

# ETSI TS 138 133 V16.21.0 (2024-11)



**5G;  
NR;**  
**Requirements for support of radio resource management  
(3GPP TS 38.133 version 16.21.0 Release 16)**

[ETSI TS 138 133 V16.21.0 \(2024-11\)](https://standards.iteh.ai/catalog/standards/etsi/59771651-08a2-4dbd-85b2-53f47d63824b/etsi-ts-138-133-v16-21-0-2024-11)

<https://standards.iteh.ai/catalog/standards/etsi/59771651-08a2-4dbd-85b2-53f47d63824b/etsi-ts-138-133-v16-21-0-2024-11>



---

**Reference**

RTS/TSGR-0438133vgl0

---

**Keywords**

5G

**ETSI**

650 Route des Lucioles  
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B  
Association à but non lucratif enregistrée à la  
Sous-Préfecture de Grasse (06) N° w061004871

---

**Important notice**

The present document can be downloaded from the  
[ETSI Search & Browse Standards application](#).

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format on [ETSI deliver repository](#).

Users should be aware that the present document may be revised or have its status changed, this information is available in the [Milestones listing](#).

If you find errors in the present document, please send your comments to the relevant service listed under [Committee Support Staff](#).

If you find a security vulnerability in the present document, please report it through our [Coordinated Vulnerability Disclosure \(CVD\)](#) program.

---

**Notice of disclaimer & limitation of liability**

The information provided in the present deliverable is directed solely to professionals who have the appropriate degree of experience to understand and interpret its content in accordance with generally accepted engineering or other professional standard and applicable regulations.

No recommendation as to products and services or vendors is made or should be implied.

No representation or warranty is made that this deliverable is technically accurate or sufficient or conforms to any law and/or governmental rule and/or regulation and further, no representation or warranty is made of merchantability or fitness for any particular purpose or against infringement of intellectual property rights.

In no event shall ETSI be held liable for loss of profits or any other incidental or consequential damages.

Any software contained in this deliverable is provided "AS IS" with no warranties, express or implied, including but not limited to, the warranties of merchantability, fitness for a particular purpose and non-infringement of intellectual property rights and ETSI shall not be held liable in any event for any damages whatsoever (including, without limitation, damages for loss of profits, business interruption, loss of information, or any other pecuniary loss) arising out of or related to the use of or inability to use the software.

---

**Copyright Notification**

No part may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm except as authorized by written permission of ETSI.

The content of the PDF version shall not be modified without the written authorization of ETSI.

The copyright and the foregoing restriction extend to reproduction in all media.

© ETSI 2024.  
All rights reserved.

---

# Intellectual Property Rights

## Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: "*Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards*", which is available from the ETSI Secretariat. Latest updates are available on the [ETSI IPR online database](#).

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

## Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

**DECT™**, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™**, **LTE™** and **5G™** logo are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM®** and the GSM logo are trademarks registered and owned by the GSM Association.

---

## Legal Notice

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

The present document may refer to technical specifications or reports using their 3GPP identities. These shall be interpreted as being references to the corresponding ETSI deliverables. (2024-11)

The cross reference between 3GPP and ETSI identities can be found at [3GPP to ETSI numbering cross-referencing](#).

---

## Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

# Contents

Intellectual Property Rights .....	2
Legal Notice .....	2
Modal verbs terminology.....	2
Foreword.....	68
1 Scope .....	70
2 References .....	70
3 Definitions, symbols and abbreviations .....	71
3.1 Definitions .....	71
3.2 Symbols.....	72
3.3 Abbreviations .....	73
3.4 Test tolerances.....	76
3.5 Frequency bands grouping .....	76
3.5.1 Introduction.....	76
3.5.2 NR operating bands in FR1 .....	76
3.5.3 NR operating bands in FR2 .....	77
3.6 Applicability of requirements in this specification version .....	77
3.6.1 RRC connected state requirements in DRX.....	78
3.6.2 Number of serving carriers .....	78
3.6.2.1 Number of serving carriers for SA .....	78
3.6.2.2 Number of serving carriers for EN-DC .....	78
3.6.2.3 Number of serving carriers for NE-DC .....	78
3.6.2.4 Number of serving carriers for NR-DC.....	79
3.6.3 Applicability for intra-band FR2 .....	79
3.6.4 Applicability for FR2 UE power classes.....	79
3.6.5 Applicability for SDL bands .....	79
3.6.6 Applicability of requirements for NGEN-DC operation.....	79
3.6.7 Applicability of QCL.....	79
3.6.9 Applicability of requirements for scheduling availability.....	80
3.6.10 Applicability of requirements for measurement restrictions.....	80
4 SA: RRC_IDLE state mobility.....	80
4.1 Cell Selection .....	80
4.2 Cell Re-selection .....	80
4.2.1 Introduction.....	80
4.2.2 Requirements .....	81
4.2.2.1 UE measurement capability .....	81
4.2.2.2 Measurement and evaluation of serving cell.....	81
4.2.2.3 Measurements of intra-frequency NR cells.....	82
4.2.2.4 Measurements of inter-frequency NR cells.....	83
4.2.2.5 Measurements of inter-RAT E-UTRAN cells.....	85
4.2.2.6 Maximum interruption in paging reception.....	87
4.2.2.7 General requirements .....	87
4.2.2.8 Minimum requirement at transitions .....	87
4.2.2.9 Measurements of intra-frequency NR cells for UE configured with relaxed measurement criterion .....	88
4.2.2.9.1 Introduction .....	88
4.2.2.9.2 Measurements for UE fulfilling low mobility criterion .....	88
4.2.2.9.3 Measurements for UE fulfilling not-at-cell edge criterion.....	89
4.2.2.9.4 Measurements for UE fulfilling low mobility and not-at-cell edge criteria.....	89
4.2.2.10 Measurements of inter-frequency NR cells for UE configured with relaxed measurement criterion .....	90
4.2.2.10.1 Introduction .....	90
4.2.2.10.2 Measurements for UE fulfilling low mobility criterion.....	90
4.2.2.10.3 Measurements for UE fulfilling not-at-cell edge criterion.....	91
4.2.2.10.4 Measurements for UE fulfilling low mobility and not-at-cell edge criterion .....	92

