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Contents

Foreword

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

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1 Scope

The present document specifies requirements for support of Radio Resource Management for the FDD and TDD modes of New Radio(NR). These requirements include requirements on measurements in NR and the UE as well as requirements on node dynamical behaviour and interaction, in terms of delay and response characteristics.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TS 38.304: "NR; User Equipment (UE) procedures in idle mode".

[2] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".

[3] 3GPP TS 38.213: "NR; Physical layer procedures for control".

[4] 3GPP TS 38.215: "NR; Physical layer measurements".

[5] 3GPP TS 38.533: "NR; User Equipment (UE) conformance specification; Radio Resource Management (RRM)".

[6] 3GPP TS 38.211: "NR; Physical channels and modulation".

[7] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification".

[8] 3GPP TS 38. 212 "NR; Multiplexing and channel coding".

[9] 3GPP TS 38.202: "NR; Physical layer services provided by the physical layer".

[10] 3GPP TS 38.300: "NR; Overall description; Stage-2".

[11] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[12] 3GPP TS 38.423: "NG-RAN; Xn Application Protocol (XnAP)".

[13] 3GPP TS 38.104: "NR; Base Station (BS) radio transmission and reception".

[14] 3GPP TS 38.306: "NR; User Equipment (UE) radio access capabilities".

[15] 3GPP TS 36.133: "Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management".

[16] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC) protocol specification".

[17] 3GPP TS 37.340: "Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Multi-connectivity", Stage 2.

[18] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[19] 3GPP TS 38.101-2: "NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".

[20] 3GPP TS 38.101-3: "NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios".

[21] 3GPP TS 38.101-4: "NR; User Equipment (UE) radio transmission and reception; Part 4: Performance requirements".

[22] 3GPP TS 38.305: "NG Radio Access Network (NG-RAN); Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN".

[23] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation".

[24] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA); Overall description".

[25] 3GPP TS 36.101: "Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [11] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [11].

Active DL BWP: Active DL bandwidth part as defined in TS 38.213 [3].

DL BWP: DL bandwidth part as defined in TS 38.213 [3].

EN-DC: E-UTRA-NR Dual Connectivity as defined in TS 37.340 [17, Section 4.1.2].

en-gNB: As defined in TS 37.340 [17].

FR1: Frequency range 1 as defined in TS 38.104 [13, Section 5.1].

FR2: Frequency range 2 as defined in TS 38.104 [13, Section 5.1].

gNB: as defined in in TS 38.300 [10].

Master Cell Group: As defined in TS 38.331 [2].

ng-eNB: As defined in TS 38.300 [10].

NSA operation mode: EN-DC operation mode, where the UE is configured at least with PSCell and E-UTRA PCell.

Primary Cell: As defined in TS 38.331 [2].

RLM-RS resource: A resource out of the set of resources configured for RLM by higher layer parameter RLM-RS-List [2] as defined in TS 38.213 [3].

SA operation mode: Operation mode when the UE is configured with at least PCell.

Secondary Cell: As defined in TS 38.331 [2].

Secondary Cell Group: As defined in TS 38.331 [2].

Serving Cell: As defined in TS 38.331 [2].

SMTC: An SSB-based measurement timing configuration configured by *SSB-MeasurementTimingConfiguration* as specified in TS 38.331 [2].

SSB: SS/PBCH block as defined in TS 38.211 [6, section 7.8.3].

Timing Advance Group: As defined in TS 38.331 [2].

3.2 Symbols

For the purposes of the present document, the following symbols apply:

[…]	Values included in square bracket must be considered for further studies, because it means that a decision about that value was not taken.
T_c	Basic time unit, defined in TS 38.211 [6, Section 4.1].
T_s	Reference time unit, defined in TS 38.211 [6, Section 4.1].

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [11] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [11].

BWP	Bandwidth Part
CA	Carrier Aggregation
CC	Component Carrier
CP	Cyclic Prefix
CSI	Channel-State Information
CSI-RS	CSI Reference Signal
DC	Dual Connectivity
DL	Downlink
DMRS	Demodulation Reference Signal
DRX	Discontinuous Reception
E-UTRA	Evolved UTRA
E-UTRAN	Evolved UTRAN
EN-DC	E-UTRA-NR Dual Connectivity
FDD	Frequency Division Duplex
FR	Frequency Range
HARQ	Hybrid Automatic Repeat Request
HO	Handover
MAC	Medium Access Control
MCG	Master Cell Group
MGL	Measurement Gap Length
MGRP	Measurement Gap Repetition Period
MIB	Master Information Block
NR	New Radio
NSA	Non-Standalone operation mode
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
PBCH	Physical Broadcast Channel
PCell	Primary Cell
PLMN	Public Land Mobile Network
PRACH	Physical RACH
PSCell	Primary SCell
PSS	Primary Synchronization Signal
PUCCH	Physical Uplink Control Channel
PUSCH	Physical Uplink Shared Channel
RACH	Random Access Channel
RAT	Radio Access Technology
RLM	Radio Link Monitoring
RLM-RS	Reference Signal for RLM
RRC	Radio Resource Control
RRM	Radio Resource Management
RSSI	Received Signal Strength Indicator
SA	Standalone operation mode
SCell	Secondary Cell
SCG	Secondary Cell Group
SCS	Subcarrier Spacing
SCS_{SSB}	SSB subcarrier spacing.

SFN	System Frame Number
SI	System Information
SIB	System Information Block
SMTC	SSB-based Measurement Timing configuration
SRS	Sounding Reference Signal
SS	Synchronization Signal
SS-RSRP	Synchronization Signal based Reference Signal Received Power
SS-RSRQ	Synchronization Signal based Reference Signal Received Quality
SS-SINR	Synchronization Signal based Signal to Noise and Interference Ratio
SSB	Synchronization Signal Block
SSB_RP	Received (linear) average power of the resource elements that carry NR SSB signals and channels, measured at the UE antenna connector.
SSS	Secondary Synchronization Signal
TA	Timing Advance
TAG	Timing Advance Group
TDD	Time Division Duplex
TTI	Transmission Time Interval
UE	User Equipment
UL	Uplink

3.4 Test tolerances

The requirements given in the present document make no allowance for measurement uncertainty. The test specification 38.5xx [x] defines the test tolerances.

Editor's note: intended to capture test tolerances. OTA test tolerance or margin will be captured in this section if needed.

3.5 Frequency bands grouping

3.5.1 Introduction

The intention with the frequency band grouping below is to increase the readability of the specification.

The frequency bands grouping is derived based on UE REFSENS requirements specified in [18, 19, 20] and assuming 0.5 dB step between the neighbour groups. The groups are defined in the order of increasing REFSENS, i.e., the group A has the smallest REFSENS among the groups. For the same SCS and a given bandwidth, the bands within the same group have the same Io conditions in a corresponding requirement in this specification, provided the bands support this SCS. For different SCSs supported by a frequency band and the same bandwidth, different Io conditions may apply for the frequency band in the requirements, while the band group is the same, based on the lowest REFSENS requirement normalized by the number of subcarriers among its supported SCSs for this bandwidth. For the same SCS but different supported bandwidths, the group for a band is determined based on the lowest REFSENS requirement normalized by the number of subcarriers among its supported bandwidths.

3.5.2 NR operating bands in FR1

NR frequency bands grouping for FR1 is specified in Table 3.5.2-1.

Table 3.5.2-1: NR frequency band groups for FR1

Group	NR FDD		NR TDD	
	Band group notation	Operating bands	Band group notation	Operating bands
A	NR_FDD_FR1_A	n1, n70	NR_TDD_FR1_A	n34, n38, n39, n40, n51
B	NR_FDD_FR1_B	n66	NR_TDD_FR1_B	-
C	NR_FDD_FR1_C	-	NR_TDD_FR1_C	n77[1], n78, n79
D	NR_FDD_FR1_D	-	NR_TDD_FR1_D	n77[2]
E	NR_FDD_FR1_E	n2, n7	NR_TDD_FR1_E	n41
F	NR_FDD_FR1_F	-	NR_TDD_FR1_F	-
G	NR_FDD_FR1_G	n3, n5, n12, n28	NR_TDD_FR1_G	-
H	NR_FDD_FR1_H	n8, n25	NR_TDD_FR1_H	-
I	NR_FDD_FR1_I	n20	NR_TDD_FR1_I	-
J	NR_FDD_FR1_J	-	NR_TDD_FR1_J	-
K	NR_FDD_FR1_K	-	NR_TDD_FR1_K	-
L	NR_FDD_FR1_L	-	NR_TDD_FR1_L	-
M	NR_FDD_FR1_M	-	NR_TDD_FR1_M	-
N	NR_FDD_FR1_N	-	NR_TDD_FR1_N	-
O	NR_FDD_FR1_O	-	NR_TDD_FR1_O	-
P	NR_FDD_FR1_P	n71	NR_TDD_FR1_P	-
NOTE 1: Except 3.8 GHz to 4.2 GHz. NOTE 2: Only 3.8 GHz to 4.2 GHz.				

3.5.3 NR operating bands in FR2

NR frequency bands grouping for FR2 is specified in Table 3.5.3-1.

Table 3.5.3-1: NR frequency band groups for FR2

Group	Band group notation	Operating bands
A	NR_TDD_FR2_A	n257[1], n258[1], n261[1]
B	NR_TDD_FR2_B	n257[4], n258[4], n261[4]
C	NR_TDD_FR2_C	
D	NR_TDD_FR2_D	
E	NR_TDD_FR2_E	
F	NR_TDD_FR2_F	n260[4]
G	NR_TDD_FR2_G	n257[2], n258[2], n260[1], n261[2]
H	NR_TDD_FR2_H	
I	NR_TDD_FR2_I	
J	NR_TDD_FR2_J	
K	NR_TDD_FR2_K	
L	NR_TDD_FR2_L	
M	NR_TDD_FR2_M	
N	NR_TDD_FR2_N	
O	NR_TDD_FR2_O	
P	NR_TDD_FR2_P	
Q	NR_TDD_FR2_Q	
R	NR_TDD_FR2_R	
S	NR_TDD_FR2_S	
T	NR_TDD_FR2_T	n257[3], n258[3], n261[3]
U	NR_TDD_FR2_U	
V	NR_TDD_FR2_V	
W	NR_TDD_FR2_W	
X	NR_TDD_FR2_X	
Y	NR_TDD_FR2_Y	n260[3]
NOTE 1: UE power class 1. NOTE 2: UE power class 2. NOTE 3: UE power class 3. NOTE 4: UE power class 4.		

3.6 Applicability of requirements in this specification version

In this specification,

- ‘cell’, ‘PCell’, ‘PSCell’ and ‘SCell’ refer to NR cell, NR PCell, NR PSCell and NR SCell,
- E-UTRA cells are referred to as ‘E-UTRA cell’, ‘E-UTRA PCell’ and ‘E-UTRA SCell’,
- E-UTRA-NR dual connectivity where E-UTRA is the master is referred to as ‘E-UTRA-NR dual connectivity’ or ‘EN-DC’.

For UE configured with supplementary UL, the requirements in section 7.1 and 7.3 shall also apply to uplink transmissions on supplementary UL.

3.6.1 RRC connected state requirements in DRX

For the requirements in RRC connected state specified in this version of the specification, the UE shall assume that no DRX is used provided the following conditions are met:

- DRX parameters are not configured or
- DRX parameters are configured and
  - drx-InactivityTimer is running or
  - drx-RetransmissionTimerDL is running or
  - drx-RetransmissionTimerUL is running or
  - ra-ContentionResolutionTimer is running or
  - a Scheduling Request sent on PUCCH is pending or
    - a PDCCH indicating a new transmission addressed to the C-RNTI of the MAC entity has not been received after successful reception of a Random Access Response for the preamble not selected by the MAC entity

Otherwise the UE shall assume that DRX is used.

3.6.2 Number of serving carriers

3.6.2.1 Number of serving carriers for SA

Requirements for standalone NR with NR PCell are applicable for the UE configured with the following number of serving NR CCs:

- up to 8 NR DL CCs in total, with 1 UL (or 2 UL if SUL is configured) in PCell and up to 1 UL (or 2 UL if SUL is configured) in SCell.
- SUL may be configured together with one of the UL

3.6.2.2 Number of serving carriers for EN-DC

Requirements for EN-DC operation of E-UTRA and NR with E-UTRA PCell and NR PSCell are applicable for the UE configured with the following number of serving NR CCs:

- up to 7 NR DL CCs in total, with 1 UL (or 2 UL if SUL is configured) in PCell and up to 1 UL (or 2 UL if SUL is configured) in SCell.
- SUL may be configured together with one of the UL

The applicable number of E-UTRA CC for EN-DC in the MCG for both UL and DL is specified in TS 36.133 [15].

4 SA: RRC_IDLE state mobility

Editor's note: intended to capture the RRM requirements for RRC_IDLE state in stand-alone operation.

4.1 Cell Selection

After a UE has switched on and a PLMN has been selected, the Cell selection process takes place, as described in TS 38.304. This process allows the UE to select a suitable cell where to camp on in order to access available services. In this process, the UE can use stored information (*Stored information cell selection*) or not (*Initial cell selection*).

4.2 Cell Re-selection

4.2.1 Introduction

The cell reselection procedure allows the UE to select a more suitable cell and camp on it.

When the UE is in either *Camped Normally* state or *Camped on Any Cell* state on a cell, the UE shall attempt to detect, synchronise, and monitor intra-frequency, inter-frequency and inter-RAT cells indicated by the serving cell. For intra-frequency and inter-frequency cells the serving cell may not provide explicit neighbour list but carrier frequency information and bandwidth information only. UE measurement activity is also controlled by measurement rules defined in TS 38.304, allowing the UE to limit its measurement activity.

4.2.2 Requirements

4.2.2.1 UE measurement capability

For idle mode cell re-selection purposes, the UE shall be capable of monitoring at least:

- Intra-frequency carrier, and
- Depending on UE capability, 7 NR inter-frequency carriers.
- Depending on UE capability, 7 FDD E-UTRA inter-RAT carriers, and
- Depending on UE capability, 7 TDD E-UTRA inter-RAT carriers, and

In addition to the requirements defined above, a UE supporting E-UTRA measurements in RRC_IDLE state shall be capable of monitoring a total of at least 14 carrier frequency layers, which includes serving layer, comprising of any above defined combination of E-UTRA FDD, E-UTRA TDD and NR layers.

4.2.2.2 Measurement and evaluation of serving cell

The UE shall measure the SS-RSRP and SS-RSRQ level of the serving cell and evaluate the cell selection criterion S defined in [1] for the serving cell at least once every M1 DRX cycle; where:

M1=2 if SMTC periodicity (T_{SMTC}) > 20 ms and DRX cycle $\leq$ 0.64 second,

otherwise M1=1.

The UE shall filter the SS-RSRP and SS-RSRQ measurements of the serving cell using at least 2 measurements. Within the set of measurements used for the filtering, at least two measurements shall be spaced by, at least DRX cycle/2.

If the UE has evaluated according to Table 4.2.2.1-1 in N_{serv} consecutive DRX cycles that the serving cell does not fulfil the cell selection criterion S, the UE shall initiate the measurements of all neighbour cells indicated by the serving cell, regardless of the measurement rules currently limiting UE measurement activities.

If the UE in RRC_IDLE has not found any new suitable cell based on searches and measurements using the intra-frequency, inter-frequency and inter-RAT information indicated in the system information for 10 s, the UE shall initiate cell selection procedures for the selected PLMN as defined in TS 38.304 [1].

Table 4.2.2.1-1: N_{serv}

DRX cycle length [s]	N_{serv} [number of DRX cycles]
0.32	M1*N1*[4]
0.64	M1*N1*[4]
1.28	N1*[2]
2.56	N1*[2]
NOTE 1: N1=[TBD] for frequency range FR2, and N1=1 for frequency range FR1.	

4.2.2.3 Measurements of intra-frequency NR cells

The UE shall be able to identify new intra-frequency cells and perform SS-RSRP and SS-RSRQ measurements of the identified intra-frequency cells without an explicit intra-frequency neighbour list containing physical layer cell identities.

The UE shall be able to evaluate whether a newly detectable intra-frequency cell meets the reselection criteria defined in TS38.304 within T_{detect,NR_Intra} when that Treselection= 0 . An intra frequency cell is considered to be detectable according to the conditions defined in Annex B.1.2 for a corresponding Band.

The UE shall measure SS-RSRP and SS-RSRQ at least every $T_{measure,NR\_Intra}$ (see table 4.2.2.3-1) for intra-frequency cells that are identified and measured according to the measurement rules.

The UE shall filter SS-RSRP and SS-RSRQ measurements of each measured intra-frequency cell using at least 2 measurements. Within the set of measurements used for the filtering, at least two measurements shall be spaced by at least $T_{measure,NR\_Intra}/2$.

The UE shall not consider a NR neighbour cell in cell reselection, if it is indicated as not allowed in the measurement control system information of the serving cell.

For an intra-frequency cell that has been already detected, but that has not been reselected to, the filtering shall be such that the UE shall be capable of evaluating that the intra-frequency cell has met reselection criterion defined [1] within $T_{evaluate,NR\_Intra}$ when $T_{reselection} = 0$ as specified in table 4.2.2.3-1 provided that:

- when *rangeToBestCell* is not configured, the cell has at least [3]dB in FR1 or [TBD]dB in FR2 better ranked or
- when *rangeToBestCell* is configured, the cell which has the highest number of beams above the threshold *absThreshSS-Consolidation* among the cells whose cell-ranking criterion R value as specified in TS 38.304 [1, Section 5.2.4.6] is within *rangeToBestCell* of the R+[TBD] dB in FR1 or R+[TBD]dB in FR2 value of the cell ranked as the best cell, and if there are multiple such cells the UE shall perform cell reselection to the highest ranked cell among them.

When evaluating cells for reselection, the SSB side conditions apply to both serving and non-serving intra-frequency cells.

If $T_{reselection}$ timer has a non zero value and the intra-frequency cell is satisfied with the reselection criteria which are defined in TS38.304 [1], the UE shall evaluate this intra-frequency cell for the $T_{reselection}$ time. If this cell remains satisfied with the reselection criteria within this duration, then the UE shall reselect that cell.

Table 4.2.2.3-1 : T_{detect,NR_Intra}, $T_{measure,NR\_Intra}$ and $T_{evaluate,NR\_Intra}$

DRX cycle length [s]	T_{detect,NR_Intra} [s] (number of DRX cycles)	$T_{measure,NR\_Intra}$ [s] (number of DRX cycles)	$T_{evaluate,NR\_Intra}$ [s] (number of DRX cycles)
0.32	11.52 x N1 x M2 [36 x N1 x M2]	1.28 x N1 x M2 (4 x N1 x M2)	5.12 x N1 x M2 (16 x N1 x M2)
0.64	17.92 x N1 [28 x N1]	1.28 x N1 (2 x N1)	5.12 x N1 (8 x N1)
1.28	32 x N1 [25 x N1]	1.28 x N1 (1 x N1)	6.4 x N1 (5 x N1)
2.56	58.88 x N1 [23 x N1]	2.56 x N1 (1 x N1)	7.68 x N1 (3 x N1)
Note 1: N1=[TBD] for frequency range FR2, and N1=1 for frequency range FR1. Note 2: M2 = 1.5 if SMTC periodicity of measured intra-frequency cell > 20 ms; otherwise M2=1.			

4.2.2.4 Measurements of inter-frequency NR cells

The UE shall be able to identify new inter-frequency cells and perform SS-RSRP or SS-RSRQ measurements of identified inter-frequency cells if carrier frequency information is provided by the serving cell, even if no explicit neighbour list with physical layer cell identities is provided.

If Srxlev > $S_{nonIntraSearchP}$ and Squal > $S_{nonIntraSearchQ}$ then the UE shall search for inter-frequency layers of higher priority at least every $T_{higher\_priority\_search}$ where $T_{higher\_priority\_search}$ is described in clause 4.2.2.7.

If Srxlev ≤ $S_{nonIntraSearchP}$ or Squal ≤ $S_{nonIntraSearchQ}$ then the UE shall search for and measure inter-frequency layers of higher, equal or lower priority in preparation for possible reselection. In this scenario, the minimum rate at which the UE is required to search for and measure higher priority layers shall be the same as that defined below.

The UE shall be able to evaluate whether a newly detectable inter-frequency cell meets the reselection criteria defined in TS38.304 within $K_{carrier}$ * T_{detect,NR_Inter} if at least carrier frequency information is provided for inter-frequency neighbour cells by the serving cells when $T_{reselection}$ = 0 provided that the reselection criteria is met by a margin of at least [5] dB in FR1 or [TBD]dB in FR2 for reselections based on ranking or [6]dB in FR1 or [TBD] dB in FR2 for SS-RSRP reselections based on absolute priorities or [4]dB in FR1 and [TBD] in FR2 for SS-RSRQ reselections based on absolute priorities. The parameter $K_{carrier}$ is the number of NR inter-frequency carriers indicated by the serving cell. An inter-frequency cell is considered to be detectable according to the conditions defined in Annex B.1.3 for a corresponding Band.

When higher priority cells are found by the higher priority search, they shall be measured at least every $T_{measure,NR\_Inter}$. If, after detecting a cell in a higher priority search, it is determined that reselection has not occurred then the UE is not required to continuously measure the detected cell to evaluate the ongoing possibility of reselection. However, the minimum measurement filtering requirements specified later in this section shall still be met by the UE before it makes any determination that it may stop measuring the cell. If the UE detects on a NR carrier a cell whose physical identity is indicated as not allowed for that carrier in the measurement control system information of the serving cell, the UE is not required to perform measurements on that cell.

The UE shall measure SS-RSRP or SS-RSRQ at least every $K_{carrier}$ * $T_{measure,NR\_Inter}$ (see table 4.2.2.4-1) for identified lower or equal priority inter-frequency cells. If the UE detects on a NR carrier a cell whose physical identity is indicated as not allowed for that carrier in the measurement control system information of the serving cell, the UE is not required to perform measurements on that cell.

The UE shall filter SS-RSRP or SS-RSRQ measurements of each measured higher, lower and equal priority inter-frequency cell using at least 2 measurements. Within the set of measurements used for the filtering, at least two measurements shall be spaced by at least $T_{measure,NR\_Inter}$/2.

The UE shall not consider a NR neighbour cell in cell reselection, if it is indicated as not allowed in the measurement control system information of the serving cell.

For an inter-frequency cell that has been already detected, but that has not been reselected to, the filtering shall be such that the UE shall be capable of evaluating that the inter-frequency cell has met reselection criterion defined TS 38.304 within $K_{carrier}$ * $T_{evaluate,NR\_Inter}$ when $T_{reselection}$ = 0 as specified in table 4.2.2.4-1 provided that the reselection criteria is met by

- the condition when performing equal priority reselection and
  - when *rangeToBestCell* is not configured, the cell has at least [3]dB in FR1 or [TBD]dB in FR2 better ranked or
  - when *rangeToBestCell* is configured, the cell which has the highest number of beams above the threshold *absThreshSS-Consolidation* among the cells whose cell-ranking criterion R value as specified in TS 38.304 [1, Section 5.2.4.6] is within *rangeToBestCell* of the R+[TBD] dB in FR1 or R+[TBD]dB in FR2 value of the cell ranked as the best cell, and if there are multiple such cells the UE shall perform cell reselection to the highest ranked cell among them or
- [6]dB in FR1 or [TBD]dB in FR2 for SS-RSRP reselections based on absolute priorities or
- [4]dB in FR1 or [TBD] in FR2 for SS-RSRQ reselections based on absolute priorities.

When evaluating cells for reselection, the SSB side conditions apply to both serving and inter-frequency cells.

If $T_{reselection}$ timer has a non zero value and the inter-frequency cell is satisfied with the reselection criteria, the UE shall evaluate this inter-frequency cell for the $T_{reselection}$ time. If this cell remains satisfied with the reselection criteria within this duration, then the UE shall reselect that cell.

Table 4.2.2.4-1 : T_{detect,NR_Inter}, $T_{measure,NR\_Inter}$ and $T_{evaluate,NR\_Inter}$

DRX cycle length [s]	T_{detect,NR_Inter} [s] (number of DRX cycles)	$T_{measure,NR\_Inter}$ [s] (number of DRX cycles)	$T_{evaluate,NR\_Inter}$ [s] (number of DRX cycles)
0.32	11.52 x N1 x 1.5 x [36 x N1 x 1.5]	1.28 x N1 x 1.5 (4 x N1 x 1.5)	5.12 x N1 x 1.5 (16 x N1 x 1.5)
0.64	17.92x N1 [28 x N1]	1.28 x N1 (2 x N1)	5.12 x N1 (8 x N1)
1.28	32 x N1 [25 x N1]	1.28 x N1 (1 x N1)	6.4 x N1 (5 x N1)
2.56	58.88 x N1 [23 x N1]	2.56 x N1 (1 x N1)	7.68 x N1 (3 x N1)
Note 1: N1=[TBD] for frequency range FR2, and N1=1 for frequency range FR1.			

Editor's Note: It is FFS how to address the scenario when SMTC periodicity = 160 ms and DRX cycles = 320 ms in both intra-frequency and inter-frequency carriers, and also SMTC durations fully collide on both intra-frequency and inter-frequency carriers.

4.2.2.5 Measurements of inter-RAT E-UTRAN cells

If Srxlev > $S_{nonIntraSearchP}$ and Squal > $S_{nonIntraSearchQ}$ then the UE shall search for inter-RAT E-UTRAN layers of higher priority at least every $T_{higher\_priority\_search}$ where $T_{higher\_priority\_search}$ is described in clause 4.2.2

If Srxlev ≤ $S_{nonIntraSearchP}$ or Squal ≤ $S_{nonIntraSearchQ}$ then the UE shall search for and measure inter-RAT E-UTRAN layers of higher, lower priority in preparation for possible reselection. In this scenario, the minimum rate at which the UE is required to search for and measure higher priority inter-RAT E-UTRAN layers shall be the same as that defined below for lower priority RATs.

The requirements in this section apply for inter-RAT E-UTRAN FDD measurements and E-UTRA TDD measurements. When the measurement rules indicate that inter-RAT E-UTRAN cells are to be measured, the UE shall measure RSRP and RSRQ of detected E-UTRA cells in the neighbour frequency list at the minimum measurement rate specified in this section. The parameter $N_{EUTRA\_carrier}$ is the total number of configured E-UTRA carriers in the neighbour frequency list. The UE shall filter RSRP and RSRQ measurements of each measured E-UTRA cell using at least 2 measurements. Within the set of measurements used for the filtering, at least two measurements shall be spaced by at least $T_{measure,EUTRAN}/2$.

An inter-RAT E-UTRA cell is considered to be detectable provided the following conditions are fulfilled:

- the same conditions as for inter-frequency RSRP measurements specified in TS 36.133 [15, Annex B.1.2] are fulfilled for a corresponding Band, and
- the same conditions as for inter-frequency RSRQ measurements specified in TS 36.133 [15, Annex B.1.2] are fulfilled for a corresponding Band.
- SCH conditions specified in TS 36.133 [15, Annex B.1.2] are fulfilled for a corresponding Band

The UE shall be able to evaluate whether a newly detectable inter-RAT E-UTRAN cell meets the reselection criteria defined in TS38.304 within ($N_{EUTRA\_carrier}$) * $T_{detect,EUTRAN}$ when Srxlev ≤ $S_{nonIntraSearchP}$ or Squal ≤ $S_{nonIntraSearchQ}$ when $T_{reselection}$ = 0 provided that the reselection criteria is met by a margin of at least 5dB for reselections based on ranking or 6dB for RSRP reselections based on absolute priorities or 4dB for RSRQ reselections based on absolute priorities.

Cells which have been detected shall be measured at least every ($N_{EUTRA\_carrier}$) * $T_{measure,EUTRAN}$ when Srxlev ≤ $S_{nonIntraSearchP}$ or Squal ≤ $S_{nonIntraSearchQ}$.

When higher priority cells are found by the higher priority search, they shall be measured at least every $T_{measure,EUTRAN}$. If, after detecting a cell in a higher priority search, it is determined that reselection has not occurred then the UE is not required to continuously measure the detected cell to evaluate the ongoing possibility of reselection. However, the minimum measurement filtering requirements specified later in this section shall still be met by the UE before it makes any determination that it may stop measuring the cell.

If the UE detects on an inter-RAT E-UTRAN carrier a cell whose physical identity is indicated as not allowed for that carrier in the measurement control system information of the serving cell, the UE is not required to perform measurements on that cell.

The UE shall not consider an inter-RAT E-UTRA cell in cell reselection, if it is indicated as not allowed in the measurement control system information of the serving cell.

For a cell that has been already detected, but that has not been reselected to, the filtering shall be such that the UE shall be capable of evaluating that an already identified inter-RAT E-UTRA cell has met reselection criterion defined in TS 38.304 [1] within ($N_{EUTRA\_carrier}$) * $T_{evaluate,EUTRAN}$ when $T_{reselection}$ = 0 as speficied in table 4.2.2.5-1 provided that the reselection criteria is met by a margin of at least 5dB for reselections based on ranking or 6dB for RSRP reselections based on absolute priorities or 4dB for RSRQ reselections based on absolute priorities.

If $T_{reselection}$ timer has a non zero value and the inter-RAT E-UTRA cell is satisfied with the reselection criteria which are defined in [1], the UE shall evaluate this E-UTRA cell for the $T_{reselection}$ time. If this cell remains satisfied with the reselection criteria within this duration, then the UE shall reselect that cell.

Table 4.2.2.5-1: $T_{detect,EUTRAN}$, $T_{measure,EUTRAN}$, and $T_{evaluate,EUTRAN}$

DRX cycle length [s]	$T_{detect,EUTRAN}$ [s] (number of DRX cycles)	$T_{measure,EUTRAN}$ [s] (number of DRX cycles)	$T_{evaluate,EUTRAN}$ [s] (number of DRX cycles)
0.32	11.52 (36)	1.28 (4)	5.12 (16)
0.64	17.92 (28)	1.28 (2)	5.12 (8)
1.28	32(25)	1.28 (1)	6.4 (5)
2.56	58.88 (23)	2.56 (1)	7.68 (3)

4.2.2.6 Maximum interruption in paging reception

UE shall perform the cell re-selection with minimum interruption in monitoring downlink channels for paging reception.

At intra-frequency and inter-frequency cell re-selection, the UE shall monitor the downlink of serving cell for paging reception until the UE is capable to start monitoring downlink channels of the target intra-frequency and inter-frequency cell for paging reception. The interruption time shall not exceed T_{SI-NR} + 2*$T_{target\_cell\_SMTC\_period}$ ms.

At inter-RAT cell re-selection, the UE shall monitor the downlink of serving cell for paging reception until the UE is capable to start monitoring downlink channels for paging reception of the target inter-RAT cell. For NR to E-UTRAN cell re-selection the interruption time must not exceed $T_{SI-EUTRA}$ + 55 ms.

T_{SI-NR} is the time required for receiving all the relevant system information data according to the reception procedure and the RRC procedure delay of system information blocks defined in TS 38.331 [2] for an NR cell.

$T_{SI-EUTRA}$ is the time required for receiving all the relevant system information data according to the reception procedure and the RRC procedure delay of system information blocks defined in TS 36.331 [16] for an E-UTRAN cell.

These requirements assume sufficient radio conditions, so that decoding of system information can be made without errors and does not take into account cell re-selection failure.

4.2.2.7 General requirements

The UE shall search every layer of higher priority at least every $T_{higher\_priority\_search}$ = ([60] * N_{layers}) seconds, where N_{layers} is the total number of higher priority NR and E-UTRA carrier frequencies broadcasted in system information.

5 SA: RRC_INACTIVE state mobility

5.1 Cell Re-selection

5.1.1 Introduction

The cell reselection procedure allows the UE to select a more suitable cell and camp on it.

When the UE is in *Camped Normally* state on a cell, the UE shall attempt to detect, synchronise, and monitor intra-frequency, inter-frequency and inter-RAT cells indicated by the serving cell. For intra-frequency and inter-frequency cells the serving cell may not provide explicit neighbour list but carrier frequency information and bandwidth information only. UE measurement activity is also controlled by measurement rules defined in TS38.304, allowing the UE to limit its measurement activity.

5.1.2 Requirements

5.1.2.1 UE measurement capability

The requirements in sub-clause 4.2.2.1 shall apply.

5.1.2.2 Measurement and evaluation of serving cell

The requirements in sub-clause 4.2.2.2 shall apply.

5.1.2.3 Measurements of intra-frequency NR cells

The requirements in sub-clause 4.2.2.3 shall apply.

5.1.2.4 Measurements of inter-frequency NR cells

The requirements in sub-clause 4.2.2.4 shall apply.

5.1.2.5 Measurements of inter-RAT E-UTRAN cells

The requirements in sub-clause 4.2.2.5 shall apply.

5.1.2.6 Maximum interruption in paging reception

The requirements in sub-clause 4.2.2.6 shall apply.

5.1.2.7 General requirements

The requirements in sub-clause 4.2.2.7 shall apply.

5.2 RRC_INACTIVE Mobility Control

Editor’s note: intended to capture requirements which applies for the transition between INACTIVE and IDLE state. This section might be removed if unnecessary.

6 RRC_CONNECTED state mobility

6.1 Handover

Editor’s note: if handover requirements are differentiated by with beamforming and without beamforming, then two sets of requirements (with/without beamforming) could be specified in this section.

6.1.1 NR Handover

6.1.1.1 Introduction

6.1.1.2 NR FR1 - NR FR1 Handover

The requirements in this clause are applicable to both intra-frequency and inter-frequency handovers from NR FR1 cell to NR FR1 cell.

6.1.1.2.1 Handover delay

Procedure delays for all procedures that can command a handover are specified in TS 38.331 [2].

When the UE receives a RRC message implying handover the UE shall be ready to start the transmission of the new uplink PRACH channel within $D_{handover}$ seconds from the end of the last TTI containing the RRC command.

Where:

$D_{handover}$ equals the maximum RRC procedure delay to be defined in clause12 in TS 38.331 [2] plus the interruption time stated in clause 6.1.1.2.2.

6.1.1.2.2 Interruption time

The interruption time is the time between end of the last TTI containing the RRC command on the old PDSCH and the time the UE starts transmission of the new PRACH, excluding the RRC procedure delay.

When intra-frequency or inter-frequency handover is commanded, the interruption time shall be less than $T_{interrupt}$

$$T_{interrupt} = T_{search} + T_{IU} + 20 + T_{\Delta} \text{ ms}$$

Where:

T_{search} is the time required to search the target cell when the target cell is not already known when the handover command is received by the UE. If the target cell is known, then T_{search} = 0 ms. If the target cell is an unknown intra-frequency cell and signal quality is sufficient for successful cell detection on the first attempt, then $T_{search} = T_{rs} + 2$ ms. If the target cell is an unknown inter-frequency cell and signal quality is sufficient for successful cell detection on the first attempt, then $T_{search} = [3^* T_{rs} + 2]$ ms. Regardless of whether DRX is in use by the UE, T_{search} shall still be based on non-DRX target cell search times.

T_{Δ} is time for fine time tracking and acquiring full timing information of the target cell. $T_{\Delta} = T_{rs}$.

T_{IU} is the interruption uncertainty in acquiring the first available PRACH occasion in the new cell. T_{IU} can be up to x*10 +10 ms. x is defined in the table 6.3.3.2-2 of TS 38.211 [6].

Trs is the SMTC period of the target NR cell if the UE has been provided with an SMTC configuration for the target cell prior to or in the handover command, otherwise Trs is the target cell SSB transmission period, if such is provided. If the UE is not provided with an SMTC configuration or SSB transmission period, the requirement in this section is applied with Trs=5ms unless the SSB transmission periodicity is not 5ms. If UE is provided with both SMTC configuration and SSB transmission period the requirement shall be based on SMTC periodicity.

NOTE 1: The actual value of T_{IU} shall depend upon the PRACH configuration used in the target cell.

In the interruption requirement a cell is known if it has been meeting the relevant cell identification requirement during the last 5 seconds otherwise it is unknown. Relevant cell identification requirements are described in Clause 9.2.5 for intra-frequency handover and Clause 9.3.1 for inter-frequency handover.

6.1.1.3 NR FR2- NR FR1 Handover

The requirements in this clause are applicable to inter-frequency handovers from NR FR2 cell to NR FR1 cell.

6.1.1.3.1 Handover delay

Procedure delays for all procedures that can command a handover are specified in TS 38.331 [2].

When the UE receives a RRC message implying handover the UE shall be ready to start the transmission of the new uplink PRACH channel within $D_{handover}$ seconds from the end of the last TTI containing the RRC command.

Where:

$D_{handover}$ equals the maximum RRC procedure delay to be defined in clause 12 in TS 38.331 [2] plus the interruption time stated in clause 6.1.1.3.2.

6.1.1.3.2 Interruption time

The interruption time is the time between end of the last TTI containing the RRC command on the old PDSCH and the time the UE starts transmission of the new PRACH, excluding the RRC procedure delay.

When intra-frequency or inter-frequency handover is commanded, the interruption time shall be less than $T_{interrupt}$

$$T_{interrupt} = T_{search} + T_{IU} + 40 + T_{\Delta} \text{ ms}$$

Where:

T_{search} is the time required to search the target cell when the target cell is not already known when the handover command is received by the UE. If the target cell is known, then T_{search} = 0 ms. If the target cell is an unknown inter-frequency cell and signal quality is sufficient for successful cell detection on the first attempt, then T_{search} = [3* T_{rs} + 2] ms. Regardless of whether DRX is in use by the UE, T_{search} shall still be based on non-DRX target cell search times.

T_{Δ} is time for fine time tracking and acquiring full timing information of the target cell. $T_{\Delta} = T_{rs}$.

T_{IU} is the interruption uncertainty in acquiring the first available PRACH occasion in the new cell. T_{IU} can be up to x*10 +10 ms. x is defined in the table 6.3.3.2-2 of [6].

Trs is the SMTC period of the target NR cell if the UE has been provided with an SMTC configuration for the target cell prior to or in the handover command, otherwise Trs is the target cell SSB transmission period, if such is provided. If the UE is not provided with an SMTC configuration or SSB transmission period, the requirement in this section is applied with Trs=5ms unless the SSB transmission periodicity is not 5ms. If UE is provided with both SMTC configuration and SSB transmission period the requirement shall be based on SMTC periodicity.

NOTE 1: The actual value of T_{IU} shall depend upon the PRACH configuration used in the target cell.

In the interruption requirement a cell is known if it has been meeting the relevant cell identification requirement during the last 5 seconds otherwise it is unknown. Relevant cell identification requirements are described in Clause 9.2.5 for intra-frequency handover and Clause 9.3.1 for inter-frequency handover.

6.1.1.4 NR FR2- NR FR2 Handover

The requirements in this clause are applicable to both intra-frequency and inter-frequency handovers from NR FR2 cell to NR FR2 cell.

6.1.1.4.1 Handover delay

Procedure delays for all procedures that can command a handover are specified in TS 38.331 [2].

When the UE receives a RRC message implying handover the UE shall be ready to start the transmission of the new uplink PRACH channel within $D_{handover}$ seconds from the end of the last TTI containing the RRC command.

Where:

$D_{handover}$ equals the maximum RRC procedure delay to be defined in clause 12 in TS 38.331 [2] plus the interruption time stated in clause 6.1.1.4.2.

6.1.1.4.2 Interruption time

The interruption time is the time between end of the last TTI containing the RRC command on the old PDSCH and the time the UE starts transmission of the new PRACH, excluding the RRC procedure delay.

When intra-frequency or inter-frequency handover is commanded, the interruption time shall be less than $T_{interrupt}$

$$T_{interrupt} = T_{search} + T_{IU} + T_{processing} + T_{\Delta} \text{ ms}$$

Where:

T_{search} is the time required to search the target cell when the handover command is received by the UE. If the target cell is an intra-frequency cell and signal quality is sufficient for successful cell detection on the first attempt, then T_{search} = [8* T_{rs} + 2] ms. If the target cell is an inter-frequency cell and signal quality is sufficient for successful cell detection on the first attempt, then T_{search} = [8*3* T_{rs} + 2] ms. Regardless of whether DRX is in use by the UE, T_{search} shall still be based on non-DRX target cell search times.

$T_{processing}$ is time for UE processing. $T_{processing}$ can be up to 20ms.

T_{Δ} is time for fine time tracking and acquiring full timing information of the target cell. T_{Δ} = [1]* T_{rs}.

T_{IU} is the interruption uncertainty in acquiring the first available PRACH occasion in the new cell. T_{IU} can be up to x*10 +10 ms. x is defined in the table 6.3.3.2-2 of [6].

Trs is the SMTC period of the target NR cell if the UE has been provided with an SMTC configuration for the target cell prior to or in the handover command, otherwise Trs is the target cell SSB transmission period, if such is provided. If the UE is not provided with an SMTC configuration or SSB transmission period, the requirement in this section is applied with Trs=5ms unless the SSB transmission periodicity is not 5ms. If UE is provided with both SMTC configuration and SSB transmission period the requirement shall be based on SMTC periodicity.

NOTE 1: The actual value of T_{IU} shall depend upon the PRACH configuration used in the target cell.

NOTE 2: Void

6.1.1.5 NR FR1- NR FR2 Handover

The requirements in this clause are applicable to inter-frequency handovers from NR FR1 cell to NR FR2 cell.

6.1.1.5.1 Handover delay

Procedure delays for all procedures that can command a handover are specified in TS 38.331 [2].

When the UE receives a RRC message implying handover the UE shall be ready to start the transmission of the new uplink PRACH channel within $D_{handover}$ seconds from the end of the last TTI containing the RRC command.

Where:

$D_{handover}$ equals the maximum RRC procedure delay to be defined in clause 12 in TS 38.331 [2] plus the interruption time stated in clause 6.1.1.5.2.

6.1.1.5.2 Interruption time

The interruption time is the time between end of the last TTI containing the RRC command on the old PDSCH and the time the UE starts transmission of the new PRACH, excluding the RRC procedure delay.

When intra-frequency or inter-frequency handover is commanded, the interruption time shall be less than $T_{interrupt}$

$$T_{interrupt} = T_{search} + T_{IU} + T_{processing} + T_{\Delta} \text{ ms}$$

Where:

T_{search} is the time required to search the target cell when the handover command is received by the UE. If the target cell is an intra-frequency cell and signal quality is sufficient for successful cell detection on the first attempt, then T_{search} = [8* T_{rs} + 2] ms. If the target cell is an inter-frequency cell and signal quality is sufficient for successful cell detection on the first attempt, then T_{search} = [8*3* T_{rs} + 2] ms. Regardless of whether DRX is in use by the UE, T_{search} shall still be based on non-DRX target cell search times.

$T_{processing}$ is time for UE processing. $T_{processing}$ can be up 40ms.

T_{Δ} is time for fine time tracking and acquiring full timing information of the target cell. T_{Δ} = [1]* T_{rs}.

T_{IU} is the interruption uncertainty in acquiring the first available PRACH occasion in the new cell. T_{IU} can be up to x*10 +10 ms. x is defined in the table 6.3.3.2-2 of [6].

Trs is the SMTC period of the target NR cell if the UE has been provided with an SMTC configuration for the target cell prior to or in the handover command, otherwise Trs is the target cell SSB transmission period, if such is provided. If the UE is not provided with an SMTC configuration or SSB transmission period, the requirement in this section is applied with Trs=5ms unless the SSB transmission periodicity is not 5ms. If UE is provided with both SMTC configuration and SSB transmission period the requirement shall be based on SMTC periodicity.

