# 8 Signalling characteristics

## 8.1 Radio Link Monitoring

### 8.1.1 Introduction

The requirements in clause 8.1 apply for radio link monitoring on:

- PCell in SA NR, NR-DC and NE-DC operation mode,

- PSCell in NR-DC and EN-DC operation mode,

- Deactivated PSCell in NR-DC and EN-DC operation mode, when configured.

The UE shall monitor the downlink radio link quality based on the reference signal configured as RLM-RS resource(s) in order to detect the downlink radio link quality of the PCell, PSCell and deactivated PSCell if configured with *bfd-and-RLM* with value *true* as specified in TS 38.213 [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 Qout and Qin for the purpose of monitoring downlink radio link quality of the cell.

When a CORESET that the UE uses for monitoring PDCCH includes two TCI states and the UE is provided *sfnSchemePdcch* set to 'sfnSchemeA' or 'sfnSchemeB', the UE shall estimate a single downlink radio link quality to derive single SNR and compare it to the single thresholds Qout and Qin for the purpose of monitoring downlink radio link quality of the cell(s). How to compute the single SNR based on two active TCI states is up to UE implementation.

The threshold Qout 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 (BLERout) as defined in Table 8.1.1-1. For SSB based radio link monitoring, Qout\_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, Qout\_CSI-RS is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1.3.1-1.

The threshold Qin is defined as the level at which the downlink radio link quality can be received with significantly higher reliability than at Qout and shall correspond to the in-sync block error rate (BLERin) as defined in Table 8.1.1-1. For SSB based radio link monitoring, Qin\_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, Qin\_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 (BLERout) and in-sync block error rate (BLERin) are determined from the network configuration via parameter *rlmInSyncOutOfSyncThreshold* signalled by higher layers. When UE is not configured with *rlmInSyncOutOfSyncThreshold* from the network, UE determines out-of-sync and in-sync block error rates from Configuration #0 in Table 8.1.1-1 by default. All requirements in clause 8.1 are applicable for BLER Configuration #0 in Table 8.1.1-1.

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

|  |  |  |
| --- | --- | --- |
| Configuration | BLERout | BLERin |
| 0 | 10% | 2% |

UE shall be able to monitor up to NRLM RLM-RS resources of the same or different types in each corresponding carrier frequency range, depending on a maximum number  of SSBs per half frame according to TS 38.213 [3], where NRLM is specified in Table 8.1.1-2 according TS 38.213 [3], and meet the requirements as specified in clause 8.1. UE is not required to meet the requirements in clause 8.1 if RLM-RS is not configured and no TCI state for PDCCH is activated.

Table 8.1.1-2: Maximum number of RLM-RS resources NRLM

|  |  |  |
| --- | --- | --- |
| Carrier frequency range of PCell/PSCell |  | Maximum number of RLM-RS resources, NRLM |
| FR1, ≤ 3 GHzNote | 4 | 2 |
| FR1, > 3 GHzNote | 8 | 4 |
| FR2 | 64 | 8 |
| NOTE: For unpaired spectrum operation with Case C - 30 kHz SCS, 3GHz is replaced by 1.88GHz, as specified in clause 4.1 in TS 38.213 [3]. | | |

#### 8.1.1.1 Introduction of Requirement on Radio Link Monitoring for UE Configured with Relaxed Measurement Criteria

For the UE supports *rlm-Relaxation-r17*and configured with explicit signaling *goodServingCellEvaluationRLM*, which is always configured to the UE when the network enables RLM relaxation for the UE as specified in TS 38.331 [2], the relaxed requirements defined in clause 8.1.2.4 for SSB based radio link monitoring and the relaxed requirements defined in clause 8.1.3.4 for CSI-RS based radio link monitoring are allowed to apply to the relaxed RLM measurements on SpCell after fulfilling the following conditions:

- for the serving cells in intra-band carrier aggregation configured with SSB-based or CSI-RS based RLM on SpCell together with CSI-RS based BFD on SCell, when

- the good serving cell quality criterion defined in clause 5.7.13.2 of TS 38.331 [2] is fulfilled for the serving cell based on the measurements that are configured for SSB-based or CSI-RS based RLM on SpCell together with CSI-RS based BFD on Scell in the intra-band carrier aggregation if the *lowMobilityEvaluationConnected* is not configured, or

- the UE is also configured with *lowMobilityEvaluationConnected* and both low mobility criterion defined in clause 5.7.13.1 of TS 38.331 [2] is fulfilled for a period of *TSearchDeltaP-Connected* and good serving cell quality criterion defined in clause 5.7.13.2 of TS 38.331 [2] is fulfilled for the serving cell based on the measurements that are configured for SSB-based or CSI-RS based RLM on SpCell together with CSI-RS based BFD on Scell in the intra-band carrier aggregation.

- for other serving cells, when

- the good serving cell quality criterion defined in clause 5.7.13.2 of TS 38.331 [2] is fulfilled for the SpCell if the *lowMobilityEvaluationConnected* is not configured, or

- the UE is also configured with *lowMobilityEvaluationConnected*  and both low mobility criterion defined in clause 5.7.13.1 of TS 38.331 [2] is fulfilled for a period of TSearchDeltaP-Connected and good serving cell quality criterion defined in clause 5.7.13.2 of TS 38.331 [2] is fulfilled for the SpCell.

otherwise, UE shall apply the requirements defined in clause 8.1.2.2 for SSB based radio link monitoring and the requirements defined in clause 8.1.3.2 for CSI-RS based radio link monitoring. Note that when multiple resources are configured on a serving cell for RLM or BFD evaluation, the good serving cell quality critierion is considered as fulfilled for the serving cell when any resource configured for the cell fulfills the good serving defined in clause 5.7.13.2 of TS 38.331 [2].

The UE is no longer allowed to relax RLM measurements and apply the relaxed radio link monitoring provided that at least one of the following conditions is met:

- The UE sends out-of sync indications to the higher layers,

- The timer T310 is running.

- No DRX is used or DRX cycle is longer than 80ms

### 8.1.2 Requirements for SSB based radio link monitoring

#### 8.1.2.1 Introduction

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

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

|  |  |
| --- | --- |
| Attribute | Value for BLER Configuration #0 |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| 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 (PRBs) | 24 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

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

|  |  |
| --- | --- |
| Attribute | Value for BLER Configuration #0 |
| DCI payload size | 1-0 |
| Number of control OFDM symbols | 2 |
| 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 (PRBs) | 24 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| 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 TEvaluate\_out\_SSB [ms] period becomes worse than the threshold Qout\_SSB within TEvaluate\_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 TEvaluate\_in\_SSB [ms] period becomes better than the threshold Qin\_SSB within TEvaluate\_in\_SSB [ms] evaluation period.

TEvaluate\_out\_SSB and TEvaluate\_in\_SSB are defined in Table 8.1.2.2-1 for FR1.

TEvaluate\_out\_SSB and TEvaluate\_in\_SSB are defined in Table 8.1.2.2-2 for FR2 with scaling factor N=8 for FR2-1 and N=12 for FR2-2, for FR2 power classes other than power class 6 or for FR2 class 6 when *highSpeedMeasFlagFR2-r17* is not configured

TEvaluate\_out\_SSB and TEvaluate\_in\_SSB are defined in Table 8.1.2.2-3 for FR2 power class 6 UE configured with *highSpeedMeasFlagFR2-r17*.

TEvaluate\_out\_SSB and TEvaluate\_in\_SSB are defined in Table 8.1.2.2-4 for FR1 (deactivated PSCell).

TEvaluate\_out\_SSB and TEvaluate\_in\_SSB are defined in Table 8.1.2.2-4 for FR1 (deactivated PSCell).

TEvaluate\_out\_SSB and TEvaluate\_in\_SSB are defined in Table 8.1.2.2-5 for FR2 (deactivated PSCell) with scaling factor N=8 for FR2-1 and N=12 for FR2-2.

When concurrent gaps are configured,

- P value for an RLM-RS resource to be measured is defined as

- Ntotal / Noutside\_MG in FR1

- Psharing factor \* Ntotal / Noutside\_MG in FR2 with Navailable = 0

- Ntotal / Navailable in FR2 with Navailable > 0

- For a window W of duration max(TL1, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gaps and per-FR measurement gaps within the same FR as serving cell, and starting at the beginning of any RLM-RS resource occasion:

- Ntotal is the total number of RLM-RS resource occasions within the window, including those overlapped with measurement gap occasions or SMTC occasions within the window, and

- Noutside\_MG is the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion within the window W

- Navailable is the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion nor any SMTC occasion within the window W

- TL1 is periodicity of the target RLM-RS.

Otherwise, for a UE not supporting *concurrentMeasGap-r17* or when concurrent gaps are not configured,

For FR1,

- , when in the monitored cell there are GAPs configured for intra-frequency, inter-frequency or inter-RAT measurements, and these GAPs are overlapping with some but not all occasions of the SSB; and

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

For FR2

- , when RLM-RS resource is not overlapped with GAP and the RLM-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P is Psharing factor, when the RLM-RS resource is not overlapped with GAP and RLM-RS resource is fully overlapped with SMTC period (TSSB = TSMTCperiod).

- , when the RLM-RS resource is partially overlapped with GAP and the RLM-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with [measurement gap] and

- TSMTCperiod ≠ xRP or

- TSMTCperiod = xRP and TSSB < 0.5\*TSMTCperiod

- , when the RLM-RS is partially overlapped with GAP and the RLM-RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with [measurement gap] and TSMTCperiod = xRP and TSSB = 0.5 × TSMTCperiod

- , when the RLM-RS resource is partially overlapped with GAP and the RLM-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is partially or fully overlapped with [measurement gap]

- , when the RLM-RS resource is partially overlapped with GAP and the RLM-RS resource is fully overlapped with SMTC occasion (TSSB = TSMTCperiod) and SMTC occasion is partially overlapped with GAP (TSMTCperiod < xRP)

where,

- Psharing factor = 1, if the RLM-RS resource outside gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and,

- not overlapped by the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured.

- Psharing factor = 3, otherwise.

- If the high layer in TS 38.331 [2] signaling of *smtc2*is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1.* TSMTCperiod is the shortest SMTC period among all CCs in the same FR2 band, provided the SMTC offset of all CCs in FR2 have the same offset.

- When a measurement gap is configured and the measurement gap is not NCSG,

- an RLM-RS resource or an SMTC occasion is considered to be overlapped with the GAP if it overlaps a measurement gap occasion, and

- xRP = MGRP

- Otherwise,when NCSG measurement gap is configured,

- an RLM-RS resource or an SMTC occasion is considered to be overlapped with the GAP if

- it overlaps the VIL1 or VIL2 of NCSG, or

- it overlaps the ML of NCSG in FR2, and there exists a target carrier to be measured within NCSG that is intra-frequency carrier or inter-frequency carrier in the same band as the serving cell, or inter-frequency carrier in different band as the serving cell and UE does not support IBM between the target carrier and the serving cell,

- and

- xRP = VIRP

- If the UE is configured with Pre-MG, an RLM-RS resource or an SMTC occasion is only considered to be overlapped by the Pre-MG if the Pre-MG is activated.

- When concurrent gaps are configured, an RLM-RS or an SMTC occasion is not considered as overlapped by a gap occasion if the gap occasion is dropped according to 9.1.8.

If the high layer in TS 38.331 [2] signaling of *smtc2*is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1.*

Longer evaluation period would be expected if the combination of RLM-RS resource, SMTC occasion and GAP configurations does not meet previous conditions

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

Table 8.1.2.2-1: Evaluation period TEvaluate\_out\_SSB and TEvaluate\_in\_SSB for FR1

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_SSB (ms) | TEvaluate\_in\_SSB (ms) |
| no DRX | Max(200, Ceil(10 × P) × TSSB) | Max(100, Ceil(5 × P) × TSSB) |
| DRX cycle≤320ms | Max(200, Ceil(15 × P) × Max(TDRX,TSSB)) | Max(100, Ceil(7.5 × P) × Max(TDRX,TSSB)) |
| DRX cycle>320ms | Ceil(10 × P) × TDRX | Ceil(5 × P) × TDRX |
| NOTE: TSSB is the periodicity of the SSB configured for RLM. TDRX is the DRX cycle length. | | |

Table 8.1.2.2-2: Evaluation period TEvaluate\_out\_SSB and TEvaluate\_in\_SSB for FR2

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_SSB (ms) | TEvaluate\_in\_SSB (ms) |
| no DRX | Max(200, Ceil(10 × P × N) × TSSB) | Max(100, Ceil(5 × P × N) × TSSB) |
| DRX cycle≤320ms | Max(200, Ceil(15 × P × N) × Max(TDRX,TSSB)) | Max(100, Ceil(7.5 × P × N) × Max(TDRX,TSSB)) |
| DRX cycle>320ms | Ceil(10 × P × N) × TDRX | Ceil(5 × P × N) × TDRX |
| NOTE: TSSB is the periodicity of the SSB configured for RLM. TDRX is the DRX cycle length. | | |

Table 8.1.2.2-3: Evaluation period TEvaluate\_out\_SSB and TEvaluate\_in\_SSB for FR2 power class 6 UE configured with *highSpeedMeasFlagFR2-r17*

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_SSB (ms) | TEvaluate\_in\_SSB (ms) |
| no DRX | Max(200, Ceil(10 × P × N Note2) × TSSB) | Max(100, Ceil(5 × P × N Note2) × TSSB) |
| DRX cycle≤80ms | Max(200, Ceil(15 × P × N Note2) × Max(TDRX,TSSB)) | Max(100, Ceil(7.5 × P × N Note2) × Max(TDRX,TSSB)) |
| NOTE 1: TSSB is the periodicity of the SSB configured for RLM. TDRX is the DRX cycle length.  NOTE 2: scaling factor N=2 when *highSpeedMeasFlagFR2-r17* is configured to set1 or scaling factor N=6 when *highSpeedMeasFlagFR2-r17* is configured to set2. | | |

Table 8.1.2.2-4: Evaluation period TEvaluate\_out\_SSB and TEvaluate\_in\_SSB for FR1(deactivated PSCell)

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_SSB (ms) | TEvaluate\_in\_SSB (ms) |
| no DRX | Ceil(10 × P) × measCyclePSCell | Ceil(5 × P) × measCyclePSCell |
| DRX cycle≤ 320ms | Ceil(15 × P) × Max(TDRX, measCyclePSCell) | Ceil(7.5 × P) × Max(TDRX, measCyclePSCell) |
| DRX cycle> 320ms | Ceil(10 × P) × Max(TDRX, measCyclePSCell) | Ceil(5 × P) × Max(TDRX, measCyclePSCell) |
| NOTE: TDRX is the DRX cycle length of SCG. measCyclePSCell is the measurement cycle length of the deactivated PSCell. | | |

Table 8.1.2.2-5: Evaluation period TEvaluate\_out\_SSB and TEvaluate\_in\_SSB for FR2(deactivated PSCell)

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_SSB (ms) | TEvaluate\_in\_SSB (ms) |
| no DRX | Ceil(10 × P× N) × measCyclePSCell | Ceil(5 × P× N) × measCyclePSCell |
| DRX cycle≤ 320 ms | Ceil(15 × P× N) × Max(TDRX, measCyclePSCell) | Ceil(7.5 × P× N) × Max(TDRX, measCyclePSCell) |
| DRX cycle> 320 ms | Ceil(10 × P× N) × Max(TDRX, measCyclePSCell) | Ceil(5 × P× N) × Max(TDRX, measCyclePSCell) |
| NOTE: TDRX is the DRX cycle length of SCG. measCyclePSCell is the measurement cycle length of the deactivated PSCell. | | |

#### 8.1.2.3 Measurement restrictions for SSB based RLM

The UE is required to be capable of measuring SSB for RLM without measurement gaps. The UE is required to perform the SSB measurements with measurement restrictions as described in the following scenarios.

For FR1, when the SSB for RLM is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, UE shall be able to measure the SSB for RLM without any restriction;

- If SSB and CSI-RS have different SCS,

- If UE supports *simultaneousRxDataSSB-DiffNumerology*, UE shall be able to measure the SSB for RLM without any restriction;

- If UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both SSB for RLM and CSI-RS. Longer measurement period for SSB based RLM is expected, and no requirements are defined

For FR2, when the SSB for RLM measurement on one CC is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both SSB for RLM and CSI-RS. Longer measurement period for SSB based RLM is expected, and no requirements are defined.

For FR2, when the SSB for RLM measurement on one CC is in the same or adjacent OFDM symbol as SSB from cell with additional PCI for BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both SSBs. Longer measurement period for SSB based RLM is expected, and no requirements are defined.

For FR2, there is no measurement restriction allowed when the network configures mixed numerology between SSB for RLM measurement on one FR2 band and CSI-RS for RLM, BFD, CBD, L1-RSRP or L1-SINR measurement on the other FR2 band, provided that UE is capable of independent beam management on this FR2 band pair.

#### 8.1.2.4 Minimum requirement of SSB based radio link monitoring for UE fulfilling relaxed measurement criteria

This clause contains minimum requirements for relaxed radio link monitoring based on SSB.

UE shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last TEvaluate\_out\_SSB\_Relax [ms] period becomes worse than the threshold Qout\_SSB within TEvaluate\_out\_SSB\_Relax [ms] evaluation period.

TEvaluate\_out\_SSB\_Relax is defined in Table 8.1.2.4-1 for FR1.

TEvaluate\_out\_SSB\_Relax is defined in Table 8.1.2.4-2 for FR2 with scaling factor N=8.

The value of P is defined in clause 8.1.2.2.

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

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

Table 8.1.2.4-1: Evaluation period TEvaluate\_out\_SSB\_Relax for FR1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_out\_SSB\_Relax (ms) |
| Max(TDRX,TSSB) ≤80ms | Max(200× K3 NOTE3, Ceil(15 × K1NOTE2 × P) × Max(TDRX,TSSB)) |
| 80ms < Max(TDRX,TSSB) ≤160ms | Ceil(15 × P) × Max(TDRX,TSSB) |
| NOTE 1: TSSB is the periodicity of the SSB configured for RLM. TDRX is the DRX cycle length and no longer than 80ms.  NOTE 2: K1 = 4 for Max(TDRX,TSSB) ≤40ms and K1 = 2 for 40ms<Max(TDRX,TSSB) ≤80ms.  NOTE 3: K3 = K1, if K1 ≤ 2; otherwise K3 = 1. | |

Table 8.1.2.4-2: Evaluation period TEvaluate\_out\_SSB\_Relax for FR2

|  |  |
| --- | --- |
| Configuration | TEvaluate\_out\_SSB\_Relax (ms) |
| Max(TDRX,TSSB) ≤80ms | Max(200× K4 NOTE3, Ceil(15 × K2 NOTE2 × P × N) × Max(TDRX,TSSB)) |
| 80ms < Max(TDRX,TSSB) ≤160ms | Ceil(15 × P × N) × Max(TDRX,TSSB) |
| NOTE 1: TSSB is the periodicity of the SSB configured for RLM. TDRX is the DRX cycle length and no longer than 80ms.  NOTE 2: K2 = 2.  NOTE 3: K4 = K2, if K2 ≤ 2; otherwise K4 = 1. | |

### 8.1.3 Requirements for CSI-RS based radio link monitoring

#### 8.1.3.1 Introduction

The requirements in this clause apply for each CSI-RS based RLM-RS resource configured for PCell, PSCell or deactivated PSCell, provided that the CSI-RS configured for RLM is actually transmitted within UE active DL BWP during the entire evaluation period specified in clause 8.1.3.2. UE is not expected to perform radio link monitoring measurements on the CSI-RS configured as RLM-RS if the CSI-RS is not in the active TCI state of any CORESET configured in the UE active BWP.

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

|  |  |
| --- | --- |
| Attribute | Value for BLER Configuration #0 |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| 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 (PRBs) | 48 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

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

|  |  |
| --- | --- |
| Attribute | Value for BLER Configuration #0 |
| DCI payload size | 1-0 |
| Number of control OFDM symbols | 2 |
| 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 | 0dB |
| Bandwidth (PRBs) | 48 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

#### 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 TEvaluate\_out\_CSI-RS ms period becomes worse than the threshold Qout\_CSI-RS within TEvaluate\_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 TEvaluate\_in\_CSI-RS ms period becomes better than the threshold Qin\_CSI-RS within TEvaluate\_in\_CSI-RS ms evaluation period.

- TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS are defined in Table 8.1.3.2-1 for FR1.

- TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS are defined in Table 8.1.3.2-2 for FR2 with scaling factor N=1.

- TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS are defined in Table 8.1.3.2-3 for FR1 (deactivated PSCell).

- TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS are defined in Table 8.1.3.2-4 for FR2 (deactivated PSCell) with scaling factor N=1.

The requirements of TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS apply provided that the CSI-RS for RLM is not in a resource set configured with repetition ON. The requirements do not apply when the CSI-RS resource in the active TCI state of CORESET is the same CSI-RS resource for RLM and the TCI state information of the CSI-RS resource is not given, wherein the TCI state information means QCL Type-D to SSB for L1-RSRP or CSI-RS with repetition ON.

When concurrent gaps are configured,

- P value for an RLM-RS resource to be measured is defined as

- Ntotal / Noutside\_MG in FR1

- Psharing factor \* Ntotal / Noutside\_MG in FR2 with Navailable = 0

- Ntotal / Navailable in FR2 with Navailable > 0

- For a window W of duration max(TL1, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gaps and per-FR measurement gaps within the same FR as serving cell, and starting at the beginning of any RLM-RS resource occasion:

- Ntotal is the total number of RLM-RS resource occasions within the window, including those overlapped with measurement gap occasions or SMTC occasions within the window, and

- Noutside\_MG is the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion within the window W

- Navailable is the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion nor any SMTC occasion within the window W

- TL1 is periodicity of the target RLM-RS.Otherwise, for a UE not supporting *concurrentMeasGap-r17* or when concurrent gaps are not configured,

For FR1,

- , when in the monitored cell there are GAPs configured for intra-frequency, inter-frequency or inter-RAT measurements, and these GAPs] are overlapping with some but not all occasions of the CSI-RS; and

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

For FR2,

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

- , when the RLM-RS resource is partially overlapped with GAP and the RLM-RS resource is not overlapped with SMTC occasion (TCSI-RS < xRP)

- , when the RLM-RS resource is not overlapped with GAP and the RLM-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod).

- P = Psharing factor, when the RLM-RS resource is not overlapped with GAP and RLM-RS resource is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod).

- , when the RLM-RS resource is partially overlapped with GAP and the RLM-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with GAP and

- TSMTCperiod ≠ xRP or

- TSMTCperiod = xRP and TCSI-RS < 0.5 × TSMTCperiod

- , when the RLM-RS resource is partially overlapped with measurement gap and the RLM-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with GAP and TSMTCperiod = xRP and TCSI-RS = 0.5 × TSMTCperiod

- , when the RLM-RS resource is partially overlapped with GAP and the RLM-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is partially or fully overlapped with GAP

- , when the RLM-RS resource is partially overlapped with measurement gap and the RLM-RS resource is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < xRP)

where,

- Psharing factor = 1, if the RLM-RS resource outside gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and,

- not overlapped by the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured.

- Psharing factor = 3, otherwise.

- If the high layer in TS 38.331 [2] signaling of *smtc2*is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1.* TSMTCperiod is the shortest SMTC period among all CCs in the same FR2 band, provided the SMTC offset of all CCs in FR2 have the same offset.

- When a measurement gap is configured and the measurement gap is not NCSG,

- an RLM-RS resource or an SMTC occasion is considered to be overlapped with the GAP if it overlaps a measurement gap occasion, and

- xRP = MGRP

- Otherwise, when NCSG measurement gap is configured,

- an RLM-RS resource or an SMTC occasion is considered to be overlapped with the GAP if

- it overlaps the VIL1 or VIL2 of NCSG, or

- it overlaps the ML of NCSG in FR2, and there exists a target carrier to be measured within NCSG that is intra-frequency carrier or inter-frequency carrier in the same band as the serving cell, or inter-frequency carrier in different band as the serving cell and UE does not support IBM between the target carrier and the serving cell,

- and

- xRP = VIRP

If the UE is configured with Pre-MG, an RLM-RS resource or an SMTC occasion is only considered to be overlapped by the Pre-MG if the Pre-MG is activated.

When concurrent gaps are configured, an RLM-RS or an SMTC occasion is not considered to be overlapped by a gap occasion if the gap occasion is dropped according to 9.1.8.

If the high layer in TS 38.331 [2] signaling of *smtc2*is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1.*

Note: The overlap between CSI-RS for 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 resource, SMTC occasion and GAP configurations does not meet previous conditions.

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of Mout and Min used in Table 8.1.3.2-1, Table 8.1.3.2-2, Table 8.1.3.2-3 and Table 8.1.3.2-4 are defined as:

- Mout = 20 and Min = 10, if the CSI-RS resource configured for RLM is transmitted with higher layer CSI-RS parameter *density* [6, clause 7.4.1] set to 3 and over the bandwidth ≥ 24 PRBs.

Table 8.1.3.2-1: Evaluation period TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS for FR1

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_CSI-RS (ms) | TEvaluate\_in\_CSI-RS (ms) |
| no DRX | Max(200, Ceil(Mout×P)×TCSI-RS) | Max(100, Ceil(Min×P) × TCSI-RS) |
| DRX ≤ 320ms | Max(200, Ceil(1.5×Mout×P)× Max(TDRX, TCSI-RS)) | Max(100, Ceil(1.5×Min×P)× Max(TDRX, TCSI-RS)) |
| DRX > 320ms | Ceil(Mout×P) × TDRX | Ceil(Min×P) × TDRX |
| NOTE: TCSI-RS is the periodicity of the CSI-RS resource configured for RLM. The requirements in this table apply for TCSI-RS equal to 5 ms, 10ms, 20 ms or 40 ms. TDRX is the DRX cycle length. | | |

Table 8.1.3.2-2: Evaluation period TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS for FR2

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_CSI-RS (ms) | TEvaluate\_in\_CSI-RS (ms) |
| no DRX | Max(200, Ceil(Mout×P×N)×TCSI-RS) | Max(100, Ceil(Min×P×N) × TCSI-RS) |
| DRX ≤ 320ms | Max(200, Ceil(1.5×Mout×P×N)× Max(TDRX, TCSI-RS)) | Max(100, Ceil(1.5×Min×P×N)× Max(TDRX, TCSI-RS)) |
| DRX > 320ms | Ceil(Mout×P×N) × TDRX | Ceil(Min×P×N) × TDRX |
| NOTE: TCSI-RS is the periodicity of the CSI-RS resource configured for RLM. The requirements in this table apply for TCSI-RS equal to 5 ms, 10 ms, 20 ms or 40 ms. TDRX is the DRX cycle length. | | |

Table 8.1.3.2-3: Evaluation period TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS for FR1 (deactivated PSCell)

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_CSI-RS (ms) | TEvaluate\_in\_CSI-RS (ms) |
| no DRX | Ceil(Mout×P) × measCyclePSCell | Ceil(Min×P) × measCyclePSCell |
| DRX ≤ 320ms | Ceil(1.5 ×Mout×P) × Max(TDRX, measCyclePSCell) | Ceil(1.5 ×Min×P) × Max(TDRX, measCyclePSCell) |
| DRX > 320ms | Ceil(Mout×P) × Max(TDRX, measCyclePSCell) | Ceil(Min×P) × Max(TDRX, measCyclePSCell) |
| NOTE: TDRX is the DRX cycle length of SCG. measCyclePSCell is the measurement cycle length of the deactivated PSCell. | | |

Table 8.1.3.2-4: Evaluation period TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS for FR2 (deactivated PSCell)

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_CSI-RS (ms) | TEvaluate\_in\_CSI-RS (ms) |
| no DRX | Ceil(Mout×P×N) × measCyclePSCell | Ceil(Min×P×N) × measCyclePSCell |
| DRX ≤ 320ms | Ceil(1.5 × Mout×P×N) × Max(TDRX, measCyclePSCell) | Ceil(1.5 × Min×P×N) × Max(TDRX, measCyclePSCell) |
| DRX > 320ms | Ceil(Mout×P×N) × Max(TDRX, measCyclePSCell) | Ceil(Min×P×N) × Max(TDRX, measCyclePSCell) |
| NOTE: TDRX is the DRX cycle length of SCG. measCyclePSCell is the measurement cycle length of the deactivated PSCell. | | |

#### 8.1.3.3 Measurement restrictions for CSI-RS based RLM

The SSB mentioned in this clause can be associated with either the serving cell PCI or a PCI different from serving cell PCI.

The UE is required to be capable of measuring CSI-RS for RLM without measurement gaps. The UE is required to perform the CSI-RS measurements with measurement restrictions as described in the following clauses.

For both FR1 and FR2, when the CSI-RS for RLM is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, UE is not required to receive CSI-RS for RLM in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD, or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for RLM, the UE shall be able to perform CSI-RS measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for RLM, the UE shall be able to perform CSI-RS measurement with restrictions according to its capabilities:

- If the UE supports *simultaneousRxDataSSB-DiffNumerology* the UE shall be able to perform CSI-RS for RLM measurement without restrictions.

- If the UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both CSI-RS for RLM and SSB. Longer measurement period for CSI-RS based RLM is expected, and no requirements are defined.

For FR1, when the CSI-RS for RLM is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, UE shall be able to measure the CSI-RS for RLM without any restriction.

For FR2, when the CSI-RS for RLM measurement on one CC is in the same OFDM symbol as SSB for RLM, BFD, or L1-RSRP measurement on the same CC or different CCs in the same band, or in the same symbol as SSB for CBD measurement on the same CC or different CCs in the same band when beam failure is detected, UE is required to measure one of but not both CSI-RS for RLM and SSB. Longer measurement period for CSI-RS based RLM is expected, and no requirements are defined.

For FR2, when the CSI-RS for RLM measurement on one CC is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band,

- In the following cases, UE is required to measure one of but not both CSI-RS for RLM and the other CSI-RS. Longer measurement period for CSI-RS based RLM is expected, and no requirements are defined.

- The CSI-RS for RLM or the other CSI-RS in a resource set configured with repetition ON, or

- The other CSI-RS is configured in q1 and beam failure is detected, or

- The two CSI-RS-es are not QCL-ed w.r.t. QCL-TypeD, or the QCL information is not known to UE,

- Otherwise, UE shall be able to measure the CSI-RS for RLM without any restriction.

#### 8.1.3.4 Minimum requirement of CSI-RS based radio link monitoring for UE fulfilling relaxed measurement criteria

This clause contains minimum requirements for relaxed radio link monitoring based on CSI-RS.

UE shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last TEvaluate\_out\_CSI-RS\_Relax [ms] period becomes worse than the threshold Qout\_CSI-RS within TEvaluate\_out\_CSI-RS\_Relax [ms] evaluation period.

TEvaluate\_out\_CSI-RS\_Relax is defined in Table 8.1.3.4-1 for FR1.

TEvaluate\_out\_CSI-RS\_Relax is defined in Table 8.1.3.4-2 for FR2 with scaling factor N=1.

The value of P is defined in clause 8.1.3.2.

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

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of Mout used in Table 8.1.3.4-1 and Table 8.1.3.4-2 are defined as:

- Mout = 20, if the CSI-RS resource configured for RLM is transmitted with higher layer CSI-RS parameter *density* [6, clause 7.4.1] set to 3 and over the bandwidth ≥ 24 PRBs.

Table 8.1.3.4-1: Evaluation period TEvaluate\_out\_CSI-RS\_Relax for FR1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_out\_CSI-RS\_Relax (ms) |
| Max(TDRX, TCSI-RS) ≤ 80 ms | Max(200 × K3 NOTE3, Ceil(1.5 × Mout × P × K1 NOTE2) × Max(TDRX, TCSI-RS) NOTE1) |
| NOTE1: TCSI-RS is the periodicity of the CSI-RS resource configured for RLM. The requirements in this table apply for TCSI-RS equal to 5 ms, 10ms, 20 ms or 40 ms. TDRX is the DRX cycle length and no longer than 80ms.  NOTE2: K1 = 2 for 40 ms < MAX(TDRX, TCSI-RS) ≤ 80 ms, K1 = 4 for MAX(TDRX, TCSI-RS) ≤ 40 ms  NOTE3: K3 = K1, if K1 ≤ 2; K3 = 1 otherwise. | |

Table 8.1.3.4-2: Evaluation period TEvaluate\_out\_CSI-RS\_Relax for FR2

|  |  |
| --- | --- |
| Configuration | TEvaluate\_out\_CSI-RS\_Relax (ms) |
| Max(TDRX, TCSI-RS) ≤ 80 ms | Max(200 × K4 NOTE3, Ceil(1.5 × Mout × P × N × K2 NOTE2) × Max(TDRX, TCSI-RS) NOTE1) |
| NOTE1: TCSI-RS is the periodicity of the CSI-RS resource configured for RLM. The requirements in this table apply for TCSI-RS equal to 5 ms, 10 ms, 20 ms or 40 ms. TDRX is the DRX cycle length and no longer than 80ms.  NOTE2: K2 = 2.  NOTE3: K4 = K2, if K2 ≤ 2; K4 = 1 otherwise. | |

### 8.1.4 Minimum requirement at transitions

When the UE transitions between DRX and no 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 the monitored cell.

When the UE transitions from a first configuration of RLM resources to a second configuration of RLM resources that is different from the first configuration, for each RLM 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 resource present in the second configuration. This requirement shall be applied to both out-of-sync evaluation and in-sync evaluation of the monitored cell.

When the UE transitions from a first configuration of active TCI state of the CORESET to a second configuration of active TCI state of the CORESET, for each CSI-RS for RLM present in the second configuration, the UE shall use an evaluation period corresponding to the second configuration from the time of transition. This requirement shall be applied to both out-of-sync evaluation and in-sync evaluation of the monitored 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 Qout, 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 Qin, 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 TIndication\_interval.

When DRX is not used TIndication\_interval is max(10ms, TRLM-RS,M), where TRLM-RS,M is the shortest periodicity of all configured RLM-RS resources for the monitored cell, which corresponds to TSSB specified in clause 8.1.2 if the RLM-RS resource is SSB, or TCSI-RS specified in clause 8.1.3 if the RLM-RS resource is CSI-RS.

In case DRX is used, TIndication\_interval is Max(10ms, 1.5 × DRX\_cycle\_length, 1.5 × TRLM-RS,M)) if DRX cycle\_length is less than or equal to 320ms, and TIndication\_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 no DRX mode until the expiry or stop of T310 timer.

For deactivated PSCell, when DRX is not used TIndication\_interval is Max (10ms, *measCyclePSCell*). In case DRX is used, TIndication\_interval is Max(10ms, 1.5 × DRX\_cycle\_length, 1.5 × *measCyclePSCell*)) if DRX cycle\_length is less than or equal to 320ms, and TIndication\_interval is Max (DRX\_cycle\_length, *measCyclePSCell*) if DRX cycle\_length is greater than 320ms.

### 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 or is on frequency range 2, 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 UEs which support *simultaneousRxDataSSB-DiffNumerology* [14] there are no restrictions on scheduling availability due to radio link monitoring based on SSB as RLM-RS. For UEs 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 SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on SSB symbols to be measured for radio link monitoring.

When intra-band carrier aggregation in FR1 is performed, the scheduling restrictions on FR1 serving PCell or PSCell applies to all serving cells in the same band on the symbols that fully or partially overlap with the restricted symbols. 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 the RLM-RS is CSI-RS which is type-D QCLed with active TCI state for PDCCH or PDSCH, and the CSI-RS is not in a CSI-RS resource set with repetition ON,

- There are no scheduling restrictions due to radio link monitoring based on the CSI-RS.

- Otherwise

- For FR2-1 or the RLM-RS is not using 480 kHz SCS or 960 kHz SCS on FR2-2, the UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on RLM-RS symbols to be measured for radio link monitoring.

- For FR2-2 and the RLM-RS is using 480 kHz SCS or 960 kHz SCS, the UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on RLM-RS symbols to be measured for radio link monitoring, and on one data symbol before each RLM-RS symbol to be measured and one data symbol after each RLM-RS symbol to be measured.

When intra-band carrier aggregation in FR2 is performed, the scheduling restrictions on FR2 serving PCell or PSCell applies to all serving cells in the same band on the symbols that fully or partially overlap with restricted symbols.

When inter-band carrier aggregation in FR2 is performed, there are no scheduling restrictions on FR2 serving cell(s) in the bands for the following cases, provided that UE is capable of independent beam management on this FR2 band pair:

- when performing radio link monitoring performed on FR2 serving PCell or PSCell in different bands,

- the UE is configured with same or different numerology between SSB on one FR2 band and data on the other FR2 band.

For FR2, if following conditions are met,

- UE has been notified about system information update through paging,

- The gap between UE’s reception of PDCCH that UE monitors in the Type2-PDCCH CSS set and that notifies system information update, and the PDCCH that UE monitors in the Type0-PDCCH CSS set, is greater than 2 slots,

For the SSB for RLM and CORESET for RMSI scheduling multiplexing patterns 3, UE is expected to receive the PDCCH that UE monitors in the Type0-PDCCH CSS set, and the corresponding PDSCH, on SSB symbols to be measured for RLM; and

For the SSB for RLM and CORESET for RMSI scheduling multiplexing patterns 2, UE is expected to receive PDSCH that corresponds to the PDCCH that UE monitors in the Type0-PDCCH CSS set, on SSB symbols to be measured for RLM.

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

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.

## 8.1A Radio Link Monitoring with CCA on Target Frequency

### 8.1A.1 Introduction

The requirements in clause 8.1A apply for radio link monitoring on a carrier frequency with CCA for cells:

- PCell in SA NR operation mode,

- PSCell in EN-DC operation mode.