4.2.2.11	Measurements of inter-RAT E-UTRAN cells for UE configured with relaxed measurement criterion .....	92
4.2.2.11.1	Introduction .....	92
4.2.2.11.2	Measurements for UE fulfilling low mobility criterion .....	93
4.2.2.11.3	Measurements for UE fulfilling with not-at-cell edge criterion .....	94
4.2.2.11.4	Measurements for UE fulfilling low mobility and not-at-cell edge criterion .....	95
4.2A	Cell Re-selection when subject to CCA .....	95
4.2A.1	Introduction.....	95
4.2A.2	Requirements .....	96
4.2A.2.1	UE measurement capability .....	96
4.2A.2.2	Measurement and evaluation when subject to CCA on the serving cell .....	96
4.2A.2.3	Measurements of intra-frequency NR cells when subject to CCA on the serving cell and target cell.....	97
4.2A.2.4	Measurements of inter-frequency NR cells when subject to CCA on the target cell .....	98
4.2A.2.5	Measurements of inter-RAT E-UTRAN cells when subject to CCA on the serving cell.....	100
4.2A.2.6	Maximum interruption in paging reception when subject to CCA on the target cell .....	100
4.2A.2.7	General requirements .....	100
4.3	Minimization of Drive Tests (MDT) .....	100
4.3.1	Introduction.....	100
4.3.2	Measurement Requirements.....	101
4.3.3	Requirements for Relative Time Stamp Accuracy.....	101
4.3.4	Requirements for Relative Time Stamp Accuracy for RRC Connection Establishment Failure Log Reporting .....	101
4.3.5	Requirements for Relative Time Stamp Accuracy for Radio Link Failure and Handover Failure Log Reporting .....	102
4.4	Idle Mode CA/DC Measurements .....	102
4.4.1	Introduction.....	102
4.4.2	Measurement Requirements.....	102
4.4.2.1	Detected cell requirement during state transition and Idle mode .....	102
4.4.2.2	Measurements of inter-frequency CA/DC candidate cells .....	103
4.4.2.3	Measurements on serving cell .....	104
4.4.2.4	Measurements of E-UTRAN inter-RAT DC candidate cells .....	104
5	SA: RRC_INACTIVE state mobility .....	105
5.1	Cell Re-selection .....	105
5.1.1	Introduction.....	105
5.1.2	Requirements .....	105
5.1.2.1	UE measurement capability .....	105
5.1.2.2	Measurement and evaluation of serving cell.....	105
5.1.2.3	Measurements of intra-frequency NR cells .....	105
5.1.2.4	Measurements of inter-frequency NR cells.....	105
5.1.2.5	Measurements of inter-RAT E-UTRAN cells .....	105
5.1.2.6	Maximum interruption in paging reception.....	105
5.1.2.7	General requirements .....	105
5.1A	Cell Re-selection with CCA .....	105
5.1A.1	Introduction.....	105
5.1A.2	Requirements .....	106
5.1A.2.1	UE measurement capability .....	106
5.1A.2.2	Measurement and evaluation when CCA is used on the serving cell.....	106
5.1A.2.3	Measurements of intra-frequency NR cells when CCA is used on the serving cell and target cell.....	106
5.1A.2.4	Measurements of inter-frequency NR cells when CCA is used on the target cell.....	106
5.1A.2.5	Measurements of inter-RAT E-UTRAN cells when CCA is used on the serving cell .....	106
5.1A.2.6	Maximum interruption in paging reception when CCA is used on the target cell .....	106
5.1A.2.7	General requirements .....	106
5.2	Void.....	106
5.3	Minimization of Drive Tests (MDT) .....	106
5.3.1	Introduction.....	106
5.3.2	Measurement Requirements.....	107
5.3.3	Requirements for Relative Time Stamp Accuracy.....	107
5.3.4	Requirements for Relative Time Stamp Accuracy for RRC Connection Establishment Failure Log Reporting .....	107

