |
| EPRE ratio of PDSCH to PDSCH DMRS |                                                                                                                                                                    | dB          |                           |        |       |       |       |
| EPRE ratio of OCNG DMRS to SSS    |                                                                                                                                                                    | dB          |                           |        |       |       |       |
| EPRE ratio of OCNG to OCNG DMRS   |                                                                                                                                                                    | dB          |                           |        |       |       |       |
| SNR_SSB of set $q_0$              | Config 1                                                                                                                                                           | dB          | 5                         | -3     | -12   | -12   | -12   |
|                                   | Config 2                                                                                                                                                           |             | 5                         | -3     | -12   | -12   | -12   |
| SNR_SSB of set $q_1$              | Config 1                                                                                                                                                           | dB          | 0.2                       | 0.2    | 20.2  | 20.2  | 20.2  |
|                                   | Config 2                                                                                                                                                           |             | 0.2                       | 0.2    | 20.2  | 20.2  | 20.2  |
| SSB_RP of set $q_1$               | Config 1                                                                                                                                                           | dBm/SSB     | -104.5                    | -104.5 | -84.5 | -84.5 | -84.5 |
|                                   | Config 2                                                                                                                                                           | SCS         | -101.5                    | -101.5 | -81.5 | -81.5 | -81.5 |
| $N_{oc}$                          | Config 1                                                                                                                                                           | dBm/120 KHz | -104.7                    |        |       |       |       |
|                                   | Config 2                                                                                                                                                           |             | -104.7                    |        |       |       |       |
| Propagation condition             |                                                                                                                                                                    |             | TDL-A 30ns 75Hz           |        |       |       |       |
| Note 1:                           | OCNG shall be used such that the resources in Cell 1 are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols. |             |                           |        |       |       |       |
| Note 2:                           | The uplink resources for CSI reporting are assigned to the NCR-MT prior to the start of time period T1.                                                            |             |                           |        |       |       |       |
| Note 3:                           | NZP CSI-RS resource set configuration for CSI reporting are assigned to the NCR-MT prior to the start of time period T1.                                           |             |                           |        |       |       |       |
| Note 4:                           | Void                                                                                                                                                               |             |                           |        |       |       |       |
| Note 5:                           | The timers and layer 3 filtering related parameters are configured prior to the start of time period T1.                                                           |             |                           |        |       |       |       |
| Note 6:                           | The signal contains PDCCH for NCR-MTs other than the device under test as part of OCNG.                                                                            |             |                           |        |       |       |       |
| Note 7:                           | SNR levels correspond to the signal to noise ratio over the SSS REs.                                                                                               |             |                           |        |       |       |       |
| Note 8:                           | The SNR in time periods T1, T2, T3, T4 and T5 is denoted as SNR1, SNR2 and SNR3 respectively in figure G.2.3.2.X.1-1.                                              |             |                           |        |       |       |       |
| Note 9:                           | The SNR values are specified for testing an NCR-MT which supports 2RX on at least one band.                                                                        |             |                           |        |       |       |       |

**Figure G.2.3.2.2.1-1: SNR and L1-RSRP variation SSB for SSB-based beam failure detection and link recovery testing in non-DRX mode**

#### G.2.3.2.2.2 Test Requirements

The NCR-MT behaviour during time durations T1, T2, T3, T4 and T5 shall be as follows:

During the time duration T1 and T2, the NCR-MT shall transmit uplink signal at least in all subframes configured for CSI transmission on Cell 1.

During the period from time point A to time point B the NCR-MT shall transmit uplink signal in Cell 1 in all uplink slots configured for CSI transmission according to the configured periodic CSI reporting for Cell 1.

During T3 the NCR-MT shall detect beam failure and initiate link recovery. During T4 and T5 the NCR-MT measures and evaluate beam candidate from beam candidate set  $q_1$ .

No later than time point F occurring no later than  $D1 = 560 + 650$  ms after the start of T5, the NCR-MT shall transmit preamble on a beam associated with the candidate beam set  $q_1$ . The NCR-MT shall not transmit preamble on a beam associated with the candidate beam set  $q_1$  earlier than time point B.

Test is concluded once the test equipment has received the initial preamble transmission from the NCR-MT. The rate of correct events observed during repeated tests shall be at least 90%.

### G.2.3.2.3 Beam Failure Detection and Link Recovery Test for FR1 PCell configured with CSI-RS-based BFD and LR

#### G.2.3.2.3.1 Test Purpose and Environment

The purpose of this test is to verify that the NCR-MT properly detects CSI-RS-based beam failure in the set  $q_0$  configured for a serving cell and that the NCR-MT performs correct CSI-RS-based link recovery based on beam candidate set  $q_1$ . The purpose is to test the downlink monitoring for beam failure detection within the NCR-MT's active DL BWP, during the evaluation period, and link recovery. This test will partly verify the CSI-RS based beam failure detection and link recovery for an FR1 serving cell requirements in clause 12.3.2.

The test parameters are given in Tables G.2.3.2.3.1-1, G.2.3.2.3.1-2 and G.2.3.2.3.1-3 below. There is one cell, cell 1 which is the active cell, in the test. The test consists of five successive time periods, with time duration of T1, T2, T3, T4 and T5 respectively. Figure G.2.3.2.3.1-1 shows the variation of the downlink SNR of the CSI-RS in set  $q_0$  in the active cell to emulate CSI-RS based beam failure. Figure G.2.3.2.3.1-1 additionally shows the variation of the downlink L1-RSRP of the CSI-RS in set  $q_1$  of the candidate beam used for link recovery. Prior to the start of the time duration T1, the NCR-MT shall be fully synchronized to cell 1. The NCR-MT shall be configured for periodic CSI reporting with a reporting periodicity of 2 ms.