- PSCell in NR-DC operation mode.

The UE shall monitor the downlink radio link quality based on the reference signal configured as RLM-RS resource(s) in order to detect the downlink radio link quality of the PCell and PSCell as specified in TS 38.213 [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 Qout,CCA and Qin,CCA for the purpose of monitoring downlink radio link quality of the cell.

The threshold Qout,CCA 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 (BLERout,CCA) as defined in Table 8.1A.1-1. For SSB based radio link monitoring, Qout\_SSB,CCA is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1A.2.1-1.

The threshold Qin,CCA is defined as the level at which the downlink radio link quality can be received with significantly higher reliability than at Qout,CCA and shall correspond to the in-sync block error rate (BLERin) as defined in Table 8.1A.1-1. For SSB based radio link monitoring, Qin\_SSB,CCA is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1A.2.1-2.

The out-of-sync block error rate (BLERout,CCA) and in-sync block error rate (BLERin,CCA) are determined from the network configuration via parameter *rlmInSyncOutOfSyncThreshold* signalled by higher layers. When UE is not configured with *rlmInSyncOutOfSyncThreshold* from the network, UE determines out-of-sync and in-sync block error rates from Configuration #0 in Table 8.1A.1-1 as default. All requirements in clause 8.1A are applicable for BLER Configuration #0 in Table 8.1A.1-1.

Table 8.1A.1-1: Out-of-sync and in-sync block error rates

|  |  |  |
| --- | --- | --- |
| Configuration | BLERout,CCA | BLERin,CCA |
| 0 | 10% | 2% |

UE shall be able to monitor up to NRLM RLM-RS resources of the same or different types in each corresponding carrier frequency range, depending on a maximum number Lmax of SSBs per half frame according to TS 38.213 [3], where NRLM is specified in Table 8.1A.1-2, and meet the requirements as specified in clause 8.1A. UE is not required to meet the requirements in clause 8.1A if RLM-RS is not configured and no TCI state for PDCCH is activated.

Table 8.1A.1-2: Maximum number of RLM-RS resources NRLM

|  |  |  |
| --- | --- | --- |
| Carrier frequency range of PCell/PSCell | Lmax | Maximum number of RLM-RS resources, NRLM |
| FR1 | 8 | 4 |
| FR2-2 | 64 | 8 |

In the requirements of clause 8.1A, the term RLM-RS SSB occasion not available at the UE refers to when the RLM-RS SSB is configured by gNB in a cell on a carrier frequency subject to CCA, but the first two successive candidate SSB positions for the same SSB index within the set of configured RLM-RS resources are not available at the UE due to DL CCA failures at gNB during the corresponding evaluation period; otherwise the RLM-RS SSB is considered as available at the UE.

The requirements in clause 8.1A apply for any *channelAccessMode* configuration [TS 38.331, 2].

### 8.1A.2 Requirements for SSB Based Radio Link Monitoring

#### 8.1A.2.1 Introduction

The requirements in this clause apply for each SSB based RLM-RS resource configured for PCell or PSCell, provided that the SSB configured for RLM are actually configured to be transmitted within UE active DL BWP during the entire evaluation period specified in clause 8.1A.2.2 but occasionally may not be transmitted due to CCA operation.

Table 8.1A.2.1-1: PDCCH transmission parameters for out-of-sync evaluation

|  |  |
| --- | --- |
| Attribute | Value for BLER Configuration #0 |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| Aggregation level (CCE) | 8 |
| Ratio of hypothetical PDCCH RE energy to average SSS RE energy | 4 dB |
| Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | 4 dB |
| Bandwidth (PRBs) | 24 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

Table 8.1A.2.1-2: PDCCH transmission parameters for in-sync evaluation

|  |  |
| --- | --- |
| Attribute | Value for BLER Configuration #0 |
| DCI payload size | 1-0 |
| Number of control OFDM symbols | 2 |
| 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 (PRBs) | 24 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

#### 8.1A.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 TEvaluate\_out\_SSB,CCA [ms] period becomes worse than the threshold Qout\_SSB,CCA within TEvaluate\_out\_SSB,CCA [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 TEvaluate\_in\_SSB,CCA [ms] period becomes better than the threshold Qin\_SSB,CCA within TEvaluate\_in\_SSB,CCA [ms] evaluation period. During the in-sync evaluation procedure, layer 1 of the UE shall not send any in-sync indication for the cell to the higher layers when Lin exceeds Lin,max, where Lin and Lin,max are defined in Table 8.1A.2.2-1.

TEvaluate\_out\_SSB,CCA and TEvaluate\_in\_SSB,CCA are defined in Table 8.1A.2.2-1 for FR1.

TEvaluate\_out\_SSB,CCA and TEvaluate\_in\_SSB,CCA are defined in Table 8.1A.2.2-2 for FR2-2 with scaling factor N = 12.

When concurrent gaps are configured,

- P value for an RLM-RS resource to be measured is defined as Ntotal / Noutside\_MG

- For a window W of duration max(TL1, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gap and per-FR measurement gap within the same FR as serving cell, and starting at the beginning of any RLM-RS resource occasion:

- Ntotal is the total number of RLM-RS resource occasions within the window, including those overlapped with measurement gap occasions within the window, and

- Noutside\_MG is the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion within the window W

Otherwise, for a UE not supporting *concurrentMeasGap-r17* or when concurrent gaps are not configured,

For FR1,

- , when in the monitored cell there are GAPs configured for intra-frequency, inter-frequency or inter-RAT measurements, and these GAPs are overlapping with some but not all occasions of the SSB RLM-RS resources; and

- P=1 when in the monitored cell there are no GAPs overlapping with any occasion of the SSB RLM-RS resources.

When a measurement gap is configured and the measurement gap is not NCSG,

- an RLM-RS resource is considered to be overlapped with the GAP f it overlaps a measurement gap occasion, and

- xRP = MGRP

Otherwise, when NCSG measurement gap is configured,

- an RLM-RS resource is considered to be overlapped with the GAP if it overlaps the VIL1 or VIL2 of NCSG, and

- xRP = VIRP

If the UE is configured with Pre-MG, an RLM-RS resource is only considered to be overlapped by the Pre-MG if the Pre-MG is activated.

When concurrent gaps are configured, an RLM-RS is not considered to be overlapped by a gap occasion if the gap occasion is dropped according to 9.1.8.

For FR2-2,

- , when RLM-RS resource is not overlapped with measurement gap and the RLM-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P is Psharing factor, when the RLM-RS resource is not overlapped with measurement gap and RLM-RS resource is fully overlapped with SMTC period (TSSB = TSMTCperiod).

- , when the RLM-RS resource is partially overlapped with measurement gap and the RLM-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TSSB < 0.5\*TSMTCperiod

- , when the RLM-RS is partially overlapped with measurement gap and the RLM-RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TSSB = 0.5 × TSMTCperiod

- , when the RLM-RS resource is partially overlapped with measurement gap and the RLM-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap

- , when the RLM-RS resource is partially overlapped with measurement gap and the RLM-RS resource is fully overlapped with SMTC occasion (TSSB = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the RLM-RS resource outside measurement gap is

* not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and K data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and K data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and K is defined in clause 9.2.5.3.3, and,
* not overlapped by the RSSI symbols indicated by *ss-RSSI-Measurement* and K data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and K data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured, and K is defined in clause 9.2.5.3.3.

- Psharing factor = 3, otherwise.

where,

If the high layer in TS 38.331 [2] signaling of *smtc2*is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1.* TSMTCperiod is the shortest SMTC period among all CCs in the same FR2-2 band, provided the SMTC offset of all CCs in FR2-2 have the same offset.

Longer evaluation period would be expected if the combination of RLM-RS resource, SMTC occasion and GAP configurations does not meet previous conditions.

Table 8.1A.2.2-1: Evaluation period TEvaluate\_out\_SSB,CCA and TEvaluate\_in\_SSB,CCA for FR1

|  |  |  |  |
| --- | --- | --- | --- |
| Configuration | TEvaluate\_out\_SSB,CCA (ms) | | TEvaluate\_in\_SSB,CCA (ms) |
|  | RLM-RS SSB Es/IotNote4 ≥-7 dB | RLM-RS SSB Es/Iot Note4 <-7 dB |  |
| no DRX | Max(200, Ceil(17\*P)\*TSSB) | Max(200, Ceil(24\*P)\*TSSB) | Max(100, Ceil((5+Lin)\*P)\*TSSB) |
| DRX cycle≤320 | Max(200, Ceil(1.5\*15\*P)\*Max(TDRX,TSSB)) | Max(200, Ceil(1.5\*20\*P)\*Max(TDRX,TSSB)) | Max(100, Ceil(1.5\*(5+Lin)\*P)\*Max(TDRX,TSSB)) |
| DRX cycle>320 | Ceil(13\*P)\*TDRX | Ceil(16\*P)\*TDRX | Ceil((5+Lin)\*P)\*TDRX |
| NOTE 1: TSSB is the periodicity of the SSB configured for RLM. TDRX is the DRX cycle length.  NOTE 2: When DRX is not configured, Lin is the number of RLM-RS SSB occasions which are not available at the UE during TEvaluate\_in\_SSB,CCA, where Lin ≤ Lin,max. When DRX is configured, Lin is the number of DRX cycles in which at least one RLM-RS SSB occasion is not available at the UE during TEvaluate\_in\_SSB,CCA, where Lin ≤ Lin,max. The UE is not required to determine the availability of SSB occasions more frequent than  Once per Max(10ms, P \* TSSB) if no DRX is used,  Once per Max(10ms, Ceil(1.5 \* P) \* Max(TDRX, TSSB)) if DRX cycle ≤ 320ms,  Once per P \* TDRX if DRX cycle > 320ms.  NOTE 3: Lin,max=7 for Max(TDRX,TSSB) ≤ 40 assuming TDRX=0 for non-DRX case,  Lin,max=5 for 40<Max(TDRX,TSSB)≤320,  Lin,max=3 for TDRX>320.  NOTE 4: RLM-RS SSB Es/Iot is the averaged Es/Iot over the most recent previous out-of-sync evaluation period. | | | |

Table 8.1A.2.2-2: Evaluation period TEvaluate\_out\_SSB,CCA and TEvaluate\_in\_SSB,CCA for FR2-2

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_SSB,CCA (ms) | TEvaluate\_in\_SSB,CCA (ms) |
|  |  |
| no DRX | Max(200, Ceil([12]\*P\* N)\*TSSB) | Max(100, Ceil((5 +Lin)\*P\* N)\*TSSB) |
| DRX cycle≤320 | Max(200, Ceil(1.5\*[10]\*P\* N)\*Max(TDRX,TSSB)) | Max(100, Ceil(1.5\*(5 +Lin)\*P\* N)\*Max(TDRX,TSSB)) |
| DRX cycle>320 | Ceil([10]\*P\* N)\*TDRX | Ceil((5+Lin)\*P\* N)\*TDRX |
| NOTE 1: TSSB is the periodicity of the SSB configured for RLM. TDRX is the DRX cycle length.  NOTE 2: When DRX is not configured, Lin is the number of RLM-RS SSB occasions groups which are not available at the UE during TEvaluate\_in\_SSB,CCA, where Lin ≤ Lin,max. A RLM-RS SSB occasions group consists of N consecutive RLM-RS SSB occasions, and the RLM-RS SSB occasions group is not available at the UE when at least one RLM-SSB occasion in the group is not transmitted by the gNB. When DRX is configured, Lin is the number of DRX cycles groups which are not available at the UE during TEvaluate\_in\_SSB,CCA, where Lin ≤ Lin,max. A DRX group consists of N DRX cycles, and the DRX group is not available when there is at least one DRX in which at least one RLM-RS SSB occasion is not available. The UE is not required to determine the availability of SSB occasions more frequent than once per DRX cycle length, when configured with DRX.  NOTE 3: Lin,max=7 for Max(TDRX,TSSB) ≤ 40 assuming TDRX=0 for non-DRX case,  Lin,max=5 for 40<Max(TDRX,TSSB)≤320,  Lin,max=3 for TDRX>320. | | |

8.1A.2.3 Measurement Restrictions for SSB based RLM

The UE is required to be capable of measuring SSB for RLM without measurement gaps. The UE is required to perform the SSB measurements with measurement restrictions as described in the following clauses.

For FR1, when the SSB for RLM is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, UE shall be able to measure the SSB for RLM without any restriction;

- If SSB and CSI-RS have different SCS,

- If UE supports *simultaneousRxDataSSB-DiffNumerology*, UE shall be able to measure the SSB for RLM without any restriction;

- If UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure SSB for RLM.

For FR2-2, when the SSB for RLM measurement on one CC is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both SSB for RLM and CSI-RS. Longer measurement period for SSB based RLM is expected, and no requirements are defined.

### 8.1A.3 Minimum requirement at transitions

When the UE transitions between DRX and no 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 the monitored cell.

When the UE transitions from a first configuration of RLM resources to a second configuration of RLM resources that is different from the first configuration, for each RLM 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 resource present in the second configuration. This requirement shall be applied to both out-of-sync evaluation and in-sync evaluation of the monitored cell.

### 8.1A.4 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]. The UE shall not perform CCA procedure on any of the serving carrier frequencies with CCA after the expiry of T310.

### 8.1A.5 Minimum requirement for L1 indication

When the downlink radio link quality on all the configured RLM-RS resources is worse than Qout,CCA, 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 Qin,CCA, 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 TIndication\_interval,CCA.

When DRX is not used TIndication\_interval,CCA is max(10ms, TRLM-RS,M), where TRLM,M is the shortest periodicity of all configured RLM-RS resources for the monitored cell, which corresponds to TSSB specified in clause 8.1A.2 if the RLM-RS resource is SSB.

In case DRX is used, TIndication\_interval,CCA is Max(10ms, 1.5 × DRX\_cycle\_length, 1.5 × TRLM-RS,M)) if DRX cycle\_length is less than or equal to 320ms, and TIndication\_interval,CCA 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 no DRX mode until the expiry or stop of T310 timer.

### 8.1A.6 Scheduling availability of UE during radio link monitoring

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

8.1A.6.1 Scheduling availability of UE performing radio link monitoring with the 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.

8.1A.6.2 Scheduling availability of UE performing radio link monitoring 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 radio link monitoring based on SSB as RLM-RS. For UEs 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 SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on SSB symbols to be measured for radio link monitoring.

When intra-band carrier aggregation is performed, the scheduling restrictions on PCell or PSCell applies to all serving cells in the same band on the symbols that fully or partially overlap with the restricted symbols.

#### 8.1A.6.3 Scheduling availability of UE performing radio link monitoring on FR2-2

The following scheduling restriction applies due to radio link monitoring on an FR2-2 serving PCell and/or PSCell.

- If the RLM-RS is CSI-RS which is type-D QCLed with active TCI state for PDCCH or PDSCH, and the CSI-RS is not in a CSI-RS resource set with repetition ON,

- There are no scheduling restrictions due to radio link monitoring based on the CSI-RS.

- Otherwise

- When the RLM-RS is using 120 KHz SCS, the UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on RLM-RS symbols to be measured for radio link monitoring.

- When the RLM-RS is using 480 kHz SCS or 960 kHz SCS, the UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on RLM-RS resource symbols to be measured for radio link monitoring, and on one data symbol before each RLM-RS symbol to be measured and one data symbol after each RLM-RS symbol to be measured.

When intra-band carrier aggregation in FR2-2 is performed, the scheduling restrictions on FR2-2 serving PCell or PSCell applies to all serving cells in the same band on the symbols that fully or partially overlap with restricted symbols.

For FR2-2, if following conditions are met,

- UE has been notified about system information update through paging,

- The gap between UE’s reception of PDCCH that UE monitors in the Type2-PDCCH CSS set and that notifies system information update, and the PDCCH that UE monitors in the Type0-PDCCH CSS set, is greater than 2 slots,

For the SSB for RLM and CORESET for RMSI scheduling multiplexing patterns 3, UE is expected to receive the PDCCH that UE monitors in the Type0-PDCCH CSS set, and the corresponding PDSCH, on SSB symbols to be measured for RLM; and

For the SSB for RLM and CORESET for RMSI scheduling multiplexing patterns 2, UE is expected to receive PDSCH that corresponds to the PDCCH that UE monitors in the Type0-PDCCH CSS set, on SSB symbols to be measured for RLM.

#### 8.1A.6.4 Scheduling availability of UE performing radio link monitoring on FR1 or FR2-2 in case of FR1-FR2-2 inter-band CA and NR-DC

There are no scheduling restrictions on FR1 serving cell(s) due to radio link monitoring performed on FR2-2 serving PCell and/or PSCell.

There are no scheduling restrictions on FR2-2 serving cell(s) due to radio link monitoring performed on FR1 serving PCell and/or PSCell.

## 8.1B Radio Link Monitoring for RedCap

### 8.1B.1 Introduction

The requirements in clause 8.1B apply for radio link monitoring on UE with reduced capabilites:

- PCell in SA NR operation mode,

The UE shall monitor the downlink radio link quality based on the reference signal configured as RLM-RS resource(s) in order to detect the downlink radio link quality of the PCell as specified in TS 38.213 [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. The SSB and SMTC in this section applies for both CD-SSB and NCD-SSB if it is not additional specified.

On each RLM-RS resource, the UE shall estimate the downlink radio link quality and compare it to the thresholds Qout,RedCap and Qin,RedCap for the purpose of monitoring downlink radio link quality of the cell.

The threshold Qout,RedCap 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 (BLERout) as defined in Table 8.1B.1-1. For SSB based radio link monitoring, Qout\_SSB,RedCap is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1B.2.1-1. For CSI-RS based radio link monitoring, Qout\_CSI-RS,RedCap is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1B.3.1-1.

The threshold Qin,RedCap is defined as the level at which the downlink radio link quality can be received with significantly higher reliability than at Qout,RedCap and shall correspond to the in-sync block error rate (BLERin,RedCap) as defined in Table 8.1B.1-1. For SSB based radio link monitoring, Qin\_SSB,RedCap is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1B.2.1-2. For CSI-RS based radio link monitoring, Qin\_CSI-RS,RedCap is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1B.3.1-2.

The out-of-sync block error rate (BLERout,RedCap) and in-sync block error rate (BLERin,RedCap) are determined from the network configuration via parameter *rlmInSyncOutOfSyncThreshold* signalled by higher layers. When UE is not configured with *rlmInSyncOutOfSyncThreshold* from the network, UE determines out-of-sync and in-sync block error rates from Configuration #0 in Table 8.1B.1-1 by default. All requirements in clause 8.1B are applicable for BLER Configuration #0 in Table 8.1B.1-1.

Table 8.1B.1-1: Out-of-sync and in-sync block error rates for RedCap UE

|  |  |  |
| --- | --- | --- |
| Configuration | BLERout,RedCap | BLERin,RedCap |
| 0 | 10% | 2% |

UE shall be able to monitor up to NRLM RLM-RS resources of the same or different types in each corresponding carrier frequency range, depending on a maximum number  of SSBs per half frame according to TS 38.213 [3], where NRLM is specified in Table 8.1B.1-2 according TS 38.213 [3], and meet the requirements as specified in clause 8.1B. UE is not required to meet the requirements in clause 8.1B if RLM-RS is not configured and no TCI state for PDCCH is activated.

Table 8.1B.1-2: Maximum number of RLM-RS resources NRLM for RedCap UE

|  |  |  |
| --- | --- | --- |
| Carrier frequency range of PCell |  | Maximum number of RLM-RS resources, NRLM |
| FR1, ≤ 3 GHzNote | 4 | 2 |
| FR1, > 3 GHzNote | 8 | 4 |
| FR2 | 64 | 8 |
| NOTE: For unpaired spectrum operation with Case C - 30 kHz SCS, 3GHz is replaced by 1.88GHz, as specified in clause 4.1 in TS 38.213 [3]. | | |

### 8.1B.2 Requirements for SSB based radio link monitoring

#### 8.1B.2.1 Introduction

The requirements in this clause apply for each SSB based RLM-RS resource configured for PCell, provided that the SSB configured for RLM is actually transmitted within UE active DL BWP during the entire evaluation period specified in clause 8.1B.2.2.

Table 8.1B.2.1-1: PDCCH transmission parameters for out-of-sync evaluation for RedCap UE

|  |  |
| --- | --- |
| Attribute | Value for BLER Configuration #0 |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| Aggregation level (CCE) | 16; for RedCap UE with 1Rx branch.  8; for RedCap UE with 2Rx branches. |
| 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 (PRBs) | 48; for RedCap UE with 1Rx branch.  24; for RedCap UE with 2Rx branches. |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |
| Note: SCS = 60KHz is not applicable for FR1. | |

Table 8.1B.2.1-2: PDCCH transmission parameters for in-sync evaluation for RedCap UE

|  |  |
| --- | --- |
| Attribute | Value for BLER Configuration #0 |
| DCI payload size | 1-0 |
| Number of control OFDM symbols | 2 |
| Aggregation level (CCE) | 8; for RedCap UE with 1Rx branch.  4; for RedCap UE with 2Rx branches. |
| 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 (PRBs) | 48; for RedCap UE with 1Rx branch.  24; for RedCap UE with 2Rx branches. |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |
| Note: SCS = 60KHz is not applicable for FR1. | |

#### 8.1B.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 TEvaluate\_out\_SSB,RedCap [ms] period becomes worse than the threshold Qout\_SSB,RedCap within TEvaluate\_out\_SSB,RedCap [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 TEvaluate\_in\_SSB,RedCap [ms] period becomes better than the threshold Qin\_SSB,RedCap within TEvaluate\_in\_SSB,RedCap [ms] evaluation period.

TEvaluate\_out\_SSB,RedCap and TEvaluate\_in\_SSB,RedCap are defined in Table 8.1B.2.2-1 and Table 8.1B.2.2-3 for FR1 for UE with 2Rx RedCap and 1Rx RedCap, respectively.

TEvaluate\_out\_SSB,RedCap and TEvaluate\_in\_SSB,RedCap are defined in Table 8.1B.2.2-2 and for FR2 with scaling factor N=8 for 2Rx RedCap.

For FR1,

- , when in the monitored cell there are measurement gaps configured for intra-frequency, inter-frequency or inter-RAT measurements, and these measurement gaps 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,

- , when RLM-RS resource is not overlapped with measurement gap and the RLM-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P is Psharing factor, when the RLM-RS resource is not overlapped with measurement gap and RLM-RS resource is fully overlapped with SMTC period (TSSB = TSMTCperiod).

- , when the RLM-RS resource is partially overlapped with measurement gap and the RLM-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TSSB < 0.5\*TSMTCperiod

- , when the RLM-RS is partially overlapped with measurement gap and the RLM-RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TSSB = 0.5 × TSMTCperiod

- , when the RLM-RS resource is partially overlapped with measurement gap and the RLM-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap

- , when the RLM-RS resource is partially overlapped with measurement gap and the RLM-RS resource is fully overlapped with SMTC occasion (TSSB = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the RLM-RS resource outside measurement gap is

* not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and,
* not overlapped by the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured.

- Psharing factor = 3, otherwise.

where,

If the high layer in TS 38.331 [2] signaling of *smtc2*is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1.*

If the high layer in TS 38.331 [2] signaling of *smtc2*is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1.*

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

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

Table 8.1B.2.2-1: Evaluation period TEvaluate\_out\_SSB,RedCap and TEvaluate\_in\_SSB,RedCap for FR1 for 2Rx RedCap UE

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_SSB,RedCap (ms) | TEvaluate\_in\_SSB,RedCap (ms) |
| no DRX | Max(200, Ceil(10 × P) × TSSB) | Max(100, Ceil(5 × P) × TSSB) |
| DRX cycle≤320ms | Max(200, Ceil(15 × P) × Max(TDRX,TSSB)) | Max(100, Ceil(7.5 × P) × Max(TDRX,TSSB)) |
| DRX cycle>320ms | Ceil(10 × P) × TDRX | Ceil(5 × P) × TDRX |
| NOTE: TSSB is the periodicity of the SSB configured for RLM. TDRX is the DRX cycle length. | | |

Table 8.1B.2.2-2: Evaluation period TEvaluate\_out\_SSB,RedCap and TEvaluate\_in\_SSB,RedCap for FR2 for 2Rx RedCap UE

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_SSB,RedCap (ms) | TEvaluate\_in\_SSB,RedCap (ms) |
| no DRX | Max(200, Ceil(10 × P × N) × TSSB) | Max(100, Ceil(5 × P × N) × TSSB) |
| DRX cycle≤320ms | Max(200, Ceil(15 × P × N) × Max(TDRX,TSSB)) | Max(100, Ceil(7.5 × P × N) × Max(TDRX,TSSB)) |
| DRX cycle>320ms | Ceil(10 × P × N) × TDRX | Ceil(5 × P × N) × TDRX |
| NOTE: TSSB is the periodicity of the SSB configured for RLM. TDRX is the DRX cycle length. | | |

Table 8.1B.2.2-3: Evaluation period TEvaluate\_out\_SSB,RedCap and TEvaluate\_in\_SSB,RedCap for FR1 for 1Rx RedCap UE

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_SSB,RedCap (ms) | TEvaluate\_in\_SSB,RedCap (ms) |
| no DRX | Max(400, Ceil(20 × P) × TSSB) | Max(100, Ceil(5 × P) × TSSB) |
| DRX cycle≤320ms | Max(400, Ceil(30 × P) × Max(TDRX,TSSB)) | Max(100, Ceil(7.5 × P) × Max(TDRX,TSSB)) |
| DRX cycle>320ms | Ceil(20 × P) × TDRX | Ceil(5 × P) × TDRX |
| NOTE: TSSB is the periodicity of the SSB configured for RLM. TDRX is the DRX cycle length. | | |

#### 8.1B.2.3 Measurement restrictions for SSB based RLM

The UE is required to be capable of measuring SSB for RLM without measurement gaps. The UE is required to perform the SSB measurements with measurement restrictions as described in the following scenarios.

For FR1, when the SSB for RLM is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, UE shall be able to measure the SSB for RLM without any restriction;

- If SSB and CSI-RS have different SCS,

- If UE supports *simultaneousRxDataSSB-DiffNumerology*, UE shall be able to measure the SSB for RLM without any restriction;

- If UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both SSB for RLM and CSI-RS. Longer measurement period for SSB based RLM is expected, and no requirements are defined.

For FR2, when the SSB for RLM measurement is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, UE is required to measure one of but not both SSB for RLM and CSI-RS. Longer measurement period for SSB based RLM is expected, and no requirements are defined.

### 8.1B.3 Requirements for CSI-RS based radio link monitoring

#### 8.1B.3.1 Introduction

The requirements in this clause apply for each CSI-RS based RLM-RS resource configured for PCell, provided that the CSI-RS configured for RLM is actually transmitted within UE active DL BWP during the entire evaluation period specified in clause 8.1B.3.2. UE is not expected to perform radio link monitoring measurements on the CSI-RS configured as RLM-RS if the CSI-RS is not in the active TCI state of any CORESET configured in the UE active BWP.

Table 8.1B.3.1-1: PDCCH transmission parameters for out-of-sync evaluation for RedCap UE

|  |  |
| --- | --- |
| Attribute | Value for BLER Configuration #0 |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| Aggregation level (CCE) | 16; for RedCap UE with 1Rx branch.  8; for RedCap UE with 2Rx branches. |
| 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 (PRBs) | 48 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |
| Note: SCS = 60KHz is not applicable for FR1. | |

Table 8.1B.3.1-2: PDCCH transmission parameters for in-sync evaluation for RedCap UE

|  |  |
| --- | --- |
| Attribute | Value for BLER Configuration #0 |
| DCI payload size | 1-0 |
| Number of control OFDM symbols | 2 |
| Aggregation level (CCE) | 8; for RedCap UE with 1Rx branch.  4; for RedCap UE with 2Rx branches. |
| 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 (PRBs) | 48 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |
| Note: SCS = 60KHz is not applicable for FR1. | |

#### 8.1B.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 TEvaluate\_out\_CSI-RS,RedCap ms period becomes worse than the threshold Qout\_CSI-RS,RedCap within TEvaluate\_out\_CSI-RS,RedCap 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 TEvaluate\_in\_CSI-RS,RedCap ms period becomes better than the threshold Qin\_CSI-RS,RedCap within TEvaluate\_in\_CSI-RS,RedCap ms evaluation period.

- TEvaluate\_out\_CSI-RS,RedCap and TEvaluate\_in\_CSI-RS,RedCap are defined in Table 8.1B.3.2-1 and Table 8.1B.3.2-3 for FR1 for RedCap 2Rx RedCap and 1Rx RedCap, respectively.

- TEvaluate\_out\_CSI-RS,RedCap and TEvaluate\_in\_CSI-RS,RedCap are defined in Table 8.1B.3.2-2 for FR2 with scaling factor N=1 for 2 Rx RedCap.

The requirements of TEvaluate\_out\_CSI-RS,RedCap and TEvaluate\_in\_CSI-RS,RedCap apply provided that the CSI-RS for RLM is not in a resource set configured with repetition ON. The requirements do not apply when the CSI-RS resource in the active TCI state of CORESET is the same CSI-RS resource for RLM and the TCI state information of the CSI-RS resource is not given, wherein the TCI state information means QCL Type-D to SSB for L1-RSRP or CSI-RS with repetition ON.

For FR1,

- , when in the monitored cell there are measurement gaps configured for intra-frequency, inter-frequency or inter-RAT measurements, and these measurement gaps 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 the RLM-RS resource is not overlapped with measurement gap and also not overlapped with SMTC occasion.

- , when the RLM-RS resource is partially overlapped with measurement gap and the RLM-RS resource is not overlapped with SMTC occasion (TCSI-RS < MGRP)

- , when the RLM-RS resource is not overlapped with measurement gap and the RLM-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod).

- P = Psharing factor, when the RLM-RS resource is not overlapped with measurement gap and RLM-RS resource is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod).

- , when the RLM-RS resource is partially overlapped with measurement gap and the RLM-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TCSI-RS < 0.5 × TSMTCperiod

- , when the RLM-RS resource is partially overlapped with measurement gap and the RLM-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TCSI-RS = 0.5 × TSMTCperiod

- , when the RLM-RS resource is partially overlapped with measurement gap and the RLM-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap

- , when the RLM-RS resource is partially overlapped with measurement gap and the RLM-RS resource is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the RLM-RS resource outside measurement gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and,

- not overlapped by the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured.

- Psharing factor = 3, otherwise.

where,

If the high layer in TS 38.331 [2] signaling of *smtc2*is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1.*

If the high layer in TS 38.331 [2] signaling of *smtc2*is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1.*

Note: The overlap between CSI-RS for 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 resource, SMTC occasion and measurement gap configurations does not meet previous conditions.

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of Mout,RedCap and Min,RedCap used in Table 8.1B.3.2-1 and Table 8.1B.3.2-2 for UE with 2Rx are defined as:

- Mout,RedCap = 20 and Min,RedCap = 10, if the CSI-RS resource configured for RLM is transmitted with higher layer CSI-RS parameter *density* [6, clause 7.4.1] set to 3 and over the bandwidth ≥ 24 PRBs.

The values of Mout,RedCap and Min,RedCap used in Table 8.1B.3.2-3 for RedCap UE with 1Rx are defined as:

- Mout,RedCap = 40 and Min,RedCap = 10, if the CSI-RS resource configured for RLM is transmitted with higher layer CSI-RS parameter *density* [6, clause 7.4.1] set to 3 and over the bandwidth ≥ 24 PRBs.

Table 8.1B.3.2-1: Evaluation period TEvaluate\_out\_CSI-RS,RedCap and TEvaluate\_in\_CSI-RS,RedCap for FR1 for 2Rx RedCap UE

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_CSI-RS,RedCap (ms) | TEvaluate\_in\_CSI-RS,RedCap (ms) |
| no DRX | Max(200, Ceil(Mout,RedCap×P)×TCSI-RS) | Max(100, Ceil(Min,RedCap×P) × TCSI-RS) |
| DRX ≤ 320ms | Max(200, Ceil(1.5×Mout,RedCap ×P)× Max(TDRX, TCSI-RS)) | Max(100, Ceil(1.5×Min,RedCap×P)× Max(TDRX, TCSI-RS)) |
| DRX > 320ms | Ceil(Mout,RedCap ×P) × TDRX | Ceil(Min,RedCap ×P) × TDRX |
| NOTE: TCSI-RS is the periodicity of the CSI-RS resource configured for RLM. The requirements in this table apply for TCSI-RS equal to 5 ms, 10ms, 20 ms or 40 ms. TDRX is the DRX cycle length. | | |

Table 8.1B.3.2-2: Evaluation period TEvaluate\_out\_CSI-RS,RedCap and TEvaluate\_in\_CSI-RS,RedCap for FR2 for 2Rx RedCap UE

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_CSI-RS,RedCap (ms) | TEvaluate\_in\_CSI-RS,RedCap (ms) |
| no DRX | Max(200, Ceil(Mout,RedCap×P×N)×TCSI-RS) | Max(100, Ceil(Min,RedCap×P×N) × TCSI-RS) |
| DRX ≤ 320ms | Max(200, Ceil(1.5×Mout,RedCap×P×N)× Max(TDRX, TCSI-RS)) | Max(100, Ceil(1.5×Min,RedCap×P×N)× Max(TDRX, TCSI-RS)) |
| DRX > 320ms | Ceil(Mout,RedCap×P×N) × TDRX | Ceil(Min,RedCap×P×N) × TDRX |
| NOTE: TCSI-RS is the periodicity of the CSI-RS resource configured for RLM. The requirements in this table apply for TCSI-RS equal to 5 ms, 10 ms, 20 ms or 40 ms. TDRX is the DRX cycle length. | | |

Table 8.1B.3.2-3: Evaluation period TEvaluate\_out\_CSI-RS,RedCap and TEvaluate\_in\_CSI-RS,RedCap for FR1 for 1Rx RedCap UE

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_CSI-RS,RedCap (ms) | TEvaluate\_in\_CSI-RS,RedCap (ms) |
| no DRX | Max(400, Ceil(Mout,RedCap×P)×TCSI-RS) | Max(100, Ceil(Min,RedCap×P) × TCSI-RS) |
| DRX ≤ 320ms | Max(400, Ceil(1.5×Mout,RedCap ×P)× Max(TDRX, TCSI-RS)) | Max(100, Ceil(1.5×Min,RedCap×P)× Max(TDRX, TCSI-RS)) |
| DRX > 320ms | Ceil(Mout,RedCap ×P) × TDRX | Ceil(Min,RedCap ×P) × TDRX |
| NOTE: TCSI-RS is the periodicity of the CSI-RS resource configured for RLM. The requirements in this table apply for TCSI-RS equal to 5 ms, 10ms, 20 ms or 40 ms. TDRX is the DRX cycle length. | | |

#### 8.1B.3.3 Measurement restrictions for CSI-RS based RLM

The UE is required to be capable of measuring CSI-RS for RLM without measurement gaps. The UE is required to perform the CSI-RS measurements with measurement restrictions as described in the following clauses.

For both FR1 and FR2, when the CSI-RS for RLM is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, UE is not required to receive CSI-RS for RLM in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD, or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for RLM, the UE shall be able to perform CSI-RS measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for RLM, the UE shall be able to perform CSI-RS measurement with restrictions according to its capabilities:

- If the UE supports *simultaneousRxDataSSB-DiffNumerology* the UE shall be able to perform CSI-RS for RLM measurement without restrictions.

- If the UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both CSI-RS for RLM and SSB. Longer measurement period for CSI-RS based RLM is expected, and no requirements are defined.

For FR1, when the CSI-RS for RLM is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, UE shall be able to measure the CSI-RS for RLM without any restriction.

For FR2, when the CSI-RS for RLM is in the same OFDM symbol as SSB for RLM, BFD, or L1-RSRP measurement, or in the same symbol as SSB for CBD when beam failure is detected, UE is required to measure one of but not both CSI-RS for RLM and SSB. Longer measurement period for CSI-RS based RLM is expected, and no requirements are defined.

For FR2, when the CSI-RS for RLM measurement is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- In the following cases, UE is required to measure one of but not both CSI-RS for RLM and the other CSI-RS. Longer measurement period for CSI-RS based RLM is expected, and no requirements are defined.

- The CSI-RS for RLM or the other CSI-RS in a resource set configured with repetition ON, or

- The other CSI-RS is configured in q1 and beam failure is detected, or

- The two CSI-RS-es are not QCL-ed w.r.t. QCL-TypeD, or the QCL information is not known to UE,

- Otherwise, UE shall be able to measure the CSI-RS for RLM without any restriction.

### 8.1B.4 Minimum requirement at transitions

When the UE transitions between RLM CD-SSB resource and RLM NCD-SSB resource due to BWP switching during one evaluation period, the UE shall use an evaluation period that is the maximum of the evaluation periods corresponding to the first SSB type and the second SSB type after the BWP switching. Subsequent to this duration, the UE shall use an evaluation period corresponding to the second SSB type for each RLM-RS resource.

The requirements in clause 8.1.4 shall also apply except the scenarios described above.

### 8.1B.5 Minimum requirement for UE turning off the transmitter

The requirements in clause 8.1.5 shall apply.

### 8.1B.6 Minimum requirement for L1 indication

When the downlink radio link quality on all the configured RLM-RS resources is worse than Qout,RedCap, 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 Qin,RedCap, 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 TIndication\_interval,RedCap.