5.3.5 Requirements for Relative Time Stamp Accuracy for Radio Link Failure and Handover Failure Log Reporting .....107

5.3.6 Requirements for Relative Time Stamp Accuracy for RRC Resume Failure Log Reporting .....107

5.4 Inactive Mode CA/DC Measurements .....107

5.4.1 Introduction.....107

5.4.2 Measurement Requirements.....107

5.4.2.1 Detected cell requirement during state transition and inactive mode.....108

5.4.2.2 Measurements of inter-frequency CA/DC candidate cells .....108

5.4.2.3 Measurements on serving cell.....108

5.4.2.4 Measurements on E-UTRAN inter-RAT DC candidate cells .....108

6 RRC\_CONNECTED state mobility .....108

6.1 Handover .....108

6.1.1 NR Handover .....108

6.1.1.1 Introduction.....108

6.1.1.2 NR FR1 - NR FR1 Handover .....108

6.1.1.2.1 Handover delay.....108

6.1.1.2.2 Interruption time.....108

6.1.1.3 NR FR2- NR FR1 Handover .....109

6.1.1.3.1 Handover delay.....109

6.1.1.3.2 Interruption time.....109

6.1.1.4 NR FR2- NR FR2 Handover .....110

6.1.1.4.1 Handover delay.....110

6.1.1.4.2 Interruption time.....110

6.1.1.5 NR FR1- NR FR2 Handover .....111

6.1.1.5.1 Handover delay.....111

6.1.1.5.2 Interruption time.....111

6.1.2 NR Handover to other RATs .....112

6.1.2.1 NR – E-UTRAN Handover .....112

6.1.2.1.1 Introduction .....112

6.1.2.1.2 Handover delay.....112

6.1.2.1.3 Interruption time.....112

6.1.2.2 NR – UTRAN Handover .....113

6.1.2.2.1 Introduction .....113

6.1.2.2.2 Handover delay.....113

6.1.2.2.3 Interruption time.....113

6.1.3 NR DAPS Handover .....114

6.1.3.1 Introduction.....114

6.1.3.2 NR FR1 - NR FR1 DAPS Handover .....114

6.1.3.2.1 DAPS handover delay .....114

6.1.3.2.2 Interruption time.....115

6.1.3.3 NR FR2- NR FR1 DAPS Handover.....117

6.1.3.3.1 DAPS handover delay .....117

6.1.3.3.2 Interruption time.....117

6.1.3.4 NR FR1- NR FR2 DAPS Handover.....118

6.1.3.4.1 DAPS handover delay .....118

6.1.3.4.2 Interruption time.....118

6.1.4 NR Conditional Handover .....119

6.1.4.1 Introduction.....119

6.1.4.2 NR FR1 – NR FR1 conditional handover .....119

6.1.4.3 NR FR2 – NR FR1 conditional handover .....120

6.1.4.4 NR FR2 – NR FR2 conditional handover .....120

6.1.4.4.1 Handover delay.....121

6.1.4.4.2 Measurement time .....121

6.1.4.4.3 Preparation time.....121

6.1.4.4.4 Interruption time.....121

6.1.4.5 NR FR1 – NR FR2 conditional handover .....122

6.1A Void.....122

6.1A.1 Void .....122

6.1A.1.1 Void.....122

6.1A.1.2 Void.....122

6.1A.1.2.1 Void.....122

6.1A.1.2.2	Void .....	122
6.1B	Handover to target cell using CCA .....	122
6.1B.1	NR Handover .....	122
6.1B.1.1	Introduction .....	122
6.1B.1.2	NR FR1 - NR FR1 Handover .....	123
6.1B.1.2.1	Handover delay .....	123
6.1B.1.2.2	Interruption time .....	123
6.2	RRC Connection Mobility Control .....	124
6.2.1	SA: RRC Re-establishment .....	124
6.2.1.1	Introduction .....	124
6.2.1.2	Requirements .....	124
6.2.1.2.1	UE Re-establishment delay requirement .....	124
6.2.1A	RRC Re-establishment with CCA .....	125
6.2.1A.1	Introduction .....	125
6.2.1A.2	Requirements .....	126
6.2.1A.2.1	UE Re-establishment with CCA delay requirement .....	126
6.2.2	Random access .....	127
6.2.2.1	Introduction .....	127
6.2.2.2	Requirements for 4-step RA type .....	128
6.2.2.2.1	Contention based random access .....	128
6.2.2.2.2	Non-Contention based random access .....	129
6.2.2.2.3	UE behaviour when configured with supplementary UL .....	130
6.2.2.3	Requirements for 2-step RA type .....	130
6.2.2.3.1	Contention based random access .....	130
6.2.2.3.2	Non-Contention based random access .....	131
6.2.2.3.3	UE behaviour when configured with supplementary UL .....	132
6.2.2A	Random access when CCA is used on target frequency .....	132
6.2.2A.1	Introduction .....	132
6.2.2A.2	Requirements for 4-step RA type .....	132
6.2.2A.2.1	Contention based random access .....	132
6.2.2A.2.2	Non-Contention based random access .....	133
6.2.2A.3	Requirements for 2-step RA type .....	134
6.2.2A.3.1	Contention based random access .....	135
6.2.2A.3.2	Non-Contention based random access .....	136
6.2.3	SA: RRC Connection Release with Redirection .....	136
6.2.3.1	Introduction .....	136
6.2.3.2	Requirements .....	137
6.2.3.2.1	RRC connection release with redirection to NR .....	137
6.2.3.2.2	RRC connection release with redirection to E-UTRAN .....	138
6.2.3.2.3	RRC connection release with redirection to NR carrier subject to CCA .....	138
7	Timing .....	139
7.1	UE transmit timing .....	139
7.1.1	Introduction .....	139
7.1.2	Requirements .....	139
7.1.2.1	Gradual timing adjustment .....	141
7.1.2.2	Void .....	141
7.2	UE timer accuracy .....	141
7.2.1	Introduction .....	141
7.2.2	Requirements .....	141
7.3	Timing advance .....	142
7.3.1	Introduction .....	142
7.3.2	Requirements .....	142
7.3.2.1	Timing Advance adjustment delay .....	142
7.3.2.2	Timing Advance adjustment accuracy .....	142
7.4	Cell phase synchronization accuracy .....	142
7.4.1	Definition .....	142
7.4.2	Minimum requirements .....	142
7.5	Maximum Transmission Timing Difference .....	142
7.5.1	Introduction .....	142
7.5.2	Minimum Requirements for inter-band EN-DC .....	143
7.5.2.1	Minimum Requirements for inter-band synchronous EN-DC .....	143