NOTE 1: The actual value of T_{IU} shall depend upon the PRACH configuration used in the target cell.

NOTE 2: Void

6.1.2 NR Handover to other RATs

6.1.2.1 NR – E-UTRAN Handover

6.1.2.1.1 Introduction

The purpose of inter-RAT handover from NR to E-UTRAN is to change the radio access mode from NR to E-UTRAN. The handover procedure is initiated from NR with a RRC message that implies a handover as described in TS 38.331 [2].

6.1.2.1.2 Handover delay

When the UE receives a RRC message implying handover to E-UTRAN the UE shall be ready to start the transmission of the uplink PRACH channel in E-UTRA within $D_{handover}$ seconds from the end of the last TTI containing the RRC command. $D_{handover}$ is defined as

$$D_{handover} = T_{RRC\_procedure\_delay} + T_{interruption}$$

Where:

$T_{RRC\_procedure\_delay}$: it is the RRC procedure delay, which is 50ms

$T_{interruption}$: it is the time between end of the last TTI containing the RRC command on the NR PDSCH and the time the UE starts transmission of the PRACH in E-UTRAN, excluding $T_{RRC\_procedure\_delay}$. $T_{interruption}$ is defined in clause 6.1.1.3.

6.1.2.1.3 Interruption time

When the inter-RAT handover to E-UTRAN is commanded, the interruption time shall be less than $T_{interrupt}$

$$T_{interrupt} = T_{search} + T_{IU} + 20 \text{ ms}$$

Where:

T_{search} is the time required to search the target cell when the target cell is not already known when the handover command is received by the UE. If the target cell is known, then T_{search} = 0 ms. If the target cell is unknown and signal quality is sufficient for successful cell detection on the first attempt, then T_{search} = 80 ms. Regardless of whether DRX is in use by the UE, T_{search} shall still be based on non-DRX target cell search times.

T_{IU} is the interruption uncertainty in acquiring the first available PRACH occasion in the new cell. T_{IU} can be up to 30 ms.

NOTE: The actual value of T_{IU} shall depend upon the PRACH configuration used in the target cell.

In the interruption requirement a cell is known if it has been meeting the relevant cell identification requirement during the last 5 seconds otherwise it is unknown. Relevant E-UTRAN cell identification requirements are described in clause [9.4.1].

6.2 RRC Connection Mobility Control

6.2.1 SA: RRC Re-establishment

6.2.1.1 Introduction

This clause contains requirements on the UE regarding RRC connection re-establishment procedure. RRC connection re-establishment is initiated when a UE in RRC_CONNECTED state loses RRC connection due to any of failure cases, including radio link failure, handover failure, and RRC connection reconfiguration failure. The RRC connection re-establishment procedure is specified in clause 5.3.7 of TS 38.331 [2].

The requirements in this clause are applicable for RRC connection re-establishment to NR cell.

6.2.1.2 Requirements

In RRC connected mode the UE shall be capable of sending *RRCConnectionReestablishmentRequest* message within $T_{re\text{-}establish\_delay}$ seconds from the moment it detects a loss in RRC connection. The total RRC connection delay ($T_{re\text{-}establish\_delay}$) shall be less than:

$$T_{re-establish\_delay} = T_{UL\_grant} + T_{UE\_re-establish\_delay} \quad ms$$

T_{UL_grant}: It is the time required to acquire and process uplink grant from the target PCell. The uplink grant is required to transmit *RRCConnectionReestablishmentRequest* message.

The UE re-establishment delay ($T_{UE\_re\text{-}establish\_delay}$) is specified in clause 6.2.1.2.1.

6.2.1.2.1 UE Re-establishment delay requirement

The UE re-establishment delay ($T_{UE\_re\text{-}establish\_delay}$) is the time between the moments when any of the conditions requiring RRC re-establishment as defined in clause 5.3.7 in TS 38.331 [2] is detected by the UE and when the UE sends PRACH to the target PCell. The UE re-establishment delay ($T_{UE\_re\text{-}establish\_delay}$) requirement shall be less than:

$$T_{UE\_re-establish\_delay} = 50 + T_{identify\_intra\_NR} + \sum_{i=1}^{Nfreq-1} T_{identify\_inter\_NR,i} + T_{SI-NR} + T_{PRACH} \quad ms$$

The intra-frequency target NR cell shall be considered detectable when for each relevant SSB:

- SS-RSRP related side conditions given in Section 10.1.2 and 10.1.3 are fulfilled for a corresponding NR Band for FR1 and FR2, respectively,
- SSB_RP and SSB Ês/Iot according to Annex B.2.2 for a corresponding NR Band.

The inter-frequency target NR cell shall be considered detectable when for each relevant SSB:

- SS-RSRP related side conditions given in Section 10.1.4 and 10.1.5 are fulfilled for a corresponding NR Band for FR1 and FR2, respectively,
- SSB_RP and SSB Ês/Iot according to Annex B.2.2 for a corresponding NR Band.

$T_{identify\_intra\_NR}$: It is the time to identify the target intra-frequency NR cell and it depends on whether the target NR cell is known cell or unknown cell and on the frequency range (FR) of the target NR cell. If the UE is not configured with intra-frequency NR carrier for RRC re-establishment then $T_{identify\_intra\_NR}$=0; otherwise $T_{identify\_intra\_NR}$ shall not exceed the values defined in table 6.2.1.2.1-1.

$T_{identify\_inter\_NR,i}$: It is the time to identify the target inter-frequency NR cell on inter-frequency carrier *i* configured for RRC re-establishment and it depends on whether the target NR cell is known cell or unknown cell and on the frequency range (FR) of the target NR cell. $T_{identify\_inter\_NR,i}$ shall not exceed the values defined in table 6.2.1.2.1-2.

T_{SMTC}: It is the periodicity of the SMTC occasion configured for the intra-frequency carrier.

$T_{SMTC,i}$: It is the periodicity of the SMTC occasion configured for the inter-frequency carrier *i*.

$T_{SI\text{-}NR}$ = It is the time required for receiving all the relevant system information according to the reception procedure and the RRC procedure delay of system information blocks defined in TS 38.331 [2] for the target PCell.

T_{PRACH} = It is the delay caused due to the random access procedure when sending random access to the target NR cell. The delay depends on the PRACH configuration defined in Table 6.3.3.2-2 [6] or Table 6.3.3.2-3 [6] for FR1 and in Table 6.3.3.2-4 [6] for FR2.

N_{freq}: It is the total number of NR frequencies to be monitored for RRC re-establishment; N_{freq} = 1 if the target PCell is known.

There is no requirement if the target cell does not contain the UE context.

In the requirement, the target FR1 cell is known if it has been meeting the relevant cell identification requirement during the last [5] seconds otherwise it is unknown.

Table 6.2.1.2.1-1: Time to identify target NR cell for RRC connection re-establishment to NR intra-frequency cell

Serving cell SCH Ês/Iot (dB)	Frequency range (FR) of target NR cell	$T_{identify\_intra\_NR}$ [ms]	
		Known NR cell	Unknown NR cell
≥ X	FR1	MAX (200 ms, [5] x T_{SMTC})	MAX (800 ms, [10] x T_{SMTC})
≥ X	FR2	N/A	MAX (1000 ms, [80] x T_{SMTC}))
< X	FR1	N/A	800[Note1]
< X	FR2	N/A	3420[Note1]
Note 1: T_{SMTC} =20 ms when serving cell SCH Ês/Iot < X			

***Editor's note**: The SCH Ês/Iot threshold (i.e, value of X) can be later decided based on RLM test cases.*

Table 6.2.1.2.1-2: Time to identify target NR cell for RRC connection re-establishment to NR inter-frequency cell

Serving cell SCH Ês/Iot (dB)	Frequency range (FR) of target NR cell	$T_{identify\_inter\_NR, i}$ [ms]	
		Known NR cell	Unknown NR cell
≥ X	FR1	MAX (200 ms, [6] x $T_{SMTC, i}$)	MAX (800 ms, [13] x $T_{SMTC, i}$)
≥ X	FR2	N/A	MAX (1000 ms, [104] x $T_{SMTC, i}$))
< X	FR1	N/A	800[Note1]
< X	FR2	N/A	4000[Note1]
Note 1: $T_{SMTC,i}$ =20 ms when serving cell SCH Ês/Iot < X			

***Editor's note**: The SCH Ês/Iot threshold (i.e, value of X) can be later decided based on RLM test cases.*

6.2.2 Random access

6.2.2.1 Introduction

This clause contains requirements on the UE regarding random access procedure. The random access procedure is initiated to establish uplink time synchronization for a UE which either has not acquired or has lost its uplink synchronization, or to convey UE's request Other SI, or for beam failure recovery. The random access is specified in clause 8 of TS 38.213 [3] and the control of the RACH transmission is specified in clause 5.1 of TS 38.321 [7].

6.2.2.2 Requirements

The UE shall have capability to calculate PRACH transmission power according to the PRACH power formula defined in TS 38.213 [3] and apply this power level at the first preamble or additional preambles. The absolute power applied to the first preamble shall have an accuracy as specified in Table 6.3.4.2-1 of TS 38.101-1 [18] for frequency range 1 and in Table 6.3.4.2-1 of TS 38.101-2 [19] for frequency range 2. The relative power applied to additional preambles shall have an accuracy as specified in Table 6.3.4.3-1 of TS 38.101-1 [18] for frequency range 1 and clause 6.3.4.3 of TS38.101-2 [19] for frequency range 2.

The UE shall indicate a Random Access problem to upper layers if the maximum number of preamble transmission counter has been reached for the random access procedure on PCell or PSCell as specified in clause 5.1.4 in TS 38.321 [7].

6.2.2.2.1 Contention based random access

6.2.2.2.1.1 Correct behaviour when transmitting Random Access Preamble

With the UE selected SSB with SS-RSRP above *rsrp-ThresholdSSB*, UE shall have the capability to select a Random Access Preamble randomly with equal probability from the Random Access Preambles associated with the selected SSB if the association between Random Access Preambles and SS blocks is configured, as specified in clause 5.1.2 in TS 38.321 [7].

With the UE selected SSB with SS-RSRP above *rsrp-ThresholdSSB*, UE shall have the capability to transmit Random Access Preamble on the next available PRACH occasion from the PRACH occasions corresponding to the selected SSB permitted by the restrictions given by the *ra-ssb-OccasionMaskIndex* if configured, if the association between PRACH occasions and SSBs is configured, and PRACH occasion shall be randomly selected with equal probability amongst the selected SSB associated PRACH occasions occurring simultaneously but on different subcarriers, as specified in clause 5.1.2 in TS 38.321 [7].

6.2.2.2.1.2 Correct behaviour when receiving Random Access Response

The UE may stop monitoring for Random Access Response(s) and shall transmit the msg3 if the Random Access Response contains a Random Access Preamble identifier corresponding to the transmitted Random Access Preamble.

The UE shall again perform the Random Access Resource selection procedure defined in clause 5.1.2 in TS 38.321 [7], and transmit with the calculated PRACH transmission power when the backoff time expires if all received Random Access Responses contain Random Access Preamble identifiers that do not match the transmitted Random Access Preamble.

6.2.2.2.1.3 Correct behaviour when not receiving Random Access Response

The UE shall again perform the Random Access Resource selection procedure defined in clause 5.1.2 in TS 38.321 [7], and transmit with the calculated PRACH transmission power when the backoff time expires if no Random Access Response is received within the RA Response window defined in clause 5.1.4 in TS 38.321 [7].

6.2.2.2.1.4 Correct behaviour when receiving a NACK on msg3

The UE shall re-transmit the msg3 upon the reception of a NACK on msg3.

6.2.2.2.1.5 Correct behaviour when receiving a message over Temporary C-RNTI

The UE shall send ACK if the Contention Resolution is successful.

The UE shall again perform the Random Access Resource selection procedure defined in clause 5.1.2 in TS 38.321 [7], and transmit with the calculated PRACH transmission power when the backoff time expires unless the received message includes a UE Contention Resolution Identity MAC control element and the UE Contention Resolution Identity included in the MAC control element matches the CCCH SDU transmitted in the uplink message.

6.2.2.2.1.6 Correct behaviour when contention Resolution timer expires

The UE shall re-select a preamble and transmit with the calculated PRACH transmission power when the backoff time expires if the Contention Resolution Timer expires.

6.2.2.2.2 Non-Contention based random access

6.2.2.2.2.1 Correct behaviour when transmitting Random Access Preamble

If the contention-free Random Access Resources and the contention-free PRACH occasions associated with SSBs is configured, with the UE selected SSB with SS-RSRP above *rsrp-ThresholdSSB* amongst the associated SSBs, UE shall have the capability to select the Random Access Preamble corresponding to the selected SSB, and to transmit Random Access Preamble on the next available PRACH occasion from the PRACH occasions corresponding to the selected SSB permitted by the restrictions given by the *ra-ssb-OccasionMaskIndex* if configured, and PRACH occasion shall be randomly selected with equal probability amongst the selected SSB associated PRACH occasions occurring simultaneously but on different subcarriers, as specified in clause 5.1.2 in TS 38.321 [7].

If the contention-free Random Access Resources and the contention-free PRACH occasions associated with CSI-RSs is configured, with the UE selected CSI-RS with CSI-RSRP above *cfra-csirs-DedicatedRACH-Threshold* amongst the associated CSI-RSs, UE shall have the capability to select the Random Access Preamble corresponding to the selected CSI-RS, and to transmit Random Access Preamble on the next available PRACH occasion from the PRACH occasions in *ra-OccasionList* corresponding to the selected CSI-RS, and PRACH occasion shall be randomly selected with equal probability amongst the selected CSI-RS associated PRACH occasions occurring simultaneously but on different subcarriers, as specified in clause 5.1.2 in TS 38.321 [7].

If the random access procedure is initialized for beam failure recovery and if the contention-free Random Access Resources and the contention-free PRACH occasions for beam failure recovery request associated with any of the SSBs and/or CSI-RSs is configured, UE shall have the capability to select the Random Access Preamble corresponding to the selected SSB with SS-RSRP above *rsrp-ThresholdSSB* amongst the associated SSBs or the selected CSI-RS with CSI-RSRP above *cfra-csirs-DedicatedRACH-Threshold* amongst the associated CSI-RSs, and to transmit Random Access Preamble on the next available PRACH occasion from the PRACH occasions corresponding to the selected SSB permitted by the restrictions given by the *ra-ssb-OccasionMaskIndex* if configured, or from the PRACH occasions in *ra-OccasionList* corresponding to the selected CSI-RS, and PRACH occasion shall be randomly selected with equal probability amongst the selected SSB assocated PRACH occasions or the selected CSI-RS associated PRACH occasions occurring simultaneously but on different subcarriers, as specified in clause 5.1.2 in TS 38.321 [7].

6.2.2.2.2.2 Correct behaviour when receiving Random Access Response

The UE may stop monitoring for Random Access Response(s), if the Random Access Response contains a Random Access Preamble identifier corresponding to the transmitted Random Access Preamble, unless the random access procedure is initialized for Other SI request from UE.

The UE may stop monitoring for Random Access Response(s) and shall monitor the Other SI transmission if the Random Access Response only contains a Random Access Preamble identifier which is corresponding to the transmitted Random Access Preamble and the random access procedure is initialized for SI request from UE, as specified in clause 5.1.4 in TS 38.321 [7].

The UE may stop monitoring for Random Access Response(s), if the contention-free Random Access Preamble for beam failure recovery request was transmitted and if the PDCCH addressed to UE's C-RNTI is received, as specified in clause 5.1.4 in TS 38.321 [7].

The UE shall again perform the Random Access Resource selection procedure defined in clause 5.1.2 in TS 38.321 [7] for the next available PRACH occasion, and transmit the preamble with the calculated PRACH transmission power if all received Random Access Responses contain Random Access Preamble identifiers that do not match the transmitted Random Access Preamble.

6.2.2.2.2.3 Correct behaviour when not receiving Random Access Response

The UE shall again perform the Random Access Resource selection procedure defined in clause 5.1.2 in TS 38.321 [7] for the next available PRACH occasion, and transmit the preamble with the calculated PRACH transmission power, if no Random Access Response is received within the RA Response window configured in *RACH-ConfigCommon* or if no PDCCH addressed to UE's C-RNTI is received within the RA Response window configured in *BeamFailureRecoveryConfig*, as defined in clause 5.1.4 in TS 38.321 [7].

6.2.2.2.3 UE behaviour when configured with supplementary UL

In addition to the requirements defined in clause 6.2.2.2.1 and 6.2.2.2.2, a UE configured with supplementary UL carrier shall use RACH configuration for the supplementary UL carrier contained in RMSI and RRC dedicated signalling. If the cell for the random access procedure is configured with supplementary UL, the UE shall transmit or re-transmit PRACH preamble on the supplementary UL carrier if the SS-RSRP measured by the UE on the DL carrier is lower than the *rsrp-ThresholdSSB-SUL* as defined in TS 38.331 [2].

6.2.3 SA: RRC Connection Release with Redirection

6.2.3.1 Introduction

This clause contains requirements on the UE regarding RRC connection release with redirection procedure. RRC connection release with redirection is initiated by the *RRCConnectionRelease* message with redirection to E-UTRAN or NR-RAN from NR-RAN specified in TS 38.331 [2]. The RRC connection release with redirection procedure is specified in clause 5.3.8 of TS 38.331 [2].

6.2.3.2 Requirements

6.2.3.2.1 RRC connection release with redirection to NR

The UE shall be capable of performing the RRC connection release with redirection to the target NR cell within $T_{connection\_release\_redirect\_NR}$.

The time delay ($T_{connection\_release\_redirect\_NR}$) is the time between the end of the last slot containing the RRC command, "*RRCConnectionRelease*" (TS 38.331 [2]) on the NR PDSCH and the time the UE starts to send random access to the target NR cell. The time delay ($T_{connection\_release\_redirect\_NR}$) shall be less than:

$$T_{connection\_release\_redirect\_NR} = T_{RRC\_procedure\_delay} + T_{identify\text{-}NR} + T_{SI\text{-}NR} + T_{RACH}$$

The intra-frequency target NR cell shall be considered detectable when for each relevant SSB:

- SS-RSRP related side conditions given in Section 10.1.2 and 10.1.3 are fulfilled for a corresponding NR Band for FR1 and FR2, respectively,

- SSB_RP and SSB Ês/Iot according to Annex B.2.2 for a corresponding NR Band.

The inter-frequency target NR cell shall be considered detectable when for each relevant SSB:

- SS-RSRP related side conditions given in Section 10.1.4 and 10.1.5 are fulfilled for a corresponding NR Band for FR1 and FR2, respectively,
- SSB_RP and SSB Ês/Iot according to Annex B.2.2 for a corresponding NR Band.

$T_{RRC\_procedure\_delay}$: It is the RRC procedure delay for processing the received message "[*RRCConnectionRelease*]" as defined in clause 11.2 of TS 38.331 [2].

$T_{identify-NR}$: It is the time to identify the target NR cell and depend on the frequency range (FR) of the target NR cell. It is defined in table 6.2.3.2.1-1. Note that $T_{identify-NR} = T_{PSS/SSS-sync} + T_{meas}$, in which $T_{PSS/SSS-sync}$ is the cell search time and T_{meas} is the measurement time due to cell selection criteria evaluation.

T_{SI-NR}: It is the time required for acquiring all the relevant system information of the target NR cell. This time depends upon whether the UE is provided with the relevant system information of the target NR cell or not by the old NR cell before the RRC connection is released. $T_{SI-NR} = 0$ provided the UE is provided with the SI (including MIB and all relevant SIBs) of the target NR cell before the RRC connection is released by the old NR cell.

T_{RACH}: It is the delay caused due to the random access procedure when sending random access to the target NR cell. This delay depends on the PRACH configuration defined in Table 6.3.3.2-2 [6] or Table 6.3.3.2-3 [6] for FR1 and in Table 6.3.3.2-4 [6] for FR2.

Table 6.2.3.2.1-1: Time to identify target NR cell for RRC connection release with redirection to NR

Frequency range (FR) of target NR cell	$T_{identify-NR}$
FR1	MAX (680 ms, [11] x SMTC period)
FR2	MAX (880 ms, K1x[11] x SMTC period)

Editor's note: K1 is FFS and is the number of receiver beam sweeps required to detect NR cell in FR2

6.2.3.2.2 RRC connection release with redirection to E-UTRAN

The UE shall be capable of performing the RRC connection release with redirection to the target E-UTRAN cell within $T_{connection\_release\_redirect\_E-UTRA}$.

The time delay ($T_{connection\_release\_redirect\_E-UTRA}$) is the time between the end of the last slot containing the RRC command, "[*RRCConnectionRelease*]" (TS 38.331 [2]) on the PDSCH and the time the UE starts to send random access to the target E-UTRA cell. The time delay ($T_{connection\_release\_redirect\_E-UTRA}$) shall be less than:

$$T_{connection\_release\_redirect\_E-UTRA} = T_{RRC\_procedure\_delay} + T_{identify-E-UTRA} + T_{SI-E-UTRA} + T_{RACH}$$

The target E-UTRA FDD or TDD cell shall be considered detectable when for each relevant SSB:

- RSRP related conditions in the accuracy requirements in Section 10.2.2 are fulfilled for a corresponding Band, together with the corresponding side conditions in Annex B.2 and Annex B.3 of TS 36.133 [15],
- RSRQ related conditions in the accuracy requirements in Section 10.2.3 are fulfilled for a corresponding Band, together with the corresponding side conditions in Annex B.2 and Annex B.3 of TS 36.133 [15],
- RS-SINR related conditions in the accuracy requirements in Section 10.2.5 are fulfilled for a corresponding Band, together with the corresponding side conditions in Annex B.2 and Annex B.3 of TS 36.133 [15].

$T_{RRC\_procedure\_delay}$: It is the RRC procedure delay for processing the received message "[*RRCConnectionRelease*]" as defined in clause 11.2 of TS 38.331 [2].

$T_{identify-E-UTRA}$: It is the time to identify the target E-UTRA cell. It shall be less than [320] ms.

$T_{SI-E-UTRA}$: It is the time required for acquiring all the relevant system information of the target E-UTRA cell. This time depends upon whether the UE is provided with the relevant system information (SI) of the target E-UTRA cell or not by the old NR cell before the RRC connection is released. $T_{SI-E-UTRA} = 0$ provided the UE is provided with the SI (including MIB and all relevant SIBs) of the target E-UTRA cell before the RRC connection is released by the old NR cell.

T_{RACH}: It is the delay caused due to the random access procedure when sending random access to the target E-UTRA cell.

7 Timing

7.1 UE transmit timing

7.1.1 Introduction

The UE shall have capability to follow the frame timing change of the connected gNB. The uplink frame transmission takes place $(N_{\text{TA}} + N_{\text{TA offset}}) \times T_{\text{c}}$ before the reception of the first detected path (in time) of the corresponding downlink frame from the reference cell. The reference cell is PSCell in case of EN-DC. UE initial transmit timing accuracy, maximum amount of timing change in one adjustment, minimum and maximum adjustment rate are defined in the following requirements.

7.1.2 Requirements

The UE initial transmission timing error shall be less than or equal to $\pm T_e$ where the timing error limit value T_e is specified in Table 7.1.2-1. This requirement applies:

- when it is the first transmission in a DRX cycle for PUCCH, PUSCH and SRS or it is the PRACH transmission.

The UE shall meet the Te requirement for an initial transmission provided that at least one SSB is available at the UE during the last 160 ms. The reference point for the UE initial transmit timing control requirement shall be the downlink timing of the reference cell minus $(N_{\text{TA}} + N_{\text{TA offset}}) \times T_{\text{c}}$. The downlink timing is defined as the time when the first detected path (in time) of the corresponding downlink frame is received from the reference cell. N_{TA} for PRACH is defined as 0.

$(N_{\text{TA}} + N_{\text{TA offset}}) \times T_{\text{c}}$ (in T_c units) for other channels is the difference between UE transmission timing and the downlink timing immediately after when the last timing advance in clause 7.3 was applied. N_{TA} for other channels is not changed until next timing advance is received. The value of $N_{\text{TA offset}}$ depends on the duplex mode of the cell in which the uplink transmission takes place and the frequency range (FR). $N_{\text{TA offset}}$ is defined in Table 7.1.2-2.

Table 7.1.2-1: T_e Timing Error Limit

Frequency Range	SCS of SSB signals (KHz)	SCS of uplink signals s(KHz)	T_e
1	15	15	[12]*64*T_c
		30	[10]*64*T_c
		60	[10]*64*T_c
	30	15	[8]*64*T_c
		30	[8]*64*T_c
		60	[7]*64*T_c
2	120	60	[3.5]*64*T_c
		120	[3.5]*64*T_c
	240	60	[3]*64*T_c
		120	[3]*64*T_c
Note 1: T_c is the basic timing unit defined in TS 38.211 [6] Editor's note: The final values of T_e for 120KHz SSB SCS are subject to further discussions in further meeting, and may not be outside 3*64*T_c to 3.5*64*T_c.			

Table 7.1.2-2: The Value of $N_{\text{TA offset}}$

Frequency range and band of cell used for uplink transmission	$N_{\text{TA offset}}$ (Unit: T_C)
FR1 FDD band without LTE-NR coexistence case or FR1 TDD band without LTE-NR coexistence case	25600 (Note 1)
FR1 FDD band with LTE-NR coexistence case	0 (Note 1)
FR1 TDD band with LTE-NR coexistence case	39936 or 25600 (Note 1)
FR2	13792
Note 1: The UE identifies $N_{\text{TA offset}}$ based on the information n-TimingAdvanceOffset according to [2]. If UE do not receive the information n-TimingAdvanceOffset, the default value of $N_{\text{TA offset}}$ is set as 25600 for FR1 band. Note 2: The value of $N_{\text{TA offset}}$ that applies to the supplementary UL carrier is determined from the non-supplementary UL carrier.	

When it is not the first transmission in a DRX cycle or there is no DRX cycle, and when it is the transmission for PUCCH, PUSCH and SRS transmission, the UE shall be capable of changing the transmission timing according to the received downlink frame of the reference cell except when the timing advance in clause 7.3 is applied.

When the transmission timing error between the UE and the reference timing exceeds $\pm T_e$, the UE is required to adjust its timing to within $\pm T_e$. The reference timing shall be $(N_{\text{TA}} + N_{\text{TA offset}}) \times T_c$ before the downlink timing of the reference cell. All adjustments made to the UE uplink timing shall follow these rules:

1) The maximum amount of the magnitude of the timing change in one adjustment shall be T_q.

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

3) The maximum aggregate adjustment rate shall be T_q per [200]ms.

where the maximum autonomous time adjustment step T_q and the aggregate adjustment rate T_p are specified in Table 7.1.2-3.

Table 7.1.2-3: T_q Maximum Autonomous Time Adjustment Step and T_p Minimum Aggregate Adjustment rate

Frequency Range	SCS of uplink signals (KHz)	T_q	T_p
1	15	[5.5]*64*T_c	[5.5]*64*T_c
	30	[5.5]*64*T_c	[5.5]*64*T_c
	60	[5.5]*64*T_c	[5.5]*64*T_c
2	60	[2.5]*64*T_c	[2.5]*64*T_c
	120	[2.5]*64*T_c	[2.5]*64*T_c
NOTE 1: T_c is the basic timing unit defined in TS 38.211 [6]			

7.2 UE timer accuracy

7.2.1 Introduction

UE timers are used in different protocol entities to control the UE behaviour.

7.2.2 Requirements

For UE timers specified in TS 38.331 [TBD], the UE shall comply with the timer accuracies according to Table 7.2.2-1.

The requirements are only related to the actual timing measurements internally in the UE. They do not include the following:

- Inaccuracy in the start and stop conditions of a timer (e.g. UE reaction time to detect that start and stop conditions of a timer is fulfilled), or

- Inaccuracies due to restrictions in observability of start and stop conditions of a UE timer (e.g. slot alignment when UE sends messages at timer expiry).

Table 7.2.2-1

Timer value [s]	Accuracy
timer value < 4	± 0.1s
timer value ≥ 4	± 2.5%

7.3 Timing advance

7.3.1 Introduction

The timing advance is initiated from gNB with MAC message that implies and adjustment of the timing advance, see TS 38.321 clause 5.2.

7.3.2 Requirements

7.3.2.1 Timing Advance adjustment delay

UE shall adjust the timing of its uplink transmission timing at time slot *n*+[6] for a timing advance command received in time slot *n*. The same requirement applies also when the UE is not able to transmit a configured uplink transmission due to the channel assessment procedure.

7.3.2.2 Timing Advance adjustment accuracy

The UE shall adjust the timing of its transmissions with a relative accuracy better than or equal to the UE Timing Advance adjustment accuracy requirement in Table 7.3.2.2-1, to the signalled timing advance value compared to the timing of preceding uplink transmission. The timing advance command step is defined in TS38.213.

Table 7.3.2.2-1: UE Timing Advance adjustment accuracy

Sub Carrier Spacing, SCS kHz	15	30	60	120
UE Timing Advance adjustment accuracy	$\pm 256\ T_c$	$\pm 256\ T_c$	$\pm 128\ T_c$	$\pm 32\ T_c$

7.4 Cell phase synchronization accuracy

7.4.1 Definition

Cell phase synchronization accuracy for TDD is defined as the maximum absolute deviation in frame start timing between any pair of cells on the same frequency that have overlapping coverage areas.

7.4.2 Minimum requirements

The cell phase synchronization accuracy measured at BS antenna connectors shall be better than 3 μs.

7.5 Maximum Transmission Timing Difference

7.5.1 Introduction

A UE shall be capable of handling a relative transmission timing difference between subframe timing boundary of E-UTRA PCell and slot timing boundaries of PSCell to be aggregated EN-DC

7.5.2 Minimum Requirements for inter-band EN-DC

The UE shall be capable of handling a maximum uplink transmission timing difference between E-UTRA PCell and PSCell as shown in Table 7.5.2-1. The requirements for asynchronous EN-DC are applicable for E-UTRA TDD- NR

TDD, E-UTRA FDD- NR FDD, E-UTRA FDD-NR TDD and E-UTRA TDD-NR FDD inter-band asynchronous EN-DC.

Table 7.5.2-1 Maximum uplink transmission timing difference requirement for asynchronous EN-DC

Sub-carrier spacing in E-UTRA PCell (kHz)	UL Sub-carrier spacing for data in PSCell (kHz)	Maximum uplink transmission timing difference (μs)
15	15	500
15	30	250
15	60	125
15	120 Note1	62.5
NOTE 1: For E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band EN-DC, 120kHz is not applied.		

The UE shall be capable of handling a maximum uplink transmission timing difference between E-UTRA PCell and PSCell as shown in Table 7.5.2-2 provided that the UE indicates that it is capable of synchronous EN-DC [16]. The requirements for synchronous EN-DC are applicable for E-UTRA TDD-NR TDD, E-UTRA TDD-NR FDD and E-UTRA FDD-NR TDD inter-band EN-DC.

Table 7.5.2-2 Maximum uplink transmission timing difference requirement for inter-band synchronous EN-DC

Sub-carrier spacing in E-UTRA PCell (kHz)	UL Sub-carrier spacing for data in PSCell (kHz)	Maximum uplink transmission timing difference (μs)
15	15	35.21
15	30	35.21
15	60	35.21
15	120 Note1	35.21
NOTE 1: For E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band EN-DC, 120kHz is not applied.		

7.5.3 Minimum Requirements for intra-band EN-DC

For intra-band EN-DC, only collocated deployment is applied.

The UE shall be capable of handling a maximum uplink transmission timing difference between E-UTRA PCell and PSCell as shown in Table 7.5.2-1 provided the UE indicates that it is capable of asynchronous EN-DC [16]. The requirements for asynchronous EN-DC are applicable for E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band asynchronous EN-DC.

No uplink transmission timing difference is applicable for synchronous EN-DC.

7.5.4 Minimum Requirements for NR Carrier Aggregation

For inter-band carrier aggregation, the UE shall be capable of handling at least a relative transmission timing difference between slot timing of different carriers to be aggregated as shown in Table 7.5.4-1 below:

Table 7.5.4-1: Maximum transmission timing difference requirement for inter-band NR carrier aggregation

Frequency Range	Maximum transmission timing difference (μs)
FR1	35.21
FR2	8.5
Between FR1 and FR2	[TBD]

7.6 Maximum Receive Timing Difference

7.6.1 Introduction

A UE shall be capable of handling a relative receive timing difference between subframe timing boundary of E-UTRA PCell and slot timing boundaries of PSCell to be aggregated for EN-DC.

A UE shall be capable of handling a relative receive timing difference between slot timing boundary of different carriers to be aggregated NR carrier aggregation.

7.6.2 Minimum Requirements for inter-band EN-DC

The UE shall be capable of handling at least a relative receive timing difference between subframe timing of signal from E-UTRA PCell and slot timing of signal from PSCell at the UE receiver as shown in Table 7.6.2-1. The requirements for asynchronous EN-DC are applicable for E-UTRA TDD- NR TDD, E-UTRA FDD- NR FDD, E-UTRA FDD- NR TDD and E-UTRA TDD- NR FDD inter-band EN-DC.

Table 7.6.2-1: Maximum receive timing difference requirement for asynchronous EN-DC

Sub-carrier spacing in E-UTRA PCell (kHz)	DL Sub-carrier spacing in PSCell (kHz) (Note 1)	Maximum receive timing difference (μs)
15	15	500
15	30	250
15	60	125
15	120	62.5
NOTE 1 : DL Sub-carrier spacing is min{SCS_{SS}, SCS_{DATA}}. NOTE 2 : For E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band EN-DC, 120kHz is not applied.		

The UE shall be capable of handling at least a relative receive timing difference between subframe timing of signal from E-UTRA PCell and slot timing of signal from PSCell at the UE receiver as shown in Table 7.6.2-2 provided that the UE indicates that it is capable of synchronous EN-DC[16]. The requirements for synchronous EN-DC are applicable for E-UTRA TDD- NR TDD, E-UTRA TDD- NR FDD and E-UTRA FDD- NR TDD inter-band EN-DC.

Table 7.6.2-2: Maximum receive timing difference requirement for inter-band synchronous EN-DC

Sub-carrier spacing in E-UTRA PCell (kHz)	DL Sub-carrier spacing in PSCell (kHz) (Note1)	Maximum receive timing difference (μs)
15	15	33
15	30	
15	60	
15	120	
NOTE 1: DL Sub-carrier spacing is min{SCS_{SS}, SCS_{DATA}}. NOTE 2: For E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band EN-DC, 120kHz is not applied.		

Table 7.6.2-3 Void

7.6.3 Minimum Requirements for intra-band EN-DC

For intra-band EN-DC, only collocated deployment is applied.

The UE shall be capable of handling at least a relative receive timing difference between subframe timing of signal from E-UTRA PCell and slot timing of signal from PSCell as shown in Table 7.6.2-1 provided the UE indicates that it is capable of asynchronous EN-DC [16]. The requirements for asynchronous EN-DC are applicable for E-UTRA FDD-NR FDD and E-UTRA TDD- NR TDD intra-band EN-DC.

The UE shall be capable of handling at least a relative receive timing difference between subframe timing of signal from E-UTRA PCell and slot timing of signal from PSCell as shown in Table 7.6.3-1 provided the UE indicates that it is only capable of synchronous EN-DC [16]. The requirements for synchronous EN-DC are applicable for E-UTRA TDD- NR TDD and E-UTRA FDD- NR FDD intra-band EN-DC.

Table 7.6.3-1 Maximum receive timing difference requirement for intra-band synchronous EN-DC

Sub-carrier spacing in E-UTRA PCell (kHz)	DL Sub-carrier spacing in PSCell (kHz) Note1	Maximum receive timing difference (µs)
15	15	3
15	30	3
15	60	3
NOTE 1: DL Sub-carrier spacing is min{SCS_{SS}, SCS_{DATA}}.		

Table 7.6.3-2 Void

7.6.4 Minimum Requirements for NR Carrier Aggregation

For intra-band CA, only collocated deployment is applied. For intra-band non-contiguous NR carrier aggregation, the UE shall be capable of handling at least a relative receive timing difference between slot timing of different carriers to be aggregated at the UE receiver as shown in Table 7.6.4-1 below.

Table 7.6.4-1: Maximum receive timing difference requirement for intra-band non-contiguous NR carrier aggregation

Frequency Range	Maximum receive timing difference (µs)
FR1	3
FR2	3

For inter-band NR carrier aggregation, the UE shall be capable of handling at least a relative receive timing difference between slot timing of different carriers to be aggregated at the UE receiver as shown in Table 7.6.4-2 below.

Table 7.6.4-2: Maximum receive timing difference requirement for inter-band NR carrier aggregation

Frequency Range	Maximum receive timing difference (µs)
FR1	33
FR2	8
Between FR1 and FR2	[TBD]

7.7 deriveSSB-IndexFromCell tolerance

7.7.1 Minimum requirements

When *deriveSSB-IndexFromCell* is enabled, the UE assumes frame boundary alignment (including half frame, subframe and slot boundary alignment) across cells on the same frequency carrier is within a tolerance not worse than min(2 SSB symbols, 1 PDSCH symbol) and the SFN of all cells on the same frequency carrier are the same.

8 Signalling characteristics

8.1 Radio Link Monitoring

8.1.1 Introduction

The UE shall monitor the downlink link quality based on the reference signal in the configured RLM-RS resource(s) in order to detect the downlink radio link quality of the PCell and PSCell as specified in [3]. The configured RLM-RS resources can be all SSBs, or all CSI-RSs, or a mix of SSBs and CSI-RSs. UE is not required to perform RLM outside the active DL BWP.

On each RLM-RS resource, the UE shall estimate the downlink radio link quality and compare it to the thresholds Q_{out} and Q_{in} for the purpose of monitoring downlink radio link quality of the cell.

The threshold Q_{out} is defined as the level at which the downlink radio link cannot be reliably received and shall correspond to the out-of-sync block error rate ($BLER_{out}$) as defined in Table 8.1.1-1. For SSB based radio link monitoring, Q_{out_SSB} is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1.2.1-1. For CSI-RS based radio link monitoring, Q_{out_CSI-RS} is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1.3.1-1.

The threshold Q_{in} is defined as the level at which the downlink radio link quality can be significantly more reliably received than at Q_{out} and shall correspond to the in-sync block error rate ($BLER_{in}$) as defined in Table 8.1.1-1. For SSB based radio link monitoring, Q_{in_SSB} is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1.2.1-2. For CSI-RS based radio link monitoring, Q_{in_CSI-RS} is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1.3.1-2.

The out-of-sync block error rate ($BLER_{out}$) and in-sync block error rate ($BLER_{in}$) are determined from the network configuration via parameter *rlmInSyncOutOfSyncThreshold* signalled by higher layers. The network can configure one of the two pairs of out-of-sync and in-sync block error rates which are shown in Table 8.1.1-1. When UE is not configured with *RLM-IS-OOS-thresholdConfig* from the network, UE determines out-of-sync and in-sync block error rates from Configuration #0 in Table 8.1.1-1 as default.

Table 8.1.1-1: Out-of-sync and in-sync block error rates

Configuration	$BLER_{out}$	$BLER_{in}$
0	10%	2%
1	TBD	TBD

UE shall be able to monitor up to X_{RLM-RS} RLM-RS resources of the same or different types in each corresponding carrier frequency range, where X_{RLM-RS} is specified in Table 8.1.1-2, and meet the requirements as specified in section 8.1.

Table 8.1.1-2: Maximum number of RLM-RS resources X_{RLM-RS}

Maximum number of RLM-RS resources, X_{RLM-RS}	Carrier frequency range of PCell/PSCell
2	FR1, ≤ 3 GHz
4	FR1, > 3 GHz
8	FR2

Editor's Note: FFS if SSB for RLM and CSI-RS for RLM can be FDMed if they are with different subcarrier spacing

8.1.2 Requirements for SSB based radio link monitoring

8.1.2.1 Introduction

The requirements in this section apply for each SSB based RLM-RS resource configured for PCell or PSCell, provided that the SSB configured for RLM are actually transmitted within UE active DL BWP during the entire evaluation period specified in section 8.1.2.2.

Table 8.1.2.1-1: PDCCH transmission parameters for out-of-sync

Attribute	Value for BLER pair#0	Value for BLER pair#1
DCI format	1-0	TBD
Number of control OFDM symbols	Same as the number of symbols of RMSI CORESET	
Aggregation level (CCE)	8	
Ratio of hypothetical PDCCH RE energy to average SSS RE energy	4dB	
Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy	4dB	
Bandwidth (MHz)	Same as the number of PRBs of RMSI CORESET	
Sub-carrier spacing (kHz)	Same as the SCS of RMSI CORESET	
DMRS precoder granularity	REG bundle size	
REG bundle size	6	
CP length	Same as the CP length of RMSI CORESET	
Mapping from REG to CCE	Distributed	

Table 8.1.2.1-2: PDCCH transmission parameters for in-sync

Attribute	Value for BLER pair#0	Value for BLER pair#1
DCI payload size	1-0	TBD
Number of control OFDM symbols	Same as the number of symbols of RMSI CORESET	
Aggregation level (CCE)	4	
Ratio of hypothetical PDCCH RE energy to average SSS RE energy	0dB	
Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy	0dB	
Bandwidth (MHz)	Same as the number of PRBs of RMSI CORESET	
Sub-carrier spacing (kHz)	Same as the SCS of RMSI CORESET	
DMRS precoder granularity	REG bundle size	
REG bundle size	6	
CP length	Same as the CP length of RMSI CORESET	
Mapping from REG to CCE	Distributed	

8.1.2.2 Minimum requirement

UE shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last $T_{Evaluate\_out\_SSB}$ [ms] period becomes worse than the threshold Q_{out_SSB} within $T_{Evaluate\_out\_SSB}$ [ms] evaluation period.

UE shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last $T_{Evaluate\_in\_SSB}$ [ms] period becomes better than the threshold Q_{in_SSB} within $T_{Evaluate\_in\_SSB}$ [ms] evaluation period.

$T_{Evaluate\_out\_SSB}$ and $T_{Evaluate\_in\_SSB}$ are defined in Table 8.1.2.2-1 for FR1.

$T_{Evaluate\_out\_SSB}$ and $T_{Evaluate\_in\_SSB}$ are defined in Table 8.1.2.2-2 for FR2 with

- N=1,

  if UE is not provided higher layer parameter *RadioLinkMonitoringRS* and UE is provided by higher layer parameter *TCI-state* for PDCCH SSB that has QCL-TypeD, or if the SSB configured for RLM is QCL-Type D with DM-RS for PDCCH and the QCL association is known to UE, or

if the SSB configured for RLM is QCL-Type D and TDMed to CSI-RS resources configured for L1-RSRP reporting, and the QCL association is known to UE;

- N=8, otherwise.

For FR1,

- $P=1/(1 - T_{SSB}/MGRP)$, when in the monitored cell there are measurement gaps configured for intra-frequency, inter-frequency or inter-RAT measurements, which are overlapping with some but not all occasions of the SSB; and
- P=1 when in the monitored cell there are no measurement gaps overlapping with any occasion of the SSB.

