

ETSI TS 138 133 V15.32.0 (2026-03)



TECHNICAL SPECIFICATION

**5G;
NR;
Requirements for support of radio resource management
(3GPP TS 38.133 version 15.32.0 Release 15)**

get full document from standards.iteh.ai



Reference

RTS/TSGR-0438133vfw0

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 2026.

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.

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.....	31
1 Scope	32
2 References	32
3 Definitions, symbols and abbreviations	33
3.1 Definitions	33
3.2 Symbols.....	34
3.3 Abbreviations	35
3.4 Test tolerances.....	37
3.5 Frequency bands grouping	37
3.5.1 Introduction.....	37
3.5.2 NR operating bands in FR1	37
3.5.3 NR operating bands in FR2	37
3.6 Applicability of requirements in this specification version	38
3.6.1 RRC connected state requirements in DRX.....	38
3.6.2 Number of serving carriers	39
3.6.2.1 Number of serving carriers for SA	39
3.6.2.2 Number of serving carriers for EN-DC.....	39
3.6.2.3 Number of serving carriers for NE-DC.....	39
3.6.2.4 Number of serving carriers for NR-DC.....	39
3.6.3 Applicability for intra-band FR2	39
3.6.4 Applicability for FR2 UE power classes.....	39
3.6.5 Applicability for SDL bands.....	40
3.6.6 Applicability of requirements for NGEN-DC operation.....	40
3.6.7 Applicability of QCL.....	40
4 SA: RRC_IDLE state mobility.....	40
4.1 Cell Selection	40
4.2 Cell Re-selection	40
4.2.1 Introduction.....	40
4.2.2 Requirements	40
4.2.2.1 UE measurement capability	40
4.2.2.2 Measurement and evaluation of serving cell.....	41
4.2.2.3 Measurements of intra-frequency NR cells.....	41
4.2.2.4 Measurements of inter-frequency NR cells.....	42
4.2.2.5 Measurements of inter-RAT E-UTRAN cells.....	44
4.2.2.6 Maximum interruption in paging reception.....	45
4.2.2.7 General requirements	45
5 SA: RRC_INACTIVE state mobility	46
5.1 Cell Re-selection	46
5.1.1 Introduction.....	46
5.1.2 Requirements	46
5.1.2.1 UE measurement capability	46
5.1.2.2 Measurement and evaluation of serving cell.....	46
5.1.2.3 Measurements of intra-frequency NR cells.....	46
5.1.2.4 Measurements of inter-frequency NR cells.....	46
5.1.2.5 Measurements of inter-RAT E-UTRAN cells.....	46
5.1.2.6 Maximum interruption in paging reception.....	46
5.1.2.7 General requirements	46
5.2 Void.....	47
6 RRC_CONNECTED state mobility	47

6.1	Handover	47
6.1.1	NR Handover	47
6.1.1.1	Introduction	47
6.1.1.2	NR FR1 - NR FR1 Handover	47
6.1.1.2.1	Handover delay	47
6.1.1.2.2	Interruption time	47
6.1.1.3	NR FR2- NR FR1 Handover	48
6.1.1.3.1	Handover delay	48
6.1.1.3.2	Interruption time	48
6.1.1.4	NR FR2- NR FR2 Handover	49
6.1.1.4.1	Handover delay	49
6.1.1.4.2	Interruption time	49
6.1.1.5	NR FR1- NR FR2 Handover	50
6.1.1.5.1	Handover delay	50
6.1.1.5.2	Interruption time	50
6.1.2	NR Handover to other RATs	51
6.1.2.1	NR – E-UTRAN Handover	51
6.1.2.1.1	Introduction	51
6.1.2.1.2	Handover delay	51
6.1.2.1.3	Interruption time	51
6.2	RRC Connection Mobility Control	52
6.2.1	SA: RRC Re-establishment	52
6.2.1.1	Introduction	52
6.2.1.2	Requirements	52
6.2.1.2.1	UE Re-establishment delay requirement	52
6.2.2	Random access	53
6.2.2.1	Introduction	53
6.2.2.2	Requirements	53
6.2.2.2.1	Contention based random access	54
6.2.2.2.2	Non-Contention based random access	55
6.2.2.2.3	UE behaviour when configured with supplementary UL	56
6.2.3	SA: RRC Connection Release with Redirection	56
6.2.3.1	Introduction	56
6.2.3.2	Requirements	56
6.2.3.2.1	RRC connection release with redirection to NR	56
6.2.3.2.2	RRC connection release with redirection to E-UTRAN	57
7	Timing	57
7.1	UE transmit timing	57
7.1.1	Introduction	57
7.1.2	Requirements	57
7.1.2.1	Gradual timing adjustment	58
7.1.2.2	Void	59
7.2	UE timer accuracy	59
7.2.1	Introduction	59
7.2.2	Requirements	59
7.3	Timing advance	59
7.3.1	Introduction	59
7.3.2	Requirements	60
7.3.2.1	Timing Advance adjustment delay	60
7.3.2.2	Timing Advance adjustment accuracy	60
7.4	Cell phase synchronization accuracy	60
7.4.1	Definition	60
7.4.2	Minimum requirements	60
7.5	Maximum Transmission Timing Difference	60
7.5.1	Introduction	60
7.5.2	Minimum Requirements for inter-band EN-DC	60
7.5.2.1	Minimum Requirements for inter-band synchronous EN-DC	61
7.5.3	Minimum Requirements for intra-band EN-DC	61
7.5.4	Minimum Requirements for NR Carrier Aggregation	62
7.5.5	Minimum Requirements for inter-band NE-DC	62
7.5.5.1	Minimum Requirements for inter-band synchronous NE-DC	62