**Table G.2.3.2.3.1-1: Supported test configurations for FR1 PCell**

| Configuration                                                                                | Description                                       |
|----------------------------------------------------------------------------------------------|---------------------------------------------------|
| 1                                                                                            | TDD duplex mode, 15 kHz SSB SCS, 10 MHz bandwidth |
| 2                                                                                            | TDD duplex mode, 30 kHz SSB SCS, 40 MHz bandwidth |
| 3                                                                                            | FDD duplex mode, 15 kHz SSB SCS, 10 MHz bandwidth |
| Note: The NCR-MT is only required to pass in one of the supported test configurations in FR1 |                                                   |

**Table G.2.3.2.3.1-2: General test parameters for FR1 PCell for CSI-RS-based beam failure detection and link recovery testing**

| Parameter                                                            |                                                                            | Unit            | Value           | Comment                                                                                      |
|----------------------------------------------------------------------|----------------------------------------------------------------------------|-----------------|-----------------|----------------------------------------------------------------------------------------------|
|                                                                      |                                                                            |                 | Test 1          |                                                                                              |
| Active PCell                                                         |                                                                            |                 | Cell 1          |                                                                                              |
| RF Channel Number                                                    |                                                                            |                 | 1               |                                                                                              |
| Duplex mode                                                          | Config 1, 2                                                                |                 | TDD             |                                                                                              |
|                                                                      | Config 3                                                                   |                 | FDD             |                                                                                              |
| CORESET<br>Reference<br>Channel                                      | Config 1                                                                   |                 | CR.1.1 TDD      |                                                                                              |
|                                                                      | Config 2                                                                   |                 | CR.2.1 TDD      |                                                                                              |
|                                                                      | Config 3                                                                   |                 | CR.1.1 FDD      |                                                                                              |
| SSB<br>Configuration                                                 | Config 1                                                                   |                 | SSB.1 FR1       |                                                                                              |
|                                                                      | Config 2                                                                   |                 | SSB.2 FR1       |                                                                                              |
| SMTC<br>Configuration                                                | Config 1                                                                   |                 | SMTC.1          | G.1.6                                                                                        |
|                                                                      | Config 2                                                                   |                 | SMTC.1          |                                                                                              |
| PDSCH/PDCCH<br>subcarrier<br>spacing                                 | Config 1                                                                   |                 | 15 KHz          |                                                                                              |
|                                                                      | Config 2                                                                   |                 | 30 KHz          |                                                                                              |
| csi-RS-Index assigned as beam failure detection RS<br>in set $q_0$   |                                                                            |                 | 0               |                                                                                              |
| OCNG parameters                                                      |                                                                            |                 | OP.1            | G.1.2.1                                                                                      |
| CP length                                                            |                                                                            |                 | Normal          |                                                                                              |
| Correlation Matrix and Antenna Configuration                         |                                                                            |                 | 2x2 Low         |                                                                                              |
| Beam failure<br>detection<br>transmission<br>parameters              | DCI format                                                                 |                 | 1-0             |                                                                                              |
|                                                                      | Number of Control OFDM<br>symbols                                          |                 | 2               |                                                                                              |
|                                                                      | Aggregation level                                                          | CCE             | 8               |                                                                                              |
|                                                                      | Ratio of hypothetical PDCCH<br>RE energy to average CSI-RS<br>RE energy    | dB              | 0               |                                                                                              |
|                                                                      | Ratio of hypothetical PDCCH<br>DMRS energy to average CSI-<br>RS RE energy | dB              | 0               |                                                                                              |
|                                                                      | DMRS precoder granularity                                                  |                 | REG bundle size |                                                                                              |
|                                                                      | REG bundle size                                                            |                 | 6               |                                                                                              |
| csi-RS-Index assigned as candidate beam detection<br>RS in set $q_1$ |                                                                            |                 | 1               |                                                                                              |
| rlmInSyncOutOfSyncThreshold                                          |                                                                            |                 | absent          | When the field is absent, the NCR-MT<br>applies the value 0. (Table 8.1.1-1of<br>TS 38.133). |
| rsrp-ThresholdSSB                                                    | Config 1                                                                   | dBm/S<br>CS kHz | -98             | Threshold used for $Q_{in\_LR\_SSB}$                                                         |
|                                                                      | Config 2                                                                   |                 | -95             |                                                                                              |
| powerControlOffsetSS                                                 |                                                                            |                 | db0             | Used for deriving rsrp-ThresholdCSI-<br>RS                                                   |
| beamFailureInstanceMaxCount                                          |                                                                            |                 | n1              | see clause 5.17 of TS 38.321 [14]                                                            |
| beamFailureDetectionTimer                                            |                                                                            |                 | pbfd4           | see clause 5.17 of TS 38.321 [14]                                                            |
| CSI-RS configuration for $q_0$ and $q_1$                             | Config 1                                                                   |                 | CSI-RS.1.2 TDD  |                                                                                              |
|                                                                      | Config 2                                                                   |                 | CSI-RS.2.2 TDD  |                                                                                              |
|                                                                      | Config 3                                                                   |                 | CSI-RS.1.2 FDD  |                                                                                              |
| CSI-RS configuration for CSI<br>reporting                            | Config 1                                                                   |                 | CSI-RS.1.1 TDD  |                                                                                              |
|                                                                      | Config 2                                                                   |                 | CSI-RS.2.1 TDD  |                                                                                              |
|                                                                      | Config 3                                                                   |                 | CSI-RS.1.1 FDD  |                                                                                              |
| TRS configuration                                                    | Config 1                                                                   |                 | TRS.1.1 TDD     |                                                                                              |
|                                                                      | Config 2                                                                   |                 | TRS.1.2 TDD     |                                                                                              |
|                                                                      | Config 2                                                                   |                 | TRS.1.1 FDD     |                                                                                              |
| CSI-RS-Index assigned as RLM RS                                      | Config 1                                                                   |                 | CSI-RS.1.2 TDD  |                                                                                              |
|                                                                      | Config 2                                                                   |                 | CSI-RS.2.2 TDD  |                                                                                              |
|                                                                      | Config 13                                                                  |                 | CSI-RS.1.2 FDD  |                                                                                              |
| T310 Timer                                                           |                                                                            | ms              | 1000            |                                                                                              |
| N310                                                                 |                                                                            |                 | 2               |                                                                                              |

| Parameter                                                         | Unit | Value  | Comment                                                               |
|-------------------------------------------------------------------|------|--------|-----------------------------------------------------------------------|
|                                                                   |      | Test 1 |                                                                       |
| T1                                                                | s    | 0.2    | During this time the the NCR-MT shall be fully synchronized to cell 1 |
| T2                                                                | s    | 0.18   |                                                                       |
| T3                                                                | s    | 0.14   |                                                                       |
| T4                                                                | s    | 0      |                                                                       |
| T5                                                                | s    | 0.08   |                                                                       |
| D1                                                                | s    | 0.04   |                                                                       |
| Note 1: NCR-MT-specific PDCCH is not transmitted after T1 starts. |      |        |                                                                       |

