|  |  |
| --- | --- |
| 3GPP TS 38.101-4 V18.0.0 (2023-06) | |
| Technical Specification | |
| 3rd Generation Partnership Project;  Technical Specification Group Radio Access Network;  NR;  User Equipment (UE) radio transmission and reception;  Part 4: Performance requirements  (Release 18) | |
|  | |
|  | 3GPP-logo_web |
|  | |
| The present document has been developed within the 3rd Generation Partnership Project (3GPP TM) and may be further elaborated for the purposes of 3GPP. The present document has not been subject to any approval process by the 3GPPOrganizational Partners and shall not be implemented. This Specification is provided for future development work within 3GPPonly. The Organizational Partners accept no liability for any use of this Specification. Specifications and Reports for implementation of the 3GPP TM system should be obtained via the 3GPP Organizational Partners' Publications Offices. | |

|  |
| --- |
|  |
| ***3GPP***  Postal address  3GPP support office address  650 Route des Lucioles - Sophia Antipolis  Valbonne - FRANCE  Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16  Internet  http://www.3gpp.org |
| ***Copyright Notification***  No part may be reproduced except as authorized by written permission. The copyright and the foregoing restriction extend to reproduction in all media.  © 2023, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC).  All rights reserved.  UMTS™ is a Trade Mark of ETSI registered for the benefit of its members  3GPP™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners LTE™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners  GSM® and the GSM logo are registered and owned by the GSM Association |

Contents

Foreword 14

1 Scope 16

2 References 16

3.1 Definitions 17

3.2 Symbols 17

3.3 Abbreviations 17

4 General 19

4.1 Relationship between minimum requirements and test requirements 19

4.2 Applicability of minimum requirements 19

4.3 Specification suffix information 19

4.4 Conducted requirements 20

4.4.1 Reference point 20

4.4.2 SNR definition 20

4.4.3 Noc 20

4.4.3.1 Introduction 20

4.4.3.2 Noc for NR operating bands in FR1 20

4.4.3.2.1 Derivation of Noc values for NR operating bands in FR1 21

4.4.4 Es 21

4.4.4.1 Introduction 21

4.4.4.2 Es for NR operating bands in FR1 21

4.4.4.2.1 Derivation of Es values for NR operating bands in FR1 21

4.4.5 SINR definition 22

4.5 Radiated requirements 22

4.5.1 Reference point 22

4.5.2 SNR definition 23

4.5.3 Noc 23

4.5.3.1 Introduction 23

4.5.3.2 Noc for NR operating bands in FR2 23

4.5.3.3 Derivation of Noc values for NR operating bands in FR2 24

4.5.4 Angle of arrival 24

5 Demodulation performance requirements (Conducted requirements) 25

5.1 General 25

5.1.1 Applicability of requirements 25

5.1.1.1 General 25

5.1.1.2 Applicability of requirements for different number of RX antenna ports 25

5.1.1.3 Applicability of requirements for optional UE features 25

5.1.1.4 Applicability of requirements for mandatory UE features with capability signalling 30

5.1.1.5 Applicability of different requirements for HST 33

5.1.1.6 Applicability and test rules for PDSCH performance requirements with power imbalance for intra-band contiguous CA 34