7.5.3	Minimum Requirements for intra-band EN-DC .....	144
7.5.4	Minimum Requirements for NR Carrier Aggregation .....	144
7.5.5	Minimum Requirements for inter-band NE-DC .....	144
7.5.5.1	Minimum Requirements for inter-band synchronous NE-DC .....	145
7.5.6	Minimum Requirements for inter-band NR DC .....	145
7.6	Maximum Receive Timing Difference.....	146
7.6.1	Introduction.....	146
7.6.2	Minimum Requirements for inter-band EN-DC .....	146
7.6.2.1	Minimum Requirements for inter-band synchronous EN-DC .....	146
7.6.3	Minimum Requirements for intra-band EN-DC .....	147
7.6.4	Minimum Requirements for NR Carrier Aggregation .....	147
7.6.5	Minimum Requirements for inter-band NE-DC .....	148
7.6.5.1	Minimum Requirements for inter-band synchronous NE-DC .....	148
7.6.6	Minimum Requirements for inter-band NR DC .....	149
7.7	<i>deriveSSB-IndexFromCell</i> tolerance .....	149
7.7.1	Minimum requirements.....	149
7.8	Void.....	150
8	Signalling characteristics.....	150
8.1	Radio Link Monitoring.....	150
8.1.1	Introduction.....	150
8.1.2	Requirements for SSB based radio link monitoring .....	151
8.1.2.1	Introduction.....	151
8.1.2.2	Minimum requirement .....	151
8.1.2.3	Measurement restrictions for SSB based RLM.....	153
8.1.3	Requirements for CSI-RS based radio link monitoring .....	154
8.1.3.1	Introduction.....	154
8.1.3.2	Minimum requirement .....	154
8.1.3.3	Measurement restrictions for CSI-RS based RLM.....	156
8.1.4	Minimum requirement at transitions.....	157
8.1.5	Minimum requirement for UE turning off the transmitter.....	157
8.1.6	Minimum requirement for L1 indication .....	158
8.1.7	Scheduling availability of UE during radio link monitoring.....	158
8.1.7.1	Scheduling availability of UE performing radio link monitoring with a same subcarrier spacing as PDSCH/PDCCH on FR1 .....	158
8.1.7.2	Scheduling availability of UE performing radio link monitoring with a different subcarrier spacing than PDSCH/PDCCH on FR1.....	158
8.1.7.3	Scheduling availability of UE performing radio link monitoring on FR2.....	158
8.1.7.4	Scheduling availability of UE performing radio link monitoring on FR1 or FR2 in case of FR1-FR2 inter-band CA and NR-DC.....	159
8.1A	Radio Link Monitoring with CCA on Target Frequency .....	159
8.1A.1	Introduction.....	159
8.1A.2	Requirements for SSB Based Radio Link Monitoring.....	160
8.1A.2.1	Introduction.....	160
8.1A.2.2	Minimum Requirement .....	161
8.1A.3	Minimum requirement at transitions.....	162
8.1A.4	Minimum requirement for UE turning off the transmitter .....	162
8.1A.5	Minimum requirement for L1 indication .....	162
8.1A.6	Scheduling availability of UE during radio link monitoring.....	163
8.1A.6.1	Scheduling availability of UE performing radio link monitoring with the same subcarrier spacing as PDSCH/PDCCH .....	163
8.1A.6.2	Scheduling availability of UE performing radio link monitoring with a different subcarrier spacing than PDSCH/PDCCH .....	163
8.2	Interruption.....	163
8.2.1	EN-DC Interruption .....	163
8.2.1.1	Introduction.....	163
8.2.1.2	Requirements .....	164
8.2.1.2.1	Interruptions at transitions between active and non-active during DRX .....	164
8.2.1.2.2	Interruptions at transitions from non-DRX to DRX .....	164
8.2.1.2.3	Interruptions at SCell addition/release.....	164
8.2.1.2.4	Interruptions at SCell activation/deactivation.....	166
8.2.1.2.5	Interruptions during measurements on SCC.....	167