When DRX is not used for RedCap UEs, TIndication\_interval,RedCap is max(10ms, TRLM-RS,M), where TRLM,M is the shortest periodicity of all configured RLM-RS resources for the monitored cell, which corresponds to TSSB specified in clause 8.1B.2 if the RLM-RS resource is SSB, or TCSI-RS specified in clause 8.1B.3 if the RLM-RS resource is CSI-RS.

In case DRX is used for RedCap UEs, TIndication\_interval,RedCap is Max(10ms, 1.5 × DRX\_cycle\_length, 1.5 × TRLM-RS,M)) if DRX cycle\_length is less than or equal to 320ms, and TIndication\_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 no DRX mode until the expiry or stop of T310 timer.

When DRX is not used for HD-FDD RedCap UEs, TIndication\_interval,RedCap is max(10ms, TRLM-RS,M), where TRLM,M is the shortest periodicity of all configured RLM-RS resources for the monitored cell, which corresponds to TSSB specified in clause 8.1B.2 if the RLM-RS resource is SSB, or TCSI-RS specified in clause 8.1B.3 if the RLM-RS resource is CSI-RS, under the following condition

- For each RLM-RS configuration, at least one RLM-RS sample must fall with DL occasion within an indication period.

In case DRX is used for HD-FDD RedCap UEs, TIndication\_interval,RedCap is Max(10ms, 1.5 × DRX\_cycle\_length, 1.5 × TRLM-RS,M)) if DRX cycle\_length is less than or equal to 320ms, and TIndication\_interval is DRX\_cycle\_length if DRX cycle\_length is greater than 320ms, under the following condition

- For each RLM-RS configuration, at least one RLM-RS sample must fall with DL occasion within an indication period.

### 8.1B.7 Scheduling availability of UE during radio link monitoring

The requirements in clause 8.1.7 shall apply.

#### 8.1B.7.1 Scheduling availability of UE performing radio link monitoring with a same subcarrier spacing as PDSCH/PDCCH on FR1

The requirements in clause 8.1.7.1 shall apply.

#### 8.1B.7.2 Scheduling availability of UE performing radio link monitoring 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 radio link monitoring based on SSB as RLM-RS. For UEs 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 SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on SSB symbols to be measured for radio link monitoring.

#### 8.1B.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.

- If the RLM-RS is CSI-RS which is type-D QCLed with active TCI state for PDCCH or PDSCH, and the CSI-RS is not in a CSI-RS resource set with repetition ON,

- There are no scheduling restrictions due to radio link monitoring based on the CSI-RS.

- Otherwise

- The UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on RLM-RS symbols to be measured for radio link monitoring.

For FR2, if following conditions are met,

- UE has been notified about system information update through paging,

- The gap between UE’s reception of PDCCH that UE monitors in the Type2-PDCCH CSS set and that notifies system information update, and the PDCCH that UE monitors in the Type0-PDCCH CSS set, is greater than 2 slots,

For the SSB for RLM and CORESET for RMSI scheduling multiplexing patterns 3, UE is expected to receive the PDCCH that UE monitors in the Type0-PDCCH CSS set, and the corresponding PDSCH, on SSB symbols to be measured for RLM; and

For the SSB for RLM and CORESET for RMSI scheduling multiplexing patterns 2, UE is expected to receive PDSCH that corresponds to the PDCCH that UE monitors in the Type0-PDCCH CSS set, on SSB symbols to be measured for RLM.

## 8.1C Radio Link Monitoring for Satellite Access

### 8.1C.1 Introduction

The requirements in clause 8.1C apply for radio link monitoring on PCell and the UE is configured with only PCell, which is served by satellite access node (SAN).The UE shall monitor the downlink radio link quality based on the reference signal configured as RLM-RS resource(s) in order to detect the downlink radio link quality of the PCell as specified in TS 38.213 [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 Qout and Qin for the purpose of monitoring downlink radio link quality of the cell.

The threshold Qout 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 (BLERout) as defined in Table 8.1C.1-1. For SSB based radio link monitoring, Qout\_SSB is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1C.2.1-1. For CSI-RS based radio link monitoring, Qout\_CSI-RS is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1C.3.1-1.

The threshold Qin is defined as the level at which the downlink radio link quality can be received with significantly higher reliability than at Qout and shall correspond to the in-sync block error rate (BLERin) as defined in Table 8.1C.1-1. For SSB based radio link monitoring, Qin\_SSB is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1C.2.1-2. For CSI-RS based radio link monitoring, Qin\_CSI-RS is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1C.3.1-2.

The out-of-sync block error rate (BLERout) and in-sync block error rate (BLERin) are determined from the network configuration via parameter *rlmInSyncOutOfSyncThreshold* signalled by higher layers. When UE is not configured with *rlmInSyncOutOfSyncThreshold* from the network, UE determines out-of-sync and in-sync block error rates from Configuration #0 in Table 8.1C.1-1 by default. All requirements in clause 8.1C are applicable for BLER Configuration #0 in Table 8.1C.1-1.

Table 8.1C.1-1: Out-of-sync and in-sync block error rates

|  |  |  |
| --- | --- | --- |
| Configuration | BLERout | BLERin |
| 0 | 10% | 2% |

UE shall be able to monitor up to NRLM RLM-RS resources of the same or different types in each corresponding carrier frequency range, depending on a maximum number  of SSBs per half frame according to TS 38.213 [3], where NRLM is specified in Table 8.1C.1-2 according TS 38.213 [3], and meet the requirements as specified in clause 8.1C. UE is not required to meet the requirements in clause 8.1C if RLM-RS is not configured and no TCI state for PDCCH is activated.

Table 8.1C.1-2: Maximum number of RLM-RS resources NRLM

|  |  |  |
| --- | --- | --- |
| Carrier frequency range of PCell |  | Maximum number of RLM-RS resources, NRLM |
| FR1, ≤ 3 GHzNote | 4 | 2 |
| FR1, > 3 GHzNote | 8 | 4 |
|  |  |  |
| NOTE: For unpaired spectrum operation with Case C - 30 kHz SCS, 3GHz is replaced by 1.88GHz, as specified in clause 4.1 in TS 38.213 [3]. | | |

### 8.1C.2 Requirements for SSB based radio link monitoring

#### 8.1C.2.1 Introduction

The requirements in this clause apply for each SSB based RLM-RS resource configured for PCell, provided that the SSB configured for RLM is actually transmitted within UE active DL BWP during the entire evaluation period specified in clause 8.1C.2.2.

Table 8.1C.2.1-1: PDCCH transmission parameters for out-of-sync evaluation

|  |  |
| --- | --- |
| Attribute | Value for BLER Configuration #0 |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| 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 (PRBs) | 24 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

Table 8.1C.2.1-2: PDCCH transmission parameters for in-sync evaluation

|  |  |
| --- | --- |
| Attribute | Value for BLER Configuration #0 |
| DCI payload size | 1-0 |
| Number of control OFDM symbols | 2 |
| 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 (PRBs) | 24 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

#### 8.1C.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 TEvaluate\_out\_SSB [ms] period becomes worse than the threshold Qout\_SSB within TEvaluate\_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 TEvaluate\_in\_SSB [ms] period becomes better than the threshold Qin\_SSB within TEvaluate\_in\_SSB [ms] evaluation period.

TEvaluate\_out\_SSB and TEvaluate\_in\_SSB are defined in Table 8.1C.2.2-1 for FR1.

P value for an RLM-RS resource to be measured is defined as

- Psharing factor \* Ntotal / Noutside\_MG with Navailable = 0

- Ntotal / Navailable with Navailable > 0

For a window W of duration max(TL1, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gaps, and starting at the beginning of any RLM-RS resource occasion:

- Ntotal is the total number of RLM-RS resource occasions within the window, including those overlapped with measurement gap occasions or SMTC occasions within the window W, and

- Noutside\_MG is the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion within the window W

- Navailable is

- the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion nor any SMTC occasion within the window W, if UE does not support *parallelMeasurementWithoutRestriction* and LEO satellites are measured for intra-frequency measurement, and

- same as Noutside\_MG, otherwise

- TL1 is periodicity of the target RLM-RS

- Psharing factor = 3.

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

For an FR1 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

Table 8.1C.2.2-1: Evaluation period TEvaluate\_out\_SSB and TEvaluate\_in\_SSB for FR1

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_SSB (ms) | TEvaluate\_in\_SSB (ms) |
| no DRX | Max(200, Ceil(10 ´ P) ´ TSSB) | Max(100, Ceil(5 ´ P) ´ TSSB) |
| DRX cycle≤320ms | Max(200, Ceil(15 ´ P) ´ Max(TDRX,TSSB)) | Max(100, Ceil(7.5 ´ P) ´ Max(TDRX,TSSB)) |
| DRX cycle>320ms | Ceil(10 ´ P) ´ TDRX | Ceil(5 ´ P) ´ TDRX |
| NOTE: TSSB is the periodicity of the SSB configured for RLM. TDRX is the DRX cycle length. | | |

#### 8.1C.2.3 Measurement restrictions for SSB based RLM

The UE is required to be capable of measuring SSB for RLM without measurement gaps. The UE is required to perform the SSB measurements with measurement restrictions as described in the following scenarios.

For FR1, when the SSB for RLM is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, UE shall be able to measure the SSB for RLM without any restriction;

- If SSB and CSI-RS have different SCS,

- If UE supports *simultaneousRxDataSSB-DiffNumerology*, UE shall be able to measure the SSB for RLM without any restriction;

- If UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both SSB for RLM and CSI-RS. Longer measurement period for SSB based RLM is expected, and no requirements are defined.

### 8.1C.3 Requirements for CSI-RS based radio link monitoring

#### 8.1C.3.1 Introduction

The requirements in this clause apply for each CSI-RS based RLM-RS resource configured for PCell, provided that the CSI-RS configured for RLM is actually transmitted within UE active DL BWP during the entire evaluation period specified in clause 8.1C.3.2. UE is not expected to perform radio link monitoring measurements on the CSI-RS configured as RLM-RS if the CSI-RS is not in the active TCI state of any CORESET configured in the UE active BWP.

Table 8.1C.3.1-1: PDCCH transmission parameters for out-of-sync evaluation

|  |  |
| --- | --- |
| Attribute | Value for BLER Configuration #0 |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| 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 (PRBs) | 48 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

Table 8.1C.3.1-2: PDCCH transmission parameters for in-sync evaluation

|  |  |
| --- | --- |
| Attribute | Value for BLER Configuration #0 |
| DCI payload size | 1-0 |
| Number of control OFDM symbols | 2 |
| 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 | 0dB |
| Bandwidth (PRBs) | 48 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

#### 8.1C.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 TEvaluate\_out\_CSI-RS ms period becomes worse than the threshold Qout\_CSI-RS within TEvaluate\_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 TEvaluate\_in\_CSI-RS ms period becomes better than the threshold Qin\_CSI-RS within TEvaluate\_in\_CSI-RS ms evaluation period.

- TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS are defined in Table 8.1C.3.2-1 for FR1.

The requirements of TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS apply provided that the CSI-RS for RLM is not in a resource set configured with repetition ON. The requirements do not apply when the CSI-RS resource in the active TCI state of CORESET is the same CSI-RS resource for RLM and the TCI state information of the CSI-RS resource is not given, wherein the TCI state information means QCL Type-D to SSB for L1-RSRP or CSI-RS with repetition ON.

P value for an RLM-RS resource to be measured is defined as

- Psharing factor \* Ntotal / Noutside\_MG with Navailable = 0

- Ntotal / Navailable with Navailable > 0

For a window W of duration max(TL1, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gaps, and starting at the beginning of any RLM-RS resource occasion:

- Ntotal is the total number of RLM-RS resource occasions within the window, including those overlapped with measurement gap occasions or SMTC occasions within the window W, and

- Noutside\_MG is the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion within the window W

- Navailable is

- the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion nor any SMTC occasion within the window W, if UE does not support *parallelMeasurementWithoutRestriction* and LEO satellites are measured for intra-frequency measurement, and

- same as Noutside\_MG, otherwise

- TL1 is periodicity of the target RLM-RS

- Psharing factor = 3.

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

For an FR1 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

The values of Mout and Min used in Table 8.1C.3.2-1 are defined as:

- Mout = 20 and Min = 10, if the CSI-RS resource configured for RLM is transmitted with higher layer CSI-RS parameter *density* [6, clause 7.4.1] set to 3 and over the bandwidth ≥ 24 PRBs.

Table 8.1C.3.2-1: Evaluation period TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS for FR1

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out\_CSI-RS (ms) | TEvaluate\_in\_CSI-RS (ms) |
| no DRX | Max(200, Ceil(Mout×P)×TCSI-RS) | Max(100, Ceil(Min×P) × TCSI-RS) |
| DRX ≤ 320ms | Max(200, Ceil(1.5×Mout×P)× Max(TDRX, TCSI-RS)) | Max(100, Ceil(1.5×Min×P)× Max(TDRX, TCSI-RS)) |
| DRX > 320ms | Ceil(Mout×P) × TDRX | Ceil(Min×P) × TDRX |
| NOTE: TCSI-RS is the periodicity of the CSI-RS resource configured for RLM. The requirements in this table apply for TCSI-RS equal to 5 ms, 10ms, 20 ms or 40 ms. TDRX is the DRX cycle length. | | |

#### 8.1C.3.3 Measurement restrictions for CSI-RS based RLM

The UE is required to be capable of measuring CSI-RS for RLM without measurement gaps. The UE is required to perform the CSI-RS measurements with measurement restrictions as described in the following clauses.

For FR1, when the CSI-RS for RLM is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, UE is not required to receive CSI-RS for RLM in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD, or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for RLM, the UE shall be able to perform CSI-RS measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for RLM, the UE shall be able to perform CSI-RS measurement with restrictions according to its capabilities:

- If the UE supports *simultaneousRxDataSSB-DiffNumerology* the UE shall be able to perform CSI-RS for RLM measurement without restrictions.

- If the UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both CSI-RS for RLM and SSB. Longer measurement period for CSI-RS based RLM is expected, and no requirements are defined.

For FR1, when the CSI-RS for RLM is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, UE shall be able to measure the CSI-RS for RLM without any restriction.

### 8.1C.4 Minimum requirement at transitions

When the UE transitions between DRX and no 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 the monitored cell.

When the UE transitions from a first configuration of RLM resources to a second configuration of RLM resources that is different from the first configuration, for each RLM 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 resource present in the second configuration. This requirement shall be applied to both out-of-sync evaluation and in-sync evaluation of the monitored cell.

When the UE transitions from a first configuration of active TCI state of the CORESET to a second configuration of active TCI state of the CORESET, for each CSI-RS for RLM present in the second configuration, the UE shall use an evaluation period corresponding to the second configuration from the time of transition. This requirement shall be applied to both out-of-sync evaluation and in-sync evaluation of the monitored cell.

### 8.1C.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].

### 8.1C.6 Minimum requirement for L1 indication

When the downlink radio link quality on all the configured RLM-RS resources is worse than Qout, 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 Qin, 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 TIndication\_interval.

When DRX is not used TIndication\_interval is max(10ms, TRLM-RS,M), where TRLM,M is the shortest periodicity of all configured RLM-RS resources for the monitored cell, which corresponds to TSSB specified in clause 8.1C.2 if the RLM-RS resource is SSB, or TCSI-RS specified in clause 8.1C.3 if the RLM-RS resource is CSI-RS.

In case DRX is used, TIndication\_interval is Max(10ms, 1.5 × DRX\_cycle\_length, 1.5 × TRLM-RS,M)) if DRX cycle\_length is less than or equal to 320ms, and TIndication\_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 no DRX mode until the expiry or stop of T310 timer.

### 8.1C.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 or is on frequency range 2, there are restrictions on the scheduling availability as described in the following clauses.

#### 8.1C.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.

#### 8.1C.7.2 Scheduling availability of UE performing radio link monitoring 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 radio link monitoring based on SSB as RLM-RS. For UEs 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 SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on SSB symbols to be measured for radio link monitoring.

## 8.2 Interruption

### 8.2.1 EN-DC Interruption

#### 8.2.1.1 Introduction

This clause 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(s) in SCG is activated or deactivated, or

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

a supplementary UL carrier or an UL carrier is configured or de-configured, or

UL/DL active BWP is switched on PSCell or SCell in SCG, or

E-UTRA SCell in MCG or SCell(s) in SCG is directly activated and hibernated, or

E-UTRA SCell in MCG is hibernated, or

Multiple SCells in SCG are activated or deactivated, or

SCell dormancy switches, or

CQI/RRM measurement happens during SCell dormancy, or

UE-specific CBW is changed on PSCell or SCell in SCG, or

CGI reading of an NR neighbour cell with autonomous gaps, or

CGI reading of an E-UTRA neighbour cell with autonomous gaps.

NR SRS carrier based switching, or

E-UTRA SRS carrier based switching, or

NR SRS antenna port switching, or

UE dynamic Tx switches between two uplink carriers, or

SCell in SCG is activated based on aperiodic CSI-RS.

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

This clause 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 TS 36.133 [15].

For a UE which does not support per-FR measurement gaps, interruptions to the PSCell or activated 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 activated 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.

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

|  |  |  |  |
| --- | --- | --- | --- |
|  | NR Slot | Interruption length X (slots) | |
|  | length (ms) | 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.

When PSCell and the activated SCell are in DRX, no interruption due to E-UTRA PCell transitions from non-DRX to DRX is allowed.

##### 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 in MCG is added or released:

- the UE is allowed an interruption on any active serving cell in SCG:

- of up to X1 slot, if the active serving cell is not in the same band as any of the E-UTRA SCells being added or released, or

- of up to X1 slot, if the active serving cell is in the band overlapping or partially overlapping with the E-UTRA SCell being added or released and UE indicates it is capable of *interBandMRDC-WithOverlapDL-Bands-r16* on this band pair, or

- of up to max{Y1 slot + TSMTC\_duration, 5ms}, if the active serving cells are in the same band or in the band overlapping or partially overlapping with the E-UTRA SCells being added or released, and UE does not indicates it is capable of *interBandMRDC-WithOverlapDL-Bands-r16* on this band pair,provided the cell specific reference signals from the active serving cells and the E-UTRA SCells being added or released are available in the same slot, where TSMTC\_duration is the longest SMTC duration among all above active serving cells in SCG;

Where X1 and Y1 are specified in Table 8.2.1.2.3-1.

When one SCell in SCG is added or released:

- the UE is allowed an interruption on any active serving cell in SCG:

- of up to X1 slot, if the active serving cell and the SCell being added or released are in a FR1 band pair or in a FR1+FR2 band pair.

- of up to X1 slot, if the active serving cell and the SCell being added or released are in a FR2 band pair and UE is capable of independent beam management on this FR2 band pair

or

- of up to Y1 slot + TSMTC\_duration if the active serving cells are in the same band as any of the SCells being added or released, provided the cell specific reference signals from the active serving cells and the SCells being added or released are available in the same slot, where, TSMTC\_duration is

- the longest SMTC duration among all above active serving cells in SCG and the SCell being added when one SCell is added. If SSB configuration (*absoluteFrequencySSB*) but no SMTC configuration is provided for the SCell being added, the SSB transmission periodicity is assumed to be 5ms and TSMTC duration for the SCell being added is x ms, where x = the number of consecutive subframes containing all SSBs in one SSB burst transmitted by the SCell being added. If no SSB configuration (*absoluteFrequencySSB*) nor SMTC configuration is provided for the SCell being added, TSMTC duration for the SCell being added is 0 ms;

- the longest SMTC duration among all above active serving cells in SCG when one SCell is released.

Where X1 and Y1 are specified in Table 8.2.1.2.3-2.

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | NR Slot length | Interruption length X1 (slots) | | Interruption length Y1 (slots) | |
|  | (ms) | Sync | Async | Sync | Async |
| 0 | 1 | 1 | 2 | 1 | 2 |
| 1 | 0.5 | 2 | 3 | 2 | 3 |
| 2 | 0.25 | 5 | | 4 | 5 |
| 3 | 0.125 | 9 | | N/A | - N/A |

Table 8.2.1.2.3-2: Interruption length X1 and Y1 at SCell addition/Release

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) of victim cell | Interruption length X1 (slots) | | Interruption length Y1 (slots) |
| 0 | 1 | 1 | | 1 |
| 1 | 0.5 | 2 | | 2 |
| 2 | 0.25 | Both aggressor cell and victim cell are on FR2 | 4 | 4 |
|  |  | Either aggressor cell or victim cell is on FR1 | 5 |  |
| 3 | 0.125 | Aggressor cell is on FR2 | 8 | 8 |
|  |  | Aggressor cell is on FR1 | 9 |  |

##### 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 in MCG is activated from deactivated or dormant state, or deactivated from activated or dormant state:

- the UE is allowed an interruption on any active serving cell in SCG:

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

- of up to X2 slot, if the active serving cell is in the band overlapping or partially overlapping with the E-UTRA SCell being activated or deactivated and UE indicates it is capable of *interBandMRDC-WithOverlapDL-Bands-r16* on this band pair, or

- of up to max{Y2 slot + TSMTC\_duration, 5ms}, if the active serving cells are in the same band or in the band overlapping or partially overlapping with the E-UTRA SCells being activated or deactivated, and UE does not indicate it is capable of *interBandMRDC-WithOverlapDL-Bands-r16* on this band pair, provided the cell specific reference signals from the active serving cells and the E-UTRA SCells being activated or deactivated are available in the same slot, where TSMTC\_duration is the longest SMTC duration among all above active serving cells in SCG.

Where X2 and Y2 are specified in Table 8.2.1.2.4-1.

When one SCell in SCG is activated or deactivated:

- an interruption on any active serving cell in SCG:

- of up to X2 slot, if the active serving cell and the SCell being activated or deactivated are in a FR1 band pair or in a FR1+FR2 band pair.

- of up to X2 slot, if the active serving cells and the SCells being activated or deactivated are in a FR2 band pair and UE is capable of independent beam management on this FR2 band pair.

or

- of up to Y2 slot + TSMTC\_duration if the active serving cells are in the same band as any of the SCells being activated or deactivated, provided the cell specific reference signals from the active serving cells and the SCells being activated or deactivated are available in the same slot, where, TSMTC\_duration is

- the longest SMTC duration among all above active serving cells in SCG and the SCell being activated when one SCell is activated. If SSB configuration (*absoluteFrequencySSB*) but no SMTC configuration is provided for the SCell being activated, the SSB transmission periodicity is assumed to be 5ms and TSMTC duration for the SCell being activated is x ms, where x = the number of consecutive subframes containing all SSBs in one SSB burst transmitted by the SCell being activated. If no SSB configuration (*absoluteFrequencySSB*) nor SMTC configuration is provided for the SCell being activated, TSMTC duration for the SCell being activated is 0ms;

- the longest SMTC duration among all above active serving cells in SCG when one SCell is deactivated.

Where X2 and Y2 are specified in Table 8.2.1.2.4-2.

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | NR Slot length | nterruption length X2 (slots) | | Interruption length Y2 (slots) | |
|  | (ms) | Sync | Async | Sync | Async |
| 0 | 1 | 1 | 2 | 1 | 2 |
| 1 | 0.5 | 1 | 2 | 1 | 2 |
| 2 | 0.25 | 3 | | 2 | 3 |
| 3 | 0.125 | 5 | | N/A | N/A |

Table 8.2.1.2.4-2: Interruption length X2 and Y2 at SCell activation/deactivation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) of victim cell | Interruption length X2 (slots) | | Interruption length Y2 (slots) |
| 0 | 1 | 1 | | 1 |
| 1 | 0.5 | 1 | | 1 |
| 2 | 0.25 | Both aggressor cell and victim cell are on FR2 | 2 | 2 |
|  |  | Either aggressor cell or victim cell is on FR1 | 3 |  |
| 3 | 0.125 | Aggressor cell is on FR2 | 4 | 4 |
|  |  | Aggressor cell is on FR1 | 5 |  |

##### 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 activated 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* [15] for the deactivated E-UTRA SCellsis 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* [15]for the deactivated E-UTRA SCells if indicated by the network using IE *allowInterruptions* [15].

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

- X3 slot, if the PSCell or activated SCell is in the band overlapping or partially overlapping with the E-UTRA deactivated SCC being measured, and UE indicates it is capable of *interBandMRDC-WithOverlapDL-Bands-r16* on this band pair, or

- Y3 slot + SMTC duration, if the PSCell or activated SCell is in the same band or in the band overlapping or partially overlapping with the E-UTRA deactivated SCC being measured, and UE does not indicate it is capable of *interBandMRDC-WithOverlapDL-Bands-r16* on this band pair, 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 8.2.1.2.5.2-1: Interruption length X3 and Y3 at measurements on deactivated E-UTRA SCC

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | NR Slot length | Interruption length X3 (slots) | | Interruption length Y3 (slots) | |
|  | (ms) | Sync | Async | Sync | Async |
| 0 | 1 | 1 | 2 | 1 | 2 |
| 1 | 0.5 | 1 | 2 | 1 | 2 |
| 2 | 0.25 | 3 | | 2 | 3 |
| 3 | 0.125 | 5 | | N/A | N/A |

###### 8.2.1.2.5.3 Interruptions during CQI measurements on dormant E-UTRAN SCell

When one E-UTRA SCell in MCG is dormant, the UE is allowed due to CQI measurements on the dormant E-UTRA SCell:

- an interruption on PSCell or any activated SCell with up to 0.5% probability of missed ACK/NACK.

Each interruption shall not exceed

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

- X3 slot, if the PSCell or activated SCell is in the band overlapping or partially overlapping with the E-UTRA dormant SCC being measured, and UE indicates it is capable of *interBandMRDC-WithOverlapDL-Bands-r16* on this band pair, or

- Y3 slot + SMTC duration, if the PSCell or activated SCell is in the same band or in the band overlapping or partially overlapping with the E-UTRA dormant SCell being measured, and UE does not report *interBandMRDC-WithOverlapDL-Bands-r16* on this band pair, provided the cell specific reference signals from the PSCell or activated SCell and the E-UTRA dormant SCell being measured are available in the same slot.

Where X3 and Y3 are defined in Table 8.2.1.2.5.2-1.

###### 8.2.1.2.5.4 Interruptions during RRM measurements on dormant E-UTRAN SCC

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

- an interruption on PSCell or any activated SCell with up to 0.5% probability of missed ACK/NACK.

Each interruption shall not exceed

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

- X3 slot, if the PSCell or activated SCell is in the band overlapping or partially overlapping with the E-UTRA dormant SCC being measured and UE reports *interBandMRDC-WithOverlapDL-Bands-r16* on this band pair, or

- Y3 slot + SMTC duration, if the PSCell or activated SCell is in the same band or in the band overlapping or partially overlapping with the E-UTRA dormant SCC being measured, and UE does not report *interBandMRDC-WithOverlapDL-Bands-r16* on this band pair, provided the cell specific reference signals from the PSCell or activated SCell and the E-UTRA dormant SCC being measured are available in the same slot.

Where X3 and Y3 are defined in Table 8.2.1.2.5.2-1.

##### 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 TS 38.331 [2].

When an UL carrier or supplementary UL carrier is configured or de-configured, an interruption of up to X4 slot, is allowed during the RRC reconfiguration procedure [2] on E-UTRA PCell, all activated E-UTRA SCells, PSCell and all activated SCells within the same FR as the reconfigured uplink carrier. 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.

Table 8.2.1.2.6-1: Interruption length X4 at UL carrier RRC reconfiguration

|  |  |  |  |
| --- | --- | --- | --- |
|  | NR Slot  length (ms) | Interruption length X4 (slots) | |
|  |  | Sync | Async |
| 0 | 1 | 1 | 2 |
| 1 | 0.5 | 2 | 3 |
| 2 | 0.25 | 5 | |
| 3 | 0.125 | 9 | |

##### 8.2.1.2.7 Interruptions due to Active BWP switching Requirement

The requirements for DCI-based BWP switch, timer-based BWP switch or UL BWP switch triggered by consistent uplink CCA failures in this clause apply to the case that the BWP switch is performed on a single CC or multiple CCs.

When either of the DCI-based, timer-based or RRC-based downlink BWP switch and/or uplink BWP switch occur on multiple CCs simultaneously or over partially overlapping period, the interruption requirements described in this clause apply for each BWP switch.

When UE receives a DCI indicating UE to switch its active BWP involving changes in any of the parameters listed in Table 8.2.1.2.7-2, 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 imposes changes in any of the parameters listed in Table 8.2.1.2.7-2 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 starting time of interruption is only allowed within the BWP switching delay TBWPswitchDelay as defined in clause 8.6.2 when BWP switch occurs on a single CC. The starting time of interruption caused by each BWP switch is only allowed within the BWP switch delay TMultipleBWPswitchDelay +Y as defined in clause 8.6.2A.1 when BWP switch occurs on multiple CCs. Interruptions are not allowed during BWP switch involving any other parameter change.

When a BWP timer *bwp-InactivityTimer* defined in TS 38.331 [2] expires, UE is allowed to cause interruption of up to X slot to other active serving cells due to switching its active BWP involving changes in any of the parameters listed in Table 8.2.1.2.7-2 if the UE is not capable of per-FR gap, or if the BWP switching involves SCS changing. When the BWP switch imposes changes in any of the parameters listed in Table 8.2.1.2.7-2 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 starting time of interruption is only allowed within the BWP switching delay TBWPswitchDelay as defined in clause 8.6.2 when BWP switch occurs on a single CC. The starting time of interruption caused by each BWP switch is only allowed within the BWP switch delay TMultipleBWPswitchDelay as defined in clause 8.6.2B.1 when BWP switch occurs on multiple CCs simultaneously or TMultipleBWPswitchDelayTotal as defined in clause 8.6.2B.2 when BWP switch occurs on multiple CCs over partially overlapping time period. Interruptions are not allowed during BWP switch involving any other parameter change.

When UE receives an RRC reconfiguration that only requests UE to switch its active BWP on one single CC, the UE is allowed to cause interruption of up to X slot to other active serving cells due to switching its active BWP involving changes in any of the parameters listed in Table 8.2.1.2.7-2 if the UE is not capable of per-FR gap, or if the BWP switching involves SCS changing. When the BWP switch imposes changes in any of the parameters listed in Table 8.2.1.2.7-2 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 delay TRRCprocessingDelay + TBWPswitchDelayRRC defined in clause 8.6.3 when BWP switch occurs on a single CC. The interruption is only allowed within the delay TRRCprocessingDelay + TBWPswitchDelayRRC + DRRC\*(N-1) as defined in clause 8.6.3A when BWP switch occurs on multiple CCs.

When UL BWP switch is triggered by consistent uplink CCA failures [7], the UE is allowed to cause interruption of up to X slot to other active serving cells due to switching its active UL BWP involving changes in any of the parameters listed in Table 8.2.1.2.7-2 if the UE is not capable of per-FR gap, or if the UL BWP switching involves SCS changing. When the UL BWP switch imposes changes in any of the parameters listed in Table 8.2.1.2.7-2 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 UL BWP switching. X is defined in Table 8.2.1.2.7-1. The starting time of interruption is only allowed within the UL BWP switching delay TBWPswitchDelay as defined in clause 8.6.2. Interruptions are not allowed during UL BWP switch involving other parameter change.

Table 8.2.1.2.7-1: interruption length X

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Interruption length X (slots) |
| 0 | 1 | 1 |
| 1 | 0.5 | 1 |
| 2 | 0.25 | 3 |
| 3 | 0.125 | 5 |
| Note1: void | | |

Table 8.2.1.2.7-2: Parameters which cause interruption other than SCS

|  |  |
| --- | --- |
| Parameters | Comment |
| *locationAndBandwidth* | From TS 38.331 [2] |
| *nrofSRS-Ports* |  |
| *maxMIMO-Layers-r16* |  |

##### 8.2.1.2.8 Interruptions at direct SCell activation and hibernation

###### 8.2.1.2.8.1 Interruptions during direct SCell activation and hibernation of E-UTRA SCell

When one E-UTRA SCell in MCG is directly activated and hibernated:

- the UE is allowed an interruption on any active serving cell in SCG:

- of up to X1 slots, if the active serving cell is not in the same band as any of the E-UTRA SCells being directly activated or hibernated, or

- of up to X1 slots, if the active serving cell is in the band overlapping or partially overlapping with any of the E-UTRA SCells being directly activated or hibernated and UE reports *interBandMRDC-WithOverlapDL-Bands-r16* on this band pair, or

- of up to max{Y1 slots + TSMTC\_duration, 5ms} if the active serving cells are in the same band or in the band overlapping or partially overlapping with any of the E-UTRA SCells being directly activated or hibernated, and UE does not report *interBandMRDC-WithOverlapDL-Bands-r16* on this band pair, provided the cell specific reference signals from the active serving cells and the E-UTRA SCells being directly activated or hibernated are available in the same slot, where TSMTC\_duration is the longest SMTC duration among all above active serving cells in MCG Where X1 and Y1 are specified in Table 8.2.1.2.3-1.

###### 8.2.1.2.8.2 Interruptions during direct SCell activation

When one or multiple SCell(s) in SCG are directly activated at SCell addition:

- the UE is allowed an interruption on any active serving cell in SCG:

- of up to X1 slot, if the active serving cell is not in the same band as the SCell being directly activated, or

- of up to max{Y1 slot + TSMTC\_duration, 5ms} if the active serving cells are in the same band as the SCell being directly activated, provided the cell specific reference signals from the active serving cells and the SCell being directly activated are available in the same slot, where TSMTC\_duration is the longest SMTC duration among all above active serving cells in SCG.

Where X1 and Y1 are specified in Table 8.2.1.2.3-2.

##### 8.2.1.2.9 Interruptions at SCell hibernation

When one E-UTRA SCell in MCG is hibernated:

- the UE is allowed an interruption on any active serving cell in SCG:

- of up to X2 slots, if the active serving cell is not in the same band as any of the E-UTRA SCells being hibernated, or

- of up to X2 slots, if the active serving cell is in the band overlapping or partially overlapping with any of the E-UTRA SCells being hibernated and UE reports *interBandMRDC-WithOverlapDL-Bands-r16* on this band pair, or

- of up to max{Y2 slots + TSMTC\_duration, 5ms}, if the active serving cells are in the same band or in the band overlapping or partially overlapping with any of the E-UTRA SCells being hibernated, and UE does not report *interBandMRDC-WithOverlapDL-Bands-r16* on this band pair, provided the cell specific reference signals from the active serving cells and the E-UTRA SCells being hibernated are available in the same slot, where TSMTC\_duration is the longest SMTC duration among all above active serving cells in MCG.

Where X2 and Y2 are specified in Table 8.2.1.2.4-1.

##### 8.2.1.2.10 Interruptions at SCell activation/deactivation with multiple downlink SCells

The requirements in this clause shall apply for the UE configured with PSCell and up to 6 downlink SCell(s).

When multiple SCells in SCG are activated or deactivated by one single MAC CE command:

- an interruption on any serving cell in SCG is specified as in clause 8.2.1.2.4.

##### 8.2.1.2.11 Interruptions due to UE-specific CBW change

When UE receives an RRC reconfiguration that changes *offsetToCarrier* or *carrierBandwidth*, the UE is allowed to cause interruption of up to X slot to other active serving cells due to switching its CBW. X is defined in Table 8.2.1.2.11-1. The interruption is only allowed within the delay TRRCprocessingDelay + TCBWchangeDelayRRC defined in clause 8.7.

Table 8.2.1.2.11-1: interruption length X

|  |  |  |
| --- | --- | --- |
|  | NR Slot | Interruption length X (slots) |
|  | length (ms) |  |
| 0 | 1 | 1 |
| 1 | 0.5 | 1 |
| 2 | 0.25 | 3 |
| 3 | 0.125 | 5 |

##### 8.2.1.2.12 Interruptions at NR SRS carrier based switching

SRS transmission can be configured on a carrier not configured for PUCCH/PUSCH transmission. When a UE needs to transmit periodic, semi-persistent or aperiodic SRS on a carrier of a serving cell not configured for PUCCH/PUSCH transmission, the UE can perform carrier based switching to one or more carriers not configured for PUCCH/PUSCH transmission from a carrier with PUCCH/PUSCH transmission or from a carrier not configured for PUCCH/PUSCH transmission prior to transmitting SRS, provided that:

- switching is from a configured carrier to an active UL BWP of another activated carrier;

- the carrier of SCells not configured for PUCCH/PUSCH transmission to which SRS carrier based switching is performed is indicated by DCI SRS request field for aperiodic SRS transmission, or indicated by MAC-CE for semi-persistent SRS transmission, or configured via RRC for periodic SRS transmission;

- the serving cell, from which SRS carrier based switching is performed and whose UL transmission may therefore be interrupted, is indicated by srs-SwitchFromServCellIndex and srs-SwitchFromCarrier in TS38.331 [2];

- the SRS switching is not colliding with any other transmission with higher priority defined in TS 38.214 [26].

- the SRS switching is not colliding with any SSB/CSI-RS based L3 measurements and the measurements for RLM/BFD in SCG.

- for UE, which does not support simultaneous reception and transmission for inter-band TDD CA specified in TS 38.331 [2], and is compliant to the requirements for inter-band CA with uplink in one NR band and without simultaneous Rx/Tx specified in TS 38.101-3 [20], the SRS transmission are not simultaneously scheduled with DL SSB/CSI-RS for L3 or L1 measurements transmission on other carriers.

