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| Technical Specification | |
| 3rd Generation Partnership Project;  Technical Specification Group Radio Access Network;  NR;  NR Repeater Radio Transmission and Reception  (Release 18) | |
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Contents

Foreword 13

1 Scope 15

2 References 15

3 Definitions of terms, symbols and abbreviations 16

3.1 Terms 16

3.2 Symbols 19

3.3 Abbreviations 20

4 General 20

4.1 Relationship between Minimum Requirements and Test Requirements 20

4.2 Conducted and radiated requirement reference points 21

4.2.1 *Repeater type 1-C* 21

4.2.1A Network controlled Repeater type 1-C 21

4.2.1B Network controlled Repeater type 1-H 22

4.2.2 *Repeater type 2-O* 23

4.2.2A Network controlled Repeater type 2-O 24

4.3 Repeater classes 25

4.3.1 Repeater class for downlink 25

4.3.2 Repeater class for uplink 26

4.3A Network controlled repeater classes 26

4.3A.1 Network controlled repeater class for downlink 26

4.3A.2 Network controlled repeater class for uplink 26

4.4 Regional requirements 27

4.5 Applicability of requirements 28

4.6 Requirements for contiguous and *non-contiguous spectrum* 29

4.7 Requirements for repeater capable of multi-band operation 29

5 Operating bands 30

5.1 General 30

5.2 Operating bands 30

5.3 Channel arrangement 31

5.3.1 Channel raster 31

5.3.1.1 NR-ARFCN and channel raster 31

5.3.1.2 Channel raster entries for each *operating band* 31

5.3.1.3 Channel raster to resource element mapping 31

5.3.2 Synchronization raster 31

5.3.2.1 Synchronization raster and numbering 31

5.3.2.2 Synchronization raster entries for each operating band 31

5.3.2.3 Synchronization raster to synchronization block resource element mapping 31

5.3.3 Channel spacing 32

5.3.4 TX–RX frequency separation 32

5.4 NCR-MT channel bandwidth 33

5.4.1 General 33

5.4.2 Transmission bandwidth configuration 33

5.4.3 Minimum guardband and transmission bandwidth configuration 33

5.4.4 RB alignment 34

5.4.5 NCR-MT channel bandwidth per operating band 34

6 Conducted characteristics 34

6.1 General 34

6.2 Repeater output power 34

6.2.1 General 34

6.2.2 Minimum requirement for RF repeater 35

6.2.3 Minimum requirement for NCR 36

6.2.3.1 Minimum requirement for NCR-Fwd 36

6.2.3.1.1 Minimum requirement for NCR-Fwd type 1-C 36

6.2.3.1.2 Minimum requirement for NCR-Fwd type 1-H 36

6.2.3.2 Minimum requirement for NCR-MT 36

6.2.3.2.1 General 36

6.2.3.2.2 Minimum requirement for NCR-MT type 1-C and NCR-MT type 1-H 37

6.3.3 Minimum requirement for NCR 37

6.3.3.1 Minimum requirement for NCR-Fwd 37

6.3.3.1.1 Minimum requirement for NCR-Fwd type 1-C 37

6.3.3.1.2 Minimum requirement for NCR-Fwd type 1-H 37

6.3 Frequency stability 37

6.3.1 General 37

6.3.2 Minimum requirement for RF repeater 37

6.3.3 Minimum requirement for NCR 37

6.3.3.1 Minimum requirement for NCR-Fwd 37

6.3.3.1.1 Minimum requirement for NCR-Fwd type 1-C 37

6.3.3.1.2 Minimum requirement for NCR-Fwd type 1-H 38

6.4 Out of band gain 38

6.4.1 General 38

6.4.2 Minimum requirement for RF repeater 38

6.4.3 Minimum requirement for NCR 38

6.4.3.1 Minimum requirement for NCR-Fwd 38

6.4.3.1.1 Minimum requirement for NCR-Fwd type 1-C 38

6.4.3.1.2 Minimum requirement for NCR-Fwd type 1-H 39

6.5 Unwanted emissions 39

6.5.1 General 39

6.5.2 Adjacent Channel Leakage Power Ratio 40

6.5.2.1 General 40

6.5.2.2 Limits and *basic limits* 40

6.5.2.3 Minimum requirement for *RF repeater* 45

6.5.2.4 Minimum requirement for *NCR* 45

6.5.2.4.1 Minimum requirements for NCR-Fwd 45

6.5.2.4.2 Minimum requirement for NCR-MT 46

6.5.3 Operating band unwanted emissions 47

6.5.3.1 General 47

6.5.3.2 Basic limits 49

6.5.3.2.1 basic limits for Wide Area repeater type 1-C (Category A) 49

6.5.3.2.2 Basic limit for Wide Area *repeater type 1-C* (Category B) 50

6.5.3.2.3 *Basic limits* for Medium Range *repeater type 1-C* (Category A and B) for DL 52

6.5.3.2.4 *Basic limits* for Local Area *repeater type 1-C* (Category A and B) 54

6.5.3.2.5 Additional *basic limits* 55

6.5.3.2.6 Basic limit inside passband with no UL input signal 56

6.5.3.3 Minimum requirement for NCR 57

6.5.3.3.1 Minimum requirement for NCR-Fwd 57

6.5.3.3.2 Minimum requirement for NCR-MT 58

6.5.4 Transmitter spurious emissions 59

6.5.4.1 General 59

6.5.4.2 *Basic limits* 59

6.5.4.2.1 General transmitter spurious emissions *basic limits* 59

6.5.4.2.2 Additional spurious emissions *basic limits* 60

6.5.4.2.3 Co-location with base stations and repeater Nodes 72

6.5.4.3 Minimum requirement for *RF repeater* 78

6.5.4.4 Minimum requirement for *NCR* 78

6.5.4.4.1 Minimum requirement for NCR-Fwd 78

6.5.4.4.2 Minimum requirement for NCR-MT 79

6.5.5 Receiver spurious emissions 79

6.5.5.1 General 79

6.5.5.2 Basic limits 80

6.5.5.3 Minimum requirement for *RF repeater* 80

6.5.5.4 Minimum requirement for *NCR* 80

6.5.5.4.1 Minimum requirement for NCR-Fwd 80

6.6 Repeater Error Vector Magnitude 81

6.6.1 Downlink repeater error vector magnitude 81

6.6.1.1 General 81

6.6.1.2 Minimum requirement for *RF repeater* 82

6.6.1.2A Minimum requirement for *NCR* 82

6.6.1.2A.1 Minimum requirement for NCR-Fwd 82

6.6.1.3 Repeater EVM frame structure for measurement 82

6.6.2 Uplink repeater error vector magnitude 82

6.6.2.1 General 82

6.6.2.2 Minimum requirement for *RF repeater* 83

6.6.2.3 Minimum requirement for *NCR* 83

6.6.2.3.1 Minimum requirement for NCR-Fwd 83

6.7 Input intermodulation 83

6.7.1 General requirement 83

6.7.1.1 General 83

6.7.1.2 Minimum requirement for *RF repeater* 84

6.7.1.3 Minimum requirement for *NCR* 84

6.7.1.3.1 Minimum requirement for NCR-Fwd 84

6.7.2 Co-location with BS/repeater in other systems 85

6.7.2.1 General 85

6.7.2.2 Minimum requirement for *RF repeater* 85

6.7.2.3 Minimum requirement for *NCR* 86

6.7.2.3.1 Minimum requirement for NCR-Fwd 86

6.7.3 Co-existence with other systems 86

6.7.3.1 General 86

6.7.3.2 Minimum requirement for *RF repeater* 86

6.7.3.3 Minimum requirement for *NCR* 87

6.7.3.3.1 Minimum requirement for NCR-Fwd 87

6.8 Output intermodulation 87

6.8.3 Minimum requirements for *NCR* 89

6.8.3.1 Minimum requirements for NCR-Fwd 89

6.8.3.1.1 Minimum requirements for NCR-Fwd type 1-C 89

6.8.3.1.2 Additional requirements for NCR-Fwd type 1-C 89

6.8.3.1.3 Minimum requirements for *NCR-Fwd type 1-H* 89

6.8.3.1.4 Additional requirements for NCR-Fwd type 1-H 89

6.9 Adjacent Channel Rejection Ratio (ACRR) 89

6.9.1 General 89

6.9.2 inimum Requirements for *RF repeater* 90

6.9.3 Minimum Requirements for *NCR* 91

6.9.3.1 Minimum requirements for NCR-Fwd 91

6.9.3.1.1 Minimum requirements for NCR-Fwd type 1-C 91

6.9.3.1.2 Minimum Requirements for *NCR-Fwd type 1-H* 91

6.10 Transmit ON/OFF power 92

6.10.1 Transmitter OFF power 92

6.10.1.1 General 92

6.10.1.2 Minimum requirement for *RF repeater* 92

6.10.1.3 Minimum requirement for *NCR* 92

6.10.1.3.1 Minimum requirement for NCR Fwd 92

6.10.2 Transmitter transient period 92

6.10.2.1 General 92

6.10.2.2 Minimum requirement for *RF repeater* 93

6.10.2.3 Minimum requirement for *NCR* 93

6.10.2.3.1 Minimum requirement for NCR-Fwd 93

6.11 Output power dynamics 94

6.11.1 General 94

6.11.2 Transmit OFF power for NCR-MT 94

6.11.3 Transmit ON/OFF time mask for NCR-MT 94

6.11.4 Power control for NCR-MT 94

6.12 Transmit signal quality 94

6.12.1 General 94

6.12.2 Frequency error requirements for NCR-MT 95

6.12.3 Transmit modulation quality 95

6.13 Transmit intermodulation 95

6.13.1 General 95

6.13.2 Minimum requirements for NCR-MT 95

6.14 General 95

6.15 Diversity characteristics 96

6.16 Conducted reference sensitivity 96

6.16.1 NCR-MT reference sensitivity level 96

6.16.1.1 General 96

6.16.1.2 Minimum requirements for *NCR-MT type 1-C and 1-H* 96

6.17 Conducted maximum input level 97

6.18 Conducted adjacent channel selectivity 97

6.18.1 Adjacent Channel Selectivity (ACS) 97

6.18.1.1 General 97

6.18.1.2 Minimum requirement for *NCR-MT type 1-C* 97

6.18.1.3 Minimum requirement for *NCR-MT type 1-H* 97

6.19 Conducted blocking characteristics 97

6.19.1 General 97

6.19.2 Minimum requirement for NCR-MT type 1-C 97

6.19.3 Minimum requirement for NCR-MT type 1-H 98

6.20 Conducted spurious response 98

6.20.1 General 98

6.20.2 Minimum requirements for NCR-MT type 1-C and NCR-MT type 1-H 98

6.21 Conducted intermodulation characteristics 98

6.21.1 General 98

6.21.2 Minimum requirement for NCR type 1-C 98

6.21.3 Minimum requirement for NCR type 1-H 99

6.22 Conducted spurious emissions 99

6.22.1 General 99

6.22.2 Minimum requirements for *NCR-MT type 1-C* and *type 1-H* 99

7 Radiated characteristics 100

7.1 General 100

7.2 OTA output power 100

7.2.1 General 100

7.2.2 Minimum requirement for NR repeater 102

7.2.3 Minimum requirement for NCR 102

7.2.3.1 Minimum requirement for NCR-MT 102

7.2.3.1.1 Minimum requirement for NCR-MT type 1-H 102

7.2.3.1.2 Minimum requirement for NCR-MT type 2-O 102

7.2.3.2 Minimum requirement for NCR-Fwd 102

7.2.3.2.1 Minimum requirement for NCR-Fwd type 2-O 102

7.3 OTA frequency stability 103

7.3.1 General 103

7.3.2 Minimum requirement for NR repeater 103

7.3.3 Minimum requirement for NCR 103

7.3.3.1 Minimum requirement for NCR-Fwd 103

7.3.3.1.1 Minimum requirement for NCR-Fwd type 2-O 103

7.4 OTA out of band gain 103

7.4.1 General 103

7.4.2 Minimum requirement for NR repeater 104

7.4.3 Minimum requirement for NCR 104

7.4.3.1 Minimum requirement for NCR-Fwd 104

7.4.3.1.1 Minimum requirement for NCR-Fwd type 2-O 104

7.5 OTA unwanted emissions 104

7.5.1 General 104

7.5.2 OTA Adjacent Channel Leakage Power Ratio (ACLR) 105

7.5.2.1 General 105

7.5.2.2 Minimum requirement for *NR Repeater* 105

7.5.2.3 Minimum requirement for NCR 109

7.5.2.3.1 Minimum requirement for NCR-Fwd 109

7.5.2.3.2 Minimum requirement for NCR-MT 109

7.5.3 OTA operating band unwanted emissions 109

7.5.3.1 General 109

7.5.3.2 Minimum requirement for NR repeater 109

7.5.3.2.1 General 109

7.5.3.2.2 OTA operating band unwanted emission limits (Category A) 110

7.5.3.2.3 OTA operating band unwanted emission limits (Category B) 111

7.5.3.2.4 Additional OTA operating band unwanted emission requirements 111

7.5.3.3 Minimum requirement for NCR 112

7.5.3.3.1 Minimum requirement for NCR-Fwd 112

7.5.3.3.2 Minimum requirement for NCR-MT 112

7.5.4 OTA transmitter spurious emissions 112

7.5.4.1 General 112

7.5.4.2 Minimum requirement for *NR repeater* 112

7.5.4.2.1 General 112

7.5.4.2.2 General OTA transmitter spurious emissions requirements 113

7.5.4.2.3 Additional OTA transmitter spurious emissions requirements 114

7.5.4.3 Minimum requirement for *NCR* 114

7.5.4.3.1 Minimum requirement for NCR-Fwd 114

7.5.4.3.2 Minimum requirement for NCR-MT 114

7.5.5 OTA receiver spurious emissions 115

7.5.5.1 General 115

7.5.5.2 Minimum requirement for *NR repeater* 115

7.5.5.3 Minimum requirement for *NCR* 116

7.5.5.3.1 Minimum requirement for NCR-Fwd 116

7.6 OTA Repeater Error Vector Magnitude 116

7.6.1 Downlink repeater error vector magnitude 116

7.6.1.1 General 116

7.6.1.2 Minimum requirement for NR repeater 117

7.6.1.2A Minimum requirement for NCR 117

7.6.1.2A.1 Minimum requirement for NCR-Fwd 117

7.6.1.3 Repeater EVM frame structure for measurement 117

7.6.2 Uplink repeater error vector magnitude 117

7.6.2.1 General 117

7.6.2.2 Minimum requirement for NR repeater 118

7.6.2.3 Minimum requirement for NCR 119

7.6.2.3.1 Minimum requirement for NCR-Fwd 119

7.7 OTA input intermodulation 119

7.7.1 General 119

7.7.2 Minimum requirement for NR repeater 119

7.7.3 Minimum requirement for NCR 120

7.7.3.1 Minimum requirement for NCR-Fwd 120

7.7.3.1.1 Minimum requirement for NCR-Fwd type 2-O 120

7.8 OTA Adjacent Channel Rejection Ratio (ACRR) 120

7.8.1 General 120

7.8.2 Minimum Requirements for NR repeater 120

7.8.3 Minimum Requirements for NCR 121

7.8.3.1 Minimum Requirements for NCR-Fwd 121

7.8.3.1.1 Minimum Requirements for NCR-Fwd type 2-O 121

7.9 OTA transmit ON/OFF power 122

7.9.1 General 122

7.9.2 OTA transmitter OFF power 122

7.9.2.1 General 122

7.9.2.2 Minimum requirement for NR repeater 122

7.9.2.3 Minimum requirement for NCR 122

7.9.2.3.1 Minimum requirement for NCR-Fwd 122

7.9.2.3.2 Minimum requirement for NCR-MT 122

7.9.3 OTA transient period 123

7.9.3.1 General 123

7.9.3.2 Minimum requirement for NR repeater 123

7.9.3.3 Minimum requirement for NCR 124

7.9.3.3.1 Minimum requirement for NCR-Fwd 124

7.9.3.3.2 Minimum requirement for NCR-MT 124

7.10 OTA output power dynamics 124

7.10.1 General 124

7.10.2 Minimum requirement for NCR-MT 124

7.11 OTA transmit signal quality 124

7.11.1 General 124

7.11.2 Frequency error requirements for NCR-MT 125

7.11.2.1 Minimum requirement for NCR-MT type 2-O 125

7.11.3 Transmit modulation quality 125

7.11.3.1 Minimum requirement for NCR-MT type 2-O 125

7.12 Diversity characteristics 125

7.12.1 General 125

7.12.2 Minimum requirement for NCR-MT 125

7.13 OTA reference sensitivity 125

7.13.1 General 125

7.13.2 Minimum requirement for NCR-MT type 2-O 125

7.14 OTA maximum input level 125

7.14.1 General 125

7.14.2 Minimum requirement for NCR-MT type 2-O 126

7.15 OTA adjacent channel selectivity 126

7.15.1 General 126

7.15.1 Minimum requirement for NCR-MT type 2-O 126

7.16 OTA blocking characteristics 126

7.16.1 General 126

7.16.2 Minimum requirement for NCR-MT type 2-O 126

7.17 OTA spurious emissions 127

7.17.1 General 127

7.17.2 Minimum requirement for NCR-MT type 2-O 127

8 (Reserved) 127

9 (Reserved) 127

10 NCR-MT RRC\_CONNECTED state mobility 127

10.1 RRC Connection Mobility Control for NCR-MT 127

10.1.1 SA: RRC Re-establishment 127

10.1.1.1 Introduction 127

10.1.1.2 Requirements 128

10.1.1.2.1 NCR-MT Re-establishment delay requirement 128

10.1.2 Random access 129

10.1.2.1 Introduction 129

10.1.2.2 Requirements for 4-step RA type 129

10.1.2.2.1 Contention based random access 130

10.1.2.2.2 Non-Contention based random access 131

10.2 Timing 132

10.2.1 NCR-MT transmit timing 132

10.2.1.1 Introduction 132

10.2.1.2 Requirements 132

10.2.1.2.1 Gradual timing adjustment 133

10.2.2.1 Introduction 134

10.2.2.2 Requirements 134

10.2.3 NCR-MT timing advance 134

10.2.3.1 Introduction 134

10.2.3.2 Requirements 135

10.2.3.2.1 Timing Advance adjustment delay 135

10.2.3.2.2 Timing Advance adjustment accuracy 135

10.3 Signalling Characteristics for NCR-MT 135

10.3.1 Radio Link Monitoring 135

10.3.1.1 Introduction 135

10.3.1.2 Requirements for SSB based radio link monitoring 136

10.3.1.2.1 Introduction 136

10.3.1.2.2 Minimum requirement 137

10.3.1.2.3 Measurement restrictions for SSB based RLM 138

10.3.1.3 Requirements for CSI-RS based radio link monitoring 139

10.3.1.3.1 Introduction 139

10.3.1.3.2 Minimum requirement 139

10.3.1.3.3 Measurement restrictions for CSI-RS based RLM 141

10.3.1.4 Minimum requirement for NCR-MT turning off the transmitter 142

10.3.1.5 Minimum requirement for L1 indication 142

10.3.1.6 Scheduling availability of NCR-MT during radio link monitoring 142

10.3.1.6.1 Scheduling availability of NCR-MT performing radio link monitoring with a same subcarrier spacing as PDSCH/PDCCH on FR1 142