5.1.1.7 Applicability of CA requirements 35

5.1.1.7.1 Definition of CA capability 35

5.1.1.7.2 Applicability and test rules for different CA configurations and bandwidth combination sets 35

5.1.1.7.3 Applicability rule and antenna connection for CA tests with 4 RX 37

5.1.1.7.4 Applicability of different requirements for HST 37

5.1.1.8 Applicability of different requirements with Multi-TRxP 40

5.1.1.9 Applicability of requirements for PDSCH on bands with shared spectrum access 41

5.1.1.10 Applicability of requirements for PDSCH with inter cell interference 41

5.1.1.11 Applicability of requirements for RedCap 41

5.2 PDSCH demodulation requirements 42

5.2.1 1RX requirements 46

5.2.1.1 FDD 46

5.2.1.1.1 Minimum requirements for RedCap 46

5.2.1.2 TDD 47

5.2.1.2.1 Minimum requirements for RedCap 47

5.2.2 2RX requirements 49

5.2.2.1 FDD 49

5.2.2.1.1 Minimum requirements for PDSCH Mapping Type A 49

5.2.2.1.2 Minimum requirements for PDSCH Mapping Type A and CSI-RS overlapped with PDSCH 51

5.2.2.1.3 Minimum requirements for PDSCH Mapping Type B 52

5.2.2.1.4 Minimum requirements for PDSCH Mapping Type A and LTE-NR coexistence 53

5.2.2.1.5 Minimum requirements for PDSCH 0.001% BLER 54

5.2.2.1.6 Minimum requirements for PDSCH repetitions over multiple slots 55

5.2.2.1.7 Minimum requirements for PDSCH Mapping Type B and UE processing capability 2 56

5.2.2.1.8 Minimum requirements for PDSCH pre-emption 57

5.2.2.1.9 Minimum requirements for PDSCH HST-SFN 58

5.2.2.1.10 Minimum requirements for HST-DPS 59

5.2.2.1.11 Minimum requirements for PDSCH Single-DCI based SDM scheme 62

5.2.2.1.12 Minimum requirements for PDSCH Multi-DCI based transmission scheme 65

5.2.2.1.13 Minimum requirements for PDSCH with single-DCI based FDM Scheme A 68

5.2.2.1.14 Minimum requirements for PDSCH with single-DCI based Inter-slot TDM scheme 71

5.2.2.1.15 Minimum requirements for PDSCH with inter-cell interference 74

5.2.2.1.16 Minimum requirements for PDSCH with intra cell inter user interference 76

5.2.2.1.17 Minimum requirements for RedCap 77

5.2.2.1.18 Minimum requirements for PDSCH CRS interference mitigation under NR-LTE coexistence scenario 79

5.2.2.1.19 Minimum requirements for PDSCH with inter cell CRS interference 81

5.2.2.1.20 Minimum requirements for HST-SFN Scheme A 84

5.2.2.1.21 Minimum requirements for HST-SFN Scheme B 87

5.2.2.2 TDD 90

5.2.2.2.1 Minimum requirements for PDSCH Mapping Type A 90

5.2.2.2.2 Minimum requirements for PDSCH Mapping Type A and CSI-RS overlapped with PDSCH 92

5.2.2.2.3 Minimum requirements for PDSCH Mapping Type B 93

5.2.2.2.4 Minimum requirements for PDSCH Mapping Type A and LTE-NR coexistence 94

5.2.2.2.5 Minimum requirements for PDSCH 0.001% BLER 95

5.2.2.2.6 Minimum requirements for PDSCH repetitions over multiple slots 96

5.2.2.2.7 Minimum requirements for PDSCH Mapping Type B and UE processing capability 2 97

5.2.2.2.8 Minimum requirements for PDSCH pre-emption 98

5.2.2.2.9 Minimum requirements for HST-SFN 99

5.2.2.2.10 Minimum requirements for HST-DPS 100

5.2.2.2.11 Minimum requirements for PDSCH Single-DCI based SDM scheme 103

5.2.2.2.12 Minimum requirements for PDSCH Multi-DCI based transmission scheme 106

5.2.2.2.13 Minimum requirements for PDSCH with single-DCI based FDM Scheme A 109

5.2.2.2.14 Minimum requirements for PDSCH with single-DCI based Inter-slot TDM scheme 112

5.2.2.2.15 Minimum requirements for PDSCH of PCell on band with shared spectrum access 115

5.2.2.2.16 Minimum requirements for PDSCH with inter-cell interference 116

5.2.2.2.17 Minimum requirements for PDSCH with intra cell inter user interference 118

5.2.2.2.18 Minimum requirements for RedCap 119

5.2.2.2.19 Minimum requirements for PDSCH CRS interference mitigation under NR-LTE coexistence scenario 121