For FR2,

- $P=1/(1 - T_{SSB}/T_{SMTCperiod})$, when RLM-RS is not overlapped with measurement gap and RLM-RS is partially overlapped with SMTC occasion ($T_{SSB} < T_{SMTCperiod}$).
- P is 3, when RLM-RS is not overlapped with measurement gap and RLM-RS is fully overlapped with SMTC period ($T_{SSB} = T_{SMTCperiod}$).
- P is $1/(1- T_{SSB}/MGRP - T_{SSB}/T_{SMTCperiod})$, when RLM-RS is partially overlapped with measurement gap and RLM-RS is partially overlapped with SMTC occasion ($T_{SSB} < T_{SMTCperiod}$) and SMTC occasion is not overlapped with measurement gap and
  - $T_{SMTCperiod} \neq MGRP$ or
  - $T_{SMTCperiod} = MGRP$ and $T_{SSB} < 0.5*T_{SMTCperiod}$
- P is $1/(1- T_{SSB} /MGRP)*3$, when RLM-RS is partially overlapped with measurement gap and RLM-RS is partially overlapped with SMTC occasion ($T_{SSB} < T_{SMTCperiod}$) and SMTC occasion is not overlapped with measurement gap and $T_{SMTCperiod} = MGRP$ and $T_{SSB} = 0.5*T_{SMTCperiod}$
- P is $1/\{1- T_{SSB} /\min (T_{SMTCperiod} ,MGRP)\}$, when RLM-RS is partially overlapped with measurement gap and RLM-RS is partially overlapped with SMTC occasion ($T_{SSB} < T_{SMTCperiod}$) and SMTC occasion is partially or fully overlapped with measurement gap
- P is $1/(1- T_{SSB} /MGRP)*3$, when RLM-RS is partially overlapped with measurement gap and RLM-RS is fully overlapped with SMTC occasion ($T_{SSB} = T_{SMTCperiod}$) and SMTC occasion is partially overlapped with measurement gap ($T_{SMTCperiod} < MGRP$)

If the high layer in TS 38.331 [2] signaling of *smtc2* is present, $T_{SMTCperiod}$ follows *smtc2*; Otherwise $T_{SMTCperiod}$ follows *smtc1*.

Longer evaluation period would be expected if the combination of RLM-RS, SMTC occasion and measurement gap configurations does not meet pervious conditions.

Table 8.1.2.2-1: Evaluation period $T_{Evaluate\_out}$ and $T_{Evaluate\_in}$ for FR1

Configuration	$T_{Evaluate\_out}$ (ms)	$T_{Evaluate\_in}$ (ms)
non-DRX	max(200,ceil(10*P)*T_{SSB})	max(100,ceil(5*P)*T_{SSB})
DRX cycle≤320	max(200,ceil(15*P)*max(T_{DRX},T_{SSB}))	max(100,ceil(7.5*P)*max(T_{DRX},T_{SSB}))
DRX cycle>320	ceil(10*P)*T_{DRX}	ceil(5*P)*T_{DRX}
NOTE: T_{SSB} is the periodicity of SSB configured for RLM. T_{DRX} is the DRX cycle length.		

Table 8.1.2.2-2: Evaluation period $T_{Evaluate\_out}$ and $T_{Evaluate\_in}$ for FR2

Configuration	$T_{Evaluate\_out}$ (ms)	$T_{Evaluate\_in}$ (ms)
non-DRX	max(200,ceil(10*P*N)*T_{SSB})	max(100,ceil(5*P*N)*T_{SSB})
DRX cycle≤320	max(200,ceil(15*P*N)*max(T_{DRX},T_{SSB}))	max(100,ceil(7.5*P*N)*max(T_{DRX},T_{SSB}))
DRX cycle>320	ceil(10*P*N)*T_{DRX}	ceil(5*P*N)*T_{DRX}
NOTE: T_{SSB} is the periodicity of SSB configured for RLM. T_{DRX} is the DRX cycle length.		

8.1.3 Requirements for CSI-RS based radio link monitoring

8.1.3.1 Introduction

The requirements in this section apply for each CSI-RS based RLM-RS resource configured for PCell or PSCell, provided that the CSI-RS configured for RLM are actually transmitted within UE active DL BWP during the entire evaluation period specified in section 8.1.3.2.

Table 8.1.3.1-1: PDCCH transmission parameters for out-of-sync

Attribute	Value for BLER pair#0	Value for BLER pair#1
DCI format	1-0	TBD
Number of control OFDM symbols	Same as the number of symbols of CORESET QCLed with respective CSI-RS for RLM	
Aggregation level (CCE)	8	
Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy	4dB	
Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy	4dB	
Bandwidth (MHz)	Same as the number of PRBs of CORESET QCLed with respective CSI-RS for RLM	
Sub-carrier spacing (kHz)	Same as the SCS of CORESET QCLed with respective CSI-RS for RLM	
DMRS precoder granularity	REG bundle size	
REG bundle size	6	
CP length	Same as the CP length of CORESET QCLed with respective CSI-RS for RLM	
Mapping from REG to CCE	Distributed	

Table 8.1.3.1-2: PDCCH transmission parameters for in-sync

Attribute	Value for BLER pair#0	Value for BLER pair#1
DCI payload size	1-0	TBD
Number of control OFDM symbols	Same as the number of symbols of CORESET QCLed with respective CSI-RS for RLM	
Aggregation level (CCE)	4	
Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy	0dB	
Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy	[0]dB	
Bandwidth (MHz)	Same as the number of PRBs of CORESET QCLed with respective CSI-RS for RLM	
Sub-carrier spacing (kHz)	Same as the SCS of CORESET QCLed with respective CSI-RS for RLM	
DMRS precoder granularity	REG bundle size	
REG bundle size	6	
CP length	Same as the CP length of CORESET QCLed with respective CSI-RS for RLM	
Mapping from REG to CCE	Distributed	

Editor's Note: FFS which CORESET is used as reference when CSI-RS is QCL-ed with multiple CORESETs

Editor's Note: FFS if UE shall perform RLM and if so which CORESET is used as reference, when CSI-RS is not QCL-ed with any CORESET

8.1.3.2 Minimum requirement

UE shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last $T_{Evaluate\_out\_CSI-RS}$ [ms] period becomes worse than the threshold Q_{out_CSI-RS} within $T_{Evaluate\_out\_CSI-RS}$ [ms] evaluation period.

UE shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last $T_{Evaluate\_in\_CSI-RS}$ [ms] period becomes better than the threshold Q_{in_CSI-RS} within $T_{Evaluate\_in\_CSI-RS}$ [ms] evaluation period.

- $T_{Evaluate\_out\_CSI-RS}$ and $T_{Evaluate\_in\_CSI-RS}$ are defined in Table 8.1.3.2-1 for FR1.
- $T_{Evaluate\_out\_CSI-RS}$ and $T_{Evaluate\_in\_CSI-RS}$ are defined in Table 8.1.3.2-2 for FR2, where
  - N=1,

    if UE is not provided higher layer parameter *RadioLinkMonitoringRS* and UE is provided by higher layer parameter *TCI-state* for PDCCH CSI-RS that has QCL-TypeD, or

    if the CSI-RS configured for RLM is QCL-Type D with DM-RS for PDCCH and the QCL association is known to UE, or

    if the CSI-RS resource configured for RLM is QCL-Type D and TDMed to CSI-RS resources configured for L1-RSRP reporting or SSBs configured for L1-RSRP reporting, all CSI-RS resources configured for RLM are mutually TDMed, and the QCL association is known to UE;
  - N=FFS, otherwise.

For FR1,

- P=1/(1 – T_{CSI-RS}/MGRP), when in the monitored cell there are measurement gaps configured for intra-frequency, inter-frequency or inter-RAT measurements, which are overlapping with some but not all occasions of the CSI-RS; and
- P=1 when in the monitored cell there are no measurement gaps overlapping with any occasion of the CSI-RS.

For FR2,

- P=1, when RLM-RS is not overlapped with measurement gap and also not overlapped with SMTC occasion.
- $P=1/(1 – T_{CSI-RS}/MGRP)$, when RLM-RS is partially overlapped with measurement gap and RLM-RS is not overlapped with SMTC occasion ($T_{CSI-RS} < MGRP$)
- $P=1/(1 – T_{CSI-RS} /T_{SMTCperiod})$, when RLM-RS is not overlapped with measurement gap and RLM-RS is partially overlapped with SMTC occasion ($T_{CSI-RS} < T_{SMTCperiod}$).
- P is 3, when RLM-RS is not overlapped with measurement gap and RLM-RS is fully overlapped with SMTC occasion ($T_{CSI-RS} = T_{SMTCperiod}$).
- P is $1/(1- T_{CSI-RS} /MGRP - T_{CSI-RS} /T_{SMTCperiod})$, when RLM-RS is partially overlapped with measurement gap and RLM-RS is partially overlapped with SMTC occasion (TCSI-RS < $T_{SMTCperiod}$) and SMTC occasion is not overlapped with measurement gap and
  - $T_{SMTCperiod} \neq MGRP$ or
  - $T_{SMTCperiod} = MGRP$ and $T_{CSI-RS} < 0.5*T_{SMTCperiod}$
- P is $1/(1- T_{CSI-RS} /MGRP)* 3$, when RLM-RS is partially overlapped with measurement gap and RLM-RS is partially overlapped with SMTC occasion ($T_{CSI-RS} < T_{SMTCperiod}$) and SMTC occasion is not overlapped with measurement gap and $T_{SMTCperiod} = MGRP$ and $T_{CSI-RS} = 0.5*T_{SMTCperiod}$
- P is $1/\{1- T_{CSI-RS} /\min (T_{SMTCperiod} ,MGRP)\}$, when RLM-RS is partially overlapped with measurement gap and RLM-RS is partially overlapped with SMTC occasion ($T_{CSI-RS} < T_{SMTCperiod}$) and SMTC occasion is partially or fully overlapped with measurement gap
- P is $1/(1- T_{CSI-RS} /MGRP)* 3$, when RLM-RS is partially overlapped with measurement gap and RLM-RS is fully overlapped with SMTC occasion ($T_{CSI-RS} = T_{SMTCperiod}$) and SMTC occasion is partially overlapped with measurement gap ($T_{SMTCperiod} < MGRP$)

If the high layer in TS 38.331 [2] signaling of *smtc2* is present, $T_{SMTCperiod}$ follows *smtc2*; Otherwise $T_{SMTCperiod}$ follows *smtc1*.

Note: The overlap between CSI-RS RLM and SMTC means that CSI-RS based RLM is within the SMTC window duration.Longer evaluation period would be expected if the combination of RLM-RS, SMTC occasion and measurement gap configurations does not meet pervious conditions.

The values of M_{out} and M_{in} used in Table 8.1.3.2-1 and Table 8.1.3.2-2 are defined as:

- M_{out} = 20 and M_{in} = 10, if the CSI-RS resource configured for RLM is transmitted with Density =3.

Editor's Note: FFS if requirement will be defined for the case where CSI-RS resource configured for RLM is transmitted with Density =1.

Table 8.1.3.2-1: Evaluation period $T_{Evaluate\_out}$ and $T_{Evaluate\_in}$ for FR1

Configuration	$T_{Evaluate\_out}$ (ms)	$T_{Evaluate\_in}$ (ms)
non-DRX	$\max(200, \mathrm{ceil}(M_{out}\times P)\times T_{CSI-RS})$	$\max(100, \mathrm{ceil}(M_{in}\times P) \times T_{CSI-RS})$
DRX ≤ 320ms	$\max(200, \mathrm{ceil}(1.5\times M_{out}\times P)\times \max(T_{DRX}, T_{CSI-RS}))$	$\max(100, \mathrm{ceil}(1.5\times M_{in}\times P)\times \max(T_{DRX}, T_{CSI-RS}))$
DRX > 320ms	$\mathrm{ceil}(M_{out}\times P) \times T_{DRX}$	$\mathrm{ceil}(M_{in}\times P) \times T_{DRX}$
NOTE: T_{CSI-RS} is the periodicity of CSI-RS resource configured for RLM. T_{DRX} is the DRX cycle length.		

Table 8.1.3.2-2: Evaluation period $T_{Evaluate\_out}$ and $T_{Evaluate\_in}$ for FR2

Configuration	$T_{Evaluate\_out}$ (ms)	$T_{Evaluate\_in}$ (ms)
non-DRX	max(200, ceil(M_{out}×P×N)×T_{CSI-RS})	max(100, ceil(M_{in}×P×N) × T_{CSI-RS})
DRX ≤ 320ms	max(200, ceil(1.5×M_{out}×P×N)× max(T_{DRX}, T_{CSI-RS}))	max(100, ceil(1.5×M_{in}×P×N)× max(T_{DRX}, T_{CSI-RS}))
DRX > 320ms	ceil(M_{out}×P×N) × T_{DRX}	ceil(M_{in}×P×N) × T_{DRX}
NOTE: T_{CSI-RS} is the periodicity of CSI-RS resource configured for RLM. T_{DRX} is the DRX cycle length.		

8.1.4 Minimum requirement at transitions

When the UE transitions between DRX and non-DRX or when DRX cycle periodicity changes, for each RLM-RS resource, for a duration of time equal to the evaluation period corresponding to the second mode after the transition occurs, the UE shall use an evaluation period that is no less than the minimum of evaluation period corresponding to the first mode and the second mode. Subsequent to this duration, the UE shall use an evaluation period corresponding to the second mode for each RLM-RS resource. This requirement shall be applied to both out-of-sync evaluation and in-sync evaluation of themonitored cell.

When the UE transitions from a first configuration of RLM-RS resources to a second configuration of RLM-RS resources that is different from the first configuration, for each RLM-RS resource present in the second configuration, for a duration of time equal to the evaluation period corresponding to the second configuration after the transition occurs, the UE shall use an evaluation period that is no less than the minimum of evaluation periods corresponding to the first configuration and the second configuration. Subsequent to this duration, the UE shall use an evaluation period corresponding to the second configuration for each RLM-RS resource present in the second configuration. This requirement shall be applied to both out-of-sync evaluation and in-sync evaluation of themonitored cell.

8.1.5 Minimum requirement for UE turning off the transmitter

The transmitter power of the UE in the monitored cell shall be turned off within 40ms after expiry of T310 timer as specified in TS 38.331 [2].

8.1.6 Minimum requirement for L1 indication

When the downlink radio link quality on all the configured RLM-RS resources is worse than Q_{out}, Layer 1 of the UE shall send an out-of-sync indication for the cell to the higher layers. A Layer 3 filter shall be applied to the out-of-sync indications as specified in TS 38.331 [2].

When the downlink radio link quality on at least one of the configured RLM-RS resources is better than Q_{in}, Layer 1 of the UE shall send an in-sync indication for the cell to the higher layers. A Layer 3 filter shall be applied to the in-sync indications as specified in TS 38.331 [2].

The out-of-sync and in-sync evaluations for the configured RLM-RS resources shall be performed as specified in clause 5 in TS 38.213 [3]. Two successive indications from Layer 1 shall be separated by at least $T_{Indication\_interval}$.

When DRX is not used $T_{Indication\_interval}$ is max(10ms, $T_{RLM-RS,M}$), where $T_{RLM,M}$ is the shortest periodicity of all configured RLM-RS resources for the monitored cell, which corresponds to T_{SSB} specified in section 8.1.2 if the RLM-RS resource is SSB, or T_{CSI-RS} specified in section 8.1.3 if the RLM-RS resource is CSI-RS.

In case DRX is used, $T_{Indication\_interval}$ is max(10ms, 1.5*DRX_cycle_length, 1.5*$T_{RLM-RS,M}$) if DRX cycle_length is less than or equal to 320ms, and $T_{Indication\_interval}$ is DRX_cycle_length if DRX cycle_length is greater than 320ms. Upon start of T310 timer as specified in TS 38.331 [2], the UE shall monitor the configured RLM-RS resources for recovery using the evaluation period and Layer 1 indication interval corresponding to the non-DRX mode until the expiry or stop of T310 timer.

8.1.7 Scheduling availability of UE during radio link monitoring

When the reference signal to be measured for RLM has different subcarrier spacing than PDSCH/PDCCH and on frequency range FR2, there are restrictions on the scheduling availability as described in the following clauses.

8.1.7.1 Scheduling availability of UE performing radio link monitoring with a same subcarrier spacing as PDSCH/PDCCH on FR1

There are no scheduling restrictions due to radio link monitoring performed with a same subcarrier spacing as PDSCH/PDCCH on FR1.

8.1.7.2 Scheduling availability of UE performing radio link monitoring with a different subcarrier spacing than PDSCH/PDCCH on FR1

For UE which support *simultaneousRxDataSSB-DiffNumerology* [14] there are no restrictions on scheduling availability due to radio link monitoring based on SSB as RLM-RS. For UE which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to radio link monitoring based on SSB as RLM-RS.

- The UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on SSB symbols to be measured for radio link monitoring.

When intra-band carrier aggregation is performed, the scheduling restrictions apply to all serving cells on the band due to radio link monitoring performed on FR1 serving PCell or PSCell in the same band. When inter-band carrier aggregation within FR1 is performed, there are no scheduling restrictions on FR1 serving cell(s) in the bands due to radio link monitoring performed on FR1 serving PCell or PSCell in different bands.

8.1.7.3 Scheduling availability of UE performing radio link monitoring on FR2

The following scheduling restriction applies due to radio link monitoring on an FR2 serving PCell and/or PSCell.

- If UE is not provided high layer parameter *RadioLinkMonitoringRS* and UE is provided by higher layer parameter *TCI-state* for PDCCH SSB/CSI-RS that has QCL-Type D, or if the SSB/CSI-RS configured for RLM is QCL-Type D with DM-RS for PDCCH
    - There are no scheduling restrictions due to radio link monitoring performed with a same subcarrier spacing as PDSCH/PDCCH.
- Otherwise
    - The UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on RLM-RS symbols to be measured for radio link monitoring, except for RMSI PDCCH/PDSCH and PDCCH/PDSCH which is not required to be received by RRC_CONNECTED mode UE.

When intra-band carrier aggregation is performed, for other serving cells on the band than FR2 serving PCell or PSCell in the same band, the following scheduling restriction applies due to radio link monitoring on an FR2 serving PCell and/or PSCell.

- If the RLM-RS is type-D QCLed with active TCI state for PDCCH/PDSCH, and N=1 applies for the RLM-RS as specified in section 8.1.2.2 if the RLM-RS is SSB and in section 8.1.3.2 if the RLM-RS is CSI-RS
    - There are no scheduling restrictions due to radio link monitoring performed with a same subcarrier spacing as PDSCH/PDCCH.
    - When performing radio link monitoring with a different subcarrier spacing than PDSCH/PDCCH, for UE which support *simultaneousRxDataSSB-DiffNumerology* [14] there are no restrictions on scheduling availability due to radio link monitoring. For UE which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on SSB symbols to be measured for radio link monitoring.
- Otherwise
    - The UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on RLM-RS symbols to be measured for radio link monitoring.

Editor's Note: FFS scheduling restrictions for inter-band carrier aggregation will be defined depending on band combination in future.

8.1.7.4 Scheduling availability of UE performing radio link monitoring on FR1 or FR2 in case of FR1-FR2 inter-band CA

There are no scheduling restrictions on FR1 serving cell(s) due to radio link monitoring performed on FR2 serving PCell and/or PSCell.

There are no scheduling restrictions on FR2 serving cell(s) due to radio link monitoring performed on FR1 serving PCell and/or PSCell.

8.2 Interruption

8.2.1 NSA: Interruptions with EN-DC

8.2.1.1 Introduction

This section contains the requirements related to the interruptions on PSCell, and SCell, when

E-UTRA PCell transitions between active and non-active during DRX, or

E-UTRA PCell transitions from non-DRX to DRX, or

E-UTRA SCell in MCG or SCell in SCG is added or released, or

E-UTRA SCell in MCG or SCell in SCG is activated or deactivated, or

measurements on SCC with deactivated SCell in either E-UTRA MCG or NR SCG

This section also contains the requirements related to the interruptions on other active serving cells in the same frequency range wherein the UE is performing BWP switching.

The requirements shall apply for E-UTRA-NR DC with an E-UTRA PCell.

This section contains interruptions where victim cell is PSCell or SCell belonging to SCG. Requirements for interruptions requirements when the victim cell is E-UTRA PCell or E-UTRA SCell belonging to MCG are specified in [15].

For a UE which does not support per-FR measurement gaps, interruptions to the PSCell or active SCG SCells may be caused by EUTRA PCell, EUTRA SCells or SCells on any frequency range. For UE which support per-FR gaps, interruptions to the PSCell or active SCG SCells may be caused by EUTRA PCell, EUTRA SCells or SCells on the same frequency range as the victim cell.

8.2.1.2 Requirements

8.2.1.2.1 Interruptions at transitions between active and non-active during DRX

Interruption on PSCell and the activated SCell if configured due to E-UTRA PCell transitions between active and non-active druing DRX when PSCell or SCell is in non-DRX are allowed with up to 1% probability of missed ACK/NACK when the configured E-UTRA PCell DRX cycle is less than 640 ms, and 0.625% probability of missed ACK/NACK is allowed when the configured E-UTRA PCell DRX cycle is 640 ms or longer. Each interruption shall not exceed X slot as defined in table 8.2.1.2.1-1.

Each interruption shall not exceed X slot as defined in table 8.2.1.2.1-1.

Table 8.2.1.2.1-1 Interruption length X at transition between active and non-active during DRX

μ	NR Slot length (ms)	Interruption length X	
		Sync	Async
0	1	1	2
1	0.5	1	2
2	0.25	3	
3	0.125	5	

When both E-UTRA PCell and PSCell are in DRX, no interruption is allowed.

8.2.1.2.2 Interruptions at transitions from non-DRX to DRX

Interruption on PSCell and the activated SCell if configured due to E-UTRA PCell transitions from non-DRX to DRX when PSCell or SCell is in non-DRX shall not exceed X slot as defined in table 8.2.1.2.1-1.

8.2.1.2.3 Interruptions at SCell addition/release

The requirements in this clause shall apply for the UE configured with PSCell.

When one E-UTRA SCell is added or released:

- an interruption on PSCell:
  - of up to X1 slot, if the PSCell is not in the same band as any of the E-UTRA SCells being added or released, or
  - of up to max{Y1 slot + SMTC duration, 5ms} if the PSCell is in the same band as any of the E-UTRA SCells being added or released, provided the cell specific reference signals from the PSCell and the E-UTRA SCells being added or released are available in the same slot;
- an interruption on any activated SCell in SCG:
  - of up to X1 slot, if the activated SCell is not in the same band as any of the E-UTRA SCells being added or released, or
  - of up to max{Y1 slot + SMTC duration, 5ms} if the activated SCell is in the same band as any of the E-UTRA SCells being added or released, provided the cell specific reference signals from the activated SCell and the E-UTRA SCells being added or released are available in the same slot.

When one SCell is added or released:

- an interruption on PSCell:
  - of up to X1 slot, if the PSCell is not in the same band as any of the SCells being added or released, or
  - of up to Y1 slot + SMTC duration if the PSCell is in the same band as any of the SCells being added or released, provided the cell specific reference signals from the PSCell and the SCells being added or released are available in the same slot;
- an interruption on any activated SCell in SCG:
  - of up to X1 slot, if the activated SCell is not in the same band as any of the SCells being added or released, or
  - of up to Y1 slot + SMTC duration if the activated SCell is in the same band as any of the SCells being added or released, provided the cell specific reference signals from the activated SCell and the SCells being added or released are available in the same slot.

Table 8.2.1.2.3-1: Interruption length X1 and Y1 at SCell addition/Release

μ	NR Slot length (ms)	Interruption length X1 slot		Interruption length Y1 slot[Note 1]
		Sync	Async	
0	1	1	2	1
1	0.5	2	3	2
2	0.25	5		4
3	0.125	9		8

8.2.1.2.4 Interruptions at SCell activation/deactivation

The requirements in this clause shall apply for the UE configured with PSCell and one SCell.

When one E-UTRA SCell is activated or deactivated:

- an interruption on PSCell:
  - of up to X2 slot, if the PSCell is not in the same band as any of the E-UTRA SCells being activated or deactivated, or

- of up to max{Y2 slot + SMTC duration, 5ms} if the PSCell is in the same band as any of the E-UTRA SCells being activated or deactivated, provided the cell specific reference signals from the PSCell and the E-UTRA SCells being activated or deactivated are available in the same slot;

- an interruption on any activated SCell in SCG:

  - of up to X2 slot, if the activated SCell is not in the same band as any of the E-UTRA SCells being activated or deactivated, or

  - of up to max{Y2 slot + SMTC duration, 5ms} if the activated SCell is in the same band as any of the E-UTRA SCells being activated or deactivated, provided the cell specific reference signals from the activated SCell and the E-UTRA SCells being activated or deactivated are available in the same slot.

When one SCell is activated or deactivated:

- an interruption on PSCell:

  - of up to X2 slot, if the PSCell is not in the same band as any of the SCells being activated or deactivated, or

  - of up to Y2 slot + SMTC duration if the PSCell is in the same band as any of the SCells being activated or deactivated, provided the cell specific reference signals from the PSCell and the SCells being activated or deactivated are available in the same slot;

- an interruption on any activated SCell in SCG:

  - of up to X2 slot, if the activated SCell is not in the same band as any of the SCells being activated or deactivated, or

  - of up to Y2 slot + SMTC duration if the activated SCell is in the same band as any of the SCells being activated or deactivated, provided the cell specific reference signals from the deactivated SCell and the SCells being activated or deactivated are available in the same slot.

Table 8.2.1.2.4-1: Interruption length X2 and Y2 at SCell activation/deactivation

μ	NR Slot length (ms)	Interruption length X2 slot		Interruption length Y2 slot
		Sync	Async	
0	1	1	2	1
1	0.5	1	2	1
2	0.25	3		2
3	0.125	5		4

8.2.1.2.5 Interruptions during measurements on SCC

8.2.1.2.5.1 Interruptions during measurements on deactivated NR SCC

Interruption on PSCell and other active NR SCell(s) during measurement on the deactivated NR SCC shall meet requirements in clause 8.2.2.2.3, where the term PCell in clause 8.2.2.2.3 shall be deemed to be replaced with PSCell.

8.2.1.2.5.2 Interruptions during measurements on deactivated E-UTRAN SCC

When one E-UTRA SCell in MCG is deactivated, the UE is allowed due to measurements on the E-UTRA SCC with the deactivated E-UTRA SCell:

- an interruption on PSCell or any activated SCell with up to 0.5% probability of missed ACK/NACK when any of the configured *measCycleSCell* [2] for the deactivated E-UTRA SCells is 640 ms or longer.

- an interruption on PSCell or any activated SCell with up to 0.5% probability of missed ACK/NACK regardless of the configured *measCycleSCell* [2] for the deactivated E-UTRA SCells if indicated by the network using IE *allowInterruptions* [2].

Each interruption shall not exceed

- X3 slot, if the PSCell or activated SCell is not in the same band as the E-UTRA deactivated SCC being measured, or

- Y3 slot + SMTC duration, if the PSCell or activated SCell is in the same band as the E-UTRA deactivated SCC being measured, provided the cell specific reference signals from the PSCell or activated SCell and the E-UTRA deactivated SCC being measured are available in the same slot.

Table 8.2.1.2.5-1: Interruption length X3 and Y3 at measurements on deactivated E-UTRA SCC

μ	NR Slot length (ms)	Interruption length X3 slot		Interruption length Y3 slot
		Sync	Async	
0	1	1	2	1
1	0.5	1	2	1
2	0.25	3		2
3	0.125	5		4

8.2.1.2.6 Interruptions at UL carrier RRC reconfiguration

The requirements in this clause shall apply when a supplementary UL carrier or an UL carrier is configured or de-configured in NR non-standalone operation as defined in [2].

When an UL carrier or supplementary UL carrier is configured or deconfigured, an interruption on E-UTRA PCell, all activated E-UTRA SCells, PSCell and all activated SCells within the same FR as the reconfigured uplink carrier of up to [1] slot, is allowed immediately after the RRC reconfiguration procedure [2]. The interruption is for both uplink and downlink of E-UTRA PCell, all activated E-UTRA SCells, PSCell and all activated SCells within the same FR as the configured or de-configured UL.

8.2.1.2.7 Interruption due to Active BWP switching Requirement

When UE receives a DCI indicating UE to switch its NR active BWP which corresponds to either SCS changes or other changes in BWP parameters, the UE is allowed to cause interruption of up to X slot to other active serving cells if the UE is not capable of per-FR gap. When the BWP switch only imposes BWP parameter changes other than SCS and the UE is capable of per-FR gap the UE is allowed to cause interruption of up to X slot to other active serving cells in the same frequency range wherein the UE is performing BWP switching. X is defined in Table 8.2.1.2.7-1. The interruption is only allowed within the BWP switching delay $T_{BWP\_switching\_delay\_DCI}$ as defined in clause 8.6.2 in TS38.133. Interruptions are not allowed during BWP switch involving only baseband parameter change.

When a BWP timer *bwp-InactivityTimer* defined in [2] expires, UE is allowed to cause interruption of up to X slot to other active serving cells if the UE is not capable of per-FR gap, or if the BWP switching involves SCS changing. When the BWP switch only imposes BWP parameter changes other than SCS and the UE is capable of per-FR gap the UE is allowed to cause interruption of up to X slot to other active serving cells in the same frequency range wherein the UE is performing BWP switching. X is defined in Table 8.2.1.2.7-1. The interruption is only allowed within the BWP switching delay $T_{BWP\_switching\_delay\_timer}$ as defined in clause 8.6.2 in TS38.133. Interruptions are not allowed during BWP switch involving only baseband parameter change.

Table 8.2.1.2.7-1: interruption length X

μ	NR Slot length (ms)	Interruption length X (slots[note 1])
0	1	1
1	0.5	1
2	0.25	3
3	0.125	5
Note1: If the BWP switch involves changing of SCS, the interruption due to BWP switch is determined by the larger one between the SCS before BWP swith and the SCS after the BWP switch.		

8.2.2 SA: Interruptions with Standalone NR Carrier Aggregation

8.2.2.1 Introduction

This section contains the requirements related to the interruptions on PCell and activated SCell if configured, when up to TBD SCells are configured, deconfigured, activated or deactivated.

Note: interruptions at SCell addition/release, activation/deactivation and during measurements on SCC may not be required by all UEs.

Editor's Note: The interruptions shall not interrupt RRC signalling or ACK/NACKs related to RRC reconfiguration procedure [2] for SCell addition/release or MAC control signalling [17] for SCell activation/deactivation command. How to specify this is FFS.

This section also contains the requirements related to the interruptions on other active serving cells in the same frequency range wherein the UE is performing BWP switching.

8.2.2.2 Requirements

8.2.2.2.1 Interruptions at SCell addition/release

When any number of SCells between one and TBD is added or released using the same *RRCConnectionReconfiguration* message as defined in [2], the UE is allowed an interruption on PCell and on any activated SCell during the RRC reconfiguration procedure as follows:

- an interruption on PCell:
  - of up to the duration shown in table 8.2.2.2.1-1, if the PCell is not in the same band as any of the SCells being added or released, or
  - of up to the duration shown in table 8.2.2.2.1-2, if the PCell is in the same band as any of the SCells being added or released, provided the cell specific reference signals from the PCell and the SCells being added or released are available in the same slot;
- an interruption on any activated SCell:
  - of up to to the duration shown in table 8.2.2.2.1-1, if the activated SCell is not in the same band as any of the SCells being added or released, or
  - of up to the duration shown in table 8.2.2.2.1-2, if the activated SCell is in the same band as any of the SCells being added or released, provided the cell specific reference signals from the activated SCell and the SCells being added or released are available in the same slot.

Table 8.2.2.2.1-1: Interruption duration for SCell addition/release for inter-band CA

μ	NR Slot length (ms)	Interruption length (slot)
0	1	1
1	0.5	2
2	0.25	4
3	0.125	8

Table 8.2.2.2.1-2: Interruption duration for SCell addition/release for intra-band CA

μ	NR Slot length (ms)	Interruption length (slot)
0	1	1 + SMTC duration
1	0.5	2 + SMTC duration
2	0.25	4 + SMTC duration
3	0.125	8 + SMTC duration

8.2.2.2.2 Interruptions at SCell activation/deactivation

When an intra-band SCell is activated or deactivated as defined in [17] the UE is allowed

- an interruption on PCell:
  - of up to the duration shown in table 8.2.2.2.2-1, if the PCell is not in the same band as any of the SCells being activated or deactivated, or

  - of up to the duration shown in table 8.2.2.2.2-2 if the PCell is in the same band as any of the SCells being activated or deactivated provided the cell specific reference signals from the PCell and the SCells being activated or deactivated are available in the same slot;

- an interruption on any activated SCell:
  - of up to the duration shown in table 8.2.2.2.2-1, if the activated SCell is not in the same band as any of the SCells being activated or deactivated, or
  - of up to the duration shown in table 8.2.2.2.2-2, if the activated SCell is in the same band as any of the SCells being activated or deactivated provided the cell specific reference signals from the PCell and the SCells being activated or deactivated are available in the same slot.

Table 8.2.2.2.2-1: Interruption duration for SCell activation/deactivation for inter-band CA

μ	NR Slot length (ms)	Interruption length
0	1	1
1	0.5	1
2	0.25	2
3	0.125	4

Table 8.2.2.2.2-2: Interruption duration for SCell activation/deactivation for intra-band CA

μ	NR Slot length (ms)	Interruption length
0	1	1 + SMTC duration
1	0.5	2 + SMTC duration
2	0.25	4 + SMTC duration
3	0.125	8 + SMTC duration

8.2.2.2.3 Interruptions during measurements on SCC for intra-band CA

Interruptions on PCell due to measurements when an SCell is deactivated are allowed with up to 0.5% probability of missed ACK/NACK when the configured *measCycleSCell* [2] is 640 ms or longer. The UE is only allowed to cause interruptions immediately before and immediately after an SMTC. Each interruption shall not exceed requirement in Table 8.2.2.2.2-1 if the PCell is not in the same band as the deactivated SCell. Each interruption shall not exceed requirement in Table 8.2.2.2.2-2 if the PCell is in the same band as the deactivated SCell.

Interruptions on active SCell due to measurements when an SCell is deactivated are allowed with up to 0.5% probability of missed ACK/NACK when the configured *measCycleSCell* [2] is 640 ms or longer. The UE is only allowed to cause interruptions immediately before and immediately after an SMTC. Each interruption shall not exceed requirement in Table 8.2.2.2.2-1 if the active SCell is not in the same band as the deactivated SCell. Each interruption shall not exceed requirement in Table 8.2.2.2.2-2 if the active SCell is in the same band as the deactivated SCell.

8.2.2.2.4 Interruptions at UL carrier RRC reconfiguration

The requirements in this clause shall apply when a supplementary UL carrier or an UL carrier is configured or de-configured in NR standalone carrier aggregation as defined in [2].

When an UL carrier or supplementary UL carrier is configured or deconfigured, an interruption on PCell and all activated SCells within the same FR as the reconfigured uplink carrier of up to [1] slot, is allowed immediately after the RRC reconfiguration procedure [2]. The interruption is for both uplink and downlink of PCell and all the activated SCells within the same FR as the configured or de-configured UL.

8.2.2.2.5 Interruption due to Active BWP switching Requirement

When UE receives a DCI indicating UE to switch its NR active BWP which corresponds to either SCS changes or other changes in BWP parameters, the UE is allowed to cause interruption of up to X slot to other active serving cells if the UE is not capable of per-FR gap, or if the BWP switching involves SCS changing. When the BWP switch only imposes BWP parameter changes other than SCS and the UE is capable of per-FR gap the UE is allowed to cause interruption of up to X slot to other active serving cells in the same frequency range wherein the UE is performing BWP switching. X is defined in Table 8.2.2.2.5-1. The interruption is only allowed within the BWP switching delay $T_{BWP\_switching\_delay\_DCI}$ as defined in clause 8.6.2 in TS38.133. Interruptions are not allowed during BWP switch involving only baseband parameter change.

When a BWP timer *bwp-InactivityTimer* defined in [2] expires, UE is allowed to cause interruption of up to X slot to other active serving cells if the UE is not capable of per-FR gap, or if the BWP switching involves SCS changing. When the BWP switch only imposes BWP parameter changes other than SCS and the UE is capable of per-FR gap the UE is allowed to cause interruption of up to X slot to other active serving cells in the same frequency range wherein the UE is performing BWP switching. X is defined in Table 8.2.2.2.5-1. The interruption is only allowed within the BWP switching delay $T_{BWP\_switching\_delay\_timer}$ as defined in clause 8.6.2 in TS38.133. Interruptions are not allowed during BWP switch involving only baseband parameter change.

Table 8.2.2.2.5-1: Interruption length X

μ	NR Slot length (ms)	Interruption length X (slots[note 1])
0	1	1
1	0.5	1
2	0.25	3
3	0.125	5
Note1: If the BWP switch involves changing of SCS, the interruption due to BWP switch is determined by the larger one between the SCS before BWP swith and the SCS after the BWP switch.		

8.3 SCell Activation and Deactivation Delay

8.3.1 Introduction

This section defines requirements for the delay within which the UE shall be able to activate a deactivated SCell and deactivate an activated SCell in SCG inEN-DC, or in standalone NR carrier aggregation.

The requirements shall apply for EN-DC and standalone NR carrier aggregation.

8.3.2 SCell Activation Delay Requirement for Deactivated SCell

The requirements in this section shall apply for the UE configured with one downlink SCell in SCG in EN-DC, or in standalone NR carrier aggregation.

The delay within which the UE shall be able to activate the deactivated SCell depends upon the specified conditions.

Upon receiving SCell activation command in slot *n*, the UE shall be capable to transmit valid CSI report and apply actions related to the activation command for the SCell being activated no later than in slot *n*+ [T_{HARQ} + $T_{activation\_time}$ + $T_{CSI\_Reporting}$]

Where:

T_{HARQ} is the timing between DL data transmission and acknowledgement as specified in [7].

$T_{activation\_time}$ is the SCell activation delay. If the SCell is known and belongs to FR1, $T_{activation\_time}$ is:

- [3ms+ 1* T_{SMTC_SCell} +2ms], if the SCell measurement cycle is equal to or smaller than [160ms].
- [3ms+T_{SMTC_MAX}+T_{SMTC_SCell} +2ms], if the SCell measurement cycle is larger than [160ms].

If the SCell is unknown and belongs to FR1, $T_{activation\_time}$ is:

- [3ms+ 2*T_{SMTC_MAX}+2*T_{SMTC_SCell} +2ms] provided the SCell can be successfully detected on the first attempt.

If the SCell being activated belongs to FR2, and there is at least one active serving cell on that FR2 band, then $T_{activation\_time}$ is: [3ms+ TBD], If the SCell being activated belongs to FR2, and there is no active serving cell on that FR2 band provided that PCell or PSCell is FR1, then, $T_{activation\_time}$ is [3ms+ 25*T_{SMTC_SCell} +2ms].

Where,

T_{SMTC_MAX}:

- In FR1, in case of intra-band SCell activation, T_{SMTC_MAX} is the longer SMTC periodicity between active serving cells and SCell being activated provided the cell specific reference signals from the active serving cells and the SCells being activated or released are available in the same slot; in case of inter-band SCell activation, T_{SMTC_MAX} is the SMTC periodicity of SCell being activated.
- In FR2, T_{SMTC_MAX} is the longer SMTC periodicity between active serving cells and SCell being activated provided that in Rel-15 only support FR2 intra-band CA.

T_{SMTC_SCell}: SMTC periodicity of SCell being activated.

$T_{CSI\_reporting}$ is the delay uncertainty in acquiring the first available CSI reporting resources as specified in [2].

SCell in FR1 is known if it has been meeting the following conditions:

- During the period equal to max([5] measCycleSCell, [5] DRX cycles) for FR1 before the reception of the SCell activation command:
  - the UE has sent a valid measurement report for the SCell being activated and
  - the SSB measured remains detectable according to the cell identification conditions specified in section 9.2 and 9.3.
- the SSB measured during the period equal to max([5] measCycleSCell, [5] DRX cycles) also remains detectable during the SCell activation delay according to the cell identification conditions specified in section 9.2 and 9.3.

Otherwise SCell in FR1 is unknown.

In addition to CSI reporting defined above, UE shall also apply other actions related to the activation command specified in [2] for an SCG SCell at the first opportunities for the corresponding actions once the SCell is activated.

The interruption on PSCell or any activated SCell in SCGfor EN-DC mode specified in section 8.2 shall not occur before slot n+1+[T_{HARQ}] and not occur after slot n+1+[_T_{HARQ} +3ms + $T_{SSB,max}$ + $T_{SMTC\_duration}$].

The interruption on PCell or any activated SCell in MCG for NR standalone mode specified in section 8.2 shall not occur before slot n+1+[T_{HARQ}] and not occur after slot n+1+[_T_{HARQ} +3ms + $T_{SSB,max}$ + $T_{SMTC\_duration}$].

Starting from the slot specified in section 4.3 of [3] (timing for secondary Cell activation/deactivation) and until the UE has completed the SCell activation, the UE shall report out of range if the UE has available uplink resources to report CQI for the SCell.

8.3.3 SCell Deactivation Delay Requirement for Activated SCell

The requirements in this section shall apply for the UE configured with one downlink SCell in SCG in EN-DC, or in standalone NR carrier aggregation.

Upon receiving SCell deactivation command or upon expiry of the *sCellDeactivationTimer* in slot *n*, the UE shall accomplish the deactivation actions for the SCell being deactivated no later than in slot *n*+[T_{HARQ} +3ms].

The interruption on PSCell or any activated SCell in SCG for EN-DC mode specified in section 8.2 shall not occur before slot n+1+[T_{HARQ}] and not occur after slot n+1+[T_{HARQ} +3ms].

The interruption on PCell or any activated SCell in MCG for NR standalone mode specified in section 8.2 shall not occur before slot n+1+[T_{HARQ}] and not occur after slot n+1+[_T_{HARQ} +3ms].Note1: FFS the interruption range on considering AGC adjustment.

8.4 UE UL carrier RRC reconfiguration Delay

8.4.1 Introduction

The requirements in this section apply for a UE being configured or deconfigured with a supplementary UL carrier or NR UL carrier.

8.4.2 UE UL carrier configuration Delay Requirement

When the UE receives a RRC message implying NR UL or Supplementary UL carrier configuration, the UE shall be ready to start transmission on the newly configured carrier within $T_{UL\_carrier\_config}$ from the end of the last slot containing the RRC command.

$T_{UL\_carrier\_config}$ equals the maximum RRC procedure delay defined in clause x.y in TS 38.331 [2] plus the interruption time specified in section 8.2.1.2.6.

8.4.3 UE UL carrier deconfiguration Delay Requirement

When the UE receives a RRC message implying NR UL or Supplementary UL carrier deconfiguration RRC signalling, the UE shall stop UL signalling on the deconfigured UL carrier within $T_{UL\_carrier\_deconfig}$ from the end of the last slot containing the RRC command.

$T_{UL\_carrier\_deconfig}$ equals the maximum RRC procedure delay defined in clause x.y in TS 38.331 [2].

8.5 Link Recovery Procedures

8.5.1 Introduction

The UE shall assess the downlink link quality of a serving cell based on the reference signal in the set $\overline{q}_0$ as specificed in TS 38.213 [3] in order to detect beam failure instance. The RS resources in the set $\overline{q}_0$ can be periodic CSI-RS resources and/or SSBs. UE is not required to perform beam failure detection outside the active DL BWP.

On each RS resource in the set $\overline{q}_0$, the UE shall estimate the radio link quality and compare it to the threshold Q_{out_LR} for the purpose of accessing downlink radio link quality of the serving cell.

