

ETSI TS 138 133 V16.19.0 (2024-06)



5G; NR; Requirements for support of radio resource management (3GPP TS 38.133 version 16.19.0 Release 16)

[ETSI TS 138 133 V16.19.0 \(2024-06\)](https://standards.iteh.ai/catalog/standards/etsi/d3870cd7-c7bc-4c51-89f1-85f45dc70c0d/etsi-ts-138-133-v16-19-0-2024-06)

<https://standards.iteh.ai/catalog/standards/etsi/d3870cd7-c7bc-4c51-89f1-85f45dc70c0d/etsi-ts-138-133-v16-19-0-2024-06>



ReferenceRTS/TSGR-0438133vgj0

Keywords5G

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:

<https://www.etsi.org/standards-search>

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 at www.etsi.org/deliver.

Users of the present document should be aware that the document may be subject to revision or change of status.

Information on the current status of this and other ETSI documents is available at

<https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx>

If you find errors in the present document, please send your comment to one of the following services:

<https://portal.etsi.org/People/CommitteeSupportStaff.aspx>

If you find a security vulnerability in the present document, please report it through our

Coordinated Vulnerability Disclosure Program:

<https://www.etsi.org/standards/coordinated-vulnerability-disclosure>

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 Web server (<https://ipr.etsi.org/>).

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™** and **LTE™** 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. (2024-06)

The cross reference between 3GPP and ETSI identities can be found under <https://webapp.etsi.org/key/queryform.asp>.

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.....	69
1 Scope	71
2 References	71
3 Definitions, symbols and abbreviations	72
3.1 Definitions	72
3.2 Symbols.....	73
3.3 Abbreviations	74
3.4 Test tolerances	77
3.5 Frequency bands grouping	77
3.5.1 Introduction.....	77
3.5.2 NR operating bands in FR1	77
3.5.3 NR operating bands in FR2	78
3.6 Applicability of requirements in this specification version	78
3.6.1 RRC connected state requirements in DRX.....	79
3.6.2 Number of serving carriers	79
3.6.2.1 Number of serving carriers for SA.....	79
3.6.2.2 Number of serving carriers for EN-DC.....	79
3.6.2.3 Number of serving carriers for NE-DC.....	79
3.6.2.4 Number of serving carriers for NR-DC.....	80
3.6.3 Applicability for intra-band FR2	80
3.6.4 Applicability for FR2 UE power classes.....	80
3.6.5 Applicability for SDL bands.....	80
3.6.6 Applicability of requirements for NGEN-DC operation.....	80
3.6.7 Applicability of QCL.....	80
3.6.9 Applicability of requirements for scheduling availability.....	81
3.6.10 Applicability of requirements for measurement restrictions.....	81
4 SA: RRC_IDLE state mobility.....	81
4.1 Cell Selection	81
4.2 Cell Re-selection	81
4.2.1 Introduction.....	81
4.2.2 Requirements	82
4.2.2.1 UE measurement capability	82
4.2.2.2 Measurement and evaluation of serving cell.....	82
4.2.2.3 Measurements of intra-frequency NR cells.....	83
4.2.2.4 Measurements of inter-frequency NR cells.....	84
4.2.2.5 Measurements of inter-RAT E-UTRAN cells.....	86
4.2.2.6 Maximum interruption in paging reception.....	88
4.2.2.7 General requirements	88
4.2.2.8 Minimum requirement at transitions	88
4.2.2.9 Measurements of intra-frequency NR cells for UE configured with relaxed measurement criterion	89
4.2.2.9.1 Introduction	89
4.2.2.9.2 Measurements for UE fulfilling low mobility criterion.....	89
4.2.2.9.3 Measurements for UE fulfilling not-at-cell edge criterion.....	90
4.2.2.9.4 Measurements for UE fulfilling low mobility and not-at-cell edge criteria.....	90
4.2.2.10 Measurements of inter-frequency NR cells for UE configured with relaxed measurement criterion	91
4.2.2.10.1 Introduction	91
4.2.2.10.2 Measurements for UE fulfilling low mobility criterion.....	91
4.2.2.10.3 Measurements for UE fulfilling not-at-cell edge criterion.....	92
4.2.2.10.4 Measurements for UE fulfilling low mobility and not-at-cell edge criterion	93