**Table G.2.3.2.3.1-3: Cell specific test parameters for FR1 PCell for CSI-RS-based beam failure detection and link recovery testing**

| Parameter                         |                                                                                                                                                                                                                 | Unit            | Test 1            |      |     |     |     |
|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------|------|-----|-----|-----|
|                                   |                                                                                                                                                                                                                 |                 | T1                | T2   | T3  | T4  | T5  |
| EPRE ratio of PDCCH DMRS to SSS   |                                                                                                                                                                                                                 | dB              | 0                 |      |     |     |     |
| EPRE ratio of PDCCH to PDCCH DMRS |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| EPRE ratio of PBCH DMRS to SSS    |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| EPRE ratio of PBCH to PBCH DMRS   |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| EPRE ratio of PSS to SSS          |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| EPRE ratio of PDSCH DMRS to SSS   |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| EPRE ratio of PDSCH to PDSCH DMRS |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| EPRE ratio of OCNG DMRS to SSS    |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| EPRE ratio of OCNG to OCNG DMRS   |                                                                                                                                                                                                                 | dB              |                   |      |     |     |     |
| SNR_CSI-RS of set $q_0$           | Config 1                                                                                                                                                                                                        | dB              | 5                 | -3   | -12 | -12 | -12 |
|                                   | Config 2                                                                                                                                                                                                        |                 | 5                 | -3   | -12 | -12 | -12 |
| SNR_CSI-RS of set $q_1$           | Config 1                                                                                                                                                                                                        | dB              | -10               | -10  | 10  | 10  | 10  |
|                                   | Config 2                                                                                                                                                                                                        |                 | -10               | -10  | 10  | 10  | 10  |
| CSI-RS_RP of set $q_1$            | Config 1                                                                                                                                                                                                        | dBm/S<br>CS kHz | -108              | -108 | -88 | -88 | -88 |
|                                   | Config 2                                                                                                                                                                                                        |                 | -105              | -105 | -85 | -85 | -85 |
| $N_{oc}$                          | Config 1                                                                                                                                                                                                        | dBm/15<br>KHz   | -98               |      |     |     |     |
|                                   | Config 2                                                                                                                                                                                                        |                 | -98               |      |     |     |     |
| Propagation condition             |                                                                                                                                                                                                                 |                 | TDL-C 300ns 100Hz |      |     |     |     |
| Note 1:                           | OCNG shall be used such that the resources in Cell 1 are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.                                              |                 |                   |      |     |     |     |
| Note 2:                           | The uplink resources for CSI reporting are assigned to the NCR-MT prior to the start of time period T1.                                                                                                         |                 |                   |      |     |     |     |
| Note 3:                           | NZP CSI-RS resource set configuration for CSI reporting are assigned to the NCR-MT prior to the start of time period T1.                                                                                        |                 |                   |      |     |     |     |
| Note 4:                           | Void                                                                                                                                                                                                            |                 |                   |      |     |     |     |
| Note 5:                           | The timers and layer 3 filtering related parameters are configured prior to the start of time period T1.                                                                                                        |                 |                   |      |     |     |     |
| Note 6:                           | The signal contains PDCCH for NCR-MTs other than the device under test as part of OCNG.                                                                                                                         |                 |                   |      |     |     |     |
| Note 7:                           | SNR levels correspond to the signal to noise ratio over the REs carrying CSI-RS.                                                                                                                                |                 |                   |      |     |     |     |
| Note 8:                           | The SNR in time periods T1, T2, T3, T4 and T5 is denoted as SNR1, SNR2 and SNR3 respectively in figure G.2.3.2.2.1-1.                                                                                           |                 |                   |      |     |     |     |
| Note 9:                           | The SNR values are specified for testing a NCR-MT which supports 2RX on at least one band. For testing of a NCR-MT which supports 4RX on all bands, the SNR during T3 is modified as specified in clause G.1.3. |                 |                   |      |     |     |     |

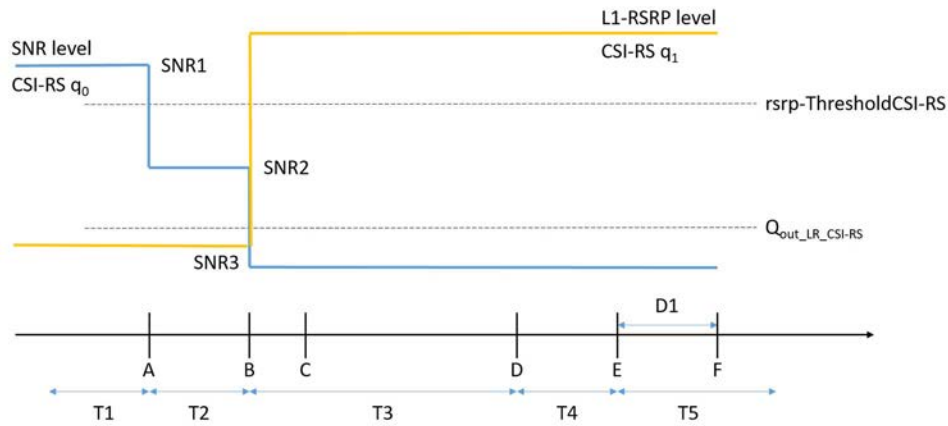


**Figure G.2.3.2.3.1-1: SNR and L1-RSRP variation for CSI-RS-based beam failure detection and link recovery testing**

#### G.2.3.2.3.2 Test Requirements

The NCR-MT behaviour during time durations T1, T2, T3, T4 and T5 shall be as follows:

During the time duration T1 and T2, the NCR-MT shall transmit uplink signal at least in all subframes configured for CSI transmission on Cell 1.