10.3.1.6.2 Scheduling availability of NCR-MT performing radio link monitoring with a different subcarrier spacing than PDSCH/PDCCH on FR1 142

10.3.1.6.3 Scheduling availability of NCR-MT performing radio link monitoring on FR2-1 142

10.3.2 Link Recovery Procedure 143

10.3.2.1 Introduction 143

10.3.2.2 Requirements for SSB based beam failure detection 144

10.3.2.2.1 Introduction 144

10.3.2.2.2 Minimum requirement 144

10.3.2.2.3 Measurement restriction for SSB based beam failure detection 145

10.3.2.3 Requirements for CSI-RS based beam failure detection 146

10.3.2.3.1 Introduction 146

10.3.2.3.2 Minimum requirement 146

10.3.2.3.3 Measurement restrictions for CSI-RS based beam failure detection 147

10.3.2.4 Minimum requirement for L1 indication 148

10.3.2.5 Requirements for SSB based candidate beam detection 149

10.3.2.5.1 Introduction 149

10.3.2.5.2 Minimum requirement 149

10.3.2.5.3 Measurement restriction for SSB based candidate beam detection 150

10.3.2.6 Requirements for CSI-RS based candidate beam detection 150

10.3.2.6.1 Introduction 150

10.3.2.6.2 Minimum requirement 151

10.3.2.6.3 Measurement restriction for CSI-RS based candidate beam detection 152

10.3.2.7 Scheduling availability of NCR-MT during beam failure detection 152

10.3.2.7.1 Scheduling availability of NCR-MT performing beam failure detection with a same subcarrier spacing as PDSCH/PDCCH on FR1 152

10.3.2.7.2 Scheduling availability of NCR-MT performing beam failure detection with a different subcarrier spacing than PDSCH/PDCCH on FR1 153

10.3.2.7.3 Scheduling availability of NCR-MT performing beam failure detection on FR2-1 153

10.3.2.8 Scheduling availability of NCR-MT during candidate beam detection 153

10.3.2.8.1 Scheduling availability of NCR-MT performing L1-RSRP measurement with a same subcarrier spacing as PDSCH/PDCCH on FR1 154

10.3.2.8.2 Scheduling availability of NCR-MT performing L1-RSRP measurement with a different subcarrier spacing than PDSCH/PDCCH on FR1 154

10.3.2.8.3 Scheduling availability of NCR-MT performing L1-RSRP measurement on FR2-1 154

Annex A (normative): Environmental requirements for the Repeater equipment 155

Annex B (informative): Change history 156

# 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:

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

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

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

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

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

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

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

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

**can** indicates that something is possible

**cannot** indicates that something is impossible

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

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

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

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

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

In addition:

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

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

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

# 1 Scope

The present document establishes the minimum RF characteristics of NR Repeater and network controlled repeater. For network controlled repeater (NCR), requirements for NCR-Fwd and NCR-MT apply.

# 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] 3GPP TS 38.213: “NR; Physical layer procedures for control”.

[20] 3GPP TS 36.104: “Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception”

[21] 3GPP TS 38.211: "NR; Physical channels and modulation".

[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”.

# 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

**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 perpassband during the *transmitter ON state* in a specified reference condition and corresponding to the declared *rated passband TRP output* power (Prated,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

**Nominal channel bandwidth:** Bandwidth calculated as min(100MHz, BWpassband) in FR1 or min(400MHz, BWpassband) 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 BWpassband.

**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.

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

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

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

**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:

BWConfig *Transmission bandwidth configuration*, where BWConfig = *N*RB x SCS x 12

BWNominal Nominal channelbandwidth

BWPassband *Passband* bandwidth

Δf Separation between the *passband edge* frequency and the nominal -3 dB point of the measuring filter closest to the carrier frequency

Δfmax f\_offsetmax minus half of the bandwidth of the measuring filter

ΔfOBUE Maximum offset of the *operating band* unwanted emissions mask from the *operating band* edge

FDL,low The lowest frequency of the downlink *operating band*

FDL,high The highest frequency of the downlink *operating band*

FFBWhigh Highest supported frequency within supported operating band, for which *fractional bandwidth* support was declared

FFBWlow Lowest supported frequency within supported operating band, for which *fractional bandwidth* support was declared

Ffilter Filter centre frequency

Foffset,high Frequency offset from FC,high to the upper *passband edge*

Foffset,low Frequency offset from FC,low to the lower *passband edge*

f\_offset Separation between the *passband edge* frequency and the centre of the measuring

f\_offsetmax The offset to the frequency ΔfOBUE outside the *operating band*

Fstep,X Frequency steps for the OTA transmitter spurious emissions (Category B)

FUL,low The lowest frequency of the uplink *operating band*

FUL,high The highest frequency of the uplink *operating band*

PEM,n50/n75,ind Declared emission level for Band n50/n75; ind = a, b

PEM,n54,ind Declared emission level for Band n54; ind = a, b, c, d, e, f

Prated,p,AC Rated passband output power per antenna connector

Prated,t,AC Rated total output power declared per antenna connector

Prated,p,EIRP Rated passband EIRP output power

Prated,p,TRP Rated passband TRP output power declared per RIB

Prated,t,TRP Rated total TRP output power declared per RIB

Pin,p,AC Input power intended to produce the maximum rated output power (Prated,p,AC) at the *antenna connector*

Pin,p,EIRP Input power intended to produce the maximum rated output power (Prated,p,TRP) at the RIB

Prated,out,FBWhigh The rated output EIRPfor the higher supported frequency range within supported *operating band,* for which *fractional bandwidth* support was declared

Prated,out,FBWlow The rated output EIRP for the lower supported frequency range within supported *operating band,* for which *fractional bandwidth* support was declared

Pmax,p,AC *Maximum passband output power* measuredper *antenna connector*

Pmax,p,EIRP *Maximum passband EIRP output power* when repeater is configured at the rated passband TRP output power (Prated,p,TRP)

Pmax,p,TRP *Maximum passband TRP output power* measuredper RIB

Wgap *Inter passband Bandwidth gap* size

## 3.3 Abbreviations

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

ACLR Adjacent Channel Leakage Ratio

AoA Angle of Arrival

BW Bandwidth

CACLR Cumulative ACLR

CP-OFDM Cyclic Prefix-OFDM

DFT-s-OFDM Discrete Fourier Transform-spread-OFDM

DL Downlink

EIRP Effective Isotropic Radiated Power

EVM Error Vector Magnitude

FBW Fractional Bandwidth

FR Frequency Range

ITU‑R Radiocommunication Sector of the International Telecommunication Union

LA Local Area

MR Medium Range

NR New Radio

OBUE Operating Band Unwanted Emissions

OOB Out-of-band

OTA Over-The-Air

QAM Quadrature Amplitude Modulation

RF Radio Frequency

RIB Radiated Interface Boundary

RX Receiver

SCS Sub-Carrier Spacing

TX Transmitter

TRP Total Radiated Power

UL Uplink

WA Wide Area

# 4 General

## 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 *Repeater type 1-C*

For *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.

Downlink

Uplink

UE-side connector

BS-side connector

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

### 4.2.1A Network controlled Repeater 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.

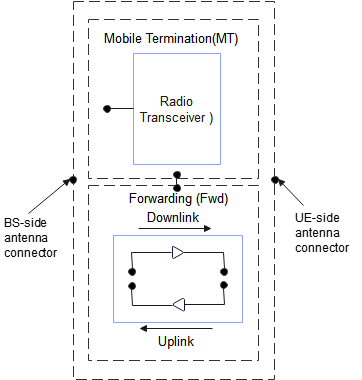


Figure 4.2.1-1A: Network controlled *Repeater type 1-C* downlink and uplink interface

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.

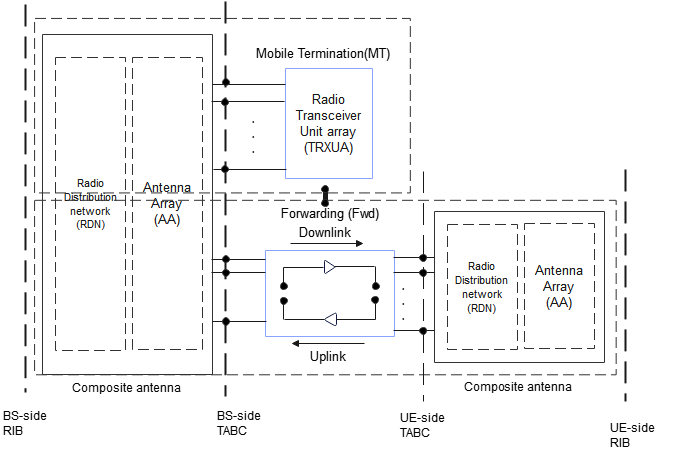


Figure 4.2.1-1B: Network controlled *Repeater type 1-H* downlink and uplink interface

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

### 4.2.2 *Repeater type 2-O*

For *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.

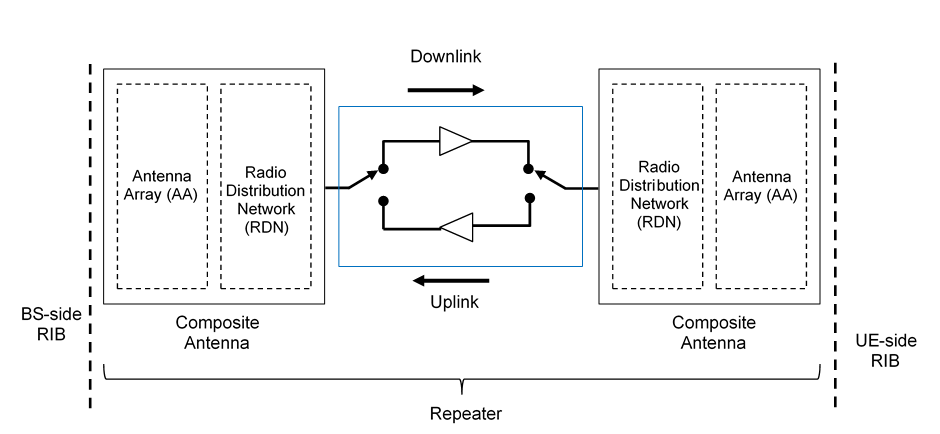


Figure 4.2.2-1: Radiated reference points for *repeater type 2-O*

### 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.

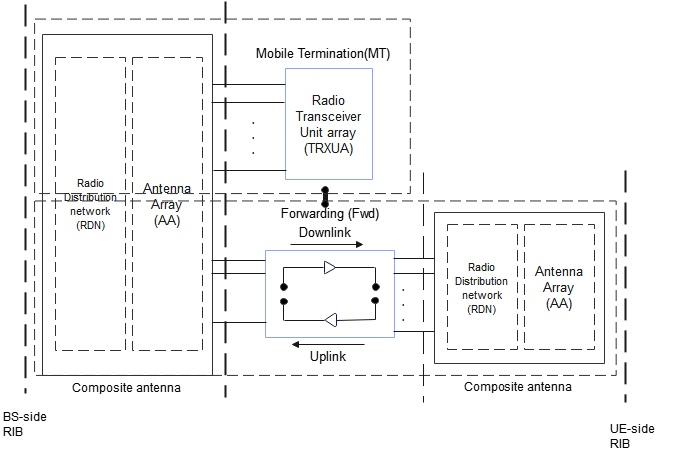


Figure 4.2.2-1A: Radiated reference points for *network controlled* *repeater type 2-O*

NOTE 1: the NCR-MT and NCR-Fwd may have the same or separate RIB

## 4.3 Repeater classes

### 4.3.1 Repeater class for downlink

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

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

- Wide Area repeaters are characterised by requirements derived from Macro Cell scenarios with a repeater to UE minimum distance along the ground equal to 35 m.

- Medium Range repeaters are characterised by requirements derived from Micro Cell scenarios with a repeater to UE minimum distance along the ground equal to 5 m.

- Local Area repeaters are characterised by requirements derived from Pico Cell scenarios with a repeater to UE minimum distance along the ground equal to 2 m or from Femto Cell scenarios.

- Note: The requirements in this specification for LA 1-C repeaters apply to 1-C repeaters with declared output power less than or equal to LA rated output power limits as in table 6.2.1-1.

### 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 *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 repeater 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

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 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 | *Operating bands* | Some NR *operating bands* 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,  7.3.4 | Repeater output power,  OTA repeater output power:  Additional requirements | These requirements may be applied regionally as additional repeater output power requirements. |
| 6.5.2 | Adjacent Channel Leakage Power Ratio | For Band n41 and n90 operation in Japan, absolute ACLR limits shall be applied to the sum of the absolute ACLR power over all *antenna connectors* for *repeater type 1-C*. |
| 6.5.3.2,  7.5.3.2 | Operating band unwanted emission,  OTA operating band unwanted emissions | Category A or Category B operating band unwanted emissions limits may be applied regionally. |
| 6.5.3.2.5.1 | Operating band unwanted 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 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 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 *antenna connectors* for *repeater type 1-C.* |
| 6.5.4.2.1,  7.5.4.2 | Tx spurious emissions,  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,  7.5.4.2.3 | Tx spurious emissions: additional requirements,  OTA Tx spurious emissions: additional requirements | These requirements may be applied for the protection of system operating in frequency ranges other than the repeater *operating band*. |
| 6.5.4.2 | Transmitter spurious emissions | 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*. |
| 6.5.5.1 | Receiver spurious emissions | 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. |
| 6.7.2 | Input intermodulation | Interfering signal positions that are partially or completely outside of any downlink *operating band* 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 | |
|  | *Repeater type 1-C* | *Repeater type 2-O* |
| Repeater output power | 6.2 |  |
| Frequency stability | 6.3 |  |
| Out of band gain | 6.4 |  |
| Unwanted emissions | 6.5 |  |
| Error Vector Magnitude | 6.6 | NA |
| Input intermodulation | 6.7 |  |
| Output intermodulation | 6.8 |  |
| Adjacent Channel Rejection Ratio (ACRR) | 6.9 |  |
| Transmit ON/OFF power | 6.10 |  |
| Repeater output power |  | 7.2 |
| OTA frequency stability |  | 7.3 |
| OTA out of band gain |  | 7.4 |
| OTA unwanted emissions |  | 7.5 |
| OTA Error Vector Magnitude | NA | 7.6 |
| OTA input intermodulation |  | 7.7 |
|  |  |  |
| OTA Adjacent Channel Rejection Ratio (ACRR) |  | 7.8 |
| OTA transmit ON/OFF power |  | 7.9 |

Table 4.5-1a: *Requirement set* applicability for NCR-Fwd

|  |  |  |  |
| --- | --- | --- | --- |
| Requirement | Requirement set | | |
|  | *NCR-Fwd type 1-C* | *NCR-Fwd type 1-H* | *NCR-Fwd type 2-O* |
| Repeater output power | 6.2 | 6.2 |  |
| Frequency stability | 6.3 | 6.3 |  |
| Out of band gain | 6.4 | 6.4 |  |
| Unwanted emissions | 6.5 | 6.5 |  |
| Error Vector Magnitude | 6.6 | 6.6 | NA |
| 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 |  |  | 7.2 |
| OTA frequency stability |  |  | 7.3 |
| OTA out of band gain |  |  | 7.4 |
| OTA unwanted emissions |  |  | 7.5 |
| OTA Error Vector Magnitude | NA | NA | 7.6 |
| OTA input intermodulation |  |  | 7.7 |
| OTA Adjacent Channel Rejection Ratio (ACRR) |  |  | 7.8 |
| OTA transmit ON/OFF power |  |  | 7.9 |

Table 4.5-1b: *Requirement set* applicability for NCR-MT

|  |  |  |  |
| --- | --- | --- | --- |
| Requirement | Requirement set | | |
|  | *NCR-MT type 1-C* | *NCR-MT type 1-H* | *NCR-MT type 2-O* |
| Conducted transmitter power | 6.2.3.2 | 6.2.3.2 |  |
| Conducted output power dynamics | 6.11 | 6.11 |  |
| Conducted transmit signal quality | 6.12 | 6.12 |  |
| Conducted output RF spectrum emissions | 6.5 | 6.5 |  |
| Diversity characteristics | 6.13 | 6.13 | NA |
| Conducted reference sensitivity | 6.14 | 6.14 |  |
| Conducted maximum input level | 6.15 | 6.15 |  |
| Conducted adjacent channel selectivity | 6.16 | 6.16 |  |
| Conducted blocking characteristics | 6.17 | 6.17 |  |
| Conducted spurious response | 6.18 | 6.18 |  |
| Conducted intermodulation characteristics | 6.19 | 6.19 |  |
| Conducted spurious emissions | 6.5.5 | 6.5.5 |  |
| Radiated transmitter power |  |  | 7.2 |
| Radiated output power dynamics |  |  | 7.10 |
| Radiated transmit signal quality |  |  | 7.11 |
| Radiated output RF spectrum emissions |  |  | 7.5 |
| Diversity characteristics | NA | NA | 7.12 |
| Radiated reference sensitivity |  |  | 7.13 |
| Radiated maximum input level |  |  | 7.14 |
| Radiated adjacent channel selectivity |  |  | 7.15 |
| Radiated blocking characteristics |  |  | 7.16 |
| Radiated spurious response |  |  | 7.17 |
| Radiated intermodulation characteristics |  |  | 7.18 |
| Radiated spurious emissions |  |  | 7.19 |

## 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.

# 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

NR 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 5.4.3.1in 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  carrier centre frequency 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 |
| n70 | 300MHz |
| n71 | -46 MHz |
| n74 | 48 MHz |
| n85 | 30 MHz |
| n91 | 570 MHz – 595 MHz  (NOTE 2) |
| n92 | 575 MHz – 680 MHz (*μ* = 0)  580 MHz – 675 MHz (*μ* = 1)  (NOTE 2) |
| n93 | 517 MHz – 547 MHz  (NOTE 2) |
| n94 | 522 MHz – 632 MHz (*μ* = 0)  527 MHz – 627 MHz (*μ* = 1)  (NOTE 2) |
| n100 | 45 MHz |
| n105 | -51 MHz |
| NOTE 1: Void  NOTE 2: The range of TX-RX frequency separation given paired UL and DL channel bandwidths BWUL and BWDL is given by the respective lower and upper limit FDL\_low – FUL\_high + 0.5(BWDL + BWUL) and FDL\_high – FUL\_low – 0.5(BWDL + BWUL). The UL and DL channel bandwidth combinations specified in Clause 5.4 depend on the subcarrier spacing configuration *μ* [21]. | |

## 5.4 NCR-MT channel bandwidth

### 5.4.1 General

The NCR-MT supports a single NR RF carrier 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.