4.2.2.11	Measurements of inter-RAT E-UTRAN cells for UE configured with relaxed measurement criterion	93
4.2.2.11.1	Introduction	93
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	95
4.2.2.11.4	Measurements for UE fulfilling low mobility and not-at-cell edge criterion	96
4.2A	Cell Re-selection when subject to CCA	96
4.2A.1	Introduction.....	96
4.2A.2	Requirements	97
4.2A.2.1	UE measurement capability	97
4.2A.2.2	Measurement and evaluation when subject to CCA on the serving cell	97
4.2A.2.3	Measurements of intra-frequency NR cells when subject to CCA on the serving cell and target cell.....	98
4.2A.2.4	Measurements of inter-frequency NR cells when subject to CCA on the target cell	99
4.2A.2.5	Measurements of inter-RAT E-UTRAN cells when subject to CCA on the serving cell.....	101
4.2A.2.6	Maximum interruption in paging reception when subject to CCA on the target cell	101
4.2A.2.7	General requirements	101
4.3	Minimization of Drive Tests (MDT)	101
4.3.1	Introduction.....	101
4.3.2	Measurement Requirements.....	102
4.3.3	Requirements for Relative Time Stamp Accuracy.....	102
4.3.4	Requirements for Relative Time Stamp Accuracy for RRC Connection Establishment Failure Log Reporting	102
4.3.5	Requirements for Relative Time Stamp Accuracy for Radio Link Failure and Handover Failure Log Reporting	103
4.4	Idle Mode CA/DC Measurements	103
4.4.1	Introduction.....	103
4.4.2	Measurement Requirements.....	103
4.4.2.1	Detected cell requirement during state transition and Idle mode	103
4.4.2.2	Measurements of inter-frequency CA/DC candidate cells	104
4.4.2.3	Measurements on serving cell	105
4.4.2.4	Measurements of E-UTRAN inter-RAT DC candidate cells	105
5	SA: RRC_INACTIVE state mobility	106
5.1	Cell Re-selection	106
5.1.1	Introduction.....	106
5.1.2	Requirements	106
5.1.2.1	UE measurement capability	106
5.1.2.2	Measurement and evaluation of serving cell	106
5.1.2.3	Measurements of intra-frequency NR cells	106
5.1.2.4	Measurements of inter-frequency NR cells.....	106
5.1.2.5	Measurements of inter-RAT E-UTRAN cells	106
5.1.2.6	Maximum interruption in paging reception.....	106
5.1.2.7	General requirements	106
5.1A	Cell Re-selection with CCA	106
5.1A.1	Introduction.....	106
5.1A.2	Requirements	107
5.1A.2.1	UE measurement capability	107
5.1A.2.2	Measurement and evaluation when CCA is used on the serving cell.....	107
5.1A.2.3	Measurements of intra-frequency NR cells when CCA is used on the serving cell and target cell.....	107
5.1A.2.4	Measurements of inter-frequency NR cells when CCA is used on the target cell.....	107
5.1A.2.5	Measurements of inter-RAT E-UTRAN cells when CCA is used on the serving cell	107
5.1A.2.6	Maximum interruption in paging reception when CCA is used on the target cell	107
5.1A.2.7	General requirements	107
5.2	Void.....	107
5.3	Minimization of Drive Tests (MDT)	107
5.3.1	Introduction.....	107
5.3.2	Measurement Requirements.....	108
5.3.3	Requirements for Relative Time Stamp Accuracy.....	108
5.3.4	Requirements for Relative Time Stamp Accuracy for RRC Connection Establishment Failure Log Reporting	108

5.3.5	Requirements for Relative Time Stamp Accuracy for Radio Link Failure and Handover Failure Log Reporting	108
5.3.6	Requirements for Relative Time Stamp Accuracy for RRC Resume Failure Log Reporting	108
5.4	Inactive Mode CA/DC Measurements	108
5.4.1	Introduction.....	108
5.4.2	Measurement Requirements.....	108
5.4.2.1	Detected cell requirement during state transition and inactive mode.....	109
5.4.2.2	Measurements of inter-frequency CA/DC candidate cells	109
5.4.2.3	Measurements on serving cell	109
5.4.2.4	Measurements on E-UTRAN inter-RAT DC candidate cells	109
6	RRC_CONNECTED state mobility	109
6.1	Handover	109
6.1.1	NR Handover	109
6.1.1.1	Introduction.....	109
6.1.1.2	NR FR1 - NR FR1 Handover	109
6.1.1.2.1	Handover delay.....	109
6.1.1.2.2	Interruption time	109
6.1.1.3	NR FR2- NR FR1 Handover	110
6.1.1.3.1	Handover delay.....	110
6.1.1.3.2	Interruption time	110
6.1.1.4	NR FR2- NR FR2 Handover	111
6.1.1.4.1	Handover delay.....	111
6.1.1.4.2	Interruption time	111
6.1.1.5	NR FR1- NR FR2 Handover	112
6.1.1.5.1	Handover delay.....	112
6.1.1.5.2	Interruption time	112
6.1.2	NR Handover to other RATs	113
6.1.2.1	NR – E-UTRAN Handover	113
6.1.2.1.1	Introduction	113
6.1.2.1.2	Handover delay.....	113
6.1.2.1.3	Interruption time	113
6.1.2.2	NR – UTRAN Handover	114
6.1.2.2.1	Introduction	114
6.1.2.2.2	Handover delay.....	114
6.1.2.2.3	Interruption time	114
6.1.3	NR DAPS Handover	115
6.1.3.1	Introduction.....	115
6.1.3.2	NR FR1 - NR FR1 DAPS Handover.....	115
6.1.3.2.1	DAPS handover delay	115
6.1.3.2.2	Interruption time	116
6.1.3.3	NR FR2- NR FR1 DAPS Handover.....	118
6.1.3.3.1	DAPS handover delay	118
6.1.3.3.2	Interruption time	118
6.1.3.4	NR FR1- NR FR2 DAPS Handover.....	119
6.1.3.4.1	DAPS handover delay	119
6.1.3.4.2	Interruption time	119
6.1.4	NR Conditional Handover	120
6.1.4.1	Introduction.....	120
6.1.4.2	NR FR1 – NR FR1 conditional handover	120
6.1.4.3	NR FR2 – NR FR1 conditional handover	121
6.1.4.4	NR FR2 – NR FR2 conditional handover	121
6.1.4.4.1	Handover delay.....	122
6.1.4.4.2	Measurement time	122
6.1.4.4.3	Preparation time.....	122
6.1.4.4.4	Interruption time	122
6.1.4.5	NR FR1 – NR FR2 conditional handover	123
6.1A	Void.....	123
6.1A.1	Void	123
6.1A.1.1	Void.....	123
6.1A.1.2	Void.....	123
6.1A.1.2.1	Void.....	123