5.2.2.2.20 Minimum requirements for PDSCH with inter cell CRS interference 122

5.2.2.2.21 Minimum requirements for HST-SFN Scheme A 125

5.2.2.2.22 Minimum requirements for HST-SFN Scheme B 128

5.2.3 4RX requirements 132

5.2.3.1 FDD 132

5.2.3.1.1 Minimum requirements for PDSCH Mapping Type A 132

5.2.3.1.2 Minimum requirements for PDSCH Mapping Type A and CSI-RS overlapped with PDSCH 134

5.2.3.1.3 Minimum requirements for PDSCH Mapping Type B 135

5.2.3.1.4 Minimum requirements for PDSCH Mapping Type A and LTE-NR coexistence 136

5.2.3.1.5 Minimum requirements for PDSCH 0.001% BLER 137

5.2.3.1.6 Minimum requirements for PDSCH repetitions over multiple slots 138

5.2.3.1.7 Minimum requirements for PDSCH Mapping Type B and UE processing capability 2 139

5.2.3.1.8 Minimum requirements for PDSCH pre-emption 140

5.2.3.1.9 Minimum requirements for PDSCH HST-SFN 141

5.2.3.1.10 Minimum requirements for HST-DPS 142

5.2.3.1.11 Minimum requirements for PDSCH Single-DCI based SDM scheme 145

5.2.3.1.12 Minimum requirements for PDSCH Multi-DCI based transmission scheme 148

5.2.3.1.13 Minimum requirements for PDSCH with single-DCI based FDM Scheme A 151

5.2.3.1.14 Minimum requirements for PDSCH with single-DCI based Inter-slot TDM scheme 154

5.2.3.1.15 Minimum requirements for PDSCH with inter-cell interference 157

5.2.3.1.16 Minimum requirements for PDSCH with intra-cell inter-user interference 159

5.2.3.1.17 Minimum requirements for PDSCH CRS interference mitigation under NR-LTE coexistence scenario 161

5.2.3.1.18 Minimum requirements for PDSCH with inter cell CRS interference 163

5.2.3.1.19 Minimum requirements for HST-SFN Scheme A 166

5.2.3.1.20 Minimum requirements for HST-SFN Scheme B 169

5.2.3.2 TDD 172

5.2.3.2.1 Minimum requirements for PDSCH Mapping Type A 172

5.2.3.2.2 Minimum requirements for PDSCH Mapping Type A and CSI-RS overlapped with PDSCH 175

5.2.3.2.3 Minimum requirements for PDSCH Mapping Type B 176

5.2.3.2.4 Minimum requirements for PDSCH Mapping Type A and LTE-NR coexistence 177

5.2.3.2.5 Minimum requirements for PDSCH 0.001% BLER 178

5.2.3.2.6 Minimum requirements for PDSCH repetitions over multiple slots 179

5.2.3.2.7 Minimum requirements for PDSCH Mapping Type B and UE processing capability 2 180

5.2.3.2.8 Minimum requirements for PDSCH pre-emption 181

5.2.3.2.9 Minimum requirements for HST-SFN 182

5.2.3.2.10 Minimum requirements for HST-DPS 183

5.2.3.2.11 Minimum requirements for PDSCH Single-DCI based SDM scheme 186

5.2.3.2.12 Minimum requirements for PDSCH Multi-DCI based transmission scheme 189

5.2.3.2.13 Minimum requirements for PDSCH with single-DCI based FDM Scheme A 192

5.2.3.2.14 Minimum requirements for PDSCH with single-DCI based Inter-slot TDM scheme 195

5.2.3.2.16 Minimum requirements for PDSCH with inter-cell interference 199

5.2.3.2.17 Minimum requirements for PDSCH with intra-cell inter-user interference 202

5.2.3.2.18 Minimum requirements for PDSCH CRS interference mitigation under NR-LTE coexistence scenario 204

5.2.3.2.19 Minimum requirements for PDSCH with inter cell CRS interference 206

5.2.3.2.20 Minimum requirements for HST-SFN Scheme A 209

5.2.3.2.21 Minimum requirements for HST-SFN Scheme B 212

5.2A PDSCH demodulation requirements for CA 216

5.2A.1 1RX requirements 217

5.2A.2 2RX requirements 217

5.2A.2.1 Minimum requirements 217

5.2A.2.2 Minimum requirements for carrier aggregation with power imbalance 219

5.2A.2.3 Minimum requirements for PDSCH of SCell on band with shared spectrum access 220

5.2A.3 4RX requirements 231

5.2A.3.1 Minimum requirements 231

5.2A.3.2 Minimum requirements for carrier aggregation with power imbalance 232

5.2A.3.3 Minimum requirements for PDSCH of SCell on band with shared spectrum access 233