The threshold Q_{out_LR} is defined as the level at which the downlink radio level link cannot be reliably received and shall correspond to the $BLER_{out}$[TBD] block error rate of a hypothetical PDCCH transmission. For SSB based beam failure detection, $Q_{out\_LR\_SSB}$ is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.5.2.1-1. For CSI-RS based beam failure detection, $Q_{out\_LR\_CSI\text{-}RS}$ is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.5.3.1-1.

The UE shall perform L1-RSRP measurements based on the reference signal in the set $\overline{q}_1$ as specified in TS 38.213 [3] in order to detect candidate beam. The RS resources in the set $\overline{q}_1$ can be periodic CSI-RS resources and/or SSBs. UE is not required to perform candidate beam detection outside the active DL BWP.

On each RS resource in the set $\overline{q}_1$, the UE shall perform L1-RSRP measurements and compare it to the threshold Q_{in_LR} for the purpose of selecting new beam(s) for beam failure recovery.

The threshold Q_{in_LR} corresponds to the value of higher layer parameter *candidateBeamThreshold*.

8.5.2 Requirements for SSB based beam failure detection

8.5.2.1 Introduction

The requirements in this section apply for each SSB resource in the set $\overline{q}_0$ configured for a serving cell, provided that the SSB configured for beam failure detection are actually transmitted within the UE active DL BWP during the entire evaluation period specified in section 8.5.2.2.

Table 8.5.2.1-1: PDCCH transmission parameters for beam failure instance

Attribute	Value for BLER
DCI format	1-0
Number of control OFDM symbols	Same as the number of symbols of RMSI CORESET
Aggregation level (CCE)	8
Ratio of hypothetical PDCCH RE energy to average SSS RE energy	0dB
Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy	0dB
Bandwidth (MHz)	Same as the number of PRBs of RMSI CORESET
Sub-carrier spacing (kHz)	Same as the SCS of RMSI CORESET
DMRS precoder granularity	REG bundle size
REG bundle size	6
CP length	Same as the CP length of RMSI CORESET
Mapping from REG to CCE	Distributed

8.5.2.2 Minimum requirement

UE shall be able to evaluate whether the downlink radio link quality on the configured SSB resource in set $\overline{q}_0$ estimated over the last $T_{Evaluate\_BFD\_SSB}$ [ms] period becomes worse than the threshold $Q_{out\_LR\_SSB}$ within $T_{Evaluate\_BFD\_SSB}$ [ms] period.

The value of $T_{Evaluate\_BFD\_SSB}$ is defined in Table 8.5.2.2-1 for FR1.

The value of $T_{Evaluate\_BFD\_SSB}$ is defined in Table 8.5.2.2-2 for FR2 with

- N=1,

  if UE is not provided higher layer parameter *failureDetectionResource* and UE is provided by higher layer parameter *TCI-state* for PDCCH SSB that has QCL-TypeD, or

  if the SSB configured for BFD is QCL-Type D with DM-RS for PDCCH and the QCL association is known to UE, or

  if the SSB configured for BFD is QCL-Type D and TDMed to CSI-RS resources configured for L1-RSRP reporting and the QCL association is known to UE, and a CSI report with L1-RSRP measurement for the SSB configured for BFD has been made within [TBD]ms;

- N=FFS, otherwise.

For FR1,

- P=1/(1 – T_{SSB}/MGRP), when in the monitored cell there are measurement gaps configured for intra-frequency, inter-frequency or inter-RAT measurements, which are overlapping with some but not all occasions of the SSB; and

- P=1 when in the monitored cell there are no measurement gaps overlapping with any occasion of the SSB.

For FR2,

- P=1/(1 – $T_{SSB}/T_{SMTCperiod}$), when BFD-RS is not overlapped with measurement gap and BFD-RS is partially overlapped with SMTC occasion ($T_{SSB} < T_{SMTCperiod}$).

- P is $P_{sharing\ factor}$, when BFD-RS is not overlapped with measurement gap and BFD-RS is fully overlapped with SMTC period ($T_{SSB} = T_{SMTCperiod}$).

- P is 1/(1- T_{SSB}/MGRP - $T_{SSB}/T_{SMTCperiod}$), when BFD-RS is partially overlapped with measurement gap and BFD-RS is partially overlapped with SMTC occasion ($T_{SSB} < T_{SMTCperiod}$) and SMTC occasion is not overlapped with measurement gap and

    - $T_{SMTCperiod} \neq$ MGRP or
    - $T_{SMTCperiod}$ = MGRP and $T_{SSB} < 0.5*T_{SMTCperiod}$

- P is $1/(1- T_{SSB}$ /MGRP)* $P_{sharing\ factor}$, when BFD-RS is partially overlapped with measurement gap and BFD-RS is partially overlapped with SMTC occasion ($T_{SSB} < T_{SMTCperiod}$) and SMTC occasion is not overlapped with measurement gap and $T_{SMTCperiod}$ = MGRP and $T_{SSB} = 0.5*T_{SMTCperiod}$
- P is $1/\{1- T_{SSB}$ /min ($T_{SMTCperiod}$,MGRP)}, when BFD-RS is partially overlapped with measurement gap (T_{SSB} <MGRP) and BFD-RS is partially overlapped with SMTC occasion ($T_{SSB} < T_{SMTCperiod}$) and SMTC occasion is partially or fully overlapped with measurement gap.
- P is $1/(1- T_{SSB}$ /MGRP)* $P_{sharing\ factor}$, when BFD-RS is partially overlapped with measurement gap and BFD-RS is fully overlapped with SMTC occasion ($T_{SSB} = T_{SMTCperiod}$) and SMTC occasion is partially overlapped with measurement gap ($T_{SMTCperiod}$ < MGRP)
- $P_{sharing\ factor}$ = 3.

If the high layer in TS 38.331 [2] signaling of *smtc2* is configured, $T_{SMTCperiod}$ corresponds to the value of higher layer parameter *smtc2*; Otherwise $T_{SMTCperiod}$ corresponds to the value of higher layer parameter *smtc1*.

Longer evaluation period would be expected if the combination of BFD-RS, SMTC occasion and measurement gap configurations does not meet pervious conditions.

Table 8.5.2.2-1: Evaluation period $T_{Evaluate\_BFD\_SSB}$ for FR1

Configuration	$T_{Evaluate\_BFD\_SSB}$ (ms)
non-DRX	max([50], ceil(5*P)*T_{SSB})
DRX cycle ≤ 320ms	max([50], ceil(7.5*P)*max(T_{DRX},T_{SSB}))
DRX cycle > 320ms	ceil(5*P)*T_{DRX}
Note: T_{SSB} is the periodicity of SSB in the set $\overline{q}_0$. T_{DRX} is the DRX cycle length.	

Table 8.5.2.2-2: Evaluation period $T_{Evaluate\_BFD\_out}$ for FR2

Configuration	$T_{Evaluate\_BFD\_SSB}$ (ms)
non-DRX	max([50], ceil(5*P*N)*T_{SSB})
DRX cycle ≤ 320ms	max([50], ceil(7.5*P*N)*max(T_{DRX},T_{SSB}))
DRX cycle > 320ms	ceil(5*P*N)*T_{DRX}
Note: T_{SSB} is the periodicity of SSB in the set $\overline{q}_0$. T_{DRX} is the DRX cycle length.	

8.5.3 Requirements for CSI-RS based beam failure detection

8.5.3.1 Introduction

The requirements in this section apply for each CSI-RS resource in the set $\overline{q}_0$ configured for a serving cell, provided that the CSI-RS resource configured for beam failure detection are actually transmitted within the UE active DL BWP during the entire evaluation period specified in section 8.5.3.2.

Table 8.5.3.1-1: PDCCH transmission parameters for beam failure instance

Attribute	Value for BLER
DCI format	1-0
Number of control OFDM symbols	Same as the number of symbols of CORESET QCLed with respective CSI-RS for BFD
Aggregation level (CCE)	8
Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy	0dB
Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy	0dB
Bandwidth (MHz)	Same as the number of PRBs of CORESET QCLed with respective CSI-RS for BFD
Sub-carrier spacing (kHz)	Same as the SCS of CORESET QCLed with respective CSI-RS for BFD
DMRS precoder granularity	REG bundle size
REG bundle size	6
CP length	Same as the CP length of CORESET QCLed with respective CSI-RS for BFD
Mapping from REG to CCE	Distributed

8.5.3.2 Minimum requirement

Editor's note: The requirements below have been derived without considering gap sharing when CSI-RS resource for BFD are partially overlapping with measurement gaps.

UE shall be able to evaluate whether the downlink radio link quality on the configured CSI-RS resource in set $\overline{q}_0$ estimated over the last $T_{Evaluate\_BFD\_CSI-RS}$ [ms] period becomes worse than the threshold $Q_{out\_LR\_CSI-RS}$ within $T_{Evaluate\_BFD\_CSI-RS}$ [ms] period.

The value of $T_{Evaluate\_BFD\_CSI-RS}$ is defined in Table 8.5.3.2-1 for FR1.

The value of $T_{Evaluate\_BFD\_CSI-RS}$ is defined in Table 8.5.3.2-2 for FR2 with

- N=1,

  if UE is not provided higher layer parameter *RadioLinkMonitoringRS* and UE is provided by higher layer parameter *TCI-state* for PDCCH CSI-RS that has QCL-TypeD, or

  if the CSI-RS configured for BFD is QCL-Type D with DM-RS for PDCCH and the QCL association is known to UE, or

  if the CSI-RS resource configured for BFD is QCL-Type D and TDMed to CSI-RS resources configured for L1-RSRP reporting or SSBs configured for L1-RSRP reporting, all CSI-RS resources configured for BFD are mutually TDMed, and the QCL association is known to UE and a CSI report with L1-RSRP measurement for the CSI-RS configured for BFD has been made within [TBD]ms;

- N=FFS, otherwise.

For FR1,

- P=1/(1 – T_{CSI-RS}/MGRP), when in the monitored cell there are measurement gaps configured for intra-frequency, inter-frequency or inter-RAT measurements, which are overlapping with some but not all occasions of the CSI-RS; and

- P=1 when in the monitored cell there are no measurement gaps overlapping with any occasion of the CSI-RS.

For FR2,

- P=1, when BFD-RS is not overlapped with measurement gap and also not overlapped with SMTC occasion.

- $P=1/(1 - T_{CSI-RS}/MGRP)$, when BFD-RS is partially overlapped with measurement gap and BFD-RS is not overlapped with SMTC occasion (T_{CSI-RS} < MGRP)
- $P=1/(1 - T_{CSI-RS} /T_{SMTCperiod})$, when BFD-RS is not overlapped with measurement gap and BFD-RS is partially overlapped with SMTC occasion ($T_{CSI-RS} < T_{SMTCperiod}$).
- P is $P_{sharing\ factor}$, when BFD-RS is not overlapped with measurement gap and BFD-RS is fully overlapped with SMTC occasion ($T_{CSI-RS} = T_{SMTCperiod}$).
- P is $1/(1- T_{CSI-RS} /MGRP - T_{CSI-RS} /T_{SMTCperiod})$, when BFD-RS is partially overlapped with measurement gap and BFD-RS is partially overlapped with SMTC occasion (TCSI-RS < $T_{SMTCperiod}$) and SMTC occasion is not overlapped with measurement gap and
    - $T_{SMTCperiod} \neq$ MGRP or
    - $T_{SMTCperiod}$ = MGRP and $T_{CSI-RS} < 0.5*T_{SMTCperiod}$
- P is $1/(1- T_{CSI-RS} /MGRP)* P_{sharing\ factor}$, when BFD-RS is partially overlapped with measurement gap and BFD-RS is partially overlapped with SMTC occasion ($T_{CSI-RS} < T_{SMTCperiod}$) and SMTC occasion is not overlapped with measurement gap and $T_{SMTCperiod}$ = MGRP and $T_{CSI-RS} = 0.5*T_{SMTCperiod}$
- P is $1/\{1- T_{CSI-RS} /\min (T_{SMTCperiod} ,MGRP)\}$, when BFD-RS is partially overlapped with measurement gap (T_{CSI-RS} < MGRP) and BFD-RS is partially overlapped with SMTC occasion ($T_{CSI-RS} < T_{SMTCperiod}$) and SMTC occasion is partially or fully overlapped with measurement gap.
- P is $1/(1- T_{CSI-RS} /MGRP)* P_{sharing\ factor}$, when BFD-RS is partially overlapped with measurement gap and BFD-RS is fully overlapped with SMTC occasion ($T_{CSI-RS} = T_{SMTCperiod}$) and SMTC occasion is partially overlapped with measurement gap ($T_{SMTCperiod}$ < MGRP)
- $P_{sharing\ factor}$ is 3**.**

If the high layer in TS 38.331 [2] signaling of *smtc2* is configured, $T_{SMTCperiod}$ corresponds to the value of higher layer parameter *smtc2*; Otherwise $T_{SMTCperiod}$ corresponds to the value of higher layer parameter *smtc1*.

Editor's Note: FFS definition of overlap between CSI-RS for BFD-RS and SMTC

Longer evaluation period would be expected if the combination of BFD-RS, SMTC occasion and measurement gap configurations does not meet pervious conditions.

The values of M_{BFD} used in Table 8.5.3.2-1 and Table 8.5.3.2-2 are defined as

- M_{BFD} = 10, if the CSI-RS resource configured for BFD is transmitted with Density = 3.

Table 8.5.3.2-1: Evaluation period $T_{Evaluate\_BFD\_CSI-RS}$ for FR1

Configuration	$T_{Evaluate\_BFD\_CSI-RS}$ (ms)
non-DRX	max([50], [M_{BFD} *P] * T_{CSI-RS})
DRX cycle ≤ 320ms	max([50], [1.5×M_{BFD} *P]*max(T_{DRX}, T_{CSI-RS}))
DRX cycle > 320ms	[M_{BFD}*P] * T_{DRX}
Note: T_{CSI-RS} is the periodicity of CSI-RS resource in the set $\overline{q}_0$. T_{DRX} is the DRX cycle length.	

Table 8.5.3.2-2: Evaluation period $T_{Evaluate\_BFD\_CSI-RS}$ for FR2

Configuration	$T_{Evaluate\_BFD\_CSI-RS}$ (ms)
non-DRX	max([50], [M_{BFD} *P*N] * T_{CSI-RS})
DRX cycle ≤ 320ms	max([50], [1.5×M_{BFD}*P*N]*max(T_{DRX}, T_{CSI-RS}))
DRX cycle > 320ms	[M_{BFD} *P*N] * T_{DRX}
Note: T_{CSI-RS} is the periodicity of CSI-RS resource in the set $\overline{q}_0$. T_{DRX} is the DRX cycle length.	

8.5.4 Minimum requirement for L1 indication

When the radio link quality on all the configured RS resources in set $\overline{q}_0$ is worse than Q_{out_LR}, Layer 1 of the UE shall send a beam failure instance indication for the cell to the higher layers. A Layer 3 filter shall be applied to the beam failure instance indications as specified in [2].

The beam failure instance evaluation for the configured RS resources in set $\overline{q}_0$ shall be performed as specified in section 6 in [3]. Two successive indications from Layer 1 shall be separated by at least $T_{Indication\_interval\_BFD}$.

When DRX is not used, $T_{Indication\_interval\_BFD}$ is max(2ms, $T_{BFD-RS,M}$), where $T_{BFD-RS,M}$ is the shortest periodicity of all configured RS resources in set $\overline{q}_0$ for the accessed cell, which corresponds to T_{SSB} specified in section 8.5.2 if a RS resource in the set $\overline{q}_0$ is SSB, or T_{CSI-RS} specified in section 8.5.3 if a RS resource in the set $\overline{q}_0$ is CSI-RS.

When DRX is used, $T_{Indication\_interval\_BFD}$ is max(1.5*DRX_cycle_length, 1.5*$T_{BFD-RS,M}$) if DRX cycle_length is less than or equal to 320ms, and $T_{Indication\_interval}$ is DRX_cycle_length if DRX cycle_length is greater than 320ms.

8.5.5 Requirements for SSB based candidate beam detection

8.5.5.1 Introduction

The requirements in this section apply for each SSB resource in the set $\overline{q}_1$ configured for a serving cell, provided that the SSBs configured for candidate beam detection are actually transmitted within UE active DL BWP during the entire evaluation period specified in section 8.5.5.2.

8.5.5.2 Minimum requirement

UE shall be able to evaluate whether the L1-RSRP measured on the configured SSB resource in set $\overline{q}_1$ estimated over the last $T_{Evaluate\_CBD\_SSB}$ [ms] period becomes better than the threshold Q_{in_LR} within $T_{Evaluate\_CBD\_SSB}$ [ms] period.

The value of $T_{Evaluate\_CBD\_SSB}$ is defined in Table 8.5.5.2-1 for FR1.

The value of $T_{Evaluate\_CBD\_SSB}$ is defined in Table 8.5.5.2-2 for FR2 with N=FFS.

Where,

- P=1/(1 – T_{SSB}/MGRP), when in the monitored cell there are measurement gaps configured for intra-frequency, inter-frequency or inter-RAT measurements, which are overlapping with some but not all occasions of the SSB; and
- P=1 when in the monitored cell there are no measurement gaps overlapping with any occasion of the SSB.

Table 8.5.5.2-1: Evaluation period $T_{Evaluate\_CBD\_SSB}$ for FR1

Configuration	$T_{Evaluate\_CBD\_SSB}$ (ms)
non-DRX	max(TBD, ceil([TBD]*P) * T_{SSB})
DRX cycle ≤ 320ms	max(TBD, ceil([TBD]*P*1.5) * max(T_{DRX},T_{SSB}))
DRX cycle > 320ms	ceil([TBD]*P) * T_{DRX}
Note: T_{SSB} is the periodicity of SSB in the set $\overline{q}_1$. T_{DRX} is the DRX cycle length.	

Table 8.5.5.2-2: Evaluation period $T_{Evaluate\_CBD\_out}$ for FR2

Configuration	$T_{Evaluate\_CBD\_SSB}$ (ms)
non-DRX	max(TBD, ceil([TBD]*P*N) * T_{SSB}
DRX cycle ≤ 320ms	max(TBD, ceil([TBD]*P*N*1.5) * max(T_{DRX},T_{SSB})
DRX cycle > 320ms	ceil([TBD]*P*N) * T_{DRX}
Note: T_{SSB} is the periodicity of SSB in the set $\overline{q}_1$. T_{DRX} is the DRX cycle length.	

Editor's Note: FFS whether the evaluation period for candidate beam detection need to be scaled in FR2

8.5.6 Requirements for CSI-RS based candidate beam detection

8.5.6.1 Introduction

The requirements in this section apply for each CSI-RS resource in the set $\overline{q}_1$ configured for a serving cell, provided that the CSI-RS resources configured for candidate beam detection are actually transmitted within UE active DL BWP during the entire evaluation period specified in section 8.5.6.2.

8.5.6.2 Minimum requirement

UE shall be able to evaluate whether the L1-RSRP measured on the configured CSI-RS resource in set $\overline{q}_1$ estimated over the last $T_{Evaluate\_CBD\_CSI-RS}$ [ms] period becomes better than the threshold Q_{in_LR} within $T_{Evaluate\_CBD\_CSI-RS}$ [ms] period.

The value of $T_{Evaluate\_CBD\_CSI-RS}$ is defined in Table 8.5.6.2-1 for FR1.

The value of $T_{Evaluate\_CBD\_CSI-RS}$ is defined in Table 8.5.6.2-2 for FR2 with N=FFS.

Where,

- P=1/(1 – T_{CSI-RS}/MGRP), when in the monitored cell there are measurement gaps configured for intra-frequency, inter-frequency or inter-RAT measurements, which are overlapping with some but not all occasions of the CSI-RS; and

- P=1 when in the monitored cell there are no measurement gaps overlapping with any occasion of the CSI-RS.

The values of M_{CBD} used in Table 8.5.6.2-1 and Table 8.5.6.2-2 are defined as

- M_{CBD} = TBD, if the CSI-RS resource configured the set $\overline{q}_1$ is transmitted with Density = 3.

Table 8.5.6.2-1: Evaluation period $T_{Evaluate\_CBD\_CSI-RS}$ for FR1

Configuration	$T_{Evaluate\_CBD\_CSI-RS}$ (ms)
non-DRX	max(TBD, ceil(M_{CBD} *P) * T_{CSI-RS})
DRX cycle ≤ 320ms	max(TBD, ceil(M_{CBD} *P*N) * max(T_{DRX}, T_{CSI-RS}))
DRX cycle > 320ms	ceil(M_{CBD} *P) *T_{DRX}
Note: T_{CSI-RS} is the periodicity of CSI-RS resource in the set $\overline{q}_1$. T_{DRX} is the DRX cycle length.	

Table 8.5.6.2-2: Evaluation period $T_{Evaluate\_BFD\_CSI-RS}$ for FR2

Configuration	$T_{Evaluate\_CBD\_CSI-RS}$ (ms)
non-DRX	max(TBD, ceil(M_{CBD} *P*N) * T_{CSI-RS})
DRX cycle ≤ 320ms	max(TBD, ceil(M_{CBD} *P*N*1.5) * max(T_{DRX}, T_{CSI-RS}))
DRX cycle > 320ms	ceil(M_{CBD} *P*N) *T_{DRX}
Note: T_{CSI-RS} is the periodicity of CSI-RS resource in the set $\overline{q}_1$. T_{DRX} is the DRX cycle length.	

Editor's Note: FFS whether the evaluation period for candidate beam detection need to be scaled under the following conditions:

UE does not support *simultaneousRxDataSSB-DiffNumerology* [14], and

The CSI-RS resource configured for CBD has different SCS with SSB resource, and

The CSI-RS resource is overlapped with SMTC window or overlapped with SSB resource in the same symbol.

8.5.7 Scheduling availability of UE during beam failure detection

Scheduling availability restrictions when the UE is performing beam failure detection are described in the following clauses.

8.5.7.1 Scheduling availability of UE performing beam failure detection with a same subcarrier spacing as PDSCH/PDCCH on FR1

There are no scheduling restrictions due to beam failure detection performed on SSB configured as BFD-RS with the same SCS as PDSCH/PDCCH in FR1.

8.5.7.2 Scheduling availability of UE performing beam failure detection with a different subcarrier spacing than PDSCH/PDCCH on FR1

For UEs which support *simultaneousRxDataSSB-DiffNumerology* [14] there are no restrictions on scheduling availability due to beam failure detection based on SSB as BFD-RS. For UEs which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to beam failure detection based on SSB configured as BFD-RS.

- The UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on SSB symbols to be measured for beam failure detection.

The following scheduling restrictions apply due to beam failure detection based on CSI-RS as BFD-RS.

- The UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on CSI-RS symbols to be measured for beam failure detection.

When intra-band carrier aggregation in FR1 is configured, the scheduling restrictions apply to all SCells that are aggregated in the same band as the PCell or PSCell. When inter-band carrier aggregation within FR1 is configured, there are no scheduling restrictions on FR1 serving cell(s) configured in other bands than the bands in which PCell or PSCell is configured.

8.5.7.3 Scheduling availability of UE performing beam failure detection on FR2

The following scheduling restriction applies due to beam failure detection on an FR2 PCell and/or PSCell.

- If UE is not provided higher layer parameter *failureDetectionResources* and UE is provided by higher layer parameter *TCI-state* for PDCCH SSB/CSI-RS that has QCL-Type D, or if the SSB/CSI-RS for BFD is QCL-Type D with DM-RS for PDCCH

  - There are no scheduling restrictions due to beam failure detection performed with same SCS as PDSCH/PDCCH.

- Otherwise

  - The UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on BFD-RS symbols to be measured for beam failure detection, except for RMSI PDCCH/PDSCH and PDCCH/PDSCH which is not required to be received by RRC_CONNECTED mode UE.

When intra-band carrier aggregation is configured, the following scheduling restrictions apply to all SCells configured in the same band as the PCell and/or PSCell on which beam failure is detected.

- For the case where no RSs are provided for BFD, or where BFD-RS is explicitly configured and is QCLed with active TCI state for PDCCH/PDSCH
  - There are no scheduling restrictions due to beam failure detection performed with a same SCS as PDSCH/PDCCH.
  - When performing beam failure detection with a different SCS than PDSCH/PDCCH, for UEs which support *simultaneousRxDataSSB-DiffNumerology* [14] there are no restrictions on scheduling availability due to beam failure detection. For UEs which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on SSB symbols to be measured for beam failure detection.
- For the case where BFD-RS is explicitly configured and is not QCLed with active TCI state for PDCCH/PDSCH
  - The UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on BFD-RS symbols to be measured for beam failure detection.

Editor's Note: FFS scheduling restrictions for inter-band carrier aggregation will be defined depending on band combination in future.

8.5.7.4 Scheduling availability of UE performing beam failure detection on FR1 or FR2 in case of FR1-FR2 inter-band CA

There are no scheduling restrictions on FR1 serving cell(s) due to beam failure detection performed on FR2 serving PCell and/or PSCell.

There are no scheduling restrictions on FR2 serving cell(s) due to beam failure detection performed on FR1 serving PCell and/or PSCell.

8.6 Active BWP switch delay

8.6.1 Introduction

The requirements in this section apply for a UE configured with more than one BWP on PCell or any activated SCell in standalone NR, or PSCell or any activated SCell in SCG in EN-DC. UE shall complete the switch of active DL and/or UL BWP within the delay defined in this section.

8.6.2 UE active BWP switch delay

For DCI-based BWP switch, after the UE receives BWP switching request at slot n on a serving cell, UE shall be able to receive PDSCH (for DL active BWP switch) or transmit PUSCH (for UL active BWP switch) on the new BWP on the serving cell on which BWP switch occurs no later than at slot n+Y.

For timer-based BWP switch, the UE shall start BWP switch at slot n, where n is the beginning of a subframe (FR1) or half-subframe (FR2) immediately after a BWP-inactivity timer expires on a serving cell, and the UE shall be able to receive PDSCH (for DL active BWP switch) or transmit PUSCH (for UL active BWP switch) on the new BWP on the serving cell on which BWP switch occurs no later than at slot n+Y.

The UE is not required to transmit UL signals or receive DL signals during time duration Y on the cell where DCI-based BWP switch or timer-based BWP switch occurs.

Depending on UE capability, UE shall finish BWP switch within the time duration Y defined in Table 8.6.2-1.

Table 8.6.2-1: BWP switch delay

μ	NR Slot length (ms)	BWP switch delay Y (slots)	
		Type 1[Note 1]	Type 2[Note 1]
0	1	TBD	[3]
1	0.5	TBD	[5]
2	0.25	TBD	[9]
3	0.125	TBD	[17]
Note 1: Depends on UE capability. Note 2: If the BWP switch involves changing of SCS, the BWP switch delay is determined by the larger one between the SCS before BWP switch and the SCS after BWP switch.			

8.7 L1-RSRP Computation for Reporting

8.7.1 Introduction

When a CSI-RS resource or a SSB index is indicated in RRC message *CSI-ReportConfig* with *reportQuantity* set to "cri-RSRP" or "none" by network, the UE shall be able to perform L1-RSRP measurements based on the configured reference signals.

The L1-RSRP compution requirements shall be applied to a SSB resource or a periodic CSI-RS resource only when *reportConfigType* of *CSI-ReportConfig* is set to "periodic".

8.7.2 SSB based L1-RSRP Reporting

The UE shall be capable of performing L1-RSRP measurements based on the configured SSB resource for L1-RSRP computation, and the UE physical layer shall be capable of reporting L1-RSRP measured over the measurement period of $T_{BM\_Measurement\_Period\_SSB}$.

The value of $T_{BM\_Measurement\_Period\_SSB}$ is defined in Table 8.7.2-1 for FR1

The value of $T_{BM\_Measurement\_Period\_SSB}$ is defined in Table 8.7.2-2 for FR2.

Table 8.7.2-1: Evaluation period $T_{BM\_Measurement\_Period\_SSB}$ for FR1

Table 8.7.2-2: Evaluation period $T_{BM\_Measurement\_Period\_SSB}$ for FR2

Editor's Note: FFS how to define the measurement period for SSB based L1-RSRP reporting.

8.7.3 CSI-RS based L1-RSRP Reporting

The UE shall be capable of performing L1-RSRP measurements based on the configured CSI-RS resource for L1-RSRP computation, and the UE physical layer shall be capable of reporting L1-RSRP measured over the measurement period of $T_{BM\_Measurement\_Period\_CSI-RS}$.

The value of $T_{BM\_Measurement\_Period\_CSI-RS}$ is defined in Table 8.7.3-1 for FR1

The value of $T_{BM\_Measurement\_Period\_CSI-RS}$ is defined in Table 8.7.3-2 for FR2.

Table 8.7.3-1: Evaluation period $T_{BM\_Measurement\_Period\_CSI-RS}$ for FR1

Table 8.7.3-2: Evaluation period $T_{BM\_Measurement\_Period\_CSI-RS}$ for FR2

Editor's Note: FFS how to define the measurement period for CSI-RS based L1-RSRP reporting.

9 Measurement Procedure

9.1 General measurement requirement

9.1.1 Introduction

This clause contains general requirements on the UE regarding measurement reporting in RRC_CONNECTED state. The requirements are split in intra-frequency, inter-frequency, inter-RAT E-UTRAN FDD, and inter-RAT E-UTRAN TDD requirements. These measurements may be used by the NG-RAN. The measurement quantities are defined in TS38.215[4], the measurement model is defined in TS38.300[10], TS37.340[17] and measurement accuracies are specified in clause 10. Control of measurement reporting is specified in [16].

9.1.2 Measurement gap

If the UE requires measurement gaps to identify and measure intra-frequency cells and/or inter-frequency cells and/or inter-RAT E-UTRAN cells, and the UE does not support independent measurement gap patterns for different frequency ranges as specified in Table 5.1-1 in [18, 19, 20], in order for the requirements in the following subsections to apply the network must provide a single per-UE measurement gap pattern for concurrent monitoring of all frequency layers.

If the UE requires measurement gaps to identify and measure intra-frequency cells and/or inter-frequency cells and/or inter-RAT E-UTRAN cells, and the UE supports independent measurement gap patterns for different frequency ranges as specified in Table 5.1-1 in [18, 19, 20], in order for the requirements in the following subsections to apply the network must provide either per-FR measurement gap patterns for frequency range where UE requires per-FR measurement gap for concurrent monitoring of all frequency layers of each frequency range independently, or a single per-UE measurement gap pattern for concurrent monitoring of all frequency layers of all frequency ranges.

During the per-UE measurement gaps the UE:

- is not required to conduct reception/transmission from/to the corresponding E-UTRAN PCell, E-UTRAN SCell(s) and NR serving cells for NSA except the reception of signals used for RRM measurement
- is not required to conduct reception/transimssion from/to the corresponding NR serving cells for SA except the reception of signals used for RRM measurement

During the per-FR measurement gaps the UE:

- is not required to conduct reception/transmission from/to the corresponding E-UTRAN PCell, E-UTRAN SCell(s) and NR serving cells in the corresponding frequency range for NSA except the reception of signals used for RRM measurement
- is not required to conduct reception/transmission from/to the corresponding NR serving cells in the corresponding frequency range for SA except the reception of signals used for RRM measurement

UEs shall support the measurement gap patterns listed in Table 9.1.2-1 based on the applicability specified in table 9.1.2-2 and 9.1.2-3. UE determines measurement gap timing based on gap offset configuration and measurement gap timing advance configuration provided by higher layer signalling as specified in [2] and [16].

Table 9.1.2-1: Gap Pattern Configurations

Gap Pattern Id	Measurement Gap Length (MGL, ms)	Measurement Gap Repetition Period (MGRP, ms)
0	6	40
1	6	80
2	3	40
3	3	80
4	6	20
5	6	160
6	4	20
7	4	40
8	4	80
9	4	160
10	3	20
11	3	160
12	5.5	20
13	5.5	40
14	5.5	80
15	5.5	160
16	3.5	20
17	3.5	40
18	3.5	80
19	3.5	160
20	1.5	20
21	1.5	40
22	1.5	80
23	1.5	160

Table 9.1.2-2: Applicability for Gap Pattern Configurations supported by the E-UTRA-NR dual connectivity UE

Measurement gap pattern configuration	Serving cell	Measurement Purpose	Applicable Gap Pattern Id
		non-NR RAT Note1,2	0,1,2,3
		FR1 and/or FR2	0-11

Per-UE measurement gap	E-UTRA + FR1, or E-UTRA + FR2, or E-UTRA + FR1 + FR2	non-NR RAT [Note1,2] and FR1 and/or FR2	0,1,2,3
Per FR measurement gap	E-UTRA and, FR1 if configured	non-NR RAT [Note1,2]	0,1,2,3
	FR2 if configured		No gap
	E-UTRA and, FR1 if configured	FR1 only	0-11
	FR2 if configured		No gap
	E-UTRA and, FR1 if configured	FR2 only	No gap
	FR2 if configured		12-23
	E-UTRA and, FR1 if configured	non-NR RAT [Note1,2] and FR1	0,1,2,3
	FR2 if configured		No gap
	E-UTRA and, FR1 if configured	FR1 and FR2	0-11
	FR2 if configured		12-23
	E-UTRA and, FR1 if configured	non-NR RAT [Note1,2] and FR2	0,1,2,3
	FR2 if configured		12-23
	E-UTRA and, FR1 if configured	non-NR RAT [Note1,2] and FR1 and FR2	0,1,2,3
	FR2 if configured		12-23

Note: if GSM or UTRA TDD or UTRA FDD inter-RAT frequency layer is configured to be monitered, only measurement gap pattern #0 and #1 can be used for per-FR gap in E-UTRA and FR1 if configured, or for per-UE gap.

NOTE 1: Non-NR RAT includes E-UTRA, UTRA and/or GSM.

NOTE 2: The gap pattern 2 and 3 are supported by UEs which support shortMeasurementGap-r14.

NOTE 3: When E-UTRA inter-frequency RSTD measurements are configured and the UE requires measurement gaps for performing such measurements, only Gap Pattern #0 can be used.

NOTE4: If per-UE measurement gap is configured with MG timing advance of 0ms, a measurement gap starts at the end of the latest LTE subframe occurring immediately before the measurement gap among MCG serving cells subframes. If per-FR measurenet gap for FR1 is configured with MG timing advance of 0ms, this measurement gap for FR1 starts at the end of the latest LTE subframe occurring immediately before the measurement gap among MCG serving cells subframes in FR1. If per-FR measurenet gap for FR2 is configured with MG timing advance of 0ms, this measurement gap for FR2 starts at [FFS]. Measurement gap starting point is [FFS] if MG timing advance is 0.5ms or 0.25ms

For per-FR measurement gap capable UE configured with E-UTRA-NR dual connectivity, when serving cells are in E-UTRA and FR1, measurement objects are in both E-UTRA /FR1 and FR2,

- If MN indicates UE that the measurement gap from MN applies to E-UTRA/FR1/FR2 serving cells, UE fulfils the per-UE measurement requirements for both E-UTRA/FR1 and FR2 measurement objects based on the measurement gap pattern configured by MN;
- If MN indicates UE that the measurement gap from MN applies to only LTE/FR1 serving cell(s),
  - UE fulfils the measurement requirements for FR1/LTE measurement objects based on the configured measurement gap pattern;
  - UE fulfils the requirements for FR2 measurement objects based on effective MGRP=20ms;

For per-FR measurement gap capable UE, when serving cells are in E-UTRA, FR1 and FR2, or in E-UTRA and FR2, measurement objects are in both E-UTRA /FR1 and FR2,

- If MN indicates UE that the measurement gap from MN applies to E-UTRA/FR1/FR2 serving cells, UE fulfils the per-UE measurement requirements for both E-UTRA/FR1 and FR2 measurement objects based on the measurement gap pattern configured by MN.

Table 9.1.2-3: Applicability for Gap Pattern Configurations supported by the UE with NR standalone operation

Measurement gap pattern configuration	Serving cell	Measurement Purpose NOTE 2	Applicable Gap Pattern Id
Per-UE measurement gap	FR1, or FR1 + FR2	E-UTRA only NOTE3	0,1,2,3
		FR1 and/or FR2	0-11
		E-UTRAN and FR1 and/or FR2 NOTE3	0,1,2,3
	FR2	E-UTRA only NOTE3	0,1,2,3
		FR1 only	0-11
		FR1 and FR2	0-11
		E-UTRAN and FR1 and/or FR2 NOTE3	0,1,2,3
		FR2 only	12-23
Per FR measurement gap	FR1 if configured	E-UTRA only NOTE3	0,1,2,3
	FR2 if configured		No gap
	FR1 if configured	FR1 only	0-11
	FR2 if configured		No gap
	FR1 if configured	FR2 only	No gap
	FR2 if configured		12-23
	FR1 if configured	E-UTRA and FR1 NOTE3	0,1,2,3
	FR2 if configured		No gap
	FR1 if configured	FR1 and FR2	0-11
	FR2 if configured		12-23
	FR1 if configured	E-UTRA and FR2 NOTE3	0,1,2,3
	FR2 if configured		12-23
	FR1 if configured	E-UTRA and FR1 and FR2 NOTE3	0,1,2,3
	FR2 if configured		12-23
NOTE 1: When E-UTRA inter-RAT RSTD measurements are configured and the UE requires measurement gaps for performing such measurements, only Gap Pattern #0 can be used. NOTE 2: Measurement purpose which includes E-UTRA measurements includes also inter-RAT E-UTRA RSRP and RSRQ measurements for E-CID NOTE 3: Editor's note: a note to be added in Table 9.1.2-3 on that measurement gap patterns #2 and #3 are supported only by the UEs which have a corresponding capability of short measurement gap once RAN2 specifies the capability. NOTE4: Starting point of measurement gap for SA is [FFS].			

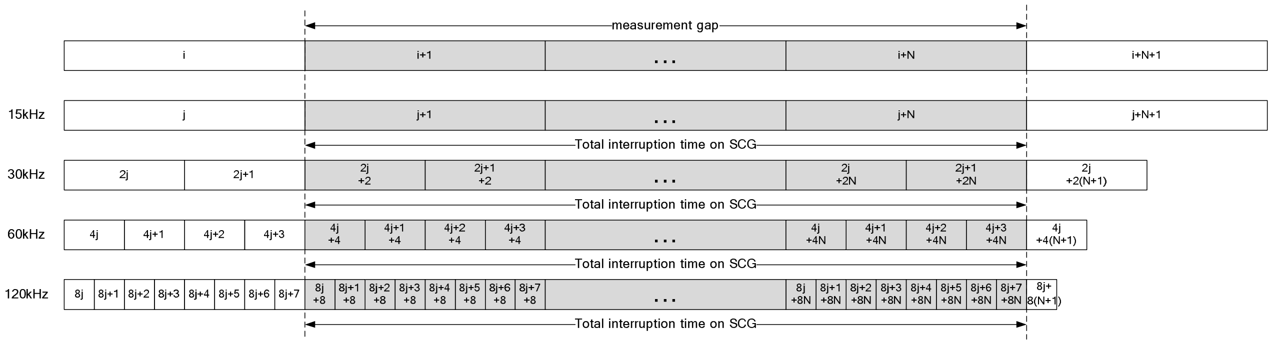
For per-FR measurement gap capable UE in NR standalone operation, for per-FR gap based measurement,when there is no serving cell in a particular FR, where measurements objects are configured, regardless if explicit per-FR measurement gap is configured in this FR, the effective MGRP in this FR used to determine requirements;

- 20ms for FR2 NR measurements
- 40ms for FR1 NR measurements
- 40ms for LTE measurements
- 40ms for FR1+LTE measurements

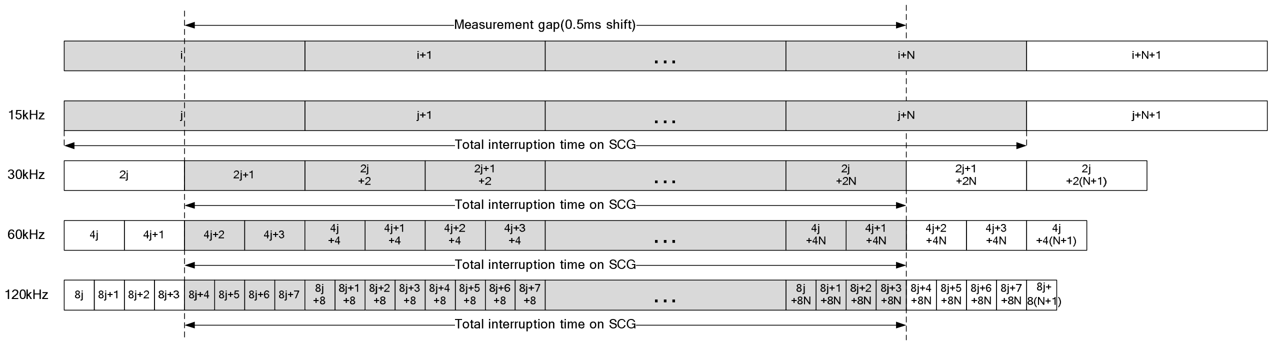
If measurement gap is configured in one FR but measurement object is not configured in the FR, the scheduling opportunity in the FR depends on the configured measurement gap pattern.

For E-UTRA-NR dual connectivity, if UE is not capable of per-FR-gap, total interruption time on SCG during MGL is defined only when MGL(N) = 6ms, 4ms and 3ms. And if UE is capable of per-FR-gap, total interruption time on FR1 serving cells in SCG during MGL is defined only when MGL(N) = 6ms, 4ms and 3ms, and total interruption time on FR2 serving cells in SCG during MGL is defined only when MGL(N) = 5.5ms, 3.5ms and 1.5ms, given that the reference time for per-FR gap in FR2 is based on an FR2 serving cell.

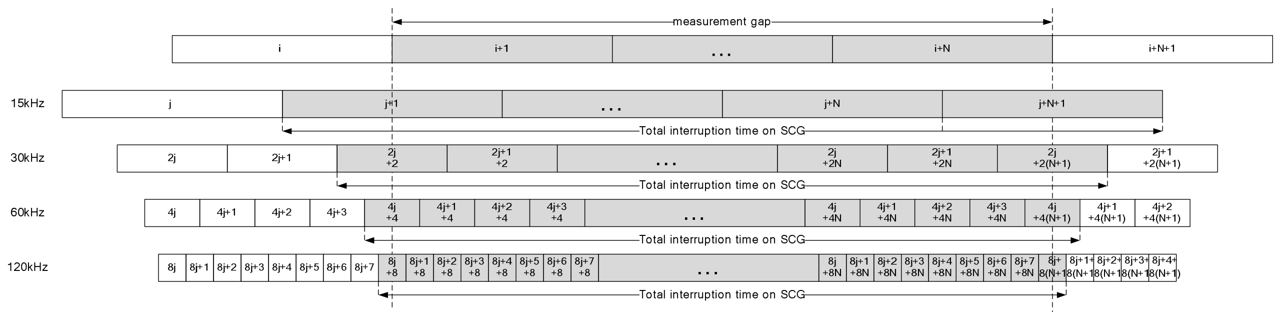
For NR standalone, if UE is not capable of per-FR-gap, total interruption time on a serving cell during MGL is defined only when MGL(N) = 6ms, 4ms and 3ms. And if UE is capable of per-FR-gap, total interruption time on FR1 serving cells during MGL is defined only when MGL(N) = 6ms, 4ms and 3ms, and total interruption time on FR2 serving cells during MGL is defined only when MGL(N) = 5.5ms, 3.5ms and 1.5ms, given that the reference time for per-FR gap in FR2 is based on an FR2 serving cell.