7.5.6	Minimum Requirements for inter-band NR DC	63
7.6	Maximum Receive Timing Difference	63
7.6.1	Introduction	63
7.6.2	Minimum Requirements for inter-band EN-DC	63
7.6.2.1	Minimum Requirements for inter-band synchronous EN-DC	64
7.6.3	Minimum Requirements for intra-band EN-DC	64
7.6.4	Minimum Requirements for NR Carrier Aggregation	64
7.6.5	Minimum Requirements for inter-band NE-DC	65
7.6.5.1	Minimum Requirements for inter-band synchronous NE-DC	65
7.6.6	Minimum Requirements for inter-band NR DC	66
7.7	<i>deriveSSB-IndexFromCell</i> tolerance	66
7.7.1	Minimum requirements	66
7.8	Void	66
8	Signalling characteristics	66
8.1	Radio Link Monitoring	66
8.1.1	Introduction	66
8.1.2	Requirements for SSB based radio link monitoring	67
8.1.2.1	Introduction	67
8.1.2.2	Minimum requirement	68
8.1.2.3	Measurement restrictions for SSB based RLM	69
8.1.3	Requirements for CSI-RS based radio link monitoring	70
8.1.3.1	Introduction	70
8.1.3.2	Minimum requirement	71
8.1.3.3	Measurement restrictions for CSI-RS based RLM	73
8.1.4	Minimum requirement at transitions	73
8.1.5	Minimum requirement for UE turning off the transmitter	74
8.1.6	Minimum requirement for L1 indication	74
8.1.7	Scheduling availability of UE during radio link monitoring	74
8.1.7.1	Scheduling availability of UE performing radio link monitoring with a same subcarrier spacing as PDSCH/PDCCH on FR1	74
8.1.7.2	Scheduling availability of UE performing radio link monitoring with a different subcarrier spacing than PDSCH/PDCCH on FR1	74
8.1.7.3	Scheduling availability of UE performing radio link monitoring on FR2	75
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	75
8.2	Interruption	75
8.2.1	EN-DC Interruption	75
8.2.1.1	Introduction	75
8.2.1.2	Requirements	76
8.2.1.2.1	Interruptions at transitions between active and non-active during DRX	76
8.2.1.2.2	Interruptions at transitions from non-DRX to DRX	76
8.2.1.2.3	Interruptions at SCell addition/release	76
8.2.1.2.4	Interruptions at SCell activation/deactivation	77
8.2.1.2.5	Interruptions during measurements on SCC	78
8.2.1.2.6	Interruptions at UL carrier RRC reconfiguration	79
8.2.1.2.7	Interruptions due to Active BWP switching Requirement	79
8.2.2	SA: Interruptions with Standalone NR Carrier Aggregation	80
8.2.2.1	Introduction	80
8.2.2.2	Requirements	81
8.2.2.2.1	Interruptions at SCell addition/release	81
8.2.2.2.2	Interruptions at SCell activation/deactivation	81
8.2.2.2.3	Interruptions during measurements on deactivated SCC	82
8.2.2.2.4	Interruptions at UL carrier RRC reconfiguration	83
8.2.2.2.5	Interruptions due to Active BWP switching Requirement	83
8.2.2.2.6	Interruptions at inter-frequency SFTD measurement	84
8.2.3	NE-DC Interruptions	85
8.2.3.1	Introduction	85
8.2.3.2	Requirements	85
8.2.3.2.1	Interruptions at transitions between active and non-active during DRX	85
8.2.3.2.2	Interruptions at transitions from non-DRX to DRX	86
8.2.3.2.3	Interruptions at PSCell/SCell addition/release	86

8.2.3.2.4	Interruptions at SCell activation/deactivation.....	87
8.2.3.2.5	Interruptions during measurements on SCC.....	88
8.2.3.2.6	Interruptions at UL carrier RRC reconfiguration	89
8.2.3.2.7	Interruptions due to Active BWP switching Requirement	89
8.2.4	NR-DC: Interruptions	89
8.2.4.1	Introduction.....	89
8.2.4.2	Requirements	90
8.2.4.2.1	Interruptions at PSCell/SCell addition/release	90
8.2.4.2.2	Interruptions at SCell activation/deactivation.....	90
8.2.4.2.3	Interruptions during measurements on SCC.....	91
8.2.4.2.4	Interruptions at UL carrier RRC reconfiguration	91
8.2.4.2.5	Interruptions due to Active BWP switching Requirement	92
8.2.4.2.6	Interruptions at transitions between active and non-active during DRX	92
8.2.4.2.7	Interruptions at transitions from non-DRX to DRX	92
8.3	SCell Activation and Deactivation Delay.....	92
8.3.1	Introduction.....	92
8.3.2	SCell Activation Delay Requirement for Deactivated SCell	93
8.3.3	SCell Deactivation Delay Requirement for Activated SCell	96
8.4	UE UL carrier RRC reconfiguration delay.....	97
8.4.1	Introduction.....	97
8.4.2	UE UL carrier configuration delay requirement	97
8.4.3	UE UL carrier deconfiguration delay requirement	97
8.5	Link Recovery Procedures	97
8.5.1	Introduction.....	97
8.5.2	Requirements for SSB based beam failure detection.....	98
8.5.2.1	Introduction.....	98
8.5.2.2	Minimum requirement	98
8.5.2.3	Measurement restriction for SSB based beam failure detection.....	100
8.5.3	Requirements for CSI-RS based beam failure detection.....	100
8.5.3.1	Introduction.....	100
8.5.3.2	Minimum requirement	101
8.5.3.3	Measurement restrictions for CSI-RS beam failure detection.....	102
8.5.4	Minimum requirement for L1 indication	103
8.5.5	Requirements for SSB based candidate beam detection	104
8.5.5.1	Introduction.....	104
8.5.5.2	Minimum requirement	104
8.5.5.3	Measurement restriction for SSB based candidate beam detection.....	105
8.5.6	Requirements for CSI-RS based candidate beam detection.....	106
8.5.6.1	Introduction.....	106
8.5.6.2	Minimum requirement	106
8.5.6.3	Measurement restriction for CSI-RS based candidate beam detection	108
8.5.7	Scheduling availability of UE during beam failure detection	108
8.5.7.1	Scheduling availability of UE performing beam failure detection with a same subcarrier spacing as PDSCH/PDCCH on FR1	108
8.5.7.2	Scheduling availability of UE performing beam failure detection with a different subcarrier spacing than PDSCH/PDCCH on FR1.....	108
8.5.7.3	Scheduling availability of UE performing beam failure detection on FR2	109
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	109
8.5.8	Scheduling availability of UE during candidate beam detection	109
8.5.8.1	Scheduling availability of UE performing L1-RSRP measurement with a same subcarrier spacing as PDSCH/PDCCH on FR1	109
8.5.8.2	Scheduling availability of UE performing L1-RSRP measurement with a different subcarrier spacing than PDSCH/PDCCH on FR1.....	109
8.5.8.3	Scheduling availability of UE performing L1-RSRP measurement on FR2	110
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.....	110
8.5.9	Minimum requirement at transitions for beam failure detection.....	110
8.6	Active BWP switch delay.....	111
8.6.1	Introduction.....	111
8.6.2	DCI and timer based BWP switch delay.....	111
8.6.3	RRC based BWP switch delay.....	112