6.1A.1.2.2	Void	123
6.1B	Handover to target cell using CCA	123
6.1B.1	NR Handover	123
6.1B.1.1	Introduction	123
6.1B.1.2	NR FR1 - NR FR1 Handover	124
6.1B.1.2.1	Handover delay	124
6.1B.1.2.2	Interruption time	124
6.2	RRC Connection Mobility Control	125
6.2.1	SA: RRC Re-establishment	125
6.2.1.1	Introduction	125
6.2.1.2	Requirements	125
6.2.1.2.1	UE Re-establishment delay requirement	125
6.2.1A	RRC Re-establishment with CCA	126
6.2.1A.1	Introduction	126
6.2.1A.2	Requirements	127
6.2.1A.2.1	UE Re-establishment with CCA delay requirement	127
6.2.2	Random access	128
6.2.2.1	Introduction	128
6.2.2.2	Requirements for 4-step RA type	129
6.2.2.2.1	Contention based random access	129
6.2.2.2.2	Non-Contention based random access	130
6.2.2.2.3	UE behaviour when configured with supplementary UL	131
6.2.2.3	Requirements for 2-step RA type	131
6.2.2.3.1	Contention based random access	131
6.2.2.3.2	Non-Contention based random access	132
6.2.2.3.3	UE behaviour when configured with supplementary UL	133
6.2.2A	Random access when CCA is used on target frequency	133
6.2.2A.1	Introduction	133
6.2.2A.2	Requirements for 4-step RA type	133
6.2.2A.2.1	Contention based random access	133
6.2.2A.2.2	Non-Contention based random access	134
6.2.2A.3	Requirements for 2-step RA type	135
6.2.2A.3.1	Contention based random access	136
6.2.2A.3.2	Non-Contention based random access	137
6.2.3	SA: RRC Connection Release with Redirection	137
6.2.3.1	Introduction	137
6.2.3.2	Requirements	138
6.2.3.2.1	RRC connection release with redirection to NR	138
6.2.3.2.2	RRC connection release with redirection to E-UTRAN	139
6.2.3.2.3	RRC connection release with redirection to NR carrier subject to CCA	139
7	Timing	140
7.1	UE transmit timing	140
7.1.1	Introduction	140
7.1.2	Requirements	140
7.1.2.1	Gradual timing adjustment	142
7.1.2.2	Void	142
7.2	UE timer accuracy	142
7.2.1	Introduction	142
7.2.2	Requirements	142
7.3	Timing advance	143
7.3.1	Introduction	143
7.3.2	Requirements	143
7.3.2.1	Timing Advance adjustment delay	143
7.3.2.2	Timing Advance adjustment accuracy	143
7.4	Cell phase synchronization accuracy	143
7.4.1	Definition	143
7.4.2	Minimum requirements	143
7.5	Maximum Transmission Timing Difference	143
7.5.1	Introduction	143
7.5.2	Minimum Requirements for inter-band EN-DC	144
7.5.2.1	Minimum Requirements for inter-band synchronous EN-DC	144