From a NCR-MT perspective, the NCR-MT per passband is configured with one carrier and NCR-MT is configured with one more BWP. 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 for NCR-MT carrier is flexible but can only be completely within the NCR-Fwd passband.

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

Unless otherwise stated, the conducted transmitter characteristics are specified at the *antenna connector* for *repeater type 1-C* configuration in normal operating conditions.

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

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

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

## 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 *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: *Repeater type 1-C* and *NCR-FWD type 1-C* DL transmission classes rated output power limits for repeater classes

|  |  |
| --- | --- |
| Repeater class | Prated,p,AC |
| Wide Area repeater | Note 1 |
| Medium Range repeater | ≤ 38 dBm + X, Note 2 |
| Local Area repeater | ≤ 24 dBm + X, Note 2 |
| NOTE 1: There is no upper limit for the Prated,p,AC *rated passband output power* of the Wide Area repeater  NOTE 2: X = 10\*log (ceil (*passband* bandwidth/20MHz)) | |

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

|  |  |
| --- | --- |
| Repeater class | Prated,p,AC |
| Wide Area repeater | Note 1 |
| Local Area repeater | ≤ 24 dBm+ X, Note 2 |
| NOTE 1: There is no upper limit for the Prated,p,AC *rated passband output power* of the Wide Area repeater.  NOTE 2: X = 10\*log (ceil (*passband* bandwidth/20MHz)) | |

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 | Prated,c,sys | Prated,c,TABC |
| --- | --- | --- |
| Wide Area NCR | (Note 1) | (Note 1) |
| Medium Range NCR | ≤ 38 dBm +10log(NTXU,counted) + X (NOTE 2) | ≤ 38 dBm+ X (NOTE 2) |
| Local Area NCR | ≤ 24 dBm +10log(NTXU,counted) + X (NOTE 2) | ≤ 24 dBm+ X (NOTE 2) |
| NOTE 1: There is no upper limit for the Prated,c,sys or Prated,c,TABC of the Wide Area NCR-Fwd.  NOTE 2: X = 10\*log (ceil (*passband* bandwidth/20MHz)) | | |

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

| Repeater class | Prated,c,sys | Prated,c,TABC |
| --- | --- | --- |
| Wide Area NCR | (Note 1) | (Note 1) |
| Local Area NCR | ≤ 24 dBm +10log(NTXU,counted) + X (NOTE 2, 3) | ≤ 24 dBm+ X (NOTE 2) |
| NOTE 1: There is no upper limit for the Prated,c,sys or Prated,c,TABC of the Wide Area NCR.  NOTE 2: X = 10\*log (ceil (*passband* bandwidth/20MHz))  NOTE 3: For joint transmission of NCR-FWD and NCR-MT, Prated,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 (Pin,p,AC) that produces the *rated passband output power* (Prated,p,AC).

Up to:

The lowest input power (Pin,p,AC) that produces the *rated passband output power* (Prated,p,AC), plus 10dB

In normal conditions, the measured output power, Pmax,p,AC shall remain within +2 dB and -2 dB of the *rated passband output power* Prated,p,AC, declared by the manufacturer.

In extreme conditions, the measured output power, Pmax,p,AC shall remain within +2.5 dB and -2.5 dB of the *rated passband output power* Prated,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 (Pin,p,AC) that produces the *rated passband output power* (Prated,p,AC).

Up to:

The lowest input power (Pin,p,AC) that produces the *rated passband output power* (Prated,p,AC), plus 10dB

In normal conditions, the measured output power, Pmax,p,AC shall remain within +2 dB and -2 dB of the *rated passband output power* Prated,p,AC, declared by the manufacturer.

In extreme conditions, the measured output power, Pmax,p,AC shall remain within +2.5 dB and -2.5 dB of the *rated passband output power* Prated,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 (Pin,p,TABC) that produces the *rated passband output power* (Prated,p,TABC).

Up to:

The lowest input power (Pin,p,TABC) that produces the *rated passband output power* (Prated,p,TABC), plus 10dB

In normal conditions, the measured output power, Pmax,p,TABC shall remain within +2 dB and -2 dB of the *rated passband output power* Prated,p,TABC, declared by the manufacturer.

In extreme conditions, the measured output power, Pmax,p,TABC shall remain within +2.5 dB and -2.5 dB of the *rated passband output power* Prated,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 | Prated,c,AC |
| Wide Area NCR-MT | (Note) |
| Local Area NCR-MT | ≤ 24 dBm |
| NOTE: There is no upper limit for the Prated,c,AC *rated output power* 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 | Prated,c,sys | Prated,c,TABC |
| --- | --- | --- |
| Wide Area NCR-MT | (Note 1) | (Note 1) |
| Local Area NCR-MT2,3 | ≤ 24 dBm +10log(NTXU,counted) | ≤ 24 dBm |
| NOTE 1: There is no upper limit for the Prated,c,AC *rated output power* 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: NTXU,counted = min(NTXU,active ,4) | | |

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

In normal conditions, Pmax,c,AC shall remain within +2 dB and -2 dB of the *rated carrier output power* Prated,c,AC, declared by the manufacturer.

In extreme conditions, Pmax,c,AC shall remain within +2.5 dB and -2.5 dB of the *rated carrier output power* Prated,c,AC, declared by the manufacturer.

### 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 ±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 ±0,01 PPM.

## 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 ±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 ±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 ±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\_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\_offset\_CW | Maximum gain |
| 0,2 ≤ f\_offset\_CW < 1,0 MHz | 60 dB |
| 1,0 ≤ f\_offset\_CW < 5,0 MHz | 45 dB |
| 5,0 ≤ f\_offset\_CW < 10,0 MHz | 45 dB |
| 10,0 MHz ≤ f\_offset\_CW | 35 dB |

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

|  |  |
| --- | --- |
| Frequency offset, f\_offset\_CW | Maximum gain |
| [0,2] < f\_offset\_CW < 4,0 MHz | 60 dB |
| 4,0 < f\_offset\_CW < 15,0 MHz | 45 dB |
| 15,0 MHz < f\_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 ΔfOBUE. 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 ΔfOBUE above and ΔfOBUE below each band. Unwanted emissions outside of this frequency range are limited by a spurious emissions requirement.

The values of ΔfOBUE 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 | ΔfOBUE (MHz) |
| *NCR-Fwd type 1-H* | FDL,high – FDL,low < 100 MHz | 10 |
|  | 100 MHz ≤ FDL,high – FDL,low ≤ 900 MHz | 40 |
|  |  |  |
| *Repeater type 1-C and NCR-Fwd type 1-C* | FDL,high – FDL,low ≤ 200 MHz | 10 |
|  | 200 MHz < FDL,high – FDL,low ≤ 900 MHz | 40 |

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

|  |  |  |
| --- | --- | --- |
| Repeater or NCRtype | *Operating band* characteristics | ΔfOBUE (MHz) |
| *NCR-Fwd type 1-H* | FDL,high – FDL,low < 100 MHz | 10 |
|  | 100 MHz ≤ FDL,high – FDL,low ≤ 900 MHz | 40 |
|  |  |  |
| *Repeater type 1-C and NCR-Fwd type 1-C* | FDL,high – FDL,low ≤ 200 MHz | 10 |
|  | 200 MHz < FDL,high – FDL,low ≤ 900 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 (BWConfig) 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 BWNominal (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 | BWNominal/2 | NR of same BW (Note 2) | Square (BWConfig) | 45 dB  38 dB (Note 4) |
|  | 1.5 x BWNominal | NR of same BW (Note 2) | Square (BWConfig) | 45 dB  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) |
| NOTE 1: BWNominal is the *nominal channel bandwidth.*BWConfigis the *transmission bandwidth configuration* assumed for the adjacent channel.  NOTE 2: With SCS that provides largest *transmission bandwidth configuration* (BWConfig).  NOTE 3: The requirements are applicable when the band is also defined for E-UTRA or UTRA.  NOTE 4: For repeater operating in band n104, ACLR requirement 38 dB applies. For repeater operating in other bands, ACLR requirement 45 dB applies.  NOTE 5: For simultaneous NCR-Fwd and NCR-MT transmission, if the NCR-MT carrier is within the NCR-Fwd then the nominal bandwidth shall be the NCR-Fwd passband. If the NCT-MT carrier is adjacent to the NCR-Fwd passband then the nominal bandwidth shall be the combined bandwidth of NCR-Fwd passband and NCR-MT carrier bandwidth. If the NCR-MT carrier is not adjacent to the passband then CACLR shall be applied in the gap between the NCR-Fwd passband and the NCR-MT carrier. | | | | |

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| nominal channel bandwidth BWNominal (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 | BWNominal/2 | NR of same BW (Note 2) | Square (BWConfig) | 31 dB |
|  | 1.5 x BWNominal | NR of same BW (Note 2) | Square (BWConfig) | 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 |
| NOTE 1: BWNominal is the *nominal channel bandwidth.*BWConfigis the *transmission bandwidth configuration* assumed for the adjacent channel.  NOTE 2: With SCS that provides the largest *transmission bandwidth configuration* (BWConfig).  NOTE 3: The requirements are applicable when the band is also defined for E-UTRA or UTRA.  NOTE 4: For simultaneous NCR-Fwd and NCR-MT transmission, if the NCR-MT carrier is within the NCR-Fwd then the nominal bandwidth shall be the NCR-Fwd passband. If the NCT-MT carrier is adjacent to the NCR-Fwd passband then the nominal bandwidth shall be the combined bandwidth of NCR-Fwd passband and NCR-MT carrier bandwidth. If the NCR-MT carrier is not adjacent to the passband then CACLR shall be applied in the gap between the NCR-Fwd passband and the NCR-MT carrier. | | | | |

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 BWNominal (MHz) (NOTE 6) | *Gap between passbands* or inter-*passband* *gap* size (Wgap) 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 | Wgap ≥ 15 (Note 3)  Wgap ≥ 45 (Note 4) | 2.5 MHz | 5 MHz NR (Note 2) | Square (BWConfig) | 45 dB  38 dB (Note 5) |
|  | Wgap ≥ 20 (Note 3)  Wgap ≥ 50 (Note 4) | 7.5 MHz | 5 MHz NR (Note 2) | Square (BWConfig) | 45 dB  38 dB (Note 5) |
| 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 | Wgap ≥ 60 (Note 4)  Wgap ≥ 30 (Note 3) | 10 MHz | 20 MHz NR (Note 2) | Square (BWConfig) | 45 dB  38 dB (Note 5) |
|  | Wgap ≥ 80 (Note 4)  Wgap ≥ 50 (Note 3) | 30 MHz | 20 MHz NR (Note 2) | Square (BWConfig) | 45 dB  38 dB (Note 5) |
| NOTE 1: BWNominal is the *nominal channel bandwidth.*BWConfigis the *transmission bandwidth configuration* assumed for the adjacent channel.  NOTE 2: With SCS that provides the largest *transmission bandwidth configuration* (BWConfig).  NOTE 3: Applicable in case the *repeater type 1-C nominal channel bandwidth* at the other edge of the gap is ≤ 20 MHz.  NOTE 4: Applicable in case the *repeater type 1-C nominal channel bandwidth* at the other edge of the gap is > 20 MHz.  NOTE 5: For repeater operating in band n104, ACLR requirement 38 dB applies. For repeater operating in other bands, ACLR requirement 45 dB applies.  NOTE 6: For simultaneous NCR-Fwd and NCR-MT transmission, if the NCR-MT carrier is within the NCR-Fwd then the nominal bandwidth shall be the NCR-Fwd passband. If the NCT-MT carrier is adjacent to the NCR-Fwd passband then the nominal bandwidth shall be the combined bandwidth of NCR-Fwd passband and NCR-MT carrier bandwidth. If the NCR-MT carrier is not adjacent to the passband then CACLR shall be applied in the gap between the NCR-Fwd passband and the NCR-MT carrier. | | | | | |

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| nominal channel bandwidth BWNominal (MHz) (NOTE 5) | Sub-block or inter-*passband* *gap* size (Wgap) 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 | Wgap ≥ 15 (Note 3)  Wgap ≥ 45 (Note 4) | 2.5 MHz | 5 MHz NR (Note 2) | Square (BWConfig) | 31 dB |
|  | Wgap ≥ 20 (Note 3)  Wgap ≥ 50 (Note 4) | 7.5 MHz | 5 MHz NR (Note 2) | Square (BWConfig) | 31 dB |
| 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 | Wgap ≥ 60 (Note 4)  Wgap ≥ 30 (Note 3) | 10 MHz | 20 MHz NR (Note 2) | Square (BWConfig) | 31 dB |
|  | Wgap ≥ 80 (Note 4)  Wgap ≥ 50 (Note 3) | 30 MHz | 20 MHz NR (Note 2) | Square (BWConfig) | 31 dB |
| NOTE 1: BWConfig is the *transmission bandwidth configuration* assumed for the adjacent channel.  NOTE 2: With SCS that provides the largest *transmission bandwidth configuration* (BWConfig).  NOTE 3: Applicable in case the *repeater type 1-C nominal channel bandwidth* at the other edge of the gap is ≤ 20 MHz.  NOTE 4: Applicable in case the *repeater type 1-C nominal channel bandwidth* at the other edge of the gap is > 20 MHz.  NOTE 5: For simultaneous NCR-Fwd and NCR-MT transmission, if the NCR-MT carrier is within the NCR-Fwd then the nominal bandwidth shall be the NCR-Fwd passband. If the NCT-MT carrier is adjacent to the NCR-Fwd passband then the nominal bandwidth shall be the combined bandwidth of NCR-Fwd passband and NCR-MT carrier bandwidth. If the NCR-MT carrier is not adjacent to the passband then CACLR shall be applied in the gap between the NCR-Fwd passband and the NCR-MT carrier. | | | | | |

The Cumulative Adjacent Channel Leakage power Ratio (CACLR) in a *gap between passbands* or the *inter-passband gap* 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* or the *inter-passband gap*, and

b) 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 BWNominal (MHz) | *Gap between passbands* or inter-*passband* *gap* size (Wgap) 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 ≤Wgap< 15 (Note 3)  5 ≤Wgap< 45 (Note 4) | 2.5 MHz | 5 MHz NR (Note 2) | Square (BWConfig) | 45 dB  38 dB (Note 5) |
|  | 10 < Wgap< 20 (Note 3)  10 ≤Wgap< 50 (Note 4) | 7.5 MHz | 5 MHz NR (Note 2) | Square (BWConfig) | 45 dB  38 dB (Note 5) |
| 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 | 20 ≤Wgap< 60 (Note 4)  20 ≤Wgap< 30 (Note 3) | 10 MHz | 20 MHz NR (Note 2) | Square (BWConfig) | 45 dB  38 dB (Note 5) |
|  | 40 < Wgap< 80 (Note 4)  40 ≤Wgap< 50 (Note 3) | 30 MHz | 20 MHz NR (Note 2) | Square (BWConfig) | 45 dB  38 dB (Note 5) |
| NOTE 1: BWConfig is the *transmission bandwidth configuration* assumed for the adjacent channel.  NOTE 2: With SCS that provides the largest *transmission bandwidth configuration* (BWConfig).  NOTE 3: Applicable in case the *nominal channel bandwidth* at the other edge of the gap is ≤ 20 MHz.  NOTE 4: Applicable in case the *nominal channel bandwidth* at the other edge of the gap is > 20MHz.  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: *C*ACLR limit for UL for Local Area

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| nominal channel bandwidth BWNominal (MHz) | *Gap between passbands* or inter-*passband* *gap* size (Wgap) 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 ≤Wgap< 15 (Note 3)  5 ≤Wgap< 45 (Note 4) | 2.5 MHz | 5 MHz NR (Note 2) | Square (BWConfig) | 31 dB |
|  | 10 < Wgap< 20 (Note 3)  10 ≤Wgap< 50 (Note 4) | 7.5 MHz | 5 MHz NR (Note 2) | Square (BWConfig) | 31 dB |
| 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 | 20 ≤Wgap< 60 (Note 4)  20 ≤Wgap< 30 (Note 3) | 10 MHz | 20 MHz NR (Note 2) | Square (BWConfig) | 31 dB |
|  | 40 < Wgap< 80 (Note 4)  40 ≤Wgap< 50 (Note 3) | 30 MHz | 20 MHz NR (Note 2) | Square (BWConfig) | 31 dB |
| NOTE 1: BWConfig is the *transmission bandwidth configuration* assumed for the adjacent channel.  NOTE 2: With SCS that provides the largest *transmission bandwidth configuration* (BWConfig).  NOTE 3: Applicable in case the *nominal channel bandwidth* at the other edge of the gap is ≤ 20 MHz.  NOTE 4: Applicable in case the *nominal channel bandwidth* 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

|  |  |
| --- | --- |
| *Repeater* category / class | CACLR 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 6.5.2.2-6: Filter parameters for the assigned channel

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

#### 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 = 10log10(NTXU,countedpercell) 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 repeater. 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 repeater 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 *repeater 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 ba*sic limit* + X of the repeater. 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 repeater scaled by X -10log10(*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 on top of NCR-MT type 1-C basic limit requirements.

10log(NTXU,counted), where NTXU,counted = min(NTXU,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 ΔfOBUE below the lowest frequency of each supported downlink *operating band* up to ΔfOBUE above the highest frequency of each supported downlink *operating band*. The values of ΔfOBUE 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 ΔfOBUE below the lowest frequency of each supported uplink *operating band* up to ΔfOBUE above the highest frequency of each supported uplink *operating band*. The values of ΔfOBUE 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:

- Δf is the separation between the *passband edge* frequency and the nominal -3dB point of the measuring filter closest to the carrier frequency.

- f\_offset is the separation between the *passband edge* frequency and the centre of the measuring filter.

- f\_offsetmax is the offset to the frequency ΔfOBUE outside the downlink *operating band* of *repeater type 1-C* DL and uplink *operating band* of *repeater type 1-C* UL, where ΔfOBUE is defined in tables 6.5.1-1 and 6.5.1-2.

- Δfmax is equal to f\_offsetmax minus half of the bandwidth of the measuring filter.