8.7	Void.....	112
8.8	NE-DC: E-UTRAN PSCell Addition and Release Delay	112
8.8.1	Introduction.....	112
8.8.2	E-UTRAN PSCell Addition Delay Requirement.....	112
8.8.3	E-UTRAN PSCell Release Delay Requirement	113
8.9	NR-DC: PSCell Addition and Release Delay.....	113
8.9.1	Introduction.....	113
8.9.2	PSCell Addition Delay Requirement	113
8.9.3	PSCell Release Delay Requirement.....	114
8.10	Active TCI state switching delay	114
8.10.6	Active TCI state list update delay.....	117
8.11	PSCell Change.....	117
9	Measurement Procedure	117
9.1	General measurement requirement.....	117
9.1.1	Introduction.....	117
9.1.2	Measurement gap	118
9.1.2.1	EN-DC: Measurement Gap Sharing.....	125
9.1.2.1a	SA: Measurement Gap Sharing.....	126
9.1.2.1b	NE-DC: Measurement Gap Sharing.....	126
9.1.2.1c	NR-DC: Measurement Gap Sharing	127
9.1.3	UE Measurement capability.....	128
9.1.3.1	EN-DC: Monitoring of multiple layers using gaps	128
9.1.3.1a	SA: Monitoring of multiple layers using gaps	128
9.1.3.1b	NE-DC: Monitoring of multiple layers using gaps	129
9.1.3.1c	NR-DC: Monitoring of multiple layers using gaps	129
9.1.3.2	EN-DC: Maximum allowed layers for multiple monitoring	129
9.1.3.2a	SA: Maximum allowed layers for multiple monitoring	130
9.1.3.2b	NE-DC: Maximum allowed layers for multiple monitoring	130
9.1.3.2c	NR-DC: Maximum allowed layers for multiple monitoring	131
9.1.4	Capabilities for Support of Event Triggering and Reporting Criteria.....	131
9.1.4.1	Introduction.....	131
9.1.4.2	Requirements	132
9.1.5	Carrier-specific scaling factor.....	133
9.1.5.1	Monitoring of multiple layers outside gaps.....	133
9.1.5.1.1	EN-DC mode: carrier-specific scaling factor for SSB-based measurements performed outside gaps.....	134
9.1.5.1.2	SA mode: carrier-specific scaling factor for SSB-based measurements performed outside gaps.....	135
9.1.5.1.3	NR-DC mode: carrier-specific scaling factor for SSB-based measurements performed outside gaps.....	135
9.1.5.1.4	NE-DC mode: carrier-specific scaling factor for SSB-based measurements performed outside gaps.....	135
9.1.5.2	Monitoring of multiple layers within gaps	136
9.1.5.2.1	EN-DC mode: carrier-specific scaling factor for SSB-based measurements performed within gaps.....	136
9.1.5.2.2	SA mode: carrier-specific scaling factor for SSB-based measurements performed within gaps.....	138
9.1.5.2.3	NE-DC: carrier-specific scaling factor for SSB-based measurements performed within gaps.....	139
9.1.5.2.4	NR-DC: carrier-specific scaling factor for SSB-based measurements performed within gaps	140
9.1.6	Minimum requirement at transitions.....	142
9.2	NR intra-frequency measurements	142
9.2.1	Introduction.....	142
9.2.2	Requirements applicability	142
9.2.3	Number of cells and number of SSB	143
9.2.3.1	Requirements for FR1	143
9.2.3.2	Requirements for FR2.....	143
9.2.4	Measurement Reporting Requirements.....	143
9.2.4.1	Periodic Reporting	143
9.2.4.2	Event-triggered Periodic Reporting.....	143
9.2.4.3	Event Triggered Reporting.....	143
9.2.5	Intrafrequency measurements without measurement gaps.....	144
9.2.5.1	Intrafrequency cell identification	144