5.2A.3.4 Minimum requirements for HST-SFN CA 234

5.2A.3.5 Minimum requirements for PDSCH HST-DPS CA 237

5.3 PDCCH demodulation requirements 243

5.3.1 1RX requirements 246

5.3.1.1 FDD 246

5.3.1.1.1 Minimum requirements for RedCap 246

5.3.1.2 TDD 247

5.3.1.2.1 Minimum requirements for RedCap 247

5.3.2 2RX requirements 247

5.3.2.1 FDD 247

5.3.2.1.1 1 Tx Antenna performances 247

5.3.2.1.2 2 Tx Antenna performances 248

5.3.2.1.3 Minimum requirements for power saving 248

5.3.2.1.4 Minimum requirements for RedCap 249

5.3.2.1.5 Minimum requirements for PDCCH with intra-slot repetition 249

5.3.2.2 TDD 251

5.3.2.2.1 1 Tx Antenna performances 251

5.3.2.2.2 2 Tx Antenna performances 251

5.3.2.2.3 Minimum requirements for power saving 251

5.3.2.2.4 Minimum requirements for RedCap 252

5.3.2.2.5 Minimum requirements for PDCCH with intra-slot repetition 252

5.3.3 4RX requirements 254

5.3.3.1 FDD 254

5.3.3.1.1 1 Tx Antenna performances 254

5.3.3.1.2 2 Tx Antenna performances 254

5.3.3.1.3 Minimum requirements for power saving 254

5.3.3.1.4 Minimum requirements for PDCCH with intra-slot repetition 255

5.3.3.2 TDD 257

5.3.3.2.1 1 Tx Antenna performances 257

5.3.3.2.2 2 Tx Antenna performances 257

5.3.3.2.3 Minimum requirements for power saving 257

5.3.3.2.4 Minimum requirements for PDCCH with intra-slot repetition 258

5.4 PBCH demodulation requirements 260

5.4.1 1RX requirements 260

5.4.1.1 FDD 260

5.4.1.2 TDD 260

5.4.2 2RX requirements 261

5.4.2.1 FDD 261

5.4.2.2 TDD 261

5.4.3 4RX requirements 262

5.4.3.1 FDD 262

5.4.3.2 TDD 263

5.5 Sustained downlink data rate provided by lower layers 263

5.5.1 FR1 single carrier requirements 263

5.5A Sustained downlink data rate provided by lower layers 264

5.5A.1 FR1 CA requirements 264

5.6 PDSCH absolute physical layer throughput requirements 270

5.6.1 1RX requirements 270

5.6.2 2RX requirements 270

5.6.2.1 FDD 270

5.6.2.1.1 Minimum requirements with Link Adaptation 270

5.6.2.2 TDD 272

5.6.2.2.1 Minimum requirements with Link Adaptation 272

5.6.3 4Rx requirements 273

5.6.3.1 FDD 273

5.6.3.1.1 Minimum requirements with Link Adaptation 273

5.6.3.2 TDD 275

5.6.3.2.1 Minimum requirements with Link Adaptation 275

6 CSI reporting requirements (Conducted requirements) 271

6.1 General 271

6.1.1 Applicability of requirements 271

6.1.1.1 General 271

6.1.1.2 Applicability of requirements for different number of RX antenna ports 271

6.1.1.3 Applicability of requirements for optional UE features 271

6.1.1.4 Applicability of requirements for mandatory UE features with capability signalling 272

6.1.1.5 Applicability of Channel Quality Indicator (CQI) reporting requirements for CA 273

6.1.1.5.1 Applicability and test rules for different duplex modes and SCS combinations 273

6.1.1.5.2 Applicability and test rules for different CA configurations and bandwidth combination sets 273

6.1.1.5.3 Test coverage for different number of componenet carriers 274

6.1.1.5.4 Applicability rule and antenna connection for CA tests with 4 RX 274

6.1.1.6 Applicability of requirements for RedCap 274

6.1.2 Common test parameters 274

6.2 Reporting of Channel Quality Indicator (CQI) 279

6.2.1 1RX requirements 279

6.2.1.1 FDD 279

6.2.1.1.1 CQI reporting definition under AWGN conditions 279

6.2.1.1.1.1 Minimum requirement for periodic CQI reporting for RedCap 279

6.2.1.1.2 CQI reporting under fading conditions 281

6.2.1.2 TDD 283

6.2.1.2.1 CQI reporting definition under AWGN conditions 283

6.2.1.2.2 CQI reporting under fading conditions 285

6.2.2 2RX requirements 287

6.2.2.1 FDD 287

6.2.2.1.1 CQI reporting definition under AWGN conditions 287

6.2.2.1.1.1 Minimum requirement for periodic CQI reporting 287

6.2.2.1.1.2 Minimum requirement for periodic CQI reporting with Table 3 288

6.2.2.1.1.3 Minimum requirement for periodic CQI reporting with Table 4 290

6.2.2.1.1.4 Minimum requirement for periodic CQI reporting for RedCap 291

6.2.2.1.2 CQI reporting under fading conditions 294

6.2.2.1.2.1 Minimum requirement for wideband CQI reporting 294

6.2.2.1.2.2 Minimum requirement for sub-band CQI reporting 296

6.2.2.1.2.3 Minimum requirement for wideband CQI reporting with inter-cell interference 299

6.2.2.1.2.4 Minimum requirement for wideband CQI reporting for RedCap 302

6.2.2.2 TDD 304

6.2.2.2.1 CQI reporting definition under AWGN conditions 304

6.2.2.2.1.1 Minimum requirement for periodic CQI reporting 304

6.2.2.2.1.2 Minimum requirement for periodic CQI reporting with Table 3 306

6.2.2.2.1.3 Minimum requirement for CQI reporting for PCell on band with shared spectrum access 307

6.2.2.2.1.4 Minimum requirement for periodic CQI reporting with Table 4 309

6.2.2.2.1.5 Minimum requirement for periodic CQI reporting for RedCap 311

6.2.2.2.2 CQI reporting under fading conditions 313

6.2.2.2.2.1 Minimum requirement for wideband CQI reporting 313

6.2.2.2.2.2 Minimum requirement for sub-band CQI reporting 315

6.2.2.2.2.3 Minimum requirement for wideband CQI reporting with inter-cell interference 318

6.2.2.2.2.4 Minimum requirement for wideband CQI reporting for RedCap 321

6.2.3 4RX requirements 323

6.2.3.1 FDD 323

6.2.3.1.1 CQI reporting definition under AWGN conditions 323

6.2.3.1.1.1 Minimum requirement for period CQI reporting 323

6.2.3.1.1.2 Minimum requirement for period CQI reporting with Table 3 324

6.2.3.1.1.3 Minimum requirement for periodic CQI reporting with Table 4 326

6.2.3.1.2 CQI reporting under fading conditions 328

6.2.3.1.2.1 Minimum requirement for wideband CQI reporting 328

6.2.3.1.2.2 Minimum requirement for sub-band CQI reporting 330

6.2.3.1.2.3 Minimum requirement for wideband CQI reporting with inter-cell interference 333

6.2.3.2 TDD 336

6.2.3.2.1 CQI reporting definition under AWGN 336

6.2.3.2.1.1 Minimum requirement for CQI periodic reporting 336

6.2.3.2.1.2 Minimum requirement for CQI periodic reporting with Table 3 338

6.2.3.2.1.3 Minimum requirement for CQI reporting for PCell on band with shared spectrum access 339

6.2.3.2.1.4 Minimum requirement for CQI periodic reporting with Table 4 341

6.2.3.2.2 CQI reporting under fading conditions 343

6.2.3.2.2.1 Minimum requirement for wideband CQI reporting 343

6.2.3.2.2.2 Minimum requirement for sub-band CQI reporting 345

6.2.3.2.2.3 Minimum requirement for wideband CQI reporting with inter-cell interference 348

6.2A Reporting of Channel Quality Indicator (CQI) for CA 351

6.2A.1 General 351

6.2A.2 1RX requirements 351

6.2A.3 2RX requirements 351

6.2A.3.1 CQI reporting definition under AWGN conditions 351

6.2A.3.1.1 Minimum requirement for periodic CQI reporting 351

6.2A.3.1.2 Minimum requirement for CQI reporting for SCell on band with shared spectrum access 354

6.2A.4 4RX requirements 356

6.2A.4.1 CQI reporting definition under AWGN conditions 356

6.2A.4.1.1 Minimum requirement for CQI reporting for SCell on band with shared spectrum access 356