For a *multi-band connector* inside any *inter-passband gaps* with Wgap < 2\*ΔfOBUE, a combined *basic limit* shall be applied which is the cumulative sum of the *basic limit* requirement specified at the *repeater type 1-C passband edges* on each side of the *inter-passband gap*. The *basic limit* requirement for *repeater type 1-C Bandwidth edge* is specified in clauses 6.5.3.2.1 to 6.5.3.2.4 below, where in this case:

- Δf 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\_offset is the separation from the *repeater type 1-C passband edge* frequency to the centre of the measuring filter.

- f\_offsetmax is equal to the *inter-passband gap* minus half of the bandwidth of the measuring filter.

- Δfmax is equal to f\_offsetmax 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\*ΔfOBUE, f\_offsetmax shall be the offset to the frequency ΔfOBUE 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 (Δfmax), shall apply from ΔfOBUE MHz below the lowest frequency, up to ΔfOBUE 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\* ΔfOBUE, f\_offsetmax shall be the offset to the frequency ΔfOBUE 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 (Δfmax), shall apply from ΔfOBUE MHz below the lowest frequency, up to ΔfOBUE 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 limitspecified 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:

- Δf 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\_offset is the separation between the *sub-block* edge frequency and the centre of the measuring filter.

- f\_offsetmax is equal to the *gap between passbands* bandwidth minus half of the bandwidth of the measuring filter.

- Δfmax is equal to f\_offsetmax 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, n71, n72, n85, 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, Δf | Frequency offset of measurement filter centre frequency, f\_offset | *Basic limits* (Notes 1, 2) | *Measurement bandwidth* |
| 0 MHz ≤ Δf < 5 MHz | 0.05 MHz ≤ f\_offset < 5.05 MHz |  | 100 kHz |
| 5 MHz ≤ Δf <  min(10 MHz, Δfmax) | 5.05 MHz ≤ f\_offset <  min(10.05 MHz, f\_offsetmax) | -14 dBm | 100 kHz |
| 10 MHz ≤ Δf ≤ Δfmax | 10.05 MHz ≤ f\_offset < f\_offsetmax | -13 dBm (Note 3) | 100 kHz |
| NOTE 1: For a *repeater* supporting *non-contiguous spectrum* operation within any *operating band*, the emission basic limits within *gaps between passbands* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* on each side of the *gap between passbands*. Exception is f ≥ 10MHz from both adjacent *sub-blocks* on each side of the *gap between passbands*, where the emission limits within *gaps between passbands* shall be ‑13 dBm/1 MHz.  NOTE 2: For a *multi-band connector* with *inter-passband gap* < 2\*ΔfOBUE the emission basic limits within the *inter-passband gaps* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* or *passband* on each side of the *inter-passband gap*, where the contribution from the far-end *sub-block* or *passband* shall be scaled according to the *measurement bandwidth* of the near-end *sub-block* or *passband*.  NOTE 3: The basic limit is not applicable when Δfmax < 10 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, 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, Δf | Frequency offset of measurement filter centre frequency, f\_offset | *Basic limit* (Notes 1, 2 | *Measurement bandwidth* |
| 0 MHz ≤ Δf < 5 MHz | 0.05 MHz ≤ f\_offset < 5.05 MHz |  | 100 kHz |
| 5 MHz ≤ Δf <  min(10 MHz, Δfmax) | 5.05 MHz ≤ f\_offset <  min(10.05 MHz, f\_offsetmax) | -14 dBm | 100 kHz |
| 10 MHz ≤ Δf ≤ Δfmax | 10.5 MHz ≤ f\_offset < f\_offsetmax | -13 dBm (Note 3) | 1MHz |
| NOTE 1: For a *repeater* supporting *non-contiguous spectrum* operation within any *operating band*, the emission basic limits within *gaps between passbands* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* on each side of the *gap between passbands*, where the contribution from the far-end *sub-block* shall be scaled according to the *measurement bandwidth* of the near-end *sub-block*. Exception is f ≥ 10MHz from both adjacent *sub-blocks* on each side of the *gap between passbands*, where the emission basic limits within *gaps between passbands* shall be ‑13 dBm/1 MHz.  NOTE 2: For a *multi-band connector* with *inter-passband gap* < 2\*ΔfOBUE the emission basic limits within the *inter-passband gaps* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* or *passband* on each side of the *inter-passband gap*, where the contribution from the far-end *sub-block* or *passband* shall be scaled according to the *measurement bandwidth* of the near-end *sub-block* or *passband*.  NOTE 3: The basic limit is not applicable when Δfmax < 10 MHz. | | | |

##### 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, n71, n72, n85, 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, Δf | Frequency offset of measurement filter centre frequency, f\_offset | *Basic limit* (Notes 1, 2) | *Measurement bandwidth* |
| 0 MHz ≤ Δf < 5 MHz | 0.05 MHz ≤ f\_offset < 5.05 MHz |  | 100 kHz |
| 5 MHz ≤ Δf <  min(10 MHz, Δfmax) | 5.05 MHz ≤ f\_offset <  min(10.05 MHz, f\_offsetmax) | -14 dBm | 100 kHz |
| 10 MHz ≤ Δf ≤ Δfmax | 10.05 MHz ≤ f\_offset < f\_offsetmax | -16 dBm (Note 3) | 100 kHz |
| NOTE 1: For a *repeater* supporting *non-contiguous spectrum* operation within any *operating band*, the emission basic limits within *gaps between passbands* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* on each side of the *gap between passbands*. Exception is f ≥ 10MHz from both adjacent *sub-blocks* on each side of the *gap between passbands*, where the emission basic limits within *gaps between passbands* shall be ‑15 dBm/1 MHz.  NOTE 2: For a *multi-band connector* with *inter-passband gap* < 2\*ΔfOBUE the emission basic limits within the *inter-passband gaps* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* or *passband* on each side of the *inter-passband gap*.  NOTE 3: The *basic limit* is not applicable when Δfmax < 10 MHz. | | | |

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, Δf | Frequency offset of measurement filter centre frequency, f\_offset | *Basic limits* (Notes 1, 2) | *Measurement bandwidth* |
| 0 MHz ≤ Δf < 5 MHz | 0.05 MHz ≤ f\_offset < 5.05 MHz |  | 100 kHz |
| 5 MHz ≤ Δf <  min(10 MHz, Δfmax) | 5.05 MHz ≤ f\_offset <  min(10.05 MHz, f\_offsetmax) | -14 dBm | 100 kHz |
| 10 MHz ≤ Δf ≤ Δfmax | 10.5 MHz ≤ f\_offset < f\_offsetmax | -15 dBm (Note 3) | 1MHz |
| NOTE 1: For a *repeater* supporting *non-contiguous spectrum* operation within any *operating band*, the emission basic limits within *gaps between passbands* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* on each side of the *gap between passbands*, where the contribution from the far-end *sub-block* shall be scaled according to the *measurement bandwidth* of the near-end *sub-block*. Exception is f ≥ 10MHz from both adjacent *sub-blocks* on each side of the *gap between passbands*, where the emission basic limits within *gaps between passbands* shall be ‑15 dBm/1 MHz.  NOTE 2: For a *multi-band connector* with *inter-passband gap* < 2\*ΔfOBUE the emission basic limits within the *inter-passband gaps* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* or *passband* on each side of the *inter-passband gap*, where the contribution from the far-end *sub-block* or *passband* shall be scaled according to the *measurement bandwidth* of the near-end *sub-block* or *passband*.  NOTE 3: The basic limit is not applicable when Δfmax < 10 MHz. | | | |

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, Δf | Frequency offset of measurement filter centre frequency, f\_offset | Basic limits | Measurement bandwidth |
| 0 MHz ≤ Δf < 20 MHz | 0.05 MHz ≤ f\_offset < 20.05 MHz |  | 100 kHz |
| 20 MHz ≤ Δf <  min(40 MHz, Δfmax) | 20.05 MHz ≤ f\_offset <  min(40.05 MHz, f\_offsetmax) | -14 dBm | 100 kHz |
| 40 MHz ≤ Δf ≤ Δfmax | 40.5 MHz ≤ f\_offset < f\_offsetmax | -15 dBm (Note 3) | 1MHz |
| NOTE 1: For a *repeater* supporting *non-contiguous spectrum* operation within any *operating band*, the emission basic limits within *gaps between passbands* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* on each side of the *gap between passband*, where the contribution from the far-end *sub-block* shall be scaled according to the *measurement bandwidth* of the near-end *sub-block*. Exception is f ≥ 40MHz from both adjacent *sub-blocks* on each side of the *gap between passband*, where the emission basic limits within *gaps between passbands* shall be ‑15 dBm/1 MHz.  NOTE 2: For a *multi-band connector* with *inter-passband gap* < 2\*ΔfOBUE the emission basic limits within the *inter-passband gaps* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* or *passband* on each side of the *inter-passband gap*, where the contribution from the far-end *sub-block* or *passband* shall be scaled according to the *measurement bandwidth* of the near-end *sub-block* or *passband*.  NOTE 3: The *basic limit* is not applicable when Δfmax < 40 MHz. | | | |

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

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency offset of measurement filter ‑3dB point, Δf | Frequency offset of measurement filter centre frequency, f\_offset | *Basic limits* (Notes 1, 2 | *Measurement bandwidth* |
| 0 MHz ≤ Δf < 0.2 MHz | 0.015 MHz ≤ f\_offset < 0.215 MHz | -14 dBm | 30 kHz |
| 0.2 MHz ≤ Δf < 1 MHz | 0.215 MHz ≤ f\_offset < 1.015 MHz |  | 30 kHz |
| (Note 4) | 1.015 MHz ≤ f\_offset < 1.5 MHz | -26 dBm | 30 kHz |
| 1 MHz ≤ Δf ≤  min(10 MHz, Δfmax) | 1.5 MHz ≤ f\_offset <  min(10.5 MHz, f\_offsetmax) | -13 dBm | 1 MHz |
| 10 MHz ≤ Δf ≤ Δfmax | 10.5 MHz ≤ f\_offset < f\_offsetmax | -15 dBm (Note 3) | 1 MHz |
| NOTE 1: For a *repeater* supporting *non-contiguous spectrum* operation within any *operating band*, the emission basic limits within *gaps between passbands* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* on each side of the *gap between passbands*, where the contribution from the far-end *sub-block* shall be scaled according to the *measurement bandwidth* of the near-end *sub-block*. Exception is f ≥ 10MHz from both adjacent *sub-blocks* on each side of the *gap between passbands*, where the emission basic limits within *gaps between passbands* shall be ‑15 dBm/1 MHz.  NOTE 2: For a *multi-band connector* with *inter-passband gap* < 2\*ΔfOBUE the emission limits within the *inter-passband gaps* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* or *passband* on each side of the *inter-passband gap*, where the contribution from the far-end *sub-block* or *passband* shall be scaled according to the *measurement bandwidth* of the near-end *sub-block* or *passband*.  NOTE 3: The *basic limit* is not applicable when Δfmax < 10 MHz.  NOTE 4: This frequency range ensures that the range of values of f\_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,* Prated,x = Prated,p,AC - 10\*log (ceil (BWPassband/20MHz))

Table 6.5.3.2.3-1: Medium Range *repeater operating band* unwanted emission *basic limits*, 31< Prated,x ≤ 38 dBm

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency offset of measurement filter ‑3dB point, Δf | Frequency offset of measurement filter centre frequency, f\_offset | *Basic limits* (Notes 1, 2) | *Measurement bandwidth* |
| 0 MHz ≤ Δf < 5 MHz | 0.05 MHz ≤ f\_offset < 5.05 MHz |  | 100 kHz |
| 5 MHz ≤ Δf < min(10 MHz, Δfmax) | 5.05 MHz ≤ f\_offset < min(10.05 MHz, f\_offsetmax) | Prated,x - 60dB | 100 kHz |
| 10 MHz ≤ Δf ≤ Δfmax | 10.05 MHz ≤ f\_offset < f\_offsetmax | Min(Prated,x - 60dB, -25dBm) (Note 3) | 100 kHz |
| NOTE 1: For a *repeater* DL supporting *non-contiguous spectrum* operation within any *operating band* the emission basic limits within *gaps between passbands* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* on each side of the *gap between passbands*. Exception is f ≥ 10MHz from both adjacent *sub-blocks* on each side of the *gap between passbands*, where the emission basic limits within *gaps between passbands* shall be Min(Prated,x -60dB, ‑25dBm)/100kHz.  NOTE 2: For a *multi-band connector* with *inter-passband gap* < 2\*ΔfOBUE the emission basic limits within the *inter-passband gaps* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* or *passband* on each side of the *inter-passband gap*.  NOTE 3: The *basic limit* is not applicable when Δfmax < 10 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< Prated,x ≤ 38 dBm

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency offset of measurement filter ‑3dB point, Δf | Frequency offset of measurement filter centre frequency, f\_offset | *Basic limits* (Notes 1, 2) | *Measurement bandwidth* |
| 0 MHz ≤ Δf < 20 MHz | 0.05 MHz ≤ f\_offset < 20.05 MHz |  | 100 kHz |
| 20 MHz ≤ Δf <  min(40 MHz, Δfmax) | 20.05 MHz ≤ f\_offset <  min(40.05 MHz, f\_offsetmax) | Prated,x - 60dB | 100 kHz |
| 40 MHz ≤ Δf ≤ Δfmax | 40.05 MHz ≤ f\_offset < f\_offsetmax | Min(Prated,x - 60dB, -25dBm) (Note 3) | 100 kHz |
| NOTE 1: For a *repeater* DL supporting *non-contiguous spectrum* operation within any *operating band* the emission basic limits within *gaps between passbands* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* on each side of the *gap between passband*. Exception is f ≥ 40MHz from both adjacent *sub-blocks* on each side of the *gap between passband*, where the emission basic limits within *gaps between passbands* shall be Min(Prated,x -60dB, ‑25dBm)/100kHz.  NOTE 2: For a *multi-band connector* with *inter-passband gap* < 2\*ΔfOBUE the emission basic limits within the *inter-passband gaps* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* or *passband* on each side of the *inter-passband gap*.  NOTE 3: The *basic limit* is not applicable when Δfmax < 40 MHz. | | | |

Table 6.5.3.2.3-2: Medium Range *repeater* operating band unwanted emission *basic limits*, Prated,x ≤ 31 dBm

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency offset of measurement filter ‑3dB point, Δf | Frequency offset of measurement filter centre frequency, f\_offset | *Basic limits* (Notes 1, 2 | *Measurement bandwidth* |
| 0 MHz ≤ Δf < 5 MHz | 0.05 MHz ≤ f\_offset < 5.05 MHz |  | 100 kHz |
| 5 MHz ≤ Δf < min(10 MHz, Δfmax) | 5.05 MHz ≤ f\_offset < min(10.05 MHz, f\_offsetmax) | -29 dBm | 100 kHz |
| 10 MHz ≤ Δf ≤ Δfmax | 10.05 MHz ≤ f\_offset < f\_offsetmax | -29 dBm (Note 3) | 100 kHz |
| NOTE 1: For a *repeater* DL supporting *non-contiguous spectrum* operation within any *operating band* the emission basic limits within *gaps between passbands* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* on each side of the *gap between passbands*. Exception is f ≥ 10MHz from both adjacent *sub-blocks* on each side of the *gap between passbands*, where the emission basic limits within *gaps between passbands* shall be -29dBm/100kHz.  NOTE 2: For a *multi-band connector* with *inter-passband gap* < 2\*ΔfOBUE the emission basic limits within the *inter-passband gaps* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* or *passband* on each side of the *inter-passband gap*.  NOTE 3: The *basic limit* is not applicable when Δfmax < 10 MHz. | | | |

Table 6.5.3.2.3-2a. Medium Range *repeater* operating band unwanted emission *basic* limits for band 104, Prated,x ≤ 31 dBm

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency offset of measurement filter ‑3dB point, Δf | Frequency offset of measurement filter centre frequency, f\_offset | *basic limits* (Notes 1, 2 | *Measurement bandwidth* |
| 0 MHz ≤ Δf < 20 MHz | 0.05 MHz ≤ f\_offset < 20.05 MHz |  | 100 kHz |
| 20 MHz ≤ Δf <  min(40 MHz, Δfmax) | 20.05 MHz ≤ f\_offset <  min(40.05 MHz, f\_offsetmax) | -29 dBm | 100 kHz |
| 40 MHz ≤ Δf ≤ Δfmax | 40.05 MHz ≤ f\_offset < f\_offsetmax | -29 dBm | 100 kHz |
| NOTE 1: For a *repeater* DL supporting *non-contiguous spectrum* operation within any *operating band* the emission basic limits within *gaps between passbands* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* on each side of the *gap between passband*. Exception is f ≥ 40MHz from both adjacent *sub-blocks* on each side of the *gap between passband*, where the emission basic limits within *gaps between passbands* shall be -29dBm/100kHz.  NOTE 2: For a *multi-band connector* with *inter-passband gap* < 2\*ΔfOBUE the emission basic limits within the *inter-passband gaps* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* or *passband* on each side of the *inter-passband gap*.  NOTE 3: The *basic limit* is not applicable when Δfmax < 40 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, Δf | Frequency offset of measurement filter centre frequency, f\_offset | *Basic limits* (Notes 1, 2) | *Measurement bandwidth* |
| 0 MHz ≤ Δf < 5 MHz | 0.05 MHz ≤ f\_offset < 5.05 MHz |  | 100 kHz |
| 5 MHz ≤ Δf < min(10 MHz, Δfmax) | 5.05 MHz ≤ f\_offset < min(10.05 MHz, f\_offsetmax) | -37 dBm | 100 kHz |
| 10 MHz ≤ Δf ≤ Δfmax | 10.05 MHz ≤ f\_offset < f\_offsetmax | -37 dBm (Note 10) | 100 kHz |
| NOTE 1: For a *repeater* supporting *non-contiguous spectrum* operation within any *operating band* the emission basic limits within *gaps between passbands* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* on each side of the *gap between passbands*. Exception is f ≥ 10MHz from both adjacent *sub-blocks* on each side of the *gap between passbands*, where the emission basic limits within *gaps between passbands* shall be -37dBm/100kHz.  NOTE 2: For a *multi-band connector* with *inter-passband gap* < 2\*ΔfOBUE the emission basic limits within the *inter-passband gaps* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* or *passband* on each side of the *inter-passband gap*  NOTE 3: The basic limit is not applicable when Δfmax < 10 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, Δf | Frequency offset of measurement filter centre frequency, f\_offset | *Basic limits* (Notes 1, 2) | *Measurement bandwidth* |
| 0 MHz ≤ Δf < 20 MHz | 0.05 MHz ≤ f\_offset < 20.05 MHz |  | 100 kHz |
| 20 MHz ≤ Δf <  min(40 MHz, Δfmax) | 20.05 MHz ≤ f\_offset <  min(40.05 MHz, f\_offsetmax) | -37 dBm | 100 kHz |
| 40 MHz ≤ Δf ≤ Δfmax | 40.05 MHz ≤ f\_offset < f\_offsetmax | -37 dBm | 100 kHz |
| NOTE 1: For a repeater supporting *non-contiguous spectrum* operation within any *operating band* the emission basic limits within *sub-block gaps* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* on each side of the *sub-block gap*. Exception is f ≥ 40MHz from both adjacent *sub-blocks* on each side of the *sub-block gap*, where the emission basic limits within *sub-block gaps* shall be -37dBm/100kHz.  NOTE 2: For a *multi-band connector* with *Inter RF Bandwidth gap* < 2\*ΔfOBUE the emission basic limits within the *Inter RF Bandwidth gaps* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* or RF Bandwidth on each side of the *Inter RF Bandwidth gap*  NOTE 3: The basic limit is not applicable when Δfmax < 40 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 Ffilter according to table 6.5.3.2.5.2-1, a basic limitPEM,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, Ffilter** | ***Measurement bandwidth*** | **Declared emission *basic limit* (dBm)** |
| Ffilter = 8\*N + 306 (MHz);  21 ≤ N ≤ 60 | 8 MHz | PEM,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 |  | | 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 - 30 dB and the power sum of all limit values (General, IQ Image or Carrier leakage) that apply. 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: *LCRB* is the .  NOTE 7: *NRB* is the .  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:  is the starting frequency offset between the end of nearest non-zero input basic unit and the measured zero-input basic unit (e.g. *∆RB*= 1 or *∆RB*= -1 for the first zero-input basic unit outside of the non-zero input part of passband.  NOTE 10:  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

6.5.3.4.1.1 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.