9.2.5.2	Measurement period.....	146
9.2.5.3	Scheduling availability of UE during intra-frequency measurements.....	148
9.2.5.3.1	Scheduling availability of UE performing measurements in TDD bands on FR1	148
9.2.5.3.2	Scheduling availability of UE performing measurements with a different subcarrier spacing than PDSCH/PDCCH on FR1	148
9.2.5.3.3	Scheduling availability of UE performing measurements on FR2	149
9.2.5.3.4	Scheduling availability of UE performing measurements on FR1 or FR2 in case of FR1-FR2 inter-band CA	149
9.2.5.4	SFTD Measurements between PCell and PSCell.....	149
9.2.5.4.1	Introduction	149
9.2.5.4.2	SFTD Measurement delay	149
9.2.5.4.3	SFTD Measurement Reporting Delay	150
9.2.6	Intra-frequency measurements with measurement gaps	150
9.2.6.1	Void.....	150
9.2.6.2	Intra-frequency cell identification	150
9.2.6.3	Intra-frequency Measurement Period.....	152
9.3	NR inter-frequency measurements	152
9.3.1	Introduction.....	152
9.3.2	Requirements applicability	152
9.3.2.1	Void.....	153
9.3.2.2	Void.....	153
9.3.3	Number of cells and number of SSB	153
9.3.3.1	Requirements for FR1	153
9.3.3.2	Requirements for FR2	153
9.3.4	Inter-frequency cell identification.....	153
9.3.4.1	Void.....	155
9.3.4.2	Void.....	155
9.3.5	Inter-frequency measurements.....	155
9.3.5.1	Void.....	155
9.3.5.2	Void.....	155
9.3.5.3	Void.....	155
9.3.6	Inter-frequency measurements reporting requirements.....	155
9.3.6.1	Periodic Reporting	155
9.3.6.2	Event-triggered Periodic Reporting.....	155
9.3.6.3	Event-triggered Reporting.....	156
9.3.7	Void	156
9.3.8	Inter-frequency SFTD measurement requirements.....	156
9.3.8.1	Introduction.....	156
9.3.8.2	SFTD Measurement delay.....	156
9.3.8.3	SFTD Measurement reporting delay	157
9.4	Inter-RAT measurements	157
9.4.1	Introduction.....	157
9.4.2	NR – E-UTRAN FDD measurements	159
9.4.2.1	Introduction	159
9.4.2.2	Requirements when no DRX is used.....	159
9.4.2.3	Requirements when DRX is used.....	160
9.4.2.4	Measurement reporting requirements.....	160
9.4.2.4.1	Periodic Reporting.....	160
9.4.2.4.2	Event-Triggered Periodic Reporting.....	160
9.4.2.4.3	Event-Triggered Reporting.....	160
9.4.3	NR – E-UTRAN TDD measurements	161
9.4.3.1	Introduction.....	161
9.4.3.2	Requirements when no DRX is used.....	161
9.4.3.3	Requirements when DRX is used.....	162
9.4.3.4	Measurement reporting requirements.....	163
9.4.3.4.1	Periodic Reporting.....	163
9.4.3.4.2	Event-Triggered Periodic Reporting.....	163
9.4.3.4.3	Event-Triggered Reporting.....	163
9.4.4	Inter-RAT RSTD measurements.....	164
9.4.4.1	NR – E-UTRAN FDD RSTD measurements.....	164
9.4.4.1.1	Introduction	164
9.4.4.1.2	Requirements.....	164

9.4.4.2	NR – E-UTRAN TDD RSTD measurements	167
9.4.4.2.1	Introduction	167
9.4.4.2.2	Requirements	168
9.4.5	Inter-RAT E-CID measurements	171
9.4.5.1	NR–E-UTRAN FDD E-CID RSRP and RSRQ measurements	171
9.4.5.1.1	Introduction	171
9.4.5.1.2	Requirements	171
9.4.5.1.3	Measurement Reporting Delay	171
9.4.5.2	NR–E-UTRAN TDD E-CID RSRP and RSRQ measurements	171
9.4.5.2.1	Introduction	171
9.4.5.2.2	Requirements	172
9.4.5.2.3	Measurement Reporting Delay	172
9.5	L1-RSRP measurements for Reporting	172
9.5.1	Introduction.....	172
9.5.2	Requirements applicability	172
9.5.3	Measurement Reporting Requirements.....	173
9.5.3.1	Periodic Reporting	173
9.5.3.2	Semi-Persistent Reporting.....	173
9.5.3.3	Aperiodic Reporting.....	173
9.5.4	L1-RSRP measurement requirements	173
9.5.4.1	SSB based L1-RSRP Reporting	173
9.5.4.2	CSI-RS based L1-RSRP Reporting.....	175
9.5.5	Measurement restriction for CSI-RS and SSB for L1-RSRP measurement.....	177
9.5.5.1	Measurement restriction for SSB based L1-RSRP.....	178
9.5.5.2	Measurement restriction for CSI-RS based L1-RSRP	178
9.5.6	Scheduling availability of UE during L1-RSRP measurement	179
9.5.6.1	Scheduling availability of UE performing L1-RSRP measurement with a same subcarrier spacing as PDSCH/PDCCH on FR1	179
9.5.6.2	Scheduling availability of UE performing L1-RSRP measurement with a different subcarrier spacing than PDSCH/PDCCH on FR1	179
9.5.6.3	Scheduling availability of UE performing L1-RSRP measurement on FR2	179
9.5.6.4	Scheduling availability of UE performing L1-RSRP measurement on FR1 or FR2 in case of FR1-FR2 inter-band CA.....	180
9.6	NE-DC: Measurements	180
9.6.1	Introduction.....	180
9.6.2	SFTD Measurements	180
9.6.2.1	Introduction.....	180
9.6.2.2	SFTD Measurement requirements	180
10	Measurement Performance requirements	181
10.1	NR measurements.....	181
10.1.1	Introduction.....	181
10.1.2	Intra-frequency RSRP accuracy requirements for FR1.....	182
10.1.2.1	Intra-frequency SS-RSRP accuracy requirements.....	182
10.1.2.1.1	Absolute SS-RSRP Accuracy	182
10.1.2.1.2	Relative SS-RSRP Accuracy	182
10.1.2.2	Void.....	183
10.1.3	Intra-frequency RSRP accuracy requirements for FR2.....	183
10.1.3.1	Intra-frequency SS-RSRP accuracy requirements.....	183
10.1.3.1.1	Absolute SS-RSRP Accuracy	183
10.1.3.1.2	Relative SS-RSRP Accuracy	184
10.1.3.2	Void.....	184
10.1.4	Inter-frequency RSRP accuracy requirements for FR1.....	184
10.1.4.1	Inter-frequency SS-RSRP accuracy requirements.....	184
10.1.4.1.1	Absolute Accuracy of SS-RSRP in FR1	184
10.1.4.1.2	Relative Accuracy of SS-RSRP in FR1	185
10.1.4.2	Void.....	186
10.1.5	Inter-frequency RSRP accuracy requirements for FR2.....	186
10.1.5.1	Inter-frequency SS-RSRP accuracy requirements.....	186
10.1.5.1.1	Absolute SS-RSRP Accuracy	186
10.1.5.1.2	Relative SS-RSRP Accuracy	187
10.1.5.2	Void.....	187