The UE shall not perform SRS carrier based switching if the above conditions cannot be met.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell in SCG if UE is not capable of Per-FR gap, or on active serving cell(s) in SCG in FR1 if UE is capable of Per-FR gap, during the switching to the carrier of a serving cell in FR1 not configured for PUCCH/PUSCH transmission,

- with up to X1 slot as specified in Table 8.2.1.2.12-1.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell in SCG if UE is not capable of Per-FR gap, or on active serving cell(s) in SCG in FR2 if UE is capable of Per-FR gap, during the switching to the carrier of a serving cell in FR2 not configured for PUCCH/PUSCH transmission,

- with up to X2 slot as specified in Table 8.2.1.2.12-2.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell in SCG if UE is not capable of Per-FR gap, or on active serving cell(s) in SCG in FR1 if UE is capable of Per-FR gap, during the switching from the carrier of a serving cell in FR1 not configured for PUCCH/PUSCH transmission,

- with up to X1 slot as specified in Table 8.2.1.2.12-1.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell in SCG if UE is not capable of Per-FR gap, or on active serving cell(s) in SCG in FR2 if UE is capable of Per-FR gap, during the switching from the carrier of a serving cell in FR2 not configured for PUCCH/PUSCH transmission,

- with up to X2 slot as specified in Table 8.2.1.2.12-2.

Table 8.2.1.2.12-1: Interruption length X1 (slot)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length | SRS carrier | Interruption length X1 (slots) | |
|  | (ms) of victim cell | switching time (us)Note 1 | Sub carrier spacing for agressor cell (kHz) | |
|  |  |  | 15 | 30 |
| 0 | 1 | ≤ 200 | 2 | 2 |
|  |  | 300, 500 | 2 | 2 |
|  |  | 900 | 3 | 3 |
| 1 | 0.5 | ≤ 200 | 3 | 2 |
|  |  | 300, 500 | 3 | 3 |
|  |  | 900 | 4 | 4 |
| 2 | 0.25 | ≤ 200 | 4 | 3 |
|  |  | 300, 500 | 5 | 4 |
|  |  | 900 | 7 | 6 |
| 3 | 0.125 | ≤ 200 | 7 | 5 |
|  |  | 300, 500 | 9 | 7 |
|  |  | 900 | 12 | 10 |
| Note1: NR SRS carrier switching time is UE capability indicated by higher layer parameter *SRS-SwitchingTimeNR*. | | | | |

Table 8.2.1.2.12-2: Interruption length X2 (slot)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot | SRS carrier | Interruption length X2 (slots) | |
|  | length (ms) of victim cell | switching time (us) Note | Sub carrier spacing for agressor cell (kHz) | |
|  |  |  | 60 | 120 |
| 0 | 1 | ≤ 200 | 2 | 2 |
| 1 | 0.5 | ≤ 200 | 2 | 2 |
| 2 | 0.25 | ≤ 200 | 3 | 3 |
| 3 | 0.125 | ≤ 200 | 4 | 4 |
| Note1: NR SRS carrier switching time is UE capability indicated by higher layer parameter *SRS-SwitchingTimeNR*. | | | | |

For intra-band SRS carrier switching in FR1 or FR2, interruptions in Table 8.2.1.2.12-1 and in Table 8.2.1.2.12-2 based on SRS carrier switching time ≤ 200us shall apply. For inter-band SRS carrier switching in FR1, interruptions in Table 8.2.1.2.12-1 and in Table 8.2.1.2.12-2 shall apply.

##### 8.2.1.2.13 Interruptions at E-UTRA SRS carrier based switching

A PUSCH-less carrier of E-UTRA SCell is a TDD carrier without PUCCH/PUSCH configured. When a UE needs to transmit periodic or aperiodic SRS [23] and/or non-contention based PRACH on a PUSCH-less carrier of E-UTRA SCell, the UE can perform carrier based switching to one or more PUSCH-less carrier of E-UTRA SCells from a E-UTRA carrier with PUSCH or from another PUSCH-less E-UTRA carrier of SCell prior to transmitting SRS and/or PRACH, provided that:

- switching is from a configured E-UTRA carrier to another activated TDD E-UTRA carrier;

- the PUSCH-less carrier of E-UTRA SCells to which SRS carrier based switching is performed is indicated by DCI SRS request field for aperiodic SRS transmission or configured via RRC [15] for periodic SRS transmission;

- the E-UTRA serving cell, from which SRS carrier based switching is performed and whose UL transmission may therefore be interrupted, is indicated by srs-SwitchFromServCellIndex [15];

- the SRS switching is not colliding with any other transmission with higher priority defined in TS36.213 [26];

- the SRS switching is not colliding with PDCCH in subframe 0 and 5 as specified in TS36.213 [26];

- for UE, which does not support simultaneous reception and transmission for inter-band TDD CA specified in TS 36.331 [2], and is compliant to the requirements for inter-band CA with uplink in one E-UTRA band and without simultaneous Rx/Tx specified in TS 36.101 [25], the SRS or RACH transmission are not simultaneously scheduled with DL subframe #0 or DL subframe #5 on other E-UTRA carriers.

The UE shall not perform SRS carrier based switching if the above conditions cannot be met.

When SRS carrier based switching is performed between E-UTRA carriers, the UE is allowed interruptions on any active serving cell in SCG if UE is not capable of Per-FR gap, or on active serving cell(s) in SCG in FR1 if UE is capable of Per-FR gap, during the switching to the PUSCH-less carrier of a serving cell,

- with up to X3 slot as specified in Table 8.2.1.2.13-1.

When SRS carrier based switching is performed between E-UTRA carriers, the UE is allowed interruptions on any active serving cell in SCG if UE is not capable of Per-FR gap, or on active serving cell(s) in SCG in FR1 if UE is capable of Per-FR gap, during the switching from the PUSCH-less carrier of a serving cell,

- with up to X3 slot as specified in Table 8.2.1.2.13-1

Table 8.2.1.2.13-1: Interruption length X3 (slot)

|  |  |  |
| --- | --- | --- |
|  | NR Slot | Interruption length X3 |
|  | length (ms) | (slots) |
| 0 | 1 | 2 |
| 1 | 0.5 | 3 |
| 2 | 0.25 | 5 |
| 3 | 0.125 | 9 |

##### 8.2.1.2.14 DL Interruptions at switching between two uplink carriers

The DL interruption requirements at dynamic switching between two uplink carriers specified in this clause are applicable for an uplink band pair of an inter-band EN-DC configuration when the capability *uplinkTxSwitchingPeriod* is present, and is only applicable for uplink switching mechanism specified in clause 6.1.6 of TS 38.214 [26], where E-UTRA UL carrier is capable of one transmit antenna connector and NR UL carrier is capable of two transmit antenna connectors, and the two uplink carriers are in different bands with different carrier frequencies.

When dynamic switching between two uplink carriers is conducted, UE is allowed to cause DL interruption of X OFDM symbols in NR downlink carrier(s) as indicated by *uplinkTxSwitching-DL-Interruption* [2]. The DL interruption starts from the first OFDM symbol which fully or partially overlaps with the UL switching period located in NR carrier. The DL interruption lengths of X for NR carrier(s) are defined in Table 8.2.1.2.14-1.

No DL interruption is allowed in the NR downlink carrier(s) which is not indicated by *uplinkTxSwitching-DL-Interruption*. No DL interruption is allowed for some inter-band EN-DC configurations as specified in clause 5.5B.4 of TS 38.101-3 [20].

Table 8.2.1.2.14-1: DL interruption length on NR carrier(s) in the unit of OFDM symbols (X) for switching between two uplink carriers

|  |  |  |  |
| --- | --- | --- | --- |
|  | NR Slot length (ms) | Uplink Tx switching period Note1 | |
|  |  | 35us | 140us |
| 0 | 1 | 2 | 3 |
| 1 | 0.5 | 3 | 6 |
| 2 | 0.25 | 4 | 10 |
| Note 1: Uplink Tx switching period depends on UE capability *uplinkTxSwitchingPeriod.* | | | |

##### 8.2.1.2.15 Interruptions due to SCell dormancy

###### 8.2.1.2.15.1 Interruptions due to SCell dormancy switch

When one SCell in SCG is switched from dormancy to non-dormancy or from non-dormancy to dormancy [7] when UE is in DRX active time,

- the UE is allowed an interruption on active serving cell in SCG as defined in clause 8.2.1.2.7, except that the interruption is allowed regardless of which parameters change between the dormant BWP and the non-dormant BWP

- The starting time of interruption shall be within the dormancy switching delay as defined in clause 8.6.2.

When multiple SCells in SCG are switched from dormancy to non-dormancy or vice versa when the UE is in DRX active time, the interruption requirement described above applies for each BWP switch.

###### 8.2.1.2.15.2 Interruptions due to CQI measurements during SCell dormancy

When one or more SCells are in dormancy, the UE is for the purpose of CQI measurements on the dormant SCell(s) allowed to cause interruptions to non-dormant serving cell(s).

The rate of ACK/NACK feedback loss on any non-dormant serving cell resulting from CQI measurements on dormant SCells shall not exceed 0.5%.

###### 8.2.1.2.15.3 Interruptions due to RRM measurements during SCell dormancy

When one or more SCells are in dormancy, the UE is for the purpose of RRM measurements on the dormant SCell(s) allowed to cause interruptions to non-dormant serving cell(s).

The rate of ACK/NACK feedback loss on any non-dormant serving cell resulting from RRM measurements on dormant SCells shall not exceed 1.0%.

##### 8.2.1.2.16 Interruptions when identifying CGI of an NR cell with autonomous gaps

When a UE is identifying CGI of an NR cell with autonomous gaps, the UE is allowed interruptions on PSCell or any activated SCell:

- with up to K1 interruptions with interrupted slots up to interruption length X1 specified in Table 8.2.1.2.16-1 for each interruption during MIB decoding time period TMIB (ms) specified in clause 9.11.

- with up to L1 interruptions with interrupted slots up to interruption length Y1 specified in Table 8.2.1.2.16-1 for each interruption during SIB1 decoding time period TSIB1 (ms) specified in clause 9.11 for SSB and CORESET for RMSI scheduling multiplexing patterns 1.

- with up to L2 interruptions with interrupted slots up to interruption length Y2 specified in Table 8.2.1.2.16-1 for each interruption during SIB1 decoding time period TSIB1 (ms) specified in clause 9.11 for SSB and CORESET for RMSI scheduling multiplexing patterns 2 and 3.

Where:

- K1 = 6 for the target cell carrier frequency on FR1 and K1 = 25 for the target cell carrier frequency on FR2, and

- L1 = TSIB1/20, and

- L2 = TSIB1/TSMTC, where TSMTC is the periodicity of the SMTC occasion configured for the target cell carrier.

Table 8.2.1.2.16-1: Interruption length X1, Y1 and Y2 during measurements with autonomous gaps

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) of victim cell | Interruption length X1 (slots) | Interruption length Y1 (slots) | Interruption length Y2 (slots) |
| 0 | 1 | 6 | 7 | 6 |
| 1 | 0.5 | 12 | 13 | 10 |
| 2 | 0.25 | 24 | 25 | 19 |
| 3 | 0.125 | 48 | 49 | 37 |

##### 8.2.1.2.17 Interruptions when identifying CGI of an E-UTRA cell with autonomous gaps

When a UE is identifying CGI of an E-UTRA FDD cell or E-UTRA TDD cell with autonomous gaps, within time period

- Tidentify\_CGI, intra specified in clause 8.1.2.2.3, or clause 8.1.2.2.4 in TS 36.133 [15], or

- Tidentify\_CGI, inter specified in clause 8.1.2.3.5, or clause 8.1.2.3.6, or clause 8.1.2.3.7, or clause 8.1.2.3.6 in TS 36.133 [15], or

- Tidentify\_CGI, E-UTRA specified in clause 9.4.7.1

the UE shall be able to transmit at least the number of ACK/NACKs specified in Table 8.2.1.2.17-1 on PSCell or any activated SCell in the frequency range where autonomous gaps are used, 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 slot,

- 2 slot ACK/NACK feedback is configured,

- 20 ms SMTC period is configured.

Table 8.2.1.2.17-1: Minimum number of ACK/NACKs transmitted by the UE

|  |  |  |
| --- | --- | --- |
| Minimum number of transmitted ACK/NACKs | Configuration of the serving cell in which the transmitted ACK/NACKs are counted | |
|  | Duplex mode configuration | SCS |
| 84 | FDD | 15 kHz |
| 193 | FDD | 30 kHz |
| 402 | FDD | 60 kHz |
| 28 | TDD Note 1 | 15 kHz |
| 81 | TDD Note 1 | 30 kHz |
| 159 | TDD Note 1 | 60 kHz |
| 233 | TDD Note 2 | 60 kHz |
| 491 | TDD Note 2 | 120 kHz |
| NOTE 1: TDD UL-DL configuration is as specified in Table A.3.3.1-1 of TS 38.101-1 [18].  NOTE 2: TDD UL-DL configuration is as specified in Table A.3.3.1-1 of TS 38.101-2 [19]. | | |

##### 8.2.1.2.18 Interruptions at NR SRS antenna port switching

The requirements in this clause are applicable to SRS antenna port switching on FR1 and SRS resource(s) is only configured within the last 6 symbols of a slot. For interruption caused by SRS antenna port switching, the victim cell is based on the entry number of the band indicated by *txSwitchImpactToRx* and/or *txSwitchWithAnotherBand* regardless of per-FR MG capability. An UL interruption is allowed on any of the serving cells as indicated in *txSwitchWithAnotherBand*, and a DL interruption is allowed on any of the serving cells as indicated in *txSwitchImpactToRx*.

The UE shall perform SRS antenna port switching only if the below conditions are met.

- the SRS switching is not colliding with any other UL transmission with higher priority defined in TS 38.214 [26] if the serving cell on which the higher priority transmission is performed is a victim cell based on *txSwitchWithAnotherBand* or is the same carrier on which SRS is transmitted.

- the SRS switching is not colliding with any NR measurements (i.e. SSB/CSI-RS based L1/L3 measurements) and the measurements for RLM/BFD/CBD if the serving cell on which the NR measurements and the measurements for RLM/BFD/CBD is performed is a victim cell based on *txSwitchImpactToRx* or is the same carrier on which SRS is transmitted.

No requirements are defined for SRS antenna port switching if aperiodic SRS switching is colliding with aperiodic L1-RSRP/L1-SINR measurements and the serving cell on which the aperiodic L1-RSRP/L1-SINR measurement is configured is indicated in *txSwitchImpactToRx* or is the same carrier on which aperiodic SRS is scheduled/configured.

No requirements apply when SRS antenna port switching is colliding with E-UTRA measurement if the carrier on which the E-UTRA measurement is performed is indicated in *txSwitchImpactToRx* or is the same carrier on which SRS is scheduled/configured.When 1 SRS symbol is configured in a slot for SRS antenna switching and the aggressor and victim cells are synchronized, the interruption requirement in Table 8.2.1.2.18-1 applies.

When 1 SRS symbol is configured in a slot for SRS antenna switching and the aggressor and victim cells are asynchronized, the interruption requirement in Table 8.2.1.2.18-2 applies. For the rest of SRS configurations, the interruption requirement in Table 8.2.1.2.18-3 applies.

Table 8.2.1.2.18-1: Interruption length in symbols of victim CC when 1 SRS symbol is configured, and aggressor and victim cells are synchronized

|  |  |  |  |
| --- | --- | --- | --- |
| **Victim cell SCS(kHz)** | **Aggressor cell SCS (kHz)** | | |
| **15** | **30** | **60** |
| 15 | 3 | 2 | 2 |
| 30 | 4 | 3 | 3 |
| 60 | 8 | 6 | 5 |
| 120 | 14 | 10 | 8 |

Table 8.2.1.2.18-2: Interruption length in slots of victim CC when 1 SRS symbol is configured, and aggressor and victim cells are asynchronized

|  |  |  |  |
| --- | --- | --- | --- |
| **Victim cell SCS(kHz)** | **Aggressor cell SCS (kHz)** | | |
| **15** | **30** | **60** |
| 15 | 2 | 2 | 2 |
| 30 | 2 | 2 | 2 |
| 60 | 2 | 2 | 2 |
| 120 | 2 | 2 | 2 |

Table 8.2.1.2.18-3: Interruption length in slots of victim CC for rest of the SRS configurations for synchronized and asynchronized scenarios

|  |  |  |  |
| --- | --- | --- | --- |
| **Victim cell SCS(kHz)** | **Aggressor cell SCS (kHz)** | | |
| **15** | **30** | **60** |
| 15 | 2 | 2 | 2 |
| 30 | 2 | 2 | 2 |
| 60 | 3 | 2 | 2 |
| 120 | 5 | 3 | 3 |

##### 8.2.1.2.19 Interruptions at fast SCell activation

The requirements in this clause shall apply for the UE configured with PSCell and one SCell when aperiodic CSI-RS resources is configured for fast SCell activation.

When one SCell in SCG configured with aperiodic CSI-RS resources is configured for fast SCell activation is activated from deactivated, the UE is allowed:

- an interruption on any serving cell in SCG:

- of up to X2 slot, if the active serving cell and the SCell being activated are in a FR1 band pair or in a FR1+FR2 band pair.

- of up to X2 slot, if the active serving cells and the SCells being activated are in a FR2 band pair and UE is capable of independent beam management on this FR2 band pair.

or

- of up to Y2 slot +TATRS\_duration if the active serving cells are in the same band as any of the SCells being activated, when

- SCell to be activated is known and belongs to FR1, if the measurement period of the SCell being activated is larger than [2400ms], or

- SCell is unknown and belongs to FR1, and SCell is contiguous to an active serving cell in the same band

or

- of up to Y2 slot if the active serving cells are in the same band as any of the SCells being activated, when

- SCell to be activated is known and belongs to FR1, if the measurement period of the SCell being activated is equal to or smaller than [2400ms], or

- SCell to be activated belongs to FR2

Where:

- TATRS\_duration is CSI-RS burst for SCell activation where the CSI-RS burst is defined as four CSI-RS resources in two consecutive slots on the being activated SCell.

- X2 and Y2 are specified in Table 8.2.1.2.4-2.

##### 8.2.1.2.20 Interruptions due to PUCCH SCell activation/deactivation

When one SCell in SCG configured with PUCCH is activated or deactivated,

The UE is allowed an interruption on active serving cell in SCG as defined in clause 8.2.1.2.4.

- The starting time of interruption shall be within the delay as defined in clause 8.3.12.

- For inter-band CA, if the UE is not capable of *parallelTxPRACH-SRS-PUCCH-PUSCH*, additional interruption is allowed on SRS/PUCCH/PUSCH of active serving cells when colliding with RACH transmission on PUCCH SCell. . Interruption occurs on the symbols containing SRS/PUCCH/PUSCH, which overlap with the duration of the PRACH preamble [3] transmitted on the PUCCH SCell.

### 8.2.2 SA: Interruptions with Standalone NR Carrier Aggregation

#### 8.2.2.1 Introduction

This clause contains the requirements related to the interruptions on PCell and activated SCell if configured, when

up to 7 SCells are configured, de-configured, activated or deactivated, or

a supplementary UL carrier or an UL carrier is configured or de-configured, or

measurements on SCC with deactivated SCell in NR SCG, or

UL/DL BWP is switched on PCell or SCell, or

CGI reading of an NR neighbour cell with autonomous gaps, or

CGI reading of an E-UTRA neighbour cell with autonomous gaps.

UE-specific CBW is changed on PCell or SCell, or

NR SRS carrier based switching, or

NR SRS antenna port switching, or

UE dynamic Tx switches between two uplink carriers, or

SCell is activated based on aperiodic CSI-RS.

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

The interruptions shall not interrupt RRC signalling or ACK/NACKs related to RRC reconfiguration procedure according to TS38.331 [2] for SCell addition/release or MAC control signalling according to TS37.340 [17] for SCell activation/deactivation command.

This clause additionally contains requirements related to interruptions at inter-frequency SFTD between PCell in FR1 and neighbour cell in FR2.

For a UE which does not support per-FR measurement gap, interruptions to the PCell and activated SCell may be caused by SCells on any frequency range. For a UE which supports per-FR gaps, interruptions to PCell and activated SCell may be caused by SCells on the same frequency range as the victim cell.

In addition to standalone NR carrier aggregation when no CCA is configured, the requirements in clause 8.2.2. and all subclauses of 8.2.2 apply when the UE is configured with

-A PCell not using CCA in downlink and one or more SCells using CCA in downlink or

-A PCell and one or more SCells using CCA in downlink

#### 8.2.2.2 Requirements

##### 8.2.2.2.1 Interruptions at SCell addition/release

When any number of SCells between one and 7 is added or released using the same *RRCConnectionReconfiguration* message as defined in TS 38.331 [2], the UE is allowed an interruption on any active serving cell during the RRC reconfiguration procedure as follows:

- an interruption on any active serving cell:

- of up to X1 slot, if the active serving cell and the SCell being added or released are in a FR1 band pair or in a FR1+FR2 band pair.

- of up to X1 slot, if the active serving cell and the SCell being added or released are in a FR2 band pair and UE is capable of independent beam management on this FR2 band pair.

Where X1 is specified in Table 8.2.2.2.1-1.

or

- of up to the duration shown in table 8.2.2.2.1-2, if the active serving cells are in the same band as any of the SCells being added or released, provided the cell specific reference signals from the active serving cells and the SCells being added or released are available in the same slot.

Table 8.2.2.2.1-1: Interruption length X1 for SCell addition/release for inter-band CA

|  |  |  |  |
| --- | --- | --- | --- |
|  | NR Slot length (ms) of victim cell | Interruption length X1 (slots) | |
| 0 | 1 | 1 | |
| 1 | 0.5 | 2 | |
| 2 | 0.25 | Both aggressor cell and victim cell are on FR2 | 4 |
|  |  | Either aggressor cell or victim cell is on FR1 | 5 |
| 3 | 0.125 | Aggressor cell is on FR2 | 8 |
|  |  | Aggressor cell is on FR1 | 9 |
| 5 | 0.03125 | Aggressor cell is on FR1 | 33 |
| 6 | 0.015625 | Aggressor cell is on FR1 | 65 |

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

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Interruption length (slots) |
| 0 | 1 | 1 + TSMTC\_duration \* |
| 1 | 0.5 | 2 + TSMTC\_duration \* |
| 2 | 0.25 | 4 + TSMTC\_duration \* |
| 3 | 0.125 | 8 + TSMTC\_duration \* |
| 5 | 0.03125 | 32+ TSMTC\_duration \* |
| 6 | 0.015625 | 64+ TSMTC\_duration \* |
| NOTE 1: TSMTC\_duration measured in subframes is  - the longest SMTC duration among all above active serving cells and the SCell being added when one SCell is added. If SSB configuration (*absoluteFrequencySSB*) but no SMTC configuration is provided for the SCell being added, the SSB transmission periodicity is assumed to be 5ms and TSMTC duration for the SCell being added is x ms, where x = the number of consecutive subframes containing all SSBs in one SSB burst transmitted by the SCell being added. If no SSB configuration (*absoluteFrequencySSB*) nor SMTC configuration is provided for the SCell being added, TSMTC duration for the SCell being added is 0ms;  - the longest SMTC duration among all active serving cells in the same band when one SCell is released.  NOTE 2: is as defined in TS 38.211 [6]. | | |

##### 8.2.2.2.2 Interruptions at SCell activation/deactivation

When an SCell is activated or deactivated as defined in TS 37.340 [17], the UE is allowed

- an interruption on any active serving cell:

- of up to X2 slot, if the active serving cell and the SCell being activated or deactivated are in a FR1 band pair or in a FR1+FR2 band pair.

- of up to X2 slot, if the active serving cell and the SCell being activated or deactivated are in a FR2 band pair and UE is capable of independent beam management on this FR2 band pair.

Where X2 is specified in Table 8.2.2.2.2-1.

or

- of up to the duration shown in table 8.2.2.2.2-2, if the active serving cells are in the same band as any of the SCells being activated or deactivated provided the cell specific reference signals from the active serving cells and the SCells being activated or deactivated are available in the same slot.

Table 8.2.2.2.2-1: Interruption length X2 for SCell activation/deactivation for inter-band CA

|  |  |  |  |
| --- | --- | --- | --- |
|  | NR Slot length (ms) of victim cell | Interruption length X2 (slots) | |
| 0 | 1 |  | 1 |
| 1 | 0.5 |  | 1 |
| 2 | 0.25 | Both aggressor cell and victim cell are on FR2 | 2 |
|  |  | Either aggressor cell or victim cell is on FR1 | 3 |
| 3 | 0.125 | Aggressor cell is on FR2 | 4 |
|  |  | Aggressor cell is on FR1 | 5 |
| 5 | 0.03125 | Aggressor cell is on FR1 | 17 |
| 6 | 0.015625 | Aggressor cell is on FR1 | 33 |

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

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Interruption length (slots) |
| 0 | 1 | 1 + TSMTC\_duration \* |
| 1 | 0.5 | 1 + TSMTC\_duration \* |
| 2 | 0.25 | 2 + TSMTC\_duration \* |
| 3 | 0.125 | 4 + TSMTC\_duration \* |
| 5 | 0.03125 | 16+ TSMTC\_duration \* |
| 6 | 0.015625 | 32+ TSMTC\_duration \* |
| NOTE 1: TSMTC\_duration measured in subframes is  - the longest SMTC duration among all above active serving cells and the SCell being activated when one SCell is activated. If SSB configuration (*absoluteFrequencySSB*) but no SMTC configuration is provided for the SCell being activated, the SSB transmission periodicity is assumed to be 5ms and TSMTC duration for the SCell being activated is x ms, where x = the number of consecutive subframes containing all SSBs in one SSB burst transmitted by the SCell being activated. If no SSB configuration (*absoluteFrequencySSB*) nor SMTC configuration is provided for the SCell being activated, TSMTC duration for the SCell being activated is 0ms;  - the longest SMTC duration among all active servingNOTE 2: is as defined in TS 38.211 [6]. | | |

##### 8.2.2.2.3 Interruptions during measurements on deactivated SCC

Interruptions on PCell or activated SCell(s) 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.

* If the PCell or activated SCell(s) is not in the same band as the deactivated SCell, the UE is only allowed to cause interruptions on PCell or activated SCell(s) immediately before and immediately after an SMTC. Each interruption shall not exceed requirement in Table 8.2.2.2.2-1.

If the PCell or activated SCell(s) is in the same band as the deactivated SCell, the UE is only allowed to cause an interruption on PCell or activated SCell(s) no earlier than X slots before TSMTC\_duration and no later than X slots after TSMTC\_duration, provided the cell specific reference signals from the active serving cells and the deactivated SCell are available in the same slot, where X and TSMTC\_duration are given by Table 8.2.2.2.3-1. The interruption shall not exceed requirements in Table 8.2.2.2.3-1.

The interruption requirements in Table 8.2.2.2.3-1 are not applicable when a UE is configured with NCSG unless the SMTC on the deactivated SCC is fully non-overlapped with NCSG.

Table 8.2.2.2.3-1: Interruption duration for measurement on deactivated SCell for intra-band CA

|  |  |  |  |
| --- | --- | --- | --- |
|  | NR Slot length (ms) | X (slots) | Interruption length (slots) |
| 0 | 1 | 1 | 2 + TSMTC\_duration \* |
| 1 | 0.5 | 1 | 2 + TSMTC\_duration \* |
| 2 | 0.25 | 2 | 4 + TSMTC\_duration \* |
| 3 | 0.125 | 4 | 8 + TSMTC\_duration \* |
| 5 | 0.03125 | 16 | 32 + TSMTC\_duration \* |
| 6 | 0.015625 | 32 | 64 + TSMTC\_duration \* |
| NOTE 1: TSMTC\_duration measured in subframes is the longest SMTC duration among all above active serving cells and the deactivated SCell to be measured;  NOTE 2: is as defined in TS 38.211 [6]. | | | |

##### 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 TS 38.331 [2]. Further, the requirements in this clause are applicable to UE capable of independent beam management in FR2 inter-band CA and UE capable of FR2 intra-band CA and FR1.

When an UL carrier or supplementary UL carrier is configured or de-configured, an interruption of up to the duration shown in table 8.2.2.2.4-1, is allowed during the RRC reconfiguration procedure [2] on PCell and all activated SCells within the same FR as the reconfigured uplink carrier. 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.

Table 8.2.2.2.4-1: Interruption duration for UL carrier RRC reconfiguration

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Interruption length (slots) |
| 0 | 1 | 1 |
| 1 | 0.5 | 2 |
| 2 | 0.25 | 4 |
| 3 | 0.125 | 8 |
| 5 | 0.03125 | 32 |
| 6 | 0.015625 | 64 |

##### 8.2.2.2.5 Interruptions due to Active BWP switching Requirement

The requirements for DCI-based BWP switch, timer-based BWP switch or UL BWP switch triggered by consistent uplink CCA failures in this clause apply to the case that the BWP switch is performed on a single CC or multiple CCs.

When either of the DCI-based, timer-based or RRC-based downlink BWP switch and/or uplink BWP switch occur on multiple CCs simultaneously or over partially overlapping period, the interruption requirements described in this clause apply for each BWP switch. Further, the requirements in this clause are applicable to UE capable of independent beam management in FR2 inter-band CA and UE capable of FR2 intra-band CA and FR1.

When UE receives a DCI indicating UE to switch its active BWP involving changes in any of the parameters listed in Table 8.2.2.2.5-2, 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 imposes changes in any of the parameters listed in Table 8.2.2.2.5-2 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 starting time of interruption is only allowed within the BWP switching delay TBWPswitchDelay as defined in clause 8.6.2 when BWP switch occurs on a single CC. The starting time of interruption caused by each BWP switch is only allowed within the BWP switch delay TMultipleBWPswitchDelay +Y as defined in clause 8.6.2A.1 when BWP switch occurs on multiple CCs. Interruptions are not allowed during BWP switch involving any other parameter change.

When a BWP timer *bwp-InactivityTimer* defined in TS 38.331 [2] expires, UE is allowed to cause interruption of up to X slot to other active serving cells due to switching its active BWP involving changes in any of the parameters listed in Table 8.2.2.2.5-2 if the UE is not capable of per-FR gap, or if the BWP switching involves SCS changing. When the BWP switch imposes changes in any of the parameters listed in Table 8.2.2.2.5-2 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 starting time of interruption is only allowed within the BWP switching delay TBWPswitchDelay as defined in clause 8.6.2 when BWP switch occurs on a single CC. The starting time of interruption caused by each BWP switch is only allowed within the BWP switch delay TMultipleBWPswitchDelay as defined in clause 8.6.2B.1 when BWP switch occurs on multiple CCs simultaneously or TMultipleBWPswitchDelayTotal as defined in clause 8.6.2B.2 when BWP switch occurs on multiple CCs over partially overlapping time period. Interruptions are not allowed during BWP switch involving any other parameter change.

When UE receives an RRC reconfiguration that only requests UE to switch its active BWP on one single CC, the UE is allowed to cause interruption of up to X slot to other active serving cells due to switching its active BWP involving changes in any of the parameters listed in Table 8.2.2.2.5-2 if the UE is not capable of per-FR gap, or if the BWP switching involves SCS changing. When the BWP switch imposes changes in any of the parameters listed in Table 8.2.2.2.5-2 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 delay TRRCprocessingDelay + TBWPswitchDelayRRC defined in clause 8.6.3 when BWP switch occurs on a single CC. The interruption is only allowed within the delay TRRCprocessingDelay + TBWPswitchDelayRRC + DRRC\*(N-1) as defined in clause 8.6.3A when BWP switch occurs on multiple CCs.

When UL BWP switch is triggered by consistent uplink CCA failures [7], UE is allowed to cause interruption of up to X slot to other active serving cells due to switching its active UL BWP involving changes in any of the parameters listed in Table 8.2.2.2.5-2 if the UE is not capable of per-FR gap, or if the BWP switching involves SCS changing. When the UL BWP switch imposes changes in any of the parameters listed in Table 8.2.2.2.5-2 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 UL BWP switching. X is defined in Table 8.2.2.2.5-1. The starting time of interruption is only allowed within the UL BWP switching delay TBWPswitchDelay as defined in clause 8.6.2. Interruptions are not allowed during BWP switch involving other parameter change.

Table 8.2.2.2.5-1: Interruption length X

|  |  |  |
| --- | --- | --- |
|  | NR Slot | Interruption length X (slots) |
|  | length (ms) |  |
| 0 | 1 | 1 |
| 1 | 0.5 | 1 |
| 2 | 0.25 | 3 |
| 3 | 0.125 | 5 |
| 5 | 0.03125 | 17 |
| 6 | 0.015625 | 33 |
| Note1: void | | |

Table 8.2.2.2.5-2: Parameters which cause interruption other than SCS

|  |  |
| --- | --- |
| Parameters | Comment |
| *locationAndBandwidth* | From TS 38.331 [2] |
| *nrofSRS-Ports* |  |
| *maxMIMO-Layers-r16* |  |

##### 8.2.2.2.6 Interruptions at inter-frequency SFTD measurement

The requirements in this clause concern interruptions on PCell, as well as on activated SCells in MCG, when the UE is performing SFTD measurements on inter-frequency neighbour cell(s). The following requirements apply when no PSCell is configured.

For a UE with per-FR gap capability:

- for neighbour cell in FR1:

- the percentage of interrupted slots on uplink and downlink on FR1 serving cells during the SFTD measurement period Tmeasure\_SFTD1 specified in Clause 9.3.8 shall not exceed the percentages specified in Table 8.2.2.2.6-1. No interruption is allowed on FR2 serving cells.

- the length of each interruption on FR1 serving cells shall not exceed the number of slots specified in Table 8.2.2.2.6-2.

- for neighbour cell in FR2:

- the percentage of interrupted slots on uplink and downlink on FR2 serving cells during the SFTD measurement period Tmeasure\_SFTD1 specified in Clause 9.3.8 shall not exceed the percentages specified in Table 8.2.2.2.6-1. No interruption is allowed on FR1 serving cells.

- the length of each interruption on FR2 serving cells shall not exceed the number of slots specified in Table 8.2.2.2.6-2.

For a UE with per-UE gap capability:

- for neighbour cell in FR1 or FR2:

- the percentage of interrupted slots on uplink and downlink on FR1 and FR2 serving cells during the SFTD measurement period Tmeasure\_SFTD1 specified in Clause 9.3.8 shall not exceed the percentages specified in Table 8.2.2.2.6-1.

- the length of each interruption on FR1 and FR2 serving cells shall not exceed the number of slots specified in Table 8.2.2.2.6-2.

Table 8.2.2.2.6-1: Requirements on maximum percentage of interrupted slots in serving cell in inter-frequency SFTD

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| SFTD configuration | Serving cell µ | Neighbour cell SMTC periodicity | | | | | |
|  |  | 5ms | 10ms | 20ms | 40ms | 80ms | 160ms |
| With RSRP | 0 | 8.4% | 6.3% | 8.4% | 6.3% | 5.3% | 4.7% |
| report | 1 |  |  |  |  |  |  |
|  | 2 |  |  |  |  |  |  |
|  | 3 |  |  |  |  |  |  |
| Without RSRP | 0 | 11.4% | 8.6% | 7.9% | 6.8% | 6.3% | 6.0% |
| report | 1 |  |  |  |  |  |  |
|  | 2 |  |  |  |  |  |  |
|  | 3 |  |  |  |  |  |  |

Table 8.2.2.2.6-2: Interruption duration for FR1 serving cell in inter-frequency SFTD with neighbour cell in FR1

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Interruption length (slots) |
| 0 | 1 | 1 |
| 1 | 0.5 | 2 |
| 2 | 0.25 | 4 |
| 3 | 0.125 | 8 |

Table 8.2.2.2.6-3: Void

Table 8.2.2.2.6-4: Void

##### 8.2.2.2.7 Interruptions at SCell activation/deactivation with multiple downlink SCells

The requirements in this clause shall apply for the UE configured with PCell and up to 7 downlink SCell(s).

When multiple SCell is activated or deactivated by one single MAC CE command:

- an interruption on any active serving cell is specified as in clause 8.2.2.2.2:

##### 8.2.2.2.8 Interruptions due to UE-specific CBW change

When UE receives an RRC reconfiguration that changes *offsetToCarrier* or *carrierBandwidth*, the UE is allowed to cause interruption of up to X slot to other active serving cells due to switching its CBW. X is defined in Table 8.2.2.2.8-1. The interruption is only allowed within the delay TRRCprocessingDelay + TCBWchangeDelayRRC defined in clause 8.13.

Table 8.2.2.2.8-1: interruption length X

|  |  |  |
| --- | --- | --- |
|  | **NR Slot** | **Interruption length X (slots)** |
|  | **length (ms)** |  |
| 0 | 1 | 1 |
| 1 | 0.5 | 1 |
| 2 | 0.25 | 3 |
| 3 | 0.125 | 5 |
| 5 | 0.03125 | 17 |
| 6 | 0.015625 | 33 |

##### 8.2.2.2.9 Interruptions at NR SRS carrier based switching

SRS transmission can be configured on a carrier not configured for PUCCH/PUSCH transmission. When a UE needs to transmit periodic, semi-persistent or aperiodic SRS on a carrier of a serving cell not configured for PUCCH/PUSCH transmission, the UE can perform carrier based switching to one or more carriers not configured for PUCCH/PUSCH transmission from a carrier with PUCCH/PUSCH transmission or from a carrier not configured for PUCCH/PUSCH transmission prior to transmitting SRS, provided that:

- switching is from a configured carrier to another activated carrier;

- the carrier of SCells not configured for PUCCH/PUSCH transmission to which SRS carrier based switching is performed is indicated by DCI SRS request field for aperiodic SRS transmission, or indicated by MAC-CE for semi-persistent SRS transmission, or configured via RRC for periodic SRS transmission;

- the serving cell, from which SRS carrier based switching is performed and whose UL transmission may therefore be interrupted, is indicated by srs-SwitchFromServCellIndex and srs-SwitchFromCarrier in TS38.331 [2];

- the SRS switching is not colliding with any other transmission with higher priority defined in TS 38.214 [26].