7.5.3	Minimum Requirements for intra-band EN-DC	145
7.5.4	Minimum Requirements for NR Carrier Aggregation	145
7.5.5	Minimum Requirements for inter-band NE-DC	145
7.5.5.1	Minimum Requirements for inter-band synchronous NE-DC	146
7.5.6	Minimum Requirements for inter-band NR DC	146
7.6	Maximum Receive Timing Difference.....	147
7.6.1	Introduction.....	147
7.6.2	Minimum Requirements for inter-band EN-DC	147
7.6.2.1	Minimum Requirements for inter-band synchronous EN-DC	147
7.6.3	Minimum Requirements for intra-band EN-DC	148
7.6.4	Minimum Requirements for NR Carrier Aggregation	148
7.6.5	Minimum Requirements for inter-band NE-DC	149
7.6.5.1	Minimum Requirements for inter-band synchronous NE-DC	149
7.6.6	Minimum Requirements for inter-band NR DC	150
7.7	<i>deriveSSB-IndexFromCell</i> tolerance	150
7.7.1	Minimum requirements.....	150
7.8	Void.....	151
8	Signalling characteristics.....	151
8.1	Radio Link Monitoring.....	151
8.1.1	Introduction.....	151
8.1.2	Requirements for SSB based radio link monitoring	152
8.1.2.1	Introduction.....	152
8.1.2.2	Minimum requirement	152
8.1.2.3	Measurement restrictions for SSB based RLM.....	154
8.1.3	Requirements for CSI-RS based radio link monitoring	155
8.1.3.1	Introduction.....	155
8.1.3.2	Minimum requirement	155
8.1.3.3	Measurement restrictions for CSI-RS based RLM.....	157
8.1.4	Minimum requirement at transitions.....	158
8.1.5	Minimum requirement for UE turning off the transmitter	158
8.1.6	Minimum requirement for L1 indication	159
8.1.7	Scheduling availability of UE during radio link monitoring.....	159
8.1.7.1	Scheduling availability of UE performing radio link monitoring with a same subcarrier spacing as PDSCH/PDCCH on FR1	159
8.1.7.2	Scheduling availability of UE performing radio link monitoring with a different subcarrier spacing than PDSCH/PDCCH on FR1.....	159
8.1.7.3	Scheduling availability of UE performing radio link monitoring on FR2.....	159
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.....	160
8.1A	Radio Link Monitoring with CCA on Target Frequency	160
8.1A.1	Introduction.....	160
8.1A.2	Requirements for SSB Based Radio Link Monitoring.....	161
8.1A.2.1	Introduction.....	161
8.1A.2.2	Minimum Requirement	162
8.1A.3	Minimum requirement at transitions.....	163
8.1A.4	Minimum requirement for UE turning off the transmitter	163
8.1A.5	Minimum requirement for L1 indication	163
8.1A.6	Scheduling availability of UE during radio link monitoring.....	164
8.1A.6.1	Scheduling availability of UE performing radio link monitoring with the same subcarrier spacing as PDSCH/PDCCH	164
8.1A.6.2	Scheduling availability of UE performing radio link monitoring with a different subcarrier spacing than PDSCH/PDCCH	164
8.2	Interruption.....	164
8.2.1	EN-DC Interruption	164
8.2.1.1	Introduction.....	164
8.2.1.2	Requirements	165
8.2.1.2.1	Interruptions at transitions between active and non-active during DRX	165
8.2.1.2.2	Interruptions at transitions from non-DRX to DRX	165
8.2.1.2.3	Interruptions at SCell addition/release.....	165
8.2.1.2.4	Interruptions at SCell activation/deactivation.....	167
8.2.1.2.5	Interruptions during measurements on SCC.....	168

8.2.1.2.6	Interruptions at UL carrier RRC reconfiguration	169
8.2.1.2.7	Interruptions due to Active BWP switching Requirement	170
8.2.1.2.8	Interruptions at direct SCell activation and hibernation	171
8.2.1.2.9	Interruptions at SCell hibernation.....	171
8.2.1.2.10	Interruptions at SCell activation/deactivation with multiple downlink SCells	172
8.2.1.2.11	Interruptions due to UE-specific CBW change	172
8.2.1.2.12	Interruptions at NR SRS carrier based switching	172
8.2.1.2.13	Interruptions at E-UTRA SRS carrier based switching	174
8.2.1.2.14	DL Interruptions at switching between two uplink carriers.....	174
8.2.1.2.15	Interruptions due to SCell dormancy	175
8.2.1.2.16	Interruptions when identifying CGI of an NR cell with autonomous gaps.....	175
8.2.1.2.17	Interruptions when identifying CGI of an E-UTRA cell with autonomous gaps	176
8.2.2	SA: Interruptions with Standalone NR Carrier Aggregation	177
8.2.2.1	Introduction.....	177
8.2.2.2	Requirements	177
8.2.2.2.1	Interruptions at SCell addition/release.....	177
8.2.2.2.2	Interruptions at SCell activation/deactivation.....	178
8.2.2.2.3	Interruptions during measurements on deactivated SCC.....	179
8.2.2.2.4	Interruptions at UL carrier RRC reconfiguration	180
8.2.2.2.5	Interruptions due to Active BWP switching Requirement	180
8.2.2.2.6	Interruptions at inter-frequency SFTD measurement	181
8.2.2.2.7	Interruptions at SCell activation/deactivation with multiple downlink SCells	182
8.2.2.2.8	Interruptions due to UE-specific CBW change	182
8.2.2.2.9	Interruptions at NR SRS carrier based switching	182
8.2.2.2.10	DL Interruptions at UE switching between two uplink carriers	184
8.2.2.2.11	Interruptions at direct SCell activation.....	184
8.2.2.2.12	Interruptions due to SCell dormancy.....	185
8.2.2.2.13	Interruptions at transitions between active and non-active during DRX	185
8.2.2.2.14	Interruptions when identifying CGI of an NR cell with autonomous gaps.....	185
8.2.2.2.15	Interruptions when identifying CGI of an E-UTRA cell with autonomous gaps	186
8.2.3	NE-DC Interruptions.....	186
8.2.3.1	Introduction.....	186
8.2.3.2	Requirements	187
8.2.3.2.1	Interruptions at transitions between active and non-active during DRX	187
8.2.3.2.2	Interruptions at transitions from non-DRX to DRX	187
8.2.3.2.3	Interruptions at PSCell/SCell addition/release	187
8.2.3.2.4	Interruptions at SCell activation/deactivation.....	189
8.2.3.2.5	Interruptions during measurements on SCC.....	190
8.2.3.2.6	Interruptions at UL carrier RRC reconfiguration	191
8.2.3.2.7	Interruptions due to Active BWP switching Requirement	191
8.2.3.2.8	Interruptions at direct SCell activation and hibernation	191
8.2.3.2.9	Interruptions at SCell hibernation.....	192
8.2.3.2.10	Interruptions at SCell activation/deactivation with multiple downlink SCells	192
8.2.3.2.11	Interruptions at NR SRS carrier based switching	192
8.2.3.2.12	Interruptions at E-UTRA SRS carrier based switching	194
8.2.3.2.13	Interruptions due to SCell dormancy	195
8.2.3.2.14	Interruptions when identifying CGI of an NR cell with autonomous gaps.....	195
8.2.3.2.15	Interruptions when identifying CGI of an E-UTRA cell with autonomous gaps	196
8.2.3.2.16	Interruptions due to UE-specific CBW change	196
8.2.4	NR-DC: Interruptions	196
8.2.4.1	Introduction.....	196
8.2.4.2	Requirements	197
8.2.4.2.1	Interruptions at PSCell/SCell addition/release	197
8.2.4.2.3	Interruptions during measurements on SCC.....	199
8.2.4.2.4	Interruptions at UL carrier RRC reconfiguration	199
8.2.4.2.5	Interruptions due to Active BWP switching Requirement	199
8.2.4.2.6	Interruptions at transitions between active and non-active during DRX	199
8.2.4.2.7	Interruptions at transitions from non-DRX to DRX	200
8.2.4.2.8	Interruptions at SCell activation/deactivation with multiple downlink SCells	200
8.2.4.2.9	Interruptions at NR SRS carrier based switching	200
8.2.4.2.10	Interruptions at direct SCell activation.....	202
8.2.4.2.11	Interruptions when identifying CGI of an NR cell with autonomous gaps.....	202