10.1.6	RSRP Measurement Report Mapping.....	187
10.1.7	Intra-frequency RSRQ accuracy requirements for FR1	189
10.1.7.1	Intra-frequency SS-RSRQ accuracy requirements in FR1	189
10.1.7.1.1	Absolute SS-RSRQ Accuracy in FR1	189
10.1.8	Intra-frequency RSRQ accuracy requirements for FR2.....	190
10.1.8.1	Intra-frequency SS-RSRQ accuracy requirements in FR2	190
10.1.8.1.1	Absolute SS-RSRQ Accuracy in FR2	190
10.1.9	Inter-frequency RSRQ accuracy requirements for FR1	190
10.1.9.1	Inter-frequency SS-RSRQ accuracy requirements in FR1	190
10.1.9.1.1	Absolute Accuracy of SS-RSRQ in FR1	190
10.1.9.1.2	Relative Accuracy of SS-RSRQ in FR1	191
10.1.10	Inter-frequency RSRQ accuracy requirements for FR2.....	192
10.1.11	RSRQ report mapping	193
10.1.12	Intra-frequency SINR accuracy requirements for FR1	193
10.1.13	Intra-frequency SINR accuracy requirements for FR2	194
10.1.14	Inter-frequency SINR accuracy requirements for FR1	195
10.1.15	Inter-frequency SINR accuracy requirements for FR2	196
10.1.16	SINR report mapping.....	197
10.1.17	Power Headroom	198
10.1.18	$P_{CMAX,c,f}$	198
10.1.19	L1-RSRP accuracy requirements for FR1	199
10.1.20	L1-RSRP accuracy requirements for FR2	202
10.1.21	SFTD accuracy requirements.....	204
10.2	E-UTRAN measurements.....	208
10.2.1	Introduction.....	208
10.2.2	E-UTRAN RSRP measurements	208
10.2.3	E-UTRAN RSRQ measurements.....	209
10.2.4	E-UTRAN RSTD measurements	209
10.2.5	E-UTRAN RS-SINR measurements.....	209
11	Void.....	209
Annex A (normative): Test Cases		210
A.1	Purpose of annex	210
A.2	Requirement classification for statistical testing.....	210
A.2.1	Types of requirements in TS 38.133	210
A.2.1.1	Time and delay requirements on UE higher layer actions	210
A.2.1.2	Measurements of power levels, relative powers and time	211
A.2.1.3	Implementation requirements	211
A.2.1.4	Physical layer timing requirements.....	211
A.3	RRM test configurations	211
A.3.1	Reference measurement channels.....	211
A.3.1.1	PDSCH	211
A.3.1.1.1	FDD.....	211
A.3.1.1.2	TDD	212
A.3.1.2	CORESET for RMSI scheduling	215
A.3.1.2.1	FDD.....	215
A.3.1.2.2	TDD	216
A.3.1.3	CORESET for RMC scheduling	218
A.3.1.3.1	FDD.....	218
A.3.1.3.2	TDD	219
A.3.1.4	TDD UL/DL configuration	221
A.3.2	OFDMA channel noise generator (OCNG).....	222
A.3.2.1	Generic OFDMA Channel Noise Generator (OCNG)	222
A.3.2.1.1	OCNG pattern 1: Generic OCNG pattern for all unused REs	222
A.3.2.1.2	OCNG pattern 2: Generic OCNG pattern for all unused REs for 2AoA setup	222
A.3.2.1.3	OCNG pattern 3: Generic OCNG pattern for unused REs in the same bandwidth as CORESET	223
A.3.2.1.4	OCNG pattern 4: Generic OCNG pattern for all unused REs outside SSB slot(s).....	223
A.3.2.2	Void	225
A.3.3	Reference DRX configurations	225