6.5.3.4.1.2 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 = 10log10(NTXU,countedpercell) 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 *repeater 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 *repeater type 1-H* limit as defined in this clause for the respective frequency span, scaled by -10log10(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 transmiting, 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 transmiting, 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.

10log(NTXU,counted), where NTXU,counted = min(NTXU,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 ΔfOBUE below the lowest frequency of each supported downlink *operating band*, up to ΔfOBUE above the highest frequency of each supported downlink *operating band*, where the ΔfOBUE is defined in table 6.5.1-1. For some *operating bands*, the upper limit is higher than 12.75 GHz in order to comply with the 5th harmonic limit of the downlink *operating band*, as specified in ITU-R recommendation SM.329 [5].

For a *multi-band connector*, for each supported *operating band* together with ΔfOBUE 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 – 5th harmonic of the upper frequency edge of the DL *operating band* in GHz |  | 1 MHz | Note 1, Note 2, Note 3 |
| NOTE 1: *Measurement bandwidth*s 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 *operating bands* for which the 5th harmonic of the upper frequency edge of the DL *operating band* 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 – 5th harmonic of the upper frequency edge of the DL *operating band* in GHz |  | 1 MHz | Note 1, Note 2, Note 3 |
| NOTE 1: *Measurement bandwidth*s 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 *operating bands* for which the 5th harmonic of the upper frequency edge of the UL *operating band* 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 | *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 – 5th harmonic of the upper frequency edge of the DL *operating band* in GHz |  | 1 MHz | Note 1, Note 2, Note 3 |
| NOTE 1: *Measurement bandwidth*s 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 *operating bands* for which the 5th harmonic of the upper frequency edge of the DL *operating band* is reaching beyond 12.75 GHz. For UL, this spurious frequency range applies only for *operating bands* for which the 5th harmonic of the upper frequency edge of the UL *operating band* 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 listed in the first column apply for *repeater type 1-C*. For a *multi-band connector*, the exclusions and conditions in the Note column of 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 | Frequency range for co-existence requirement | *basic limits* | *Measurement bandwidth* | Note |
| GSM900 | 921 – 960 MHz | -57 dBm | 100 kHz | This basic limit does not apply to repeater operating in band n8 |
|  | 876 – 915 MHz | -61 dBm | 100 kHz | For the frequency range 880-915 MHz, this basic limit does not apply to repeater operating in band n8, since it is already covered by the basic limit in clause 6.5.5.2.2. |
| DCS1800 | 1805 – 1880 MHz | -47 dBm | 100 kHz | This basic limit does not apply to repeater operating in band n3. |
|  | 1710 – 1785 MHz | -61 dBm | 100 kHz | This basic limit does not apply to repeater operating in band n3, since it is already covered by the basic limit in clause 6.5.5.2.2. |
| PCS1900 | 1930 – 1990 MHz | -47 dBm | 100 kHz | This basic limit does not apply to repeater operating in band n2, n25 or band n70. |
|  | 1850 – 1910 MHz | -61 dBm | 100 kHz | This basic limit does not apply to repeater operating in band n2 or n25 since it is already covered by the basic limit in clause 6.6.5.2.2. |
| GSM850 or | 869 – 894 MHz | -57 dBm | 100 kHz | This basic limit does not apply to repeater operating in band n5 or n26. |
| CDMA850 | 824 – 849 MHz | -61 dBm | 100 kHz | This basic limit does not apply to repeater operating in band n5 or n26, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| UTRA FDD | 2110 – 2170 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n1 or n65 |
| Band I or  E-UTRA Band 1 or NR Band n1 | 1920 – 1980 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n1 or n65, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| UTRA FDD | 1930 – 1990 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n2 or n70. |
| Band II or  E-UTRA Band 2 or NR Band n2 | 1850 – 1910 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n2, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| UTRA FDD | 1805 – 1880 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n3. |
| Band III or  E-UTRA Band 3 or NR Band n3 | 1710 – 1785 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n3, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| UTRA FDD Band IV or  E-UTRA Band 4 | 2110 – 2155 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n66 |
|  | 1710 – 1755 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n66, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| UTRA FDD Band V or  E-UTRA Band 5 or NR Band n5 | 869 – 894 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n5 or n26. |
|  | 824 – 849 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n5 or n26, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| UTRA FDD | 860 – 890 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n18. |
| Band VI, XIX or | 815 – 830 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n18, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| E-UTRA Band 6, 18, 19 or NR Band n18 | 830 – 845 MHz | -49 dBm | 1 MHz |  |
| UTRA FDD Band VII or  E-UTRA Band 7 or NR Band n7 | 2620 – 2690 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n7. |
|  | 2500 – 2570 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n7, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| UTRA FDD Band VIII or  E-UTRA Band 8 or NR Band n8 | 925 – 960 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n8. |
|  | 880 – 915 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n8, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| UTRA FDD Band IX or  E-UTRA Band 9 | 1844.9 – 1879.9 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n3. |
|  | 1749.9 – 1784.9 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n3, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| UTRA FDD Band X or  E-UTRA Band 10 | 2110 – 2170 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n66 |
|  | 1710 – 1770 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n66, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| UTRA FDD Band XI or XXI or  E-UTRA Band 11 or 21 | 1475.9 – 1510.9 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n50, n74, n75, n92, n94 or n109. |
|  | 1427.9 – 1447.9 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n50, n51, n74, n75, n76, n91, n92, n93, n94 or n109. |
|  | 1447.9 – 1462.9 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n50, n74, n75, n92, n94 or n109. |
| UTRA FDD Band XII or  E-UTRA Band 12 or NR Band n12 | 729 – 746 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n12 or n85. |
|  | 699 – 716 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n12 or n85, since it is already covered by the basic limit in clause 6.6.5.2.2.  For NR repeater operating in n29, it applies 1 MHz below the Band n29 downlink operating band (Note 5). |
| UTRA FDD Band XIII or  E-UTRA Band 13 | 746 – 756 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n13. |
|  | 777 – 787 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n13, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| UTRA FDD Band XIV or  E-UTRA Band 14 or NR band n14 | 758 – 768 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n14. |
|  | 788 – 798 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n14, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| E-UTRA Band 17 | 734 – 746 MHz | -52 dBm | 1 MHz |  |
|  | 704 – 716 MHz | -49 dBm | 1 MHz | For NR repeater operating in n29, it applies 1 MHz below the Band n29 downlink operating band (Note 5). |
| UTRA FDD Band XX or E-UTRA Band 20 or NR Band n20 | 791 – 821 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n20 or n28. |
|  | 832 – 862 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n20, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| UTRA FDD Band XXII or E-UTRA Band 22 | 3510 – 3590 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n48, n77 or n78. |
|  | 3410 – 3490 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n77 or n78. |
| E-UTRA Band 24 | 1525 – 1559 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n24. |
|  | 1626.5 – 1660.5 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n24, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| UTRA FDD Band XXV or  E-UTRA Band 25 or NR band n25 | 1930 – 1995 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n2, n25 or n70. |
|  | 1850 – 1915 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n25 since it is already covered by the basic limit in clause 6.6.5.2.2. For repeater operating in Band n2, it applies for 1910 MHz to 1915 MHz, while the rest is covered in clause 6.6.5.2.2. |
| UTRA FDD Band XXVI or  E-UTRA Band 26 or NR Band n26 | 859 – 894 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n5 or n26. |
|  | 814 – 849 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n26 since it is already covered by the basic limit in clause 6.6.5.2.2. For repeater operating in Band n5, it applies for 814 MHz to 824 MHz, while the rest is covered in clause 6.6.5.2.2. |
| E-UTRA Band 27 | 852 – 869 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n5. |
|  | 807 – 824 MHz | -49 dBm | 1 MHz | This basic limit also applies to repeater operating in Band n28, starting 4 MHz above the Band n28 downlink operating band (Note 5). |
| E-UTRA Band 28 or NR Band n28 | 758 – 803 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n20, n67 or n28. |
|  | 703 – 748 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n28, since it is already covered by the basic limit in clause 6.6.5.2.2.  For repeater operating in band n67, it applies for 703 MHz to 736 MHz. |
| E-UTRA Band 29 or NR Band n29 | 717 – 728 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n29 or n85 |
| E-UTRA Band 30 or NR Band n30 | 2350 – 2360 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n30 |
|  | 2305 – 2315 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n30, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| E-UTRA Band 31 or NR Band n31 | 462.5 – 467.5 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n31 or n72. |
|  | 452.5 – 457.5 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n31, since it is already covered by the basic limit in clause 6.6.5.2.2. This basic limit does not apply to repeater operating in band n72. |
| UTRA FDD band XXXII or E-UTRA band 32 | 1452 – 1496 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n50, n74, n75, n92, n94 or n109. |
| UTRA TDD Band a) or E-UTRA Band 33 | 1900 – 1920 MHz | -52 dBm | 1 MHz |  |
| UTRA TDD Band a) or E-UTRA Band 34 or NR band n34 | 2010 – 2025 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n34. |
| UTRA TDD Band b) or E-UTRA Band 35 | 1850 – 1910 MHz | -52 dBm | 1 MHz |  |
| UTRA TDD Band b) or E-UTRA Band 36 | 1930 – 1990 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n2 or n25. |
| UTRA TDD Band c) or E-UTRA Band 37 | 1910 – 1930 MHz | -52 dBm | 1 MHz |  |
| UTRA TDD Band d) or E-UTRA Band 38 or NR Band n38 | 2570 – 2620 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n38. |
| UTRA TDD Band f) or E-UTRA Band 39 or NR band n39 | 1880 – 1920MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n39. |
| UTRA TDD Band e) or E-UTRA Band 40 or NR Band n40 | 2300 – 2400MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n30 or n40. |
| E-UTRA Band 41 or NR Band n41, n90 | 2496 – 2690 MHz | -52 dBm | 1 MHz | This is not applicable to repeater operating in Band n41, n53 or [n90]. |
| E-UTRA Band 42 | 3400 – 3600 MHz | -52 dBm | 1 MHz | This is not applicable to repeater operating in Band n48, n77 or n78. |
| E-UTRA Band 43 | 3600 – 3800 MHz | -52 dBm | 1 MHz | This is not applicable to repeater operating in Band n48, n77 or n78. |
| E-UTRA Band 44 | 703 – 803 MHz | -52 dBm | 1 MHz | This is not applicable to repeater operating in Band n28. |
| E-UTRA Band 45 | 1447 – 1467 MHz | -52 dBm | 1 MHz |  |
| E-UTRA Band 46 | 5150 – 5925 MHz | -52 dBm | 1 MHz |  |
| E-UTRA Band 47 | 5855 – 5925 MHz | -52 dBm | 1 MHz |  |
| E-UTRA Band 48 or NR Band n48 | 3550 – 3700 MHz | -52 dBm | 1 MHz | This is not applicable to repeater operating in Band n48, n77 or n78. |
| E-UTRA Band 50 or NR band n50 | 1432 – 1517 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n50, n51, n74, n75, n76, n91, n92, n93, n94 or n109. |
| E-UTRA Band 51 or NR Band n51 | 1427 – 1432 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n50, n51, n75, n76, n91, n92, n93, n94 or n109. |
| E-UTRA Band 53 or NR Band n53 | 2483.5 - 2495 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n41, n53 or n90. |
| E-UTRA Band 54 or NR Band n54 | 1670 – 1675 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n54 |
| E-UTRA Band 65 or NR Band n65 | 2110 – 2200 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n1 or n65. |
|  | 1920 – 2010 MHz | -49 dBm | 1 MHz | For repeater operating in Band n1, it applies for 1980 MHz to 2010 MHz, while the rest is covered in clause 6.6.5.2.2.  This basic limit does not apply to repeater operating in band n65, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| E-UTRA Band 66 or NR Band n66 | 2110 – 2200 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n66. |
|  | 1710 – 1780 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n66, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| E-UTRA Band 67 | 738 – 758 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n28 or n67. |
| E-UTRA Band 68 | 753 -783 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n28. |
|  | 698-728 MHz | -49 dBm | 1 MHz | For repeater operating in Band n28, this basic limit applies between 698 MHz and 703 MHz, while the rest is covered in clause 6.6.5.2.2. |
| E-UTRA Band 69 | 2570 – 2620 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n38. |
| E-UTRA Band 70 or NR Band n70 | 1995 – 2020 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n2, n25 or n70 |
|  | 1695 – 1710 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n70, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| E-UTRA Band 71 or NR Band n71 | 617 – 652 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n71 or n105 |
|  | 663 – 698 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n71 or n105, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| E-UTRA Band 72 or NR Band n72 | 461 – 466 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n31 or n72. |
|  | 451 – 456 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n72, since it is already covered by the basic limit in clause 6.6.5.2.2. This basic limit does not apply to BS operating in band n31. |
| E-UTRA Band 74 or NR Band n74 | 1475 – 1518 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n50, n74, n75, n92, n94 or n109. |
|  | 1427 – 1470 MHz | -49 dBm | 1MHz | This basic limit does not apply to repeater operating in band n50, n51, n74, n75, n76, n91, n92, n93, n94 or n109. |
| E-UTRA Band 75 or NR Band n75 | 1432 – 1517 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n50, n51, n74, n75, n76, n91, n92, n93, n94 or n109. |
| E-UTRA Band 76 or NR Band n76 | 1427 – 1432 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n50, n51, n75, n76, n91, n92, n93, n94 or n109. |
| NR Band n77 | 3.3 – 4.2 GHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n48, n77 or n78 |
| NR Band n78 | 3.3 – 3.8 GHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n48, n77 or n78 |
| NR Band n79 | 4.4 – 5.0 GHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n79 |
| NR Band n80 | 1710 – 1785 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n3, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| NR Band n81 | 880 – 915 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n8, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| NR Band n82 | 832 – 862 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n20, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| NR Band n83 | 703 – 748 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n28, since it is already covered by the basic limit in clause 6.6.5.2.2.  For repeater operating in Band n67, it applies for 703 MHz to 736 MHz. |
| NR Band n84 | 1920 – 1980 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n1, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| E-UTRA Band 85 and NR Band n85 | 728 – 746 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n12 or n85.  For NR repeater operating in n29, it applies 1 MHz below the Band n29 downlink operating band (Note 5). |
|  | 698 – 716 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n12 or n85, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| NR Band n86 | 1710 – 1780 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n66, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| NR Band n89 | 824 – 849 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n5, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| NR Band n91 | 1427 – 1432 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n50, n51, n75, n76 or n109. |
|  | 832 – 862 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n20, since it is already covered by the basic limit in clause 6.6.5.5.1.2. |
| NR Band n92 | 1432 – 1517 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n50, n51, n74, n75, n76 or n109. |
|  | 832 – 862 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n20, since it is already covered by the basic limit in clause 6.6.5.5.1.2. |
| NR Band n93 | 1427 – 1432 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n50, n51, n75, n76 or n109. |
|  | 880 – 915 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n8, since it is already covered by the basic limit in clause 6.6.5.5.1.2. |
| NR Band n94 | 1432 – 1517 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n50, n51, n74, n75, n76 or n109. |
|  | 880 – 915 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n8, since it is already covered by the basic limit in clause 6.6.5.5.1.2. |
| NR Band n95 | 2010 – 2025 MHz | -52 dBm | 1 MHz |  |
| NR Band n96 | 5925 – 7125 MHz | -52 dBm | 1 MHz |  |
| NR Band n97 | 2300 – 2400MHz | -52 dBm | 1 MHz |  |
| NR Band n98 | 1880 – 1920MHz | -52 dBm | 1 MHz |  |
| NR Band n99 | 1626.5 – 1660.5 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n24, since it is already covered by the basic limit in clause 6.5.5.2.2. |
| NR band n101 | 1900 – 1910 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n101. |
| NR Band n102 | 5925 – 6425 MHz | -52 dBm | 1 MHz |  |
| E-UTRA Band 103 | 757 – 758 MHz | -52 dBm | 1 MHz |  |
|  | 787 – 788 MHz | -49 dBm | 1 MHz |  |
| NR Band n104 | 6425 – 7125 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in Band n104 |
| NR band n105 | 612 – 652 MHz | -52 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n71 or n105 |
|  | 663 – 703 MHz | -49 dBm | 1 MHz | This basic limit does not apply to repeater operating in band n105, since it is already covered by the basic limit in clause 6.6.5.2.2. |
| E-UTRA Band 106 | 935 - 940 MHz | -52 dBm | 1 MHz |  |
|  | 896 – 901 MHz | -49 dBm | 1 MHz |  |
| NR band n109 | 1432 – 1517 MHz | -52 dBm | 1 MHz | This basic limit does not apply to BS operating in Band n50, n51, n74, n75, n76, n91, n92, n93, n94 or n109 |
|  | 703 – 733 MHz | -49 dBm | 1 MHz | This basic limit does not apply to BS operating in band n109, since it is already covered by the basic limit in clause 6.6.6.5.2.4. |

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, the co-existence requirements in table 6.5.4.2.3 -1 do not apply for the ΔfOBUE 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*.