8.2.4.2.12	Interruptions when identifying CGI of an E-UTRA cell with autonomous gaps	202
8.2.4.2.13	Interruptions due to SCell dormancy	203
8.2.4.2.14	Interruptions due to UE-specific CBW change	204
8.2.4.2A	Void.....	204
8.2.4.2A.1	Void.....	204
8.2.4.2A.2	Void.....	204
8.2.4.2A.3	Void.....	204
8.3	SCell Activation and Deactivation Delay.....	204
8.3.1	Introduction.....	204
8.3.2	SCell Activation Delay Requirement for Deactivated SCell	204
8.3.3	SCell Deactivation Delay Requirement for Activated SCell	208
8.3.4	Direct SCell Activation at SCell addition.....	209
8.3.5	Direct SCell Activation at Handover	210
8.3.7	SCell Activation Delay Requirement for Deactivated SCell with Multiple Downlink SCells	212
8.3.8	SCell Deactivation Delay Requirement for Activated SCell with Multiple Downlink SCells	216
8.3.9	Direct SCell Activation of Multiple Downlink SCells at SCell addition.....	216
8.3.10	Direct SCell Activation of Multiple Downlink SCells at Handover	217
8.3A	SCell Activation and Deactivation Delay in Carriers with CCA.....	219
8.3A.1	Introduction.....	219
8.3A.2	SCell Activation Delay Requirement for Deactivated SCell	219
8.3A.3	SCell Deactivation Delay Requirement for Activated SCell	222
8.4	UE UL carrier RRC reconfiguration delay.....	222
8.4.1	Introduction.....	222
8.4.2	UE UL carrier configuration delay requirement	222
8.4.3	UE UL carrier deconfiguration delay requirement	222
8.5	Link Recovery Procedures	223
8.5.1	Introduction.....	223
8.5.2	Requirements for SSB based beam failure detection	224
8.5.2.1	Introduction.....	224
8.5.2.2	Minimum requirement	224
8.5.2.3	Measurement restriction for SSB based beam failure detection.....	226
8.5.3	Requirements for CSI-RS based beam failure detection.....	226
8.5.3.1	Introduction.....	226
8.5.3.2	Minimum requirement	227
8.5.3.3	Measurement restrictions for CSI-RS beam failure detection.....	229
8.5.4	Minimum requirement for L1 indication	230
8.5.5	Requirements for SSB based candidate beam detection	230
8.5.5.1	Introduction.....	230
8.5.5.2	Minimum requirement	230
8.5.5.3	Measurement restriction for SSB based candidate beam detection.....	232
8.5.6	Requirements for CSI-RS based candidate beam detection.....	233
8.5.6.1	Introduction.....	233
8.5.6.2	Minimum requirement	233
8.5.6.3	Measurement restriction for CSI-RS based candidate beam detection	235
8.5.7	Scheduling availability of UE during beam failure detection	236
8.5.7.1	Scheduling availability of UE performing beam failure detection with a same subcarrier spacing as PDSCH/PDCCH on FR1	236
8.5.7.2	Scheduling availability of UE performing beam failure detection with a different subcarrier spacing than PDSCH/PDCCH on FR1.....	236
8.5.7.3	Scheduling availability of UE performing beam failure detection on FR2	236
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	237
8.5.8	Scheduling availability of UE during candidate beam detection	237
8.5.8.1	Scheduling availability of UE performing L1-RSRP measurement with a same subcarrier spacing as PDSCH/PDCCH on FR1	237
8.5.8.2	Scheduling availability of UE performing L1-RSRP measurement with a different subcarrier spacing than PDSCH/PDCCH on FR1.....	237
8.5.8.3	Scheduling availability of UE performing L1-RSRP measurement on FR2	237
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.....	238
8.5.9	Requirements for Beam Failure Recovery in SCell.....	238
8.5.9.1	Introduction.....	238