A.3.3.1	DRX Configuration 1: DRX cycle = 40 ms and TAT = 500 ms.....	225
A.3.3.2	DRX Configuration 2: DRX cycle = 640 ms and TAT = 500 ms.....	225
A.3.3.3	DRX Configuration 3: DRX cycle = 40 ms and TAT = Infinity	225
A.3.3.4	DRX Configuration 4: DRX cycle = 160 ms and TAT = Infinity	226
A.3.3.5	DRX Configuration 5: DRX cycle = 320 ms and TAT = Infinity	226
A.3.3.6	DRX Configuration 6: DRX cycle = 320 ms and TAT = 500 ms.....	226
A.3.3.7	DRX Configuration 7: DRX cycle = 640 ms and TAT = Infinity	227
A.3.3.8	DRX Configuration 8: DRX cycle = 320 ms and TAT = Infinity	227
A.3.3.9	DRX Configuration 9: DRX cycle = 40 ms and TAT = 500 ms.....	227
A.3.3.10	DRX Configuration 10: DRX cycle = 640 ms and TAT = 500 ms.....	228
A.3.3.11	DRX Configuration 11: DRX cycle = 20 ms and TAT = Infinity	228
A.3.3.12	DRX Configuration 12: DRX cycle = 640 ms and TAT = Infinity	228
A.3.4	Test Cases with Different Channel Bandwidths.....	229
A.3.4.1	Test Cases with Different E-UTRA Channel Bandwidths.....	229
A.3.4.1.1	Introduction.....	229
A.3.4.1.2	Principle of testing	229
A.3.5	Test Cases for Synchronous and Asynchronous DC Operations.....	229
A.3.5.1	EN-DC Test Cases for Synchronous and Asynchronous EN-DC Operations	229
A.3.5.1.1	Introduction.....	229
A.3.5.1.2	Principle of Testing.....	229
A.3.6	Antenna configurations	229
A.3.6.1	Antenna configurations for FR1	229
A.3.6.1.1	Antenna connection for 4 Rx capable UEs	230
A.3.6.1.1.1	Introduction	230
A.3.6.1.1.2	Principle of testing.....	230
A.3.6.2	Antenna configurations for FR2	232
A.3.7	EN-DC test setup.....	232
A.3.7.1	Introduction.....	232
A.3.7.2	E-UTRAN Serving Cell Parameters	232
A.3.7.2.1	E-UTRAN Serving Cell Parameters for Tests with NR Cell(s) in FR1	232
A.3.7.2.2	E-UTRAN Serving Cell Parameters for Tests with NR Cell(s) in FR2	234
A.3.7A	NR FR1-FR2 test setup	235
A.3.7B	Void.....	235
A.3.7C	LTE-FR1/FR2 test setup	235
A.3.7D	NE-DC test setup.....	235
A.3.7D.1	Introduction.....	235
A.3.7D.2	E-UTRAN Serving Cell Parameters	235
A.3.7D.2.1	E-UTRAN Serving Cell Parameters for Tests with NR Cell(s) in FR1	235
A.3.7D.2.2	E-UTRAN Serving Cell Parameters for Tests with NR Cell(s) in FR2	235
A.3.8	PRACH configurations.....	235
A.3.8.1	Introduction.....	235
A.3.8.2	PRACH configurations in FR1	236
A.3.8.2.1	FR1 PRACH configuration 1	236
A.3.8.2.2	FR1 PRACH configuration 2	236
A.3.8.2.3	FR1 PRACH configuration 3	237
A.3.8.2.4	FR1 PRACH configuration 4	238
A.3.8.3	PRACH configurations in FR2	238
A.3.8.3.1	FR2 PRACH configuration 1	238
A.3.8.3.2	FR2 PRACH configuration 2	239
A.3.8.3.3	FR2 PRACH configuration 3	240
A.3.8.3.4	FR2 PRACH configuration 4	241
A.3.9	BWP configurations	241
A.3.9.1	Introduction.....	241
A.3.9.2	Downlink BWP configurations.....	241
A.3.9.2.1	Initial BWP	241
A.3.9.2.2	Dedicated BWP.....	242
A.3.9.3	Uplink BWP configurations.....	242
A.3.9.3.1	Initial BWP	242
A.3.9.3.2	Dedicated BWP.....	242
A.3.10	SSB Configurations	243
A.3.10.1	SSB Configurations for FR1	243
A.3.10.1.1	SSB pattern 1 in FR1: SSB allocation for SSB SCS=15 kHz in 10 MHz.....	243