8.2.1.2.6	Interruptions at UL carrier RRC reconfiguration .....	168
8.2.1.2.7	Interruptions due to Active BWP switching Requirement .....	169
8.2.1.2.8	Interruptions at direct SCell activation and hibernation .....	170
8.2.1.2.9	Interruptions at SCell hibernation.....	170
8.2.1.2.10	Interruptions at SCell activation/deactivation with multiple downlink SCells.....	171
8.2.1.2.11	Interruptions due to UE-specific CBW change .....	171
8.2.1.2.12	Interruptions at NR SRS carrier based switching .....	171
8.2.1.2.13	Interruptions at E-UTRA SRS carrier based switching .....	173
8.2.1.2.14	DL Interruptions at switching between two uplink carriers.....	173
8.2.1.2.15	Interruptions due to SCell dormancy .....	174
8.2.1.2.16	Interruptions when identifying CGI of an NR cell with autonomous gaps.....	174
8.2.1.2.17	Interruptions when identifying CGI of an E-UTRA cell with autonomous gaps .....	175
8.2.2	SA: Interruptions with Standalone NR Carrier Aggregation .....	176
8.2.2.1	Introduction.....	176
8.2.2.2	Requirements .....	176
8.2.2.2.1	Interruptions at SCell addition/release.....	176
8.2.2.2.2	Interruptions at SCell activation/deactivation.....	177
8.2.2.2.3	Interruptions during measurements on deactivated SCC.....	178
8.2.2.2.4	Interruptions at UL carrier RRC reconfiguration .....	179
8.2.2.2.5	Interruptions due to Active BWP switching Requirement .....	179
8.2.2.2.6	Interruptions at inter-frequency SFTD measurement .....	180
8.2.2.2.7	Interruptions at SCell activation/deactivation with multiple downlink SCells.....	181
8.2.2.2.8	Interruptions due to UE-specific CBW change .....	181
8.2.2.2.9	Interruptions at NR SRS carrier based switching .....	181
8.2.2.2.10	DL Interruptions at UE switching between two uplink carriers .....	183
8.2.2.2.11	Interruptions at direct SCell activation.....	183
8.2.2.2.12	Interruptions due to SCell dormancy.....	184
8.2.2.2.13	Interruptions at transitions between active and non-active during DRX .....	184
8.2.2.2.14	Interruptions when identifying CGI of an NR cell with autonomous gaps.....	184
8.2.2.2.15	Interruptions when identifying CGI of an E-UTRA cell with autonomous gaps .....	185
8.2.3	NE-DC Interruptions.....	185
8.2.3.1	Introduction.....	185
8.2.3.2	Requirements .....	186
8.2.3.2.1	Interruptions at transitions between active and non-active during DRX .....	186
8.2.3.2.2	Interruptions at transitions from non-DRX to DRX .....	186
8.2.3.2.3	Interruptions at PSCell/SCell addition/release .....	186
8.2.3.2.4	Interruptions at SCell activation/deactivation.....	188
8.2.3.2.5	Interruptions during measurements on SCC.....	189
8.2.3.2.6	Interruptions at UL carrier RRC reconfiguration .....	190
8.2.3.2.7	Interruptions due to Active BWP switching Requirement .....	190
8.2.3.2.8	Interruptions at direct SCell activation and hibernation .....	190
8.2.3.2.9	Interruptions at SCell hibernation.....	191
8.2.3.2.10	Interruptions at SCell activation/deactivation with multiple downlink SCells.....	191
8.2.3.2.11	Interruptions at NR SRS carrier based switching .....	191
8.2.3.2.12	Interruptions at E-UTRA SRS carrier based switching .....	193
8.2.3.2.13	Interruptions due to SCell dormancy .....	194
8.2.3.2.14	Interruptions when identifying CGI of an NR cell with autonomous gaps.....	194
8.2.3.2.15	Interruptions when identifying CGI of an E-UTRA cell with autonomous gaps .....	195
8.2.3.2.16	Interruptions due to UE-specific CBW change .....	195
8.2.4	NR-DC: Interruptions .....	195
8.2.4.1	Introduction.....	195
8.2.4.2	Requirements .....	196
8.2.4.2.1	Interruptions at PSCell/SCell addition/release .....	196
8.2.4.2.3	Interruptions during measurements on SCC.....	198
8.2.4.2.4	Interruptions at UL carrier RRC reconfiguration .....	198
8.2.4.2.5	Interruptions due to Active BWP switching Requirement .....	198
8.2.4.2.6	Interruptions at transitions between active and non-active during DRX .....	198
8.2.4.2.7	Interruptions at transitions from non-DRX to DRX .....	199
8.2.4.2.8	Interruptions at SCell activation/deactivation with multiple downlink SCells.....	199
8.2.4.2.9	Interruptions at NR SRS carrier based switching .....	199
8.2.4.2.10	Interruptions at direct SCell activation.....	201
8.2.4.2.11	Interruptions when identifying CGI of an NR cell with autonomous gaps.....	201

8.2.4.2.12	Interruptions when identifying CGI of an E-UTRA cell with autonomous gaps .....	201
8.2.4.2.13	Interruptions due to SCell dormancy .....	202
8.2.4.2.14	Interruptions due to UE-specific CBW change .....	203
8.2.4.2A	Void.....	203
8.2.4.2A.1	Void .....	203
8.2.4.2A.2	Void .....	203
8.2.4.2A.3	Void .....	203
8.3	SCell Activation and Deactivation Delay .....	203
8.3.1	Introduction.....	203
8.3.2	SCell Activation Delay Requirement for Deactivated SCell .....	203
8.3.3	SCell Deactivation Delay Requirement for Activated SCell .....	207
8.3.4	Direct SCell Activation at SCell addition.....	208
8.3.5	Direct SCell Activation at Handover .....	209
8.3.7	SCell Activation Delay Requirement for Deactivated SCell with Multiple Downlink SCells .....	211
8.3.8	SCell Deactivation Delay Requirement for Activated SCell with Multiple Downlink SCells .....	215
8.3.9	Direct SCell Activation of Multiple Downlink SCells at SCell addition.....	215
8.3.10	Direct SCell Activation of Multiple Downlink SCells at Handover .....	216
8.3A	SCell Activation and Deactivation Delay in Carriers with CCA.....	218
8.3A.1	Introduction.....	218
8.3A.2	SCell Activation Delay Requirement for Deactivated SCell .....	218
8.3A.3	SCell Deactivation Delay Requirement for Activated SCell .....	221
8.4	UE UL carrier RRC reconfiguration delay.....	221
8.4.1	Introduction.....	221
8.4.2	UE UL carrier configuration delay requirement .....	221
8.4.3	UE UL carrier deconfiguration delay requirement .....	221
8.5	Link Recovery Procedures .....	222
8.5.1	Introduction.....	222
8.5.2	Requirements for SSB based beam failure detection.....	223
8.5.2.1	Introduction.....	223
8.5.2.2	Minimum requirement .....	223
8.5.2.3	Measurement restriction for SSB based beam failure detection.....	225
8.5.3	Requirements for CSI-RS based beam failure detection.....	225
8.5.3.1	Introduction.....	225
8.5.3.2	Minimum requirement .....	226
8.5.3.3	Measurement restrictions for CSI-RS based beam failure detection.....	228
8.5.4	Minimum requirement for L1 indication .....	229
8.5.5	Requirements for SSB based candidate beam detection .....	229
8.5.5.1	Introduction.....	229
8.5.5.2	Minimum requirement .....	229
8.5.5.3	Measurement restriction for SSB based candidate beam detection.....	231
8.5.6	Requirements for CSI-RS based candidate beam detection.....	232
8.5.6.1	Introduction.....	232
8.5.6.2	Minimum requirement .....	232
8.5.6.3	Measurement restriction for CSI-RS based candidate beam detection .....	234
8.5.7	Scheduling availability of UE during beam failure detection .....	235
8.5.7.1	Scheduling availability of UE performing beam failure detection with a same subcarrier spacing as PDSCH/PDCCH on FR1 .....	235
8.5.7.2	Scheduling availability of UE performing beam failure detection with a different subcarrier spacing than PDSCH/PDCCH on FR1 .....	235
8.5.7.3	Scheduling availability of UE performing beam failure detection on FR2 .....	235
8.5.7.4	Scheduling availability of UE performing beam failure detection on FR1 or FR2 in case of FR1-FR2 inter-band CA and NR DC .....	236
8.5.8	Scheduling availability of UE during candidate beam detection .....	236
8.5.8.1	Scheduling availability of UE performing L1-RSRP measurement with a same subcarrier spacing as PDSCH/PDCCH on FR1 .....	236
8.5.8.2	Scheduling availability of UE performing L1-RSRP measurement with a different subcarrier spacing than PDSCH/PDCCH on FR1 .....	236
8.5.8.3	Scheduling availability of UE performing L1-RSRP measurement on FR2 .....	236
8.5.8.4	Scheduling availability of UE performing L1-RSRP measurement on FR1 or FR2 in case of FR1-FR2 inter-band CA and NR-DC.....	237
8.5.9	Requirements for Beam Failure Recovery in SCell.....	237
8.5.9.1	Introduction.....	237