- the SRS switching is not colliding with any SSB/CSI-RS based L3 measurements and the measurements for RLM/BFD.

- for UE, which does not support simultaneous reception and transmission for inter-band TDD CA specified in TS 38.331 [2], and is compliant to the requirements for inter-band CA with uplink in one NR band and without simultaneous Rx/Tx specified in TS 38.101-1 [18] for frequency range 1 and TS 38.101-2 [19] for frequency range 2, the SRS transmission are not simultaneously scheduled with DL SSB/CSI-RS for L3 or L1 measurements transmission on other carriers.

The UE shall not perform SRS carrier based switching if the above conditions cannot be met.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell if UE is not capable of Per-FR gap, or on active serving cell(s) in FR1 if UE is capable of Per-FR gap, during the switching to the carrier of a serving cell in FR1 not configured for PUCCH/PUSCH transmission,

- with up to X1 slot as specified in Table 8.2.2.2.9-1.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell if UE is not capable of Per-FR gap, or on active serving cell(s) in FR2 if UE is capable of Per-FR gap, during the switching to the carrier of a serving cell in FR2 not configured for PUCCH/PUSCH transmission,

- with up to X2 slot as specified in Table 8.2.2.2.9-2.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell if UE is not capable of Per-FR gap, or on active serving cell(s) in FR1 if UE is capable of Per-FR gap, during the switching from the carrier of a serving cell in FR1 not configured for PUCCH/PUSCH transmission,

- with up to X1 slot as specified in Table 8.2.2.2.9-1.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell if UE is not capable of Per-FR gap, or on active serving cell(s) in FR2 if UE is capable of Per-FR gap, during the switching from the carrier of a serving cell in FR2 not configured for PUCCH/PUSCH transmission,

- with up to X2 slot as specified in Table 8.2.2.2.9-2.

Table 8.2.2.2.9-1: Interruption length X1 (slot)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length | SRS carrier | Interruption length X1 (slots) | |
|  | (ms) of victim cell | switching time (us)Note 1 | Sub carrier spacing for agressor cell (kHz) | |
|  |  |  | 15 | 30 |
| 0 | 1 | ≤ 200 | 2 | 2 |
|  |  | 300, 500 | 2 | 2 |
|  |  | 900 | 2 | 2 |
| 1 | 0.5 | ≤ 200 | 3 | 2 |
|  |  | 300, 500 | 3 | 3 |
|  |  | 900 | 4 | 4 |
| 2 | 0.25 | ≤ 200 | 4 | 3 |
|  |  | 300, 500 | 5 | 4 |
|  |  | 900 | 7 | 6 |
| 3 | 0.125 | ≤ 200 | 7 | 5 |
|  |  | 300, 500 | 9 | 7 |
|  |  | 900 | 12 | 10 |
| 5 | 0.03125 | ≤ 200 | 22 | 15 |
|  |  | 300, 500 | 31 | 24 |
|  |  | 900 | 44 | 37 |
| 6 | 0.015625 | ≤ 200 | 42 | 28 |
|  |  | 300, 500 | 61 | 47 |
|  |  | 900 | 87 | 73 |
| Note1: NR SRS carrier switching time is UE capability indicated by higher layer parameter *SRS-SwitchingTimeNR*. | | | | |

Table 8.2.2.2.9-2: Interruption length X2 (slot)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **length (ms) of victim cell** | **switching time (us) Note 1** | **Sub carrier spacing for agressor cell (kHz)** | | | |
|  |  |  | **60** | **120** | **480** | **960** |
| 0 | 1 | ≤ 200 | 2 | 2 | 2 | 2 |
| 1 | 0.5 | ≤ 200 | 2 | 2 | 2 | 2 |
| 2 | 0.25 | ≤ 200 | 3 | 3 | 2 | 2 |
| 3 | 0.125 | ≤ 200 | 4 | 4 | 3 | 3 |
| 5 | 0.03125 | ≤ 200 | 11 | 10 | 8 | 8 |
| 6 | 0.015625 | ≤ 200 | 21 | 18 | 15 | 15 |
| Note1: NR SRS carrier switching time is UE capability indicated by higher layer parameter *SRS-SwitchingTimeNR*. | | | | | | |

For intra-band SRS carrier switching in FR1 or FR2, interruptions in Table 8.2.2.2.9-1 and in Table 8.2.2.2.9-2 based on SRS carrier switching time ≤ 200us shall apply. For inter-band SRS carrier switching in FR1, interruptions in Table 8.2.2.2.9-1 and in Table 8.2.2.2.9-2 shall apply.

##### 8.2.2.2.10 DL Interruptions at UE switching between two uplink carriers

The DL interruption requirements at dynamic switching between two uplink carreirs specified in this clause are applicable for an uplink band pair of an inter-band UL CA configuration in FR1 when the capability *uplinkTxSwitchingPeriod* is present, and is only applicable for uplink switching mechanism specified in clause 6.1.6 of TS 38.214 [26], where NR uplink carrier 1 is capable of one transmit antenna connector and NR uplink carrier 2 is capable of two transmit antenna connectors, and the two uplink carriers are in different bands with different carrier frequencies.

When dynamic switching between two uplink carriers is conducted, UE is allowed to cause DL interruption of X OFDM symbols in NR downlink carrier(s) as indicated by *uplinkTxSwitching-DL-Interruption* [2]. The DL interruption starts from the first OFDM symbol which fully or partially overlaps with the UL switching period located in either NR carrier 1 or carrier 2 as indicated in RRC signalling [2]. The DL interruption lengths of X are defined in Table 8.2.2.2.10-1.

No DL interruption is allowed in the NR downlink carrier(s) which is not indicated by *uplinkTxSwitching-DL-Interruption*. No DL interruption is allowed for some inter-band UL CA configurations as specified in clause 5.2A.2 of TS 38.101-1 [18].

Table 8.2.2.2.10-1: DL interruption length on NR carrier(s) in the unit of OFDM symbols (X) for switching between two uplink carriers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) | Uplink Tx switching period Note1 | | |
|  |  | 35us | 140us | 210us |
| 0 | 1 | 2 | 3 | 4 |
| 1 | 0.5 | 3 | 6 | 7 |
| 2 | 0.25 | 4 | 10 | 14 |
| Note 1: Uplink Tx switching period depends on UE capability *uplinkTxSwitchingPeriod* | | | | |

##### 8.2.2.2.10A DL Interruptions at UE switching between two uplink carriers with two transmit antenna connectors

The DL interruption requirements at dynamic switching between two uplink carriers specified in this clause are applicable for an uplink band pair of an inter-band UL CA configuration when the capability *[uplinkTxSwitchingPeriod2T2T]* is present, and is only applicable for uplink switching mechanism specified in clause 6.1.6 of TS 38.214 [26], where NR UL carrier 1 is capable of two transmit antenna connectors and NR UL carrier 2 is capable of two transmit antenna connectors, and the two uplink carriers are in different bands with different carrier frequencies.

When dynamic switching between two uplink carriers is conducted, UE is allowed to cause DL interruption of X OFDM symbols in NR downlink carrier(s) as indicated by *uplinkTxSwitching-DL-Interruption* [2]. The DL interruption starts from the first OFDM symbol which fully or partially overlaps with the UL switching period located in either NR carrier 1 or carrier 2 as indicated in RRC signalling [2]. The DL interruption lengths of X are defined in Table 8.2.2.2.10A-1.

No DL interruption is allowed in the NR downlink carrier(s) which is not indicated by *uplinkTxSwitching-DL-Interruption*. No DL interruption is allowed for some inter-band UL CA configurations as specified in clause 5.2A.2 of TS 38.101-1 [18].

Table 8.2.2.2.10A -1: DL interruption length on NR carrier(s) in the unit of OFDM symbols (X) for switching between two uplink carriers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) | Uplink Tx switching period Note1 | | |
|  |  | 35us | 140us | 210us |
| 0 | 1 | 2 | 3 | 4 |
| 1 | 0.5 | 3 | 6 | 7 |
| 2 | 0.25 | 4 | 10 | 14 |
| Note 1: Uplink Tx switching period depends on UE capability [*uplinkTxSwitchingPeriod2T2T]*. | | | | |

##### 8.2.2.2.10B DL Interruptions at UE switching between one uplink band with one transmit antenna connector and one uplink band with two transmit antenna connectors

The DL interruption requirements at dynamic switching between two uplink bands specified in this clause are applicable for an uplink band pair of an inter-band UL CA configuration when the capability *[uplinkTxSwitchingPeriod]* is present, and is only applicable for uplink switching mechanism specified in clause 6.1.6 of TS 38.214 [26], where NR UL carrier 1 in band A is capable of one transmit antenna connector, NR UL carrier 2 and carrier 3 in band B are capable of two transmit antenna connectors. NR UL carrier 2 and carrier 3 are two contiguous aggregated carriers, and band A and band B are different bands with different carrier frequencies.

When dynamic switching between two uplink bands is conducted, UE is allowed to cause DL interruption of X OFDM symbols in NR downlink carrier(s) as indicated by *uplinkTxSwitching-DL-Interruption* [2]. The DL interruption starts from the first OFDM symbol which fully or partially overlaps with the UL switching period located in either NR band A or band B as indicated in RRC signalling [2]. The DL interruption lengths of X are defined in Table 8.2.2.2.10-1.

No DL interruption is allowed in the NR downlink carrier(s) which is not indicated by *uplinkTxSwitching-DL-Interruption*. No DL interruption is allowed for some inter-band UL CA configurations as specified in clause 5.2A.2 of TS 38.101-1 [18].

##### 8.2.2.2.10C DL Interruptions at UE switching between two uplink bands with two transmit antenna connectors

The DL interruption requirements at dynamic switching between two uplink bands specified in this clause are applicable for an uplink band pair of an inter-band UL CA configuration when the capability *[uplinkTxSwitchingPeriod2T2T]* is present, and is only applicable for uplink switching mechanism specified in clause 6.1.6 of TS 38.214 [26], where NR UL carrier 1 in band A is capable of two transmit antenna connectors, NR UL carrier 2 and carrier 3 in band B are capable of two transmit antenna connectors. NR UL carrier 2 and carrier 3 are two contiguous aggregated carriers, and band A and band B are different bands with different carrier frequencies.

When dynamic switching between two uplink bands is conducted, UE is allowed to cause DL interruption of X OFDM symbols in NR downlink carrier(s) as indicated by *uplinkTxSwitching-DL-Interruption* [2]. The DL interruption starts from the first OFDM symbol which fully or partially overlaps with the UL switching period located in either NR band A or band B as indicated in RRC signalling [2]. The DL interruption lengths of X are defined in Table 8.2.2.2.10A -1.

No DL interruption is allowed in the NR downlink carrier(s) which is not indicated by *uplinkTxSwitching-DL-Interruption*. No DL interruption is allowed for some inter-band UL CA configurations as specified in clause 5.2A.2 of TS 38.101-1 [18].

##### 8.2.2.2.10D DL Interruptions at UE switching across three or four uplink bands

The DL interruption requirements at dynamic switching across three or four uplink bands specified in this clause are applicable for an NR inter-band CA configuration and SUL band configuration with inter-band CA when the capability [*BandCombination-UplinkTxSwitch-r18*] is present, and are only applicable for uplink switching mechanisms specified in clause [6.1.6] of TS 38.214 [26]. In the NR inter-band CA configuration and SUL band configuration with inter-band CA, the number of NR uplink bands with different carrier frequencies is three or four. NR UL carrier(s) in each of the three or four uplink bands are capable of one or two transmit antenna connector(s), according to the UE capability.

When dynamic switching across three or four uplink bands is conducted, UE is allowed to cause DL interruption of X OFDM symbols in NR downlink carrier(s) as indicated by *uplinkTxSwitching-DL-Interruption* [2]. The DL interruption starts from the first OFDM symbol which fully or partially overlaps with the UL Tx switching period located in uplink NR band(s) as indicated in RRC signalling [2]. The DL interruption lengths of X for single TAG and for 2-TAG are defined in Table 8.2.2.2.10D-1 and Table 8.2.2.2.10D-2.

Note: If one downlink carrier is indicated to be interrupted by two band pairs for dynamic switching simultaneously, the DL interruption length on the victim carrier is determined by the maximum of uplink switching periods of the two band pairs. If [*uplinkTxSwitchingPeriod1T1Tto2T*] is reported, DL interruption length is determined by the uplink Tx switching period, which is indicated by [*uplinkTxSwitchingPeriod1T1Tto2T*]. If [*TBD on-unaffeacted-band-invovled*] is reported, DL interruption length is determined by the uplink Tx switching period, which is the next larger value from the set {35 us, 140 us, 210 us} w.r.t. the length of the switching period of the band pair, and the uplink Tx switching period is 210 us when the length of the switching period for the band pair is 210 us.

No DL interruption is allowed in the NR downlink carrier(s) which is not indicated by *uplinkTxSwitching-DL-Interruption*. No DL interruption is allowed for some inter-band UL CA configurations and SUL band configurations with inter-band CA as specified in TS 38.101-1 [18].

Table 8.2.2.2.10D -1: DL interruption length on NR carrier(s) in the unit of OFDM symbols (X) for switching across three or four uplink bands for single TAG

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) | Uplink Tx switching period Note1 | | |
|  |  | 35us | 140us | 210us |
| 0 | 1 | 2 | 3 | 4 |
| 1 | 0.5 | 3 | 6 | 7 |
| 2 | 0.25 | 4 | 10 | 14 |
| Note 1: Uplink Tx switching period depends on UE capability [TBD].  Note 2: RTD=3us is assumed to derive the DL interruption length. | | | | |

Table 8.2.2.2.10D -2: DL interruption length on NR carrier(s) in the unit of OFDM symbols (X) for switching across three or four uplink bands for two TAGs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) | Uplink Tx switching period Note1 | | |
|  |  | 35us | 140us | 210us |
| 0 | 1 | 2 | 3 | 4 |
| 1 | 0.5 | 3 | 6 | 8 |
| 2 | 0.25 | 4 | 10 | 14 |
| Note 1: Uplink Tx switching period depends on UE capability [TBD].  Note 2: RTD=9 us is assumed to derive the DL interruption length. | | | | |

##### 8.2.2.2.11 Interruptions at direct SCell activation

When one or multiple SCell(s) are directly activated at SCell addition,

- the UE is allowed an interruption on any active serving cell:

- of up to the duration shown in Table 8.2.2.2.1-1, if the active serving cell is not in the same band as the SCell being directly activated, or

- of up to the duration shown in Table 8.2.2.2.1-2, if the active serving cells are in the same band as the SCell being activated provided the cell specific reference signals from the active serving cells and the SCell being activated are available in the same slot.

##### 8.2.2.2.12 Interruptions due to SCell dormancy

###### 8.2.2.2.12.1 Interruptions due to SCell dormancy switch

When one SCell in MCG is switched from dormancy to non-dormancy or from non-dormancy to dormancy [7] when UE is in DRX active time,

- the UE is allowed an interruption on active serving cell in MCG as defined in clause 8.2.2.2.5, except that the interruption is allowed regardless of which parameters change between the dormant BWP and the non-dormant BWP

- The starting time of interruption shall be within the dormancy switching delay as defined in clause 8.6.2.

When multiple SCells in MCG are switched from dormancy to non-dormancy or vice versa when the UE is in DRX active time, the interruption requirement described above applies for each BWP switch.

###### 8.2.2.2.12.2 Interruptions due to CQI measurements during SCell dormancy

When one or more SCells are in dormancy, the UE is for the purpose of CQI measurements on the dormant SCell(s) allowed to cause interruptions to non-dormant serving cell(s).

The rate of ACK/NACK feedback loss on any non-dormant serving cell resulting from CQI measurements on dormant SCells shall not exceed 0.5%.

###### 8.2.2.2.12.3 Interruptions due to RRM measurements during SCell dormancy

When one or more SCells are in dormancy, the UE is for the purpose of RRM measurements on the dormant SCell(s) allowed to cause interruptions to non-dormant serving cell(s).

The rate of ACK/NACK feedback loss on any non-dormant serving cell resulting from RRM measurements on dormant SCells shall not exceed 1.0%.

##### 8.2.2.2.13 Interruptions at transitions between active and non-active during DRX

For the UEs that are capable of *secondaryDRX-Group*[14] in FR1+FR2 CA, when two DRX groups are configured each group of serving cells, no interruption is allowed for UEs supporting either per UE or per FR gaps.

##### 8.2.2.2.14 Interruptions when identifying CGI of an NR cell with autonomous gaps

When a UE is identifying CGI of an NR cell with autonomous gaps, the UE is allowed interruptions on PCell or any activated SCell:

- with up to K1 interruptions with interrupted slots up to interruption length X1 specified in Table 8.2.2.2.14-1 for each interruption during MIB decoding time period TMIB (ms) specified in clause 9.11.

- with up to L1 interruptions with interrupted slots up to interruption length Y1 specified in Table 8.2.2.2.14-1 for each interruption during SIB1 decoding time period TSIB1 (ms) specified in clause 9.11 for SSB and CORESET for RMSI scheduling multiplexing patterns 1.

- with up to L2 interruptions with interrupted slots up to interruption length Y2 specified in Table 8.2.2.2.14-1 for each interruption during SIB1 decoding time period TSIB1 (ms) specified in clause 9.11 for SSB and CORESET for RMSI scheduling multiplexing patterns 2 and 3.

Where:

- K1 = 6 for the target cell carrier frequency on FR1 and K1 = 25 for the target cell carrier frequency on FR2, and

- L1 = TSIB1/20and

- L2 = TSIB1/TSMTC, where TSMTC is the periodicity of the SMTC occasion configured for the target cell carrier.

Table 8.2.2.2.14-1: Interruption length X1, Y1 and Y2 during measurements with autonomous gaps

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) of victim cell | Interruption length X1 (slots) | Interruption length Y1 (slots) | Interruption length Y2 (slots) |
| 0 | 1 | 6 | 7 | 6 |
| 1 | 0.5 | 12 | 13 | 10 |
| 2 | 0.25 | 24 | 25 | 19 |
| 3 | 0.125 | 48 | 49 | 37 |

##### 8.2.2.2.15 Interruptions when identifying CGI of an E-UTRA cell with autonomous gaps

When a UE is identifying CGI of an E-UTRA FDD cell or E-UTRA TDD cell with autonomous gaps, within time period Tidentify\_CGI, E-UTRA specified in clause 9.4.7.1, the UE shall be able to transmit at least the number of ACK/NACKs specified in Table 8.2.2.2.15-1 on PCell or any activated SCell in the frequency range where autonomous gaps are used, 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 slot,

- 2 slot ACK/NACK feedback is configured,

- 20 ms SMTC period is configured.

Table 8.2.2.2.15-1: Minimum number of ACK/NACKs transmitted by the UE during Tidentify\_CGI, E-UTRA

|  |  |  |
| --- | --- | --- |
| Minimum number of transmitted ACK/NACKs | SCS | |
|  | Duplex mode configuration | SCS |
|  | Duplex mode configuration | SCS |
| 84 | FDD | 15 kHz |
| 193 | FDD | 30 kHz |
| 402 | FDD | 60 kHz |
| 28 | TDD Note 1 | 15 kHz |
| 81 | TDD Note 1 | 30 kHz |
| 159 | TDD Note 1 | 60 kHz |
| 233 | TDD Note 2 | 60 kHz |
| 491 | TDD Note 2 | 120 kHz |
| NOTE 1: TDD UL-DL configuration is as specified in Table A.3.3.1-1 of TS 38.101-1 [18].  NOTE 2: TDD UL-DL configuration is as specified in Table A.3.3.1-1 of TS 38.101-2 [19]. | | |

##### 8.2.2.2.16 Interruptions at NR SRS antenna port switching

The requirements in this clause are applicable to SRS antenna port switching on FR1 and SRS resource(s) is only configured within the last 6 symbols of a slot. For interruption caused by SRS antenna port switching, the victim cell is based on the entry number of the band indicated by *txSwitchImpactToRx* and/or *txSwitchWithAnotherBand* regardless of per-FR MG capability. An UL interruption is allowed on any of the serving cells as indicated in *txSwitchWithAnotherBand*, and a DL interruption is allowed on any of the serving cells as indicated in *txSwitchImpactToRx*.

The UE shall perform SRS antenna port switching only if the below conditions are met.

- the SRS switching is not colliding with any other UL transmission with higher priority defined in TS 38.214 [26] if the serving cell on which the higher priority transmission is performed is a victim cell based on *txSwitchWithAnotherBand* or is the same carrier on which SRS is transmitted.

- the SRS switching is not colliding with any NR measurements (i.e. SSB/CSI-RS based L1/L3 measurements) and the measurements for RLM/BFD/CBD if the serving cell on which the NR measurements and the measurements for RLM/BFD/CBD is performed is a victim cell based on *txSwitchImpactToRx* or is the same carrier on which SRS is transmitted.

No requirements are defined for SRS antenna port switching if aperiodic SRS switching is colliding with aperiodic L1-RSRP/L1-SINR measurements and the serving cell on which the aperiodic L1-RSRP/L1-SINR measurement is configured is indicated in *txSwitchImpactToRx* or is the same carrier on which aperiodic SRS is scheduled/configured.

When 1 SRS symbol is configured in a slot for SRS antenna switching and the aggressor and victim cells are synchronized, the interruption requirement in Table 8.2.2.2.16-1 applies. When 1 SRS symbol is configured in a slot for SRS antenna switching and the aggressor and victim cells are asynchronized, the interruption requirement in Table 8.2.2.2.16-2 applies. For the rest of SRS configurations, the interruption requirement in Table 8.2.2.2.16-3 applies.

**Table 8.2.2.2.16-1: Interruption length in symbols of victim CC when 1 SRS symbol is configured, and aggressor and victim cells are synchronized**

|  |  |  |  |
| --- | --- | --- | --- |
| **Victim cell SCS(kHz)** | **Aggressor cell SCS (kHz)** | | |
| **15** | **30** | **60** |
| 15 | 3 | 2 | 2 |
| 30 | 4 | 3 | 3 |
| 60 | 8 | 6 | 5 |
| 120 | 14 | 10 | 8 |

**Table 8.2.2.2.16.2: Interruption length in slots of victim CC when 1 SRS symbol is configured, and aggressor and victim cells are asynchronized**

|  |  |  |  |
| --- | --- | --- | --- |
| **Victim cell SCS(kHz)** | **Aggressor cell SCS (kHz)** | | |
| **15** | **30** | **60** |
| 15 | 2 | 2 | 2 |
| 30 | 2 | 2 | 2 |
| 60 | 2 | 2 | 2 |
| 120 | 2 | 2 | 2 |

**Table 8.2.2.2.16-3: Interruption length in slots of victim CC for rest of the SRS configurations for synchronised and asynchronized scenarios**

|  |  |  |  |
| --- | --- | --- | --- |
| **Victim cell SCS(kHz)** | **Aggressor cell SCS (kHz)** | | |
| **15** | **30** | **60** |
| 15 | 2 | 2 | 2 |
| 30 | 2 | 2 | 2 |
| 60 | 3 | 2 | 2 |
| 120 | 5 | 3 | 3 |

##### 8.2.2.2.17 Interruptions at fast SCell activation

The requirements in this clause shall apply for the UE configured with PCell and one SCell when aperiodic CSI-RS resources is configured for fast SCell activation.

When one SCell in MCG configured with aperiodic CSI-RS resources is configured for fast SCell activation is activated from deactivated, the UE is allowed:

- an interruption on any active serving cell:

- of up to X2 slot, if the active serving cell and the SCell being activated are in a FR1 band pair or in a FR1+FR2 band pair.

- of up to X2 slot, if the active serving cell and the SCell being activated are in a FR2 band pair and UE is capable of independent beam management on this FR2 band pair.

- Where X2 is specified in Table 8.2.2.2.2-1.

or

- of up to Y2 slot +TATRS\_duration, if the active serving cells are in the same band as any of the SCells being activated, when

- SCell to be activated is known and belongs to FR1, if the measurement period of the SCell being activated is larger than [2400ms], or

- SCell is unknown and belongs to FR1, and SCell is contiguous to an active serving cell in the same band

or

- of up to Y2 slot if the active serving cells are in the same band as any of the SCells being activated, when

- SCell to be activated is known and belongs to FR1, if the measurement period of the SCell being activated is equal to or smaller than [2400ms], or

- SCell to be activated belongs to FR2

Where:

- TATRS\_duration is CSI-RS burst for SCell activation where the CSI-RS burst is defined as four CSI-RS resources in two consecutive slots on the being activated SCell.

- Y2 are specified in Table 8.2.1.2.4-2.

##### 8.2.2.2.18 Interruptions due to PUCCH SCell activation/deactivation

When one SCell configured with PUCCH is activated or deactivated,

- The UE is allowed an interruption on active serving cell as defined in clause 8.2.2.2.2.

- The starting time of interruption shall be within the delay as defined in clause 8.3.12.

- For inter-band CA, if the UE is not capable of *parallelTxPRACH-SRS-PUCCH-PUSCH*, additional interruption is allowed on SRS/PUCCH/PUSCH of active serving cells when colliding with RACH transmission on PUCCH SCell. Interruption occurs on the symbols containing SRS/PUCCH/PUSCH, which overlap with the duration of the PRACH preamble [3] transmitted on the PUCCH SCell.

### 8.2.3 NE-DC Interruptions

#### 8.2.3.1 Introduction

This clause contains the requirements related to the interruptions on PCell and SCell, when

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

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

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

E-UTRA PSCell/SCell in SCG or SCell(s) in MCG is activated or deactivated, or

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

PUSCH/PUCCH carrier configuration and deconfiguration in NR MCG, or

UL/DL BWP is switched on PCell or SCell in MCG, or

UE-specific CBW is changed on PCell or SCell in MCG, or

CGI reading of an NR neighbour cell with autonomous gaps, or

CGI reading of an E-UTRA neighbour cell with autonomous gaps.

NR SRS carrier based switching, or

E-UTRA SRS carrier based switching, or

NR SRS antenna port switching.

SCell in NR MCG is activated based on aperiodic CSI-RS.

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

This clause contains interruptions where victim cell is PCell or SCell belonging to MCG. Requirements for interruptions requirements when the victim cell is E-UTRA PSCell or E-UTRA SCell belonging to SCG are specified in TS 36.133 [15].

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

#### 8.2.3.2 Requirements

##### 8.2.3.2.1 Interruptions at transitions between active and non-active during DRX

Interruption on PCell and the activated SCell if configured due to E-UTRA PSCell transitions between active and non-active druing DRX when PCell or SCell is in non-DRX are allowed with up to 1% probability of missed ACK/NACK when the configured E-UTRA PSCell 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 8.2.3.2.1-1.

Table 8.2.3.2.1-1: Interruption length X at transition between active and non-active during DRX

|  |  |  |  |
| --- | --- | --- | --- |
|  | NR slot length (ms) | Interruption length X (slots) | |
|  |  | Sync | Async |
| 0 | 1 | 1 | 2 |
| 1 | 0.5 | 1 | 2 |
| 2 | 0.25 | 3 | |
| 3 | 0.125 | 5 | |

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

##### 8.2.3.2.2 Interruptions at transitions from non-DRX to DRX

Interruption on PCell and the activated SCell if configured due to E-UTRA PSCell transitions from non-DRX to DRX when PCell or SCell is in non-DRX shall not exceed X slots as defined in table 8.2.3.2.1-1.

##### 8.2.3.2.3 Interruptions at PSCell/SCell addition/release

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

When one E-UTRA PSCell/SCell in SCG is added or released:

- the UE is allowed an interruption on any active serving cell in MCG:

- of up to X1 slots, if the active serving cell is not in the same band as any of the E-UTRA PSCell/SCells being added or released, or

- of up to max{Y1 slots + TSMTC\_duration, 5ms} if the active serving cells are in the same band as any of the E-UTRA PSCell/SCells being added or released, provided the cell specific reference signals from the active serving cells and the E-UTRA PSCell/SCells being added or released are available in the same slot, where TSMTC\_duration is the longest SMTC duration among all above activated serving cells in MCG;

Where X1 and Y1 are specified in Table 8.2.3.2.3-1.

When one SCell in MCG is added or released:

- the UE is allowed an interruption on any activated serving cell in MCG:

- of up to X1 slots, if the active serving cell and the SCell being added or released are in a FR1 band pair or in a FR1+FR2 band pair.

- of up to X1 slot, if the active serving cell and the SCell being added or released are in a FR2 band pair and UE is capable of independent beam management on this FR2 band pair.

or

- of up to Y1 slots + TSMTC\_duration if the active serving cells are in the same band as any of the SCells being added or released, provided the cell specific reference signals from the active serving cells and the SCells being added or released are available in the same slot, where, TSMTC\_duration is

- the longest SMTC duration among all above active serving cells in MCG and the SCell being added when one SCell is added. If SSB configuration (*absoluteFrequencySSB*) but no SMTC configuration is provided for the SCell being added, the SSB transmission periodicity is assumed to be 5ms and TSMTC duration for the SCell being added is x ms, where x = the number of consecutive subframes containing all SSBs in one SSB burst transmitted by the SCell being added. If no SSB configuration (*absoluteFrequencySSB*) nor SMTC configuration is provided for the SCell being added, TSMTC duration for the SCell being added is 0ms;

- the longest SMTC duration among all above active serving cells in MCG when one SCell is released.

Where X1 and Y1 are specified in Table 8.2.3.2.3-2.

Table 8.2.3.2.3-1: Interruption length X1 and Y1 at E-UTRA PSCell/SCell addition/release

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | NR Slot length | Interruption length X1 (slots) | | Interruption length Y1 (slots) | |
|  | (ms) | Sync | Async | Sync | Async |
| 0 | 1 | 1 | 2 | 1 | 2 |
| 1 | 0.5 | 2 | 3 | 2 | 3 |
| 2 | 0.25 | 5 | | 4 | 5 |
| 3 | 0.125 | 9 | | N/A | N/A |

Table 8.2.3.2.3-2: Interruption length X1 and Y1 at SCell addition/Release

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) of victim cell | Interruption length X1 (slots) | | Interruption length Y1 (slots) |
| 0 | 1 | 1 | | 1 |
| 1 | 0.5 | 2 | | 2 |
| 2 | 0.25 | Both aggressor cell and victim cell are on FR2 | 4 | 4 |
|  |  | Either aggressor cell or victim cell is on FR1 | 5 |  |
| 3 | 0.125 | Aggressor cell is on FR2 | 8 | 8 |
|  |  | Aggressor cell is on FR1 | 9 |  |

##### 8.2.3.2.4 Interruptions at SCell activation/deactivation

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

When one E-UTRA SCell in SCG is activated from deactivated or dormant state, or deactivated from activated or dormant state:

- the UE is allowed an interruption on any active serving cell in MCG:

- of up to X2 slots, if the active serving cell is not in the same band as any of the SCells being activated or deactivated, or

- of up to max{Y2 slots + TSMTC\_duration, 5ms} if the active serving cells are in the same band as any of the E-UTRA SCells being activated or deactivated, provided the cell specific reference signals from the active serving cells and the E-UTRA SCells being activated or deactivated are available in the same slot, where TSMTC\_duration is the longest SMTC duration among all above active serving cells in MCG.

Where X2 and Y2 are specified in Table 8.2.3.2.4-1.

When one SCell in MCG is activated or deactivated:

- the UE is allowed an interruption on any serving cell in MCG:

- of up to X2 slots, if the active serving cell is not in the same band as any of the SCells being activated or deactivated, or

- of up to Y2 slots + TSMTC\_duration if the active serving cells are in the same band as any of the SCells being activated or deactivated, provided the cell specific reference signals from the active serving cells and the SCells being activated or deactivated are available in the same slot, where, TSMTC\_duration is

- the longest SMTC duration among all above active serving cells in MCG and the SCell being activated when one SCell is activated, If SSB configuration (*absoluteFrequencySSB*) but no SMTC configuration is provided for the SCell being activated, the SSB transmission periodicity is assumed to be 5ms and TSMTC duration for the SCell being activated is x ms, where x = the number of consecutive subframes containing all SSBs in one SSB burst transmitted by the SCell being activated. If no SSB configuration (*absoluteFrequencySSB*) nor SMTC configuration is provided for the SCell being activated, TSMTC duration for the SCell being activated is 0ms;

- the longest SMTC duration among all above active serving cells in MCG when one SCell is deactivated.

Where X2 and Y2 are specified in Table 8.2.3.2.4-2.

Table 8.2.3.2.4-1: Interruption length X2 and Y2 at E-UTRA SCell activation/deactivation

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | NR Slot length (ms) | Interruption length X2 (slots) | | Interruption length Y2 (slots) | |
|  |  | Sync | Async | Sync | Async |
| 0 | 1 | 1 | 2 | 1 | 2 |
| 1 | 0.5 | 1 | 2 | 1 | 2 |
| 2 | 0.25 | 3 | | 2 | 3 |
| 3 | 0.125 | 5 | | N/A | N/A |

Table 8.2.3.2.4-2: Interruption length X2 and Y2 at SCell activation/deactivation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) of victim cell | Interruption length X2 (slots) | | Interruption length Y2 (slots) |
| 0 | 1 | 1 | | 1 |
| 1 | 0.5 | 1 | | 1 |
| 2 | 0.25 | Both aggressor cell and victim cell are on FR2 | 2 | 2 |
|  |  | Either aggressor cell or victim cell is on FR1 | 3 |  |
| 3 | 0.125 | Aggressor cell is on FR2 | 4 | 4 |
|  |  | Aggressor cell is on FR1 | 5 |  |

##### 8.2.3.2.5 Interruptions during measurements on SCC

###### 8.2.3.2.5.1 Interruptions during measurements on deactivated NR SCC

Interruption on PCell and other activated SCell(s) during measurement on the deactivated NR SCC shall meet requirements in clause 8.2.2.2.3.

###### 8.2.3.2.5.2 Interruptions during measurements on deactivated E-UTRAN SCC

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

- an interruption on PCell or any activated SCell with up to 0.5% probability of missed ACK/NACK when any of the configured *measCycleSCell* [15] for the deactivated E-UTRA SCellsis 640 ms or longer.

- an interruption on PCell or any activated SCell with up to 0.5% probability of missed ACK/NACK regardless of the configured *measCycleSCell* [15]for the deactivated E-UTRA SCells if indicated by the network using IE *allowInterruptions* [15].

Each interruption shall not exceed

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

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

Where X3 and Y3 are specified in Table 8.2.3.2.5-1

Table 8.2.3.2.5-1: Interruption length X3 and Y3 at measurements on deactivated E-UTRA SCC

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | NR Slot length | Interruption length X3 (slots) | | Interruption length Y3 (slot) | |
|  | (ms) | Sync | Async | Sync | Async |
| 0 | 1 | 1 | 2 | 1 | 2 |
| 1 | 0.5 | 1 | 2 | 1 | 2 |
| 2 | 0.25 | 3 | | 2 | 3 |
| 3 | 0.125 | 5 | | N/A | N/A |

###### 8.2.3.2.5.3 Interruptions during CQI measurements on dormant E-UTRAN SCC

When one E-UTRA SCell in SCG is dormant, the UE is allowed due to CQI measurements on the dormant E-UTRA SCell:

- an interruption on PCell or any activated SCell with up to 0.5% probability of missed ACK/NACK.

Each interruption shall not exceed

- X3 slots, if the PCell or activated SCell is not in the same band as the E-UTRA dormant SCell being measured, or

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

Where X3 and Y3 are defined in Table 8.2.3.2.5.2-1.

###### 8.2.3.2.5.4 Interruptions during RRM measurements on dormant E-UTRAN SCC

When one E-UTRA SCell in SCG is dormant, the UE is allowed due to RRM measurements on the E-UTRA SCC with the dormant E-UTRA SCell:

- an interruption on PCell or any activated SCell with up to 0.5% probability of missed ACK/NACK.

Each interruption shall not exceed

- X3 slots, if the PCell or activated SCell is not in the same band as the E-UTRA dormant SCC being measured, or

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

Where X3 and Y3 are defined in Table 8.2.3.2.5.2-1.

##### 8.2.3.2.6 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 NE-DC.

When an UL carrier or supplementary UL carrier is configured or deconfigured, an interruption of up to X4 slot as specified in Table 8.2.3.2.6-1, is allowed during the RRC reconfiguration procedure in TS 38.331 [2] on PCell, all activated SCells within the same FR as the reconfigured uplink carrier. The interruption is for both uplink and downlink of PCell, all activated E-UTRA SCells, E-UTRA PSCell and all activated SCells within the same FR as the configured or de-configured UL.

Table 8.2.3.2.6-1: Interruption length X4 at UL carrier RRC reconfiguration

|  |  |  |  |
| --- | --- | --- | --- |
|  | NR Slot length (ms) | Interruption length X4 (slots) | |
|  |  | Sync | Async |
| 0 | 1 | 1 | 2 |
| 1 | 0.5 | 2 | 3 |
| 2 | 0.25 | 5 | |
| 3 | 0.125 | 9 | |

##### 8.2.3.2.7 Interruptions due to Active BWP switching Requirement

The requirements for DCI-based BWP switch , timer-based BWP switch or UL BWP switch triggered by consistent uplink CCA failures in this clause apply to the case that the BWP switch is performed on a single CC or multiple CCs.

When either of the DCI-based, timer-based or RRC-based downlink BWP switch and/or uplink BWP switch occur on multiple CCs simultaneously or over partially overlapping period, the interruption requirements described in this clause apply for each BWP switch.