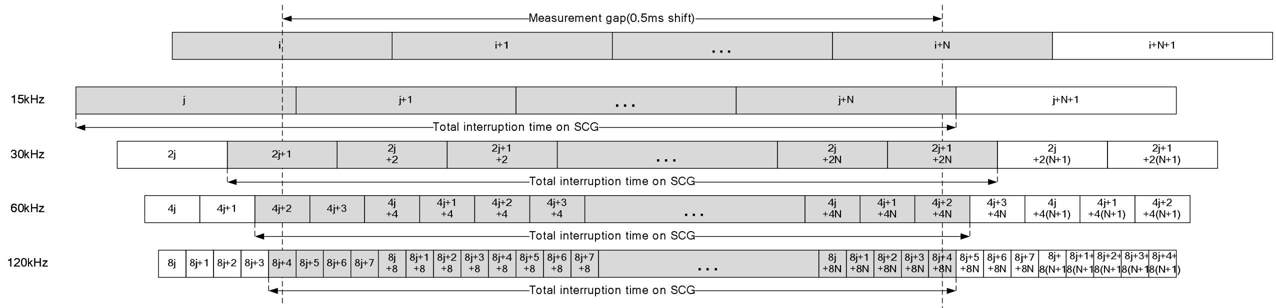
(a) Measurement gap with MGL = N(ms) with MG timing advance of 0ms for synchronous EN-DC and NR carrier aggregation



(b) Measurement gap with MGL = N(ms) with MG timing advance of 0.5ms for synchronous EN-DC



(c) Measurement gap with MGL = N(ms) with MG timing advance of 0ms for asynchronous EN-DC and NR carrier aggregation



(d) Measurement gap with MGL = N(ms) with MG timing advance of 0.5ms for asynchronous EN-DC

Figure 9.1.2-1: Measurement GAP and total interruption time on serving cells for EN-DC and NR carrier aggregation

The corresponding total number of interrupted slots on serving cells during MGL is listed in Table9.1.2-4 and Table9.1.2-4a for synchronous EN-DC and NR carrier aggregation, and asynchronous EN-DC respectively.

Table 9.1.2-4: Total number of interrupted slots on serving cells during MGL for Synchronous EN-DC and NR carrier aggregation with per-UE measurement gap or per-FR measurement gap for FR1

NR SCS (kHz)	Total number of interrupted slots on serving cells					
	When MG timing advance of 0ms is applied			When MG timing advance of 0.5ms is applied		
	MGL=6ms	MGL=4ms	MGL=3ms	MGL=6ms	MGL=4ms	MGL=3ms
15	6	4	3	7	5	4
30	12	8	6	12	8	6
60	24	16	12	24	16	12
120	48	32	24	48	32	24
NOTE 1: For Gap Pattern ID 0, 1, 2 and 3, total number of interrupted subframes on MCG is MGL subframes when MG timing advance of 0ms is applied, and (MGL+1) subframes when MG timing advance of 0.5ms is applied. NOTE 2: NR SCS of 120 kHz is only applicable to the case with per-UE measurement gap.						

Table 9.1.2-4a: Total number of interrupted slots on serving cells during MGL for Asynchronous EN-DC with per-UE measurement gap or per-FR measurement gap for FR1

NR SCS (kHz)	Total number of interrupted slots on serving cells					
	When MG timing advance of 0ms is applied			When MG timing advance of 0.5ms is applied		
	MGL=6ms	MGL=4ms	MGL=3ms	MGL=6ms	MGL=4ms	MGL=3ms
15	7	5	4	7	5	4
30	13	9	7	13	9	7
60	25	17	13	25	17	13
120	49	33	25	49	33	25
NOTE 1: For Gap Pattern ID 0, 1, 2 and 3, total number of interrupted subframes on MCG is MGL subframes when MG timing advance of 0ms is applied, and (MGL+1) subframes when MG timing advance of 0.5ms is applied. NOTE 2: NR SCS of 120 kHz is only applicable to the case with per-UE measurement gap.						

In case that UE capable of per-FR measurement gap is configured with per-FR measurement gap for FR2 serving cells, total number of interrupted slots on FR2 serving cells during MGL is listed in Table9.1.2-4b.

Table 9.1.2-4b: Total number of interrupted slots on FR2 serving cells during MGL for EN-DC and NR carrier aggregation with per-FR measurement gap for FR2

NR SCS (kHz)	Total number of interrupted slots on FR2 serving cells					
	When MG timing advance of 0ms is applied			When MG timing advance of 0.25ms is applied		
	MGL=5.5ms	MGL=3.5ms	MGL=1.5ms	MGL=5.5ms	MGL=3.5ms	MGL=1.5ms
60	22	14	6	22	14	6
120	44	28	12	44	28	12

Measurement gap sharing shall be applies when UE requires measurement gaps to identify and measure intra-frequency cells or when SMTC configured for intra-frequency measurement are fully overlapping with measurement gaps, and when UE is configured to identify and measure cells on inter-frequency carriers and inter-RAT carriers.When network signals “01”, “10” or “11”, where X is a signalled RRC parameter TBD and is defined as in Table 9.1.2-5,

- the performance of intra-frequency measurements with no measurement gaps as specified in section 9.2.5, when SMTC configured for intra-frequency measurement are fully overlapping with measurement gaps, shall consider the factor $K_{intra} = 1 / X * 100$,

- the performance of intra-frequency measurements with measurement gaps as specified in section 9.2.6 shall consider the factor $K_{intra} = 1 / X * 100$,

- the performance of inter-frequency measurement as specified in section 9.3 and the performance of inter-RAT measurement as specified in section 9.4 shall consider the factor $K_{inter} = 1 / (100 – X) * 100$,

When network signals "00" indicating equal splitting gap sharing, X is not applied and the performance of intra-frequency measurements as specified in section 9.2.5 and section 9.2.6, the performance of inter-frequency measurement as specified in section 9.3 and the performance of inter-RAT measurement as specified in section 9.4 are FFS.

Table 9.1.2-5: Value of parameter X

Network signaling ParameterName (to be determined by RAN2)	Value of X (%)
'00'	Equal splitting
'01'	25
'10'	50
'11'	75

9.1.3 UE Measurement capability

9.1.3.1 NSA: Monitoring of multiple layers using gaps

The requirements in this section are applicable for UE capable of E-UTRA-NR dual connectivity operation with E-UTRA PCell.

When monitoring of multiple inter-frequency E-UTRAN, inter-RAT NR, GSM, UTRA FDD and UTRA TDD carriers as configured by E-UTRA PCell, and inter-frequency NR carriers as configured by PSCell using gaps (or without using gaps provided the UE supports such capability) is configured, the UE shall be capable of performing one measurement of the configured measurement type (SS-RSRP, SS-RSRQ, SS-SINR, SFTD, E-UTRAN RSRP, E-UTRAN RSRQ, E-UTRAN RS-SINR measurements, UTRAN TDD P-CCPCH RSCP, UTRAN FDD CPICH measurements, GSM carrier RSSI, etc.) of detected cells on all the layers.

For UE configured with the E-UTRA-NR dual connectivity operation, the effective total number of frequencies excluding the frequencies of the PSCell, SCells, E-UTRA PCell, and E-UTRA SCells being monitored is $N_{freq, NSA}$, which is defined as:

$N_{freq, NSA} = N_{freq, NSA, NR} + N_{freq, NSA, E-UTRA} + N_{freq, NSA, UTRA} + M_{NSA, GSM}$,

where

$N_{freq, NSA, E-UTRA}$ is the number of E-UTRA inter-frequency carriers being monitored (FDD and TDD) as configured by E-UTRA PCell or via LPP [22].

$N_{freq, NSA, NR} \leq N_{freq, NSA, NR, inter-RAT} + N_{freq, NSA, NR, inter-freq}$

where

$N_{freq, NSA, NR, inter-RAT}$ is the number of NR inter-RAT carriers excluding NR serving carrier(s) being monitored as configured by E-UTRA PCell [15]

$N_{freq, NSA, NR, inter-freq}$ is the number of NR inter-frequency carriers being monitored as configured by PSCell

$N_{freq, NSA, UTRA}$ is the number of UTRA inter-RAT carriers being monitored as configured by E-UTRA PCell (FDD and TDD)

$M_{NSA, GSM}$ is an integer which is a function of the number of GSM inter-RAT carriers as configured by E-UTRA PCell on which measurements are being performed. $M_{NSA, GSM}$ is equal to 0 if no GSM carrier is being monitored. For a MGRP of 40 ms, $M_{NSA, GSM}$ is equal to 1 if cells on up to 32 GSM carriers are being measured. For a MGRP of 80 ms, $M_{NSA, GSM}$ is equal to ceil($N_{carriers,GSM}$ /20) where $N_{carriers,GSM}$ is the number of GSM carriers on which cells are being measured.

9.1.3.1a SA: Monitoring of multiple layers using gaps

The requirements in this section are applicable for UE configured with at least a PCell.

When monitoring of multiple inter-RAT E-UTRAN carriers and inter-frequency NR carriers using gaps (or without using gaps provided the UE supports such capability) is configured by PCell, the UE shall be capable of performing one measurement of the configured measurement type (SS-RSRP, SS-RSRQ, SS-SINR, E-UTRAN RSRP, E-UTRAN RSRQ, E-UTRAN RS-SINR measurements, etc.) of detected cells on all the layers.

For UE configured with the NR SA operation, the effective total number of frequencies, excluding the frequencies of the PCell, PSCell and SCells being monitored, is $N_{freq, SA}$, which is defined as:

$N_{freq, SA} = N_{freq, SA, NR} + N_{freq, SA, E\text{-}UTRA}$,

where

$N_{freq, SA, E\text{-}UTRA}$ is the number of E-UTRA inter-RAT carriers being monitored (FDD and TDD) as configured by PCell or via LPP [22].

$N_{freq, SA, NR}$ is the number of NR inter-frequency carriers being monitored as configured by PCell.

9.1.3.2 NSA: Maximum allowed layers for multiple monitoring

If a UE is configured with E-UTRA-NR dual connectivity operation, the UE shall be capable of monitoring at least:

- Depending on UE capability, 7 NR inter-frequency carriers configured by PScell, and
- Depending on UE capability, 7 NR inter-RAT carriers excluding NR serving carrier(s) configured by E-UTRA PCell [15], and
- Depending on UE capability, 6 E-UTRA TDD inter-frequency carriers configured by E-UTRA PCell [15], and
- Depending on UE capability, 6 E-UTRA FDD inter-frequency carriers configured by E-UTRA PCell [15], and
- Depending on UE capability, 3 FDD UTRA carriers, and
- Depending on UE capability, 3 TDD UTRA carriers, and
- Depending on UE capability, 32 GSM carriers (one GSM layer corresponds to 32 carriers), and
- Depending on UE capability, 1 E-UTRA FDD inter-frequency carrier for RSTD measurements configured via LPP [22], and
- Depending on UE capability, 1 E-UTRA TDD inter-frequency carrier for RSTD measurements configured via LPP [22].

In addition to the requirements defined above, the UE shall be capable of monitoring a total of at least 13 effective carrier frequency layers comprising of any above defined combination of NR, E-UTRA FDD, E-UTRA TDD, UTRA FDD, UTRA TDD and GSM (one GSM layer corresponds to 32 carriers) layers. The UE shall be capable of monitoring a total of at least 7 effective NR carrier frequency layers excluding NR serving carrier(s), comprising of any above defined combination of NR inter-RAT carriers excluding NR serving carrier(s) configured by E-UTRA PCell and NR inter-frequency carriers configured by PSCell.

When the E-UTRA PCell and PSCell configure the same NR carrier frequency layer to be monitored by the UE in synchronous intra-band EN-DC, this layer shall be counted only once to the total number of effective carrier frequency layers provided that the SFN-s and slot boundries are aligned, unless the configured NR carrier frequency layers to be monitored have

- different subcarrier spacing or
- different RSSI measurement resources or
- different deriveSSB-IndexFromCell indications or
- different SMTC configurations.

Editor's note: FFS when MN and SN are inter-band and synchronous.

Note 1: The E-UTRA-NR dual connectivity capable UE configured with PSCell shall fulfil the requirements defined in only one of Section 9.1.3.2 and Section 8.1.2.1.1b.1 of [15].

NOTE 2: Void

Editor's note: FFS when the E-UTRA PCell and PSCell configure the same NR carrier frequency layer to be monitored, whether this layer shall be counted only once under the condition that the UE is configured with differences in SMTC configurations or different useServingCellTimingForSync indications.

9.1.3.2a SA: Maximum allowed layers for multiple monitoring

If a UE is configured with at least a PCell, the UE shall be capable of monitoring at least:

- Depending on UE capability, 7 NR inter-frequency carriers configured by PCell, and
- Depending on UE capability, 7 E-UTRA TDD inter-RAT carriers configured by PCell, and
- Depending on UE capability, 7 E-UTRA FDD inter-RAT carriers configured by PCell, and
- Depending on UE capability, 1 E-UTRA FDD inter-RAT carrier for RSTD measurements configured via LPP [22], and
- Depending on UE capability, 1 E-UTRA TDD inter-RAT carrier for RSTD measurements configured via LPP [22].

In addition to the requirements defined above, the UE shall be capable of monitoring a total of at least [13] effective carrier frequency layers comprising of any above defined combination of NR, E-UTRA FDD and E-UTRA TDD layers.

9.1.4 Capabilities for Support of Event Triggering and Reporting Criteria

9.1.4.1 Introduction

This clause contains requirements on UE capabilities for support of event triggering and reporting criteria. As long as the measurement configuration does not exceed the requirements stated in Section 9.1.4.2, the UE shall meet all other performance requirements defined in Section 9 and Section 10.

The UE can be requested to make measurements under different measurement identities defined in TS 38.331 [2]. Each measurement identity corresponds to either event based reporting, periodic reporting, or no reporting. In case of event based reporting, each measurement identity is associated with an event triggering criterion. In case of periodic reporting, a measurement identity is associated with one periodic reporting criterion. In case of no reporting, a measurement identity is associated with one no reporting criterion.

The purpose of this clause is to set some limits on the number of different event triggering, periodic, and no reporting criteria the UE may be requested to track in parallel.

9.1.4.2 Requirements

In this section a reporting criterion corresponds to either one event (in the case of event based reporting), or one periodic reporting criterion (in case of periodic reporting), or one no reporting criterion (in case of no reporting). For event based reporting, each instance of event, with the same or different event identities, is counted as separate reporting criterion in Table 9.1.4.2-1.

The UE shall be able to support in parallel per category up to E_{cat} reporting criteria according to Table 9.1.4.2-1. For the measurement categories belonging to intra-frequency, inter-frequency, and inter-RAT measurements (i.e. without counting other categories that the UE shall always support in parallel), the UE need not support more than the total number of reporting criteria as follows:

- For UE configured with EN-DC: $E_{cat,NSA,NR} + E_{cat,NSA,E-UTRA}$, where

  $E_{cat,NSA,NR} = 10 + 9 \times n$ is the total number of NR reporting criteriaapplicable for UE configured with EN-DC according to Table 9.1.4.2-1, and n is the number of configured NR serving frequencies, including PSCell and SCells carrier frequencies,

$E_{cat,NSA,E-UTRA}$ is the total number of reporting criteria for E-UTRA PCell as specified in TS 36.133 [15] for UE configured with EN-DC,

- For UE not configured of EN-DC: $E_{cat,SA,NR} + E_{cat,SA,E-UTRA}$, where

  $E_{cat,SA,NR} = 10 + 9 \times n$ is the total number of NR reporting criteria according to Table 9.1.4.2-1, and n is the number of configured NR serving frequencies, including PCell and SCells carrier frequencies,

  $E_{cat,SA,E-UTRA}$ is the total number of E-UTRA inter-RAT reporting criteria according to Table 9.1.4.2-1.

Table 9.1.4.2-1: Requirements for reporting criteria per measurement category

Measurement category	E_{cat}	Note
Intra-frequency Note 1	9	Events for any one or a combination of intra-frequency SS-RSRP, SS-RSRQ, and SS-SINR for NG-RAN intra-frequency cells
Inter-frequency	10	Events for any one or a combination of inter-frequency SS-RSRP, SS-RSRQ, and SS-SINR for NG-RAN inter-frequency cells
Inter-RAT (E-UTRA FDD, E-UTRA TDD)	10	Only applicable for UE with this (inter-RAT) capability when the UE is not configured with EN-DC operation.
Inter-RAT (E-UTRA FDD, E-UTRA TDD) RSTD	1	Inter-RAT RSTD measurement reporting for UE supporting OTDOA; 1 report capable of minimum 16 inter-RAT cell measurements. Only applicable for UE with this (inter-RAT RSTD via LPP [22]) capability and when the UE is not configured with EN-DC operation.
Inter-RAT (E-UTRA FDD, E-UTRA TDD) RSRP and RSRQ measurements for E-CID	1	Inter-RAT RSRP and RSRQ measurements for E-CID reported to E-SMLC via LPP [22]. One report capable of at least in total 10 inter-RAT RSRP and RSRQ measurements. Applicable to UE capable of reporting inter-RAT RSRP and RSRQ to E-SMLC via LPP and when the UE is not configured with EN-DC operation.
NOTE 1: When the UE is configured with PSCell and SCell carrier frequencies, E_{cat} for Intra-frequency is applied per serving frequency.		

9.2 NR intra-frequency measurements

9.2.1 Introduction

A measurement is defined as a SSB based intra-frequency measurement provided the centre frequency of the SSB of the serving cell indicated for measurement and the centre frequency of the SSB of the neighbour cell are the same, and the subcarrier spacing of the two SSB are also the same.

The UE shall be able to identify new intra-frequency cells and perform SS-RSRP, SS-RSRQ, and SS-SINR measurements of identified intra-frequency cells if carrier frequency information is provided by PCell or the PSCell, even if no explicit neighbour list with physical layer cell identities is provided.

The UE can perform intra-frequency SSB based measurements without measurement gaps if

- the SSB is completely contained in the active BWP of the UE, or
- the active downlink BWP is initial BWP[3].

For intra-frequency SSB based measurements without measurement gaps, UE may cause scheduling restriction as specified in section 9.2.5.3.

SSB based measurements are configured along with one or two measurement timing configuration(s) (SMTC) which provides periodicity, duration and offset information on a window of up to 5ms where the measurements are to be performed. For intra-frequency connected mode measurements, up to two measurement window periodicities may be configured. A single measurement window offset and measurement duration are configured per intra-frequency measurement object.

When measurement gaps are needed, the UE is not expected to detect SSB which start earlier than the gap starting time + switching time, nor detect SSB which end later than the gap end – switching time. Switching time is 0.5ms for frequency range FR1 and 0.25ms for frequency range FR2.

9.2.2 Requirements applicability

The requirements in Section 9.2 apply, provided:

- The cell being identified or measured is detectable.

An intra-frequency cell shall be considered detectable when for each relevant SSB:

- SS-RSRP related side conditions given in Sections 10.1.2 and 10.1.3 for FR1 and FR2, respectively, for a corresponding Band,
- SS-RSRQ related side conditions given in Sections 10.1.7 and 10.1.8 for FR1 and FR2, respectively, for a corresponding Band,
- SS-SINR related side conditions given in Sections 10.1.12 and 10.1.13 for FR1 and FR2, respectively, for a corresponding Band,
- SSB_RP and SSB Ês/Iot according to Annex B.2.2 for a corresponding Band.

9.2.3 Number of cells and number of SSB

9.2.3.1 Requirements for FR1

For each intra-frequency layer, the UE shall be capable of monitoring at least 8 cells.

For each intra-frequency layer, during each layer 1 measurement period, the UE shall be capable of monitoring at least [14] SSBs with different SSB index and/or PCI on the intra-frequency layer, where the number of SSBs in the serving cell (except for the SCell) is no smaller than the number of configured RLM-RS SSB resources.

9.2.3.2 Requirements for FR2

For each intra-frequency layer the UE shall be capable of monitoring at least 6 cells on a single serving carrier (PCC or PSCC or 1 SCC if PCC/PSCC is in a band different from SCC) out of all the serving carriers configured in the same band.

For each intra-frequency layer, during each layer 1 measurement period, the UE shall be capable of monitoring at least 24 SSB with different SSB index and/or PCI on a single serving carrier (PCC or PSCC or 1 SCC if PCC/PSCC is in a band different from SCC) out of all the serving carriers configured in the same band. UE shall be capable of monitoring 2 SSB(s) on serving cell for each of the other serving carrier(s) in the same band. UE shall be capable of performing SS-RSRP, SS-RSRQ, and SS-SINR on all above-mentioned SSBs

9.2.4 Measurement Reporting Requirements

9.2.4.1 Periodic Reporting

Reported RSRP, RSRQ, and RS-SINR measurements contained in periodically triggered measurement reports shall meet the requirements in sections 10.x,10.y and 10.z, respectively.

9.2.4.2 Event-triggered Periodic Reporting

Reported RSRP, RSRQ, and RS-SINR measurements contained in periodically triggered measurement reports shall meet the requirements in sections 10.x,10.y and 10.z, respectively.

The first report in event triggered periodic measurement reporting shall meet the requirements specified in clause 9.2.4.3.

9.2.4.3 Event Triggered Reporting

Reported RSRP, RSRQ, and RS-SINR measurements contained in periodically triggered measurement reports shall meet the requirements in sections 10.x,10.y and 10.z, respectively.

The UE shall not send any event triggered measurement reports, as long as no reporting criteria are fulfilled.

The measurement reporting delay is defined as the time between an event that will trigger a measurement report and the point when the UE starts to transmit the measurement report over the air interface. This requirement assumes that the measurement report is not delayed by other RRC signalling on the DCCH. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the TTI of the uplink DCCH. The delay uncertainty is: 2 x TTI_{DCCH}.This measurement reporting delay excludes a delay which caused by no UL resoureces for UE to send the measurement report.

The event triggered measurement reporting delay, measured without L3 filtering shall be less than $T_{\text{identify intra with index}}$ or $T_{\text{identify intra without index}}$ defined in clause 9.2.5.1 or clause 9.2.6.2. When L3 filtering is used an additional delay can be expected.

If a cell which has been detectable at least for the time period than $T_{\text{identify intra without index}}$ or $T_{\text{identify intra with index}}$ defined in clause 9.2.5.1 or clause 9.2.6.2 becomes undetectable for a period ≤ TBD seconds and then the cell becomes detectable again and triggers an event, the event triggered measurement reporting delay shall be less than $T_{\text{Measurement\_Period, Intra}}$ provided the timing to that cell has not changed more than ± TBD Ts and the L3 filter has not been used. When L3 filtering is used, an additional delay can be expected.

9.2.5 Intrafrequency measurements with no measurement gaps

9.2.5.1 Intrafrequency cell identification

Editor's Note :The requirements below have been derived without considering gap sharing when all SMTC occasion are fully overlapping with measurement gaps.

The UE shall be able to identify a new detectable intra frequency cell within $T_{\text{identify\_intra\_without\_index}}$ if UE is not indicated to report SSB based RRM measurement result with the associated SSB index, or the UE has been indicated that the neighbour cell is synchronous with the serving cell. Otherwise UE shall be able to identify a new detectable intra frequency cell within $T_{\text{identify\_intra\_with\_index}}$. The UE shall be able to identify a new detectable intra frequency SS block of an already detected cell within $T_{\text{identify\_intra\_without\_index}}$. It is assumed that *deriveSSB-IndexFromCell*is always enabled for FR2, and hence the identification time is always $T_{\text{identify\_intra\_without\_index}}$

$$T_{\text{identify\_intra\_without\_index}} = K_{ca}\,(T_{\text{PSS/SSS\_sync\_intra}} + T_{\text{SSB\_measurement\_period\_intra}})\ \text{ms}$$

$$T_{\text{identify\_intra\_with\_index}} = K_{ca}\,(T_{\text{PSS/SSS\_sync\_intra}} + T_{\text{SSB\_measurement\_period\_intra}} + T_{\text{SSB\_time\_index\_intra}})\ \text{ms}$$

Where:

$T_{\text{PSS/SSS\_sync\_intra}}$: it is the time period used in PSS/SSS detection given in table 9.2.5.1-1, 9.2.5.1-2, 9.2.5.1-4 (deactivated Scell) or 9.2.5.1-5 (deactivated SCell)

$T_{\text{SSB\_time\_index\_intra}}$: it is the time period used to acquire the index of the SSB being measured given in table 9.2.5.1-3 or 9.2.5.1-6 (deactivated SCell)

$T_{\text{SSB\_measurement\_period\_intra}}$: equal to a measurement period of SSB based measurement given in table 9.2.5.2-1, table 9.2.5.2-2 table 9.2.5.2-3 (deactivated Scell) or 9.2.5.2-4(deactivated SCell)

K_{ca}: For FR1, K_{ca} =1 for measurements on frequencies corresponding to PCell or PSCell, and K_{ca} =number of configured SCells for measurements on frequencies corresponding to FR1 only SCells

Editor's note : K_{ca} for SCells on FR1 assumes that all Scell SMTC are overlapping(definition FFS). K_{ca} definition may be revised for non overlapping Scell SMTCs.

Editor's note:K_{ca} is FFS if any FR2 serving cells are configured

$M_{\text{pss/sss\_sync\_w/o\_gaps}}$: For a UE supporting power class 1(fixed wireless access), $M_{\text{pss/sss\_sync}}$=40. For a UE supporting power class 2(vehicle mounted), $M_{\text{pss/sss\_sync\_w/o\_gaps}}$ =[24]. For a UE supporting power class 3(handheld), $M_{\text{pss/sss\_sync\_w/o\_gaps}}$ =[24]. For a UE supporting power class 4, $M_{\text{pss/sss\_sync\_w/o\_gaps}}$ =TBD

$M_{meas\_period\_w/o\_gaps}$: For a UE supporting power class 1 (fixed wireless access), $M_{meas\_period\_w/o\_gaps}$ =40. For a UE supporting power class 2 (vehicle mounted), $M_{meas\_period\_w/o\_gaps}$ =[24]. For a UE supporting power class 3 (handheld), $M_{meas\_period\_w/o\_gaps}$ =[24]. For a UE supporting power class 4, $M_{meas\_period\_w/o\_gaps}$ =TBD.

When intrafrequency SMTC is fully non overlapping with measurement gaps, Kp=1

When intrafrequency SMTC is partially overlapping with measurent gaps, Kp = 1/(1- (SMTC period /MGRP)), where SMTC period < MGRP

For FR2 when RLM-RS outside measurement gap is fully overlapping with intra-frequency SMTC, K_{RLM}= 1.5, otherwise K_{RLM}=1.

Editor's note : It is FFS how requirements are defined for the case that SMTC are fully overlapping with measurement gap

Table 9.2.5.1-1: Time period for PSS/SSS detection, (Frequency range FR1)

DRX cycle	T_{PSS/SSS_sync_intra}
No DRX	max[600ms, ceil([5] x K_p) x SMTC period]$^{Note 1}$
DRX cycle≤ 320ms	max[600ms, ceil(1.5x [5] x K_p) x max(SMTC period,DRX cycle)]
DRX cycle>320ms	Ceil([5] x K_p) x DRX cycle
NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified	

Table 9.2.5.1-2: Time period for PSS/SSS detection, (Frequency range FR2)

DRX cycle	T_{PSS/SSS_sync_intra}
No DRX	max[600ms, ceil($M_{pss/sss\_sync\_w/o\_gaps}$ x K_p x K_{RLM}) x SMTC period]$^{Note 1}$
DRX cycle≤ 320ms	max[600ms, ceil(1.5 x $M_{pss/sss\_sync\_w/o\_gaps}$ x K_p x K_{RLM}) x max(SMTC period,DRX cycle)]
DRX cycle>320ms	Ceil($M_{pss/sss\_sync\_w/o\_gaps}$ x K_p x K_{RLM}) x DRX cycle
...	...
NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified	

Table 9.2.5.1-3: Time period for time index detection (Frequency range FR1)

DRX cycle	$T_{SSB\_time\_index\_intra}$
No DRX	max[120ms, ceil(3 x K_p) x SMTC period]$^{Note 1}$
DRX cycle≤ 320ms	max[120ms, ceil (1.5 x 3 x K_p) x max(SMTC period,DRX cycle)]
DRX cycle>320ms	Ceil(3 x K_p) x DRX cycle
NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified	

Table 9.2.5.1-4: Time period for PSS/SSS detection, deactivated SCell (Frequency range FR1)

DRX cycle	T_{PSS/SSS_sync_intra}
No DRX	[5] x measCycleSCell
DRX cycle≤ 320ms	[5] x max(measCycleSCell, 1.5xDRX cycle)
DRX cycle> 320ms	[5] x max(measCycleSCell, DRX cycle)

Table 9.2.5.1-5: Time period for PSS/SSS detection, deactivated SCell (Frequency range FR2)

DRX cycle	T_{PSS/SSS_sync_intra}
No DRX	$M_{pss/sss\_sync\_w/o\_gaps}$ x measCycleSCell
DRX cycle≤ 320ms	$M_{pss/sss\_sync\_w/o\_gaps}$ x max(measCycleSCell, 1.5xDRX cycle)
DRX cycle> 320ms	$M_{pss/sss\_sync\_w/o\_gaps}$ x max(measCycleSCell, DRX cycle)

Table 9.2.5.1-6: Time period for time index detection, deactivated SCell (Frequency range FR1)

DRX cycle	$T_{SSB\_time\_index\_intra}$
No DRX	[3] x measCycleSCell
DRX cycle≤ 320ms	[3] x max(measCycleSCell, 1.5xDRX cycle)
DRX cycle> 320ms	[3] x max(measCycleSCell, DRX cycle)

Table 9.2.5.1-7: Void

Table 9.2.5.1-8: Void

9.2.5.2 Measurement period

Editor's Note : The requirements below have been derived so far assuming no configured Scell or E-UTRA SCell. The requirements when one or more SCells or E-UTRA SCells are configured is for further study. The requirements below have been derived without considering gap sharing when all SMTC occasion are fully overlapping with measurement gaps.

The measurement period for intrafrequency measurements without gaps is as shown in table 9.2.5.2-1, 9.2.5.2-2, 9.2.5.2-3 (deactivated SCell) or 9.2.5.2-4(deactivated SCell).

Table 9.2.5.2-1: Measurement period for intrafrequency measurements without gaps(Frequency FR1)

DRX cycle	$T_{SSB\_measurement\_period\_intra}$
No DRX	max[200ms, ceil(5 x K_p) x SMTC period][Note 1]
DRX cycle≤ 320ms	max[200ms, ceil(1.5x 5 x K_p) x max(SMTC period,DRX cycle)]
DRX cycle>320ms	ceil(5 x K_p) x DRX cycle
NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified	

Table 9.2.5.2-2: Measurement period for intrafrequency measurements without gaps(Frequency FR2)

DRX cycle	$T_{SSB\_measurement\_period\_intra}$
No DRX	max[400ms, ceil($M_{meas\_period\_w/o\_gaps}$ x K_p x K_{RLM}) x SMTC period][Note 1]
DRX cycle≤ 320ms	max[400ms, ceil(1.5x $M_{meas\_period\_w/o\_gaps}$ x K_p x K_{RLM}) x max(SMTC period,DRX cycle)]
DRX cycle>320ms	ceil($M_{meas\_period\_w/o\_gaps}$ xK_p x K_{RLM}) x DRX cycle
NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified	

Table 9.2.5.2-3: Measurement period for intrafrequency measurements without gaps (deactivated SCell) (Frequency range FR1)

DRX cycle	$T_{SSB\_measurement\_period\_intra}$
No DRX	[5] x measCycleSCell
DRX cycle≤ 320ms	[5] x max(measCycleSCell, 1.5xDRX cycle)
DRX cycle> 320ms	[5] x max(measCycleSCell, DRX cycle)

Table 9.2.5.2-4: Measurement period for intrafrequency measurements without gaps (deactivated SCell) (Frequency range FR2)

DRX cycle	$T_{SSB\_measurement\_period\_intra}$
No DRX	$M_{meas\_period\ with\_gaps}$ x measCycleSCell
DRX cycle≤ 320ms	$M_{meas\_period\ with\_gaps}$ x max(measCycleSCell, 1.5xDRX cycle)
DRX cycle> 320ms	$M_{meas\_period\ with\_gaps}$ x max(measCycleSCell, DRX cycle)

9.2.5.3 Scheduling availability of UE during intra-frequency measurements

UE are required to be capable of measuring without measurement gaps when the SSB is completely contained in the active bandwidth part of the UE. When the measurement signal has different subcarrier spacing than PDSCH/PDCCH or on frequency range FR2, there are restrictions on the scheduling availability as described in the following clauses.

9.2.5.3.1 Scheduling availability of UE performing measurements with a same subcarrier spacing as PDSCH/PDCCH on FR1

There are no scheduling restrictions due to measurements performed with a same subcarrier spacing as PDSCH/PDCCH on FR1.

9.2.5.3.2 Scheduling availability of UE performing measurements with a different subcarrier spacing than PDSCH/PDCCH on FR1

For UE which support *simultaneousRxDataSSB-DiffNumerology* [14] there are no restrictions on scheduling availability due to measurements. For UE which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to SS-RSRP/RSRQ/SINR measurement

- If *deriveSSB_IndexFromCell* is enabled the UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on SSB symbols to be measured, and on 1 data symbol before each consecutive SSB symbols and 1 data symbol after each consecutive SSB symbols within SMTC window duration. If the high layer in TS 38.331 [2] signaling of *smtc2* is configured, the SMTC periodicity follows *smtc2*; Otherwise SMTC periodicity follows *smtc1*.

- If *deriveSSB_IndexFromCell* is not enabled the UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on all symbols within SMTC window duration. If the high layer in TS 38.331 [2] signaling of *smtc2* is configured, the SMTC periodicity follows *smtc2*; Otherwise SMTC periodicity follows *smtc1*.

When intra-band carrier aggregation is performed, the scheduling restrictions apply to all serving cells on the band. When inter-band carrier aggregation within FR1 is performed, there are no scheduling restrictions on FR1 serving cell(s) in the bands due to measurements performed on FR1 serving cell frequency layer in different bands.

9.2.5.3.3 Scheduling availability of UE performing measurements on FR2

The following scheduling restriction applies due to SS-RSRP or SS-SINR measurement on an FR2 intra-frequency cell

The UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on SSB symbols to be measured, and on 1 symbol before each consecutive SSB symbols and 1 data symbol after each consecutive SSB symbols within SMTC window duration (The signaling *deriveSSB_IndexFromCell* is always enabled for FR2) . If the high layer in TS 38.331 [2] signaling of *smtc2* is configured, the SMTC periodicity follows *smtc2*; Otherwise SMTC periodicity follows *smtc1*.

The following scheduling restriction applies to SS-RSRQ measurement on an FR2 intra-frequency cell

- UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on SSB symbols to be measured, RSSI measurement symbols, and on 1 data symbol before each consecutive SSB/RSSI symbols and 1 data symbol after each consecutive SSB/RSSI symbols within SMTC window duration (The signaling *deriveSSB_IndexFromCellc* is always enabled for FR2). If the high layer in TS 38.331 [2] signaling of *smtc2* is configured, the SMTC periodicity follows *smtc2*; Otherwise SMTC periodicity follows *smtc1*.

When intra-band carrier aggregation is performed, the scheduling restrictions apply to all serving cells on the band. When inter-band carrier aggregation within FR2 is performed, the scheduling restrictions apply to all serving cells on the bands.

Editor's Note: FFS scheduling restrictions for inter-band carrier aggregation will be defined depending on band combination in future.

9.2.5.3.4 Scheduling availability of UE performing measurements on FR1 or FR2 in case of FR1-FR2 inter-band CA

There are no scheduling restrictions on FR1 serving cell(s) due to measurements performed on FR2 serving cell frequency layer.

There are no scheduling restrictions on FR2 serving cell(s) due to measurements performed on FR1 serving cell frequency layer.

9.2.6 Intrafrequency measurements with measurement gaps

9.2.6.1 Intra gap sharing

[Editor's note : This is being studied]

9.2.6.2 Intrafrequency cell identification

Editor's Note : The impact of gap sharing between intrafrequency and interfrequency measurements has not been include in the requirements below.

The UE shall be able to identify a new detectable intra frequency cell within $T_{identify\_intra\_without\_index}$ if UE is not indicated to report SSB based RRM measurement result with the associated SSB index, or the UE has been indicated that the neighbour cell is synchronous with the serving cell.. Otherwise UE shall be able to identify a new detectable intra frequency cell within $T_{identify\_intra\_with\_index.}$ The UE shall be able to identify a new detectable intra frequency SS block of an already detected cell within $T_{identify\_intra\_without\_index.}$ It is assumed that *deriveSSB-IndexFromCell* is always enabled for FR2, and hence the identification time is always $T_{identify\_intra\_without\_index}$

$$T_{identify\_intra\_without\_index} = T_{PSS/SSS\_sync\_intra} + T_{SSB\_measurement\_period\_intra} \text{ ms}$$

$$T_{identify\_intra\_with\_index} = T_{PSS/SSS\_sync\_ntra} + T_{SSB\_measurement\_period\_intra} + T_{SSB\_time\_index\_intra}$$

Where:

T_{PSS/SSS_sync_intra}: it is the time period used in PSS/SSS detection given in table 9.2.6.2-1, 9.2.6.2-2, or 9.2.6.2-4 or 9.2.6.2-5 (deactivated SCell)

$T_{SSB\_time\_index\_intra}$: it is the time period used to acquire the index of the SSB being measured given in table 9.2.6.2-3or 9.2.6.2-6(deactivated SCell).

$T_{SSB\_measurement\_period\_intra}$: equal to a measurement period of SSB based measurement given in table 9.2.6.2-1, 9.2.6.2-2, 9.2.6.2-3 (deactivated Scell) or 9.2.6.2-4(deactivated SCell)

$M_{pss/sss\_sync\_with\_gaps}$: For a UE supporting power class 1(fixed wireless access), $M_{pss/sss\_sync\ with\_gaps}$=40. For a UE supporting power class 2(vehicle mounted), $M_{pss/sss\_sync\ with\_gaps}$ =[24]. For a UE supporting power class 3(handheld), $M_{pss/sss\_sync\ with\_gaps}$ =[24]. For a UE supporting power class 4, $M_{pss/sss\_sync\ with\_gaps}$ =TBD

$M_{meas\_period\_\ with\_gaps}$: For a UE supporting power class 1(fixed wireless access), $M_{meas\_period\_\ with\_gaps}$ =40. For a UE supporting power class 2(vehicle mounted), $M_{meas\_period\_\ with\_gaps}$ =[24]. For a UE supporting power class 3(handheld), $M_{meas\_period\_\ with\_gaps}$ =[24]. For a UE supporting power class 4, $M_{meas\_period\ with\_gaps}$ =TBD.

Table 9.2.6.2-1: Time period for PSS/SSS detection (Frequency range FR1)

DRX cycle	T_{PSS/SSS_sync_intra}
No DRX	max[600ms, [5] x max(MGRP, SMTC period)]
DRX cycle≤ 320ms	max[600ms, ceil(1.5x [5]) x max(MGRP, SMTC period,DRX cycle)]
DRX cycle>320ms	[5] x max(MGRP, DRX cycle)

Table 9.2.6.2-2: Time period for PSS/SSS detection (Frequency range FR2)

DRX cycle	T_{PSS/SSS_sync_intra}
No DRX	max[600ms, $M_{pss/sss\_sync\_with\_gaps}$ x max(MGRP, SMTC period)]
DRX cycle≤ 320ms	max[600ms, ceil(1.5x $M_{pss/sss\_sync\_with\_gaps}$) x max(MGRP, SMTC period, DRX cycle)]
DRX cycle>320ms	$M_{pss/sss\_sync\_with\_gaps}$ x max(MGRP, DRX cycle)

Table 9.2.6.2-3: Time period for time index detection (Frequency range FR1)

DRX cycle	$T_{SSB\_time\_index\_intra}$
No DRX	max[120ms, 3 x max(MGRP, SMTC period)]
DRX cycle≤ 320ms	max[120ms, ceil(1.5x 3) x max(MGRP, SMTC period,DRX cycle)]
DRX cycle>320ms	3 x max(MGRP, DRX cycle)

Table 9.2.6.2-4: Time period for PSS/SSS detection, deactivated SCell (Frequency range FR1)

DRX cycle	T_{PSS/SSS_sync_intra}
No DRX	[5] x measCycleSCell
DRX cycle≤ 320ms	[5] x max(measCycleSCell, 1.5xDRX cycle)
DRX cycle>320ms	[5] x max(measCycleSCell, DRX cycle)

Table 9.2.6.2-5: Time period for PSS/SSS detection, deactivated SCell (Frequency range FR2)

DRX cycle	T_{PSS/SSS_sync_intra}
No DRX	$M_{pss/sss\_sync with\_gaps}$ x measCycleSCell
DRX cycle≤ 320ms	$M_{pss/sss\_sync with\_gaps}$ x max(measCycleSCell, 1.5xDRX cycle)
DRX cycle>320ms	$M_{pss/sss\_sync with\_gaps}$ x max(measCycleSCell, DRX cycle)

Table 9.2.6.2-6: Time period for time index detection (Frequency range FR1), deactivated SCell

DRX cycle	$T_{SSB\_time\_index\_intra}$
No DRX	[3] x measCycleSCell
DRX cycle≤ 320ms	[3] x max(measCycleSCell, 1.5xDRX cycle)
DRX cycle>320ms	[3] x max(measCycleSCell, DRX cycle)

Table 9.2.6.2-7: Void

Table 9.2.6.2-8: Void

9.2.6.3 Intrafrequency Measurement Period

Editor's Note : The requirements below have been derived so far assuming no configured Scell or E-UTRA SCell. The requirements when one or more SCells or E-UTRA SCells are configured is for further study. . The impact of gap sharing between intrafrequency and interfrequency measurements has not been include in the requirements below.

The measurement period for FR1 intrafrequency measurements with gaps is as shown in table 9.2.6.3-1 or 9.2.6.3-3(deactivated Scell)

The measurement period for FR2 intrafrequency measurements with gaps is as shown in table 9.2.6.3-2 or 9.2.6.3-4(deactivated Scell)

Editor's note: The values of X, Y and N in the following tables are to be updated.

Table 9.2.6.3-1: Measurement period for intrafrequency measurements with gaps(Frequency Range FR1)

DRX cycle	$T_{SSB\_measurement\_period\_intra}$
No DRX	max[200ms, 5 x max(MGRP, SMTC period)]
DRX cycle≤ 320ms	max[200ms, ceil(1.5x 5) x max(MGRP, SMTC period,DRX cycle)]
DRX cycle>320ms	5 x max(MGRP, DRX cycle)

Table 9.2.6.3-2: Measurement period for intrafrequency measurements with gaps(Frequency Range FR2)

DRX cycle	$T_{SSB\_measurement\_period\_intra}$
No DRX	max[400ms, $M_{meas\_period\ with\_gaps}$ x max(MGRP, SMTC period)]
DRX cycle≤ 320ms	max[400ms, ceil(1.5 x $M_{meas\_period\ with\_gaps}$) x max(MGRP, SMTC period, DRX cycle)] Note 1
DRX cycle>320ms	$M_{meas\_period\ with\_gaps}$ x max(MGRP, DRX cycle)

Table 9.2.6.3-3: Measurement period for intrafrequency measurements with gaps, deactivated SCell (Frequency Range FR1)

DRX cycle	$T_{SSB\_measurement\_period\_intra}$
No DRX	[5] x measCycleSCell
DRX cycle≤ 320ms	[5] x max(measCycleSCell, 1.5xDRX cycle)
DRX cycle>320ms	[5] x max(measCycleSCell, DRX cycle)

Table 9.2.6.3-4: Measurement period for intrafrequency measurements with gaps, deactivated SCell (Frequency Range FR2)

DRX cycle	$T_{SSB\_measurement\_period\_intra}$
No DRX	$M_{meas\_period\ with\_gaps}$ x measCycleSCell
DRX cycle≤ 320ms	$M_{meas\_period\ with\_gaps}$ x max(measCycleSCell, 1.5xDRX cycle)
DRX cycle>320ms	$M_{meas\_period\ with\_gaps}$ x max(measCycleSCell, DRX cycle)

9.3 NR inter-frequency measurements

Editor's note: DRX and non DRX requirement might be separately defined in this section. The numerology and BW combinations might be reflected in the requirement table.