8.5.9.2	Requirement .....	237
8.5.10	Minimum requirement at transitions for beam failure detection.....	237
8.5A	Link Recovery Procedures when CCA is used on target frequency .....	238
8.5A.1	Introduction.....	238
8.5A.2	Requirements for SSB based beam failure detection .....	238
8.5A.2.1	Introduction.....	238
8.5A.2.2	Minimum requirement .....	239
8.5A.2.3	Measurement restriction for SSB based beam failure detection.....	239
8.5A.4	Minimum requirement for L1 indication .....	240
8.5A.5	Requirements for SSB based candidate beam detection .....	240
8.5A.5.1	Introduction.....	240
8.5A.5.2	Minimum requirement .....	240
8.5A.5.3	Measurement restriction for SSB based candidate beam detection.....	241
8.5A.7	Scheduling availability of UE during beam failure detection .....	241
8.5A.7.1	Scheduling availability of UE performing beam failure detection with a same subcarrier spacing as PDSCH/PDCCH .....	241
8.5A.7.2	Scheduling availability of UE performing beam failure detection with a different subcarrier spacing than PDSCH/PDCCH .....	241
8.5A.8	Scheduling availability of UE during candidate beam detection .....	241
8.5A.8.1	Scheduling availability of UE performing L1-RSRP measurement with a same subcarrier spacing as PDSCH/PDCCH .....	241
8.5A.8.2	Scheduling availability of UE performing L1-RSRP measurement with a different subcarrier spacing than PDSCH/PDCCH .....	242
8.6	Active BWP switch delay.....	242
8.6.1	Introduction.....	242
8.6.2	DCI and timer based BWP switch delay on a single CC .....	242
8.6.2A	DCI based BWP switch delay on multiple CCs.....	243
8.6.2A.1	Simultaneous DCI based BWP switch delay on multiple CCs .....	243
8.6.2A.2	Non-simultaneous DCI based BWP switch delay on multiple CCs .....	245
8.6.2B	Timer based BWP switch delay on multiple CCs.....	245
8.6.2B.1	Simultaneous timer based BWP switch delay on multiple CCs .....	245
8.6.2B.2	Non-simultaneous timer based BWP switch delay on multiple CCs .....	245
8.6.3	RRC based BWP switch delay on a single CC .....	246
8.6.3A	RRC based BWP switch delay on multiple CCs.....	247
8.6.3A.1	Simultaneous RRC based BWP switch delay on multiple CCs .....	247
8.6.3A.2	Non-simultaneous RRC based BWP switch delay on multiple CCs .....	247
8.6.4	BWP switch delay on Consistent UL CCA recovery.....	248
8.7	Void.....	248
8.8	NE-DC: E-UTRAN PSCell Addition and Release Delay .....	248
8.8.1	Introduction.....	248
8.8.2	E-UTRAN PSCell Addition Delay Requirement.....	248
8.8.3	E-UTRAN PSCell Release Delay Requirement .....	249
8.9	NR-DC: PSCell Addition and Release Delay.....	249
8.9.1	Introduction.....	249
8.9.2	PSCell Addition Delay Requirement .....	249
8.9.3	PSCell Release Delay Requirement.....	250
8.10	Active TCI state switching delay .....	250
8.10.4	DCI based TCI state switch delay.....	251
8.10.5	RRC based TCI state switch delay.....	252
8.10.6	Active TCI state list update delay .....	252
8.10A	Active TCI state switching delay with CCA .....	252
8.10A.1	Introduction.....	252
8.10A.2	Known conditions for TCI state.....	253
8.10A.3	MAC-CE based TCI state switch delay .....	253
8.10A.4	DCI based TCI state switch delay.....	254
8.10A.5	RRC based TCI state switch delay.....	254
8.10A.6	Active TCI state list update delay .....	255
8.11	PSCell Change.....	255
8.11A	void.....	255
8.11B	Conditional PSCell Change .....	255
8.11B.1	Introduction.....	255
8.11B.2	Conditionial PSCell Change delay.....	255