6.3 Reporting of Precoding Matrix Indicator (PMI) 358

6.3.1 1RX requirements 359

6.3.1.1 FDD 359

6.3.1.1.1 Single PMI with 4TX TypeI-SinglePanel Codebook for RedCap 359

6.3.1.2 TDD 362

6.3.1.2.1 Single PMI with 4TX TypeI-SinglePanel Codebook for RedCap 362

6.3.2 2RX requirements 365

6.3.2.1 FDD 365

6.3.2.1.1 Single PMI with 4TX TypeI-SinglePanel Codebook 365

6.3.2.1.2 Single PMI with 8TX TypeI-SinglePanel Codebook 368

6.3.2.1.3 Multiple PMI with 16TX TypeI-SinglePanel Codebook 371

6.3.2.1.4 Single PMI with 32TX TypeI-SinglePanel Codebook 373

6.3.2.1.5 Multiple PMI with 16TX TypeII Codebook 375

6.3.2.1.6 Multiple PMI with 16TX Enhanced Type II Codebook 378

6.3.2.1.7 Single PMI with 8 ports TypeI-SinglePanel Codebook for Single-DCI based transmission scheme 381

6.3.2.2 TDD 384

6.3.2.2.1 Single PMI with 4TX TypeI-SinglePanel Codebook 384

6.3.2.2.2 Single PMI with 8TX TypeI-SinglePanel Codebook 387

6.3.2.2.3 Multiple PMI with 16TX TypeI-SinglePanel Codebook 390

6.3.2.2.4 Single PMI with 32TX TypeI-SinglePanel Codebook 392

6.3.2.2.5 Multiple PMI with 16TX TypeII Codebook 394

6.3.2.2.6 Single PMI with 16Tx Enhanced Type II Codebook 397

6.3.2.2.7 Single PMI with 4TX TypeI-SinglePanel Codebook for RedCap 400

6.3.2.2.8 Single PMI with 8 ports TypeI-SinglePanel Codebook for Single-DCI based transmission scheme 403

6.3.3 4RX requirements 406

6.3.3.1 FDD 406

6.3.3.1.1 Single PMI with 4TX TypeI-SinglePanel Codebook 406

6.3.3.1.2 Single PMI with 8TX TypeI-SinglePanel Codebook 409

6.3.3.1.3 Multiple PMI with 16TX TypeI-SinglePanel Codebook 412

6.3.3.1.4 Single PMI with 32TX TypeI-SinglePanel Codebook 414

6.3.3.1.5 Multiple PMI with 16TX TypeII Codebook 416

6.3.3.1.6 Multiple PMI with 16Tx Enhanced Type II Codebook 419

6.3.3.1.7 Single PMI with 8 ports TypeI-SinglePanel Codebook for Single-DCI based transmission scheme 422

6.3.3.2 TDD 425

6.3.3.2.1 Single PMI with 4TX TypeI-SinglePanel Codebook 425

6.3.3.2.2 Single PMI with 8TX TypeI-SinglePanel Codebook 428

6.3.3.2.3 Multiple PMI with 16TX TypeI-SinglePanel Codebook 431

6.3.3.2.4 Single PMI with 32TX TypeI-SinglePanel Codebook 433

6.3.3.2.5 Multiple PMI with 16TX TypeII Codebook 436

6.3.3.2.6 Multiple PMI with 16Tx Enhanced Type II Codebook 439

6.3.3.2.7 Single PMI with 8 ports TypeI-SinglePanel Codebook for Single-DCI based transmission scheme 442

6.4 Reporting of Rank Indicator (RI) 445

6.4.1 1RX requirements 445

6.4.2 2RX requirements 445

6.4.2.1 FDD 445

6.4.2.1.1 Minimum requirements for RedCap 448

6.4.2.2 TDD 450

6.4.2.2.1 Minimum requirements for RedCap 453

6.4.3 4RX requirements 455

6.4.3.1 FDD 455

6.4.3.2 TDD 458

7 Demodulation performance requirements (Radiated requirements) 461

7.1 General 461

7.1.1 Applicability of requirements 461

7.1.1.1 General 461

7.1.1.2 Applicability of requirements for different number of RX antenna ports 461

7.1.1.3 Applicability of requirements for optional UE features 461

7.1.1.5 Applicability of CA requirements 463

7.1.1.5.1 Definition of CA capability 463

7.1.1.5.2 Applicability and test rules for different CA configurations and bandwidth combination sets 463

7.1.1.6 Applicability of requirements for operating bands in FR2-1 464

7.1.1.7 Applicability of requirements for RedCap 464

7.1.1.8 Applicability of requirements for operating bands in FR2-2 465

7.2 PDSCH demodulation requirements 465

7.2.1 1RX requirements 470

7.2.2 2RX requirements 470

7.2.2.1 FDD 470

7.2.2.2 TDD 470

7.2.2.2.1 Minimum requirements for PDSCH Mapping Type-A 470

7.2.2.2.2 Minimum requirements for PDSCH repetitions over multiple slots 474

7.2.2.2.3 Minimum requirements for PDSCH Mapping Type B 475

7.2.2.2.4 Minimum requirements for HST-DPS 476

7.2A PDSCH demodulation requirements for CA 484

7.2A.1 1RX requirements 484

7.2A.2 2RX requirements 485

7.2A.2.1 Minimum requirements 485

7.3 PDCCH demodulation requirements 486

7.3.1 1RX requirements 489

7.3.2 2RX requirements 489

7.3.2.1 FDD 489

7.3.2.2 TDD 489

7.3.2.2.1 1 Tx Antenna performances 490