9.3.1 Introduction

A measurement is defined as a SSB based inter-frequency measurement provided it is not defined as in intra-frequency measurement according to section 9.2.

The UE shall be able to identify new inter-frequency cells and perform SS-RSRP, SS-RSRQ, and SS-SINR measurements of identified inter-frequency cells if carrier frequency information is provided by PCell or the PSCell, even if no explicit neighbour list with physical layer cell identities is provided.

SSB based measurements are configured along with a measurement timing configuration (SMTC) per carrier, which provides periodicity, duration and offset information on a window of up to 5ms where the measurements on the configured inter-frequency carrier are to be performed. For inter-frequency connected mode measurements, one measurement window periodicity may be configured per inter-frequency measurement object.

When measurement gaps are needed, the UE is not expected to detect SSB on an inter-frequency measurement object which start earlier than the gap starting time + switching time, nor detect SSB which end later than the gap end – switching time. When the inter-frequency cells are in FR2 and the per-FR gap is configured to the UE in EN-DC and SA, or the serving cells are in FR2, the inter-frequency cells are in FR2 and the per-UE gap is configured to the UE in SA, the switching time is 0,25ms Otherwise the switching time is 0.5ms.

9.3.2 Requirements applicability

The requirements in Section 9.3 apply, provided:

- The cell being identified or measured is detectable.

An inter-frequency cell shall be considered detectable when for each relevant SSB:

- SS-RSRP related side conditions given in Sections 10.1.4 and 10.1.5 for FR1 and FR2, respectively, for a corresponding Band,
- SS-RSRQ related side conditions given in Sections 10.1.9 and 10.1.10 for FR1 and FR2, respectively, for a corresponding Band,
- SS-SINR related side conditions given in Sections 10.1.14 and 10.1.15 for FR1 and FR2, respectively, for a corresponding Band,
- SSB_RP and SSB Ês/Iot according to Annex B.2.3 for a corresponding Band.

9.3.2.1 Void

9.3.2.2 Void

9.3.3 Number of cells and number of SSB

9.3.3.1 Requirements for FR1

For each inter-frequency layer, the UE shall be capable of monitoring at least 4 cells.

For each inter-frequency layer, during each layer 1 measurement period, the UE shall be capable of monitoring at least 7 SSBs with different SSB index and/or PCI on the inter-frequency layer.

9.3.3.2 Requirements for FR2

For each inter-frequency layer, the UE shall be capable of monitoring at least 4 cells.

For each inter-frequency layer, during each layer 1 measurement period, the UE shall be capable of monitoring at least 10 SSBs with different SSB index and/or PCI on the inter-frequency layer. The UE shall be capable of monitoring at least one SSB per cell.

9.3.4 Inter frequency cell identification

When measurement gaps are provided, or the UE supports capability of conducting such measurements without gaps, the UE shall be able to identify a new detectable inter frequency cell within $T_{identify\_inter\_without\_index}$ if UE is not indicated to report SSB based RRM measurement result with the associated SSB index. Otherwise UE shall be able to identify a new detectable inter frequency cell within $T_{identify\_inter\_with\_index}$. The UE shall be able to identify a new detectable inter frequency SS block of an already detected cell within $T_{SSB\_time\_index\_inter}$.

$$T_{identify\_inter\_without\_index} = (T_{PSS/SSS\_sync\_inter} + T_{SSB\_measurement\_period\_inter})\ ms$$

$$T_{identify\_inter\_with\_index} = (T_{PSS/SSS\_sync\_inter} + T_{SSB\_measurement\_period\_inter} + T_{SSB\_time\_index\_inter})\ ms$$

Where:

T_{PSS/SSS_sync_inter}: it is the time period used in PSS/SSS detection given in table 9.3.4-1 and table 9.3.4-2.

$T_{SSB\_time\_index\_inter}$: it is the time period used to acquire the index of the SSB being measured given in table 9.3.4-3 and table 9.3.4-4.

$T_{SSB\_measurement\_period\_inter}$: equal to a measurement period of SSB based measurement given in table 9.3.5-1 and table 9.3.5-2.

M_{pss/sss_sync_inter} : For a UE supporting power class 1, M_{pss/sss_sync_inter}=[64] samples. For a vehicle mounted UE supporting power class 2 or a UE supporting power class 3, M_{pss/sss_sync_inter}=[TBD] samples. For a UE supporting power class 4, M_{pss/sss_sync}=[TBD] samples.

$M_{SSB\_index\_inter}$: For a UE supporting power class 1, $M_{SSB\_index\_inter}$ =[TBD] samples. For a vehicle mounted UE supporting power class 2 or a UE supporting power class 3, $M_{SSB\_index\_inter}$ =[TBD] samples. For a UE supporting power class 4, $M_{meas\_period\_inter}$ =[TBD] samples.

$M_{meas\_period\_inter}$: For a UE supporting power class 1, $M_{meas\_period\_inter}$ =[64] samples. For a vehicle mounted UE supporting power class 2 or a UE supporting power class 3, $M_{meas\_period\_inter}$ =[TBD] samples. For a UE supporting power class 4, $M_{meas\_period\_inter}$ =[TBD] samples.

Table 9.3.4-1: Time period for PSS/SSS detection, (Frequency range FR1)

Condition	T_{PSS/SSS_sync_inter}
No DRX	max[600ms, [8] x max[MGRP, SMTC period] x CSF_{inter}] Note 1, Note 2
DRX cycle ≤ [320]ms	max[600ms, [8x1.5] x max(MGRP, SMTC period, DRX cycle) x CSF_{inter}] Note 1, Note 2
DRX cycle > [320]ms	[8] x DRX cycle x CSF_{inter} Note 2
NOTE 1: If different SMTC periodicities are configured for different inter-frequency carriers, the SMTC period in the requirement is the SMTC period of the inter-frequency carrier being identified NOTE 2: CSF_{inter} is a carrier specific scaling factor and is determined according to section [9.3.6]	

Table 9.3.4-2: Time period for PSS/SSS detection, (Frequency range FR2)

Condition	T_{PSS/SSS_sync_inter}
No DRX	max[600ms, M_{pss/sss_sync_inter} x max[MGRP, SMTC period] x CSF_{inter}] Note 1, Note 2
DRX cycle ≤ [320]ms	max[600ms, M_{pss/sss_sync_inter} x max(MGRP, SMTC period, DRX cycle) x CSF_{inter}] Note 1, Note 2
DRX cycle > [320]ms	M_{pss/sss_sync_inter} x DRX cycle x CSF_{inter} Note 2
NOTE 1: If different SMTC periodicities are configured for different inter-frequency carriers, the SMTC period in the requirement is the SMTC period of the inter-frequency carrier being identified NOTE 2: CSF_{inter} is a carrier specific scaling factor and is determined according to section [9.3.6]	

Table 9.3.4-3: Time period for time index detection (Frequency range FR1)

Condition	$T_{SSB\_time\_index\_inter}$
No DRX	max[120ms, [3] x max[MGRP, SMTC period] x CSF_{inter}] Note 1, Note 2
DRX cycle ≤ [320]ms	max[120ms, [3 x 1.5] x max(MGRP, SMTC period, DRX cycle) x CSF_{inter}] Note 1, Note 2
DRX cycle > [320]ms	[3] x DRX cycle x CSF_{inter} Note 2
NOTE 1: If different SMTC periodicities are configured for different inter-frequency carriers, the SMTC period in the requirement is the SMTC period of the inter-frequency carrier being identified NOTE 2: CSF_{inter} is a carrier specific scaling factor and is determined according to section [9.3.6]	

Table 9.3.4-4: Time period for time index detection (Frequency range FR2)

Condition	$T_{SSB\_time\_index\_inter}$
No DRX	max[200ms, $M_{SSB\_index\_inter}$ x max[MGRP, SMTC period] x CSF_{inter}] Note 1, Note 2
DRX cycle ≤ [320]ms	max[200ms, $M_{SSB\_index\_inter}$ x max(MGRP, SMTC period, DRX cycle) x CSF_{inter}] Note 1, Note 2
DRX cycle > [320]ms	$M_{SSB\_index\_inter}$ x DRX cycle x CSF_{inter} Note 2
NOTE 1: If different SMTC periodicities are configured for different inter-frequency carriers, the SMTC period in the requirement is the SMTC period of the inter-frequency carrier being identified NOTE 2: CSF_{inter} is a carrier specific scaling factor and is determined according to section [9.3.6]	

9.3.4.1 Void

9.3.4.2 Void

9.3.5 Inter frequency measurements

When measurement gaps are provided for inter frequency measurements, or the UE supports capability of conducting such measurements without gaps, the UE physical layer shall be capable of reporting SS-RSRP, SS-RSRQ and SS-SINR measurements to higher layers with measurement accuracy as specified in sub-clauses [TBD], [TBD], and [TBD], respectively, as shown in table 9.3.5-1 and 9.3.5-2:

Table 9.3.5-1: Measurement period for inter-frequency measurements with gaps (Frequency FR1)

Condition	$T_{SSB\_measurement\_period\_inter}$
No DRX	max[200ms, [8] x max[MGRP, SMTC period] x CSF_{inter}] Note 1, Note 2
DRX cycle ≤ [320]ms	max[200ms, [8 x 1.5] x max(MGRP, SMTC period, DRX cycle) x CSF_{inter}] Note 1, Note 2
DRX cycle > [320]ms	[8] x DRX cycle x CSF_{inter} Note 2
...	...
NOTE 1: If different SMTC periodicities are configured for different inter-frequency carriers, the SMTC period in the requirement is the SMTC period of the inter-frequency carrier being measured NOTE 2: CSF_{inter} is a carrier specific scaling factor and is determined according to section [9.3.6]	

Table 9.3.5-2: Measurement period for inter-frequency measurements with gaps (Frequency FR2)

Condition	$T_{SSB\_measurement\_period\_inter}$
No DRX	max[400ms, $M_{meas\_period\_inter}$ x max[MGRP, SMTC period] x CSF_{inter}] Note 1, Note 2
DRX cycle ≤ [320]ms	max[400ms, $M_{meas\_period\_inter}$ x max(MGRP, SMTC period, DRX cycle) x CSF_{inter}] Note 1, Note 2
DRX cycle > [320]ms	$M_{meas\_period\_inter}$ x DRX cycle x CSF_{inter} Note 2
...	...
NOTE 1: If different SMTC periodicities are configured for different inter-frequency carriers, the SMTC period in the requirement is the SMTC period of the inter-frequency carrier being measured NOTE 2: CSF_{inter} is a carrier specific scaling factor and is determined according to section [9.3.6]	

9.3.5.1 Void

9.3.5.2 Void

9.3.5.3 Void

9.3.6 NR Inter frequency measurements reporting requirements

9.3.6.1 Periodic Reporting

Reported SS-RSRP, SS-RSRQ, and SS-SINR measurements contained in periodically triggered measurement reports shall meet the requirements in sections [TBD], respectively.

9.3.6.2 Event-triggered Periodic Reporting

Reported SS-RSRP, SS-RSRQ, and SS-SINR measurements contained in event triggered periodic measurement reports shall meet the requirements in sections [TBD], respectively.

The first report in event triggered periodic measurement reporting shall meet the requirements specified in clause [TBD].

9.3.6.3 Event-triggered Reporting

Reported SS-RSRP, SS-RSRQ, and SS-SINR measurements contained in event triggered measurement reports shall meet the requirements in sections [TBD], respectively.

The UE shall not send any event triggered measurement reports, as long as no reporting criteria are fulfilled.

The measurement reporting delay is defined as the time between an event that will trigger a measurement report and the point when the UE starts to transmit the measurement report over the air interface. This requirement assumes that that the measurement report is not delayed by other RRC signalling on the [DCCH]. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the [TTI] of the uplink [DCCH]. The delay uncertainty is: [2 x TTI_{DCCH}.] This measurement reporting delay excludes a delay which caused by no UL resources for UE to send the measurement report.

The event triggered measurement reporting delay, measured without L3 filtering shall be less than [$T_{identify\text{-}inter}$] defined in clause [TBD]. When L3 filtering is used an additional delay can be expected.

If a cell which has been detectable at least for the time period [$T_{identify\_inter}$] defined in clause [TBD] and then triggers the measurement report as per TS 38.331 [TBD], the event triggered measurement reporting delay shall be less than [$T_{Measurement\_Period\_Inter\_FDD}$]defined in clause [TBD] provided the timing to that cell has not changed more than [± 50 Ts] while measurement gap has not been available and the L3 filter has not been used. When L3 filtering is used an additional delay can be expected.

Editor's note: To be captured once the RAN2 work progresses.

9.3.7 Derivation of CSF_{inter}

Editors note: this section includes how to determine the scaling factor used in determining the UE cell detection, Index detection and measurement requirements.

9.4 Inter-RAT measurements

9.4.1 Introduction

The requirements in this section are specified for NR−E-UTRAN FDD and NR−E-UTRAN TDD measurements and are applicable without an explicit E-UTRAN neighbour cell list containing physical layer cell identities, for a UE:

- in RRC_CONNECTED state, and
- configured with at least PCell, and
- configured with an appropriate measurement gap pattern according to Table 9.1.2-3.

Parameter T_{Inter1} used in inter-RAT requirements in Section 9.4 is specified in Table 9.4.1-1.

Table 9.4.1-1: Minimum available time for inter-RAT measurements

Gap Pattern Id	MeasurementGap Length (MGL, ms)	Measurement Gap Repetition Period (MGRP, ms)	Minimum available time for inter-frequency and inter-RAT measurements during 480ms period (Tinter1, ms)
0	6	40	60
1	6	80	30
2	3	40	24 Note 1
3	3	80	12 Note 1
NOTE 1: When determing UE requirements using Tinter1 for GP2 and GP3, Tinter1 = 60 for GP2 and Tinter1 = 30 for GP3 shall be used. NOTE 2: Measurement gaps pattern configurations applicability is as specified in Table 9.1.2-1.			

Editor's note: a note to be added in Table 9.4.1-1 on that measurement gap patterns #2 and #3 are supported only by the UEs which have a corresponding capability once RAN2 specifies the capability.

9.4.2 SA: NR − E-UTRAN FDD measurements

9.4.2.1 Introduction

The requirements are applicable for NR−E-UTRAN FDD RSRP, RSRQ, and RS-SINR measeuements.

In the requirements, an E-UTRAN FDD cell is considered to be detectable when:

- RSRP related conditions in the accuracy requirements in Section 10.2.2 are fulfilled for a corresponding Band, together with the corresponding side conditions in Annex B.2 and Annex B.3 of TS 36.133 [15],
- RSRQ related conditions in the accuracy requirements in Section 10.2.3 are fulfilled for a corresponding Band, together with the corresponding side conditions in Annex B.2 and Annex B.3 of TS 36.133 [15],
- RS-SINR related conditions in the accuracy requirements in Section 10.2.5 are fulfilled for a corresponding Band, together with the corresponding side conditions in Annex B.2 and Annex B.3 of TS 36.133 [15].

9.4.2.2 Requirements when no DRX is used

When the UE requires measurement gaps to idenitify and measurement inter-RAT cells and an appropriate measurement gap pattern is scheduled, the UE shall be able to identify a new detectable FDD cell within $T_{Identify,\ E\text{-}UTRAN\ FDD}$ according to the following expression:

$$T_{Identify,E-UTRAN\ FDD} = T_{BasicIdentify} * \frac{480}{T_{Inter1}} * K \quad ms,$$

where:

$T_{BasicIdentify}$ = 480 ms,

T_{Inter1} is defined in Section 9.4.1,

K=TBD and depends at least on $N_{freq,\ SA}$ defined in Section 9.1.3.3 and whether and how gaps are shared.

Identification of a cell shall include detection of the cell and additionally performing a single measurement with measurement period of $T_{Measure,\ E\text{-}UTRAN\ FDD}$ defined in Table 9.4.2.2-1.

Table 9.4.2.2-1: Measurement period and measurement bandwidth

Configuration	Physical Layer Measurement period: $T_{Measure,\ E\text{-}UTRAN\ FDD}$ [ms]	Measurement bandwidth [RB]
0	480 x TBD	6
1 (Note 1)	240 x TBD	50
NOTE 1: This configuration is optional.		

The UE shall be capable of identifying and performing NR – E-UTRAN FDD RSRP, RSRQ, and RS-SINR measurements of at least 4 E-UTRAN FDD cells per E-UTRA FDD carrier frequency layer for up to 7 E-UTRA FDD carrier frequency layers.

If higher layer filtering is used, an additional cell identification delay can be expected.

The NR – E-UTRAN FDD RSRP measurement accuracy for all measured cells shall be as specified in Section 10.2.2. The NR – E-UTRAN FDD RSRQ measurement accuracy for all measured cells shall be as specified in Section 10.2.3. The NR – E-UTRAN FDD RS-SINR measurement accuracy for all measured cells shall be as specified in Section 10.2.5.

9.4.2.3 Requirements when DRX is used

When DRX is in use and measurement gaps are configured, the UE shall be able to identify a new detectable E-UTRAN FDD cell within $T_{Identify,\ E\text{-}UTRAN\ FDD}$ specified in Table 9.4.2.3-1.

Table 9.4.2.3-1: Requirement to identify a newly detectable E-UTRAN FDD cell

DRX cycle length (s)	$T_{Identify,\ E\text{-}UTRAN\ FDD}$ (s) (DRX cycles)	
	Gap period = 40 ms	Gap period = 80 ms
≤0.16	Non-DRX requirements in Section 9.4.2.2 apply	Non-DRX requirements in Section 9.4.2.2 apply
0.256	5.12*K (20*K)	7.68*K (30*K)
0.32	6.4*K (20*K)	7.68*K (24*K)
0.32< DRX-cycle ≤10.24	Note1 (20*K)	Note1 (20*K)
NOTE 1: The time depends on the DRX cycle length. NOTE 2: K=TBD and depends at least on $N_{freq,\ SA}$ defined in Section 9.1.3.3.		

When DRX is in use, the UE shall be capable of performing NR – E-UTRAN FDD RSRP, RSRQ, and RS-SINR measurements of at least 4 E-UTRAN FDD cells per E-UTRA FDD frequency layer for up to 7 E-UTRA FDD carrier frequency layers, and the UE physical layer shall be capable of reporting NR – E-UTRAN FDD RSRP, RSRQ, and RS-SINR measurements to higher layers with the measurement period $T_{measure,\ E\text{-}UTRAN\ FDD}$ specified in Table 9.4.2.3-2.

Table 9.4.2.3-2: Requirement to measure E-UTRAN FDD cells

DRX cycle length (s)	$T_{measure,\ E\text{-}UTRAN\ FDD}$ (s) (DRX cycles)
≤0.08	Non-DRX requirements in Section 9.4.2.2 apply
0< DRX-cycle ≤10.24	Note1 (5*K)
NOTE 1: The time depends on the DRX cycle length. NOTE 2: K=TBD and depends at least on $N_{freq,\ SA}$ defined in Section 9.1.3.3.	

If higher layer filtering is used, an additional cell identification delay can be expected.

The NR – E-UTRAN FDD RSRP measurement accuracy for all measured cells shall be as specified in Section 10.2.2. The NR – E-UTRAN FDD RSRQ measurement accuracy for all measured cells shall be as specified in Section 10.2.3. The NR – E-UTRAN FDD RS-SINR measurement accuracy for all measured cells shall be as specified in Section 10.2.5.

Editor's note: gap sharing to be accounted for.

9.4.2.4 Measurement reporting requirements

9.4.2.4.1 Periodic Reporting

The reported NR – E-UTRAN FDD RSRP, RSRQ, and RS-SINR measurements contained in periodically triggered measurement reports shall meet the requirements in Sections 10.2.2, 10.2.3, and 10.2.5, respectively.

9.4.2.4.2 Event-Triggered Periodic Reporting

The reported NR – E-UTRAN FDD RSRP, RSRQ, and RS-SINR measurements contained in event-triggered periodic measurement reports shall meet the requirements in Sections 10.2.2, 10.2.3, and 10.2.5, respectively.

The first report in event-triggered periodic measurement reporting shall meet the requirements specified in Section 9.4.2.4.3.

9.4.2.4.3 Event-Triggered Reporting

The reported NR – E-UTRAN FDD RSRP, RSRQ, and RS-SINR measurements contained in event-triggered measurement reports shall meet the requirements in Sections 10.2.2, 10.2.3, and 10.2.5, respectively.

The UE shall not send any event-triggered measurement reports, as long as no reporting criteria are fulfilled.

The measurement reporting delay is defined as the time between an event that will trigger a measurement report and the point when the UE starts to transmit the measurement report over the air interface. This requirement assumes that that the measurement report is not delayed by other RRC signalling on the DCCH. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the TTI of the uplink DCCH. The delay uncertainty is: 2 x TTI_{DCCH} where TTI_{DCCH} is the duration of subframe or slot or subslot when the measurement report is transmitted on the PUSCH with subframe or slot or subslot duration. This measurement reporting delay excludes a delay which caused by no UL resources for UE to send the measurement report.

The event triggered measurement reporting delay, measured without L3 filtering shall be less than $T_{\text{Identify, E-UTRAN FDD}}$ defined in Sections 9.4.2.2 and 9.4.2.3 without DRX and with DRX, respectively. When L3 filtering is used, an additional delay can be expected.

If a cell which has been detectable at least for the time period $T_{\text{Identify, E-UTRAN FDD}}$ becomes undetectable for a period ≤ TBD seconds and then the cell becomes detectable again and triggers an event as per TS 38.331 [2], the event triggered measurement reporting delay shall be less than $T_{\text{Measure, E-UTRAN FDD}}$ provided the timing to that cell has not changed more than ± 50 Ts while measurement gap has not been available and the L3 filter has not been used.

9.4.3 SA: NR − E-UTRAN TDD measurements

9.4.3.1 Introduction

The requirements are applicable for NR−E-UTRAN TDD RSRP, RSRQ, and RS-SINR measuements.

In the requirements, an E-UTRAN TDD cell is considered to be detectable when:

- RSRP related conditions in the accuracy requirements in Section 10.2.2 are fulfilled for a corresponding Band, together with the corresponding side conditions in Annex B.2 and Annex B.3 of TS 36.133 [15],
- RSRQ related conditions in the accuracy requirements in Section 10.2.3 are fulfilled for a corresponding Band, together with the corresponding side conditions in Annex B.2 and Annex B.3 of TS 36.133 [15],
- RS-SINR related conditions in the accuracy requirements in Section 10.2.5 are fulfilled for a corresponding Band, together with the corresponding side conditions in Annex B.2 and Annex B.3 of TS 36.133 [15].-.

9.4.3.2 Requirements when no DRX is used

When the UE requires measurement gaps to idenitify and measurement inter-RAT cells and an appropriate measurement gap pattern is scheduled, the UE shall be able to identify a new detectable TDD cell within $T_{\text{Identify, E-UTRAN TDD}}$ according to the following expression:

- When configuration 0 or configuration 1 in Table 9.4.3.2-1 is applied,

$$T_{Identify,E-UTRAN\ TDD} = T_{BasicIdentify} * \frac{480}{T_{Inter1}} * K \quad ms\ ,$$

- When configuration 2 or configuration 3 in Table 9.4.3.2-1 is applied,

$$T_{Identify,E-UTRAN\ TDD} = (T_{BasicIdentify} * \frac{480}{T_{Inter1}} + 240) * K \quad ms\ ,$$

where:

$T_{\text{BasicIdentify}}$ = 480 ms,

T_{Inter1} is defined in Section 9.4.1,

K=TBD and depends at least on $N_{\text{freq, SA}}$ defined in Section 9.1.3.3 and whether and how gaps are shared.

Identification of a cell shall include detection of the cell and additionally performing a single measurement with measurement period of $T_{\text{Measure, E-UTRAN TDD}}$ defined in Table 9.4.3.2-1.

Table 9.4.3.2-1: $T_{\text{Measure, E-UTRAN TDD}}$ for different configurations

Configuration	Measurement bandwidth [RB]	Number of UL/DL sub-frames per half frame (5 ms)		DwPTS		$T_{\text{Measure, E-UTRAN TDD}}$ [ms]
		DL	UL	Normal CP	Extended CP	

0	6	2	2	$19760 \cdot T_s$	$20480 \cdot T_s$	480 x K
1 (Note 1)	50	2	2	$19760 \cdot T_s$	$20480 \cdot T_s$	240 x K
NOTE 1: This configuration is optional. NOTE 2: K=TBD and depends at least on $N_{freq, SA}$ defined in Section 9.1.3.3.						

The UE shall be capable of identifying and performing NR – E-UTRAN TDD RSRP, RSRQ, and RS-SINR measurements of at least 4 E-UTRAN TDD cells per E-UTRA TDD carrier frequency layer for up to 7 E-UTRA TDD carrier frequency layers.

If higher layer filtering is used, an additional cell identification delay can be expected.

The NR – E-UTRAN TDD RSRP measurement accuracy for all measured cells shall be as specified in Section 10.2.2. The NR – E-UTRAN TDD RSRQ measurement accuracy for all measured cells shall be as specified in Section 10.2.3. The NR – E-UTRAN TDD RS-SINR measurement accuracy for all measured cells shall be as specified in Section 10.2.5.

9.4.3.3 Requirements when DRX is used

When DRX is in use and measurement gaps are configured, the UE shall be able to identify a new detectable E-UTRAN TDD cell within $T_{Identify, E-UTRAN TDD}$ specified in Table 9.4.3.3-1.

Table 9.4.3.3-1: Requirement to identify a newly detectable E-UTRAN TDD cell

DRX cycle length (s)	$T_{Identify, E-UTRAN TDD}$ (s) (DRX cycles)	
	Gap period = 40 ms	Gap period = 80 ms
≤0.16	Non-DRX requirements in Section 9.4.3.2 apply	Non-DRX requirements in Section 9.4.3.2 apply
0.256	5.12*K (20*K)	7.68*K (30*K)
0.32	6.4*K (20*K)	7.68*K (24*K)
0.32< DRX-cycle ≤10.24	Note1 (20*K)	Note1 (20*K)
NOTE 1: The time depends on the DRX cycle length. NOTE 2: K=TBD and depends at least on $N_{freq, SA}$ defined in Section 9.1.3.3.		

When DRX is in use, the UE shall be capable of performing NR – E-UTRAN TDD RSRP, RSRQ, and RS-SINR measurements of at least 4 E-UTRAN TDD cells per E-UTRA TDD frequency layer for up to 7 E-UTRA TDD carrier frequency layers, and the UE physical layer shall be capable of reporting NR – E-UTRAN TDD RSRP, RSRQ, and RS-SINR measurements to higher layers with the measurement period $T_{measure, E-UTRAN TDD}$ specified in Table 9.4.3.3-2.

Table 9.4.3.3-2: Requirement to measure E-UTRAN TDD cells

DRX cycle length (s)	$T_{measure, E-UTRAN TDD}$ (s) (DRX cycles)
≤0.08	Non-DRX Requirements in Section 9.4.3.2 apply
0.128	For configuration 2, non-DRX requirements in section 9.4.3.2 apply, Otherwise: Note1 (5*K)
0.128<DRX-cycle≤10.24	Note1 (5*K)
NOTE 1: The time depends on the DRX cycle length. NOTE 2: K=TBD and depends at least on $N_{freq, SA}$ defined in Section 9.1.3.3.	

If higher layer filtering is used, an additional cell identification delay can be expected.

The NR – E-UTRAN TDD RSRP measurement accuracy for all measured cells shall be as specified in Section 10.2.2. The NR – E-UTRAN TDD RSRQ measurement accuracy for all measured cells shall be as specified in Section 10.2.3. The NR – E-UTRAN TDD RS-SINR measurement accuracy for all measured cells shall be as specified in Section 10.2.5.

Editor's note: gap sharing to be accounted for.

9.4.3.4 Measurement reporting requirements

9.4.3.4.1 Periodic Reporting

The reported NR – E-UTRAN TDD RSRP, RSRQ, and RS-SINR measurements contained in periodically triggered measurement reports shall meet the requirements in Sections 10.2.2, 10.2.3, and 10.2.5, respectively.

9.4.3.4.2 Event-Triggered Periodic Reporting

The reported NR – E-UTRAN TDD RSRP, RSRQ, and RS-SINR measurements contained in event-triggered periodic measurement reports shall meet the requirements in Sections 10.2.2, 10.2.3, and 10.2.5, respectively.

The first report in event-triggered periodic measurement reporting shall meet the requirements specified in Section 9.4.3.4.3.

9.4.3.4.3 Event-Triggered Reporting

The reported NR – E-UTRAN TDD RSRP, RSRQ, and RS-SINR measurements contained in event-triggered measurement reports shall meet the requirements in Sections 10.2.2, 10.2.3, and 10.2.5, respectively.

The UE shall not send any event-triggered measurement reports, as long as no reporting criteria are fulfilled.

The measurement reporting delay is defined as the time between an event that will trigger a measurement report and the point when the UE starts to transmit the measurement report over the air interface. This requirement assumes that that the measurement report is not delayed by other RRC signalling on the DCCH. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the TTI of the uplink DCCH. The delay uncertainty is: 2 x TTI_{DCCH} where TTI_{DCCH} is the duration of subframe or slot or subslot when the measurement report is transmitted on the PUSCH with subframe or slot or subslot duration. This measurement reporting delay excludes a delay which caused by no UL resources for UE to send the measurement report.

The event triggered measurement reporting delay, measured without L3 filtering shall be less than $T_{\text{Identify, E-UTRAN TDD}}$ defined in Sections 9.4.3.2 and 9.4.3.3 without DRX and with DRX, respectively. When L3 filtering is used, an additional delay can be expected.

If a cell which has been detectable at least for the time period $T_{\text{Identify, E-UTRAN TDD}}$ becomes undetectable for a period ≤ TBD seconds and then the cell becomes detectable again and triggers an event as per TS 38.331 [2], the event triggered measurement reporting delay shall be less than $T_{\text{Measure, E-UTRAN TDD}}$ provided the timing to that cell has not changed more than ± 50 Ts while measurement gap has not been available and the L3 filter has not been used.

9.4.4 SA: Inter-RAT RSTD measurements

9.4.4.1 SA: NR − E-UTRAN FDD RSTD measurements

9.4.4.1.1 Introduction

The requirements are applicable for NR−E-UTRAN FDD RSTD measuements requested via LPP [22].

The requirements in section 9.4.4.1 apply, provided:

- the UE is provided with the LTE timing information [reference TBD], or
- when the UE is not aware of the SFN of at least one LTE cell in the OTDOA assistance data, the UE is using autonomous gaps to acquire SFN of the E-UTRA OTDOA reference cell during T_{SFN} time period prior to requesting measurement gaps for performing the requested E-UTRA RSTD measurements before the $T_{\text{RSTD InterRAT, E-UTRAN FDD}}$ time period starts while meeting the requirements in Section 9.4.4.1.2.2.

9.4.4.1.2 Requirements

Editor's note: sharing factor is not yet taken into account in this section.

When the physical layer cell identities of neighbour cells together with the OTDOA assistance data are provided, the UE shall be able to detect and measure inter-RAT E-UTRAN FDD RSTD, specified in TS 38.215 [4], for at least *n*=16 cells, including the reference cell, within $T_{\text{RSTD InterRAT, E-UTRAN FDD}}$ ms as given below:

$$\mathrm{T}_{\text{RSTD InterRAT, E-UTRAN FDD}} = T_{\text{PRS}} \cdot (M - 1) + \Delta \qquad ms \qquad ,$$

where

$\mathrm{T}_{\text{RSTD InterRAT, E-UTRAN FDD}}$ is the total time for detecting and measuring at least *n* cells,

T_{PRS} is the the largest value of the cell-specific positioning subframe configuration period, defined in TS 36.211 [23], among the measured *n* cells including the reference cell,
M is the number of PRS positioning occasions as defined in Table 9.4.4.1.2-1, where each PRS positioning occasion comprises of N_{PRS} ($1 \le N_{PRS} \le 6$) consecutive downlink positioning subframes defined in TS 36.211 [23],

$\Delta = 160 \cdot \left\lceil \frac{n}{M} \right\rceil$ ms is the measurement time for a single PRS positioning occasion which includes the sampling time and the processing time, and

the *n* cells are distributed on up to two E-UTRAN FDD carrier frequencies.

Table 9.4.4.1.2-1: Number of PRS positioning occasions within $\mathrm{T}_{\text{RSTD InterRAT, E-UTRAN FDD}}$

Positioning subframe configuration period T_{PRS}	Number of PRS positioning occasions M	
	f2 Note1	f1 and f2 Note2
160 ms	16	32
>160 ms	8	16
NOTE 1: When inter-RAT E-UTRAN FDD RSTD measurements are performed over the reference cell and neighbour cells, which belong to the E-UTRAN FDD carrier frequency f2. NOTE 2: When inter-RAT E-UTRAN FDD RSTD measurements are performed over the reference cell and the neighbour cells, which belong to the E-UTRAN FDD carrier frequency f1 and the E-UTRAN FDD carrier frequency f2 respectively.		

The UE physical layer shall be capable of reporting RSTD for the reference cell and all the neighbor cells *i* out of at least (*n*-1) neighbor cells within $\mathrm{T}_{\text{RSTD InterRAT, E-UTRAN FDD}}$ provided:

$\left(\text{PRS }\hat{\mathrm{E}}_{\mathrm{s}} / \text{Iot}\right)_{ref} \ge$-6 dB for all Frequency Bands for the reference cell,

$\left(\text{PRS }\hat{\mathrm{E}}_{\mathrm{s}} / \text{Iot}\right)_{i} \ge$-13 dB for all Frequency Bands for neighbour cell *i*,

$\left(\text{PRS }\hat{\mathrm{E}}_{\mathrm{s}} / \text{Iot}\right)_{ref}$ and $\left(\text{PRS }\hat{\mathrm{E}}_{\mathrm{s}} / \text{Iot}\right)_{i}$ conditions apply for all subframes of at least $L = \frac{M}{2}$ PRS positioning occasions,
PRP $1,2|_{\text{dBm}}$ according to TS 36.133 [15, Annex B.2.6] for a corresponding Band

$\text{PRS }\hat{\mathrm{E}}_{\mathrm{s}} / \text{Iot}$ is defined as the ratio of the average received energy per PRS RE during the useful part of the symbol to the average received power spectral density of the total noise and interference for this RE, where the ratio is measured over all REs which carry PRS.

The time $\mathrm{T}_{\text{RSTD InterRAT, E-UTRAN FDD}}$ starts from the first subframe of the PRS positioning occasion closest in time after both the OTDOA-RequestLocationInformation message and the OTDOA assistance data in the OTDOA-ProvideAssistanceData message via LPP as specified in TS 38.305 [22], are delivered to the physical layer of the UE.

The RSTD measurement accuracy for all measured neighbor cells *i* shall be fulfilled according to the accuracy as specified in Section 10.2.4.

9.4.4.1.2.1 RSTD Measurement Reporting Delay

This requirement assumes that the measurement report is not delayed by other LPP signalling on the DCCH. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the TTI of the uplink DCCH. The delay uncertainty is: 2 x TTI_{DCCH} where TTI_{DCCH} is the duration of subframe or slot or subslot when the measurement report is transmitted on the PUSCH with subframe or slot or subslot duration. This measurement reporting delay excludes any delay caused by no UL resources for UE to send the measurement report.

9.4.4.1.2.2 Requirements for acquiring SFN of the E-UTRA OTDOA reference cell

The UE may make autonomous gaps in downlink reception and uplink transmission for receiving MIB according to [reference TBD] when the UE is not aware of the SFN of any E-UTRA cell in the OTDOA assistance data. The UE shall be able to acquire SFN of the E-UTRA OTDOA assistance reference cell during T_{SFN} = TBD ms time period.

The MIB of an E-UTRA cell whose SFN is acquired shall be considered decodable by the UE provided the PBCH demodulation requirements are met according to TS 36.101 [25].

The requirement for acquiring the SFN of the E-UTRA OTDOA reference cell within T_{SFN} is applicable when no DRX is used as well as when any of the DRX cycles specified in TS 38.331 [2] is used.

Within the SNF acquisition time period, T_{SFN}, the UE shall transmit at least TBD ACK/NACKs on PCell or each of activated SCell(s), provided that:

- there is continuous DL data allocation,
- no DRX cycle is used,
- no measurement gaps are configured,
- only one code word is transmitted in each subframe.

Editor' note: the requirement applicability with SRS carrier based switching is TBD.

Editor's note: the details of the design of autonomous gaps are FFS.

9.4.4.2 SA: NR − E-UTRAN TDD RSTD measurements

9.4.4.2.1 Introduction

The requirements are applicable for NR−E-UTRAN TDD RSTD measuements requested via LPP [22].

9.4.4.2.2 Requirements

Editor's note: sharing factor is not yet taken into account in this section.

When the physical layer cell identities of neighbour cells together with the OTDOA assistance data are provided, the UE shall be able to detect and measure inter-RAT -UTRAN TDD RSTD, specified in TS 38.215 [4], for at least *n*=16 cells, including the reference cell, within $\mathrm{T}_{\text{RSTD InterRAT, E-UTRAN TDD}}$ ms as given below:

$$\mathrm{T}_{\text{RSTD InterRAT, E-UTRAN TDD}} = T_{\text{PRS}} \cdot (M - 1) + \Delta \qquad ms \qquad ,$$

where

$\mathrm{T}_{\text{RSTD InterRAT, E-UTRAN TDD}}$ is the total time for detecting and measuring at least *n* cells,

T_{PRS} is the largest value of the cell-specific positioning subframe configuration period, defined in TS 36.211 [23], among the measured *n* cells including the reference cell,

M is the number of PRS positioning occasions as defined in Table 9.4.4.2.2-1, where a PRS positioning occasion is as defined in clause 9.4.4.1.2,

$\Delta = 160 \cdot \left\lceil \frac{n}{M} \right\rceil$ ms is the measurement time for a single PRS positioning occasion which includes the sampling time and the processing time, and

the *n* cells are distributed on up to two E-UTRAN TDD carrier frequencies.

Table 9.4.4.2.2-1: Number of PRS positioning occasions within $T_{\text{RSTD InterRAT, E-UTRAN TDD}}$

Positioning subframe configuration period T_{PRS}	Number of PRS positioning occasions M	
	f2 Note1	f1 and f2 Note2
160 ms	16	32
>160 ms	8	16
NOTE 1: When inter-RAT E-UTRAN TDD RSTD measurements are performed over the reference cell and neighbour cells, which belong to the E-UTRAN TDD carrier frequency f2. NOTE 2: When inter-RAT E-UTRAN TDD RSTD measurements are performed over the reference cell and the neighbour cells, which belong to the E-UTRAN TDD carrier frequency f1 and the E-UTRAN TDD carrier frequency f2 respectively.		

The requirements in this section shall apply for all TDD special subframe configurations specified in TS 36.211 [23] and for the TDD uplink-downlink configurations as specified in Table 9.4.4.2.2-2 for UE requiring measurement gaps for these measurements. For UEs capable of performing inter-RAT RSTD measurements without measurement gaps, TDD uplink-downlink subframe configurations as specified in Table 9.4.4.2.2-3 shall apply.

Table 9.4.4.2.2-2: TDD uplink-downlink subframe configurations applicable for inter-RAT RSTD requirements

PRS Transmission Bandwidth [RB]	Applicable TDD uplink-downlink configurations
6, 15	3, 4 and 5
25	1, 2, 3, 4, 5 and 6
50, 75, 100	0, 1, 2, 3, 4, 5 and 6
NOTE 1: Uplink-downlink configurations are specified in Table 4.2-2 in TS 36.211 [23].	

Table 9.4.4.2.2-3: TDD uplink-downlink subframe configurations applicable for inter-RAT RSTD requirements without gaps

PRS Transmission Bandwidth [RB]	Applicable TDD uplink-downlink configurations
6, 15	1, 2, 3, 4 and 5
25, 50, 75, 100	0, 1, 2, 3, 4, 5 and 6
NOTE: Uplink-downlink configurations are specified in Table 4.2-2 in TS 36.211 [23].	

The UE physical layer shall be capable of reporting RSTD for the reference cell and all the neighbor cells *i* out of at least (*n*-1) neighbor cells within $T_{\text{RSTD InterRAT, E-UTRAN TDD}}$ provided:

$\left(\text{PRS } \hat{\text{E}}_{\text{s}} / \text{Iot}\right)_{ref}$ ≥-6 dB for all Frequency Bands for the reference cell,

$\left(\text{PRS } \hat{\text{E}}_{\text{s}} / \text{Iot}\right)_{i}$ ≥-13 dB for all Frequency Bands for neighbour cell *i*,

$\left(\text{PRS } \hat{\text{E}}_{\text{s}} / \text{Iot}\right)_{ref}$ and $\left(\text{PRS } \hat{\text{E}}_{\text{s}} / \text{Iot}\right)_{i}$ conditions apply for all subframes of at least $L = \frac{M}{2}$ PRS positioning occasions,

PRP $1,2|_{\text{dBm}}$ according to TS 36.133 [15, Annex B.2.6] for a corresponding Band

$\text{PRS } \hat{\text{E}}_{\text{s}} / \text{Iot}$ is as defined in Section 9.4.4.1.2.

The time $T_{\text{RSTD InterRAT, E-UTRAN TDD}}$ starts from the first subframe of the PRS positioning occasion closest in time after both the OTDOA-RequestLocationInformation message and the OTDOA assistance data in the OTDOA-ProvideAssistanceData message via LPP as specified in TS 38.305 [22], are delivered to the physical layer of the UE.

The RSTD measurement accuracy for all measured neighbor cells *i* shall be fulfilled according to the accuracy as specified in Section 10.2.4.

9.4.4.2.2.1 RSTD Measurement Reporting Delay

This requirement assumes that that the measurement report is not delayed by other LPP signalling on the DCCH. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the TTI of the uplink DCCH. The delay uncertainty is: 2 x TTI_{DCCH} where TTI_{DCCH} is the duration of subframe or slot or subslot when the measurement report is transmitted on the PUSCH with subframe or slot or subslot duration. This measurement reporting delay excludes any delay caused by no UL resources for UE to send the measurement report.

9.4.5 SA: Inter-RAT E-CID measurements

9.4.5.1 NR−E-UTRAN FDD E-CID RSRP and RSRQ measurements

9.4.5.1.1 Introduction

The requirements in Section 9.4.5.1. shall apply provided the UE has received ECID-RequestLocationInformation message from LMF via LPP requesting the UE to report inter-RAT E-UTRAN FDD E-CID RSRP and RSRQ measurements [22].

9.4.5.1.2 Requirements

The requirements in Section 9.4.2 also apply for this section except the measurement reporting requirements. The measurement reporting requirements for E-CID RSRP and RSRQ are defined in Section 9.4.5.1.3.

Editor's note: sharing factor is not yet taken into account in this section.