During the period from time point A to time point B the NCR-MT shall transmit uplink signal in Cell 1 in all uplink slots configured for CSI transmission according to the configured periodic CSI reporting for Cell 1.

During T3 the shall detect beam failure and initial link recovery. During T4 and T5 the NCR-MT measures and evaluate beam candidate from beam candidate set  $q_1$ .

No later than time point F occurring no later than  $D1 = 30+10$  ms after the start of T5, the NCR-MT shall transmit preamble on a beam associated with the candidate beam set  $q_1$ . The NCR-MT shall not transmit preamble on a beam associated with the candidate beam set  $q_1$  earlier than time point B.

Test is concluded once the test equipment has received the initial preamble transmission from the NCR-MT. The rate of correct events observed during repeated tests shall be at least 90%.

#### G.2.3.2.4 Beam Failure Detection and Link Recovery Test for FR2 PCell configured with CSI-RS-based BFD and LR in non-DRX mode

##### G.2.3.2.4.1 Test Purpose and Environment

The purpose of this test is to verify that the NCR-MT properly detects CSI-RS-based beam failure in the set  $q_0$  configured for a serving cell and that the NCR-MT performs correct CSI-RS-based link recovery based on beam candidate set  $q_1$ . The purpose is to test the downlink monitoring for beam failure detection within the NCR-MT's active DL BWP, during the evaluation period, and link recovery, when no DRX is used. This test will partly verify the CSI-RS based beam failure detection and link recovery for an FR2 serving cell requirements in clause 12.3.2.

The test parameters are given in Tables G.2.3.2.4.1-1, G.2.3.2.4.1-2, and G.2.3.2.4.1-3 below. There is one cell, cell 1 which is the active cell, in the test. The test consists of five successive time periods, with time duration of T1, T2, T3, T4 and T5 respectively. Figure G.2.3.2.4.1-1 shows the variation of the downlink SNR of the CSI-RS in set  $q_0$  in the active cell to emulate CSI-RS based beam failure. Figure G.2.3.2.4.1-1 additionally shows the variation of the downlink L1-RSRP of the CSI-RS in set  $q_1$  of the candidate beam used for link recovery. Prior to the start of the time duration T1, the NCR-MT shall be fully synchronized to cell 1. The NCR-MT shall be configured for periodic CSI reporting with a reporting periodicity of 2 ms. In the test, DRX configuration is not enabled.

Table G.2.3.2.4.1-1: Supported test configurations for FR2 PCell

| Configuration | Description                                         |
|---------------|-----------------------------------------------------|
| 1             | TDD duplex mode, 120 kHz SSB SCS, 100 MHz bandwidth |

**Table G.2.3.2.4.1-2: General test parameters for FR2 PCell for CSI-RS based beam failure detection and link recovery testing in non-DRX mode**

| Parameter                                                         |                                                                     | Unit         | Value           | Comment                                                                                     |
|-------------------------------------------------------------------|---------------------------------------------------------------------|--------------|-----------------|---------------------------------------------------------------------------------------------|
|                                                                   |                                                                     |              | Test 1          |                                                                                             |
| Active PCell                                                      |                                                                     |              | Cell 1          |                                                                                             |
| RF Channel Number                                                 |                                                                     |              | 1               |                                                                                             |
| Duplex mode                                                       | Config 1                                                            |              | TDD             |                                                                                             |
| TDD Configuration                                                 | Config 1                                                            |              | TBD             |                                                                                             |
| CORESET Reference Channel                                         | Config 1                                                            |              | CR.3.1 TDD      | G.1.1.2                                                                                     |
| SSB Configuration                                                 | Config 1                                                            |              | SSB.3 FR2       | G.1.5                                                                                       |
| SMTC Configuration                                                | Config 1                                                            |              | SMTC.3          | G.1.6                                                                                       |
| PDSCH/PDCCH subcarrier spacing                                    | Config 1                                                            |              | 120KHz          |                                                                                             |
| csi-RS-Index assigned as beam failure detection RS in set $q_0$   |                                                                     |              | 0               |                                                                                             |
| TRS configuration                                                 |                                                                     |              | TRS.2.1 TDD     | G.1.10.2                                                                                    |
| TCI configuration                                                 |                                                                     |              | TBD             |                                                                                             |
| OCNG parameters                                                   |                                                                     |              | OP.1            | G.1.2.1                                                                                     |
| CP length                                                         |                                                                     |              | Normal          |                                                                                             |
| Beam failure detection transmission parameters                    | DCI format                                                          |              | 1-0             |                                                                                             |
|                                                                   | Number of Control OFDM symbols                                      |              | 2               |                                                                                             |
|                                                                   | Aggregation level                                                   | CCE          | 8               |                                                                                             |
|                                                                   | Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy   | dB           | 0               |                                                                                             |
|                                                                   | Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy | dB           | 0               |                                                                                             |
|                                                                   | DMRS precoder granularity                                           |              | REG bundle size |                                                                                             |
|                                                                   | REG bundle size                                                     |              | 6               |                                                                                             |
| DRX                                                               |                                                                     |              | OFF             |                                                                                             |
| csi-RS-Index assigned as candidate beam detection RS in set $q_1$ |                                                                     |              | 1               |                                                                                             |
| rlmInSyncOutOfSyncThreshold                                       |                                                                     |              | absent          | When the field is absent, the NCR-MT applies the value 0. (Table 8.1.1-1 in TS 38.133 [6]). |
| rsrp-ThresholdSSB                                                 |                                                                     | dBm/S CS kHz | -94.5           | Threshold used for $Q_{in\_LR\_SSB}$                                                        |
| powerControlOffsetSS                                              |                                                                     |              | db0             | Used for deriving rsrp-ThresholdCSI-RS                                                      |
| beamFailureInstanceMaxCount                                       |                                                                     |              | n1              | see clause 5.17 of TS 38.321 [14]                                                           |
| beamFailureDetectionTimer                                         |                                                                     |              | pbfd4           | see clause 5.17 of TS 38.321 [14]                                                           |
| CSI-RS configuration for $q_0$ and $q_1$                          | Config 1                                                            |              | CSI-RS.3.2 TDD  | G.1.7.1                                                                                     |
| CSI-RS configuration for CSI reporting                            | Config 1                                                            |              | CSI-RS.3.1 TDD  | G.1.7.1                                                                                     |
| csi-RS-Index assigned as RLM RS                                   |                                                                     |              | 0, 1            | G.1.7.1                                                                                     |
| T310 Timer                                                        |                                                                     | ms           | 1000            |                                                                                             |
| N310                                                              |                                                                     |              | 2               |                                                                                             |
| T1                                                                |                                                                     | s            | 0.2             | During this time the the NCR-MT shall be fully synchronized to cell 1                       |
| T2                                                                |                                                                     | s            | 0.18            |                                                                                             |