8.5.9.2	Requirement	238
8.5.10	Minimum requirement at transitions for beam failure detection.....	238
8.5A	Link Recovery Procedures when CCA is used on target frequency	239
8.5A.1	Introduction.....	239
8.5A.2	Requirements for SSB based beam failure detection	239
8.5A.2.1	Introduction.....	239
8.5A.2.2	Minimum requirement	240
8.5A.2.3	Measurement restriction for SSB based beam failure detection.....	240
8.5A.4	Minimum requirement for L1 indication	241
8.5A.5	Requirements for SSB based candidate beam detection	241
8.5A.5.1	Introduction.....	241
8.5A.5.2	Minimum requirement	241
8.5A.5.3	Measurement restriction for SSB based candidate beam detection.....	242
8.5A.7	Scheduling availability of UE during beam failure detection	242
8.5A.7.1	Scheduling availability of UE performing beam failure detection with a same subcarrier spacing as PDSCH/PDCCH	242
8.5A.7.2	Scheduling availability of UE performing beam failure detection with a different subcarrier spacing than PDSCH/PDCCH	242
8.5A.8	Scheduling availability of UE during candidate beam detection	242
8.5A.8.1	Scheduling availability of UE performing L1-RSRP measurement with a same subcarrier spacing as PDSCH/PDCCH	242
8.5A.8.2	Scheduling availability of UE performing L1-RSRP measurement with a different subcarrier spacing than PDSCH/PDCCH	243
8.6	Active BWP switch delay.....	243
8.6.1	Introduction.....	243
8.6.2	DCI and timer based BWP switch delay on a single CC	243
8.6.2A	DCI based BWP switch delay on multiple CCs.....	244
8.6.2A.1	Simultaneous DCI based BWP switch delay on multiple CCs	244
8.6.2A.2	Non-simultaneous DCI based BWP switch delay on multiple CCs	246
8.6.2B	Timer based BWP switch delay on multiple CCs.....	246
8.6.2B.1	Simultaneous timer based BWP switch delay on multiple CCs	246
8.6.2B.2	Non-simultaneous timer based BWP switch delay on multiple CCs	246
8.6.3	RRC based BWP switch delay on a single CC	247
8.6.3A	RRC based BWP switch delay on multiple CCs.....	248
8.6.3A.1	Simultaneous RRC based BWP switch delay on multiple CCs	248
8.6.3A.2	Non-simultaneous RRC based BWP switch delay on multiple CCs	248
8.6.4	BWP switch delay on Consistent UL CCA recovery.....	249
8.7	Void.....	249
8.8	NE-DC: E-UTRAN PSCell Addition and Release Delay	249
8.8.1	Introduction.....	249
8.8.2	E-UTRAN PSCell Addition Delay Requirement.....	249
8.8.3	E-UTRAN PSCell Release Delay Requirement	250
8.9	NR-DC: PSCell Addition and Release Delay.....	250
8.9.1	Introduction.....	250
8.9.2	PSCell Addition Delay Requirement	250
8.9.3	PSCell Release Delay Requirement.....	251
8.10	Active TCI state switching delay	251
8.10.4	DCI based TCI state switch delay.....	252
8.10.5	RRC based TCI state switch delay.....	253
8.10.6	Active TCI state list update delay.....	253
8.10A	Active TCI state switching delay with CCA	253
8.10A.1	Introduction.....	253
8.10A.2	Known conditions for TCI state.....	254
8.10A.3	MAC-CE based TCI state switch delay	254
8.10A.4	DCI based TCI state switch delay.....	255
8.10A.5	RRC based TCI state switch delay.....	255
8.10A.6	Active TCI state list update delay.....	256
8.11	PSCell Change.....	256
8.11A	void.....	256
8.11B	Conditional PSCell Change	256
8.11B.1	Introduction.....	256
8.11B.2	Conditional PSCell Change delay.....	256