9.4.5.1.3 Measurement Reporting Delay

This requirement assumes that that the measurement report is not delayed by other LPP signalling on the DCCH. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the TTI of the uplink DCCH. The delay uncertainty is: 2 x TTI_{DCCH} where TTI_{DCCH} is the duration of subframe or slot or subslot when the measurement report is transmitted on the PUSCH with subframe or slot or subslot duration. This measurement reporting delay excludes any delay caused by no UL resources for UE to send the measurement report.

Reported RSRP and RSRQ measurements contained in periodically triggered measurement reports shall meet the requirements in Sections 10.2.2 and 10.2.3, respectively.

9.4.5.2 NR−E-UTRAN TDD E-CID RSRP and RSRQ measurements

9.4.5.2.1 Introduction

The requirements in Section 9.4.5.2. shall apply provided the UE has received ECID-RequestLocationInformation message from LMF via LPP requesting the UE to report inter-RAT E-UTRAN TDD E-CID RSRP and RSRQ measurements [22].

9.4.5.2.2 Requirements

The requirements in Section 9.4.3 also apply for this section except the measurement reporting requirements. The measurement reporting requirements for E-CID RSRP and RSRQ are defined in Section 9.4.5.2.3.

Editor's note: sharing factor is not yet taken into account in this section.

9.4.5.2.3 Measurement Reporting Delay

This requirement assumes that that the measurement report is not delayed by other LPP signalling on the DCCH. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the TTI of the uplink DCCH. The delay uncertainty is: 2 x TTI_{DCCH} where TTI_{DCCH} is the duration of subframe or slot or subslot when the measurement report is transmitted on the PUSCH with subframe or slot or subslot duration. This measurement reporting delay excludes any delay caused by no UL resources for UE to send the measurement report.

Reported RSRP and RSRQ measurements contained in periodically triggered measurement reports shall meet the requirements in Sections 10.2.2 and 10.2.3, respectively.

9.5 CSI-RS based measurements

Editors note: this section only addresses CSI-RS for L1-RSRP in FR1.

9.5.1 UE CSI-RS measurements

The UE is required to be capable of measuring CSI-RS for L1-RSRP without measurement gaps. The UE is required to perform the CSI-RS measurements as described in the following clauses.

9.5.1.1 UE performing CSI-RS measurements with a same subcarrier spacing as SSB on FR1

When the SSB is within the active BWP and has same SCS than CSI-RS, the UE shall be able to perform CSI-RS measurement without restrictions when CSI-RS measurement are performed with same subcarrier spacing as the SSB on FR1.

9.5.1.2 CSI-RS measurement restrictions of UE performing CSI-RS measurements with a different subcarrier spacing than SSB on FR1

When the SSB is within the active BWP and has different SCS than CSI-RS, the UE shall be able to performs CSI-RS measurement with restrictions according to its capabilities:

- If CSI-RS and SSB are FDM'ed. the UE measurement capability depends on the whether the UE supports *simultaneousRxDataSSB-DiffNumerology*.
  - If the UE supports *simultaneousRxDataSSB-DiffNumerology* the UE shall be able to performs CSI-RS measurement without restrictions assuming *useServingCellTimingForSync* is enabled.
  - If the UE does not support *simultaneousRxDataSSB-DiffNumerology* the UE is not expected to perform simultaneous FDM'ed SSB and CSI-RS measurements,
- If CSI-RS and SSB are TDM'ed, the UE shall be able to performs CSI-RS measurement with restrictions: the UE is not expected to measure CSI-RS on symbols on 1 data symbol before each consecutive SSB symbols and 1 data symbol after each consecutive SSB symbols within the SMTC window duration.

10 Measurement Performance requirements

Editor's note: Accuracy requirement might be an individual top-level chapter to maintain since it is the performance part.

10.1 NR measurements

10.1.1 Introduction

Editor's note: new measurement metrics may be added according to the RAN4 discussion. Absolute/relative accuracy requirement, mapping table of RSRP/RSRQ may be specified in this section. The numerology and BW combinations might be reflected in the accuracy requirement table.

10.1.2 Intra-frequency RSRP accuracy requirements for FR1

10.1.2.1 Intra-frequency SS RSRP accuracy requirements

10.1.2.1.1 Absolute SS RSRP Accuracy

Unless otherwise specified, the requirements for absolute accuracy of SS RSRP in this clause apply to a cell on the same frequency as that of the serving cell.

The accuracy requirements in Table 10.1.2.1.1-1 are valid under the following conditions:

- Conditions for intra-frequency measurements are fulfilled according to Annex B.2.2 for a corresponding Band for each relevant SSB,

- Other conditions are TBD.

Table 10.1.2.1.1-1: SS RSRP Intra frequency absolute accuracy in FR1

Accuracy		Conditions					
Normal condition	Extreme condition	Ês/Iot	Io Note 1 range				
			NR operating band groups	Minimum Io			Maximum Io
		dB		dBm / SCS$_{SSB}$		dBm/BW$_{Channel}$	dBm/BW$_{Channel}$
dB	dB			SCS$_{SSB}$ = 15 kHz	SCS$_{SSB}$ = 30 kHz		
±[4.5]	±[9]	≥[-6] dB	NRFDD_FR1_A, NRTDD_FR1_A	TBD	TBD	N/A	-70
			NRFDD_FR1_B	TBD	TBD	N/A	-70
			NRTDD_FR1_C	TBD	TBD	N/A	-70
			NRFDD_FR1_E, NRTDD_FR1_E	TBD	TBD	N/A	-70
			NRFDD_FR1_G	TBD	TBD	N/A	-70
			NRFDD_FR1_H	TBD	TBD	N/A	-70
±[8]	±[11]	≥[-6] dB	All	N/A	N/A	-70	-50
NOTE 1: Io is assumed to have constant EPRE across the bandwidth.							

Editor's note: the minimum Io conditions in this table are subjected to the SSB SCS used and they are calculated according to system noise PN and received minimum RSRP requirement.

10.1.2.1.2 Relative SS RSRP Accuracy

The relative accuracy of SS RSRP is defined as the SS RSRP measured from one cell compared to the SS RSRP measured from another cell on the same frequency.

The accuracy requirements in Table 10.1.2.1.2-1 are valid under the following conditions:

- Conditions for intra-frequency measurements are fulfilled according to Annex B.2.2 for a corresponding Band for each relevant SSB,

- Other conditions are TBD.

Table 10.1.2.1.2-1: SS RSRP Intra frequency relative accuracy in FR1

Accuracy		Conditions					
Normal condition	Extreme condition	Ês/Iot	Io Note 1 range				
			NR operating band groups	Minimum Io			Maximum Io
		dB		dBm / SCS$_{SSB}$		dBm/BW$_{Channel}$	dBm/BW$_{Channel}$
dB	dB			SCS$_{SSB}$ = 15 kHz	SCS$_{SSB}$ = 30 kHz		
±[2]	±[3]	≥[-3] dB	NRFDD_FR1_A, NRTDD_FR1_A	TBD	TBD	N/A	-50
			NRFDD_FR1_B	TBD	TBD	N/A	-50
			NRTDD_FR1_C	TBD	TBD	N/A	-50
			NRFDD_FR1_E, NRTDD_FR1_E	TBD	TBD	N/A	-50
			NRFDD_FR1_G	TBD	TBD	N/A	-50
			NRFDD_FR1_H	TBD	TBD	N/A	-50
±[3]	±[3]	≥[-6] dB	Note 3	Note 3	Note 3	N/A	Note 3
NOTE 1: Io is assumed to have constant EPRE across the bandwidth. NOTE 2: The parameter Ês/Iot is the minimum Ês/Iot of the pair of cells to which the requirement applies. NOTE 3: The same bands and the same Io conditions for each band apply for this requirement as for the corresponding highest accuracy requirement.							

Editor's note: the minimum Io conditions in this table are subjected to the SSB SCS used and they are calculated according to system noise PN and received minimum RSRP requirement.

10.1.2.2 Intra-frequency [CSI-RS RSRP] accuracy requirements

10.1.3 Intra-frequency RSRP accuracy requirements for FR2

10.1.3.1 Intra-frequency SS RSRP accuracy requirements

10.1.3.1.1 Absolute SS RSRP Accuracy

Unless otherwise specified, the requirements for absolute accuracy of SS RSRP in this clause apply to a cell on the same frequency as that of the serving cell.

The accuracy requirements in Table 10.1.3.1.1-1 are valid under the following conditions:

- Conditions for intra-frequency measurements are fulfilled according to Annex B.2.2 for a corresponding Band for each relevant SSB,
- Other conditions are TBD.

Table 10.1.3.1.1-1: SS RSRP Intra frequency absolute accuracy

Accuracy		Conditions					
			Io Note 1 range				
Normal condition	Extreme condition	Ês/Iot	NR operating band groups	Minimum Io			Maximum Io
dB	dB	dB		dBm/120kHz SSB SCS	dBm/240kHz SSB SCS	$dBm/BW_{Channel}$	$dBm/BW_{Channel}$
±[6]	±[9]	TBD	TBD	TBD	TBD	TBD	TBD
			TBD	TBD	TBD	TBD	TBD
			TBD	TBD	TBD	TBD	TBD
			TBD	TBD	TBD	TBD	TBD
±[8]	±[11]	TBD	TBD	TBD	TBD	TBD	TBD
NOTE 1: Io is assumed to have constant EPRE across the bandwidth.							

10.1.3.1.2 Relative SS RSRP Accuracy

The relative accuracy of SS RSRP is defined as the SS RSRP measured from one cell compared to the SS RSRP measured from another cell on the same frequency.

The accuracy requirements in Table 10.1.3.1.2-1 are valid under the following conditions:

- Conditions for intra-frequency measurements are fulfilled according to Annex B.2.2 for a corresponding Band for each relevant SSB,
- Other conditions are TBD.

Table 10.1.3.1.2-1: SS RSRP Intra frequency relative accuracy

Accuracy		Conditions					
Normal condition	Extreme condition	Ês/Iot	Io Note 1 range				
			NR operating band groups	Minimum Io			Maximum Io
dB	dB	dB		dBm/120kHz SSB SCS	dBm/240kHz SSB SCS	dBm/$BW_{Channel}$	dBm/$BW_{Channel}$
±[6]	±[9]	TBD	TBD	TBD	TBD	TBD	TBD
			TBD	TBD	TBD	TBD	TBD
			TBD	TBD	TBD	TBD	TBD
			TBD	TBD	TBD	TBD	TBD
NOTE 1: Io is assumed to have constant EPRE across the bandwidth. NOTE 2: The parameter Ês/Iot is the minimum Ês/Iot of the pair of cells to which the requirement applies.							

10.1.3.2 Intra-frequency [CSI-RS RSRP] accuracy requirements

10.1.4 Inter-frequency RSRP accuracy requirements for FR1

10.1.4.1 Inter-frequency SS RSRP accuracy requirements

10.1.4.1.1 Absolute Accuracy of SS RSRP

The requirements for absolute accuracy of SS RSRP in this clause apply to a cell that has different carrier frequency from the serving cell.

The accuracy requirements in Table 10.1.4.1.1-1 are valid under the following conditions:

- Conditions for inter-frequency measurements are fulfilled according to Annex B.2.3 for a corresponding Band for each relevant SSB,
- Other conditions are TBD.

10.1.4.1.2 Relative Accuracy of SS RSRP

The relative accuracy of SS RSRP in inter frequency case is defined as the RSRP measured from one cell compared to the RSRP measured from another cell on a different frequency.

The accuracy requirements in Table 10.1.4.1.2-1 are valid under the following conditions:

- Conditions for inter-frequency measurements are fulfilled according to Annex B.2.3 for a corresponding Band for each relevant SSB,
- Other conditions are TBD.

Table 10.1.4.1.2-1: SS RSRP Inter frequency relative accuracy in FR1

Accuracy		Conditions					
Normal condition	Extreme condition	Ês/Iot	Io Note 1 range				
			NR operating band groups	Minimum Io			Maximum Io
dB	dB	dB		dBm / SCS_{SSB}		dBm/$BW_{Channel}$	dBm/$BW_{Channel}$
				SCS_{SSB} = 15 kHz	SCS_{SSB} = 30 kHz		
±[4.5]	±[6]	≥[-4] dB	NRFDD_FR1_A, NRTDD_FR1_A	TBD	TBD	N/A	-50
			NRFDD_FR1_B	TBD	TBD	N/A	-50
			NRTDD_FR1_C	TBD	TBD	N/A	-50
			NRFDD_FR1_E, NRTDD_FR1_E	TBD	TBD	N/A	-50
			NRFDD_FR1_G	TBD	TBD	N/A	-50
			NRFDD_FR1_H	TBD	TBD	N/A	-50
NOTE 1: Io is assumed to have constant EPRE across the bandwidth. NOTE 2: The parameter Ês/Iot is the minimum Ês/Iot of the pair of cells to which the requirement applies.							

Editor's note: the minimum Io conditions in this table are subjected to the SSB SCS used and they are calculated according to system noise PN and received minimum RSRP requirement.

10.1.4.2 Inter-frequency [CSI-RS RSRP] accuracy requirements

10.1.5 Inter-frequency RSRP accuracy requirementsfor FR2

10.1.5.1 Inter-frequency SS RSRP accuracy requirements

10.1.5.1.1 Absolute SS RSRP Accuracy

Unless otherwise specified, the requirements for absolute accuracy of SS RSRP in this clause apply to a cell that is on a different frequency than the serving cell.

The accuracy requirements in Table 10.1.5.1.1-1 are valid under the following conditions:

- Conditions for inter-frequency measurements are fulfilled according to Annex B.2.3 for a corresponding Band for each relevant SSB,
- Other conditions are TBD.

Table 10.1.5.1.1-1: SS RSRP Inter frequency absolute accuracy

Accuracy		Conditions					
Normal condition	Extreme condition	Ês/Iot	Io Note 1 range				
			NR operating band groups	Minimum Io			Maximum Io
dB	dB	dB		dBm/120kHz SSB SCS	dBm/240kHz SSB SCS	dBm/$BW_{Channel}$	dBm/$BW_{Channel}$
±[6]	±[9]	TBD	TBD	TBD	TBD	TBD	TBD
			TBD	TBD	TBD	TBD	TBD
			TBD	TBD	TBD	TBD	TBD
			TBD	TBD	TBD	TBD	TBD
±[8]	±[11]	TBD	TBD	TBD	TBD	TBD	TBD
NOTE 1: Io is assumed to have constant EPRE across the bandwidth.							

10.1.5.1.2 Relative SS RSRP Accuracy

The relative accuracy of SS RSRP is defined as the SS RSRP measured from one cell compared to the SS RSRP measured from another cell on another frequency.

The accuracy requirements in Table 10.1.5.1.2-1 are valid under the following conditions:

- Conditions for inter-frequency measurements are fulfilled according to Annex B.2.3 for a corresponding Band for each relevant SSB,
- Other conditions are TBD.

Table 10.1.5.1.2-1: SS RSRP Inter frequency relative accuracy

Accuracy		Conditions					
Normal condition	Extreme condition	Ês/Iot	Io Note 1 range				
			NR operating band groups	Minimum Io			Maximum Io
dB	dB	dB		dBm/120kHz SSB SCS	dBm/240kHz SSB SCS	dBm/$BW_{Channel}$	dBm/$BW_{Channel}$
±[6]	±[9]	TBD	TBD	TBD	TBD	TBD	TBD
			TBD	TBD	TBD	TBD	TBD
			TBD	TBD	TBD	TBD	TBD
			TBD	TBD	TBD	TBD	TBD
NOTE 1: Io is assumed to have constant EPRE across the bandwidth. NOTE 2: The parameter Ês/Iot is the minimum Ês/Iot of the pair of cells to which the requirement applies.							

10.1.5.2 Inter-frequency [CSI-RS RSRP] accuracy requirements

10.1.6 RSRP Measurement Report Mapping

The reporting range of SS-RSRP for L3 reporting is defined from -156 dBm to -31 dBm with 1 dB resolution. The reporting range of SS-RSRP and CSI-RSRP for L1 reporting is defined from -140 to -40dBm with 1dB resolution.

The mapping of measured quantity is defined in Table 10.1.6.1-1. The range in the signalling may be larger than the guaranteed accuracy range.

The reporting range of differential SS-RSRP and CSI-RSRP for L1 reporting is defined from 0 dBm to -30 dB with 2 dB resolution.

The mapping of measured quantity is defined in Table 10.1.6.1-2. The range in the signalling may be larger than the guaranteed accuracy range.

Table 10.1.6.1-1: SS-RSRP and CSI-RSRP measurement report mapping

Reported value	Measured quantity value(L3 SS-RSRP)	Measured quantity value(L1 SS-RSRP and CSI-RSRP)	Unit
RSRP_0	SS-RSRP<-156	Not valid	dBm
RSRP_1	-156≤ SS-RSRP<-155	Not valid	dBm
RSRP_2	-155≤ SS-RSRP<-154	Not valid	dBm
RSRP_3	-154≤ SS-RSRP<-153	Not valid	dBm
RSRP_4	-153≤ SS-RSRP<-152	Not valid	dBm
RSRP_5	-152≤ SS-RSRP<-151	Not valid	dBm
RSRP_6	-151≤ SS-RSRP<-150	Not valid	dBm
RSRP_7	-150≤ SS-RSRP<-149	Not valid	dBm
RSRP_8	-149≤ SS-RSRP<-148	Not valid	dBm
RSRP_9	-148≤ SS-RSRP<-147	Not valid	dBm
RSRP_10	-147≤ SS-RSRP<-146	Not valid	dBm
RSRP_11	-146≤ SS-RSRP<-145	Not valid	dBm
RSRP_12	-145≤ SS-RSRP<-144	Not valid	dBm
RSRP_13	-144≤ SS-RSRP<-143	Not valid	dBm
RSRP_14	-143≤ SS-RSRP<-142	Not valid	dBm
RSRP_15	-142≤ SS-RSRP<-141	Not valid	dBm
RSRP_16	-141≤ SS-RSRP<-140	Not valid	dBm
RSRP_17	-140≤ SS-RSRP<-139	RSRP<-139	dBm
RSRP_18	-139≤ SS-RSRP<-138	-139≤ RSRP<-138	dBm
…	…		…
RSRP_111	-46≤ SS-RSRP<-45	-46≤ RSRP<-45	dBm
RSRP_112	-45≤ SS-RSRP<-44	-45≤ RSRP	dBm
RSRP_113	-44≤ SS-RSRP<-43	Not valid	dBm
RSRP_114	-43≤ SS-RSRP<-42	Not valid	dBm
RSRP_115	-42≤ SS-RSRP<-41	Not valid	dBm
RSRP_116	-41≤ SS-RSRP<-40	Not valid	dBm
RSRP_117	-40≤ SS-RSRP<-39	Not valid	dBm
RSRP_118	-39≤ SS-RSRP<-38	Not valid	dBm
RSRP_119	-38≤ SS-RSRP<-37	Not valid	dBm
RSRP_120	-37≤ SS-RSRP<-36	Not valid	dBm
RSRP_121	-36≤ SS-RSRP<-35	Not valid	dBm
RSRP_122	-35≤ SS-RSRP<-34	Not valid	dBm
RSRP_123	-34≤ SS-RSRP<-33	Not valid	dBm
RSRP_124	-33≤ SS-RSRP<-32	Not valid	dBm
RSRP_125	-32≤ SS-RSRP<-31	Not valid	dBm
RSRP_126	-31≤ SS-RSRP	Not valid	dBm
RSRP_127	Infinity	Not valid	dBm

Table 10.1.6.1-2:Differential SS-RSRP and CSI-RSRP measurement report mapping

Reported value	Measured quantity value(difference in measured RSRP from strongest RSRP)	Unit
DIFFRSRP_0	0≥ΔRSRP>-2	dB
DIFFRSRP_1	-2≥ΔRSRP>-4	dB
DIFFRSRP_2	-4≥ΔRSRP>-6	dB
DIFFRSRP_3	-6≥ΔRSRP>-8	dB
DIFFRSRP_4	-8≥ΔRSRP>-10	dB
DIFFRSRP_5	-10≥ΔRSRP>-12	dB
DIFFRSRP_6	-12≥ΔRSRP>-14	dB
DIFFRSRP_7	-14≥ΔRSRP>-16	dB
DIFFRSRP_8	-16≥ΔRSRP>-18	dB
DIFFRSRP_9	-18≥ΔRSRP>-20	dB
DIFFRSRP_10	-20≥ΔRSRP>-22	dB
DIFFRSRP_11	-22≥ΔRSRP>-24	dB
DIFFRSRP_12	-24≥ΔRSRP>-26	dB
DIFFRSRP_13	-26≥ΔRSRP>-28	dB
DIFFRSRP_14	-28≥ΔRSRP>-30	dB
DIFFRSRP_15	-30≥ΔRSRP	dB

10.1.7 Intra-frequency RSRQ accuracy requirements for FR1

10.1.7.1 Intra-frequency SS RSRQ accuracy requirements in FR1

10.1.7.1.1 Absolute SS RSRQ Accuracy in FR1

Unless otherwise specified, the requirements for absolute accuracy of SS RSRQ in this clause apply to a cell on the same frequency as that of the serving cell in FR1.

The accuracy requirements in Table 10.1.7.1.1-1 are valid under the following conditions:

- Conditions for intra-frequency measurements are fulfilled according to Annex B.2.2 for a corresponding Band for each relevant SSB,
- Other conditions are TBD.

Table 10.1.7.1.1-1: SS RSRQ Intra frequency absolute accuracy in FR1

Accuracy		Conditions					
			Io Note 1 range				
Normal condition	Extreme condition	Ês/Iot	NR operating band groups	Minimum Io			Maximum Io
dB	dB	dB		dBm / SCS_{SSB}		dBm/$BW_{Channel}$	dBm/$BW_{Channel}$
				SCS_{SSB} = 15 kHz	SCS_{SSB} = 30 kHz		
±[2.5]	±[4]	≥[-3] dB	NRFDD_FR1_A, NRTDD_FR1_A	TBD	TBD	N/A	-50
			NRFDD_FR1_B	TBD	TBD	N/A	-50
			NRTDD_FR1_C	TBD	TBD	N/A	-50
			NRFDD_FR1_E, NRTDD_FR1_E	TBD	TBD	N/A	-50
			NRFDD_FR1_G	TBD	TBD	N/A	-50
			NRFDD_FR1_H	TBD	TBD	N/A	-50
±[3.5]	±[4]	≥[-6] dB	Note 2	Note 2	Note 2	Note 2	Note 2

NOTE 1: Io is assumed to have constant EPRE across the bandwidth.
NOTE 2: The same bands and the same Io conditions for each band apply for this requirement as for the corresponding highest accuracy requirement.

10.1.8 Intra-frequency RSRQ accuracy requirements for FR2

10.1.8.1 Intra-frequency SS RSRQ accuracy requirements in FR2

10.1.8.1.1 Absolute SS RSRQ Accuracy in FR2

Unless otherwise specified, the requirements for absolute accuracy of SS RSRQ in this clause apply to a cell on the same frequency as that of the serving cell in FR2.

The accuracy requirements in Table 10.1.8.1.1-1 are valid under the following conditions:

- Conditions for intra-frequency measurements are fulfilled according to Annex B.2.2 for a corresponding Band for each relevant SSB,

- Other conditions are TBD.

Table 10.1.8.1.1-1: SS RSRQ Intra frequency absolute accuracy in FR2

Accuracy		Conditions					
			Io Note 1 range				
Normal condition	Extreme condition	Ês/Iot	NR operating band groups	Minimum Io			Maximum Io
dB	dB	dB		dBm / SCS_{SSB}		dBm/$BW_{Channel}$	dBm/$BW_{Channel}$
				SCS_{SSB} = 120 kHz	SCS_{SSB} = 240 kHz		
±[2.5]	±[4]	≥[TBD] dB	NR_TDD_FR2_A	TBD	TBD	N/A	-50
			NR_TDD_FR2_B	TBD	TBD	N/A	-50
			NR_TDD_FR2_F	TBD	TBD	N/A	-50
			NR_TDD_FR2_G	TBD	TBD	N/A	-50
			NR_TDD_FR2_T	TBD	TBD	N/A	-50
			NR_TDD_FR2_Y	TBD	TBD	N/A	-50
±[3.5]	±[4]	≥[TBD] dB	Note 2	Note 2	Note 2	Note 2	Note 2

NOTE 1: Io is assumed to have constant EPRE across the bandwidth.
NOTE 2: The same bands and the same Io conditions for each band apply for this requirement as for the corresponding highest accuracy requirement.

10.1.9 Inter-frequency RSRQ accuracy requirements for FR1

10.1.9.1 Inter-frequency SS RSRQ accuracy requirements in FR1

10.1.9.1.1 Aboslute Accuracy of SS RSRQ in FR1

The requirements for absolute accuracy of SS RSRQ in this clause apply to a cell on a frequency in FR1 that has different carrier frequency from the serving cell.

The accuracy requirements in Table 10.1.9.1.1-1 are valid under the following conditions:

- Conditions for inter-frequency measurements are fulfilled according to Annex B.2.3 for a corresponding Band for each relevant SSB,

- Other conditions are TBD.

Table 10.1.9.1.1-1: SS RSRQ Inter frequency absolute accuracy in FR1

Accuracy		Conditions					
Normal condition	Extreme condition	Ês/Iot	Io Note 1 range				
			NR operating band groups	Minimum Io			Maximum Io
dB	dB	dB		dBm / SCS_{SSB}		dBm/$BW_{Channel}$	dBm/$BW_{Channel}$
				SCS_{SSB} = 15 kHz	SCS_{SSB} = 30 kHz		
±[2.5]	±[4]	≥[-3] dB	NRFDD_FR1_A, NRTDD_FR1_A	TBD	TBD	N/A	-50
			NRFDD_FR1_B	TBD	TBD	N/A	-50
			NRTDD_FR1_C	TBD	TBD	N/A	-50
			NRFDD_FR1_E, NRTDD_FR1_E	TBD	TBD	N/A	-50
			NRFDD_FR1_G	TBD	TBD	N/A	-50
			NRFDD_FR1_H	TBD	TBD	N/A	-50
±[3.5]	±[4]	≥[-4] dB	Note 2	Note 2	Note 2	Note 2	Note 2
NOTE 1: Io is assumed to have constant EPRE across the bandwidth. NOTE 2: The same bands and the same Io conditions for each band apply for this requirement as for the corresponding highest accuracy requirement.							

10.1.9.1.2 Relative Accuracy of SS RSRQ in FR1

The relative accuracy of SS RSRQ in inter frequency case is defined as the RSRQ measured from one cell on a frequency in FR1 compared to the RSRP measured from another cell on a different frequency in FR1.

The accuracy requirements in Table 10.1.9.1.2-1 are valid under the following conditions:

- Conditions for inter-frequency measurements are fulfilled according to Annex B.2.3 for a corresponding Band for each relevant SSB,

- Other conditions are TBD.

Table 10.1.9.1.2-1: SS RSRQ Inter frequency relative accuracy in FR1

Accuracy		Conditions					
Normal condition	Extreme condition	Ês/Iot Note 2	Io Note 1 range				
			NR operating band groups	Minimum Io			Maximum Io
dB	dB	dB		dBm / SCS_{SSB}		dBm/$BW_{Channel}$	dBm/$BW_{Channel}$
				SCS_{SSB} = 15 kHz	SCS_{SSB} = 30 kHz		
±[3]	±[4]	≥[-3] dB	NRFDD_FR1_A, NRTDD_FR1_A	TBD	TBD	N/A	-50
			NRFDD_FR1_B	TBD	TBD	N/A	-50
			NRTDD_FR1_C	TBD	TBD	N/A	-50
			NRFDD_FR1_E, NRTDD_FR1_E	TBD	TBD	N/A	-50
			NRFDD_FR1_G	TBD	TBD	N/A	-50
			NRFDD_FR1_H	TBD	TBD	N/A	-50
±[4]	±[4]	≥[-4] dB	Note 3	Note 3	Note 3	Note 3	Note 3

NOTE 1: Io is assumed to have constant EPRE across the bandwidth.
NOTE 2: The parameter Ês/Iot is the minimum Ês/Iot of the pair of cells to which the requirement applies.
NOTE 3: The same bands and the same Io conditions for each band apply for this requirement as for the corresponding highest accuracy requirement.

10.1.10 Inter-frequency RSRQ accuracy requirements for FR2

10.1.10.1 Inter-frequency SS RSRQ accuracy requirements in FR2

10.1.10.1.1 Aboslute Accuracy of SS RSRQ in FR2

The requirements for absolute accuracy of SS RSRQ in this clause apply to a cell on a frequency in FR2 that has different carrier frequency from the serving cell.

The accuracy requirements in Table 10.1.10.1.1-1 are valid under the following conditions:

- Conditions for inter-frequency measurements are fulfilled according to Annex B.2.3 for a corresponding Band for each relevant SSB,
- Other conditions are TBD.

Table 10.1.10.1.1-1: SS RSRQ Inter frequency absolute accuracy in FR2

Accuracy		Conditions					
Normal condition	Extreme condition	Ês/Iot	Io Note 1 range				
			NR operating band groups	Minimum Io			Maximum Io
dB	dB	dB		dBm / SCS_{SSB}		dBm/$BW_{Channel}$	dBm/$BW_{Channel}$
				SCS_{SSB} = 120 kHz	SCS_{SSB} = 240 kHz		
±[2.5]	±[4]	≥[TBD] dB	NR_TDD_FR2_A	TBD	TBD	N/A	-50
			NR_TDD_FR2_B	TBD	TBD	N/A	-50
			NR_TDD_FR2_F	TBD	TBD	N/A	-50
			NR_TDD_FR2_G	TBD	TBD	N/A	-50
			NR_TDD_FR2_T	TBD	TBD	N/A	-50
			NR_TDD_FR2_Y	TBD	TBD	N/A	-50
±[3.5]	±[4]	≥[TBD] dB	Note 2	Note 2	Note 2	Note 2	Note 2

NOTE 1: Io is assumed to have constant EPRE across the bandwidth.
NOTE 2: The same bands and the same Io conditions for each band apply for this requirement as for the corresponding highest accuracy requirement.

10.1.10.1.2 Relative Accuracy of SS RSRQ in FR2

The relative accuracy of SS RSRQ in inter frequency case is defined as the RSRQ measured from one cell on a frequency in FR2 compared to the RSRP measured from another cell on a different frequency in FR2.

The accuracy requirements in Table 10.1.10.1.2-1 are valid under the following conditions:

- Conditions for inter-frequency measurements are fulfilled according to Annex B.2.3 for a corresponding Band for each relevant SSB,
- Other conditions are TBD.

Table 10.1.10.1.2-1: SS RSRQ Inter frequency relative accuracy in FR2

Accuracy		Conditions					
Normal condition	Extreme condition	Ês/Iot Note 2	Io Note 1 range				
			NR operating band groups	Minimum Io			Maximum Io
dB	dB	dB		dBm / SCS_{SSB}		dBm/$BW_{Channel}$	dBm/$BW_{Channel}$
				SCS_{SSB} = 120 kHz	SCS_{SSB} = 240 kHz		
±[3]	±[4]	≥[TBD] dB	NR_TDD_FR2_A	TBD	TBD	N/A	-50
			NR_TDD_FR2_B	TBD	TBD	N/A	-50
			NR_TDD_FR2_F	TBD	TBD	N/A	-50
			NR_TDD_FR2_G	TBD	TBD	N/A	-50
			NR_TDD_FR2_T	TBD	TBD	N/A	-50
			NR_TDD_FR2_Y	TBD	TBD	N/A	-50
±[4]	±[4]	≥[TBD] dB	Note 3	Note 3	Note 3	Note 3	Note 3

NOTE 1: Io is assumed to have constant EPRE across the bandwidth.
NOTE 2: The parameter Ês/Iot is the minimum Ês/Iot of the pair of cells to which the requirement applies.
NOTE 3: The same bands and the same Io conditions for each band apply for this requirement as for the corresponding highest accuracy requirement.

10.1.11 RSRQ report mapping

10.1.11.1 SS-RSRQ measurement report mapping

The reporting range of SS-RSRQ is defined from -43 dB to 20 dB with 0.5 dB resolution. The mapping of measured quantity is defined in Table 10.1.11.1-1. The range in the signalling may be larger than the guaranteed accuracy range.

Table 10.1.11.1-1: SS-RSRQ measurement report mapping

Reported value	Measured quantity value	Unit
SS-RSRQ_0	SS-RSRQ<-43	dB
SS-RSRQ_1	-43≤ SS-RSRQ<-42.5	dB
SS-RSRQ_2	-42.5≤ SS-RSRQ<-42	dB
SS-RSRQ_3	-42≤ SS-RSRQ<-41.5	dB
SS-RSRQ_4	-41.5≤ SS-RSRQ<-41	dB
..	..	…
SS-RSRQ_122	17.5≤ SS-RSRQ<18	dB
SS-RSRQ_123	18≤ SS-RSRQ<18.5	dB
SS-RSRQ_124	18.5≤ SS-RSRQ<19	dB
SS-RSRQ_125	19≤ SS-RSRQ<19.5	dB
SS-RSRQ_126	19.5≤ SS-RSRQ<20	dB

10.1.12 Intra-frequency SINR accuracy requirements for FR1

10.1.12.1 Intra-frequency SS-SINR accuracy requirements in FR1

10.1.12.1.1 Absolute SS-SINR Accuracy in FR1

Unless otherwise specified, the requirements for absolute accuracy of SS-SINR in this clause apply to a cell on the same frequency as that of the serving cell in FR1.

The accuracy requirements in Table 10.1.12.1.1-1 are valid under the following conditions:

- Conditions for intra-frequency measurements are fulfilled according to Annex B.2.2 for a corresponding Band.
- Other conditions are TBD.

Table 10.1.12.1.1-1: SS-SINR Intra frequency absolute accuracy in FR1

Accuracy		Conditions					
Normal condition	Extreme condition	SSB Ês/Iot	Io Note 1 range				
			NR operating band groups	Minimum Io			Maximum Io
dB	dB	dB		dBm / SCS_{SSB}		dBm/$BW_{Channel}$	dBm/$BW_{Channel}$
				SCS_{SSB} = 15 kHz	SCS_{SSB} = 30 kHz		
±[3.0]	±[4]	≥[-3] dB	NRFDD_FR1_A, NRTDD_FR1_A	TBD	TBD	N/A	-50
			NRFDD_FR1_B	TBD	TBD	N/A	-50
			NRTDD_FR1_C	TBD	TBD	N/A	-50
			NRFDD_FR1_E, NRTDD_FR1_E	TBD	TBD	N/A	-50
			NRFDD_FR1_G	TBD	TBD	N/A	-50
			NRFDD_FR1_H	TBD	TBD	N/A	-50
±[3.5]	±[4]	≥[-6] dB	Note 2	Note 2	Note 2	Note 2	Note 2
NOTE 1: Io is assumed to have constant EPRE across the bandwidth. NOTE 2: The same bands and the same Io conditions for each band apply for this requirement as for the corresponding highest accuracy requirement. NOTE 3: The requirements apply for SSB Ês/Iot ≤ [25] dB.							

10.1.13 Intra-frequency SINR accuracy requirements for FR2

10.1.13.1 Intra-frequency SS-SINR accuracy requirements in FR2

10.1.13.1.1 Absolute SS-SINR Accuracy in FR2

Unless otherwise specified, the requirements for absolute accuracy of SS-SINR in this clause apply to a cell on the same frequency as that of the serving cell in FR2.

The accuracy requirements in Table 10.1.13.1.1-1 are valid under the following conditions:

Conditions for intra-frequency measurements are fulfilled according to Annex B.2.2 for a corresponding Band.

Other conditions are TBD.

Table 10.1.13.1.1-1: SS-SINR Intra frequency absolute accuracy in FR2

Accuracy		Conditions					
Normal condition	Extreme condition	SSB Ês/Iot	Io Note 1 range				
			NR operating band groups	Minimum Io			Maximum Io
dB	dB	dB		dBm / SCS_{SSB}		dBm/$BW_{Channel}$	dBm/$BW_{Channel}$
				SCS_{SSB} = 120 kHz	SCS_{SSB} = 240 kHz		
±[3.0]	±[4]	≥[TBD] dB	NR_TDD_FR2_A	TBD	TBD	N/A	-50
			NR_TDD_FR2_B	TBD	TBD	N/A	-50
			NR_TDD_FR2_F	TBD	TBD	N/A	-50
			NR_TDD_FR2_G	TBD	TBD	N/A	-50
			NR_TDD_FR2_T	TBD	TBD	N/A	-50
			NR_TDD_FR2_Y	TBD	TBD	N/A	-50
±[3.5]	±[4]	≥[TBD] dB	Note 2	Note 2	Note 2	Note 2	Note 2

NOTE 1: Io is assumed to have constant EPRE across the bandwidth.
NOTE 2: The same bands and the same Io conditions for each band apply for this requirement as for the corresponding highest accuracy requirement.
NOTE 3: The requirements apply for SSB Ês/Iot ≤ [TBD] dB.

10.1.14 Inter-frequency SINR accuracy requirements for FR1

10.1.14.1 Inter-frequency SS-SINR accuracy requirements in FR1

10.1.14.1.1 Aboslute Accuracy of SS-SINR in FR1

The requirements for absolute accuracy of SS-SINR in this clause apply to a cell on a frequency in FR1 that has different carrier frequency from the serving cell.

The accuracy requirements in Table 10.1.14.1.1-1 are valid under the following conditions:

Conditions for inter-frequency measurements are fulfilled according to Annex B.2.3 for a corresponding Band.

Other conditions are TBD.

Table 10.1.14.1.1-1: SS-SINR Inter frequency absolute accuracy in FR1

Accuracy		Conditions					
Normal condition	Extreme condition	SSB Ês/Iot	Io Note 1 range				
			NR operating band groups	Minimum Io			Maximum Io
dB	dB	dB		dBm / SCS_{SSB}		dBm/$BW_{Channel}$	dBm/$BW_{Channel}$
				SCS_{SSB} = 15 kHz	SCS_{SSB} = 30 kHz		
±[3.0]	±[4]	≥[-3] dB	NRFDD_FR1_A, NRTDD_FR1_A	TBD	TBD	N/A	-50
			NRFDD_FR1_B	TBD	TBD	N/A	-50
			NRTDD_FR1_C	TBD	TBD	N/A	-50
			NRFDD_FR1_E, NRTDD_FR1_E	TBD	TBD	N/A	-50
			NRFDD_FR1_G	TBD	TBD	N/A	-50
			NRFDD_FR1_H	TBD	TBD	N/A	-50
±[3.5]	±[4]	≥[-4] dB	Note 2	Note 2	Note 2	Note 2	Note 2

NOTE 1: Io is assumed to have constant EPRE across the bandwidth.
NOTE 2: The same bands and the same Io conditions for each band apply for this requirement as for the corresponding highest accuracy requirement.
NOTE 3: The requirements apply for SSB Ês/Iot ≤ [25] dB.

10.1.15 Inter-frequency SINR accuracy requirements for FR2

10.1.15.1 Inter-frequency SS-SINR accuracy requirements in FR2

10.1.15.1.1 Aboslute Accuracy of SS-SINR in FR2

The requirements for absolute accuracy of SS-SINR in this clause apply to a cell on a frequency in FR2 that has different carrier frequency from the serving cell.

The accuracy requirements in Table 10.1.15.1.1-1 are valid under the following conditions:

Conditions for inter-frequency measurements are fulfilled according to Annex B.2.3 for a corresponding Band.

Other conditions are TBD.

Table 10.1.15.1.1-1: SS-SINR Inter frequency absolute accuracy in FR2

<table>
<tr><th colspan="2">Accuracy</th><th colspan="6">Conditions</th></tr>
<tr><th rowspan="2">Normal condition</th><th rowspan="2">Extreme condition</th><th rowspan="2">SSB Ês/Iot</th><th colspan="5">Io Note 1 range</th></tr>
<tr><th>NR operating band groups</th><th colspan="3">Minimum Io</th><th>Maximum Io</th></tr>
<tr><th rowspan="2">dB</th><th rowspan="2">dB</th><th rowspan="2">dB</th><th rowspan="2"></th><th colspan="2">dBm / SCS_{SSB}</th><th rowspan="2">dBm/BW_{Channel}</th><th rowspan="2">dBm/BW_{Channel}</th></tr>
<tr><th>SCS_{SSB} = 120 kHz</th><th>SCS_{SSB} = 240 kHz</th></tr>
<tr><td rowspan="6">±[3.0]</td><td rowspan="6">±[4]</td><td rowspan="6">≥[TBD] dB</td><td>NR_TDD_FR2_A</td><td>TBD</td><td>TBD</td><td>N/A</td><td>-50</td></tr>
<tr><td>NR_TDD_FR2_B</td><td>TBD</td><td>TBD</td><td>N/A</td><td>-50</td></tr>
<tr><td>NR_TDD_FR2_F</td><td>TBD</td><td>TBD</td><td>N/A</td><td>-50</td></tr>
<tr><td>NR_TDD_FR2_G</td><td>TBD</td><td>TBD</td><td>N/A</td><td>-50</td></tr>
<tr><td>NR_TDD_FR2_T</td><td>TBD</td><td>TBD</td><td>N/A</td><td>-50</td></tr>
<tr><td>NR_TDD_FR2_Y</td><td>TBD</td><td>TBD</td><td>N/A</td><td>-50</td></tr>
<tr><td>±[3.5]</td><td>±[4]</td><td>≥[TBD] dB</td><td>Note 2</td><td>Note 2</td><td>Note 2</td><td>Note 2</td><td>Note 2</td></tr>
<tr><td colspan="8">NOTE 1: Io is assumed to have constant EPRE across the bandwidth.
NOTE 2: The same bands and the same Io conditions for each band apply for this requirement as for the corresponding highest accuracy requirement.
NOTE 3: The requirements apply for SSB Ês/Iot ≤ [TBD] dB.</td></tr>
</table>

10.1.15.1.2 Relative Accuracy of SS-SINR in FR2

The relative accuracy of SS-SINR in inter frequency case is defined as the SS-SINR measured from one cell on a frequency in FR2 compared to the SS-SINR measured from another cell on a different frequency in FR2.

The accuracy requirements in Table 10.1.15.1.2-1 are valid under the following conditions:

Conditions for inter-frequency measurements are fulfilled according to Annex B.2.3 for a corresponding Band.

Other conditions are TBD.

Table 10.1.14.1.2-1: SS-SINR Inter frequency relative accuracy in FR2

Accuracy		Conditions					
Normal condition	Extreme condition	SSB Ês/Iot Note 2	Io Note 1 range				
			NR operating band groups	Minimum Io			Maximum Io
dB	dB	dB		dBm / SCS_{SSB}		dBm/$BW_{Channel}$	dBm/$BW_{Channel}$
				SCS_{SSB} = 120 kHz	SCS_{SSB} = 240 kHz		
±[3.5]	±[4]	≥[TBD] dB	NR_TDD_FR2_A	TBD	TBD	N/A	-50
			NR_TDD_FR2_B	TBD	TBD	N/A	-50
			NR_TDD_FR2_F	TBD	TBD	N/A	-50
			NR_TDD_FR2_G	TBD	TBD	N/A	-50
			NR_TDD_FR2_T	TBD	TBD	N/A	-50
			NR_TDD_FR2_Y	TBD	TBD	N/A	-50
±[4]	±[4]	≥[TBD] dB	Note 3	Note 3	Note 3	Note 3	Note 3

NOTE 1: Io is assumed to have constant EPRE across the bandwidth.
NOTE 2: The parameter SSB Ês/Iot is the minimum SSB Ês/Iot of the pair of cells to which the requirement applies.
NOTE 3: The same bands and the same Io conditions for each band apply for this requirement as for the corresponding highest accuracy requirement.
NOTE 4: The requirements apply for SSB Ês/Iot ≤ [TBD] dB.