NOTE 5: For NR Band n29 repeater, specific solutions may be required to fulfil the spurious emissions limits for NR 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.

The following requirement may be applied for the protection of PHS. This requirement is also applicable at specified frequencies falling between ΔfOBUE below the lowest repeater transmitter frequency of the downlink *operating band* and ΔfOBUE above the highest repeater transmitter frequency of the downlink *operating band*. ΔfOBUE 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 | *basic limit* | *Measurement Bandwidth* | 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 NR 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 ΔfOBUE below the lowest frequency of the repeater downlink *operating band* up to ΔfOBUE 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 NR repeater operating in Band n50 and n75 within 1432 – 1452 MHz, and in Band n51 and n76

|  |  |  |
| --- | --- | --- |
| Filter centre frequency, Ffilter | *basic limit* | *Measurement Bandwidth* |
| Ffilter = 1413.5 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 Ffilter with filter bandwidth according to Table 6.5.4.2.3-5, shall be defined according to the *basic limits* PEM,n50/n75,a nor PEM,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, Ffilter | Declared *basic limits* (dBm) | *Measurement bandwidth* |
| 1518.5 MHz ≤ Ffilter ≤ 1519.5 MHz | PEM, n50/n75,a | 1 MHz |
| 1520.5 MHz ≤ Ffilter ≤ 1558.5 MHz | PEM,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 | *Basic limit* | *Measurement Bandwidth* |
| 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 NR 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 NR repeater spurious emissions basic limits for Band n30

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency range | *basic limits* | *Measurement Bandwidth* | 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 | *Basic limits* | *Measurement Bandwidth* (NOTE) | Note |
| 3530 MHz – 3720 MHz | -25 dBm | 1 MHz | Applicable 10 MHz from the assigned *passband edge* |
| 3100 MHz – 3530 MHz  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 *passband* 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 ΔfOBUE below the lowest frequency of the Repeater downlink operating band up to ΔfOBUE 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, Ffilter [MHz] | *Basic limit* [dBm] | *Measurement bandwidth* [MHz] |
| All | 3430 – 3440  3560 – 3570 | 3430.5 ≤ Ffilter < 3439.5  3560.5 ≤ Ffilter < 3569.5 | -25 | 1 |
| All | ≤ 3430  > 3570 | Ffilter < 3429.5  3570.5 ≤ Ffilter | -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 PEM,n54,a, PEM,n54,b, PEM,n54,c, PEM,n54,d, PEM,n54,e and PEM,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)  (Measurement bandwidth = 1 MHz) | Declared emission level (dBW) of discrete emissions of less than 700 Hz bandwidth  (Measurement bandwidth = 1 kHz) | Declared emission level (dBW) of discrete emissions of less than 2 kHz bandwidth  (Measurement bandwidth = 1 kHz) |
| n54 | 1541 - 1559 MHz | PEM,n54,a |  | PEM,n54,f |
|  | 1559 - 1610 MHz | PEM,n54,b | PEM,n54,d |  |
|  | 1610 - 1650 MHz | PEM,n54,c | PEM,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: PEIRP = PE + Gant where PE denotes the repeater unwanted emission level at the antenna connector, Gant 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 listed in the first column apply, depending on the declared class. For a *multi-band connector*, the exclusions and conditions in the Note column of 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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Type of co-located BS | Frequency range for | *Basic limits* | | | Measurement | Note |
|  | co-location requirement | WA repeater | MR repeater | LA repeater | bandwidth |  |
| GSM900 | 876 – 915 MHz | -98 dBm | -91 dBm | -70 dBm | 100 kHz |  |
| DCS1800 | 1710 – 1785 MHz | -98 dBm | -91 dBm | -80 dBm | 100 kHz |  |
| PCS1900 | 1850 – 1910 MHz | -98 dBm | -91 dBm | -80 dBm | 100 kHz |  |
| GSM850 or CDMA850 | 824 – 849 MHz | -98 dBm | -91 dBm | -70 dBm | 100 kHz |  |
| UTRA FDD Band I or E-UTRA Band 1 or NR Band n1 | 1920 – 1980 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band II or E-UTRA Band 2 or NR Band n2 | 1850 – 1910 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band III or E-UTRA Band 3 or NR Band n3 | 1710 – 1785 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band IV or E-UTRA Band 4 | 1710 – 1755 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band V or E-UTRA Band 5 or NR Band n5 | 824 – 849 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band VI, XIX or E-UTRA Band 6, 19 | 830 – 845 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band VII or E-UTRA Band 7 or NR Band n7 | 2500 – 2570 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band VIII or E-UTRA Band 8 or NR Band n8 | 880 – 915 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band IX or E-UTRA Band 9 | 1749.9 – 1784.9 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band X or E-UTRA Band 10 | 1710 – 1770 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band XI or E-UTRA Band 11 | 1427.9 –1447.9 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n50, n75, n91, n92, n93 or n94 |
| UTRA FDD Band XII or  E-UTRA Band 12 or NR Band n12 | 699 – 716 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band XIII or  E-UTRA Band 13 or NR Band n13 | 777 – 787 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band XIV or  E-UTRA Band 14 or NR Band n14 | 788 – 798 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 17 | 704 – 716 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 18 or NR Band n18 | 815 – 830 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band XX or E-UTRA Band 20 or NR Band n20 | 832 – 862 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band XXI or E-UTRA Band 21 | 1447.9 – 1462.9 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n50, n75, n92 or n94 |
| UTRA FDD Band XXII or E-UTRA Band 22 | 3410 – 3490 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n48, n77 or n78 |
| E-UTRA Band 24 or NR Band n24 | 1626.5 – 1660.5 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band XXV or  E-UTRA Band 25 or NR Band n25 | 1850 – 1915 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA FDD Band XXVI or  E-UTRA Band 26 or NR Band n26 | 814 – 849 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 27 | 807 – 824 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 28 or NR Band n28 | 703 – 748 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 30 or NR Band n30 | 2305 – 2315 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 31 or NR Band n31 | 452.5 – 457.5 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA TDD Band a) or E-UTRA Band 33 | 1900 – 1920 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA TDD Band a) or E-UTRA Band 34 or NR band n34 | 2010 – 2025 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n34 |
| UTRA TDD Band b) or E-UTRA Band 35 | 1850 – 1910 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA TDD Band b) or E-UTRA Band 36 | 1930 – 1990 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n2 or band n25 |
| UTRA TDD Band c) or E-UTRA Band 37 | 1910 – 1930 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| UTRA TDD Band d) or E-UTRA Band 38 or NR Band n38 | 2570 – 2620 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n38. |
| UTRA TDD Band f) or E-UTRA Band 39 or NR band n39 | 1880 – 1920MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n39 |
| UTRA TDD Band e) or E-UTRA Band 40 or NR Band n40 | 2300 – 2400MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n30 or n40. |
| E-UTRA Band 41 or NR Band n41, n90 | 2496 – 2690 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n41, n53 or [n90] |
| E-UTRA Band 42 | 3400 – 3600 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n48, n77 or n78 |
| E-UTRA Band 43 | 3600 – 3800 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n48, n77 or n78 |
| E-UTRA Band 44 | 703 – 803 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n28 |
| E-UTRA Band 45 | 1447 – 1467 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 46 or NR Band n46 | 5150 – 5925 MHz | N/A | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 48 or NR Band n48 | 3550 – 3700 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n48, n77 or n78 |
| E-UTRA Band 50 or NR Band n50 | 1432 – 1517 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n51, n74, n75, n91, n92, n93 or n94 |
| E-UTRA Band 51 or NR Band n51 | 1427 – 1432 MHz | N/A | N/A | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n50, n74, n75, n76, n91, n92, n93 or n94 |
| E-UTRA Band 53 or NR Band n53 | 2483.5 – 2495 MHz | N/A | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n41, n53 or n90 |
| E-UTRA Band 54 or NR Band n54 | 1670 – 1675 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n54 |
| E-UTRA Band 65 or NR Band n65 | 1920 – 2010 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 66 or NR Band n66 | 1710 – 1780 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 68 | 698 – 728 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 70 or NR Band n70 | 1695 – 1710 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 71 or NR Band n71 | 663 – 698 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 72 or NR Band n72 | 451 – 456 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 74 or NR Band n74 | 1427 – 1470 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n50, n51, n91, n92, n93 or n94 |
| NR Band n77 | 3.3 – 4.2 GHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n48, n77 or n78 |
| NR Band n78 | 3.3 – 3.8 GHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz | This is not applicable to repeater operating in Band n48, n77 or n78 |
| NR Band n79 | 4.4 – 5.0 GHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n80 | 1710 – 1785 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n81 | 880 – 915 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n82 | 832 – 862 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n83 | 703 – 748 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n84 | 1920 – 1980 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 85 or NR Band n85 | 698 – 716 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n86 | 1710 – 1780 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n89 | 824 – 849 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n91 | 832 – 862 MHz | N/A | N/A | -88 dBm | 100 kHz |  |
| NR Band n92 | 832 – 862 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n93 | 880 – 915 MHz | N/A | N/A | -88 dBm | 100 kHz |  |
| NR Band n94 | 880 – 915 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n95 | 2010 – 2025 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n96 | 5925 – 7125 MHz | N/A | -90 dBm | -87 dBm | 100 kHz |  |
| NR Band n97 | 2300 – 2400MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n98 | 1880 – 1920MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n99 | 1626.5 – 1660.5 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n101 | 1900 – 1910 MHz | -96 dBm | NA | NA | 100 kHz |  |
| NR Band n102 | 5925 – 6425 MHz | N/A | -90 dBm | -87 dBm | 100 kHz |  |
| E-UTRA Band 103 | 787 – 788 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n104 | 6425 – 7125 MHz | -95 dBm | -90 dBm | -87 dBm | 100 kHz | This requirement does not apply to repeater operating in Band n104. |
| NR Band n105 | 663 – 703 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| E-UTRA Band 106 | 896 – 901 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |
| NR Band n109 | 703 – 733 MHz | -96 dBm | -91 dBm | -88 dBm | 100 kHz |  |

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 ΔfOBUE 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.

#### 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 = 10log10(NTXU,countedpercell) 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 -10log10(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 transmting 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 transmting 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 transmting 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.

10log(NTXU,counted), where NTXU,counted = min(NTXU,active ,8)

When WA NCR-MT and NCR-Fwd are transmting 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 transmting 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 transmting 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 a*ntenna 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 – 5th harmonic of the upper frequency edge of the UL *operating band* 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: *Measurement bandwidth*s 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: This spurious frequency range applies only for *operating bands* for which the 5th harmonic of the upper frequency edge of the UL *operating band* is reaching beyond 12.75 GHz.  NOTE 4: The frequency range from ΔfOBUE below the lowest frequency of the repeater transmitter *operating band* to ΔfOBUE above the highest frequency of the repeater transmitter *operating band* may be excluded from the requirement. ΔfOBUE is defined in clause 6.5.1. For *multi-band* *connectors*, the exclusion applies for all supported *operating bands*.  NOTE 5: Does not apply for band n104.  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 limit*s + X, where X = 10log10(NRXU,countedpercell) 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 -10log10(*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 | 256QAM1 |
| 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 % 1 |
| 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 is 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 | 256QAM1 |
| 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 1 |
| 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:

- f1 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

|  |  |  |  |
| --- | --- | --- | --- |
| f1 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 NR repeater receivers when GSM, CDMA, UTRA, E-UTRA, NR BS or repeater operating in a different frequency band are co-located with a NR 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 NR 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 *passband* | +16 | +8 | x (Note 1) | 2 CW carriers |
| NOTE 1: x = -7 dBm for NR repeater co-located with Pico GSM850 or Pico CDMA850  x = -4 dBm for NR repeater co-located with Pico DCS1800 or Pico PCS1900  x = -6 dBm for NR repeater co-located with UTRA bands or E-UTRA bands or NR bands  NOTE 2: The requirement does not apply when the interfering signal falls within the *passband*.  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 NR 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 *passband* | +16 | Prated,p,AC -30 | 2 CW carriers |
| NOTE 1: The requirement does not apply when the interfering signal falls within the *passband*.  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 NR repeater receivers when GSM, CDMA, UTRA, E-UTRA, NR BS or repeater operating in another frequency band co-exist with a NR 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 NR 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 FUL,high or X MHz lower than FUL,low, where X equals to 20MHz when FUL,high - FUL,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* (Prated,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 *passbands* in the operating band and with sufficient carriers to fill each *passband*. 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 | *Rated total output power* (Prated,t,AC) in the *passband* – 30 dB |
| Interfering signal centre frequency offset from the lower/upper edge of the wanted signal or edge of *sub-block* inside a *sub-block gap* | , 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 *passband bandwidth* |
| Interfering signal level | *Rated total output power* (Prated,t,AC) in the *passband* – 30 dB |
| Interfering signal centre frequency offset from the lower/upper *passband* centre frequency of the wanted signal | ± 5 MHz  ± 15 MHz  ± 25 MHz |
| NOTE: This requirement applies for *passband* 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* (Prated,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* (Prated,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 inimum 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. In normal conditions the 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 *passband* (MHz) | ACRR limit |
| UTRA, E-UTRA, NR | Wide Area repeater | BWNominal/2 | 45 |
| Medium Range repeater | BWNominal/2 | 45 |
| Local Area repeater | BWNominal/2 | 33  (Note 1) |
| NOTE 1: This requirement does not applicable if the *passband* occupies the entire *operating band*. | | | |

For a repeater 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.

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

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

For a repeater 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.

Table 6.9.2-2: Repeater Uplink ACRR below 2496 MHz

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

For a repeater 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.

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

|  |  |  |  |
| --- | --- | --- | --- |
| Co-existence with other systems | Repeater Class | Channel offset from frequency edge of *passband* (MHz) | ACRR limit |
| UTRA, E-UTRA, NR | Wide Area repeater | BWNominal/2 | 33dB |
| Local Area repeater | 5MHz | 20dBc (Note 1, Note 2) |
| BWNominal/2 | 33dBc (Note 1) |
| NOTE 1: This requirement does not applicable if the *passband* occupies the entire *operating band*.  NOTE 2: In this case, the channel within the *passband* 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 6.9.3-1 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 (BWpassband) centred on the assigned channel frequency during the *transmitter OFF state*. N = 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 / (SCS\*(12\*NRB+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 / (SCS\*(12\*NRB+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\*(12\*NRB+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

### 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 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 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 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 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 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 applies.

## 6.12 Transmit signal quality

### 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 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 apply to both NCR-MT type 1-C and NCR-MT type 1-H.

## 6.13 Transmit intermodulation

### 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 apply for WA and LA NCR-MT. The IM interference level is based on NCR-Fwd link.

## 6.14 General

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 9:

- 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*.

## 6.15 Diversity characteristics

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 Conducted reference sensitivity

### 6.16.1 NCR-MT reference sensitivity level

#### 6.16.1.1 General

The reference sensitivity power level PREFSENS 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 Wide Area NCR-MT reference sensitivity level is specified the same as the Wide Area IAB-MT reference sensitivity level requirement for *IAB-MT type 1-H* in TS 38.174 [22], clause 7.2.2, where references to *nominal channel bandwidth* apply to NCR-MT *passband*.

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 Conducted maximum input level

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 ≥ 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 Conducted adjacent channel selectivity

### 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*

For Wide Area *NCR-MT type 1-C*, minimum requirement is the same as specified for BS type 1-C in TS 38.104 [2], clause 7.4.1.2.

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

#### 6.18.1.3 Minimum requirement for *NCR-MT type 1-H*

For Wide Area *NCR-MT type 1-H,* minimum requirement is the same as specified for *IAB-MT type 1-H* in TS 38.174 [22], clause 7.4.1.3.

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

## 6.19 Conducted blocking characteristics

### 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

For Wide Area *NCR-MT type 1-C*, minimum requirement is the same as specified for BS type 1-C in TS 38.104 [2], clause 7.4.2.2.

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

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

For Wide Area *NCR-MT type 1-H*, minimum requirement at TAB connector is the same as specified for IAB-MT in TS 38.174 [22], clause 7.4.2.3.

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

## 6.20 Conducted spurious response

### 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 Conducted intermodulation characteristics

### 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 type 1-C

For Wide Area *NCR-MT type 1-C*, minimum requirement at antenna connector is the same as specified for *BS type 1-C* in TS 38.104 [2], clause 7.7.2.

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

### 6.21.3 Minimum requirement for NCR type 1-H

For Wide Area *NCR-MT type 1-H*, minimum requirement at TAB connector is the same as specified for *IAB-MT type 1-H* in TS 38.174 [22], clause 7.7.3.

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

## 6.22 Conducted spurious emissions

### 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 (NRXU,counted) for Wide Area *NCR-MT type 1-H* is calculated as follows:

NRXU,counted = min(NRXU,active , 8 )

NOTE: NRXU,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 – 5th harmonic of the upper frequency edge of the UL *operating band* 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: *Measurement bandwidth*s 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: This spurious frequency range applies only for *operating bands* for which the 5th harmonic of the upper frequency edge of the UL *operating band* is reaching beyond 12.75 GHz.  NOTE 4: The frequency range from ΔfOBUE below the lowest frequency of the repeater transmitter *operating band* to ΔfOBUE above the highest frequency of the repeater transmitter *operating band* may be excluded from the requirement. ΔfOBUE is defined in clause 6.5.1. For *multi-band* *connectors*, the exclusion applies for all supported *operating bands*.  NOTE 5: Does not apply for band n104.  NOTE 6: Applies only for band n104. | | | |

# 7 Radiated characteristics

## 7.1 General

Radiated characteristics are specified at RIB for *repeater type 2-O*. Requirements apply in both DL and UL unless otherwise stated or declared.

## 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:

- Prated,out,FBWlow for lower supported frequency range, and

- Prated,out,FBWhigh for higher supported frequency range.

For frequencies in between FFBWlow and FFBWhigh the rated beam EIRP is:

- Prated,out,FBWlow, for the output whose frequency is within frequency range FFBWlow ≤ f < (FFBWlow +FFBWhigh) / 2,

- Prated,out,FBWhigh, for the output whose frequency is within frequency range (FFBWlow +FFBWhigh) / 2 ≤ f ≤FFBWhigh.