A.3.10.1.2	SSB pattern 2 in FR1: SSB allocation for SSB SCS=30 kHz in 40 MHz	243
A.3.10.1.3	SSB pattern 3 in FR1: SSB allocation for SSB SCS=15 kHz in 10 MHz	244
A.3.10.1.4	SSB pattern 4 in FR1: SSB allocation for SSB SCS=30 kHz in 40 MHz	244
A.3.10.1.5	SSB pattern 5 in FR1: SSB allocation for SSB SCS=15 kHz starting from odd SFN in 10 MHz	245
A.3.10.1.6	SSB pattern 6 in FR1: SSB allocation for SSB SCS=30 kHz starting from odd SFN in 40 MHz	245
A.3.10.2	SSB Configurations for FR2	245
A.3.10.2.1	SSB pattern 1 in FR2: SSB allocation for SSB SCS=120 kHz in 100 MHz	245
A.3.10.2.2	SSB pattern 2 in FR2: SSB allocation for SSB SCS=240 kHz in 100 MHz	246
A.3.10.2.3	SSB pattern 3 in FR2: SSB allocation for SSB SCS=120 kHz in 100 MHz	246
A.3.10.2.4	SSB pattern 4 in FR2: SSB allocation for SSB SCS=240 kHz in 100 MHz	247
A.3.10.2.5	SSB pattern 5 in FR2: SSB allocation for SSB SCS=120 kHz in 100 MHz	247
A.3.10.2.6	SSB pattern 6 in FR2: SSB allocation for SSB SCS=240 kHz in 100 MHz	247
A.3.10.2.7	SSB pattern 7 in FR2: SSB allocation for SSB SCS=120 kHz in 100 MHz	248
A.3.10.2.8	SSB pattern 8 in FR2: SSB allocation for SSB SCS=240 kHz in 100 MHz	248
A.3.11	SMTC Configurations	249
A.3.11.1	SMTC pattern 1: SMTC period = 20 ms with SMTC duration = 1 ms	249
A.3.11.2	SMTC pattern 2: SMTC period = 20 ms with SMTC duration = 5 ms	249
A.3.11.3	SMTC pattern 3: SMTC period = 160 ms with SMTC duration = 1 ms	249
A.3.11.4	SMTC pattern 4: SMTC period = 20 ms with SMTC duration = 1 ms	249
A.3.11.5	SMTC pattern 5: SMTC period = 20 ms with SMTC duration = 5 ms	250
A.3.11.6	SMTC pattern 6: SMTC period = 20 ms with SMTC duration = 5 ms	250
A.3.12	Test Cases with Different CC Configurations	250
A.3.12.1	EN-DC Test Cases with Different EN-DC Configurations	250
A.3.12.1.1	Introduction	250
A.3.12.1.2	Principle of testing	250
A.3.12.2	Carrier Aggregation Test Cases with Different CA Configurations	250
A.3.12.2.1	Introduction	250
A.3.12.2.2	Principle of testing	251
A.3.13	Test Cases in SA and EN-DC Operations	251
A.3.13.1	Introduction	251
A.3.13.2	Principle of Testing	251
A.3.13B	Test Cases for EN-DC and NE-DC Operations	252
A.3.13B.1	Active BWP switch Test Cases for EN-DC and NE-DC Operations	252
A.3.13B.1.1	Introduction	252
A.3.13B.1.2	Principle of Testing	252
A.3.13B.2	SFTD accuracy Test Cases for EN-DC and NE-DC Operations	252
A.3.13B.2.1	Introduction	252
A.3.13B.2.2	Principle of Testing	252
A.3.14	CSI-RS configurations	253
A.3.14.1	FDD	253
A.3.14.2	TDD	253
A.3.15	Angle of Arrival (AoA) for FR2 RRM test cases	256
A.3.15.1	Setup 1: Single AoA in Rx beam peak direction	256
A.3.15.2	Setup 2: Single AoA in non Rx beam peak direction	256
A.3.15.2.1	Setup 2a: Single AoA in non Rx beam peak direction without change in direction	256
A.3.15.2.2	Setup 2b: Single AoA in non Rx beam peak direction with change in direction	256
A.3.15.3	Setup 3: 2 AoAs	256
A.3.15.4	Setup 4: 2 AoAs, 1 AoA in Rx beam peak direction, 1 in non Rx beam peak	257
A.3.15.4.1	Setup 4a: 2 AoAs, 1 AoA in Rx beam peak direction, 1 in non Rx beam peak without change in direction	257
A.3.15.4.2	Setup 4b: 2 AoAs, 1 AoA in Rx beam peak direction, 1 in non Rx beam peak with change in direction	257
A.3.16	TCI State Configuration	257
A.3.16.1	Introduction	257
A.3.16.2	TCI states	258
A.3.17	Configurations of CSI-RS for tracking	258
A.3.17.1	Configuration of CSI-RS for tracking for FR1	258
A.3.17.1.1	FDD	258
A.3.17.1.2	TDD	259
A.3.17.2	Configuration of CSI-RS for tracking for FR2	260
A.3.17.2.1	TDD	260
A.3.18	Additional definitions related to OTA testing for FR2 RRM test cases	261

A.3.18.1	Introduction.....	261
A.3.18.2	PRACH Power Measurement	261
A.4	EN-DC tests with all NR cells in FR1	261
A.4.1	Void.....	261
A.4.2	Void.....	261
A.4.3	RRC_CONNECTED state mobility	261
A.4.3.1	Void.....	261
A.4.3.2	RRC Connection Mobility Control.....	261
A.4.3.2.1	Void.....	261
A.4.3.2.2	Random Access	261
A.4.3.2.2.1	Contention based random access test in FR1 for PSCell in EN-DC.....	261
A.4.3.2.2.1.1	Test Purpose and Environment.....	261
A.4.3.2.2.2	Non-contention based random access test in FR1 for PSCell in EN-DC	264
A.4.3.2.3	Void.....	268
A.4.4	Timing	268
A.4.4.1	UE transmit timing	268
A.4.4.1.1	NR UE Transmit Timing Test for FR1	268
A.4.4.1.1.1	Test Purpose and environment	268
A.4.4.1.1.2	Test requirements	270
A.4.4.2	UE timer accuracy	271
A.4.4.3	Timing advance	271
A.4.4.3.1	EN-DC FR1 timing advance adjustment accuracy.....	271
A.4.4.3.1.1	Test Purpose and Environment.....	271
A.4.4.3.1.2	Test Parameters	271
A.4.4.3.1.3	Test Requirements	274
A.4.5	Signaling characteristics.....	274
A.4.5.1	Radio link Monitoring	274
A.4.5.1.1	Radio Link Monitoring Out-of-sync Test for FR1 PSCell configured with SSB-based RLM RS in non-DRX mode.....	275
A.4.5.1.1.1	Test Purpose and Environment.....	275
A.4.5.1.1.2	Test Requirements.....	278
A.4.5.1.2	Radio Link Monitoring In-sync Test for FR1 PSCell configured with SSB-based RLM RS in non-DRX mode	278
A.4.5.1.2.2	Test Requirements	282
A.4.5.1.3	Radio Link Monitoring Out-of-sync Test for FR1 PSCell configured with SSB-based RLM RS in DRX mode	282
A.4.5.1.3.1	Test Purpose and Environment.....	282
A.4.5.1.3.2	Test Requirements	285
A.4.5.1.4	Radio Link Monitoring In-sync Test for FR1 PSCell configured with SSB-based RLM RS in DRX mode	286
A.4.5.1.4.1	Test Purpose and Environment.....	286
A.4.5.1.4.2	Test Requirements.....	289
A.4.5.1.5	EN-DC Radio Link Monitoring Out-of-sync Test for FR1 PSCell configured with CSI-RS-based RLM in non-DRX mode	289
A.4.5.1.5.1	Test Purpose and Environment.....	289
A.4.5.1.5.2	Test Requirements	293
A.4.5.1.6	EN-DC Radio Link Monitoring In-sync Test for FR1 PSCell configured with CSI-RS-based RLM in non-DRX mode	293
A.4.5.1.6.1	Test Purpose and Environment.....	293
A.4.5.1.6.2	Test Requirements	297
A.4.5.1.7	EN-DC Radio Link Monitoring Out-of-sync Test for FR1 PSCell configured with CSI-RS-based RLM in DRX mode.....	297
A.4.5.1.7.1	Test Purpose and Environment.....	297
A.4.5.1.7.2	Test Requirements	300
A.4.5.1.8	EN-DC Radio Link Monitoring In-sync Test for FR1 PSCell configured with CSI-RS-based RLM in DRX mode.....	300
A.4.5.1.8.1	Test Purpose and Environment.....	300
A.4.5.1.8.2	Test Requirements	304
A.4.5.2	Interruption	304
A.4.5.2.1	E-UTRAN – NR FR1 interruptions at transitions between active and non-active during DRX in synchronous EN-DC	304