7.3.2.2.2 2 Tx Antenna performances 491

7.3.2.2.3 Minimum requirements for power saving 491

7.4 PBCH demodulation requirements 492

7.4.1 1RX requirements 492

7.4.2 2RX requirements 492

7.4.2.1 FDD 492

7.4.2.2 TDD 492

7.5 Sustained downlink data rate provided by lower layers 493

7.5.1 FR2 single carrier requirements 493

7.5A Sustained downlink data rate provided by lower layers 493

7.5A.1 FR2 CA requirements 493

7.6 PDSCH absolute physical layer throughput requirements 500

7.6.1 1Rx requirements 500

7.6.2 2Rx requirements 500

7.6.2.1 FDD 500

7.6.2.2 TDD 500

7.6.2.2.1 Minimum requirements with Link Adaptation 500

8 CSI reporting requirements (Radiated requirements) 502

8.1 General 502

8.1.1 Applicability of requirements 502

8.1.1.1 General 502

8.1.1.2 Applicability of requirements for different number of RX antenna ports 502

8.1.1.3 Applicability of requirements for optional UE features 502

8.1.1.4 Applicability of requirements for mandatory UE features with capability signalling 503

8.1.1.5 Applicability of Channel Quality Indicator (CQI) reporting requirements for CA 503

8.1.1.5.1 Applicability and test rules for different CA configurations and bandwidth combination sets 503

8.1.1.5.2 Test coverage for different number of componenet carriers 503

8.1.1.6 Applicability of requirements for RedCap 503

8.1.2 Common test parameters 504

8.2 Reporting of Channel Quality Indicator (CQI) 509

8.2.1 1RX requirements 509

8.2.2 2RX requirements 509

8.2.2.1 FDD 509

8.2.2.2 TDD 509

8.2.2.2.1 CQI reporting under AWGN conditions 509

8.2.2.2.1.1 Minimum requirement for periodic CQI reporting 509

8.2.2.2.2 CQI reporting under fading conditions 512

8.2.2.2.2.1 Minimum requirement for wideband CQI reporting 512

8.2A Reporting of Channel Quality Indicator (CQI) for CA 515

8.2A.1 General 515

8.2A.2 1RX requirements 515

8.2A.3 2RX requirements 515

8.2A.3.1 CQI reporting definition under AWGN conditions 515

8.2A.3.1.1 Minimum requirement for periodic CQI reporting 515

8.3 Reporting of Precoding Matrix Indicator (PMI) 517

8.3.1 1RX requirements 517

8.3.2 2RX requirements 517

8.3.2.1 FDD 517

8.3.2.2 TDD 517

8.3.2.2.1 Single PMI with 2TX TypeI-SinglePanel Codebook 517

8.4 Reporting of Rank Indicator (RI) 520

8.4.1 1RX requirements 520

8.4.2 2RX requirements 521

8.4.2.1 FDD 521

8.4.2.2 TDD 521

9 Demodulation performance requirements for interworking 524

9.1 General 524

9.1.1 Applicability of requirements 524

9.1.1.1 Applicability of requirements for optional UE features 526

9.1.1.2 Applicability of requirements for mandatory UE features with capability signalling 526

9.1.1.3 Applicability of requirements for operating bands in FR2-2 527

9.1.2 E-UTRA Cell setup 527

9.1.2.1 FDD 527

9.1.2.2 TDD 528

9.2 PDSCH Demodulation 529

9.2A PDSCH demodulation for CA 529

9.2A.1 NR CA between FR1 and FR2 529

9.2A.1.1 NR CA between FR1 and FR2-2 529

9.2B PDSCH demodulation for DC 531

9.2B.1 EN-DC 531

9.2B.1.1 EN-DC within FR1 531

9.2B.1.1.1 PDSCH 531

9.2B.1.2 EN-DC including FR2 NR carrier only 531

9.2B.1.2.1 PDSCH 531

9.2B.1.3 EN-DC including FR1 and FR2 NR carriers 531

9.2B.2 NR DC between FR1 and FR2 532

9.3 PDCCH demodulation 532

9.3A PDCCH demodulation for CA 532

9.3A.1 NR CA between FR1 and FR2 532

9.3A.1.1 NR CA between FR1 and FR2-2 532

9.3B PDCCH demodulation for DC 532

9.3B.1 EN-DC 532

9.3B.1.1 EN-DC within FR1 532

9.3B.1.1.1 PDCCH 532

9.3B.1.2 EN-DC including FR2 NR carrier only 532

9.3B.1.2.1 PDCCH 532

9.3B.1.3 EN-DC including FR1 and FR2 NR carriers 532

9.3B.2 NR DC between FR1 and FR2 532

9.4 Void 533

9.4A SDR test for CA 533

9.4A.1 NR CA between FR1 and FR2 533

9.4B SDR test for DC 533

9.4B.1 EN-DC 533

9.4B.1.1 EN-DC within FR1 533

9.4B.1.1.1 SDR test 533

9.4B.1.2 EN-DC including FR2 NR carrier 535

9.4B.1.2.1 SDR test 535

9.4B.1.3 EN-DC including FR1 and FR2 NR carriers 536

9.4B.2 NR DC between FR1 and FR2 537

9.4B.3.1 NE-DC within FR1 537

9.5B PDSCH demodulation for DC with power imbalance 537