| Parameter                                                         | Unit | Value  | Comment |
|-------------------------------------------------------------------|------|--------|---------|
|                                                                   |      | Test 1 |         |
| T3                                                                | s    | 0.14   |         |
| T4                                                                | s    | 0      |         |
| T5                                                                | s    | 0.08   |         |
| D1                                                                | s    | 0.04   |         |
| Note 1: NCR-MT-specific PDCCH is not transmitted after T1 starts. |      |        |         |

**Table G.2.3.2.4.1-3: Cell specific test parameters for FR2 PCell for CSI-RS based beam failure detection and link recovery testing in non-DRX mode**

| Parameter                         |                                                                                                                                                                                                                     | Unit            | Test 1                   |        |       |       |       |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------------|--------|-------|-------|-------|
|                                   |                                                                                                                                                                                                                     |                 | T1                       | T2     | T3    | T4    | T5    |
| AoA setup                         |                                                                                                                                                                                                                     |                 | Setup 1 defined in G.1.8 |        |       |       |       |
| EPRE ratio of PDCCH DMRS to SSS   |                                                                                                                                                                                                                     | dB              | 0                        |        |       |       |       |
| EPRE ratio of PDCCH to PDCCH DMRS |                                                                                                                                                                                                                     | dB              |                          |        |       |       |       |
| EPRE ratio of PBCH DMRS to SSS    |                                                                                                                                                                                                                     | dB              |                          |        |       |       |       |
| EPRE ratio of PBCH to PBCH DMRS   |                                                                                                                                                                                                                     | dB              |                          |        |       |       |       |
| EPRE ratio of PSS to SSS          |                                                                                                                                                                                                                     | dB              |                          |        |       |       |       |
| EPRE ratio of PDSCH DMRS to SSS   |                                                                                                                                                                                                                     | dB              |                          |        |       |       |       |
| EPRE ratio of PDSCH to PDSCH DMRS |                                                                                                                                                                                                                     | dB              |                          |        |       |       |       |
| EPRE ratio of OCNG DMRS to SSS    |                                                                                                                                                                                                                     | dB              |                          |        |       |       |       |
| EPRE ratio of OCNG to OCNG DMRS   |                                                                                                                                                                                                                     | dB              |                          |        |       |       |       |
| SNR_CSI-RS of set $q_0$           | Config 1                                                                                                                                                                                                            | dB              | 5                        | -3     | -12   | -12   | -12   |
| SNR_CSI-RS of set $q_1$           | Config 1                                                                                                                                                                                                            | dB              | 0.2                      | 0.2    | 20.2  | 20.2  | 20.2  |
| CSI-RS_RP of set $q_1$            | Config 1                                                                                                                                                                                                            | dBm/S<br>CS kHz | -104.5                   | -104.5 | -84.5 | -84.5 | -84.5 |
| $N_{oc}$                          | Config 1                                                                                                                                                                                                            | dBm/15<br>KHz   | -104.7                   |        |       |       |       |
| Propagation condition             |                                                                                                                                                                                                                     |                 | TDL-A 30ns 75Hz          |        |       |       |       |
| Note 1:                           | OCNG shall be used such that the resources in Cell 1 are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.                                                  |                 |                          |        |       |       |       |
| Note 2:                           | The uplink resources for CSI reporting are assigned to the NCR-MT prior to the start of time period T1.                                                                                                             |                 |                          |        |       |       |       |
| Note 3:                           | NZP CSI-RS resource set configuration for CSI reporting are assigned to the NCR-MT prior to the start of time period T1.                                                                                            |                 |                          |        |       |       |       |
| Note 4:                           | Void                                                                                                                                                                                                                |                 |                          |        |       |       |       |
| Note 5:                           | The timers and layer 3 filtering related parameters are configured prior to the start of time period T1.                                                                                                            |                 |                          |        |       |       |       |
| Note 6:                           | The signal contains PDCCH for UEs other than the device under test as part of OCNG.                                                                                                                                 |                 |                          |        |       |       |       |
| Note 7:                           | SNR levels correspond to the signal to noise ratio over the REs carrying CSI-RS.                                                                                                                                    |                 |                          |        |       |       |       |
| Note 8:                           | The SNR in time periods T1, T2, T3, T4 and T5 is denoted as SNR1, SNR2 and SNR3 respectively in figure G.2.3.2.x.1-1.                                                                                               |                 |                          |        |       |       |       |
| Note 9:                           | The SNR values are specified for testing an NCR-MT which supports 2RX on at least one band. For testing of an NCR-MT which supports 4RX on all bands, the SNR during T3 is modified as specified in clause G.1.3.2. |                 |                          |        |       |       |       |