A.4.5.2.1.1	Test Purpose and Environment.....	304
A.4.5.2.1.2	Test Requirements	307
A.4.5.2.2	E-UTRAN – NR FR1 interruptions at transitions between active and non-active during DRX in asynchronous EN-DC.....	307
A.4.5.2.2.1	Test Purpose and Environment.....	307
A.4.5.2.2.2	Test Requirements	310
A.4.5.2.3	E-UTRAN – NR FR1 interruptions during measurements on deactivated NR SCC in synchronous EN-DC	310
A.4.5.2.3.1	Test Purpose and Environment.....	310
A.4.5.2.3.2	Test Requirements	315
A.4.5.2.4	E-UTRAN – NR FR1 interruptions during measurements on deactivated NR SCC in asynchronous EN-DC.....	315
A.4.5.2.4.1	Test Purpose and Environment.....	315
A.4.5.2.4.2	Test Requirements	320
A.4.5.2.5	E-UTRAN – NR FR1 interruptions during measurements on deactivated E-UTRAN SCC in synchronous EN-DC	320
A.4.5.2.5.1	Test Purpose and Environment.....	320
A.4.5.2.5.2	Test Requirements	323
A.4.5.2.6	E-UTRAN – NR FR1 interruptions during measurements on deactivated E-UTRAN SCC in asynchronous EN-DC.....	323
A.4.5.2.6.1	Test Purpose and Environment.....	323
A.4.5.2.6.2	Test Requirements	326
A.4.5.2.7	Void.....	326
A.4.5.3.1	SCell Activation and deactivation of known SCell in FR1 for 160ms SCell measurement cycle	326
A.4.5.3.1.1	Test Purpose and Environment.....	326
A.4.5.3.1.2	Test Requirements	332
A.4.5.3.2	SCell Activation and deactivation of known SCell in FR1 for 640ms SCell measurement cycle	333
A.4.5.3.2.1	Test Purpose and Environment.....	333
A.4.5.3.2.2	Test Requirements	333
A.4.5.3.3	SCell Activation and deactivation of unknown SCell in FR1	333
A.4.5.3.3.1	Test Purpose and Environment.....	333
A.4.5.3.3.2	Test Requirements	334
A.4.5.4	UE UL carrier RRC reconfiguration Delay	334
A.4.5.4.1	UE UL carrier RRC reconfiguration Delay.....	334
A.4.5.4.1.1	Test Purpose and Environment.....	334
A.4.5.4.1.2	Test Requirements	341
A.4.5.5	Beam Failure Detection and Link recovery procedures.....	341
A.4.5.5.1	EN-DC Beam Failure Detection and Link Recovery Test for FR1 PSCell configured with SSB-based BFD and LR in non-DRX mode	341
A.4.5.5.1.1	Test Purpose and Environment.....	341
A.4.5.5.1.2	Test Requirements	345
A.4.5.5.2	EN-DC Beam Failure Detection and Link Recovery Test for FR1 PSCell configured with SSB-based BFD and LR in DRX mode.....	346
A.4.5.5.2.1	Test Purpose and Environment.....	346
A.4.5.5.2.2	Test Requirements	350
A.4.5.5.3	EN-DC Beam Failure Detection and Link Recovery Test for FR1 PSCell configured with CSI-RS-based BFD and LR in non-DRX mode	351
A.4.5.5.3.1	Test Purpose and Environment.....	351
A.4.5.5.3.2	Test Requirements	355
A.4.5.5.4	EN-DC Beam Failure Detection and Link Recovery Test for FR1 PSCell configured with CSI-RS-based BFD and LR in DRX mode.....	355
A.4.5.5.4.1	Test Purpose and Environment.....	355
A.4.5.5.4.2	Test Requirements	359
A.4.5.6.1	DCI-based and Timer-based Active BWP Switch	360
A.4.5.6.1.1	E-UTRAN – NR PSCell FR1 DL active BWP switch in non-DRX in synchronous EN-DC	360
A.4.5.6.1.1.1	Test Purpose and Environment	360
A.4.5.6.1.1.2	Test Requirements	363
A.4.5.6.1.2	E-UTRAN – NR PSCell FR1 DL active BWP switch with FR1 SCell in non-DRX in synchronous EN-DC.....	364
A.4.5.6.1.2.1	Test Purpose and Environment	364
A.4.5.6.1.2.2	Test Requirements	369
A.4.5.6.2	RRC-based Active BWP Switch	370