9.5B.1 EN-DC 537

9.5B.1.1 Intra-band contiguous EN-DC within FR1 537

9.5B.1.1.1 PDSCH 537

9.5B.1.2 Intra-band non-contiguous EN-DC within FR1 538

9.5B.1.2.1 PDSCH 538

10 CSI reporting requirements for interworking 540

10.1 General 540

10.1.1 Applicability of requirements 540

10.1.1.1 Applicability of requirements for optional UE features 540

10.1.1.2 Applicability of requirements for mandatory UE features with capability signalling 540

10.2 Reporting of Channel Quality Indicator (CQI) 541

10.2A Reporting of Channel Quality Indicator (CQI) for CA 541

10.2A.1 NR CA between FR1 and FR2 541

10.2A.1.1 NR CA between FR1 and FR2-2 541

10.2B Reporting of Channel Quality Indicator (CQI) for DC 541

10.2B.1 EN-DC 541

10.2B.1.1 EN-DC within FR1 541

10.2B.1.2 EN-DC including FR2 NR carrier 541

10.2B.1.3 EN-DC including FR1 and FR2 NR carriers 541

10.2B.2 NR DC between FR1 and FR2 541

10.3 Reporting of Precoding Matrix Indicator (PMI) 541

10.3A Reporting of Precoding Matrix Indicator (PMI) for CA 541

10.3B Reporting of Precoding Matrix Indicator (PMI) for DC 542

10.3B.1 EN-DC 542

10.3B.1.1 EN-DC within FR1 542

10.3B.1.2 EN-DC including NR FR2 carrier 542

10.3B.1.3 EN-DC including FR1 and FR2 NR carriers 542

10.3B.2 NR DC between FR1 and FR2 542

10.4 Reporting of Rank Indicator (RI) 542

10.4A Reporting of Rank Indicator (RI) for CA 542

10.4B Reporting of Rank Indicator (RI) for DC 542

10.4B.1 EN-DC 542

10.4B.1.1 EN-DC within FR1 542

10.4B.1.2 EN-DC including NR FR2 carrier 542

10.4B.1.3 EN-DC including FR1 and FR2 NR carriers 542

10.4B.2 NR DC between FR1 and FR2 543

Annex A (normative): Measurement channels 544

11.1 Demodulation performance requirements (Conducted requirements) 544

11.1.1.1 Applicability of requirements 544

11.1.1.1.1 General 544

11.1.1.1.2 Applicability of requirements for mandatory UE V2X features with capability signalling 544

11.1.1.2 Common test parameters 544

11.1.2 PSSCH demodulation requirements 545

11.1.2.1 2Rx requirements 545

11.1.2.1.1 Minimum requirements 545

11.1.3.1 2Rx requirements 546

11.1.3.1.1 Minimum requirements 546

11.1.4.1 2Rx requirements 546

11.1.4.1.1 Minimum requirements 546

11.1.5.1 2Rx requirements 547

11.1.5.1.1 Minimum requirements 547

11.1.5.1.1.1 NACK missed detection requirements 547

11.1.5.1.1.2 DTX to NACK requirements 548

11.1.6 Power imbalance performance with two links 548

11.1.6.1 2RX requirements 548

11.1.6.1.1 Minimum requirements 548

11.1.7 HARQ buffer soft combining test 549

11.1.7.1 2Rx requirement 549

11.1.7.1.1 Minimum requirement 549

11.1.8 PSCCH decoding capability test 550

11.1.8.1 2RX requirements 550

11.1.8.1.1 Minimum requirements 550

11.1.9 PSFCH decoding capability test 551

11.1.9.1 2RX requirements 551

11.1.9.1.1 Minimum requirements 551

Annex A (normative): Measurement channels 542

A.1 General 542

A.1.1 Throughput definition 542

A.1.2 TDD UL-DL configurations for FR1 542

A.1.3 TDD UL-DL configurations for FR2 547

A.2 Void 549

A.3 DL reference measurement channels 549

A.3.1 General 549

A.3.2 Reference measurement channels for PDSCH performance requirements 549

A.3.2.1 FDD 550

A.3.2.1.1 Reference measurement channels for SCS 15 kHz FR1 550

A.3.2.1.2 Reference measurement channels for SCS 30 kHz FR1 569

A.3.2.1.3 Reference measurement channels for SCS 60 kHz FR1 570

A.3.2.1.4 Reference measurement channels for E-UTRA 570

A.3.2.1.5 Reference measurement channels for Intra-cell Inter-UE interference scenario 576

A.3.2.2 TDD 577

A.3.2.2.1 Reference measurement channels for SCS 15 kHz FR1 577

A.3.2.2.2 Reference measurement channels for SCS 30 kHz FR1 584

A.3.2.2.3 Reference measurement channels for SCS 60 kHz FR1 646

A.3.2.2.4 Reference measurement channels for SCS 60 kHz FR2 646

A.3.2.2.5 Reference measurement channels for SCS 120 kHz FR2 647

A.3.2.2.6 Reference measurement channels for E-UTRA 665

A.3.2.2.7 Reference measurement channels for Intra-cell Inter-UE interference scenario 671