When UE receives a DCI indicating the UE to switch its active BWP, or when a BWP timer *bwp-InactivityTimer* defined in TS 38.331 [2] expires, or when the UE receives an RRC command indicating the UE to switch its active BWP or when UL BWP switch is triggered by consistent uplink CCA failures, the UE is allowed an interruption on PCell and any activated SCells as defined in clause 8.2.2.2.5.

##### 8.2.3.2.8 Interruptions at direct SCell activation and hibernation

8.2.3.2.8.1 Interruptions during direct SCell activation and hibernation of E-UTRA SCell

When one E-UTRA SCell in SCG is directly activated and hibernated:

- the UE is allowed an interruption on any active serving cell in MCG:

- of up to X1 slot, if the active serving cell is not in the same band as any of the E-UTRA SCells being directly activated or hibernated, or

- of up to max{Y1 slot + TSMTC\_duration, 5ms} if the active serving cells are in the same band as any of the E-UTRA SCells being directly activated or hibernated, provided the cell specific reference signals from the active serving cells and the E-UTRA SCells being directly activated or hibernated are available in the same slot, where TSMTC\_duration is the longest SMTC duration among all above active serving cells in MCG.

Where X1 and Y1 are specified in Table 8.2.3.2.3-1.

8.2.3.2.8.2 Interruptions during direct SCell activation

When one or multiple SCell(s) in MCG are directly activated at SCell addition:

- the UE is allowed an interruption on any active serving cell in MCG:

- of up to X1 slot, if the active serving cell is not in the same band as the SCell being directly activated, or

- of up to max{Y1 slot + TSMTC\_duration, 5ms} if the active serving cells are in the same band as the SCell being directly activated, provided the cell specific reference signals from the active serving cells and the SCell being directly activated are available in the same slot, where TSMTC\_duration is the longest SMTC duration among all above active serving cells in MCG.

Where X1 and Y1 are specified in Table 8.2.3.2.3-2.

##### 8.2.3.2.9 Interruptions at SCell hibernation

When one E-UTRA SCell in SCG is hibernated:

- the UE is allowed an interruption on any active serving cell in MCG:

- of up to X2 slot, if the active serving cell is not in the same band as any of the E-UTRA SCells being hibernated, or

- of up to max{Y2 slot + TSMTC\_duration, 5ms} if the active serving cells are in the same band as any of the E-UTRA SCells being hibernated, provided the cell specific reference signals from the active serving cells and the E-UTRA SCells being hibernated are available in the same slot, where TSMTC\_duration is the longest SMTC duration among all above active serving cells in MCG.

Where X2 and Y2 are specified in Table 8.2.3.2.4-1.

##### 8.2.3.2.10 Interruptions at SCell activation/deactivation with multiple downlink SCells

The requirements in this clause shall apply for the UE configured with E-UTRA PSCell and up to 6 downlink SCell(s).

When multiple SCells in MCG are activated or deactivated by one single MAC CE command:

- an interruption on any serving cell in MCG is specified as in clause 8.2.3.2.4.

##### 8.2.3.2.11 Interruptions at NR SRS carrier based switching

SRS transmission can be configured on a carrier not configured for PUCCH/PUSCH transmission. When a UE needs to transmit periodic, semi-persistent or aperiodic SRS on a carrier of a serving cell not configured for PUCCH/PUSCH transmission, the UE can perform carrier based switching to one or more carriers not configured for PUCCH/PUSCH transmission from a carrier with PUCCH/PUSCH transmission or from a carrier not configured for PUCCH/PUSCH transmission prior to transmitting SRS, provided that:

- switching is from a configured carrier to another activated carrier;

- the carrier of SCells not configured for PUCCH/PUSCH transmission to which SRS carrier based switching is performed is indicated by DCI SRS request field for aperiodic SRS transmission, or indicated by MAC-CE for semi-persistent SRS transmission, or configured via RRC for periodic SRS transmission;

- the serving cell, from which SRS carrier based switching is performed and whose UL transmission may therefore be interrupted, is indicated by srs-SwitchFromServCellIndex and srs-SwitchFromCarrier in TS38.331 [2];

- the SRS switching is not colliding with any other transmission with higher priority defined in TS 38.214 [26].

- the SRS switching is not colliding with any SSB/CSI-RS based L3 measurements and the measurements for RLM/BFD in MCG.- for UE, which does not support simultaneous reception and transmission for inter-band TDD CA specified in TS 38.331 [2], and is compliant to the requirements for inter-band CA with uplink in one NR band and without simultaneous Rx/Tx specified in TS 38.101-3 [20], the SRS transmission are not simultaneously scheduled with DL SSB/CSI-RS for L3 or L1 measurements transmission on other carriers.

The UE shall not perform SRS carrier based switching if the above conditions cannot be met.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell in MCG if UE is not capable of Per-FR gap, or on active serving cell(s) in MCG in FR1 if UE is capable of Per-FR gap, during the switching to the carrier of a serving cell in FR1 not configured for PUCCH/PUSCH transmission,

- with up to X1 slot as specified in Table 8.2.3.2.11-1.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell in MCG if UE is not capable of Per-FR gap, or on active serving cell(s) in MCG in FR2 if UE is capable of Per-FR gap, during the switching to the carrier of a serving cell in FR2 not configured for PUCCH/PUSCH transmission,

- with up to X2 slot as specified in Table 8.2.3.2.11-2.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell in MCG if UE is not capable of Per-FR gap, or on active serving cell(s) in MCG in FR1 if UE is capable of Per-FR gap, during the switching from the carrier of a serving cell in FR1 not configured for PUCCH/PUSCH transmission,

- with up to X1 slot as specified in Table 8.2.3.2.11-1.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell in MCG if UE is not capable of Per-FR gap, or on active serving cell(s) in MCG in FR2 if UE is capable of Per-FR gap, during the switching from the carrier of a serving cell in FR2 not configured for PUCCH/PUSCH transmission,

- with up to X2 slot as specified in Table 8.2.3.2.11-2.

Table 8.2.3.2.11-1: Interruption length X1 (slot)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length | SRS carrier | Interruption length X1 (slots) | |
|  | (ms) of victim cell | switching time (us)Note 1 | Sub carrier spacing for agressor cell (kHz) | |
|  |  |  | 15 | 30 |
| 0 | 1 | ≤ 200 | 2 | 2 |
|  |  | 300, 500 | 2 | 2 |
|  |  | 900 | 3 | 3 |
| 1 | 0.5 | ≤ 200 | 3 | 2 |
|  |  | 300, 500 | 3 | 3 |
|  |  | 900 | 4 | 4 |
| 2 | 0.25 | ≤ 200 | 4 | 3 |
|  |  | 300, 500 | 5 | 4 |
|  |  | 900 | 7 | 6 |
| 3 | 0.125 | ≤ 200 | 7 | 5 |
|  |  | 300, 500 | 9 | 7 |
|  |  | 900 | 12 | 10 |
| Note1: NR SRS carrier switching time is UE capability indicated by higher layer parameter *SRS-SwitchingTimeNR*. | | | | |

Table 8.2.3.2.11-2: Interruption length X2 (slot)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot | SRS carrier | Interruption length X2 (slots) | |
|  | length (ms) of victim cell | switching time (us) Note 1 | Sub carrier spacing for agressor cell (kHz) | |
|  |  |  | 60 | 120 |
| 0 | 1 | ≤ 200 | 2 | 2 |
| 1 | 0.5 | ≤ 200 | 2 | 2 |
| 2 | 0.25 | ≤ 200 | 3 | 3 |
| 3 | 0.125 | ≤ 200 | 4 | 4 |
| Note1: NR SRS carrier switching time is UE capability indicated by higher layer parameter *SRS-SwitchingTimeNR*. | | | | |

For intra-band SRS carrier switching in FR1 or FR2, interruptions in Table 8.2.3.2.11-1 and in Table 8.2.3.2.11-2 based on SRS carrier switching time ≤ 200us shall apply. For inter-band SRS carrier switching in FR1, interruptions in Table 8.2.3.2.11-1 and in Table 8.2.3.2.11-2 shall apply.

##### 8.2.3.2.12 Interruptions at E-UTRA SRS carrier based switching

A PUSCH-less carrier of E-UTRA SCell is a TDD carrier without PUCCH/PUSCH configured. When a UE needs to transmit periodic or aperiodic SRS [23] and/or non-contention based PRACH on a PUSCH-less E-UTRA carrier of SCell, the UE can perform carrier based switching to one or more PUSCH-less carrier of E-UTRA SCells from a E-UTRA carrier with PUSCH or from another PUSCH-less E-UTRA carrier of SCell prior to transmitting SRS and/or PRACH, provided that:

- switching is from a configured E-UTRA carrier to another activated TDD carrier;

- the PUSCH-less carrier of E-UTRA SCells to which SRS carrier based switching is performed is indicated by DCI SRS request field for aperiodic SRS transmission or configured via RRC [15] for periodic SRS transmission;

- the E-UTRA serving cell, from which SRS carrier based switching is performed and whose UL transmission may therefore be interrupted, is indicated by srs-SwitchFromServCellIndex [15];

- the SRS switching is not colliding with any other transmission with higher priority defined in TS36.213 [TBD];

- the SRS switching is not colliding with PDCCH in subframe 0 and 5 as specified in TS36.213 [TBD];

- for UE, which does not support simultaneous reception and transmission for inter-band TDD CA specified in TS 36.331 [2], and is compliant to the requirements for inter-band CA with uplink in one E-UTRA band and without simultaneous Rx/Tx specified in TS 36.101 [25], the SRS or RACH transmission are not simultaneously scheduled with DL subframe #0 or DL subframe #5 on other E-UTRA carriers.

The UE shall not perform SRS carrier based switching if the above conditions cannot be met.

When SRS carrier based switching is performed between E-UTRA carriers, the UE is allowed interruptions on any active serving cell in MCG if UE is not capable of Per-FR gap, or on active serving cell(s) in MCG in FR1 if UE is capable of Per-FR gap, during the switching to the PUSCH-less carrier of a serving cell,

- with up to X2 slot as specified in Table 8.2.3.2.12-1.

When SRS carrier based switching is performed between E-UTRA carriers, the UE is allowed interruptions on any active serving cell in MCG if UE is not capable of Per-FR gap, or on active serving cell(s) in MCG in FR1 if UE is capable of Per-FR gap, during the switching from the PUSCH-less carrier of a serving cell,

- with up to X2 slot as specified in Table 8.2.3.2.12-1

Table 8.2.3.2.12-1: Interruption length X2 (slot)

|  |  |  |
| --- | --- | --- |
|  | NR Slot | Interruption length X2 |
|  | length (ms) | (slots) |
| 0 | 1 | 2 |
| 1 | 0.5 | 3 |
| 2 | 0.25 | 5 |
| 3 | 0.125 | 9 |

##### 8.2.3.2.13 Interruptions due to SCell dormancy

8.2.3.2.13.1 Interruptions due to SCell dormancy switch

When one SCell in MCG is switched from dormancy to non-dormancy or from non-dormancy to dormancy [7] when UE is in DRX active time,

- the UE is allowed an interruption on active serving cell in MCG as defined in clause 8.2.3.2.7, except that the interruption is allowed regardless of which parameters change between the dormant BWP and the non-dormant BWP

- The starting time of interruption shall be within the dormancy switching delay as defined in clause 8.6.2.

When multiple SCells in MCG are switched from dormancy to non-dormancy or vice versa when the UE is in DRX active time, the interruption requirement described above applies for each BWP switch.

8.2.3.2.13.2 Interruptions due to CQI measurements during SCell dormancy

When one or more SCells are in dormancy, the UE is for the purpose of CQI measurements on the dormant SCell(s) allowed to cause interruptions to non-dormant serving cell(s).

The rate of ACK/NACK feedback loss on any non-dormant serving cell resulting from CQI measurements on dormant SCells shall not exceed 0.5%.

8.2.3.2.13.3 Interruptions due to RRM measurements during SCell dormancy

When one or more SCells are in dormancy, the UE is for the purpose of RRM measurements on the dormant SCell(s) allowed to cause interruptions to non-dormant serving cell(s).

The rate of ACK/NACK feedback loss on any non-dormant serving cell resulting from RRM measurements on dormant SCells shall not exceed 1.0%.

##### 8.2.3.2.14 Interruptions when identifying CGI of an NR cell with autonomous gaps

When a UE is identifying CGI of an NR cell with autonomous gaps, the UE is allowed interruptions on PCell or any activated SCell:

- with up to K1 interruptions with interrupted slots up to interruption length X1 specified in Table 8.2.3.2.14-1 for each interruption during MIB decoding time period TMIB (ms) specified in clause 9.11.

- with up to L1 interruptions with interrupted slots up to interruption length Y1 specified in Table 8.2.3.2.14-1 for each interruption during SIB1 decoding time period TSIB1 (ms) specified in clause 9.11 for SSB and CORESET for RMSI scheduling multiplexing patterns 1.

- with up to L2 interruptions with interrupted slots up to interruption length Y2 specified in Table 8.2.3.2.14-1 for each interruption during SIB1 decoding time period TSIB Where:

- K1 = 6 for the target cell carrier frequency on FR1 and K1 = 25 for the target cell carrier frequency on FR2, and

- L1 = TSIB1/20, and

- L2 = TSIB1/TSMTC, where TSMTC is the periodicity of the SMTC occasion configured for the target cell carrier.

Table 8.2.3.2.14-1: Interruption length X1, Y1 and Y2 during measurements with autonomous gaps

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) of victim cell | Interruption length X1 (slots) | Interruption length Y1 (slots) | Interruption length Y2 (slots) |
| 0 | 1 | 6 | 7 | 6 |
| 1 | 0.5 | 12 | 13 | 10 |
| 2 | 0.25 | 24 | 25 | 19 |
| 3 | 0.125 | 48 | 49 | 37 |

##### 8.2.3.2.15 Interruptions when identifying CGI of an E-UTRA cell with autonomous gaps

When a UE is identifying CGI of an E-UTRA FDD cell or E-UTRA TDD cell with autonomous gaps, within time period

- Tidentify\_CGI, intra specified in clause 8.1.2.2.3, or clause 8.1.2.2.4 in TS 36.133 [15], or

- Tidentify\_CGI, inter specified in clause 8.1.2.3.5, or clause 8.1.2.3.6, or clause 8.1.2.3.7, or clause 8.1.2.3.6 in TS 36.133 [15], or

- Tidentify\_CGI, E-UTRA specified in clause 9.4.7.1

the UE shall be able to transmit at least the number of ACK/NACKs specified in Table 8.2.3.2.15-1 on PCell or any activated SCell in the frequency range where autonomous gaps are used, 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 slot,

- 2 slot ACK/NACK feedback is configured,

- 20 ms SMTC period is configured.

Table 8.2.3.2.15-1: Minimum number of ACK/NACKs transmitted by the UE

|  |  |  |
| --- | --- | --- |
| Minimum number of transmitted ACK/NACKs | Configuration of the serving cell in which the transmitted ACK/NACKs are counted | |
|  | Duplex mode configuration | SCS |
| 84 | FDD | 15 kHz |
| 193 | FDD | 30 kHz |
| 402 | FDD | 60 kHz |
| 28 | TDD Note 1 | 15 kHz |
| 81 | TDD Note 1 | 30 kHz |
| 159 | TDD Note 1 | 60 kHz |
| 233 | TDD Note 2 | 60 kHz |
| 491 | TDD Note 2 | 120 kHz |
| NOTE 1: TDD UL-DL configuration is as specified in Table A.3.3.1-1 of TS 38.101-1 [18].  NOTE 2: TDD UL-DL configuration is as specified in Table A.3.3.1-1 of TS 38.101-2 [19]. | | |

8.2.3.2.16 Interruptions at NR SRS antenna port switching

The requirements in this clause are applicable to SRS antenna port switching on FR1 and SRS resource(s) is only configured within the last 6 symbols of a slot. For interruption caused by SRS antenna port switching, the victim cell is based on the entry number of the band indicated by *txSwitchImpactToRx* and/or *txSwitchWithAnotherBand* regardless of per-FR MG capability. An UL interruption is allowed on any of the serving cells as indicated in *txSwitchWithAnotherBand*, and a DL interruption is allowed on any of the serving cells as indicated in *txSwitchImpactToRx*.

The UE shall perform SRS antenna port switching only if the below conditions are met.

- the SRS switching is not colliding with any other UL transmission with higher priority defined in TS 38.214 [26] if the serving cell on which the higher priority transmission is performed is a victim cell based on *txSwitchWithAnotherBand* or is the same carrier on which SRS is transmitted.

- the SRS switching is not colliding with any NR measurements (i.e. SSB/CSI-RS based L1/L3 measurements) and the measurements for RLM/BFD/CBD if the serving cell on which the NR measurements and the measurements for RLM/BFD/CBD is performed is a victim cell based on *txSwitchImpactToRx* or is the same carrier on which SRS is transmitted.

No requirements are defined for SRS antenna port switching if aperiodic SRS switching is colliding with aperiodic L1-RSRP/L1-SINR measurements and the serving cell on which the aperiodic L1-RSRP/L1-SINR measurement is configured is indicated in *txSwitchImpactToRx* or is the same carrier on which aperiodic SRS is scheduled/configured.

No requirements apply when SRS antenna port switching is colliding with E-UTRA measurement if the carrier on which the E-UTRA measurement is performed is indicated in *txSwitchImpactToRx* or is the same carrier on which SRS is scheduled/configured.

When 1 SRS symbol is configured in a slot for SRS antenna switching and the aggressor and victim cells are synchronized, the interruption requirement in Table 8.2.3.2.16-1 applies. When 1 SRS symbol is configured in a slot for SRS antenna switching and the aggressor and victim cells are asynchronized, the interruption requirement in Table 8.2.3.2.16-2 applies. For the rest of SRS configurations, the interruption requirement in Table 8.2.3.2.16-3 applies.

Table 8.2.3.2.16-1: Interruption length in symbols of victim CC when 1 SRS symbol is configured, and aggressor and victim cells are synchronized

|  |  |  |  |
| --- | --- | --- | --- |
| **Victim cell SCS(kHz)** | **Aggressor cell SCS (kHz)** | | |
| **15** | **30** | **60** |
| 15 | 3 | 2 | 2 |
| 30 | 4 | 3 | 3 |
| 60 | 8 | 6 | 5 |
| 120 | 14 | 10 | 8 |

Table 8.2.3.2.16-2: Interruption length in slots of victim CC when 1 SRS symbol is configured, and aggressor and victim cells are asynchronized

|  |  |  |  |
| --- | --- | --- | --- |
| **Victim cell SCS(kHz)** | **Aggressor cell SCS (kHz)** | | |
| **15** | **30** | **60** |
| 15 | 2 | 2 | 2 |
| 30 | 2 | 2 | 2 |
| 60 | 2 | 2 | 2 |
| 120 | 2 | 2 | 2 |

Table 8.2.3.2.16-3: Interruption length in slots of victim CC for rest of the SRS configurations for synchronised and asynchronized scenarios

|  |  |  |  |
| --- | --- | --- | --- |
| **Victim cell SCS(kHz)** | **Aggressor cell SCS (kHz)** | | |
| **15** | **30** | **60** |
| 15 | 2 | 2 | 2 |
| 30 | 2 | 2 | 2 |
| 60 | 3 | 2 | 2 |
| 120 | 5 | 3 | 3 |

##### 8.2.3.2.17 Interruptions at fast SCell activation

The requirements in this clause shall apply for the UE configured with E-UTRA PSCell and one SCell in MCG when aperiodic CSI-RS resources is configured for fast SCell activation.

When one SCell in MCG configured with aperiodic CSI-RS resources is configured for fast SCell activation is activated from deactivated, the UE is allowed:

- the UE is allowed an interruption on any serving cell in MCG:

- of up to X2 slots, if the active serving cell is not in the same band as any of the SCells being activated, or

- of up to Y2 slots + TATRS\_duration if the active serving cells are in the same band as any of the SCells being activated, when

- SCell to be activated is known and belongs to FR1, if the measurement period of the SCell being activated is larger than [2400ms], or

- SCell is unknown and belongs to FR1, and SCell is contiguous to an active serving cell in the same band

- of up to Y2 slot if the active serving cells are in the same band as any of the SCells being activated, when

- SCell to be activated is known and belongs to FR1, if the measurement period of the SCell being activated is equal to or smaller than [2400ms], or

- SCell to be activated belongs to FR2

Where

- TATRS\_duration is CSI-RS burst for SCell activation where the CSI-RS burst is defined as four CSI-RS resources in two consecutive slots on the being activated SCell.

- X2 and Y2 are specified in Table 8.2.3.2.4-2.

##### 8.2.3.2.18 Interruptions due to UE-specific CBW change

The requirements in clause 8.2.1.2.11 apply for this clause.

##### 8.2.3.2.19 Interruptions due to PUCCH SCell activation/deactivation

When one SCell in MCG configured with PUCCH is activated or deactivated,

The UE is allowed an interruption on active serving cell in MCG as defined in clause 8.2.3.2.4.

- The starting time of interruption shall be within the delay as defined in clause 8.3.12.

- For inter-band CA, if the UE is not capable of *parallelTxPRACH-SRS-PUCCH-PUSCH*, additional interruption is allowed on SRS/PUCCH/PUSCH of active serving cells when colliding with RACH transmission on PUCCH SCell. Interruption occurs on the symbols containing SRS/PUCCH/PUSCH, which overlap with the duration of the PRACH preamble [3] transmitted on the PUCCH SCell.

### 8.2.4 NR-DC: Interruptions

#### 8.2.4.1 Introduction

This clause contains the requirements related to the interruptions on PCell, PSCell and activated SCell if configured, when

up to 1 SCell in FR1 and up to 7 SCell(s) in FR2 are configured, deconfigured, activated or deactivated or,

a supplementary UL carrier or an UL carrier is configured or de-configured, or

measurements on SCC with deactivated SCell in NR SCG, or

measurements on the deactivated PSCell in NR SCG, or

UL/DL BWP is switched on PCell, PSCell or SCell,

UE-specific CBW is changed on PCell, PSCell or SCell, or

transitions between active and non-active during DRX, or

transitions from non-DRX to DRX, or

CGI reading of an NR neighbour cell with autonomous gaps, or

CGI reading of an E-UTRA neighbour cell with autonomous gaps.

NR SRS carrier based switching, or

NR SRS antenna port switching.

RLM/BFD Measurement on deactivatd NR PSCell, or

NR SCell is activated based on aperiodic CSI-RS.

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

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.

The requirements shall apply for NR-DC with an NR PCell, PSCell or SCell.

For a UE which does not support per-FR measurement gap, interruptions to the PCell and activated SCell may be caused by SCells on any frequency range. For a UE which supports per-FR gaps, interruptions to PCell, PSCell and activated SCell may be caused by SCells on the same frequency range as the victim cell.

#### 8.2.4.2 Requirements

##### 8.2.4.2.1 Interruptions at PSCell/SCell addition/release

When PSCell or one or more SCells is added or released using the same *RRCConnectionReconfiguration* message as defined in TS 38.331 [2], the UE is allowed an interruption on any activated serving cell during the RRC reconfiguration procedure as follows:

- an interruption on any active serving cell:

- of up to the duration shown in table 8.2.4.2.1-1, if the active serving cell is not in the same band as the PSCell or SCell being added or released, where the requriements for Sync apply for synchronous NR-DC, and for asynchronous NR-DC if the active serving cell is in the same CG as the PSCell or SCell being added or released, and the requriements for Async apply for asynchronous NR-DC if the active serving cell is not in the same CG as the PSCell or SCell being added or released, or

- of up to the duration shown in table 8.2.4.2.1-2, if the active serving cells are in the same band as the SCell being added or released, provided the cell specific reference signals from the active serving cells and the SCell being added or released are available in the same slot.

Table 8.2.4.2.1-1: Interruption duration for PSCell/SCell addition/release for inter-band DC/CA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) | Interruption length (slots) | | |
|  | of victim cell | Sync | | Async |
| 0 | 1 | 1 | | 2 |
| 1 | 0.5 | 2 | | 3 |
| 2 | 0.25 | Both aggressor cell and victim cell are on FR2 | 4 | 5 |
|  |  | Either aggressor cell or victim cell is on FR1 | 5 |  |
| 3 | 0.125 | Aggressor cell is on FR2 | 8 | 9 |
|  |  | Aggressor cell is on FR1 | 9 |  |
| 5 | 0.03125 | Aggressor cell is on FR1 | 33 | 33 |
| 6 | 0.015625 | Aggressor cell is on FR1 | 65 | 65 |

Table 8.2.4.2.1-2: Interruption duration for SCell addition/release for intra-band DC/CA

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Interruption length (slots) |
| 0 | 1 | 1 + TSMTC\_duration \* |
| 1 | 0.5 | 2 + TSMTC\_duration \* |
| 2 | 0.25 | 4 + TSMTC\_duration \* |
| 3 | 0.125 | 8 + TSMTC\_duration \* |
| 5 | 0.03125 | 32+ TSMTC\_duration \* |
| 6 | 0.015625 | 64+ TSMTC\_duration \* |
| NOTE 1: TSMTC\_duration measured in subframes is  - the longest SMTC duration among all above activeserving cells and the SCell being added when one SCell is added. If SSB configuration (*absoluteFrequencySSB*) but no SMTC configuration is provided for the SCell being added, the SSB transmission periodicity is assumed to be 5ms and TSMTC duration for the SCell being added is x ms, where x = the number of consecutive subframes containing all SSBs in one SSB burst transmitted by the SCell being added. If no SSB configuration (*absoluteFrequencySSB*) nor SMTC configuration is provided for the SCell being added, TSMTC duration for the SCell being added is 0ms;  - the longest SMTC duration among all active serving cells in the same band when one SCell is released.  NOTE 2: is as defined in TS 38.211 [6]. | | |

##### 8.2.4.2.2 Interruptions at SCell activation/deactivation

When a SCell is activated or deactivated as defined in TS 37.340 [17], the UE is allowed

- an interruption on any active serving cell:

- of up to the duration shown in table 8.2.4.2.2-1, if the active serving cell is not in the same band as any of the SCells being activated or deactivated, where the requriements for Sync apply for synchronous NR-DC, and for asynchronous NR-DC if the active serving cell is in the same CG as all the SCells being activated, and the requriements for Async apply for asynchronous NR-DC if the active serving cell is not in the same CG as any of the SCells being activated, or

- of up to the duration shown in table 8.2.4.2.2-2, if the active serving cells are in the same band as any of the SCells being activated or deactivated provided the cell specific reference signals from the active serving cells and the SCells being activated or deactivated are available in the same slot.

Table 8.2.4.2.2-1: Interruption duration for SCell activation/deactivation for inter-band DC/CA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length | Interruption length (slots) | | |
|  | (ms) of victim cell | Sync | | Async |
| 0 | 1 | 1 | | 2 |
| 1 | 0.5 | 1 | | 2 |
| 2 | 0.25 | Both aggressor cell and victim cell are on FR2 | 2 | 3 |
|  |  | Either aggressor cell or victim cell is on FR1 | 3 |  |
| 3 | 0.125 | Aggressor cell is on FR2 | 4 | 5 |
|  |  | Aggressor cell is on FR1 | 5 |  |
| 5 | 0.03125 | Aggressor cell is on FR1 | 17 | 17 |
| 6 | 0.015625 | Aggressor cell is on FR1 | 33 | 33 |

Table 8.2.4.2.2-2: Interruption duration for SCell activation/deactivation for intra-band DC/CA

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Interruption length (slots) |
| 0 | 1 | 1 + TSMTC\_duration \* |
| 1 | 0.5 | 1 + TSMTC\_duration \* |
| 2 | 0.25 | 2 + TSMTC\_duration \* |
| 3 | 0.125 | 4 + TSMTC\_duration \* |
| 5 | 0.03125 | 16+ TSMTC\_duration \* |
| 6 | 0.015625 | 32+ TSMTC\_duration \* |
| NOTE 1: TSMTC\_duration measured in subframes is  - the longest SMTC duration among all above active serving cells and the SCell being activated when one SCell is activated. If SSB configuration (*absoluteFrequencySSB*) but no SMTC configuration is provided for the SCell being activated, the SSB transmission periodicity is assumed to be 5ms and TSMTC duration for the SCell being activated is x ms, where x = the number of consecutive subframes containing all SSBs in one SSB burst transmitted by the SCell being activated. If no SSB configuration (*absoluteFrequencySSB*) nor SMTC configuration is provided for the SCell being activated, TSMTC duration for the SCell being activated is 0ms;  - the longest SMTC duration among all active serving cells in the same band when one SCell is deactivated.  NOTE 2: is as defined in TS 38.211 [6]. | | |

##### 8.2.4.2.3 Interruptions during measurements on SCC

Interruption on PCell, PSCell and other activated 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 SpCell.

##### 8.2.4.2.4 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-DC as defined in TS 38.331 [2].

When an UL carrier or supplementary UL carrier is configured or de-configured, an interruption of up to the duration shown in table 8.2.4.2.4-1, is allowed during the RRC reconfiguration procedure in TS38.331 [2] on all the other activated serving cells within the same FR as the reconfigured uplink carrier. The interruption is for both uplink and downlink of all the other serving cells within the same FR as the configured or de-configured UL.

Table 8.2.4.2.4-1: Interruption duration for UL carrier RRC reconfiguration

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Interruption length (slots) |
| 0 | 1 | 1 |
| 1 | 0.5 | 2 |
| 2 | 0.25 | 4 |
| 3 | 0.125 | 8 |
| 5 | 0.03125 | 32 |
| 6 | 0.015625 | 64 |

##### 8.2.4.2.5 Interruptions due to Active BWP switching Requirement

The requirements for DCI-based BWP switch, timer-based BWP switch or UL BWP switch triggered by consistent uplink CCA failures in this clause apply to the case that the BWP switch is performed on a single CC or multiple CCs.

When either of the DCI-based, timer-based or RRC-based downlink BWP switch and/or uplink BWP switch occur on multiple CCs simultaneously or over partially overlapping period, the interruption requirements described in this clause apply for each BWP switch.

When UE receives a DCI indicating the UE to switch its active BWP, or when a BWP timer bwp-InactivityTimer defined in TS 38.331 [2] expires, or when the UE receives an RRC command indicating the UE to switch its active BWP or when UL BWP switch is triggered by consistent uplink CCA failures,, the UE is allowed to cause an interruption on any other serving cells as defined in clause 8.2.2.2.5. In addition to what is defined in 8.2.2.5, when RRC-based BWP switch occurs on multiple CCs over partially overlapping period, the interruption is only allowed within the delay TRRCprocessingDelay + TWaiting + TBWPswitchDelayRRC + DRRC\*(M-1) as defined in clause 8.6.3A.3. Besides, in asynchronous scenario the UE is allowed an additional interrupt of 1 slot length.

##### 8.2.4.2.6 Interruptions at transitions between active and non-active during DRX

When PCell is in non-DRX and PSCell is in DRX, interruptions on PCell and the activated SCell in MCG if configured due to transitions from active to non-active and from non-active to active during PSCell DRX are allowed with up to 1% probability of missed ACK/NACK when the configured PSCell DRX cycle is less than 640 ms, and 0.625% probability of missed ACK/NACK is allowed when the configured PSCell DRX cycle is 640 ms or longer. Each interruption shall not exceed X slot as defined in table 8.2.4.2.6-1.

When PSCell is in non-DRX and PCell is in DRX, interruptions on PSCell on the activated SCell in SCG if configured due to transitions from active to non-active and from non-active to active during PCell DRX are allowed with up to 1 % probability of missed ACK/NACK when the configured PCell DRX cycle is less than 640 ms, and 0.625% probability of missed ACK/NACK is allowed when the configured PCell DRX cycle is 640 ms or longer. Each interruption shall not exceed X slot as defined in table 8.2.4.2.6-1.

Table 8.2.4.2.6-1: Interruption length X at transition between active and non-active during DRX

|  |  |  |  |
| --- | --- | --- | --- |
|  | NR Slot length (ms) | Interruption length X (slots) | |
|  |  | Sync | Async |
| 0 | 1 | 1 | 2 |
| 1 | 0.5 | 1 | 2 |
| 2 | 0.25 | 3 | |
| 3 | 0.125 | 5 | |
| 5 | 0.03125 | 17 | |
| 6 | 0.015625 | 33 | |

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

##### 8.2.4.2.7 Interruptions at transitions from non-DRX to DRX

Interruption on PCell and the activated SCell in MCG if configured due to PSCell transitions from non-DRX to DRX when PCell is in non-DRX shall not exceed X slots as defined in table 8.2.4.2.6-1.

Interruption on PSCell and the activated SCell in SCG if configured due to PCell transitions from non-DRX to DRX when PSCell is in non-DRX shall not exceed X slots as defined in table 8.2.4.2.6-1.

##### 8.2.4.2.8 Interruptions at SCell activation/deactivation with multiple downlink SCells

The requirements in this clause shall apply for the UE configured with NR-DC and up to 1 downlink SCell in FR1 and up to 7 downlink SCell(s) in FR2.

When multiple SCell are activated or deactivated by one single MAC CE command in MCG or SCG:

- an interruption on any serving cell in MCG or SCG is specified as in clause 8.2.4.2.2.

When multiple SCell are activated or deactivated in both MCG and SCG by two MAC CE commands respectively:

- an interruption on any serving cell in MCG is specified as in clause 8.2.4.2.2, and

- an interruption on any serving cell in SCG is specified as in clause 8.2.4.2.2.

##### 8.2.4.2.9 Interruptions at NR SRS carrier based switching

SRS transmission can be configured on a carrier not configured for PUCCH/PUSCH transmission. When a UE needs to transmit periodic, semi-persistent or aperiodic SRS on a carrier of a serving cell not configured for PUCCH/PUSCH transmission, the UE can perform carrier based switching to one or more carriers not configured for PUCCH/PUSCH transmission from a carrier with PUCCH/PUSCH transmission or from a carrier not configured for PUCCH/PUSCH transmission prior to transmitting SRS, provided that:

- switching is from a configured carrier to another activated carrier;

- the carrier of SCells not configured for PUCCH/PUSCH transmission to which SRS carrier based switching is performed is indicated by DCI SRS request field for aperiodic SRS transmission, or indicated by MAC-CE for semi-persistent SRS transmission, or configured via RRC for periodic SRS transmission;

- the serving cell, from which SRS carrier based switching is performed and whose UL transmission may therefore be interrupted, is indicated by srs-SwitchFromServCellIndex and srs-SwitchFromCarrier in TS38.331 [2];

- the SRS switching is not colliding with any other transmission with higher priority defined in TS 38.214 [26].

- the SRS switching is not colliding with any SSB/CSI-RS based L3 measurements and the measurements for RLM/BFD in the same CG.- for UE, which does not support simultaneous reception and transmission for inter-band TDD CA specified in TS 38.331 [2], and is compliant to the requirements for inter-band CA with uplink in one NR band and without simultaneous Rx/Tx specified in TS 38.101-3 [20], the SRS transmission are not simultaneously scheduled with DL SSB/CSI-RS for L3 or L1 measurements transmission on other carriers.

The UE shall not perform SRS carrier based switching if the above conditions cannot be met.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell if UE is not capable of Per-FR gap, or on active serving cell(s) in FR1 if UE is capable of Per-FR gap, during the switching to the carrier of a serving cell in FR1 not configured for PUCCH/PUSCH transmission,

- with up to X1 slot as specified in Table 8.2.4.2.9-1.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell if UE is not capable of Per-FR gap, or on active serving cell(s) in FR2 if UE is capable of Per-FR gap, during the switching to the carrier of a serving cell in FR2 not configured for PUCCH/PUSCH transmission,

- with up to X2 slot as specified in Table 8.2.4.2.9-2.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell if UE is not capable of Per-FR gap, or on active serving cell(s) in FR1 if UE is capable of Per-FR gap, during the switching from the carrier of a serving cell in FR1 not configured for PUCCH/PUSCH transmission,

- with up to X1 slot as specified in Table 8.2.4.2.9-1.

When SRS carrier based switching is performed between carriers, the UE is allowed interruptions on any active serving cell if UE is not capable of Per-FR gap, or on active serving cell(s) in FR2 if UE is capable of Per-FR gap, during the switching from the carrier of a serving cell in FR2 not configured for PUCCH/PUSCH transmission,

- with up to X2 slot as specified in Table 8.2.4.2.9-2.