10.1.16 SINR report mapping

10.1.16.1 SS-SINR measurement report mapping

The reporting range of SS-SINR is defined from -23 dB to 40 dB with 0.5 dB resolution. The mapping of measured quantity is defined in Table 10.1.16.1-1. The range in the signalling may be larger than the guaranteed accuracy range.

Table 10.1.16.1-1: SS-SINR measurement report mapping

Reported value	Measured quantity value	Unit
SS-SINR_0	SS-SINR<-23	dB
SS-SINR_1	-23≤ SS-SINR<-22.5	dB
SS-SINR_2	-22.5≤ SS-SINR<-22	dB
SS-SINR_3	-22≤ SS-SINR<-21.5	dB
SS-SINR_4	-21.5≤ SS-SINR<-21	dB
..	..	…
SS-SINR_123	38≤ SS-SINR<38.5	dB
SS-SINR_124	38.5≤ SS-SINR<39	dB
SS-SINR_125	39≤ SS-SINR<39.5	dB
SS-SINR_126	39.5≤ SS-SINR<40	dB
SS-SINR_127	40≤ SS-SINR	dB

10.1.17 Power Headroom

10.1.17.1 Power Headroom Report

10.1.17.1.1 Power Headroom Report Mapping

The power headroom reporting range is from -32 ...+42 dB. Table 10.1.17.1-1 defines the report mapping.

Table 10.1.17.1-1: Power headroom report mapping

Reported value	Measured quantity value (dB)
POWER_HEADROOM_0	PH < -32
POWER_HEADROOM_1	-32 ≤ PH < -31
POWER_HEADROOM_2	-31 ≤ PH < -30
POWER_HEADROOM_3	-30 ≤ PH < -29
…	…
POWER_HEADROOM_53	25 ≤ PH < 26
POWER_HEADROOM_54	26 ≤ PH < 27
POWER_HEADROOM_55	27 ≤ PH < 28
POWER_HEADROOM_56	28 ≤ PH < 30
POWER_HEADROOM_57	30 ≤ PH < 32
POWER_HEADROOM_58	32 ≤ PH < 34
POWER_HEADROOM_59	34 ≤ PH < 36
POWER_HEADROOM_60	36 ≤ PH < 38
POWER_HEADROOM_61	38 ≤ PH < 40
POWER_HEADROOM_62	40 ≤ PH < 42
POWER_HEADROOM_63	PH ≥ 42

10.1.18 $P_{CMAX,c,f}$

The UE is required to report the UE configured maximum output power ($P_{CMAX,c,f}$) together with the power headroom. This clause defines the requirements for the $P_{CMAX,c,f}$ reporting.

10.1.18.1 Report Mapping

The $P_{CMAX,c,f}$ reporting range is defined from -29dBm to 33 dBm with 1 dB resolution. Table 10.1.18.1-1 defines the reporting mapping.

Table 10.1.18.1-1 Mapping of $P_{CMAX,c.f}$

Reported value	Measured quantity value	Unit
PCMAX_C_00	$P_{CMAX,c,f}$ < -29	dBm
PCMAX_C_01	-29 ≤ $P_{CMAX,c,f}$ < -28	dBm
PCMAX_C_02	-28 ≤ $P_{CMAX,c,f}$ < -27	dBm
…	…	…
PCMAX_C_61	31 ≤ $P_{CMAX,c,f}$ < 32	dBm
PCMAX_C_62	32 ≤ $P_{CMAX,c,f}$ < 33	dBm
PCMAX_C_63	33 ≤ $P_{CMAX,c,f}$	dBm

10.2 E-UTRAN measurements

10.2.1 Introduction

Accuracy requirements for E-UTRAN measurements are specified in Section 10.2.

If the UE needs measurement gaps to perform the inter-RAT NR – E-UTRAN FDD and NR – E-UTRAN TDD measurements, the relevant measurement procedure and measurement gap patterns stated in Section 9.1.2 shall apply.

10.2.2 E-UTRAN RSRP measurements

NOTE: This measurement is for handover between NR and E-UTRAN.

The requirements in this clause are applicable for a UE:

- in RRC_CONNECTED state
- performing measurements according to clause 9.4.2 for E-UTRAN FDD and clause 9.4.3 for E-UTRAN TDD with appropriate measurement gaps

- that is synchronised to the cell that is measured.

The reported measurement result after layer 1 filtering shall be an estimate of the average value of the measured quantity over the measurement period. The reference point for the measurement result after layer 1 filtering is referred to as point B in the measurement model described in TS 36.300 [24].

The accuracy requirements of E-UTRA RSRP measurements in this clause are valid for the reported measurement result after layer 1 filtering. The accuracy requirements are verified from the measurement report at point D in the measurement model having the layer 3 filtering disabled.

The requirements for accuracy of E-UTRA RSRP measurements in RRC_CONNECTED state and the corresponding side conditions shall be the same as the inter-frequency RSRP Accuracy Requirements in TS 36.133 [15, Section 9.1.3].

The reporting range and mapping specified for RSRP measurements in TS 36.133 [15, Section 9.1.4] shall apply.

10.2.3 E-UTRAN RSRQ measurements

NOTE: This measurement is for handover between NR and E-UTRAN.

The requirements in this clause are applicable for a UE:

- in RRC_CONNECTED state
- performing measurements according to clause 9.4.2 for E-UTRAN FDD and clause 9.4.3 for E-UTRAN TDD with appropriate measurement gaps
- that is synchronised to the cell that is measured.

The reported measurement result after layer 1 filtering shall be an estimate of the average value of the measured quantity over the measurement period. The reference point for the measurement result after layer 1 filtering is referred to as point B in the measurement model described in TS 36.300 [24].

The accuracy requirements of E-UTRA RSRQ measurements in this clause are valid for the reported measurement result after layer 1 filtering. The accuracy requirements are verified from the measurement report at point D in the measurement model having the layer 3 filtering disabled.

The requirements for accuracy of E-UTRA RSRQ measurements in RRC_CONNECTED state and the corresponding side conditions shall be the same as the inter-frequency RSRQ Accuracy Requirements in TS 36.133 [15, Section 9.1.6].

The reporting range and mapping specified for RSRQ measurements in TS 36.133 [15, Section 9.1.7] shall apply.

10.2.4 E-UTRAN RSTD measurements

The requirements in this section are valid for UE supporting this capability.

The measurement period is specified in Sections 9.4.4.1 and 9.4.4.2 for inter-RAT NR ─ E-UTRAN FDD and inter-RAT NR ─ E-UTRAN TDD RSTD measurements, respectively.

The accuracy requirements and the corresponding side conditions shall be the same as the inter-frequency measurement accuracy requirements for RSTD measurements in RRC_CONNECTED in TS 36.133 [15, Section 9.1.10.2].

If the UE needs measurement gaps to perform the inter-RAT NR ─ E-UTRAN FDD and NR ─ E-UTRAN TDD RSTD measurements, the relevant measurement procedure and measurement gap patterns stated in Section 9.1.2 shall apply.

The reporting range and mapping for the inter-RAT NR ─ E-UTRAN FDD and NR ─ E-UTRAN TDD RSTD measurements is the same as specified for RSTD measurements in TS 36.133 [15, Sections 9.1.10.3 and 9.1.10.4].

10.2.5 E-UTRAN RS-SINR measurements

NOTE: This measurement is for handover between NR and E-UTRAN.

The requirements in this clause are applicable for a UE:

- in RRC_CONNECTED state

- performing measurements according to clause 9.4.2 for E-UTRAN FDD and clause 9.4.3 for E-UTRAN TDD with appropriate measurement gaps
- that is synchronised to the cell that is measured.

The reported measurement result after layer 1 filtering shall be an estimate of the average value of the measured quantity over the measurement period. The reference point for the measurement result after layer 1 filtering is referred to as point B in the measurement model described in TS 36.300 [24].

The accuracy requirements of E-UTRA RS-SINR measurements in this clause are valid for the reported measurement result after layer 1 filtering. The accuracy requirements are verified from the measurement report at point D in the measurement model having the layer 3 filtering disabled.

The requirements for accuracy of E-UTRA RS-SINR measurements in RRC_CONNECTED state and the corresponding side conditions shall be the same as the inter-frequency RS-SINR Accuracy Requirements in TS 36.133 [15, Section 9.1.17.3].

The reporting range and mapping for E-UTRA RS-SINR measurements shall be the same as specified for RS-SINR measurements in TS 36.133 [15, 9.1.10.3 and 9.1.10.4.

11 Measurements Performance Requirements for NR network

Editor's note: network side measurement and mapping tables may be specified in this section. If RAN4 decides to move NR network requirements to gNodeB specification, this section might be removed.

Annex A (normative): Test Cases

A.1 Purpose of annex

A.2 Requirement classification for statistical testing

A.2.1 Types of requirements in TS 38.133

A.2.1.1 Time and delay requirements on UE higher layer actions

A.2.1.2 Measurements of power levels, relative powers and time

A.2.1.3 Implementation requirements

A.2.1.4 Physical layer timing requirements

A.3 RRM test configurations

A.3.1 Reference measurement channels

A.3.1.1 PDSCH

A.3.1.1.1 FDD

Table A.3.1.1.1-1: PDSCH Reference Measurement Channels for SCS=15kHz

Parameter	Unit	Value						
Reference channel		SR.1.1 FDD						
Channel bandwidth	MHz	10						
Number of transmitter antennas		1						
Allocated resource blocks for PDSCH Note 1		24						
Allocated slots per Radio Frame		10						
MCS index		[4]						
Modulation		QPSK						
Target Coding Rate		1/3						
Number of control symbols		2						
Information Bit Payload								
For slots with RMSI Note 2	Bits	TBD						
Number of Code Blocks per slot		1						
Binary Channel Bits Per slot								
For slots with RMSI Note 2	Bits	TBD						

Note 1: Allocation is located in the middle of active DL BWP.
Note 2: PDSCH is scheduled on the slots with RMSI.
Note 3: If necessary the information bit payload size can be adjusted to facilitate the test implementation. The payload sizes are defined in TS 38.213 [3].

A.3.1.1.2 TDD

Table A.3.1.1.2-1: PDSCH Reference Measurement Channels for SCS=15kHz

Parameter	Unit	Value						
Reference channel		SR.1.1 TDD						
Channel bandwidth	MHz	10						
Number of transmitter antennas		1						
Allocated resource blocks for PDSCH [Note 1]		24						
Uplink-Downlink Configuration		3D1S1U						
Flexible Slot 'S' Configuration		9DL:3GP:2UL						
Allocated slots per Radio Frame		TBD						
MCS index		[4]						
Modulation		QPSK						
Target Coding Rate		1/3						
Number of control symbols		2						
Information Bit Payload								
For slots with RMSI [Note 2]	Bits	TBD						
Number of Code Blocks per slot		1						
Binary Channel Bits Per slot								
For slots with RMSI [Note 2]	Bits	TBD						
Note 1: Allocation is located in the middle of active DL BWP. Note 2: PDSCH is scheduled on the slots with RMSI. Note 3: If necessary the information bit payload size can be adjusted to facilitate the test implementation. The payload sizes are defined in TS 38.213 [3].								

Table A.3.1.1.2-2: PDSCH Reference Measurement Channels for SCS=30kHz

Parameter	Unit	Value						
Reference channel		SR.2.1 TDD						
Channel bandwidth	MHz	40						
Number of transmitter antennas		1						
Allocated resource blocks for PDSCH [Note 1]		24						
Uplink-Downlink Configuration		3D1S1U						
Flexible Slot 'S' Configuration		9DL:3GP:2UL						
Allocated slots per Radio Frame		TBD						
MCS index		[4]						
Modulation		QPSK						
Target Coding Rate		1/3						
Number of control symbols		2						
Information Bit Payload								
For slots with RMSI [Note 2]	Bits	TBD						
Number of Code Blocks per slot		1						
Binary Channel Bits Per slot								
For slots with RMSI [Note 2]	Bits	TBD						
Note 1: Allocation is located in the middle of active DL BWP. Note 2: PDSCH is scheduled on the slots with RMSI. Note 3: If necessary the information bit payload size can be adjusted to facilitate the test implementation. The payload sizes are defined in TS 38.213 [3].								

Table A.3.1.1.2-3: PDSCH Reference Measurement Channels for SCS=120kHz

Parameter	Unit	Value						
Reference channel		SR.3.1 TDD						
Channel bandwidth	MHz	100						
Number of transmitter antennas		1						
Allocated resource blocks for PDSCH Note 1		24						
Uplink-Downlink Configuration		3D1S1U						
Flexible Slot 'S' Configuration		9DL:3GP:2UL						
Allocated slots per Radio Frame		TBD						
MCS index		[4]						
Modulation		QPSK						
Target Coding Rate		1/3						
Number of control symbols		2						
Information Bit Payload								
For slots with RMSI Note 2	Bits	TBD						
Number of Code Blocks per slot		1						
Binary Channel Bits Per slot								
For slots with RMSI Note 2	Bits	TBD						
Note 1: Allocation is located in the middle of active DL BWP. Note 2: PDSCH is scheduled on the slots with RMSI. Note 3: If necessary the information bit payload size can be adjusted to facilitate the test implementation. The payload sizes are defined in TS 38.213 [3].								

A.3.1.2 CORESET

A.3.1.2.1 FDD

Table A.3.1.2.1-1: RMSI CORESET Reference Channel for FDD with SCS=15KHz

Parameter	Unit	Value						
Reference channel		CR.1.1 FDD						
Channel bandwidth	MHz	10						
Subcarrier spacing for RMSI CORESET	KHz	15						
Allocated resource blocks for RMSI CORESET		24						
Subcarrier spacing for SSB	KHz	15						
Periodicity of SSB	ms	20						
Index of transmited SSB within an SS-Burst		#0						
SSB and RMSI CORESET multiplexing configuration		Pattern 1						
Offset between SSB and RMSI CORESET Note 3	RB	0						
Configuration of PDCCH monitoring occasions for RMSI CORESET Note 4		[Index 4]						
Number of transmitter antennas		1						
Control region OFDM symbols	symbols	2						
DCI Format Note 1		Note 2						
Aggregation level	CCE	8						
DMRS precoder granularity		6						
REG bundle size		6						
Mapping from REG to CCE		Distributed						
Cell ID		Note 5						
Payload (without CRC)	Bits	Note 6						

Note 1: DCI formats are defined in TS 38.212.
Note 2: DCI format shall depend upon the test configuration.
Note 3: The offset is defined with respect to the subcarrier spacing of the CORESET from the smallest RB index of RMSI CORESET to the smallest RB index of the common RB overlapping with the first RB of the SS/PBCH block.
Note 4: The configuration of PDCCH monitoring occasions for RMSI CORESET is defined in Table 13-11 in TS 38.213 [3].
Note 5: Cell ID shall depend upon the test configuration.
Note 6: Payload size shall depend upon the test configuration.

A.3.1.2.2 TDD

Table A.3.1.2.2-1: RMSI CORESET Reference Channel for TDD with SCS=15KHz

Parameter	Unit	Value						
Reference channel		CR.1.1 TDD						
Channel bandwidth	MHz	10						
Subcarrier spacing	KHz	15						
Allocated resource blocks for RMSI CORESET		24						
Subcarrier spacing for SSB	KHz	15						
Periodicity of SSB	ms	20						
Index of transmited SSB within an SS-Burst		#0						
SSB and RMSI CORESET multiplexing configuration		Pattern 1						
Offset between SSB and RMSI CORESET Note 3	RB	0						
Configuration of PDCCH monitoring occasions for RMSI CORESET Note 4		[Index 4]						
Number of transmitter antennas		1						
Control region OFDM symbols	symbols	2						
DCI Format Note 1		Note 2						
Aggregation level	CCE	8						
DMRS precoder granularity		6						
REG bundle size		6						
Mapping from REG to CCE		Distributed						
Cell ID		Note 5						
Payload (without CRC)	Bits	Note 6						

Note 1: DCI formats are defined in TS 38.212.
Note 2: DCI format shall depend upon the test configuration.
Note 3: The offset is defined with respect to the subcarrier spacing of the CORESET from the smallest RB index of RMSI CORESET to the smallest RB index of the common RB overlapping with the first RB of the SS/PBCH block.
Note 4: The configuration of PDCCH monitoring occasions for RMSI CORESET is defined in Table 13-11 in TS 38.213 [3].
Note 5: Cell ID shall depend upon the test configuration.
Note 6: Payload size shall depend upon the test configuration.

Table A.3.1.2.2-2: RMSI CORESET Reference Channel for TDD with SCS=30KHz

Parameter	Unit	Value						
Reference channel		CR.2.1 TDD						
Channel bandwidth	MHz	40						
Subcarrier spacing	KHz	30						
Allocated resource blocks for RMSI CORESET		24						
Subcarrier spacing for SSB	KHz	30						
Periodicity of SSB	ms	20						
Index of transmited SSB within an SS-Burst		#0						
SSB and RMSI CORESET multiplexing configuration		Pattern 1						
Offset between SSB and RMSI CORESET Note 3	RB	0						
Configuration of PDCCH monitoring occasions for RMSI CORESET Note 4		[Index 4]						
Number of transmitter antennas		1						
Control region OFDM symbols	symbols	2						
DCI Format Note 1		Note 2						
Aggregation level	CCE	8						
DMRS precoder granularity		6						
REG bundle size		6						
Mapping from REG to CCE		Distributed						
Cell ID		Note 5						
Payload (without CRC)	Bits	Note 6						

Note 1: DCI formats are defined in TS 38.212.
Note 2: DCI format shall depend upon the test configuration.
Note 3: The offset is defined with respect to the subcarrier spacing of the CORESET from the smallest RB index of RMSI CORESET to the smallest RB index of the common RB overlapping with the first RB of the SS/PBCH block.
Note 4: The configuration of PDCCH monitoring occasions for RMSI CORESET is defined in Table 13-11 in TS 38.213 [3].
Note 5: Cell ID shall depend upon the test configuration.
Note 6: Payload size shall depend upon the test configuration.

Table A.3.1.2.2-3: RMSI CORESET Reference Channel for TDD with SCS=120KHz

Parameter	Unit	Value						
Reference channel		CR.3.1 TDD						
Channel bandwidth	MHz	100						
Subcarrier spacing	KHz	30						
Allocated resource blocks for RMSI CORESET		24						
Subcarrier spacing for SSB	KHz	120						
Periodicity of SSB	ms	20						
Index of transmited SSB within an SS-Burst		#0, #1						
SSB and RMSI CORESET multiplexing configuration		Pattern 1						
Offset between SSB and RMSI CORESET [Note 3]	RB	0						
Configuration of PDCCH monitoring occasions for RMSI CORESET [Note 4]		[Index 4]						
Number of transmitter antennas		1						
Control region OFDM symbols	symbols	2						
DCI Format [Note 1]		Note 2						
Aggregation level	CCE	8						
DMRS precoder granularity		6						
REG bundle size		6						
Mapping from REG to CCE		Distributed						
Cell ID		Note 5						
Payload (without CRC)	Bits	Note 6						

Note 1: DCI formats are defined in TS 38.212.
Note 2: DCI format shall depend upon the test configuration.
Note 3: The offset is defined with respect to the subcarrier spacing of the CORESET from the smallest RB index of RMSI CORESET to the smallest RB index of the common RB overlapping with the first RB of the SS/PBCH block.
Note 4: The configuration of PDCCH monitoring occasions for RMSI CORESET is defined in Table 13-12 in TS 38.213 [3].
Note 5: Cell ID shall depend upon the test configuration.
Note 6: Payload size shall depend upon the test configuration.

A.3.2 OFDMA channel noise generator (OCNG)

A.3.2.1 Generic OFDMA Channel Noise Generator (OCNG)

The OCNG pattern is used in a test for modelling allocations of unused resources in the channel bandwidth to virtual UEs (which are not under test). The OCNG pattern comprises PDCCH and PDSCH transmissions to the virtual UEs.

A.3.2.1.1 OCNG pattern 1: Generic OCNG pattern for all unused REs

Table A.3.2.1.1-1: OP.1: Generic OCNG pattern for all unused REs

OCNG Parameters	Control Region	Data Region
Resource allocation	Unused REs (Note 1)	Unused REs (Note 2)
Channel	PDCCH	PDSCH
Contents	Virtual UE IDs	Uncorrelated pseudo random QPSK modulated data
Antenna transmission scheme	Same as used in PDCCH RMC	Same as used in PDSCH RMC
Subcarrier spacing	Same as used in PDCCH RMC	Same as used in PDSCH RMC
Aggregation level	Same as used in PDCCH RMC	N/A
Code rate	Same as used in PDCCH RMC	Same as used in PDSCH RMC
Transmit Power	Same as used in PDCCH RMC	Same as used in PDSCH RMC
CP length	Same as used in PDCCH RMC	Same as used in PDSCH RMC
Note 1: REs not used in the active CORESETs where PDCCH is scheduled for the UE under test. Note 2: REs not allocated to any physical channels, CORESET, SSB or any other reference signal within the channel bandwidth of the cell.		

A.3.2.2 SMTC Configurations

A.3.2.2.1 SMTC Configurations for FR1

A.3.2.2.1.1 SMTC pattern 1 in FR1: SSB allocation for SSB SCS=15 KHz in 10 MHz

Table A.3.2.2.1.1-1: SMTC.1 FR1: SMTC Pattern 1 for SSB SCS=15 KHz in 10 MHz channel

SMTC Parameters	Values
Channel bandwidth	10 MHz
SMTC periodicity	20 ms
SMTC duration	1 ms
SSB SCS	15 KHz
Number of SSBs per SS-burst	1
Slot number of slot containing SSB	0
Symbol numbers of symbols containing SSB	2-5
RB numbers containing SSB within channel BW	0-19

A.3.2.2.1.2 SMTC pattern 2 in FR1: SSB allocation for SSB SCS=30 KHz in 40 MHz

Table A.3.2.2.1.2-1: SMTC.2 FR1: SSB Pattern 2 for SSB SCS=30 KHz in 40 MHz channel

SMTC Parameters	Values
Channel bandwidth	40 MHz
SMTC periodicity	20 ms
SMTC duration	1 ms
SSB SCS	30 KHz
Number of SSBs per SS-burst	1
Slot number of slot containing SSB	0
Symbol numbers of symbols containing SSB	2-5
RB numbers containing SSB within channel BW	0-19

A.3.2.2.2 SMTC Configurations for FR2

A.3.2.2.2.1 SMTC pattern 1 in FR2: SSB allocation for SSB SCS=120 KHz in 100 MHz

Table A.3.2.2.2.1-1: SMTC.1 FR2: SSB Pattern 1 for SSB SCS = 120 KHz in 100 MHz channel

SMTC Parameters	Values
Channel bandwidth	100 MHz
SMTC periodicity	20 ms
SMTC duration	1 ms
SSB SCS	120 KHz
Number of SSBs per SS-burst	2
Slot number of slot containing SSBs	0
Symbol numbers of symbols containing SSBs	4-11
RB numbers containing SSBs within channel BW	0-19

A.3.2.2.2.2 SMTC pattern 2 in FR2: SSB allocation for SSB SCS=240 KHz in 100 MHz

Table A.3.2.2.2.2-1: SMTC.2 FR2: SSB Pattern 2 for SSB SCS = 240 KHz in 100 MHz channel

SMTC Parameters	Values	
Channel bandwidth	100 MHz	
SMTC periodicity	20 ms	
SMTC duration	1 ms	
SSB SCS	240 KHz	
Number of SSBs per SS-burst	2	
Slot numbers of slot containing SSBs	0	1
Symbol numbers of symbols containing SSBs	8-13	0-1
RB numbers containing SSBs within channel BW	0-19	

A.3.3 Reference DRX configurations

A.3.4 Duplex mode

A.3.5 Test cases with different numerologies

A.3.6 Antenna configurations

A.3.7 EN-DC test setup

A.3.7.1 Introduction

A.3.7.2 E-UTRAN Serving Cell Parameters

A.3.7.2.1 E-UTRAN Serving Cell Parameters for Tests with NR Cell(s) in FR1

Table A.3.7.2.1-1 defines cell specific test parameters for E-UTRAN cell which can be used in EN-DC test cases with all NR cells in FR1.

Table A.3.7.2.1-1: E-UTRAN cell specific test parameters for tests with all NR cells in FR1

Parameter	Unit	E-UTRAN Cell1
E-UTRA RF Channel Number		1
Duplex mode		FDD or TDD
TDD special subframe configuration[Note1]		6
TDD uplink-downlink configuration[Note1]		1
$BW_{channel}$		5MHz: $N_{RB,c}$ = 25 10MHz: $N_{RB,c}$ = 50 20MHz: $N_{RB,c}$ = 100
PDSCH parameters: DL Reference Measurement Channel[Note2]		5MHz: R.7 FDD 10MHz: R.3 FDD 20MHz: R.6 FDD 5MHz: R.4 TDD 10MHz: R.0 TDD 20MHz: R.3 TDD
PCFICH/PDCCH/PHICH parameters: DL Reference Measurement Channel[Note2]		5MHz: R.11 FDD 10MHz: R.6 FDD 20MHz: R.10 FDD 5MHz: R.11 TDD 10MHz: R.6 TDD 20MHz: R.10 TDD
OCNG Patterns[Note2]		5MHz: OP.20 FDD 10MHz: OP.10 FDD 20MHz: OP.17 FDD 5MHz: OP.9 TDD 10MHz: OP.1 TDD 20MHz: OP.7 TDD
PBCH_RA	dB	0
PBCH_RB	dB	
PSS_RA	dB	
SSS_RA	dB	
PCFICH_RB	dB	
PHICH_RA	dB	
PHICH_RB	dB	
PDCCH_RA	dB	
PDCCH_RB	dB	
PDSCH_RA	dB	
PDSCH_RB	dB	
OCNG_RA[Note3]	dB	
OCNG_RB[Note3]	dB	
N_{oc}[Note4]	dBm/15 kHz	-104
$\hat{E}_s/N_{oc}$	dB	17
$\hat{E}_s/I_{ot}$	dB	17
RSRP [Note5]	dBm/15 kHz	-87
SCH_RP [Note5]	dBm/15 kHz	-87
Io [Note5]	dBm/Ch BW	-59.13 +10log ($N_{RB,c}$ /50)
Propagation Condition		AWGN
Antenna Configuration		1x2

Note 1: Special subframe and uplink-downlink configurations are specified in table 4.2-1 in TS 36.211.
Note 2: DL RMCs and OCNG patterns are specified in sections A 3.1 and A 3.2 of TS 36.133 respectively.
Note 3: OCNG shall be used such that all cells are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols.
Note 4: Interference from other cells and noise sources not specified in the test is assumed to be constant over subcarriers and time and shall be modelled as AWGN of appropriate power for N_{oc} to be fulfilled.
Note 5: Es/Iot, RSRP, SCH_RP and Io levels have been derived from other parameters for information purposes. They are not settable parameters themselves.

A.3.7.2.2 E-UTRAN Serving Cell Parameters for Tests with NR Cell(s) in FR2

Table A.3.7.2.2-1 defines cell specific test parameters for E-UTRAN cell which can be used in EN-DC test cases with one or more NR cells in FR2.

Table A.3.7.2.2-1: E-UTRAN cell specific test parameters for tests with one or more NR cells in FR2

Parameter	Unit	E-UTRAN Cell1
E-UTRA RF Channel Number		1
Duplex mode		FDD or TDD
TDD special subframe configuration[Note1]		6
TDD uplink-downlink configuration[Note1]		1
$BW_{channel}$	MHz	5MHz: $N_{RB,c}$ = 25 10MHz: $N_{RB,c}$ = 50 20MHz: $N_{RB,c}$ = 100
PDSCH parameters: DL Reference Measurement Channel[Note2]		5MHz: R.7 FDD 10MHz: R.3 FDD 20MHz: R.6 FDD 5MHz: R.4 TDD 10MHz: R.0 TDD 20MHz: R.3 TDD
PCFICH/PDCCH/PHICH parameters: DL Reference Measurement Channel[Note2]		5MHz: R.11 FDD 10MHz: R.6 FDD 20MHz: R.10 FDD 5MHz: R.11 TDD 10MHz: R.6 TDD 20MHz: R.10 TDD
OCNG Patterns[Note2]		5MHz: OP.20 FDD 10MHz: OP.10 FDD 20MHz: OP.17 FDD 5MHz: OP.9 TDD 10MHz: OP.1 TDD 20MHz: OP.7 TDD
PBCH_RA	dB	0
PBCH_RB	dB	
PSS_RA	dB	
SSS_RA	dB	
PCFICH_RB	dB	
PHICH_RA	dB	
PHICH_RB	dB	
PDCCH_RA	dB	
PDCCH_RB	dB	
PDSCH_RA	dB	
PDSCH_RB	dB	
OCNG_RA[Note3]	dB	
OCNG_RB[Note3]	dB	
Note 1: Special subframe and uplink-downlink configurations are specified in table 4.2-1 in TS 36.211. Note 2: DL RMCs and OCNG patterns are specified in sections A 3.1 and A 3.2 of TS 36.133 respectively. Note 3: OCNG shall be used such that all cells are fully allocated and a constant total transmitted power spectral density is achieved for all OFDM symbols. Note 4: The E-UTRA signal is required only to ensure the E-UTRA link to the DUT in the EN-DC operation. The Test System shall provide a stable and noise-free E-UTRA signal without need of precise propagation modelling, path loss and polarization control. Further details of the E-UTRA signal configuration are not defined as part of the cell specific test parameters, since the E-UTRA link is not under performance verification and is not expected to influence the NR FR2 requirement.		

A.4 EN-DC tests with PSCell in FR1

A.4.1 Void

A.4.2 Void

A.4.3 RRC_CONNECTED state mobility

A.4.3.1 Void

A.4.3.2 RRC Connection Mobility Control

A.4.3.2.1 Void

A.4.3.2.2 Random Access

A.4.3.2.3 Void

A.4.4 Timing

A.4.4.1 UE transmit timing

A.4.4.2 UE timer accuracy

A.4.4.3 Timing advance

A.4.5 Signaling characteristics

A.4.5.1 Radio link Monitoring

A.4.5.2 Interruption

A.4.5.2.1 NSA: Interruptions with EN-DC

A.4.5.3 SCell Activation and Deactivation Delay

A.4.5.4 UE UL carrier RRC reconfiguration Delay

A.4.5.5 Link recovery procedures

A.4.5.6 Active BWP switch delay

A.4.6 Measurement procedure

A.4.6.1 Intra-frequency Measurements

A.4.6.1.1 EN-DC event triggered reporting tests

A.4.6.2 Inter-frequency Measurements

A.4.7 Measurement Performance requirements

A.4.7.1 SS-RSRP

A.4.7.1.1 intra-frequency case

A.4.7.1.2 inter-frequency case

A.4.7.2 SS-RSRQ

A.4.7.3 SS-SINR

A.5 EN-DC tests with PSCell in FR2

A.5.1 Void

A.5.2 Void

A.5.3 RRC_CONNECTED state mobility

A.5.3.1 Void

A.5.3.2 RRC Connection Mobility Control

A.5.3.2.1 Void

A.5.3.2.2 Random Access

A.5.3.2.3 Void

A.5.4 Timing

A.5.4.1 UE transmit timing

A.5.4.2 UE timer accuracy

A.5.4.3 Timing advance

A.5.5 Signaling characteristics

A.5.5.1 Radio link Monitoring

A.5.5.2 Interruption

A.5.5.2.1 NSA: Interruptions with EN-DC

A.5.5.3 SCell Activation and Deactivation Delay

A.5.5.4 UE UL carrier RRC reconfiguration Delay

A.5.5.5 Link recovery procedures

A.5.5.6 Active BWP switch delay

A.5.6 Measurement procedure

A.5.6.1 Intra-frequency Measurements

A.5.6.1.1 EN-DC event triggered reporting tests

A.5.6.2 Inter-frequency Measurements

A.5.7 Measurement Performance requirements

A.5.7.1 SS-RSRP

A.5.7.1.1 intra-frequency case

A.5.7.1.2 inter-frequency case

A.5.7.2 SS-RSRQ

A.5.7.3 SS-SINR

A.6 NR standalone tests in FR1

A.6.1 SA: RRC_IDLE state mobility

A.6.2 SA: RRC_INACTIVE state mobility

A.6.3 RRC_CONNECTED state mobility

A.6.3.1 Handover

A.6.3.2 RRC Connection Mobility Control

A.6.3.2.1 SA: RRC Re-establishment

A.6.3.2.2 Random Access

A.6.3.2.3 SA: RRC Connection Release with Redirection

A.6.4 Timing

A.6.4.1 UE transmit timing

A.6.4.2 UE timer accuracy

A.6.4.3 Timing advance

A.6.5 Signaling characteristics

A.6.5.1 Radio link Monitoring

A.6.5.2 Interruption

A.6.5.2.2 SA: interruptions with standalone NR Carrier Aggregation

A.6.5.3 SCell Activation and Deactivation Delay

A.6.5.4 UE UL carrier RRC reconfiguration Delay

A.6.5.5 Link recovery procedures

A.6.5.6 Active BWP switch delay

A.6.6 Measurement procedure

A.6.6.1 Intra-frequency Measurements

A.6.6.1.1 SA event triggered reporting tests

A.6.7 Measurement Performance requirements

A.6.7.1 SS-RSRP

A.6.7.1.1 intra-frequency case

A.6.7.1.2 inter-frequency case

A.6.7.2 SS-RSRQ

A.6.7.3 SS-SINR

A.7 NR standalone tests in FR2

A.7.1 SA: RRC_IDLE state mobility

A.7.2 SA: RRC_INACTIVE state mobility

A.7.3 RRC_CONNECTED state mobility

A.7.3.1 Handover

A.7.3.2 RRC Connection Mobility Control

A.7.3.2.1 SA: RRC Re-establishment

A.7.3.2.2 Random Access

A.7.3.2.3 SA: RRC Connection Release with Redirection

A.7.4 Timing

A.7.4.1 UE transmit timing

A.7.4.2 UE timer accuracy

A.7.4.3 Timing advance

A.7.5 Signaling characteristics

A.7.5.1 Radio link Monitoring

A.7.5.2 Interruption

A.7.5.2.2 SA: interruptions with standalone NR Carrier Aggregation

A.7.5.3 SCell Activation and Deactivation Delay

A.7.5.4 UE UL carrier RRC reconfiguration Delay

A.7.5.5 Link recovery procedures

A.7.5.6 Active BWP switch delay

A.7.6 Measurement procedure

A.7.6.1 Intra-frequency Measurements

A.7.6.1.1 SA event triggered reporting tests

A.7.7 Measurement Performance requirements

A.7.7.1 SS-RSRP

A.7.7.1.1 intra-frequency case

A.7.7.1.2 inter-frequency case

A.7.7.2 SS-RSRQ

A.7.7.3 SS-SINR

Annex B (normative): Conditions for RRM requirements applicability for operating bands

B.1 Conditions for NR RRC_IDLE state mobility

B.1.1 Introduction

In Annex B.1, the following conditions are specified:

- UE conditions which shall apply for UE intra-frequency measurements procedures and requirements in Section 4,
- UE conditions which shall apply for UE inter-frequency measurements procedures and requirements in Section 4.

B.1.2 Conditions for measurements on NR intra-frequency cells for cell re-selection

This section defines the following conditions for NR intra-frequency measurements performed based on SSBs for cell re-selection: SSB_RP and SSB Ês/Iot, applicable for a corresponding operating band.

The conditions are defined in Table B.1.2-1 for FR1 NR cells.

The conditions are defined in Table B.1.2-2 for FR2 NR cells.

Table B.1.2-1: Conditions for intra-frequency cell re-selection in FR1

Parameter	NR operating band groups [Note1]	Minimum SSB_RP dBm / SCS_{SSB}		SSB Ês/Iot dB
		SCS_{SSB} = 15 kHz	SCS_{SSB} = 30 kHz	
	NR_FDD_FR1_A, NR_TDD_FR1_A	TBD	TBD	
	NR_FDD_FR1_B	TBD	TBD	
	NR_TDD_FR1_C	TBD	TBD	
Conditions	NR_FDD_FR1_D, NR_TDD_FR1_D	TBD	TBD	≥ -4
	NR_FDD_FR1_E, NR_TDD_FR1_E	TBD	TBD	
	NR_FDD_FR1_G	TBD	TBD	
	NR_FDD_FR1_H	TBD	TBD	
NOTE 1: NR operating band groups are defined in Section 3.5.2.				

Table B.1.2-2: Conditions for intra-frequency cell re-selection in FR2

Parameter	NR operating band groups [Note1]	Minimum SSB_RP dBm / SCS_{SSB}		SSB Ês/Iot dB
		SCS_{SSB} = 120 kHz	SCS_{SSB} = 240 kHz	
	NR_TDD_FR2_A	TBD	TBD	
	NR_TDD_FR2_B	TBD	TBD	
Conditions	NR_TDD_FR2_F	TBD	TBD	TBD
	NR_TDD_FR2_G	TBD	TBD	
	NR_TDD_FR2_T	TBD	TBD	
	NR_TDD_FR2_Y	TBD	TBD	
NOTE 1: NR operating band groups are defined in Section 3.5.3.				

B.1.3 Conditions for measurements on NR inter-frequency cells for cell re-selection

This section defines the following conditions for NR inter-frequency measurements performed based on SSBs for cell re-selection: SSB_RP and SSB Ês/Iot, applicable for a corresponding operating band.

The conditions defined in Table B.1.2-1 for FR1 NR intra-frequency cell re-selection shall also apply for FR1 NR inter-frequency cells in this section.

The conditions defined in Table B.1.2-2 for FR2 NR intra-frequency cell re-selection shall also apply for FR2 NR inter-frequency cells in this section.

B.2 Conditions for UE measurements procedures and performance requirements in RRC_CONNECTED state

B.2.1 Introduction

In Annex B.2, the following conditions are specified:

- UE conditions which shall apply for UE intra-frequency measurements procedures and requirements in Section 9,

  UE conditions which shall apply for UE inter-frequency measurements procedures and requirements in Section 9,

- UE conditions which shall apply for UE intra-frequency measurements performance requirements in Section 10,

- UE conditions which shall apply for UE inter-frequency measurements performance requirements in Section 10.

B.2.2 Conditions for NR intra-frequency measurements

This section defines the following conditions for NR intra-frequency measurements and corresponding procedures performed based on SSBs: SSB_RP and SSB Ês/Iot, applicable for a corresponding operating band.

The conditions are defined in Table B.2.2-1 for FR1 NR cells.

The conditions are defined in Table B.2.2-2 for FR2 NR cells.

Table B.2.2-1: Conditions for intra-frequency measurements in FR1

Parameter	NR operating band groups Note1	Minimum SSB_RP dBm / SCS_{SSB}		SSB Ês/Iot
		SCS_{SSB} = 15 kHz	SCS_{SSB} = 30 kHz	dB
Conditions	NR_FDD_FR1_A, NR_TDD_FR1_A	TBD	TBD	≥ -6
	NR_FDD_FR1_B	TBD	TBD	
	NR_TDD_FR1_C	TBD	TBD	
	NR_FDD_FR1_D, NR_TDD_FR1_D	TBD	TBD	
	NR_FDD_FR1_E, NR_TDD_FR1_E	TBD	TBD	
	NR_FDD_FR1_G	TBD	TBD	
	NR_FDD_FR1_H	TBD	TBD	
NOTE 1: NR operating band groups are defined in Section 3.5.2.				

Table B.2.2-2: Conditions for intra-frequency measurements in FR2

Parameter	NR operating band groups [Note1]	Minimum SSB_RP dBm / SCS$_{SSB}$		SSB Ês/Iot
		SCS$_{SSB}$ = 120 kHz	SCS$_{SSB}$ = 240 kHz	dB
Conditions	NR_TDD_FR2_A	TBD	TBD	TBD
	NR_TDD_FR2_B	TBD	TBD	
	NR_TDD_FR2_F	TBD	TBD	
	NR_TDD_FR2_G	TBD	TBD	
	NR_TDD_FR2_T	TBD	TBD	
	NR_TDD_FR2_Y	TBD	TBD	
NOTE 1: NR operating band groups are defined in Section 3.5.3.				

B.2.3 Conditions for NR inter-frequency measurements

This section defines the following conditions for NR inter-frequency measurements and corresponding procedures performed based on SSBs: SSB_RP and SSB Ês/Iot, applicable for a corresponding operating band.

The conditions are defined in Table B.2.3-1 for FR1 NR cells.

The conditions are defined in Table B.2.3-2 for FR2 NR cells.

Table B.2.3-1: Conditions for inter-frequency measurements in FR1

Parameter	NR operating band groups [Note1]	Minimum SSB_RP dBm / SCS$_{SSB}$		SSB Ês/Iot
		SCS$_{SSB}$ = 15 kHz	SCS$_{SSB}$ = 30 kHz	dB
Conditions	NR_FDD_FR1_A, NR_TDD_FR1_A	TBD	TBD	≥ -4
	NR_FDD_FR1_B	TBD	TBD	
	NR_TDD_FR1_C	TBD	TBD	
	NR_FDD_FR1_D, NR_TDD_FR1_D	TBD	TBD	
	NR_FDD_FR1_E, NR_TDD_FR1_E	TBD	TBD	
	NR_FDD_FR1_G	TBD	TBD	
	NR_FDD_FR1_H	TBD	TBD	
NOTE 1: NR operating band groups are defined in Section 3.5.2.				

Table B.2.3-2: Conditions for inter-frequency measurements in FR2

Parameter	NR operating band groups [Note1]	Minimum SSB_RP dBm / SCS$_{SSB}$		SSB Ês/Iot
		SCS$_{SSB}$ = 120 kHz	SCS$_{SSB}$ = 240 kHz	dB
Conditions	NR_TDD_FR2_A	TBD	TBD	TBD
	NR_TDD_FR2_B	TBD	TBD	
	NR_TDD_FR2_F	TBD	TBD	
	NR_TDD_FR2_G	TBD	TBD	
	NR_TDD_FR2_T	TBD	TBD	
	NR_TDD_FR2_Y	TBD	TBD	
NOTE 1: NR operating band groups are defined in Section 3.5.3.				

Annex C (informative): Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2017-05	RAN4#83	R4-1706324				Specification skeleton	0.0.1
2017-09						Email approved	0.1.0
2017-09	RAN4-NR AH #3	R4-1709413				Capture TPs approved in the meeting	0.2.0
2017-10	RAN4#84-Bis	R4-1711985				Capture TPs approved in the meeting	0.3.0
2017-12	RAN4#85	R4-1714546				Capture TPs approved in RAN4#85	0.4.0
2017-12	RAN#78	RP-172407				v1.0.0 submitted for plenary approval	1.0.0
2017-12	RAN#78					Approved by plenary – Rel-15 spec under change control	15.0.0
2018-03	RAN#79	RP-180264	0032		B	CR to TS38.133	15.1.0
2018-06	RAN#80	RP-181075	0037		B	CR to TS 38.133: Implementation of endorsed draft CRs from RAN4 #86bis and RAN4 #87	15.2.0
2018-09	RAN#81	RP-181896	0043		B	CR to TS 38.133: Implementation of endorsed draft CRs from RAN4-AH-1807 and RAN4 #88	15.3.0

History

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