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 transmissionshall 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 | Prated,p,TRP | Prated,p,EIRP |
| Wide Area | (note 1) | (note 1) |
| Local Area | ≤ + 35 + X dBm (Note 2) | ≤ + 55 + X dBm (Note 2) |
| NOTE1: There is no upper limit for the Prated,p,TRP or Prated,p,EIRP of the *repeater type 2-O* UL transmission.  NOTE2: X = 10\*log (ceil (*passband* bandwidth/100MHz)) | | |

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 transmissionshall 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 | Prated,p,TRP | Prated,p,EIRP |
| Wide Area | (note 1) | (note 1) |
| Local Area | ≤ + 35 + X dBm (Note 2) | ≤ + 55 + X dBm (Note 2) |
| NOTE1: There is no upper limit for the Prated,p,TRP or Prated,p,EIRP of the *NCR type 2-O* UL transmission.  NOTE2: X = 10\*log (ceil (*passband* bandwidth/100MHz)) | | |

### 7.2.2 Minimum requirement for NR 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 (Pp,in,EIRP) that produces the *rated passband TRP output power* (Prated,p,TRP)

Up to:

The lowest input power (Pp,in,EIRP) that produces the *rated passband TRP output power* (Prated,p,TRP), plus 10dB

In normal conditions, the measured output power, Pmax,p,EIRP shall remain within +3.4 dB and -3.4 dB of the *rated beam EIRP output power* Prated,p,EIRP, declared by the manufacturer.

In extreme conditions, the measured output power, Pmax,p,,EIRP shall remain within +4.5 dB and -4.5 dB of the *rated beam EIRP output power* Prated,p,EIRP, declared by the manufacturer.

In normal conditions, the *repeater type 2-O* *maximum passband TRP output power*, Pmax,p,TRP measured at the RIB shall remain within ±3 dB of the *rated passband TRP output power* Prated,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 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 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 (Pp,in,EIRP) that produces the *rated passband TRP output power* (Prated,p,TRP)

Up to:

- The lowest input power (Pp,in,EIRP) that produces the *rated passband TRP output power* (Prated,p,TRP), plus 10dB

In normal conditions, the measured output power, Pmax,p,EIRP shall remain within +3.4 dB and -3.4 dB of the *rated beam EIRP output power* Prated,p,EIRP, declared by the manufacturer.

In extreme conditions, the measured output power, Pmax,p,,EIRP shall remain within +4.5 dB and -4.5 dB of the *rated beam EIRP output power* Prated,p,EIRP, declared by the manufacturer.

In normal conditions, the *repeater type 2-O* *maximum passband TRP output power*, Pmax,p,TRP measured at the RIB shall remain within ±3 dB of the *rated passband TRP output power* Prated,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 NR repeater

The frequency deviation of the output signal with respect to the input signal shall be no more than ±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 ±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 NR 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\*Minimum {400MHz, *passband* BW}  f\_offset\_CW < 150 MHz | 68 dB |
| 150 MHz  f\_offset\_CW < 400 MHz | 55 dB |
| 400 MHz  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 ΔfOBUE. The value of ΔfOBUE are defined in table 7.5.1-1and 7.5.1-2 for *repeater type 2-O* for NR *operating bands*.

Table 7.5.1-1: Maximum offset ΔfOBUE outside the downlink *operating band* for *repeater type 2-O and NCR-Fwd type 2-O DL*

|  |  |  |
| --- | --- | --- |
| Repeater type | *Operating band* characteristics | ΔfOBUE (MHz) |
| Repeater type 2-O  NCR-Fwd type 2-O | FDL,high – FDL,low ≤ 4000 MHz | 1500 |

Table 7.5.1-2: Maximum offset ΔfOBUE outside the downlink *operating band* for *repeater type 2-O and NCR-Fwd type 2-O UL*

|  |  |  |
| --- | --- | --- |
| Repeater type | *Operating band* characteristics | ΔfOBUE (MHz) |
| Repeater type 2-O, NCR-Fwd type 2-O | FUL,high – FUL,low ≤ 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 *NR 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, 7.5.5.2-3a, 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 BWNominal (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 | BWNominal/2 | NR of same BW (Note 2) | Square (BWConfig) | 28 (Note 3)  26 (Note 4) |
| NOTE 1: BWNominal is the *nominal channel bandwidth.*BWConfigis the *transmission bandwidth configuration* assumed for the adjacent channel.  NOTE 2: With SCS that provides the largest *transmission bandwidth configuration* (BWConfig).  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 | | | | |

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Repeater nominal channel bandwidth BWNominal (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 | BWNominal/2 | NR of same BW (Note 2) | Square (BWConfig) | 17 (Note 3)  16 (Note 4) |
| NOTE 1: BWNominal is the *nominal channel bandwidth.*BWConfigis the *transmission bandwidth configuration* assumed for the adjacent channel.  NOTE 2: With SCS that provides the largest *transmission bandwidth configuration* (BWConfig).  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 | | | | |

**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 BWNominal (MHz) | Gap between passbands size (Wgap) 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 | Wgap≥ 100 (Note 5)  Wgap≥ 250 (Note 6) | 25 MHz | 50 MHz NR (Note 2) | Square (BWConfig) | 28 (Note 3)  26 (Note 4) |
| 50, 100, 200, 400 | Wgap≥ 400 (Note 6)  Wgap≥ 250 (Note 5) | 100 MHz | 200 MHz NR (Note 2) | Square (BWConfig) | 28 (Note 3)  26 (Note 4) |
| NOTE 1: BWNominal is the *nominal channel bandwidth.*BWConfigis the *transmission bandwidth configuration* assumed for the adjacent channel.  NOTE 2: With SCS that provides the largest *transmission bandwidth configuration* (BWConfig).  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 ≤ 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 BWNominal  (MHz) | Gap between passbands size (Wgap) 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 | Wgap≥ 100 (Note 5)  Wgap≥ 250 (Note 6) | 25 MHz | 50 MHz NR (Note 2) | Square (BWConfig) | 17 (Note 3)  16 (Note 4) |
| 50, 100, 200, 400 | Wgap≥ 400 (Note 6)  Wgap≥ 250 (Note 5) | 100 MHz | 200 MHz NR (Note 2) | Square (BWConfig) | 17 (Note 3)  16 (Note 4) |
| NOTE 1: BWConfig is the *transmission bandwidth configuration* assumed for the adjacent channel.  NOTE 2: With SCS that provides the largest *transmission bandwidth configuration* (BWConfig).  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 ≤ 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 BWNominal (MHz) | Gap between passbands size (Wgap) 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 ≤Wgap< 100 (Note 5)  50 ≤Wgap< 250 (Note 6) | 25 MHz | 50 MHz NR (Note 2) | Square (BWConfig) | 28 (Note 3)  26 (Note 4) |
| 50, 100, 200, 400 | 200 ≤Wgap< 400 (Note 6)  200 ≤Wgap< 250 (Note 5) | 100 MHz | 200 MHz NR (Note 2) | Square (BWConfig) | 28 (Note 3)  26 (Note 4) |
| NOTE 1: BWConfig is the *transmission bandwidth configuration* assumed for the adjacent channel.  NOTE 2: With SCS that provides the largest *transmission bandwidth configuration* (BWConfig).  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 ≤ 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 BWNominal  (MHz) | Gap between passbands size (Wgap) 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 ≤Wgap< 100 (Note 5)  50 ≤Wgap< 250 (Note 6) | 25 MHz | 50 MHz NR (Note 2) | Square (BWConfig) | 17 (Note 3)  16 (Note 4) |
| 50, 100, 200, 400 | 200 ≤Wgap< 400 (Note 6)  200 ≤Wgap< 250 (Note 5) | 100 MHz | 200 MHz NR (Note 2) | Square (BWConfig) | 17 (Note 3)  16 (Note 4) |
| NOTE 1: BWConfig is the *transmission bandwidth configuration* assumed for the adjacent channel.  NOTE 2: With SCS that provides the largest *transmission bandwidth configuration* (BWConfig).  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 ≤ 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 *transmission bandwidth configuration* |

#### 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 NR 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 ΔfOBUE below the lowest frequency of each supported downlink *operating band* up to ΔfOBUE above the highest frequency of each supported downlink *operating band*.

The values of ΔfOBUE 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 (ΔfOBUE) 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:

- Δf is the separation between the *passband* edge frequency and the nominal -3dB point of the measuring filter closest to the *passband* edge.

- f\_offset is the separation between the *passband* edge frequency and the centre of the measuring filter.

- f\_offsetmax is the offset to the frequency ΔfOBUE outside thedownlink *operating band*, where ΔfOBUE is defined in table 7.5.1-1 and 7.5.1-2..

- Δfmax is equal to f\_offsetmax 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:

- Δf 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\_offset is the separation between the *sub-block* edge frequency and the centre of the measuring filter.

- f\_offsetmax is equal to the *gap between passbands* bandwidth minus half of the bandwidth of the measuring filter.

- Δfmax is equal to f\_offsetmax 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, Δf** | **Frequency offset of measurement filter centre frequency, f\_offset** | **Limit** | ***Measurement bandwidth*** |
| 0 MHz ≤ Δf < 0.1\*BWcontiguous | 0.5 MHz ≤ f\_offset < 0.1\* BWcontiguous +0.5 MHz | Min(-5 dBm, Max(Prated,t,TRP – 35 dB, -12 dBm)) | 1 MHz |
| 0.1\*BWcontiguous ≤ Δf < Δfmax | 0.1\* BWcontiguous +0.5 MHz ≤ f\_offset < f\_ offsetmax | Min(-13 dBm, Max(Prated,t,TRP – 43 dB, -20 dBm)) | 1 MHz |
| NOTE 1: For *non-contiguous spectrum* operation within any *operating band* the limitwithin *gaps between passbands* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* on each side of the *gap between passbands*. | | | |

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, Δf** | **Frequency offset of measurement filter centre frequency, f\_offset** | **Limit** | ***Measurement bandwidth*** |
| 0 MHz ≤ Δf < 0.1\*BWcontiguous | 0.5 MHz ≤ f\_offset < 0.1\* BWcontiguous +0.5 MHz | Min(-5 dBm, Max(Prated,t,TRP – 33 dB, -12 dBm)) | 1 MHz |
| 0.1\*BWcontiguous ≤ Δf < Δfmax | 0.1\* BWcontiguous +0.5 MHz ≤ f\_offset < f\_ offsetmax | Min(-13 dBm, Max(Prated,t,TRP – 41 dB, -20 dBm)) | 1 MHz |
| NOTE 1: For *non-contiguous spectrum* operation within any *operating band* the limitwithin *gaps between passbands* is calculated as a cumulative sum of contributions from adjacent *sub-blocks* on each side of the *gap between passbands*. | | | |

##### 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, Δf** | **Frequency offset of measurement filter centre frequency, f\_offset** | **Limit** | ***Measurement bandwidth*** |
| 0 MHz ≤ Δf < 0.1\*BWcontiguous | 0.5 MHz ≤ f\_offset < 0.1\* BWcontiguous +0.5 MHz | Min(-5 dBm, Max(Prated,t,TRP – 35 dB, -12 dBm)) | 1 MHz |
| 0.1\*BWcontiguous ≤ Δf < ΔfB | 0.1\* BWcontiguous +0.5 MHz ≤ f\_offset < ΔfB +0.5 MHz | Min(-13 dBm, Max(Prated,t,TRP – 43 dB, -20 dBm)) | 1 MHz |
| ΔfB ≤ Δf < Δfmax | ΔfB +5 MHz ≤ f\_offset < f\_ offsetmax | Min(-5 dBm, Max(Prated,t,TRP – 33 dB, -10 dBm)) | 10 MHz |
| NOTE 1: For non-contiguous spectrum operation within any *operating band* the limitwithin gaps between *passbands* is calculated as a cumulative sum of contributions from adjacent sub-blocks on each side of the gap between *passbands*.  NOTE 2: ΔfB = 2\*BWcontiguous when BWcontiguous ≤ 500 MHz, otherwise ΔfB = BWcontiguous + 500 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, Δf** | **Frequency offset of measurement filter centre frequency, f\_offset** | **Limit** | ***Measurement bandwidth*** |
| 0 MHz ≤ Δf < 0.1\*BWcontiguous | 0.5 MHz ≤ f\_offset < 0.1\* BWcontiguous +0.5 MHz | Min(-5 dBm, Max(Prated,t,TRP – 33 dB, -12 dBm)) | 1 MHz |
| 0.1\*BWcontiguous ≤ Δf < ΔfB | 0.1\* BWcontiguous +0.5 MHz ≤ f\_offset < ΔfB +0.5 MHz | Min(-13 dBm, Max(Prated,t,TRP – 41 dB, -20 dBm)) | 1 MHz |
| ΔfB ≤ Δf < Δfmax | ΔfB +5 MHz ≤ f\_offset < f\_ offsetmax | Min(-5 dBm, Max(Prated,t,TRP – 31 dB, -10 dBm)) | 10 MHz |
| NOTE 1: For non-contiguous spectrum operation within any *operating band* the limitwithin gaps between *passbands* is calculated as a cumulative sum of contributions from adjacent sub-blocks on each side of the gap between *passbands*.  NOTE 2: ΔfB = 2\*BWcontiguous when BWcontiguous ≤ 500 MHz, otherwise ΔfB = BWcontiguous + 500 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 table7.5.3.2.4.1-2.

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.  NOTE 2: This limit applies to repeater brought into use after 1 September 2027. | | |

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 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 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 *NR repeater*

##### 7.5.4.2.1 General

For *repeater type 2-O*, the OTA transmitter spurious emission limits apply from 30 MHz to 2nd harmonic of the upper frequency edge of the downlink *operating band*, excluding the frequency range from ΔfOBUE below the lowest frequency of the downlink *operating band*, up to ΔfOBUE above the highest frequency of the downlink *operating band*, where the ΔfOBUE 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 – 2nd harmonic of the upper frequency edge of the *passband* |  | 1 MHz | Note 1, Note 2 |
| NOTE 1: Bandwidth as in ITU-R SM.329 [5], s4.1  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 ↔ Fstep,1 | -20 dBm | 10 MHz | Note 2 |
| Fstep,1  ↔ Fstep,2 | -15 dBm | 10 MHz | Note 2 |
| Fstep,2 ↔ Fstep,3 | -10 dBm | 10 MHz | Note 2 |
| Fstep,4  ↔ Fstep,5 | -10 dBm | 10 MHz | Note 2 |
| Fstep,5  ↔ Fstep,6 | -15 dBm | 10 MHz | Note 2 |
| Fstep,6 ↔ 2nd harmonic of the upper frequency edge of the *passband* | -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 Fstep,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** | **Fstep,1 (GHz)** | **Fstep,2 (GHz)** | **Fstep,3 (GHz) (Note 2)** | **Fstep,4 (GHz) (Note 2)** | **Fstep,5 (GHz)** | **Fstep,6 (GHz)** |
| n258 | 18 | 21 | 22.75 | 29 | 30.75 | 40.5 |
| n259 | 23.5 | 35.5 | 38 | 45 | 47.5 | 59.5 |
| NOTE 1: Fstep,X are based on ERC Recommendation 74-01 [9], Annex 2.  NOTE 2: Fstep,3 and Fstep,4 are aligned with the values for ΔfOBUE 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.  NOTE 2: This limit applies to Repeater brought into use after 1 September 2027. | | | |

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 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 *NR 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 ↔ Fstep,1 | -20 dBm | 10 MHz | Note 2 |
| Fstep,1  ↔ Fstep,2 | -15 dBm | 10 MHz | Note 2 |
| Fstep,2 ↔ Fstep,3 | -10 dBm | 10 MHz | Note 2 |
| Fstep,4  ↔ Fstep,5 | -10 dBm | 10 MHz | Note 2 |
| Fstep,5  ↔ Fstep,6 | -15 dBm | 10 MHz | Note 2 |
| Fstep,6 ↔ 2nd harmonic of the upper frequency edge of the UL *operating band* | -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 Fstep,X are defined in table 7.5.5.3-2.  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 | Fstep,1 (GHz) | Fstep,2 (GHz) | Fstep,3 (GHz) | Fstep,4 (GHz) | Fstep,5 (GHz) | Fstep,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 *NR 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 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 (Prated,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 1 | 256QAM 2 | Up to 16 QAM | 64QAM 1 | 256QAM 2 |
| WA, MR, LA | -77- GRX\_ANT | -73- GRX\_ANT | -66- GRX\_ANT | -75- GRX\_ANT | -71- GRX\_ANT | -64- GRX\_ANT |
| Note 1: support of 64QAM is based on the declaration  Note 2: support of 256QAM is based on the declaration | | | | | | |

Where GRX\_ANT is the gain of the receive side antennas and is estimated based on the 3dB gain RoAoA and a formula, GRX\_ANT = 44.1 - 10\*log10(BeWθ,REFSENS\*BeWφ,REFSENS) dB.

#### 7.6.1.2 Minimum requirement for NR 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 % 1 |
| 256QAM | 3.5 % 2 |
| 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 is 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 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 (Prated,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 1 | Up to 16 QAM | 64QAM1 |
| WA, LA | -77- GRX\_ANT | -73- GRX\_ANT | -75- GRX\_ANT | -71- GRX\_ANT |
| Note 1: support of 64QAM is based on the declaration | | | | |

Where GRX\_ANT is the gain of the receive side antennas and is estimated based on the 3dB gain RoAoA and a formula, GRX\_ANT = 44.1 - 10\*log10(BeWθ,REFSENS\*BeWφ,REFSENS) dB.

#### 7.6.2.2 Minimum requirement for NR 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 1 |
| 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 NR 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 NR 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:

- f1 offset is the offset from the channel edge frequency of the first or last channel in the *passband* of the closer carrier.

- GRX\_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

|  |  |  |  |
| --- | --- | --- | --- |
| f1 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 NR 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. In normal conditions the 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 *passband* (MHz) | ACRR limit (dB) |
| NR | Wide Area repeater | BWNominal/2 | 28 (Note 2)  26 (Note 3) |
| Medium Range repeater | BWNominal/2 | 28 (Note 2)  26 (Note 3) |
| Local Area repeater | BWNominal/2 | 28 (Notes 1, 2)  26 (Note 1, 3) |
| NOTE 1: This requirement does not applicable if the *passband* occupies the entire *operating band*.  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. In normal conditions the 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 *passband* (MHz) | ACRR limit (dB) |
| NR | Wide Area repeater | BWNominal/2 | 28 (Note 2)  26 (Note 3) |
| Local Area repeater | BWNominal/2 | 17 (Note 1, 2)  16 (Note 1, 3) |
| NOTE 1: This requirement does not applicable if the *passband* occupies the entire *operating band*.  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 *passband* (MHz) | ACRR limit (dB) |
| NR | Wide Area repeater | BWNominal/2 | 28 (Note 2)  26 (Note 3) |
| Medium Range repeater | BWNominal/2 | 28 (Note 2)  26 (Note 3) |
| Local Area repeater | BWNominal/2 | 28 (Notes 1, 2)  26 (Note 1, 3) |
| NOTE 1: This requirement is not applicable if the *passband* occupies the entire *operating band*.  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 *passband* (MHz) | ACRR limit (dB) |
| NR | Wide Area repeater | BWNominal/2 | 28 (Note 2)  26 (Note 3) |
| Local Area repeater | BWNominal/2 | 17 (Note 1, 2)  16 (Note 1, 3) |
| NOTE 1: This requirement is not applicable if the *passband* occupies the entire *operating band*.  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 µs filtered with a square filter of bandwidth equal to the *passband bandwidth* of the repeater (BWpassband ) centred on the assigned channel frequency during the *transmitter OFF state*. N = 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 NR 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).