8.11B.2.1	Measurement time .....	256
8.12	Uplink spatial relation switch delay .....	257
8.12.1	Introduction.....	257
8.12.2	Known conditions for spatial relation when associated with DL-RS .....	257
8.12.3	MAC-CE based spatial relation switch delay .....	257
8.12.4	DCI based spatial relation switch delay.....	258
8.12.5	RRC based spatial relation switch delay.....	258
8.13	UE-specific CBW change.....	258
8.13.1	Introduction.....	258
8.13.2	UE-specific CBW change delay .....	259
8.14	Pathloss reference signal switching delay.....	259
8.14.1	Introduction.....	259
8.14.2	Known conditions for pathloss reference signal .....	259
8.14.3	MAC-CE based pathloss reference signal switch delay .....	260
9	Measurement Procedure .....	260
9.1	General measurement requirement.....	260
9.1.1	Introduction.....	260
9.1.2	Measurement gap.....	261
9.1.2.1	EN-DC: Measurement Gap Sharing.....	269
9.1.2.1a	SA: Measurement Gap Sharing.....	270
9.1.2.1b	NE-DC: Measurement Gap Sharing.....	270
9.1.2.1c	NR-DC: Measurement Gap Sharing .....	271
9.1.3	UE Measurement capability.....	272
9.1.3.1	EN-DC: Monitoring of multiple layers using gaps .....	272
9.1.3.1a	SA: Monitoring of multiple layers using gaps .....	273
9.1.3.1b	NE-DC: Monitoring of multiple layers using gaps .....	273
9.1.3.1c	NR-DC: Monitoring of multiple layers using gaps .....	274
9.1.3.2	EN-DC: Maximum allowed layers for multiple monitoring .....	274
9.1.3.2a	SA: Maximum allowed layers for multiple monitoring .....	275
9.1.3.2b	NE-DC: Maximum allowed layers for multiple monitoring .....	276
9.1.3.2c	NR-DC: Maximum allowed layers for multiple monitoring .....	276
9.1A.3.2	Void.....	277
9.1.3A	UE Measurement capability under operation mode with CCA.....	277
9.1.3A.1	EN-DC: Monitoring of multiple layers using gaps under CCA .....	277
9.1.3A.1A	SA: Monitoring of multiple layers using gaps under CCA .....	277
9.1.3A.2	EN-DC: Maximum allowed layers for multiple monitoring under CCA .....	277
9.1A.3.2a	Void.....	278
9.1.3A.2A	SA: Maximum allowed layers for multiple monitoring under CCA .....	278
9.1.4	Capabilities for Support of Event Triggering and Reporting Criteria.....	278
9.1.4.1	Introduction.....	278
9.1.4.2	Requirements .....	279
9.1.5	Carrier-specific scaling factor.....	281
9.1.5.1	Monitoring of multiple layers outside gaps.....	281
9.1.5.1.1	EN-DC mode: carrier-specific scaling factor for SSB-based, CSI-RS based L3 measurements and RSSI and channel occupancy measurements performed outside gaps.....	283
9.1.5.1.2	SA mode: carrier-specific scaling factor for SSB-based, CSI-RS based L3 measurements and RSSI and channel occupancy measurements performed outside gaps.....	284
9.1.5.1.3	NR-DC mode: carrier-specific scaling factor for SSB-based and CSI-RS based L3 measurements performed outside gaps.....	285
9.1.5.1.4	NE-DC mode: carrier-specific scaling factor for SSB-based and CSI-RS based measurements performed outside gaps.....	285
9.1.5.2	Monitoring of multiple layers within gaps .....	286
9.1.5.2.1	EN-DC mode: carrier-specific scaling factor for SSB, CSI-RS-based L3 measurements and RSSI and channel occupancy measurements performed within gaps .....	287
9.1.5.2.2	SA mode: carrier-specific scaling factor for SSB, CSI-RS-based L3 measurements and RSSI and channel occupancy measurements performed within gaps .....	289
9.1.5.2.3	NE-DC: carrier-specific scaling factor for SSB-based and CSI-RS based L3 measurements performed within gaps .....	291
9.1.5.2.4	NR-DC: carrier-specific scaling factor for SSB-based and CSI-RS-based L3 measurements performed within gaps .....	292
9.1.5.2.5	SA mode: carrier-specific scaling factor for PRS-based measurements performed within gaps.....	294