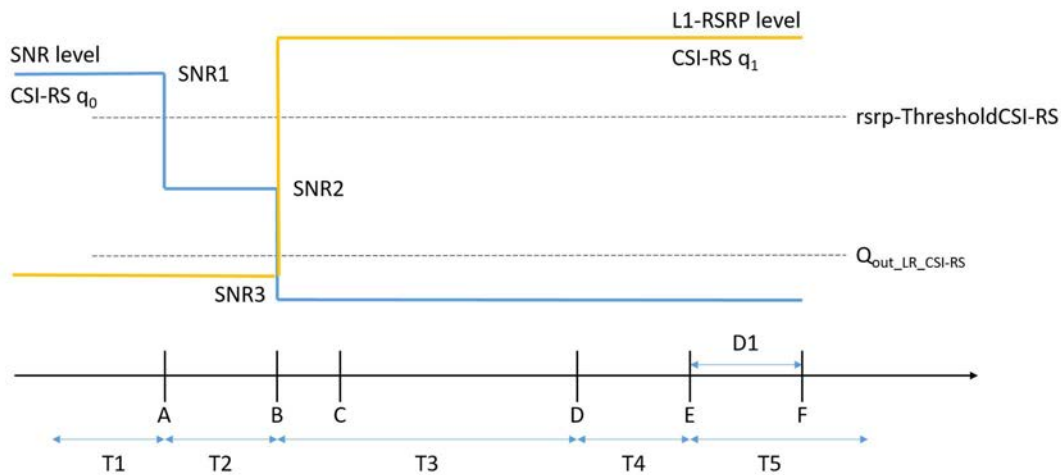


**Figure G.2.3.2.4.1-1: SNR and L1-RSRP variation for CSI-RS based beam failure detection and link recovery testing in non-DRX mode**

#### G.2.3.2.4.2 Test Requirements

The NCR-MT behaviour during time durations T1, T2, T3, T4 and T5 shall be as follows:

During the time duration T1 and T2, the NCR-MT shall transmit uplink signal at least in all subframes configured for CSI transmission on Cell 1.

During the period from time point A to time point B the NCR-MT shall transmit uplink signal in Cell 1 in all uplink slots configured for CSI transmission according to the configured periodic CSI reporting for Cell 1.

During T3 the shall detect beam failure and initial link recovery. During T4 and T5 the NCR-MT measures and evaluate beam candidate from beam candidate set  $q_1$ .

No later than time point F occurring no later than  $D1 = [560+650 \text{ ms}]$  after the start of T5, the NCR-MT shall transmit preamble on a beam associated with the candidate beam set  $q_1$ . The NCR-MT shall not transmit preamble on a beam associated with the candidate beam set  $q_1$  earlier than time point B.

Test is concluded once the test equipment has received the initial preamble transmission from the NCR-MT. The rate of correct events observed during repeated tests shall be at least 90%.

## Annex H (informative): Change history

| Change history |         |           |    |     |                                              |     |       |
|----------------|---------|-----------|----|-----|----------------------------------------------|-----|-------|
| Date           | TSG #   | TSG Doc.  | CR | Rev | Subject/Comment                              | Old | New   |
| 2022-03        | RAN#95e | RP-220790 |    |     | NR Repeater Radio Transmission and Reception |     | 1.0.0 |

| Change history |          |           |      |     |     |                                                                                |             |
|----------------|----------|-----------|------|-----|-----|--------------------------------------------------------------------------------|-------------|
| Date           | Meeting  | TDoc      | CR   | Rev | Cat | Subject/Comment                                                                | New version |
| 2022-03        | RAN#95   |           |      |     |     | Approved by plenary – Rel-17 spec under change control                         | 17.0.0      |
| 2022-06        | RAN#96   | RP-221681 | 0002 | 1   | F   | CR to 38.106: TDD off power radiated requirement correction                    | 17.1.0      |
| 2022-06        | RAN#96   | RP-221681 | 0003 | 1   | F   | CR to 38.106: Corections to definitions, symbols and abbreviations             | 17.1.0      |
| 2022-06        | RAN#96   | RP-221681 | 0004 | 1   | F   | CR to 38.106: Output power definitions for NR repeaters                        | 17.1.0      |
| 2022-06        | RAN#96   | RP-221681 | 0006 | 1   | F   | CR for TS 38.106 R17: clean up of clause 4                                     | 17.1.0      |
| 2022-06        | RAN#96   | RP-221681 | 0007 | 1   | F   | CR for TS 38.106 R17: clean up of clause 6                                     | 17.1.0      |
| 2022-06        | RAN#96   | RP-221681 | 0008 | 1   | F   | CR for TS 38.106 R17: clean up of clause 7                                     | 17.1.0      |
| 2022-06        | RAN#96   | RP-221681 | 0009 | 1   | F   | CR to TS38.106: clarification on the supported operating bands for NR repeater | 17.1.0      |
| 2022-06        | RAN#96   | RP-221681 | 0011 | 1   | F   | CR to TS 38.106 with corrections to repeater core specification                | 17.1.0      |
| 2022-06        | RAN#96   | RP-221681 | 0012 |     | F   | BIG CR to 38.106 maintenance                                                   | 17.1.0      |
| 2022-09        | RAN#97   | RP-222034 | 0013 |     | F   | CR to 38.106: NR repeater ACLR requirements                                    | 17.2.0      |
| 2022-09        | RAN#97   | RP-222034 | 0015 | 1   | F   | CR to 38.106: NR repeater receiver spurious emissions requirements             | 17.2.0      |
| 2022-09        | RAN#97   | RP-222034 | 0016 |     | F   | CR to 38.106: Removal of unlicensed bands for NR repeaters                     | 17.2.0      |
| 2022-09        | RAN#97   | RP-222034 | 0017 | 1   | F   | CR to 38.106: Correction of LA ACLR requirements                               | 17.2.0      |
| 2022-09        | RAN#97   | RP-222034 | 0018 |     | F   | CR to 38.106: Correction of LA ACLR requirements                               | 17.2.0      |
| 2022-09        | RAN#97   | RP-222034 | 0019 | 1   | F   | CR to TS 38.106 with updates and corrections for conductive part               | 17.2.0      |
| 2022-09        | RAN#97   | RP-222034 | 0020 |     | F   | CR to TS 38.106 with updates and corrections for radiated part                 | 17.2.0      |
| 2022-09        | RAN#97   | RP-222034 | 0021 |     | F   | Big CR for TS 38.106 Maintenance (Rel-17, CAT F)                               | 17.2.0      |
| 2022-12        | RAN#98-e | RP-223310 | 0026 | 1   | F   | CR to 38.106: ACLR requirements                                                | 17.3.0      |
| 2022-12        | RAN#98-e | RP-223310 | 0027 | 1   | F   | CR to 38.106: EVM requirements                                                 | 17.3.0      |
| 2022-12        | RAN#98-e | RP-223310 | 0028 | 1   | F   | CR to 38.106: ACRR requirements                                                | 17.3.0      |
| 2023-03        | RAN#99   | RP-230518 | 0029 | 1   | F   | CR for TS 38.106: Correction of some errors in 3.2                             | 17.4.0      |