Table 8.2.4.2.9-1: Interruption length X1 (slot)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length | SRS carrier | Interruption length X1 (slots) | |
|  | (ms) of victim cell | switching time (us)Note 1 | Sub carrier spacing for agressor cell (kHz) | |
|  |  |  | 15 | 30 |
| 0 | 1 | ≤ 200 | 2 | 2 |
|  |  | 300, 500 | 2 | 2 |
|  |  | 900 | 3 | 3 |
| 1 | 0.5 | ≤ 200 | 3 | 2 |
|  |  | 300, 500 | 3 | 3 |
|  |  | 900 | 4 | 4 |
| 2 | 0.25 | ≤ 200 | 4 | 3 |
|  |  | 300, 500 | 5 | 4 |
|  |  | 900 | 7 | 6 |
| 3 | 0.125 | ≤ 200 | 7 | 5 |
|  |  | 300, 500 | 9 | 7 |
|  |  | 900 | 12 | 10 |
| 5 | 0.03125 | ≤ 200 | 22 | 15 |
|  |  | 300, 500 | 31 | 24 |
|  |  | 900 | 44 | 37 |
| 6 | 0.015625 | ≤ 200 | 42 | 28 |
|  |  | 300, 500 | 61 | 47 |
|  |  | 900 | 87 | 73 |
| Note1: NR SRS carrier switching time is UE capability indicated by higher layer parameter *SRS-SwitchingTimeNR*. | | | | |

Table 8.2.4.2.9-2: Interruption length X2 (slot)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **NR Slot** | **SRS carrie** | **Interruption length X2 (slots)** | | | |
|  | **length (ms) of victim cell** | **switching time (us) Note 1** | **Sub carrier spacing for agressor cell (kHz)** | | | |
|  |  |  | **60** | **120** | **480** | **960** |
| 0 | 1 | ≤ 200 | 2 | 2 | 2 | 2 |
| 1 | 0.5 | ≤ 200 | 2 | 2 | 2 | 2 |
| 2 | 0.25 | ≤ 200 | 3 | 3 | 2 | 2 |
| 3 | 0.125 | ≤ 200 | 4 | 4 | 3 | 3 |
| 5 | 0.03125 | ≤ 200 | 11 | 10 | 8 | 8 |
| 6 | 0.015625 | ≤ 200 | 21 | 18 | 15 | 15 |
| Note1: NR SRS carrier switching time is UE capability indicated by higher layer parameter *SRS-SwitchingTimeNR*. | | | | | | |

For intra-band SRS carrier switching in FR1or FR2, interruptions in Table 8.2.2.2.9-1 and in Table 8.2.2.2.9-2 based on SRS carrier switching time ≤ 200us shall apply. For inter-band SRS carrier switching in FR1, interruptions in Table 8.2.2.2.9-1 and in Table 8.2.2.2.9-2 shall apply.

##### 8.2.4.2.10 Interruptions at direct SCell activation

When one or multiple SCell(s) are directly activated at SCell addition:

- the UE is allowed an interruption on any active serving cell:

- of up to the duration shown in Table 8.2.4.2.1-1, if the active serving cell is not in the same band as the SCell being directly activated, where the requriements for Sync apply for synchronous NR-DC, and for asynchronous NR-DC if the active serving cell is in the same CG as the SCell being directly activated, and the requriements for Async apply for asynchronous NR-DC if the active serving cell is not in the same CG as the SCell being directly activated, or

- of up to the duration shown in Table 8.2.4.2.1-2, if the active serving cells are in the same band as the SCell being directly activated provided the cell specific reference signals from the active serving cells and the SCell being directly activated are available in the same slot.

##### 8.2.4.2.11 Interruptions when identifying CGI of an NR cell with autonomous gaps

When a UE is identifying CGI of an NR cell with autonomous gaps, the UE is allowed interruptions on PCell, PSCell or any activated SCell:

- with up to K1 interruptions with interrupted slots up to interruption length X1 specified in Table 8.2.4.2.11-1 for each interruption during MIB decoding time period TMIB (ms) specified in clause 9.11.

- with up to L1 interruptions with interrupted slots up to interruption length Y1 specified in Table 8.2.4.2.11-1 for each interruption during SIB1 decoding time period TSIB1 (ms) specified in clause 9.11 for SSB and CORESET for RMSI scheduling multiplexing patterns 1.

- with up to L2 interruptions with interrupted slots up to interruption length Y2 specified in Table 8.2.4.2.11-1 for each interruption during SIB1 decoding time period TSIB1 (ms) specified in clause 9.11 for SSB and CORESET for RMSI scheduling multiplexing patterns 2 and 3.

Where:

- K1 = 6 for the target cell carrier frequency on FR1 and K1 = 25 for the target cell carrier frequency on FR2, and

- L1 = TSIB1/20, and

- L2 = TSIB1/TSMTC, where TSMTC is the periodicity of the SMTC occasion configured for the target cell carrier.

Table 8.2.4.2.11-1: Interruption length X1, Y1 and Y2 during measurements with autonomous gaps

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) of victim cell | Interruption length X1 (slots) | Interruption length Y1 (slots) | Interruption length Y2 (slots) |
| 0 | 1 | 6 | 7 | 6 |
| 1 | 0.5 | 12 | 13 | 10 |
| 2 | 0.25 | 24 | 25 | 19 |
| 3 | 0.125 | 48 | 49 | 37 |
| 5 | 0.03125 | 192 | 193 | 145 |
| 6 | 0.015625 | 384 | 385 | 289 |

##### 8.2.4.2.12 Interruptions when identifying CGI of an E-UTRA cell with autonomous gaps

When a UE is identifying CGI of an E-UTRA FDD cell or E-UTRA TDD cell with autonomous gaps, within time period Tidentify\_CGI, E-UTRA specified in clause 9.4.7.1, the UE shall be able to transmit at least the number of ACK/NACKs specified in Table 8.2.4.2.12-1 on PCell, PSCell or any activated SCell in the frequency range where autonomous gaps are used, 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 slot,

- 2 slot ACK/NACK feedback is configured,

- 20 ms SMTC period is configured.

Table 8.2.4.2.12-1: Minimum number of ACK/NACKs transmitted by the UE during Tidentify\_CGI, E-UTRA

|  |  |  |
| --- | --- | --- |
| Minimum number of transmitted ACK/NACKs | Configuration of the serving cell in which the transmitted ACK/NACKs are counted | |
|  | Duplex mode configuration | SCS |
| 84 | FDD | 15 kHz |
| 193 | FDD | 30 kHz |
| 402 | FDD | 60 kHz |
| 28 | TDD Note 1 | 15 kHz |
| 81 | TDD Note 1 | 30 kHz |
| 159 | TDD Note 1 | 60 kHz |
| 233 | TDD Note 2 | 60 kHz |
| 491 | TDD Note 2 | 120 kHz |
| NOTE 1: TDD UL-DL configuration is as specified in Table A.3.3.1-1 of TS 38.101-1 [18].  NOTE 2: TDD UL-DL configuration is as specified in Table A.3.3.1-1 of TS 38.101-2 [19]. | | |

##### 8.2.4.2.13 Interruptions due to SCell dormancy

8.2.4.2.13.1 Interruptions due to SCell dormancy switch

When one SCell in MCG or SCG is switched from dormancy to non-dormancy or from non-dormancy to dormancy [7] when UE is in DRX active time,

- the UE is allowed an interruption on active serving cell in MCG and SCG as defined in clause 8.2.4.2.5, except that the interruption is allowed regardless of which parameters change between the dormant BWP and the non-dormant BWP

- The starting time of interruption shall be within the dormancy switching delay as defined in clause 8.6.2.

When multiple SCells in MCG or SCG are switched from dormancy to non-dormancy or vice versa when the UE is in DRX active time, the interruption requirement described above applies for each BWP switch.

8.2.4.2.13.2 Interruptions due to CQI measurements during SCell dormancy

When one or more SCells are in dormancy, the UE is for the purpose of CQI measurements on the dormant SCell(s) allowed to cause interruptions to non-dormant serving cell(s).

The rate of ACK/NACK feedback loss on any non-dormant serving cell resulting from CQI measurements on dormant SCells shall not exceed 0.5%.

8.2.4.2.13.3 Interruptions due to RRM measurements during SCell dormancy

When one or more SCells are in dormancy, the UE is for the purpose of RRM measurements on the dormant SCell(s) allowed to cause interruptions to non-dormant serving cell(s).

The rate of ACK/NACK feedback loss on any non-dormant serving cell resulting from RRM measurements on dormant SCells shall not exceed 1.0%.

##### 8.2.4.2.14 Interruptions at NR SRS antenna port switching

The requirements in this clause are applicable to SRS antenna port switching on FR1 and SRS resource(s) is only configured within the last 6 symbols of a slot. For interruption caused by SRS antenna port switching, the victim cell is based on the entry number of the band indicated by *txSwitchImpactToRx* and/or *txSwitchWithAnotherBand* regardless of per-FR MG capability. An UL interruption is allowed on any of the serving cells as indicated in *txSwitchWithAnotherBand*, and a DL interruption is allowed on any of the serving cells as indicated in *txSwitchImpactToRx*..

The UE shall perform SRS antenna port switching only if the below conditions are met.

- the SRS switching is not colliding with any other UL transmission with higher priority defined in TS 38.214 [26] if the serving cell on which the higher priority transmission is performed is a victim cell based on *txSwitchWithAnotherBand* or is the same carrier on which SRS is transmitted.

- the SRS switching is not colliding with any NR measurements (i.e. SSB/CSI-RS based L1/L3 measurements) and the measurements for RLM/BFD/CBD if the serving cell on which the NR measurements and the measurements for RLM/BFD/CBD is performed is a victim cell based on *txSwitchImpactToRx* or is the same carrier on which SRS is transmitted.

No requirements are defined for SRS antenna port switching if aperiodic SRS switching is colliding with aperiodic L1-RSRP/L1-SINR measurements and the serving cell on which the aperiodic L1-RSRP/L1-SINR measurement is configured is indicated in *txSwitchImpactToRx* or is the same carrier on which aperiodic SRS is scheduled/configured.

When 1 SRS symbol is configured in a slot for SRS antenna switching and the aggressor and victim cells are synchronized, the interruption requirement in Table 8.2.4.2.14-1 applies. When 1 SRS symbol is configured in a slot for SRS antenna switching and the aggressor and victim cells are asynchronized, the interruption requirement in Table 8.2.4.2.14-2 applies. For the rest of SRS configurations, the interruption requirement in Table 8.2.4.2.14-3 applies.

Table 8.2.4.2.14-1: Interruption length in symbols of victim CC when 1 SRS symbol is configured, and aggressor and victim cells are synchronized

|  |  |  |  |
| --- | --- | --- | --- |
| **Victim cell SCS(kHz)** | **Aggressor cell SCS (kHz)** | | |
| **15** | **30** | **60** |
| 15 | 3 | 2 | 2 |
| 30 | 4 | 3 | 3 |
| 60 | 8 | 6 | 5 |
| 120 | 14 | 10 | 8 |

Table 8.2.4.2.14-2: Interruption length in slots of victim CC when 1 SRS symbol is configured, and aggressor and victim cells are asynchronized

|  |  |  |  |
| --- | --- | --- | --- |
| **Victim cell SCS(kHz)** | **Aggressor cell SCS (kHz)** | | |
| **15** | **30** | **60** |
| 15 | 2 | 2 | 2 |
| 30 | 2 | 2 | 2 |
| 60 | 2 | 2 | 2 |
| 120 | 2 | 2 | 2 |

Table 8.2.4.2.14-3: Interruption length in slots of victim CC for rest of the SRS configurations for synchronised and asynchronized scenarios

|  |  |  |  |
| --- | --- | --- | --- |
| **Victim cell SCS(kHz)** | **Aggressor cell SCS (kHz)** | | |
| **15** | **30** | **60** |
| 15 | 2 | 2 | 2 |
| 30 | 2 | 2 | 2 |
| 60 | 3 | 2 | 2 |
| 120 | 5 | 3 | 3 |

##### 8.2.4.2.15 Interruptions at fast SCell activation

The requirements in this clause shall apply for the UE configured with one SCell when aperiodic CSI-RS resources is configured for fast SCell activation.

When one SCell in MCG or SCG is activated from deactivated, and aperiodic CSI-RS resources is configured for fast SCell activation, the UE is allowed.

- an interruption on any active serving cell:

- of up to the duration shown in table 8.2.4.2.2-1, if the active serving cell is not in the same band as the SCell being activated, where the requriements for Sync apply for synchronous NR-DC, and for asynchronous NR-DC if the active serving cell is in the same CG as the SCell being activated, and the requriements for Async apply for asynchronous NR-DC if the active serving cell is not in the same CG as the SCell being activated, or

- of up to Y2 slots + TATRS\_duration if the active serving cells are in the same band as the SCell being activated, when

- SCell to be activated is known and belongs to FR1, if the measurement period of the SCell being activated is larger than [2400ms], or

- SCell is unknown and belongs to FR1, and SCell is contiguous to an active serving cell in the same band

- of up to Y2 slot if the active serving cells are in the same band as any of the SCells being activated, when

- SCell to be activated is known and belongs to FR1, if the measurement period of the SCell being activated is equal to or smaller than [2400ms], or

- SCell to be activated belongs to FR2

Where

- TATRS\_duration is CSI-RS burst for SCell activation where the CSI-RS burst is defined as four CSI-RS resources in two consecutive slots on the being activated SCell.

- Y2 are specified in Table 8.2.3.2.4-2.

##### 8.2.4.2.16 Interruptions at SCG activation/deactivation

When SCG is activated or deactivated using an *RRCConnectionReconfiguration* message as defined in TS 38.331 [2], the UE is allowed an interruption on any activated serving cell in MCG during the RRC reconfiguration procedure as follows:

- an interruption on any active serving cell in MCG:

- of up to the duration shown in table 8.2.4.2.16-1, if the active serving cell is not in the same band as the PSCell being activated or deactivated, where the requriements for Sync apply for synchronous NR-DC. The requriements for Async apply for asynchronous NR-DC.

Table 8.2.4.2.16-1: Interruption duration for SCG activation/deactivation for inter-band DC/CA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) | Interruption length (slots) | | |
|  | of victim cell | Sync | | Async |
| 0 | 1 | 1 | | 2 |
| 1 | 0.5 | 2 | | 3 |
| 2 | 0.25 | Both aggressor cell and victim cell are on FR2 | 4 | 5 |
|  |  | Either aggressor cell or victim cell is on FR1 | 5 |  |
| 3 | 0.125 | Aggressor cell is on FR2 | 8 | 9 |
|  |  | Aggressor cell is on FR1 | 9 |  |

##### 8.2.4.2.17 Interruptions due to RRM measurements on deactivated SCG

If the UE is not configured with RLM or BFD on the deactivated PSCell, interruptions on PCell or activated SCell(s) due to measurements on the deactivated PSCell are allowed with up to 0.5% probability of missed ACK/NACK feedback when the configured *measCyclePSCell* is 640ms or longer. The UE is only allowed to cause interruptions on PCell or activated SCell(s) immediately before and immediately after an SMTC. Each interruption shall not exceed requirement in Table 8.2.2.2.2-1.

If the UE is configured with RLM or BFD on the deactivated PSCell, the rate of ACK/NACK feedback loss on any active serving cell resulting from RRM measurements on the deactivated PSCell shall not exceed 1.0%.

##### 8.2.4.2.18 Interruptions during RLM/BFD measurements on deactivated PScell

When PSCell is configured with *bfd-and-RLM* with value *true*, if NR PScell is deactivated, the UE is for the purpose RLM/BFD measurements on the deactivated PSCell allowed to cause interruptions to activated serving cell(s) which can either be Pcell or Scell in MCG.

The rate of ACK/NACK feedback loss on any activated serving cell resulting from RLM/BFD measurements on deactivated PSCell shall not exceed 0.5%.

##### 8.2.4.2.19 Interruptions due to UE-specific CBW change

The requirements in clause 8.2.2.2.8 apply for this clause.

#### 8.2.4.2A Void

##### 8.2.4.2A.1 Void

##### 8.2.4.2A.2 Void

##### 8.2.4.2A.3 Void

## 8.3 SCell Activation and Deactivation Delay

### 8.3.1 Introduction

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

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

### 8.3.2 SCell Activation Delay Requirement for Deactivated SCell

The requirements in this clause shall apply for the UE configured with one downlink SCell in EN-DC, or in standalone NR carrier aggregation or in NE-DC or in NR-DC and when one SCell is being activated.

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 , where:

THARQ (in ms) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3]

Tactivation\_time is the SCell activation delay in millisecond.

If the SCell is known and belongs to FR1, Tactivation\_time is:

- TFirstSSB+ 5ms, if the measurement period of the SCell being activated is equal to or smaller than 2400ms.

- TFirstSSB\_MAX + Trs + 5ms, if the measurement period of the SCell being activated is larger than 2400ms.

If the SCell is unknown and belongs to FR1, and if one of the following conditions is met

- ‘ssb-PositionInBurst’ indicates only one SSB is being actually transmitted, or

- ‘ssb-PositionInBurst’ indicates multiple SSBs and TCI indication is provided in same MAC PDU with SCell activation,

provided that the side condition Ês/Iot ≥ -2dB is fulfilled, Tactivation\_time is:

- TFirstSSB\_MAX + TSMTC\_MAX + Trs + 5ms, if the following conditions are met,

- the SCell is contiguous to an active serving cell in the same band, and

- its *ssb-PositionInBurst* is same as the one of contiguous FR1 active serving cell, and

- its SMTC offset is same as the one of contiguous FR1 active serving cell, and

- its RTD with contiguous FR1 active serving cell is smaller than or equal to 260ns with respect to the to-be-activated SCell’s SSB numerology, and its reception power difference with contiguous FR1 active serving cell is smaller than or equal to 6dB;

- TFirstSSB\_MAX + TSMTC\_MAX + 2\*Trs + 5ms, otherwise.

otherwise, provided that the side condition Ês/Iot ≥ -2dB is fulfilled, Tactivation\_time is:

- 6ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + TL1-RSRP,measure + TL1-RSRP,report + THARQ + max(Tuncertainty\_MAC + TFineTiming + 2ms, Tuncertainty\_SP), if semi-persistent CSI-RS is used for CSI reporting,

- 3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + TL1-RSRP,measure + TL1-RSRP,report + max(THARQ + Tuncertainty\_MAC + 5ms + TFineTiming, Tuncertainty\_RRC + TRRC\_delay), if periodic CSI-RS is used for CSI reporting.

- However, when the following conditions are fulfilled, no activation requirement will be applied for this unknown SCell:

- the SCell is contiguous to an active serving cell in the same band, and

- A single SSB is used in the unknown SCell; or multiple SSBs are used in the SCell and TCI state indication for PDCCH is provided by the same MAC PDU used for SCell activation; and

- its *ssb-PositionInBurst* is same as the one of contiguous FR1 active serving cell, and

- its SMTC offset is same as the one of contiguous FR1 active serving cell

- its RTD with contiguous FR1 active serving cell is larger than 260ns with respect to the to-be-activated SCell’s SSB numerology, or its reception power difference with contiguous FR1 active serving cell is larger than 6dB;

If the SCell being activated belongs to FR1 and if there is at least one active serving cell contiguous to the SCell on that FR1 band, if the UE is not provided with SSB configuration (*absoluteFrequencySSB*) nor SMTC configuration for the target SCell, Tactivation\_time is 3 ms for UE supporting *scellWithoutSSB*, provided

- The RTD between the target SCell and the contiguous active serving cell is within within ±260ns, and

- The difference of the reception power with the contiguous active serving cell is <= 6dB, and

- The RS(s) of SCell being activated is (are) QCL-TypeA with TRS(s) of the SCell being activated, and the TRS(s) of the SCell being activated is (are) further QCL-TypeC with SSB(s) of any active serving cell that is contiguous to the SCell being activated on that FR1 band.

If the SCell being activated belongs to FR2 and if there is at least one active serving cell on that FR2 band, then Tactivation\_time is TFirstSSB+ 5ms provided:

- The UE is provided with SMTC for the target SCell, and

- The SSBs in the serving cell(s) and the SSBs in the SCell fulfil the condition defined in clause 3.6.3, and

- The parameter ssb-PositionsInBurst is same for the serving cell(s) and the Scell, and

- SSB is in the same half-frame on the SCell and the contiguous FR2 active serving cell.

If the SCell being activated belongs to FR2 and if there is at least one active serving cell on that FR2 band, if the UE supporting *scellWithoutSSB* is not provided with any SMTC for the target SCell, Tactivation\_time is 3 ms, provided

- the RS (s) of SCell being activated is (are) QCL-TypeD with RS (s) of one active serving cell on that FR2 band.

If the SCell being activated belongs to FR2 and if there is no active serving cell on that FR2 band provided that PCell or PSCell is in FR1 or in FR2:

If the target SCell is known to UE and semi-persistent CSI-RS is used for CSI reporting, then Tactivation\_time is:

- 3ms + max(Tuncertainty\_MAC + TFineTiming + 2ms, Tuncertainty\_SP), where Tuncertainty\_MAC=0 and Tuncertainty\_SP=0 if UE receives the SCell activation command, semi-persistent CSI-RS activation command and TCI state activation command at the same time.

If the target SCell is known to UE and periodic CSI-RS is used for CSI reporting, then Tactivation\_time is:

- max(Tuncertainty\_MAC + 5ms + TFineTiming, Tuncertainty\_RRC + TRRC\_delay-THARQ), where Tuncertainty\_MAC=0 if UE receives the SCell activation command and TCI state activation commands at the same time.

If the PCell/PSCell and the target SCell are configured as FR1-FR2-1 CA or if the PCell/PSCell and the target SCell are in a FR2-1 band pair with independent beam management, and the target SCell is unknown to UE and semi-persistent CSI-RS is used for CSI reporting, provided that the side condition Ês/Iot ≥ -2dB is fulfilled, then Tactivation\_time is:

- 6ms + TFirstSSB\_MAX + 15\*TSMTC\_MAX + 8\*Trs + TL1-RSRP, measure + TL1-RSRP, report + THARQ + max(Tuncertainty\_MAC + TFineTiming + 2ms, Tuncertainty\_SP).

If the PCell/PSCell and the target SCell are configured as FR1-FR2-2 CA or if the PCell/PSCell and the target SCell are in a FR2-2 band pair with independent beam management, and the target SCell is unknown to UE and semi-persistent CSI-RS is used for CSI reporting, provided that the side condition Ês/Iot ≥ -2dB is fulfilled, then Tactivation\_time is:

- 6ms + TFirstSSB\_MAX + 23\*TSMTC\_MAX + 12\*Trs + TL1-RSRP, measure + TL1-RSRP, report + THARQ + max(Tuncertainty\_MAC + TFineTiming + 2ms, Tuncertainty\_SP).

If the PCell/PSCell and the target SCell are configured as FR1-FR2-1 CA or if the PCell/PSCell and the target SCell are in a FR2-1 band pair with independent beam management, and the target SCell is unknown to UE and periodic CSI-RS is used for CSI reporting, provided that the side condition Ês/Iot ≥ -2dB is fulfilled, then Tactivation\_time is:

- 3ms + TFirstSSB\_MAX + 15\*TSMTC\_MAX + 8\*Trs + TL1-RSRP, measure + TL1-RSRP, report + max {(THARQ + Tuncertainty\_MAC + 5ms + TFineTiming), (Tuncertainty\_RRC + TRRC\_delay)}.

If the PCell/PSCell and the target SCell are configured as FR1-FR2-2 CA or if the PCell/PSCell and the target SCell are in a FR2-2 band pair with independent beam management, and the target SCell is unknown to UE and periodic CSI-RS is used for CSI reporting, provided that the side condition Ês/Iot ≥ -2dB is fulfilled, then Tactivation\_time is:

- 3ms + TFirstSSB\_MAX + 23\*TSMTC\_MAX + 12\*Trs + TL1-RSRP, measure + TL1-RSRP, report + max {(THARQ + Tuncertainty\_MAC + 5ms + TFineTiming), (Tuncertainty\_RRC + TRRC\_delay)}.

where,

TSMTC\_MAX:

- In FR1, in case of intra-band SCell activation, TSMTC\_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, TSMTC\_MAX is the SMTC periodicity of SCell being activated.

- In FR2, in case of intra-band SCell activation, TSMTC\_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; in case of FR2 inter-band SCell activation, TSMTC\_MAX is the SMTC periodicity of SCell being activated.

- TSMTC\_MAX is bounded to a minimum value of 10ms.

Trs is the SMTC periodicity of the SCell being activated if the UE has been provided with an SMTC configuration for the SCell in SCell addition message, otherwise Trs is the SMTC configured in the measObjectNR having the same SSB frequency and subcarrier spacing. If the measObjectNRs having the same SSB frequency and subcarrier spacing configured by MN and SN have different SMTC, Trs is the periodicity of one of the SMTC which is up to UE implementation. If the UE is not provided SMTC configuration or measurement object on this frequency, the requirement which involves Trs is applied with Trs = 5ms assuming the SSB transmission periodicity is 5ms. There are no requirements if the SSB transmission periodicity is not 5ms

TFirstSSB: is the time to the end of the first complete SSB burst indicated by the SMTC, or within 5ms if SMTC is not configured, after slot n + .

TFirstSSB\_MAX: Is the time to the end of the first complete SSB burst indicated by the SMTC, or within 5ms if SMTC is not configured, after slot n + , further fulfilling:

- In FR1, in case of intra-band SCell activation, the occasion when all active serving cells and SCells being activated or released are transmitting SSB bursts in the same slot; in case of inter-band SCell activation, the first occasion when the SCell being activated is transmitting SSB burst.

- In FR2, the occasion when all active serving cells and SCells being activated or released are transmitting SSB bursts in the same slot.

TFineTiming is the time period between UE finish processing the last activation command for PDCCH TCI, PDSCH TCI (when applicable) and the timing of first complete available SSB corresponding to the TCI state.

TL1-RSRP, measure is L1-RSRP measurement delay TL1-RSRP\_Measurement\_Period\_SSB msor TL1-RSRP\_Measurement\_Period\_CSI-RS based on applicability as defined in clause 9.5 assuming M=1 and TReport=0.

TL1-RSRP, report is delay of acquiring CSI reporting resources.

Tuncertainty\_MAC is the time period between reception of the last activation command for PDCCH TCI, PDSCH TCI (when applicable) relative to

- SCell activation command for known case;

- First valid L1-RSRP reporting for unknown case.

Tuncertainty\_RRC is the time period between reception of the RRC configuration message for TCI of periodic CSI-RS for CQI reporting (when applicable) relative to

- SCell activation command for known case;

- First valid L1-RSRP reporting for unknown case.

Tuncertainty\_SP is the time period between reception of the activation command for semi-persistent CSI-RS resource set for CQI reporting relative to

- SCell activation command for known case;

- First valid L1-RSRP reporting for unknown case.

TRRC\_delay is the RRC procedure delay as specified in TS38.331 [2].

Longer delays for RRM measurement requirements, and in case of FR2 also SSB based RLM/BFD/CBD/L1-RSRP measurement requirements, can be expected during the cell detection time for unknown SCell activation.

When *absoluteFrequencySSB* is not configured in *DownlinkConfigCommon* for target SCell but SMTC for target SCell is configured, no requirement would be applied.

TCSI\_reporting is the delay (in ms) including uncertainty in acquiring the first available downlink CSI reference resource, UE processing time for CSI reporting and uncertainty in acquiring the first available CSI reporting resources as specified in TS 38.331 [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 clause 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 clause 9.2 and 9.3.

Otherwise SCell in FR1 is unknown.

For the first SCell activation in FR2 bands, the SCell is known if it has been meeting the following conditions:

- During the period equal to 4s for UE supporting power class 1/5 and 3s for UE supporting power class 2/3/4 before UE receives the last activation command for PDCCH TCI, PDSCH TCI (when applicable) and semi-persistent CSI-RS for CQI reporting (when applicable):

- the UE has sent a valid L3-RSRP measurement report with SSB index, and

- SCell activation command is received after L3-RSRP reporting and no later than the time when UE receives MAC-CE command for TCI activation

- During the period from L3-RSRP reporting to the valid CQI reporting, the reported SSBs with indexes remain detectable according to the cell identification conditions specified in clauses 9.2 and 9.3, and the TCI state is selected based on one of the latest reported SSB indexes.

Otherwise, the first SCell in FR2 band is unknown. The requirement for unknown SCell applies provided that the activation commands for PDCCH TCI, PDSCH TCI (when applicable), semi-persistent CSI-RS for CQI reporting (when applicable), and configuration message for TCI of periodic CSI-RS for CQI reporting (when applicable) are based on the latest valid L1-RSRP reporting.

If the UE has been provided with higher layer in TS 38.331 [2] signaling of *smtc2*prior to the activation command, TSMTC\_Scell follows *smtc1* or *smtc2* according to the physical cell ID of the target cell being activated. TSMTC\_MAX follows *smtc1* or *smtc2* according to the physical cell IDs of the target cells being activated and the active serving cells.

In addition to CSI reporting defined above, UE shall also apply other actions related to the activation command specified in TS 38.331 [2] for a SCell at the first opportunities for the corresponding actions once the SCell is activated.

The starting point of an interruption window on spCell or any activated SCell, as specified in clause 8.2, shall not occur before slot n+1+ and not occur after slot slot n+1+, where NR slot length is with respect to the numerology used in the SCell being activated, and TX is:

- 0, if Tactivation\_time is 3ms;

- TFirstSSB, for any scenario where Tactivation\_time includes TFirstSSB;

- TFirstSSB\_MAX, for any scenario where Tactivation\_time includes TFirstSSB\_MAX;

- Tuncertainty\_MAC +TFineTiming, for any scenario where Tactivation\_time includes only TFineTiming and no TFirstSSB\_MAX.

The length of the interruption window may be different for different victim cells, and depends on the applicable scenario and on the frequency band relation between the aggressor cell and the victim cell.

The requirements in this clause and requriements on interruption due to SCell activation in clause 8.2 apply provided that the SSB of the to-be-activated SCell is within the first active DL BWP of the Scell.

Starting from the slot specified in clause 4.3 of TS 38.213 [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.

Starting from the slot specified in clause 4.3 of TS 38.213 [3] (timing for secondary Cell activation/deactivation) and until the UE has completed a first L1-RSRP measurement, the UE shall report lowest valid L1 SS-RSRP range if the UE has available uplink resources to report L1-RSRP for the SCell.

### 8.3.3 SCell Deactivation Delay Requirement for Activated SCell

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

Upon receiving SCell deactivation command in slot *n*, the UE shall accomplish the deactivation actions for the SCell being deactivated no later than in slot *n +*. The starting point of an interruption window on spCell or any activated SCell, as specified in clause 8.2, shall not occur before slot n+1+ and not occur after slot n+1+, where NR slot length is with respect to the numerology used in the SCell being deactivated.

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 +*. The starting point of an interruption window on spCell or any activated SCell, as specified in clause 8.2, shall not occur before slot n+1 and not occur after slot n+1+, where NR slot length is with respect to the numerology used in the SCell being deactivated.

The length of the interruption window may be different for different victim cells, and depends on the applicable scenario and on the frequency band relation between the aggressor cell and the victim cell.

### 8.3.4 Direct SCell Activation at SCell addition

The requirements in this clause apply for UE being configured in the RRC reconfiguration message, TS 38.331 [2], with one SCell for which the parameter *sCellState* is set to *activated*. If the RRC reconfiguration message for direct SCell activation also configures PSCell addition or PSCell change, the direct SCell activation delay may be longer than the requirements defined in this clause.

If the RRC reconfiguration message for direct SCell activation also configures TCI state information, the requirements in section 8.3.2 based on that TCI state activation command is received at the same time as SCell activation command shall apply.

The UE shall configure the SCell in activated state upon successful completion of the RRC reconfiguration procedure within the specified delay. The UE shall be capable to transmit valid CSI report and apply actions for the directly activated SCell no later than in slot ,

where:

- Slot n is the last slot overlapping with the PDSCH containing the RRC reconfiguration message,

- Ndirect = TRRC\_Process + T1 + Tactivation\_time + TCSI\_Reporting - 3ms for the cases specified in clause 8.3.2 that TCI state is not indicated within Tactivation\_time; otherwise, Ndirect = TRRC\_Process + T1 + THARQ + Tactivation\_time + TCSI\_Reporting

*-* TRRC\_Process: RRC procedure delay as specified in clause 11.2 of TS 36.331 [16] if the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the RRC procedure delay defined in clause 12 of TS 38.331 [2],

*-* T1: Delay from slot until the transmission of *RRCReconfigurationComplete* message,

Note: *T1* is UE implementation dependent.

*THARQ* (in ms) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3],

If the SCell is known and belongs to FR1, *TCSI\_Reporting* is specified in clause 8.3.2 and *Tactivation\_time* is defined as:

- TFirstSSB+ 5ms, if the measurement period of the SCell being activated is equal to or smaller than 2400ms.

- TFirstSSB\_MAX + Trs + 5ms, if measurement period of the SCell being activated is larger than 2400ms.

where,

the measurement period in Table 9.2.5.2-1 applies if the target SCell was in an intra-frequency layer corresponding to an activated SCell;

the measurement period in Table 9.2.5.2-3 applies if the target SCell was in an intra-frequency layer corresponding to a deactivated SCell;

the measurement period in Table 9.3.5-1 applies if the target SCell was in an inter-frequency layer.

*-* Otherwise, Tactivation\_time and TCSI\_Reporting are specified in clause 8.3.2, where the following definitions of TFirstSSB and TFirstSSB\_MAX shall override the existing ones:

- TFirstSSB: the time to the end of the first complete SSB burst indicated by the SMTC after slot n +

- TFirstSSB\_MAX: the time to the end of the first complete SSB burst indicated by the SMTC after slot n +

- In FR1, in case of intra-band SCell activation, the occasion when all active serving cells and SCells being activated or released are transmitting SSB bursts in the same slot; in case of inter-band SCell activation, the first occasion when the SCell being activated is transmitting SSB burst.

- In FR2, the occasion when all active serving cells and SCells being activated or released are transmitting SSB bursts in the same slot.

In addition to CSI reporting defined above, UE shall also apply other actions related to the activation command specified in TS38.321 [7] for an SCell at the first opportunities for the corresponding actions once the SCell is activated.

The SCell in FR1 is known provided the following conditions are met for the SCell:

- During the last 5 seconds before the reception of the direct SCell configuration command:

- the UE has sent a valid measurement report for the SCell being directly activated, and

- the SSB measured remains detectable according to the cell identification conditions specified in sections 9.2 and 9.3,

- the SSB measured during the period equal to [5] seconds also remains detectable during the SCell activation delay according to the cell identification conditions specified in clause 9.2 and 9.3.

Otherwise, the SCell is unknown.

The SCell in FR2 is known provided it meets the corresponding conditions as defined in clause 8.3.2. Otherwise, the SCell is unknown.

The UE may be allowed to cause interruptions to serving cells on other component carriers during an interruption window, as specified in clause 8.2. The starting point of an interruption window on spCell or any activated SCell shall not occur before slot *n*+1, and shall not occur after slot *n+*1+, where NR slot length is with respect to the numerology of the SCell being activated, and *TX* is:

- *TFirstSSB*, for any scenario where *Tactivation\_time*includes *TFirstSSB*;

- *TFirstSSB\_MAX*, for any scenario where *Tactivation\_time*includes *TFirstSSB\_MAX*;

- *Tuncertainty\_MAC +TFineTiming*, for any scenario where *Tactivation\_time*includes *TFineTiming*.

The length of the interruption window may be different for different victim cells, and depends on the applicable scenario and on the frequency band relation between the aggressor cell and the victim cell.

Starting from the slot until the UE has completed the direct SCell activation, the UE shall report CQI index = 0 (out of range) if the UE has available uplink resources to report CQI for the SCell.

### 8.3.5 Direct SCell Activation at Handover

The requirements in this clause apply for UE being configured in the RRC reconfiguration message, TS 38.331 [2], for handover with one SCell for which the parameter *sCellState* is set to *activated*.

The UE shall configure the SCell in activated state upon successful completion of the RRC reconfiguration procedure within the specified delay. The UE shall be capable to transmit valid CSI report and apply actions for the directly activated SCell no later than in slot ,

Where:

- Slot n is the last slot overlapping with the PDSCH containing RRC reconfiguration message.

- Ndirect = TRRC\_process + Tinterrupt + T2 + T3 + Tactivation\_time + TCSI\_Reporting - 3ms for the cases specified in clause 8.3.2 that TCI state is not indicated within Tactivation\_time; otherwise, Ndirect = TRRC\_process + Tinterrupt + T2 + T3 + THARQ +Tactivation\_time + TCSI\_Reporting

- TRRC\_Process: RRC procedure delay as specified in clause 11.2 of TS 36.331 [16] if the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the RRC procedure delay defined in clause 12 of TS 38.331 [2],

- Tinterrupt: Interruption time during handover as specified in clause 6.1.1,

- T2: Delay from slot until UE has obtained a valid TA command for the target PCell,

- T3: Delay for applying the received TA for uplink transmission in the target PCell, and greater than or equal to k+1 slot, where k is defined in clause 4.2 in TS 38.213,

- *THARQ* (in ms) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3],

*-* If the SCell is known and belongs to FR1, *TCSI\_Reporting* is specified in clause 8.3.2 and *Tactivation\_time* is defined as:

- TFirstSSB+ 5ms, if the measurement period of the SCell being activated is equal to or smaller than [2400ms].

- TFirstSSB\_MAX + Trs + 5ms, if measurement period of the SCell being activated is larger than [2400ms].

where,

the measurement period in Table 9.2.5.2-1 applies if the target SCell was in an intra-frequency layer corresponding to an activated SCell;

the measurement period in Table 9.2.5.2-3 applies if the target SCell was in an intra-frequency layer corresponding to a deactivated SCell;

the measurement period in Table 9.3.5-1 applies if the target SCell was in an inter-frequency layer.

- Otherwise, *Tactivation\_time* and *TCSI\_Reporting* are specified in clause 8.3.2, where the following definitions of *TFirstSSB* and *TFirstSSB\_MAX*shall override the existing ones:

- TFirstSSB: the time to the end of the first complete SSB burst indicated by the SMTC after slot n +

- TFirstSSB\_MAX: the time to the end of the first complete SSB burst indicated by the SMTC after slot n +

- In FR1, in case of intra-band SCell activation, the occasion when all active serving cells and SCells being activated or released are transmitting SSB bursts in the same slot; in case of inter-band SCell activation, the first occasion when the SCell being activated is transmitting SSB burst.