A.3.2.2.8 Reference measurement channels for SCS 480 kHz FR2-2 672

A.3.2.3 HD-FDD 679

A.3.2.3.1 Reference measurement channels for SCS 15 kHz FR1 679

A.3.3 Reference measurement channels for PDCCH performance requirements 682

A.3.3.1 FDD 682

A.3.3.1.1 Reference measurement channels for SCS 15 kHz FR1 682

A.3.3.1.2 Reference measurement channels for SCS 30 kHz FR1 683

A.3.3.2 TDD 683

A.3.3.2.1 Reference measurement channels for SCS 15 kHz FR1 683

A.3.3.2.2 Reference measurement channels for SCS 30 kHz FR1 684

A.3.3.2.3 Reference measurement channels for SCS 60 kHz FR1 685

A.3.3.2.4 Reference measurement channels for SCS 60 kHz FR2 685

A.3.3.2.5 Reference measurement channels for SCS 120 kHz FR2 685

A.3.3.2.6 Reference measurement channels for SCS 480 kHz FR2-2 685

A.3.4 Reference measurement channels for PBCH demodulation requirements 686

A.3.4.1 Reference measurement channels for FR1 686

A.3.4.2 Reference measurement channels for FR2 686

A.4 CSI reference measurement channels 686

A.5 OFDMA Channel Noise Generator (OCNG) 692

A.5.1 OCNG Patterns for FDD 692

A.5.1.1 OCNG FDD pattern 1: Generic OCNG FDD Pattern for all unused REs 692

A.5.2 OCNG Patterns for TDD 692

A.5.2.1 OCNG TDD pattern 1: Generic OCNG TDD Pattern for all unused REs 692

A.6 SL reference measurement channels 693

A.6.1 General 693

A.6.2 Reference measurement channels for PSSCH performance requirements 693

A.6.2.1 Reference measurement channels for SCS 15 kHz FR1 693

A.6.2.2 Reference measurement channels for SCS 30 kHz FR1 693

A.6.3 Reference measurement channels for PSCCH performance requirements 694

A.6.3.1 Reference measurement channels for SCS 15 kHz FR1 694

A.6.3.2 Reference measurement channels for SCS 30 kHz FR1 694

A.6.4 Reference measurement for PSBCH performance requirements 694

A.6.4.1 Reference measurement channels for SCS 15 kHz FR1 694

A.6.4.2 Reference measurement channels for SCS 30 kHz FR1 694

Annex B (normative): Propagation conditions 695

B.1 Static propagation condition 695

B.1.0 UE Receiver with 1Rx 695

B.1.1 UE Receiver with 2Rx 695

B.1.2 UE Receiver with 4Rx 695

B.2 Multi-path fading propagation conditions 696

B.2.1 Delay profiles 696

B.2.1.1 Delay profiles for FR1 698

B.2.1.2 Delay profiles for FR2 699

B.2.2 Combinations of channel model parameters 701

B.2.3 MIMO Channel Correlation Matrices 702

B.2.3.1 MIMO Correlation Matrices using Uniform Linear Array (ULA) 702

B.2.3.1.1 Definition of MIMO Correlation Matrices 702

B.2.3.1.2 MIMO Correlation Matrices at High, Medium and Low Level 703

B.2.3.2 MIMO Correlation Matrices using Cross Polarized Antennas (X-pol) 707

B.2.3.2.1 Definition of MIMO Correlation Matrices using cross polarized antennas 708

B.2.3.2.2 MIMO Correlation Matrices using cross polarized antennas 710

B.2.3.2.3 Beam steering approach 712

B.2.3.2.3A Beam steering approach with dual cluster beams 714

B.2.4 Two-tap propagation conditions for CQI tests 715

B.3 High Speed Train Scenario 715

B.3.1 Single Tap Channel Profile 715

B.3.2 HST-SFN Channel Profile 719

B.3.3 HST-DPS Channel Profile 722

B.3.4 FR2 HST-DPS Channel Profile 726

B.3.4.1 Unidirectional Deployment Channel Profile 726

B.3.4.2 Bidirectional Deployment Channel Profile 729

B.3.5 HST-SFN Scheme A Channel Profile 731

B.3.6 HST-SFN Scheme B Channel Profile 734

B.4 Physical signals, channels mapping and precoding 737

B.4.1 General 737

B.4.2 Beamforming for MU-MIMO 738

B.5 Downlink Transmission Model for requirements on bands with shared spectrum access 739

B.5.1 Downlink Transmission Model for bands with shared spectrum access 739

B.6 Interference model for PDSCH requirements with intercell interference 740

B.6.1 Interference to Noise ratio (INR) 740

B.6.2 Interference model for PDSCH requirements 740

B.7 Interference model for PDSCH requirements with LTE-NR spectrum sharing 740

Annex C (normative): Downlink physical channels 742

C.1 General 742

C.2 Setup (Conducted) 742

C.3 Connection (Conducted) 742

C.3.1 Measurement of Performance requirements 742

C.4 Setup (Radiated) 743

Annex D (informative): Void 745

Annex E (normative): Environmental conditions 746

E.1 General 746

E.2 Environmental (Conducted) 746

E.2.1 Temperature 746

E.2.2 Voltage 746

E.2.3 Vibration 747

E.3 Environmental (Radiated) 747

E.3.1 Temperature 747

E.3.2 Voltage 747

E.3.3 Void 748

Annex F (informative): Void 749

Annex G (informative): Void 749

Annex H (informative): Void 749

Annex I (informative): Void 749

Annex J (informative): Void 749

Annex K (informative): Void 749

Annex L (informative): Change history 750