8.11B.2.1	Measurement time	257
8.12	Uplink spatial relation switch delay	258
8.12.1	Introduction.....	258
8.12.2	Known conditions for spatial relation when associated with DL-RS	258
8.12.3	MAC-CE based spatial relation switch delay	258
8.12.4	DCI based spatial relation switch delay	259
8.12.5	RRC based spatial relation switch delay	259
8.13	UE-specific CBW change.....	259
8.13.1	Introduction.....	259
8.13.2	UE-specific CBW change delay	260
8.14	Pathloss reference signal switching delay	260
8.14.1	Introduction.....	260
8.14.2	Known conditions for pathloss reference signal	260
8.14.3	MAC-CE based pathloss reference signal switch delay	261
9	Measurement Procedure	261
9.1	General measurement requirement	261
9.1.1	Introduction.....	261
9.1.2	Measurement gap	262
9.1.2.1	EN-DC: Measurement Gap Sharing.....	270
9.1.2.1a	SA: Measurement Gap Sharing.....	271
9.1.2.1b	NE-DC: Measurement Gap Sharing.....	271
9.1.2.1c	NR-DC: Measurement Gap Sharing	272
9.1.3	UE Measurement capability	273
9.1.3.1	EN-DC: Monitoring of multiple layers using gaps	273
9.1.3.1a	SA: Monitoring of multiple layers using gaps	274
9.1.3.1b	NE-DC: Monitoring of multiple layers using gaps	274
9.1.3.1c	NR-DC: Monitoring of multiple layers using gaps	275
9.1.3.2	EN-DC: Maximum allowed layers for multiple monitoring	275
9.1.3.2a	SA: Maximum allowed layers for multiple monitoring	276
9.1.3.2b	NE-DC: Maximum allowed layers for multiple monitoring	277
9.1.3.2c	NR-DC: Maximum allowed layers for multiple monitoring	277
9.1.3.2	Void.....	278
9.1.3A	UE Measurement capability under operation mode with CCA.....	278
9.1.3A.1	EN-DC: Monitoring of multiple layers using gaps under CCA	278
9.1.3A.1A	SA: Monitoring of multiple layers using gaps under CCA	278
9.1.3A.2	EN-DC: Maximum allowed layers for multiple monitoring under CCA	278
9.1.3.2a	Void.....	279
9.1.3A.2A	SA: Maximum allowed layers for multiple monitoring under CCA	279
9.1.4	Capabilities for Support of Event Triggering and Reporting Criteria.....	279
9.1.4.1	Introduction.....	279
9.1.4.2	Requirements	280
9.1.5	Carrier-specific scaling factor.....	282
9.1.5.1	Monitoring of multiple layers outside gaps.....	282
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.....	284
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.....	285
9.1.5.1.3	NR-DC mode: carrier-specific scaling factor for SSB-based and CSI-RS based L3 measurements performed outside gaps.....	286
9.1.5.1.4	NE-DC mode: carrier-specific scaling factor for SSB-based and CSI-RS based measurements performed outside gaps.....	286
9.1.5.2	Monitoring of multiple layers within gaps	287
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	288
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	290
9.1.5.2.3	NE-DC: carrier-specific scaling factor for SSB-based and CSI-RS based L3 measurements performed within gaps	292
9.1.5.2.4	NR-DC: carrier-specific scaling factor for SSB-based and CSI-RS-based L3 measurements performed within gaps	293
9.1.5.2.5	SA mode: carrier-specific scaling factor for PRS-based measurements performed within gaps...	295

9.1.5.2.6	NE-DC: carrier-specific scaling factor for PRS-based measurements performed within gaps.....	296
9.1.5.2.7	NR-DC: carrier-specific scaling factor for PRS-based measurements performed within gaps	296
9.1.6	Minimum requirement at transitions.....	296
9.2	NR intra-frequency measurements	296
9.2.1	Introduction.....	296
9.2.2	Requirements applicability	297
9.2.3	Number of cells and number of SSB	297
9.2.3.1	Requirements for FR1	297
9.2.3.2	Requirements for FR2	297
9.2.4	Measurement Reporting Requirements.....	298
9.2.4.1	Periodic Reporting	298
9.2.4.2	Event-triggered Periodic Reporting.....	298
9.2.4.3	Event Triggered Reporting.....	298
9.2.5	Intrafrequency measurements without measurement gaps.....	299
9.2.5.1	Intrafrequency cell identification	299
9.2.5.2	Measurement period.....	301
9.2.5.3	Scheduling availability of UE during intra-frequency measurements.....	303
9.2.5.3.1	Scheduling availability of UE performing measurements in TDD bands on FR1.....	303
9.2.5.3.2	Scheduling availability of UE performing measurements with a different subcarrier spacing than PDSCH/PDCCH on FR1	303
9.2.5.3.3	Scheduling availability of UE performing measurements on FR2	304
9.2.5.3.4	Scheduling availability of UE performing measurements on FR1 or FR2 in case of FR1-FR2 inter-band CA	305
9.2.5.4	SFTD Measurements between PCell and PSCell.....	305
9.2.5.4.1	Introduction	305
9.2.5.4.2	SFTD Measurement delay.....	305
9.2.5.4.3	SFTD Measurement Reporting Delay	306
9.2.6	Intra-frequency measurements with measurement gaps	306
9.2.6.1	Void.....	306
9.2.6.2	Intra-frequency cell identification.....	306
9.2.6.3	Intrafrequency Measurement Period	307
9.2A	NR intra-frequency measurements with CCA.....	308
9.2A.1	Introduction.....	308
9.2A.2	Requirements applicability	309
9.2A.3	Number of cells and number of SSB	309
9.2A.4	Measurement Reporting Requirements.....	310
9.2A.5	Intra-frequency measurements without measurement gaps	310
9.2A.5.2	Measurement period.....	312
9.2A.5.3	Scheduling availability of UE during intra-frequency measurements.....	313
9.2A.5.3.1	Scheduling availability of UE performing measurements in TDD bands.....	313
9.2A.5.3.2	Scheduling availability of UE performing measurements with a different subcarrier spacing than PDSCH/PDCCH.....	314
9.2A.6	Intra-frequency measurements with measurement gaps	314
9.2A.6.1	Intra-frequency cell identification.....	314
9.2A.6.2	Intra-frequency Measurement Period.....	315
9.2A.7	Intra-frequency RSSI and Channel occupancy measurements.....	316
9.2A.7.1	Intra-frequency RSSI measurements.....	316
9.2A.7.2	Intra-frequency Channel occupancy measurements.....	317
9.2A.7.3	Scheduling restriction during RSSI and Channel Occupancy measurements	318
9.3	NR inter-frequency measurements	318
9.3.1	Introduction.....	318
9.3.2	Requirements applicability	319
9.3.2.1	Void.....	319
9.3.2.2	Void.....	319
9.3.3	Number of cells and number of SSB	319
9.3.3.1	Requirements for FR1	319
9.3.3.2	Requirements for FR2	319
9.3.4	Inter-frequency measurement with measurement gaps.....	320
9.3.4.1	Void.....	321
9.3.4.2	Void.....	321
9.3.5	Inter-frequency measurements.....	321
9.3.5.1	Void.....	322