Table7.9.2.3.2.1-1: 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 tra*nsmitter 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 NR 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

### 7.10.1 General

### 7.10.2 Minimum requirement for NCR-MT

## 7.11 OTA transmit signal quality

### 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

### 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

### 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

### 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

### 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

### 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 spurious emissions

### 7.17.1 General

The spurious emissions power is the power of emissions generated or amplified in a receiver. The 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.

# 8 (Reserved)

# 9 (Reserved)

# 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 Tre-establish\_delay seconds from the moment it detects a loss in RRC connection. The total RRC connection delay (Tre-establish\_delay) shall be less than:

TUL\_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 (TNCR-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 (TNCR-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 (TNCR-MT\_re-establish\_delay) requirement shall be less than:

The intra-frequency target NR cell shall be considered detectable if each relevant SSB can satisfy that:

- the conditions of SSB\_RP and SSB Ês/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 Ês/Iot according to Annex TBD for the LA NCR-MT class and NCR type are fulfilled.

Tidentify\_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 Tidentify\_intra\_NR=0; otherwise Tidentify\_intra\_NR shall not exceed the values defined in Table 10.1.1.2.1-1.

Tidentify\_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. Tidentify\_inter\_NR,i shall not exceed the values defined in Table 10.1.1.2.1-2.

TSMTC: 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 TSMTC follows *smtc1* or *smtc2* according to the physical cell ID of the target cell.

TSMTC,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.

TSI-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.

TPRACH: It is the delay uncertainty in acquiring the first available PRACH occasion in the target NR cell. TPRACH 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].

Nfreq: It is the total number of NR frequencies to be monitored for RRC re-establishment; Nfreq = 1 if the target intra-frequency NR cell is known, else Nfreq = 2 and Tidentify\_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 Ês/Iot (dB) | Frequency range (FR) of target NR cell | Tidentify\_intra\_NR [ms] | |
| Known NR cell | Unknown NR cell |
| ≥ -8 | FR1 | MAX (1600 ms, 40 x TSMTC) | MAX (6400 ms, 80 x TSMTC) |
| ≥ -8 | FR2-1 | N/A | MAX (8000 ms, 640 x TSMTC) |
| < -8 | FR1 | N/A | 6400Note1 |
| < -8 | FR2-1 | N/A | 28160Note1 |
| Note 1: The NCR-MT is not required to successfullyidentify a cell on any NR frequency layer when TSMTC >20 ms and serving cell SSB Ês/Iot < -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 Ês/Iot (dB) | Frequency range (FR) of target NR cell | Tidentify\_inter\_NR, i [ms] | |
| Known NR cell | Unknown NR cell |
| ≥ -8 | FR1 | MAX (1600 ms, 48 x TSMTC, i) | MAX (6400 ms, 104 x TSMTC, i) |
| ≥ -8 | FR2-1 | N/A | MAX (8000 ms, 832 x TSMTC, i) |
| < -8 | FR1 | N/A | 6400Note1 |
| < -8 | FR2-1 | N/A | 32000Note1 |
| Note 1: The NCR-MT is not required to successfully identify a cell on any NR frequency layer when TSMTC,i >20 ms and serving cell SSB Ês/Iot < -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 PDCCH 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 preamblewith 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.

10.1.2.2.2.3 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 before the reception of the first detected path (in time) of the corresponding downlink frame from the reference cell. NCR-MT belonging to local area NCR-MT class as defined in clause 4.3A.2 shall use the SpCell 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 NCR-MT initial transmission timing error shall be less than or equal to ±Te where the timing error limit value Te 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 Te 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 . 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.

 (in *Tc* 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 ofdepends on the duplex mode of the cell in which the uplink transmission takes place and the frequency range (FR). is defined in Table 10.2.1.2-2.

Table 10.2.1.2-1: Te Timing Error Limit

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | SCS of SSB signals ( kHz) | SCS of uplink signals ( kHz) | Te |
| 1 | 15 | 15 | 12\*64\*Tc |
|  |  | 30 | 10\*64\*Tc |
|  |  | 60 | 10\*64\*Tc |
|  | 30 | 15 | 8\*64\*Tc |
|  |  | 30 | 8\*64\*Tc |
|  |  | 60 | 7\*64\*Tc |
| 2-1 | 120 | 60 | 3.5\*64\*Tc |
|  |  | 120 | 3.5\*64\*Tc |
|  | 240 | 60 | 3\*64\*Tc |
|  |  | 120 | 3\*64\*Tc |
| Note 1: Tc is the basic timing unit defined in TS 38.211 [26] | | | |

Table 10.2.1.2-2: The Value of 

|  |  |
| --- | --- |
| Frequency range and band of cell used for uplink transmission | (Unit: TC) |
| 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  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  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 ±Te then the NCR-MT is required to adjust its timing to within ±Te. The reference timing shall be  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 Tq.

2) The minimum aggregate adjustment rate shall be Tp per second.

3) The maximum aggregate adjustment rate shall be Tq per 200 ms.

where the maximum autonomous time adjustment step Tq and the aggregate adjustment rate Tp are specified in Table 10.2.1.2.1-1.

Table 10.2.1.2.1-1: Tq Maximum Autonomous Time Adjustment Step and Tp Minimum Aggregate Adjustment rate

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | SCS of uplink signals (kHz) | Tq | Tp |
| 1 | 15 | 5.5\*64\*Tc | 5.5\*64\*Tc |
|  | 30 | 5.5\*64\*Tc | 5.5\*64\*Tc |
|  | 60 | 5.5\*64\*Tc | 5.5\*64\*Tc |
| 2-1 | 60 | 2.5\*64\*Tc | 2.5\*64\*Tc |
|  | 120 | 2.5\*64\*Tc | 2.5\*64\*Tc |
| NOTE: Tc 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 | ± 0.1s |
| timer value ≥ 4 | ± 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].

#### 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 |
| UE Timing Advance adjustment accuracy | ±256 Tc | ±256 Tc | ±128 Tc | ±32 Tc |
| NOTE: Tc 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 8.1 apply for radio link monitoring 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 Qout and Qin for the purpose of monitoring downlink radio link quality of the cell.

The threshold Qout 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 (BLERout) as defined in Table 10.3.1-1. For SSB based radio link monitoring, Qout\_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, Qout\_CSI-RS is derived based on the hypothetical PDCCH transmission parameters listed in Table 10.3.1.3.1-1.

The threshold Qin is defined as the level at which the downlink radio link quality can be received with significantly higher reliability than at Qout and shall correspond to the in-sync block error rate (BLERin) as defined in Table 10.3.1-1. For SSB based radio link monitoring, Qin\_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, Qin\_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 (BLERout) and in-sync block error rate (BLERin) 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 | BLERout | BLERin |
| 0 | 10% | 2% |

NCR-MT shall be able to monitor up to NRLM RLM-RS resources of the same or different types in each corresponding carrier frequency range, depending on a maximum number  of SSBs per half frame according to TS 38.213 [24], where NRLM 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 NRLM

|  |  |  |
| --- | --- | --- |
| Carrier frequency range of PCell |  | Maximum number of RLM-RS resources, NRLM |
| FR1, ≤ 3 GHzNote | 4 | 2 |
| FR1, > 3 GHzNote | 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 TEvaluate\_out\_SSB [ms] period becomes worse than the threshold Qout\_SSB within TEvaluate\_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 TEvaluate\_in\_SSB [ms] period becomes better than the threshold Qin\_SSB within TEvaluate\_in\_SSB [ms] evaluation period.

TEvaluate\_out\_SSB and TEvaluate\_in\_SSB are defined in Table 10.3.1.2.2-1 for FR1 with scaling factor K1 = 5.

TEvaluate\_out\_SSB and TEvaluate\_in\_SSB are defined in Table 10.3.1.2.2-2 for FR2-1 with scaling factor N=8 and K2 = 3.

For FR1,

- P = 1

For FR2-1,

- P=1, when the RLM-RS resource is not overlapped with SMTC occasion.

- , when the RLM-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P = 3, when RLM-RS resource is fully overlapped with SMTC period (TSSB = TSMTCperiod).

If the high layer in TS 38.331 [23] signaling of smtc2 is present, TSMTCperiod follows smtc2; Otherwise TSMTCperiod follow smtc1.

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 TEvaluate\_out\_SSB and TEvaluate\_in\_SSB for FR1

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_SSB (ms) | TEvaluate\_in\_SSB (ms) |
| no DRX | Max(200 × K1, Ceil(10 × P × K1) × TSSB) | Max(100 × K1, Ceil(5 × P × K1) × TSSB) |
| NOTE: TSSB is the periodicity of the SSB configured for RLM. | | |

Table 10.3.1.2.2-2: Evaluation period TEvaluate\_out\_SSB and TEvaluate\_in\_SSB for FR2-1

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_SSB (ms) | TEvaluate\_in\_SSB (ms) |
| no DRX | Max(200 × K2, Ceil(10 × P × N × K2) × TSSB) | Max(100 × K2, Ceil(5 × P × N × K2) × TSSB) |
| NOTE: TSSB 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 TEvaluate\_out\_CSI-RS [ms] period becomes worse than the threshold Qout\_CSI-RS within TEvaluate\_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 TEvaluate\_in\_CSI-RS [ms] period becomes better than the threshold Qin\_CSI-RS within TEvaluate\_in\_CSI-RS [ms] evaluation period.

- TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS are defined in Table 10.3.1.3.2-1 for FR1 with scaling factor K1 = 5.

- TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS are defined in Table 10.3.1.3.2-2 for FR2-1 with scaling factor K2 = 3.

The requirements of TEvaluate\_out\_CSI-RS and TEvaluate\_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.

- , when the RLM-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod).

- P = 3, when the RLM-RS resource is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod).

If the high layer in TS 38.331 [23] signaling of smtc2 is present, TSMTCperiod follows smtc2; Otherwise TSMTCperiod follow smtc1.

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 Mout and Min used in Table 10.3.1.3.2-1 and Table 10.3.1.3.2-2 are defined as:

- Mout = 20 and Min = 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 ≥ 24 PRBs.

Table 10.3.1.3.2-1: Evaluation period TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS for FR1

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_CSI-RS (ms) | TEvaluate\_in\_CSI-RS (ms) |
| no DRX | Max(200 × K1, Ceil(Mout×P × K1)×TCSI-RS) | Max(100 × K1, Ceil(Min×P × K1) × TCSI-RS) |
| NOTE: TCSI-RS is the periodicity of the CSI-RS resource configured for RLM. The requirements in this table apply for TCSI-RS equal to 5 ms, 10ms, 20 ms or 40 ms. | | |

Table 10.3.1.3.2-2: Evaluation period TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS for FR2-1

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_CSI-RS (ms) | TEvaluate\_in\_CSI-RS (ms) |
| no DRX | Max(200 × K2, Ceil(Mout×P × K2)×TCSI-RS) | Max(100 × K2, Ceil(Min×P × K2) × TCSI-RS) |
| NOTE: TCSI-RS is the periodicity of the CSI-RS resource configured for RLM. The requirements in this table apply for TCSI-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 Qout, 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 Qin, 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 TIndication\_interval.

TIndication\_interval is max(10ms, TRLM-RS,M), where TRLM,M is the shortest periodicity of all configured RLM-RS resources for the monitored cell, which corresponds to TSSB specified in clause 10.3.1.2 if the RLM-RS resource is SSB, or TCSI-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 NCR-MT shall assess the downlink radio link quality of a serving cell based on the reference signal in the set  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  on PCell can be periodic CSI-RS resources and/or SSBs. RS resource configuration in the set  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 .

On each RS resource configuration in the set , the NCR-MT shall estimate the radio link quality and compare it to the threshold Qout\_LR for the purpose of accessing downlink radio link quality of the serving cell beams.

The threshold Qout\_LR is defined as the level at which the downlink radio level link of a given resource configuration on set  cannot be reliably received and shall correspond to the BLERout = 10% block error rate of a hypothetical PDCCH transmission. For SSB based beam failure detection, Qout\_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, Qout\_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 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 Qin\_LR, which is indicated by higher layer parameter *rsrp-ThresholdSSB*. The NCR-MT applies the Qin\_LR threshold to the L1-RSRP measurement obtained from an SSB. The NCR-MT applies the Qin\_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  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  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  estimated over the last TEvaluate\_BFD\_SSB ms period becomes worse than the threshold Qout\_LR\_SSB within TEvaluate\_BFD\_SSB ms period.

The value of TEvaluate\_BFD\_SSB is defined in Table 10.3.2.2.2-1 for FR1.

The value of TEvaluate\_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.

- , when the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P = 3, when the BFD-RS resource is fully overlapped with SMTC period (TSSB = TSMTCperiod).

If the high layer in TS 38.331 [23] signaling of smtc2 is present, TSMTCperiod follows smtc2; Otherwise TSMTCperiod follow smtc1.

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 TEvaluate\_BFD\_SSB for FR1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_SSB (ms) |
| no DRX | Max(50, Ceil(5 × P) × TSSB) |
| Note: TSSB is the periodicity of SSB in the set . | |

Table 10.3.2.2.2-2: Evaluation period TEvaluate\_BFD\_SSB for FR2-1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_SSB (ms) |
| no DRX | Max(50, Ceil(5 × P × N) × TSSB) |
| Note: TSSB is the periodicity of SSB in the set . | |

##### 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  of resource configurations for a serving cell, provided that the CSI-RS resource(s) in set 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  estimated over the last TEvaluate\_BFD\_CSI-RS ms period becomes worse than the threshold Qout\_LR\_CSI-RS within TEvaluate\_BFD\_CSI-RS ms period.

The value of TEvaluate\_BFD\_CSI-RS is defined in Table 10.3.2.3.2-1 for FR1.

The value of TEvaluate\_BFD\_CSI-RS is defined in Table 10.3.2.3.2-2 for FR2-1 with N=1.

The requirements of TEvaluate\_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.

- , when the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod).

- P = Psharing factor, when BFD-RS resource is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod).

- Psharing factor = 3**.**

If the high layer in TS 38.331 [23] signaling of smtc2 is present, TSMTCperiod follows smtc2; Otherwise TSMTCperiod follow smtc1.

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 MBFD used in Table 10.3.2.3.2-1 and Table 10.3.2.3.2-2 are defined as

- MBFD = 10, if the CSI-RS resource(s) in set  used for BFD is transmitted with Density = 3.

Table 10.3.2.3.2-1: Evaluation period TEvaluate\_BFD\_CSI-RS for FR1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_CSI-RS (ms) |
| no DRX | Max(50, [MBFD × P] × TCSI-RS) |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . | |

Table 10.3.2.3.2-2: Evaluation period TEvaluate\_BFD\_CSI-RS for FR2-1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_CSI-RS (ms) |
| no DRX | Max(50, [MBFD × P × N] × TCSI-RS) |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . | |

##### 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  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  is worse than Qout\_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  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 TIndication\_interval\_BFD.

TIndication\_interval\_BFD is max(2ms, TSSB-RS,M) ) or max(2ms, TCSI-RS,M), where TSSB-RS,M and TCSI-RS,M is the shortest periodicity of all RS resources in set  for the accessed cell, corresponding to either the shortest periodicity of the SSB in the set  or CSI-RS resource in the set .

#### 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  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  estimated over the last TEvaluate\_CBD\_SSB ms period becomes better than the threshold Qin\_LR provided SSB\_RP and SSB Ês/Iot 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 TEvaluate\_CBD\_SSB is defined in Table 10.3.2.5.2-1 for FR1.

The value of TEvaluate\_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.

- , when candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P = 3, when candidate beam detection RS is fully overlapped with SMTC period (TSSB = TSMTCperiod).

If the high layer in TS 38.331 [23] signaling of smtc2 is present, TSMTCperiod follows smtc2; Otherwise TSMTCperiod follow smtc1.

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 TEvaluate\_CBD\_SSB for FR1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_CBD\_SSB (ms) |
| non-DRX | Ceil(3 × P) × TSSB |
| Note: TSSB is the periodicity of SSB in the set . | |

Table 10.3.2.5.2-2: Evaluation period TEvaluate\_CBD\_SSB for FR2-1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_CBD\_SSB (ms) |
| non-DRX | Ceil(3 × P × N) × TSSB |
| Note: TSSB is the periodicity of SSB in the set . | |

##### 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  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  estimated over the last TEvaluate\_CBD\_CSI-RS [ms] period becomes better than the threshold Qin\_LR within TEvaluate\_CBD\_CSI-RS [ms] period provided CSI-RS Ês/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 TEvaluate\_CBD\_CSI-RS is defined in Table 10.3.2.6.2-1 for FR1.

The value of TEvaluate\_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.

- , when candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod).

- P = 3, when candidate beam detection RS is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod).

If the high layer in TS 38.331 [23] signaling of smtc2 is present, TSMTCperiod follows smtc2; Otherwise TSMTCperiod follow smtc1.

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 MCBD used in Table 10.3.2.6.2-1 and Table 10.3.2.6.2-2 are defined as

- MCBD = 3, if the CSI-RS resource configured in the set  is transmitted with Density = 3.

Table 10.3.2.6.2-1: Evaluation period TEvaluate\_CBD\_CSI-RS for FR1

|  |  |
| --- | --- |
| Configuration | TEvaluateC\_CBD\_CSI-RS (ms) |
| non-DRX | Max(25, Ceil(MCBD × P) × TCSI-RS) |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . | |

Table 10.3.2.6.2-2: Evaluation period TEvaluate\_CBD\_CSI-RS for FR2-1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_CBD\_CSI-RS (ms) |
| non-DRX | Max(25, Ceil(MCBD × P × N) × TCSI-RS) |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . | |

##### 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 mesurement; 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 mesurement.

#### 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.

Annex A (normative):  
Environmental requirements for the Repeater equipment

<Text will be added.>

Annex B (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 |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **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 definitons, 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 |
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| **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 |
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| 2023-12 | RAN#102 | RP-233361 | 0050 |  | B | Big CR to TS 38.106 Introduction of NCR | 18.3.0 |