9.1.5.2.6	NE-DC: carrier-specific scaling factor for PRS-based measurements performed within gaps.....	295
9.1.5.2.7	NR-DC: carrier-specific scaling factor for PRS-based measurements performed within gaps .....	295
9.1.6	Minimum requirement at transitions.....	295
9.2	NR intra-frequency measurements .....	295
9.2.1	Introduction.....	295
9.2.2	Requirements applicability .....	296
9.2.3	Number of cells and number of SSB .....	296
9.2.3.1	Requirements for FR1 .....	296
9.2.3.2	Requirements for FR2 .....	296
9.2.4	Measurement Reporting Requirements.....	297
9.2.4.1	Periodic Reporting .....	297
9.2.4.2	Event-triggered Periodic Reporting.....	297
9.2.4.3	Event Triggered Reporting.....	297
9.2.5	Intrafrequency measurements without measurement gaps.....	298
9.2.5.1	Intrafrequency cell identification .....	298
9.2.5.2	Measurement period.....	300
9.2.5.3	Scheduling availability of UE during intra-frequency measurements.....	302
9.2.5.3.1	Scheduling availability of UE performing measurements in TDD bands on FR1 .....	302
9.2.5.3.2	Scheduling availability of UE performing measurements with a different subcarrier spacing than PDSCH/PDCCH on FR1 .....	302
9.2.5.3.3	Scheduling availability of UE performing measurements on FR2 .....	303
9.2.5.3.4	Scheduling availability of UE performing measurements on FR1 or FR2 in case of FR1-FR2 inter-band CA .....	304
9.2.5.4	SFTD Measurements between PCell and PSCell.....	304
9.2.5.4.1	Introduction .....	304
9.2.5.4.2	SFTD Measurement delay .....	304
9.2.5.4.3	SFTD Measurement Reporting Delay .....	305
9.2.6	Intra-frequency measurements with measurement gaps .....	305
9.2.6.1	Void.....	305
9.2.6.2	Intra-frequency cell identification.....	305
9.2.6.3	Intrafrequency Measurement Period .....	306
9.2.A	NR intra-frequency measurements with CCA.....	307
9.2.A.1	Introduction.....	307
9.2.A.2	Requirements applicability .....	308
9.2.A.3	Number of cells and number of SSB .....	308
9.2.A.4	Measurement Reporting Requirements.....	309
9.2.A.5	Intra-frequency measurements without measurement gaps .....	309
9.2.A.5.2	Measurement period.....	311
9.2.A.5.3	Scheduling availability of UE during intra-frequency measurements.....	312
9.2.A.5.3.1	Scheduling availability of UE performing measurements in TDD bands.....	312
9.2.A.5.3.2	Scheduling availability of UE performing measurements with a different subcarrier spacing than PDSCH/PDCCH.....	313
9.2.A.6	Intra-frequency measurements with measurement gaps .....	313
9.2.A.6.1	Intra-frequency cell identification .....	313
9.2.A.6.2	Intra-frequency Measurement Period.....	314
9.2.A.7	Intra-frequency RSSI and Channel occupancy measurements.....	315
9.2.A.7.1	Intra-frequency RSSI measurements.....	315
9.2.A.7.2	Intra-frequency Channel occupancy measurements.....	316
9.2.A.7.3	Scheduling restriction during RSSI and Channel Occupancy measurements .....	317
9.3	NR inter-frequency measurements .....	317
9.3.1	Introduction.....	317
9.3.2	Requirements applicability .....	318
9.3.2.1	Void.....	318
9.3.2.2	Void.....	318
9.3.3	Number of cells and number of SSB .....	318
9.3.3.1	Requirements for FR1 .....	318
9.3.3.2	Requirements for FR2 .....	318
9.3.4	Inter-frequency measurement with measurement gaps .....	319
9.3.4.1	Void.....	320
9.3.4.2	Void.....	320
9.3.5	Inter-frequency measurements.....	320
9.3.5.1	Void.....	321

9.3.5.2	Void.....	321
9.3.5.3	Void.....	321
9.3.6	Inter-frequency measurements reporting requirements.....	321
9.3.6.1	Periodic Reporting .....	321
9.3.6.2	Event-triggered Periodic Reporting.....	321
9.3.6.3	Event-triggered Reporting.....	321
9.3.7	Void.....	322
9.3.8	Inter-frequency SFTD measurement requirements.....	322
9.3.8.1	Introduction.....	322
9.3.8.2	SFTD Measurement delay.....	322
9.3.8.3	SFTD Measurement reporting delay.....	323
9.3.9	Inter frequency measurements without measurement gaps.....	323
9.3.9.1	Inter frequency Cell identification .....	323
9.3.9.2	Measurement period.....	325
9.3.9.3	Scheduling availability of UE during inter-frequency measurements.....	325
9.3.9.3.1	Scheduling availability of UE performing measurements in TDD bands on FR1 .....	325
9.3.9.3.2	Scheduling availability of UE performing measurements with a different subcarrier spacing than PDSCH/PDCCH on FR1 .....	326
9.3.9.3.3	Scheduling availability of UE performing measurements on FR2 .....	326
9.3.9.3.4	Scheduling availability of UE performing measurements on FR1 or FR2 in case of FR1-FR2 inter-band CA .....	327
9.3A	NR inter-frequency measurements in carrier frequencies with CCA.....	327
9.3A.1	Introduction.....	327
9.3A.2	Requirements applicability .....	327
9.3A.3	Number of cells and number of SSB .....	328
9.3A.3.1	Requirements .....	328
9.3A.4	Inter-frequency cell identification.....	328
9.3A.5	Inter-frequency measurements.....	329
9.3A.6	NR Inter-frequency measurements reporting requirements .....	330
9.3A.6.1	Periodic Reporting .....	330
9.3A.6.2	Event-triggered Periodic Reporting.....	330
9.3A.6.3	Event-triggered Reporting.....	330
9.3A.8	Inter-frequency RSSI measurements .....	330
9.3A.9	Inter-frequency channel occupancy measurements .....	331
9.4	Inter-RAT measurements .....	331
9.4.1	Introduction.....	331
9.4.2	NR – E-UTRAN FDD measurements .....	333
9.4.2.1	Introduction.....	333
9.4.2.2	Requirements when no DRX is used.....	333
9.4.2.3	Requirements when DRX is used.....	334
9.4.2.4	Measurement reporting requirements.....	335
9.4.2.4.1	Periodic Reporting.....	335
9.4.2.4.2	Event-Triggered Periodic Reporting.....	335
9.4.2.4.3	Event-Triggered Reporting.....	335
9.4.3	NR – E-UTRAN TDD measurements .....	335
9.4.3.1	Introduction.....	335
9.4.3.2	Requirements when no DRX is used.....	335
9.4.3.3	Requirements when DRX is used.....	336
9.4.3.4	Measurement reporting requirements.....	338
9.4.3.4.1	Periodic Reporting.....	338
9.4.3.4.2	Event-Triggered Periodic Reporting.....	338
9.4.3.4.3	Event-Triggered Reporting.....	338
9.4.4	Inter-RAT RSTD measurements.....	338
9.4.4.1	NR – E-UTRAN FDD RSTD measurements.....	338
9.4.4.1.1	Introduction .....	338
9.4.4.1.2	Requirements .....	339
9.4.4.2	NR – E-UTRAN TDD RSTD measurements .....	342
9.4.4.2.1	Introduction .....	342
9.4.4.2.2	Requirements .....	342
9.4.5	Inter-RAT E-CID measurements .....	346
9.4.5.1	NR–E-UTRAN FDD E-CID RSRP and RSRQ measurements .....	346
9.4.5.1.1	Introduction .....	346