9.3.5.2	Void.....	322
9.3.5.3	Void.....	322
9.3.6	Inter-frequency measurements reporting requirements.....	322
9.3.6.1	Periodic Reporting	322
9.3.6.2	Event-triggered Periodic Reporting.....	322
9.3.6.3	Event-triggered Reporting.....	322
9.3.7	Void.....	323
9.3.8	Inter-frequency SFTD measurement requirements.....	323
9.3.8.1	Introduction.....	323
9.3.8.2	SFTD Measurement delay.....	323
9.3.8.3	SFTD Measurement reporting delay	324
9.3.9	Inter frequency measurements without measurement gaps.....	324
9.3.9.1	Inter frequency Cell identification	324
9.3.9.2	Measurement period.....	326
9.3.9.3	Scheduling availability of UE during inter-frequency measurements.....	326
9.3.9.3.1	Scheduling availability of UE performing measurements in TDD bands on FR1.....	326
9.3.9.3.2	Scheduling availability of UE performing measurements with a different subcarrier spacing than PDSCH/PDCCH on FR1	327
9.3.9.3.3	Scheduling availability of UE performing measurements on FR2	327
9.3.9.3.4	Scheduling availability of UE performing measurements on FR1 or FR2 in case of FR1-FR2 inter-band CA	328
9.3A	NR inter-frequency measurements in carrier frequencies with CCA	328
9.3A.1	Introduction.....	328
9.3A.2	Requirements applicability	328
9.3A.3	Number of cells and number of SSB	329
9.3A.3.1	Requirements	329
9.3A.4	Inter-frequency cell identification.....	329
9.3A.5	Inter-frequency measurements.....	330
9.3A.6	NR Inter-frequency measurements reporting requirements	331
9.3A.6.1	Periodic Reporting	331
9.3A.6.2	Event-triggered Periodic Reporting.....	331
9.3A.6.3	Event-triggered Reporting.....	331
9.3A.8	Inter-frequency RSSI measurements	331
9.3A.9	Inter-frequency channel occupancy measurements	332
9.4	Inter-RAT measurements	332
9.4.1	Introduction.....	332
9.4.2	NR – E-UTRAN FDD measurements	334
9.4.2.1	Introduction.....	334
9.4.2.2	Requirements when no DRX is used.....	334
9.4.2.3	Requirements when DRX is used.....	335
9.4.2.4	Measurement reporting requirements.....	336
9.4.2.4.1	Periodic Reporting.....	336
9.4.2.4.2	Event-Triggered Periodic Reporting.....	336
9.4.2.4.3	Event-Triggered Reporting.....	336
9.4.3	NR – E-UTRAN TDD measurements	336
9.4.3.1	Introduction.....	336
9.4.3.2	Requirements when no DRX is used.....	336
9.4.3.3	Requirements when DRX is used.....	337
9.4.3.4	Measurement reporting requirements.....	339
9.4.3.4.1	Periodic Reporting.....	339
9.4.3.4.2	Event-Triggered Periodic Reporting.....	339
9.4.3.4.3	Event-Triggered Reporting.....	339
9.4.4	Inter-RAT RSTD measurements.....	339
9.4.4.1	NR – E-UTRAN FDD RSTD measurements.....	339
9.4.4.1.1	Introduction	339
9.4.4.1.2	Requirements	340
9.4.4.2	NR – E-UTRAN TDD RSTD measurements	343
9.4.4.2.1	Introduction	343
9.4.4.2.2	Requirements	343
9.4.5	Inter-RAT E-CID measurements	347
9.4.5.1	NR–E-UTRAN FDD E-CID RSRP and RSRQ measurements	347
9.4.5.1.1	Introduction	347