| Change history |         |           |      |     |     |                                                                                                            |             |
|----------------|---------|-----------|------|-----|-----|------------------------------------------------------------------------------------------------------------|-------------|
| Date           | Meeting | TDoc      | CR   | Rev | Cat | Subject/Comment                                                                                            | New version |
| 2023-03        | RAN#99  | RP-230535 | 0030 | 1   | B   | CR to 38.106 on introduction of Band n54                                                                   | 18.0.0      |
| 2023-03        | RAN#99  | RP-230533 | 0032 |     | B   | CR to TS38.106 the introduction of APT600MHz                                                               | 18.0.0      |
| 2023-06        | RAN#100 | RP-231339 | 0036 |     | A   | CR to 38.106: Corrections on repeater OTA output power requirements (Rel-18)                               | 18.1.0      |
| 2023-09        | RAN#101 | RP-232496 | 0037 |     | D   | CR to 38.106: Editorial correction in transmitter transient period for NR repeaters                        | 18.2.0      |
| 2023-09        | RAN#101 | RP-232496 | 0039 |     | A   | [NR repeaters] CR to 38.106: Input intermodulation                                                         | 18.2.0      |
| 2023-12        | RAN#102 | RP-233366 | 0041 |     | B   | CR to TS38.106: introduction of NR bands n31 and n72                                                       | 18.3.0      |
| 2023-12        | RAN#102 | RP-233366 | 0042 |     | B   | CR to TS 38.106 - Introduction of band n109                                                                | 18.3.0      |
| 2023-12        | RAN#102 | RP-233350 | 0044 |     | A   | CR to 38.106: Correction of terminologies for NR repeaters (Rel-18)                                        | 18.3.0      |
| 2023-12        | RAN#102 | RP-233350 | 0047 | 1   | F   | CR to TS 38.106 with correction of co-existence and co-location requirements                               | 18.3.0      |
| 2023-12        | RAN#102 | RP-233361 | 0049 | 1   | B   | Big CR to TS 38.106 on RRM core requirements for NR network-controlled repeaters                           | 18.3.0      |
| 2023-12        | RAN#102 | RP-233361 | 0050 |     | B   | Big CR to TS 38.106 Introduction of NCR                                                                    | 18.3.0      |
| 2024-03        | RAN#103 | RP-240588 | 0055 | 1   | F   | CR to TS 38.106 on correction of requirement set applicability for NCR-MT                                  | 18.4.0      |
| 2024-03        | RAN#103 | RP-240588 | 0057 | 1   | F   | CR for TS 38.106 updating reference measurement channels                                                   | 18.4.0      |
| 2024-03        | RAN#103 | RP-240588 | 0058 | 1   | F   | (NR_netcon_repeater-Core) CR to TS 38.106 with corrections to NCR part                                     | 18.4.0      |
| 2024-03        | RAN#103 | RP-240588 | 0061 |     | F   | CR to 38.106: NCR-MT channel bandwidth                                                                     | 18.4.0      |
| 2024-03        | RAN#103 | RP-240574 | 0064 | 1   | F   | CR to 38.106: NR repeater transmitter spurious emissions requirements (rel-18)                             | 18.4.0      |
| 2024-03        | RAN#103 | RP-240588 | 0065 |     | B   | Draft CR for TS38.106 on conducted performance requirements for NCR-MT                                     | 18.4.0      |
| 2024-03        | RAN#103 | RP-240588 | 0066 |     | F   | Big CR on Core maintenance for NR Network-controlled Repeaters                                             | 18.4.0      |
| 2024-06        | RAN#104 | RP-241468 | 0067 |     | F   | CR for TS 38.106, Correction on ACLR requirement for NCR                                                   | 18.5.0      |
| 2024-06        | RAN#104 | RP-241468 | 0068 |     | F   | CR for TS 38.106, Correction on ACRR requirement for NCR                                                   | 18.5.0      |
| 2024-06        | RAN#104 | RP-241468 | 0069 | 1   | F   | CR for TS 38.106, Correction on conducted receiver general requirement                                     | 18.5.0      |
| 2024-06        | RAN#104 | RP-241468 | 0070 | 1   | F   | CR to 38.106: Correction of requirement set applicability table                                            | 18.5.0      |
| 2024-06        | RAN#104 | RP-241468 | 0073 | 2   | F   | CR to 38.106: Correction on clause titles for NCR-MT requirements                                          | 18.5.0      |
| 2024-06        | RAN#104 | RP-241468 | 0075 |     | F   | CR to TS 38.106: maintenance corrections                                                                   | 18.5.0      |
| 2024-06        | RAN#104 | RP-241468 | 0076 |     | D   | CR to TS 38.106: NCR-Fwd editorials maintenance                                                            | 18.5.0      |
| 2024-06        | RAN#104 | RP-241422 | 0077 |     | F   | CR on FRCs of NCR MT Demodulation Performance in 38.106                                                    | 18.5.0      |
| 2024-06        | RAN#104 | RP-241422 | 0078 |     | F   | CR on Propagation Condition of NCR-MT for 38.106                                                           | 18.5.0      |
| 2024-06        | RAN#104 | RP-241468 | 0080 |     | A   | CR to TS 38.106: removal of environmental annex                                                            | 18.5.0      |
| 2024-06        | RAN#104 | RP-241422 | 0081 | 1   | B   | Big CR to TS 38.106: the introduction of NCR RRM test case                                                 | 18.5.0      |
| 2024-09        | RAN#105 | RP-242172 | 0082 | 1   | F   | CR for TS 38.106, Correction on spurious emission requirements for NCR                                     | 18.6.0      |
| 2024-09        | RAN#105 | RP-242172 | 0083 | 1   | F   | CR for TS 38.106, Correction on general requirements for NCR                                               | 18.6.0      |
| 2024-09        | RAN#105 | RP-242172 | 0084 | 1   | F   | CR for TS 38.106, Correction on antenna connector and TAB connector related symbols for NCR                | 18.6.0      |
| 2024-09        | RAN#105 | RP-242172 | 0085 | 1   | F   | (NR_netcon_repeater-Core)CR for TS 38.106, Correction on network controlled repeater classes for NCR       | 18.6.0      |
| 2024-09        | RAN#105 | RP-242172 | 0086 | 1   | F   | (NR_netcon_repeater-Core)CR for TS 38.106, Correction on requirement for 5MHz channel bandwidth for NCR MT | 18.6.0      |
| 2024-09        | RAN#105 | RP-242172 | 0089 | 1   | F   | CR to 38.106: Requirement set applicability                                                                | 18.6.0      |
| 2024-09        | RAN#105 | RP-242172 | 0090 | 1   | F   | CR on 38.106 for NCR requirements                                                                          | 18.6.0      |
| 2024-09        | RAN#105 | RP-242186 | 0093 | 1   | F   | Clarification on extreme conditions                                                                        | 18.6.0      |
| 2024-12        | RAN#106 | RP-243030 | 0096 |     | A   | (LTE410_Europe_PPDR-Core) CR to Rel-18 38.106: Add missing LTE band 87 and band 88                         | 18.7.0      |
| 2024-12        | RAN#106 | RP-243053 | 0097 | 1   | F   | CR on Correlation Matrix of NCR Demodulation in 38.106                                                     | 18.7.0      |
| 2024-12        | RAN#106 | RP-243053 | 0098 | 1   | F   | CR to 38.106: ACLR requirements for NCR                                                                    | 18.7.0      |
| 2024-12        | RAN#106 | RP-243053 | 0100 | 1   | F   | CR to TS 38.106 with terminology alignment for Rel-18                                                      | 18.7.0      |
| 2024-12        | RAN#106 | RP-243063 | 0101 |     | A   | (NR_repeater-Core) CR on TS38.106 on mmWave EESS protection for NCR for R18                                | 18.7.0      |
| 2025-03        | RAN#107 | RP-250611 | 0106 |     | F   | (TEI18) CR to 38.106 on corrections to co-existence table [bands_coex_req]                                 | 18.8.0      |
| 2025-03        | RAN#107 | RP-250592 | 0108 |     | F   | CR on NCR-MT Correlation Matrix in 38.106                                                                  | 18.8.0      |

| Change history |         |           |      |     |     |                                                                                                                    |             |
|----------------|---------|-----------|------|-----|-----|--------------------------------------------------------------------------------------------------------------------|-------------|
| Date           | Meeting | TDoc      | CR   | Rev | Cat | Subject/Comment                                                                                                    | New version |
| 2025-03        | RAN#107 | RP-250618 | 0102 |     | B   | CR related to Introduction of new LTE FDD Band 111                                                                 | 19.0.0      |
| 2025-03        | RAN#107 | RP-250621 | 0103 |     | B   | CR to TS38.106 on introduction of NR bands n87 and n88                                                             | 19.0.0      |
| 2025-03        | RAN#107 | RP-250622 | 0104 |     | B   | CR to TS38.106 on introduction of NR band n68                                                                      | 19.0.0      |
| 2025-03        | RAN#107 | RP-250627 | 0107 |     | B   | CR to TS 38.106 on introduction of Band n110                                                                       | 19.0.0      |
| 2025-06        | RAN#108 | RP-250923 | 0111 |     | F   | (LTE410_Europe_PPDR-Core)CR to Rel-19 TS38.106 to add missing LTE bands 87 and 88                                  | 19.1.0      |
| 2025-06        | RAN#108 | RP-250944 | 0112 | 2   | B   | CR to TS 38.106 for introduction of expected EIRP mask core requirement for NCR                                    | 19.1.0      |
| 2025-06        | RAN#108 | RP-250929 | 0114 |     | A   | CR on NCR MIMO Correlation Matrices in 38.106                                                                      | 19.1.0      |
| 2025-09        | RAN#109 | RP-252420 | 0116 |     | B   | CR to TS 38106 - 7 MHz channel BW clarification                                                                    | 19.2.0      |
| 2025-12        | RAN#110 | RP-253646 | 0119 | 1   | F   | (TEI19)CR for 38.106, on framework simplification for co-location/co-existence requirement [BDaT_simp_improvement] | 19.3.0      |
| 2025-12        | RAN#110 | RP-253636 | 0120 |     | F   | CR to TS 38.106 with improvements for EIRP mask for NCR                                                            | 19.3.0      |

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# History

| Version | Date          | Status      |
|---------|---------------|-------------|
| V19.2.0 | February 2026 | Publication |
| V19.3.0 | February 2026 | Publication |
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|         |               |             |
|         |               |             |