- In FR2, the occasion when all active serving cells and SCells being activated or released are transmitting SSB bursts in the same slot.

In addition to CSI reporting defined above, UE shall also apply other actions related to the activation command specified in TS 38.321 [7] for an SCell at the first opportunities for the corresponding actions once the SCell is activated.

The SCell in FR1 is known provided the following conditions are met for the SCell:

- During the last 5 seconds before the reception of the direct SCell configuration command:

- the UE has sent a valid measurement report for the SCell being directly activated, and

- the SSB measured remains detectable according to the cell identification conditions specified in sections 9.2 and 9.3,

- the SSB measured during the period equal to [5] seconds also remains detectable during the SCell activation delay according to the cell identification conditions specified in clause 9.2 and 9.3.

Otherwise, the SCell is unknown.

The SCell in FR2 is known provided it meets the corresponding conditions as defined in clause 8.3.2. Otherwise, the SCell is unknown.

The UE may be allowed to cause interruptions to PCell during an interruption window, as specified in clause 8.2. The starting point of an interruption window on PCell shall not occur before slot *n*+1+, and not occur after slot *n*+1+, where NR slot length is with respect to the numerology of the SCell being activated, and *TX* is:

- *TFirstSSB*, for any scenario where *Tactivation\_time*includes *TFirstSSB*;

- *TFirstSSB\_MAX*, for any scenario where *Tactivation\_time*includes *TFirstSSB\_MAX*;

- *Tuncertainty\_MAC +TFineTiming*, for any scenario where *Tactivation\_time*includes *TFineTiming*.

The length of the interruption window depends on the frequency band relation between the aggressor SCell and the victim PCell.

Starting from the slot and until the UE has completed the direct SCell activation, the UE shall report CQI index = 0 (out of range) if the UE has available uplink resources to report CQI for the SCell.

8.3.6 Direct SCell Activation at RRCResume

The requirements in this clause apply for UE being configured in the RRC reconfiguration message in TS38.331 [2] for RRC Resume with one SCell for which the parameter *sCellState* is set to *activated*.

The requirements in clause 8.3.4 shall apply, except that the definition of *T1* shall be deemed to be replaced with

*T1*: Delay from slot until the transmission of RRCResumeComplete message,

### 8.3.7 SCell Activation Delay Requirement for Deactivated SCell with Multiple Downlink SCells

The requirements in this clause shall apply for the UE configured with more than one SCells.

In EN-DC, NE-DC, standalone NR, or in one CG of NR-DC, the requirements in this clause shall apply when the following conditions are met:

- UE only receives one single MAC command for multiple SCell activation within the activation period defined in this clause

- in each single CG, there are no other SCell activation, deactivation, addition or release before activation is completed for all the SCells activated by the single MAC CE in this clause, and

- in EN-DC and NE-DC, there are no E-UTRAN SCell activation, deactivation, addition or release before multiple SCell activation is completed in this clause, and

- any to-be-activated unknown SCell has active serving cell(s) or known to-be-activated SCell(s) on the same band

In two CGs of NR-DC, the requirements in this clause shall apply when the following conditions are met:

- UE receives one MAC command per CG for multiple SCell activation within the activation period defined in this clause, and

- UE supports per-FR measurement gap capability, and

- any to-be-activated unknown SCell has active serving cell(s) or known to-be-activated SCell(s) on the same band

The delay within which the UE shall be able to activate the deactivated SCell with other downlink to-be-activated SCell(s) depends upon the specified conditions.

Upon receiving SCell activation command in slot *n* for more than one SCell, for each of the to-be-activated SCell, 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 , where:

THARQ (in ms) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3]

Tactivation\_time\_multiple\_scells is the target SCell activation delay in millisecond in multiple SCell activation scenario.

If the SCell is known and belongs to FR1 and the measurement period of the SCell being activated is equal to or smaller than [2400ms], Tactivation\_time\_multiple\_scells is:

- TFirstSSB\_MAX\_multiple\_scells + Trs + 5ms, if on the same band UE also has at least one parallel to-be-activated SCell which is FR1 known Scell with the measurement period larger than [2400ms] but does not have any parallel to-be-activated SCell which is FR1 unknown SCell.

- TFirstSSB\_MAX\_multiple\_scells + TSMTC\_MAX\_multiple\_scells + Trs + 5ms, if on the same band UE also has at least one parallel to-be-activated SCell which is FR1 unknown Scell

- otherwise, TFirstSSB\_MAX\_multiple\_scells + 5ms.

If the SCell is known and belongs to FR1 and the measurement period of the SCell being activated is larger than [2400ms], Tactivation\_time\_multiple\_scells is:

- TFirstSSB\_MAX\_multiple\_scells + TSMTC\_MAX\_multiple\_scells + Trs + 5ms, if on the same band UE also has at least one parallel to-be-activated SCell which is FR1 unknown Scell

- otherwise, TFirstSSB\_MAX\_multiple\_scells + Trs + 5ms

If the SCell is unknown and belongs to FR1, provided that the side condition Ês/Iot ≥ -2dB is fulfilled, Tactivation\_time\_multiple\_scells is:

- TFirstSSB\_MAX\_multiple\_scells + TSMTC\_MAX\_multiple\_scells+Trs +5ms, if the SCell is not counted in N1

- The activation delay may be longer if SSB is not in the same half-frame on the SCell and the contiguous FR1 known cell or contiguous FR1 active serving cell

otherwise

- if the following conditions are met

- ‘ssb-PositionInBurst’ indicates only one SSB is being actually transmitted, or

- ‘ssb-PositionInBurst’ indicates multiple SSBs and TCI indication is provided in same MAC PDU with SCell activation,

- Tactivation\_time\_multiple\_scells is:

- TFirstSSB\_MAX\_multiple\_scells + TSMTC\_MAX\_multiple\_scells+Trs\*N1 +Trs +5ms,

- Otherwise:

Tactivation\_time\_multiple\_scells is:

- 6ms + TFirstSSB\_MAX\_multiple\_scells + TSMTC\_MAX\_multiple\_scells + Trs\*N1 + TL1-RSRP,measure + TL1-RSRP,report + THARQ + max(Tuncertainty\_MAC\_multiple\_scells + TFineTiming + 2ms, Tuncertainty\_SP\_multiple\_scells), if semi-persistent CSI-RS is used for CSI reporting,

- 3ms + TFirstSSB\_MAX\_multiple\_scells + TSMTC\_MAX\_multiple\_scells + Trs\*N1 + TL1-RSRP,measure + TL1-RSRP,report + max(THARQ + Tuncertainty\_MAC\_multiple\_scells + 5ms + TFineTiming, Tuncertainty\_RRC\_multiple\_scells + TRRC\_delay), if periodic CSI-RS is used for CSI reporting.

If the SCell being activated belongs to FR1 and if there is at least one active serving cell contiguous to the SCell on that FR1 band, if the UE is not provided with SSB configuration (*absoluteFrequencySSB*) nor SMTC configuration for the target SCell, Tactivation\_time\_multiple\_scells is same as single SCell activation delay requirement as defined in clause 8.3.2.

If the SCell being activated belongs to FR2 and if there is at least one active serving cell on that FR2 band, then Tactivation\_time\_multiple\_scells is same as single SCell activation delay requirement as defined in clause 8.3.2.

If the SCell being activated belongs to FR2 and if there is at least one active serving cell on that FR2 band, if the UE is not provided with any SMTC for the target SCell, Tactivation\_time\_multiple\_scells is same as single SCell activation delay requirement as defined in clause 8.3.2

If the SCell being activated belongs to FR2 and if there is no active serving cell on that FR2 band provided that PCell or PSCell is FR1:

If the target SCell is known to UE and semi-persistent CSI-RS is used for CSI reporting, then Tactivation\_time\_multiple\_scells is same as single SCell activation delay requirement as defined in clause 8.3.2.

If the target SCell is known to UE and periodic CSI-RS is used for CSI reporting, then Tactivation\_time\_multiple\_scells is same as single SCell activation delay requirement as defined in clause 8.3.2.

If the target SCell is unknown to UE and semi-persistent CSI-RS is used for CSI reporting, provided that the side condition Ês/Iot ≥ -2dB is fulfilled, then Tactivation\_time\_multiple\_scells is:

- 3 ms + max(Tuncertainty\_MAC\_multiple\_scells +TFineTiming + 2ms, Tuncertainty\_SP\_multiple\_scells), if on the same band UE also has at least one parallel to-be-activated SCell which is FR2 known Scell. Tuncertainty\_MAC\_multiple\_scells =0 and Tuncertainty\_SP\_multiple\_scells =0 if UE receives the SCell activation command, semi-persistent CSI-RS activation command and TCI state activation commands at the same time.

If the target SCell is unknown to UE and periodic CSI-RS is used for CSI reporting, provided that the side condition Ês/Iot ≥ -2dB is fulfilled, then Tactivation\_time\_multiple\_scells is:

- max(Tuncertainty\_MAC\_multiple\_scells + 5ms + TFineTiming, Tuncertainty\_RRC\_multiple\_scells + TRRC\_delay-THARQ), if on the same band UE also has at least one parallel to-be-activated SCell which is FR2 known Scell . Tuncertainty\_MAC\_multiple\_scells =0 if UE receives the SCell activation command and TCI state activation commands at the same time.

The requirements for FR2 unknown SCells apply provided that the parameter *ssb-PositionsInBurst* is same for the SCell and the known serving cell on the same FR2 band. The activation delay FR2 unknown SCell may be longer if SSB is not in the same half-frame on the SCell and the contiguous FR2 known cell.

Where,

N1 is the number counting for parallel FR1 unknown to-be-activated SCell(s) only except the ones which fulfilled the following conditions:

- contiguous to an active serving cell in the same band, or to a known SCell in the same band being activated by the same MAC PDU, and

- A single SSB is used in the unknown SCell; or multiple SSBs are used in the unknown SCell and TCI state indication for PDCCH is provided by the same MAC PDU used for SCell activation; and

- its *ssb-PositionInBurst* is same as the one of contiguous FR1 known cell or contiguous FR1 active serving cell, and

- its RTD with contiguous FR1 known cell or contiguous FR1 active serving cell is smaller than or equal to 260ns with respect to the to-be-activated SCell’s SSB numerology and its reception power difference with contiguous FR1 known cell or contiguous FR1 active serving cell is smaller than or equal to 6dB, and

- its SMTC offset is same as the one of contiguous FR1 known cell or contiguous FR1 active serving cell

However, when the following conditions are fulfilled, no activation requirement will be applied for this unknown SCell and other SCells being activated and counted in N1:

- contiguous to an active serving cell in the same band, or to a known SCell in the same band being activated by the same MAC PDU, and

- A single SSB is used in the unknown SCell; or multiple SSBs are used in the unknown SCell and TCI state indication for PDCCH is provided by the same MAC PDU used for SCell activation; and

- its *ssb-PositionInBurst* is same as the one of FR1 known cell or FR1 active serving cell, and

- its RTD with contiguous FR1 known cell or contiguous FR1 active serving cell is larger than 260ns with respect to the to-be-activated SCell’s SSB numerology or its reception power difference with contiguous FR1 known cell or contiguous FR1 active serving cell is larger than 6dB, and

- its SMTC offset is same as the one of FR1 known cell or FR1 active serving cell

TSMTC\_MAX\_multiple\_scells:

- In FR1, in case of intra-band SCell activation, TSMTC\_MAX\_multiple\_scells is the longest SMTC periodicity between active serving cells and SCells being activated on the same band 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, TSMTC\_MAX\_multiple\_scells is the longest SMTC periodicity of SCells being activated on the same band.

- In FR2, TSMTC\_MAX\_multiple\_scells is the longest SMTC periodicity between active serving cells and SCell(s) being activated in FR2 intra-band CA.

- TSMTC\_MAX\_multiple\_scells is bounded to a minimum value of 10ms.

TFirstSSB\_MAX\_multiple\_scells: is the time to the end of the first complete SSB burst indicated by the SMTC after slot n + , further fulfilling:

- In FR1, in case of intra-band SCell activation, the occasion when all active serving cells and SCells being activated or released are transmitting SSB bursts in the same slot; in case of inter-band SCell activation, the first occasion when the SCells being activated are transmitting SSB burst.

- In FR2, the occasion when all active serving cells and SCells being activated or released are transmitting SSB bursts in the same slot.

Tuncertainty\_MAC\_multiple\_scells is the time period between reception of the activation command for PDCCH TCI, PDSCH TCI (when applicable) and SCell activation command of this unknown SCell.

Tuncertainty\_SP\_multiple\_scells is the time period between reception of the activation command for semi-persistent CSI-RS resource set for CQI reporting and SCell activation command of this unknown SCell.

Tuncertainty\_RRC\_multiple\_scells is the time period between reception of the RRC configuration message for TCI of periodic CSI-RS for CQI reporting (when applicable) and SCell activation command of this unknown SCell.

Trs, TFineTiming, and TRRC\_delay is defined in clause 8.3.2.

Longer delays for RRM measurement requirements, and in case of FR2 also SSB based RLM/BFD/CBD/L1-RSRP measurement requirements, can be expected during the cell detection time for unknown SCell activation.

The condition of known SCell in FR1 or FR2 is defined in clause 8.3.2.

If the UE has been provided with higher layer in TS 38.331 [2] signaling of *smtc2*prior to the activation command, TSMTC\_Scell follows *smtc1* or *smtc2* according to the physical cell ID of the target cell being activated. TSMTC\_MAX\_multiple\_scell follows *smtc1* or *smtc2* according to the physical cell IDs of the target cells being activated and the active serving cells.

The starting point and the end-point of an interruption window on PCell or any activated SCell in MCG for NR standalone mode, or on PSCell or any activated SCell in SCG for EN-DC mode is same as single SCell activation requirement in clause 8.3.2.

Starting from the slot specified in clause 4.3 of TS 38.213 [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.

Upon receiving SCell activation command in slot *n,* if the start of the first complete SSB used in the *TX* in the different bands which have SCells being activated after *n*+ are not aligned on time domain among

- SCells in different bands being activated by the same MAC CE if UE does not support per FR gap, or

* SCells in different FR1 bands being activated by the same MAC CE if UE supports per FR gap,

additional interruptions may be expected for the activated serving cells, where

- The number of additional interruptions is no more than the number of FR1 bands which have both SCell being activated for which the activation requirements involve *TFirstSSB\_MAX* *multiple\_scells* with *Trs* and the active serving cell, and

- In each interruption occasion, the interruption length is defined in clause 8.2.2.2.2, and

- Longer activation delay may be expected for multiple SCell activation under one MAC CE with multiple interruptions, and

- *TX* is:

- TFirstSSB, for any scenario where Tactivation\_time multiple\_scells includes TFirstSSB;

- TFirstSSB\_MAX multiple\_scells, for any scenario where Tactivation\_time multiple\_scells includes TFirstSSB\_MAX multiple\_scells;

- Tuncertainty\_MAC+TFineTiming or Tuncertainty\_MAC multiple\_scells+TFineTiming, for any scenario where Tactivation\_time multiple\_scells includes TFineTiming.

Otherwise, no additional interruption is expected due to activation of multiple SCells.

Starting from slot *n* + THARQ + 3 ms where slot *n* is the slot where SCell activation command is received (as specified in clause 4.3 of TS 38.213 [3]) and until the SCell activation completion at UE, after at least one CSI-RS transmission occasion for the channel measurement and reporting (specified in clause 5.2.2.5 of TS 38.214 [26]), the UE shall report out of range if the UE has available uplink resources to report CQI for the SCell.

Starting from the slot specified in clause 4.3 of TS 38.213 [3] (timing for secondary Cell activation/deactivation) and until the UE has completed a first L1-RSRP measurement, the UE shall report lowest valid L1 SS-RSRP range if the UE has available uplink resources to report L1-RSRP for the SCell.

### 8.3.8 SCell Deactivation Delay Requirement for Activated SCell with Multiple Downlink SCells

The requirements in this clause shall apply for the UE configured with multiple downlink SCells in EN-DC, or in standalone NR carrier aggregation, or in NE-DC, or in NR-DC, provided that,

- in each single CG, there are no other SCell activation, deactivation, addition or release before deactivation is completed for all the SCells deactivated by the single MAC CE in this clause, and

- in EN-DC and NE-DC, there are no E-UTRAN SCell activation, deactivation, addition or release before multiple SCell deactivation is completed in this clause, and

- in EN-DC, NE-DC, NR-DC and standalone NR, UE only receives one single MAC command for multiple SCell deactivation within the deactivation period defined in this clause, or, in NR-DC, per-FR measurement gap capable UE receives one MAC command per CG for multiple SCell deactivation within the deactivation period defined in this clause

Upon receiving SCell deactivation command in slot *n*, the UE shall accomplish the deactivation actions for the SCell being deactivated within the same delay as specified in clause 8.3.3.

The starting point and the end-point of an interruption window on PCell or any activated SCell in MCG for NR standalone mode, or on PSCell or any activated SCell in SCG for EN-DC mode is same as single SCell activation requirement in clause 8.3.3.

### 8.3.9 Direct SCell Activation of Multiple Downlink SCells at SCell addition

The requirements in this clause apply for UE being configured in the RRC reconfiguration message, TS 38.331 [2], with 2 SCells for which the parameter *sCellState* is set to *activated*.

In EN-DC, NE-DC, stand-alone NR, or in one CG of NR-DC, the requirements in this clause shall apply when the following conditions are met:

- UE only receives one RRC reconfiguration message for direct activation of SCells within the activation period defined in this clause,

- in each single CG, there are no other SCell activation, deactivation, addition or release before direct activation is completed for all the SCells activated by the single RRC reconfiguration message in this clause, and

- in EN-DC and NE-DC, there are no E-UTRAN SCell activation, deactivation, addition or release before the direct SCell activation of multiple SCells in this clause is completed.

In two CGs of NR-DC, the requirements in this clause shall apply when the following conditions are met:

- UE receives one RRC message per CG for direct activation of SCells within the activation period defined in this clause,

- UE supports per-FR measurement gap capability, and

- any to-be-activated unknown SCell has active serving cell(s) or known to-be-activated SCell(s) on the same band.

The UE shall configure the SCells in activated state upon successful completion of the RRC reconfiguration procedure within the specified delay. The UE shall be capable to transmit valid CSI report and apply actions for the directly activated SCell no later than in slot ,

where:

- Slot n is the last slot overlapping with the PDSCH containing the RRC reconfiguration message.

- Ndirect\_multiple\_scells = TRRC\_Process + T1 + Tactivation\_time\_multiple\_scells + TCSI\_Reporting - 3ms for the cases specified in clause 8.3.7 that TCI state is not indicated within Tactivation\_time; otherwise, Ndirect\_multiple\_scells = TRRC\_Process + T1 + THARQ + Tactivation\_time\_multiple\_scells + TCSI\_Reporting

*- T1* and *TRRC\_Process* are specified in clause 8.3.4,

*- THARQ* (in ms) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3],

*- Tactivation\_time\_multiple\_scells* and *TCSI\_Reporting* are specified in clause 8.3.7, where the following definition of *TFirstSSB*, *TFirstSSB\_MAX*, and *TFirstSSB\_MAX\_multiple\_scells*shall override the existing ones:

*- TFirstSSB* and *TFirstSSB\_MAX*: as specified in clause 8.3.4,

- *TFirstSSB\_MAX\_multiple\_scells*: the time to the end of the first complete SSB burst indicated by the SMTC after slot *n +* , further fulfilling:

- In FR1, in case of intra-band SCell activation, the occasion when all active serving cells and SCells being activated or released are transmitting SSB bursts in the same slot; in case of inter-band SCell activation, the first occasion when the SCells being activated are transmitting SSB burst.

- In FR2, the occasion when all active serving cells and SCells being activated or released are transmitting SSB bursts in the same slot.

In addition to CSI reporting defined above, UE shall also apply other actions related to the activation command specified in TS38.321 [7] for an SCell at the first opportunities for the corresponding actions once the SCell is activated.

The UE may be allowed to cause interruptions to serving cells on other component carriers during an interruption window, as specified in clause 8.2. The starting point of an interruption window on spCell or any activated SCell shall not occur before slot *n*+1+, and shall not occur after slot *n+*1+, where NR slot length is with respect to the numerology of the SCell being activated, and *TX* is:

- *TFirstSSB*, for any scenario where *Tactivation\_time\_multiple\_scells*includes *TFirstSSB*;

- *TFirstSSB\_MAX*, for any scenario where *Tactivation\_time\_multiple\_scells*includes *TFirstSSB\_MAX*;

- *TFirstSSB\_MAX\_multiple\_scell*, for any scenario where *Tactivation\_time\_multiple\_scells*includes *TFirstSSB\_MAX\_multiple\_scells*;

- *Tuncertainty\_MAC +TFineTiming*, for any scenario where *Tactivation\_time\_multiple\_scells*includes *TFineTiming.*

The length of the interruption window may be different for different victim cells, and depends on the applicable scenario and on the frequency band relation between the aggressor cell and the victim cell.

Starting from the slot until the UE has completed the direct SCell activation, the UE shall report CQI index = 0 (out of range) if the UE has available uplink resources to report CQI for the SCells.

### 8.3.10 Direct SCell Activation of Multiple Downlink SCells at Handover

The requirements in this clause apply for UE being configured in the RRC reconfiguration message, TS 38.331 [2], for handover with 2 SCells for which the parameter *sCellState* is set to *activated*.

In MCG of NE-DC, MCG of NR-DC, or in stand-alone NR, the requirements in this clause shall apply when the following conditions are met:

- UE does not receive any RRC reconfiguration message for direct activation of SCells within the activation period defined in this clause,

- there is no other SCell activation, deactivation, addition or release before direct activation is completed for all the SCells activated by the single RRC reconfiguration message in this clause, and

- in NE-DC, there is no E-UTRAN SCell activation, deactivation, addition or release before the direct activation of SCells in this clause is completed.

The UE shall configure the SCells in activated state upon successful completion of the RRC reconfiguration procedure within the specified delay. The UE shall be capable to transmit valid CSI report and apply actions for the directly activated SCells no later than in slot where:

- Slot n is the last slot overlapping with the PDSCH containing the RRC reconfiguration message,

- Ndirect\_multiple\_scells = TRRC\_process + Tinterrupt + T2 + T3 + Tactivation\_time\_multiple\_scells + TCSI\_Reporting - 3ms for the cases specified in clause 8.3.7 that TCI state is not indicated within Tactivation\_time; otherwise, Ndirect\_multiple\_scells = TRRC\_process + Tinterrupt + T2 + T3 + THARQ + Tactivation\_time\_multiple\_scells + TCSI\_Reporting

- *TRRC\_Process, Tinterrupt,T2*, and *T3* are specified in clause 8.3.5,

*- THARQ* (in ms) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3],

*- Tactivation\_time\_multiple\_scells* and *TCSI\_Reporting* are specified in clause 8.3.7, where the following definitions of *TFirstSSB*, *TFirstSSB\_MAX*, and *TFirstSSB\_MAX\_multiple\_scells* shall override the existing ones:

- *TFirstSSB*, *TFirstSSB\_MAX*: as specified in clause 8.3.5,

- TFirstSSB\_MAX\_multiple\_scell: the time to the end of the first complete SSB burst indicated by the SMTC after slot n +, further fulfilling:

- In FR1, in case of intra-band SCell activation, the occasion when all active serving cells and SCells being activated or released are transmitting SSB bursts in the same slot; in case of inter-band SCell activation, the first occasion when the SCells being activated are transmitting SSB burst.

- In FR2, the occasion when all active serving cells and SCells being activated or released are transmitting SSB bursts in the same slot.

In addition to CSI reporting defined above, UE shall also apply other actions related to the activation command specified in TS 38.321 [7] for an SCell at the first opportunities for the corresponding actions once the SCell is activated.

The UE may be allowed to cause interruptions to PCell during an interruption window, as specified in clause 8.2. The starting point of an interruption window on PCell shall not occur before slot *n*+1+, and not occur after slot *n*+1+, where NR slot length is with respect to the numerology of the SCell being activated, and *TX* is:

- *TFirstSSB*, for any scenario where *Tactivation\_time\_multiple\_scells*includes *TFirstSSB*;

- *TFirstSSB\_MAX*, for any scenario where Tactivation\_time\_multiple\_scells includes TFirstSSB\_MAX;

- *TFirstSSB\_MAX\_multiple\_scell*, for any scenario where *Tactivation\_time\_multiple\_scells*includes *TFirstSSB\_MAX\_multiple\_scells*;

- *Tuncertainty\_MAC +TFineTiming*, for any scenario where *Tactivation\_time\_multiple\_scells*includes *TFineTiming*.

The length of the interruption window depends on the frequency band relation between the aggressor SCell and the victim PCell.

Starting from the slot and until the UE has completed the direct SCell activation, the UE shall report CQI index = 0 (out of range) if the UE has available uplink resources to report CQI for the SCells.

8.3.11 Direct SCell Activation of Multiple Downlink SCells at RRC Resume

The requirements in this clause apply for UE being configured in the RRC reconfiguration message in TS38.331 [2] for RRC Resume with 2 SCells for which the parameter *sCellState* is set to *activated*.

The requirements in clause 8.3.9 shall apply, except that the definition of *T1* shall be replaced by the corresponding definition in clause 8.3.6.

### 8.3.12 SCell Activation Delay Requirement for Deactivated PUCCH SCell

The requirements in this clause shall apply for the UE configured with one downlink SCell and when PUCCH is configured for the SCell being activated.

If the UE has a valid TA for transmitting on an SCell then the UE shall be capable to transmit valid CSI report and apply actions related to the activation command for the SCell being activated on the PUCCH SCell no later than in slot n+,

Where:

- A TA is considered to be valid provided that the *TimeAlignmentTimer* [2] associated with the TAG containing the PUCCH SCell is running.

- THARQ (in ms) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3].

- Tactivation\_time is the SCell activation delay in millisecond as specified in section 8.3.2 except the definition of Tuncertainty\_MAC is replaced with:

- Tuncertainty\_MAC is the time period between reception of the last activation command for PDCCH TCI, PDSCH TCI (when applicable), UL spatial relation (for FR2) relative to

- SCell activation command for known case;

- First valid L1-RSRP reporting for unknown case.

- Ttarget\_PL-RS is the periodicity of the target pathloss reference signal determined during PUCCH SCell activation.

- TFirst\_available\_CSI is the delay uncertainty (in ms) in acquiring the first available downlink CSI reference resource.

- TCSI\_processing is the UE processing time for CSI reporting.

- TCSI\_reporting\_after is the delay uncertainty (in ms) in acquiring the first available CSI reporting resources after end of max ((TFirst\_available\_CSI + TCSI\_processing), 3\*Ttarget\_PL-RS)

- If the UE does not have a valid TA for transmitting on an SCell then the UE shall be capable to perform downlink actions related to the SCell activation command as specified in [7] for the SCell being activated on the PUCCH SCell no later than in slot n+, and shall be capable to perform uplink actions related to the SCell activation command as specified in [7] for the SCell being activated on the PUCCH SCell no later than in slot and shall transmit valid CSI report for the SCell being activated on the PUCCH SCell no later than in slot , where:

Tdelay\_PUCCH\_SCell = Tactivation\_time + max ((TFirst\_available\_CSI + TCSI\_processing), (T1+T2+T3), 3\*Ttarget\_PL-RS) + TCSI\_reporting\_after

Where:

- Tactivation\_time is the SCell activation delay in millisecond as specified in section 8.3.2 except the definition of Tuncertainty\_MAC is replaced with:

- Tuncertainty\_MAC is the time period between reception of the last activation command for PDCCH TCI, PDSCH TCI (when applicable), UL spatial relation (when applicable in FR2) relative to

- SCell activation command for known case;

- First valid L1-RSRP reporting for unknown case.

- Ttarget\_PL-RS is the periodicity of the target pathloss reference signal determined during PUCCH SCell activation.

- TFirst\_available\_CSI is the delay uncertainty (in ms) in acquiring the first available downlink CSI reference resource.

- TCSI\_processing is the UE processing time for CSI reporting.

- TCSI\_reporting\_after is the delay uncertainty (in ms) in acquiring the first available CSI reporting resources after end of max ((TFirst\_available\_CSI + TCSI\_processing), (T1+T2+T3), 3\*Ttarget\_PL-RS)

- T1 is the delay uncertainty in acquiring the first available PDCCH triggered PRACH occasion in the PUCCH SCell after the slot n+.

- T1 is up to the summation of a delay uncertainty for reception of PDCCH order, SSB to PRACH occasion association period and 10 ms, where SSB to PRACH occasion association period is defined in the table 8.1-1 of TS 38.213

- T2 is the delay from slot n+until UE has obtained a valid TA command for the target PUCCH Scell being activated. Slot n is the slot where the UE receives PUCCH SCell activation command.

- T3 is the delay for applying the received TA for uplink transmission on target PUCCH SCell being activated, as specified in clause 4.2 in TS 38.213.

The pathloss reference signal is known for known PUCCH SCell during activation if the following conditions are met during the period between the last transmission of the RS resource used for L3 RSRP measurement reporting and the completion of PUCCH SCell activation, where the RS resource is the target pathloss reference signal or QCLed (with Type D) to the target pathloss reference signal:

-The PUCCH SCell activation command is received within 1280 ms upon the last transmission of the RS resource used for L3 measurement reporting

- The target pathloss reference signal determination is based on the latest L3 RSRP measurement reporting

- The target pathloss reference signal remains detectable during the PUCCH SCell activation period

- SNR of the target pathloss reference signal≥-3dB

- The associated SSBs with the target pathloss reference signal remain detectable during the PUCCH SCell activation period

- SNR of the associated SSB ≥-3dB

The pathloss reference signal is known for unknown PUCCH SCell during activation if the following conditions are met during the period between the last transmission of the RS resource used for L1-RSRP measurement reporting and the completion of PUCCH SCell activation, where the RS resource is the target pathloss reference signal or QCLed (with Type D) to the target pathloss reference signal.

- The PUCCH SCell activation command is received within 1280 ms upon the last transmission of the RS resource used for L1-RSRP measurement reporting

- The target pathloss reference signal determination is based on the latest L1-RSRP measurement reporting

- The target pathloss reference signal remains detectable during the PUCCH SCell activation period

- SNR of the target pathloss reference signal≥-3dB

- The associated SSBs with the target pathloss reference signal remain detectable during the PUCCH SCell activation period

- SNR of the associated SSB ≥-3dB

Otherwise, the pathloss reference signal is unknown.

The above delay requirement shall apply provided that:

- The target pathloss reference signal determined during PUCCH SCell activation is known otherwise longer activation time is expected if the pathloss reference signal is unknown; and

- The RA on PUCCH SCell is not interrupted by the RA on PCell otherwise additional delay to activate the SCell is expected; and

- No SRS carrier based switching or SRS antenna port switching occurs during the SCell activation procedure otherwise the PUCCH SCell activation delay can be extended.

The starting point and the end-point of an interruption window on PCell or any activated SCell in MCG for NR standalone mode, or on PSCell or any activated SCell in SCG for EN-DC mode is the same as the interruption in single SCell activation requirement in clause 8.3.2.

In addition to the interruption due to RF retuning during PUCCH SCell activation, if the UE is not capable of *parallelTxPRACH-SRS-PUCCH-PUSCH*, and PRACH on PUCCH SCell and PUCCH/PUSCH/SRS on other active serving cell are fully or partially overlapping in time, the UE shall transmit PRACH on PUCCH SCell and is allowed to drop or cause interruption to SRS or PUCCH or PUSCH transmission on the SpCell or on any activated SCell. Otherwise, UE is not allowed to drop or cause any interruption to SRS or PUCCH or PUSCH transmission on SpCell or on any activated SCell.

For unknown PUCCH SCell activation in FR2, the requirement only apply when UE supports CSI reporting cross PUCCH group capability, and UE is configured with CSI reporting via SpCell. For unknown PUCCH SCell activation in FR1, the requirement only applies when UE supports CSI reporting cross PUCCH group capability, and UE is configured with CSI reporting via SpCell, if ‘ssb-PositionInBurst’ indicates multiple SSBs but TCI state indication is not provided in same MAC PDU with SCell activation.

The requirement for unknown SCell applies provided that the PDCCH order (when applicable) and the activation commands for TCI, UL spatial relation and PL-RS (when applicable) are based on the latest valid L1-RSRP reporting via Primary PUCCH group.

### 8.3.13 SCell activation delay Requirement for Deactivated PUCCH SCell with Multiple SCells

#### 8.3.13.1 Introduction

The requirements in this clause shall apply for the UE configured with multiple deactivated downlink SCells and PUCCH is configured for a SCell, and when PUCCH SCell with downlink SCell(s) are activated by one MAC command.

For EN-DC, NE-DC, and standalone NR, the requirements in this clause shall apply when the following conditions are met:

- UE only receives one single MAC command for multiple SCell activation within the activation period defined in this clause

- in each single CG, there are no other SCell activation, deactivation, addition or release before activation is completed for all the SCells activated by the single MAC CE in this clause, and

- in EN-DC and NE-DC, there are no E-UTRAN SCell activation, deactivation, addition or release before multiple SCell activation is completed in this clause, and

- any to-be-activated unknown non-PUCCH SCell in a different band from to-be-activated PUCCH SCell has active serving cell(s) or known to-be-activated non-PUCCH SCell(s) on the same band.

- All DL SCells being activated in the secondary PUCCH group are unknown if PUCCH SCell being activated is unknown.

Upon receiving SCell activation command in slot *n* for more than one SCell and one among the multiple SCells is PUCCH SCell, the UE shall be able to transmit valid CSI report on PUCCH SCell and apply actions related to the SCell activation command as specified in [7] for the PUCCH SCell being activated no later than in slot *n*+ Tactivate\_total\_PUCCH\_SCell. The UE shall be capable to transmit valid CSI report of other SCell no later than in slot n+ Tactivate\_total\_other\_SCell.

Where:

- Tactivate\_total\_PUCCH\_SCell is ,

- Tactivate\_total\_other\_SCell is

Where:

Tdelay\_multiple\_SCells\_other\_SCell is the SCell activation delay for other SCell when the other SCell is activated with multiple SCells and is given by Tactivation\_time\_multiple\_scells +TCSI\_Reporting.

Tdelay\_multiple\_SCells\_PUCCH\_SCell = Tactivation\_time\_multiple\_scells + max ((TFirst\_available\_CSI + TCSI\_processing), (T1+T2+T3), 3\*Ttarget\_PL-RS) + TCSI\_reporting\_after

- If UE has a Valid TA for transmitting on PUCCH SCell,

- A TA is considered to be valid provided that the *TimeAlignmentTimer* [2] associated with the TAG containing the PUCCH SCell is running.

Tdelay\_multiple\_SCells\_PUCCH\_SCell = Tactivation\_time\_multiple\_scells + 3\*Ttarget\_PL-RS + TCSI\_Reporting

- If UE do not have valid TA for PUCCH SCell,

Tdelay\_multiple\_SCells\_PUCCH\_SCell = Tactivation\_time\_multiple\_scells + max ((TFirst\_available\_CSI + TCSI\_processing), (T1+T2+T3), 3\*Ttarget\_PL-RS) + TCSI\_reporting\_after

Where:

- Tactivation\_time\_multiple\_scells is the target SCell activation delay in millisecond in multiple SCell activation scenario as specified in section 8.3.7.

- Ttarget\_PL-RS is the periodicity of PL-RS resource when PL-RS of target PUCCH SCell is known

- TCSI\_Reporting is the delay (in ms) including uncertainty in acquiring the first available downlink CSI reference resource, UE processing time for CSI reporting and uncertainty in acquiring the first available CSI reporting resources as specified in TS 38.331 [2]. If the CSI for other SCell is reported to PUCCH SCell, CSI reporting delay may include uncertainty of waiting for PUCCH SCell activation completion.

- Tfirst\_available\_CSI: the delay uncertainty in acquiring the first available downlink CSI reference resources for secondary PUCCH group.

- TCSI\_processing: the UE processing time for CSI reporting of secondary group PUCCH SCells.

- TCSI\_reporting\_after the delay uncertainty in acquiring the first available CSI reporting resource after end of max ((TFirst\_available\_CSI + TCSI\_processing), (T1+T2+T3), 3\*Ttarget\_PL-RS)

- T1 is the delay uncertainty in acquiring the first available PDCCH triggered PRACH occasion in the PUCCH SCell after Tactivation\_time\_multiple\_scells.

- T1 is up to the summation of a delay uncertainty for reception of PDCCH order, SSB to PRACH occasion association period and 10 ms, where SSB to PRACH occasion association period is defined in the table 8.1-1 of TS 38.213

- T2 is the delay from slot n + (THARQ + Tactivation\_time\_multiple\_scells + T1)/NR slot length until UE has obtained a valid TA command for the target PUCCH SCell being activated. Slot n is the slot where the UE receives PUCCH SCell activation command.

- T3 is the delay for applying the received TA for uplink transmission on target PUCCH SCell being activated, and greater than or equal to k+1 slot, where k is defined in clause 4.2 in TS 38.213. The starting point and the endpoint of an interruption window on PCell or any activated SCell in MCG for NR standalone mode, or on PSCell or any activated SCell in SCG for EN-DC mode is same as single SCell activation requirement in clause 8.3.2.

Starting from slot n + THARQ + 3 ms where n is the slot where SCell activation command is received (as specified in clause 4.3 of TS 38.213 [3]) and until the SCell activation completion at UE, after at least one CSI-RS transmission occasion for the channel measurement and reporting (specified in clause 5.2.2.5 of TS 38.214 [26]), the UE shall report out of range if the UE has available uplink resources to report CQI for the SCell.

In addition to the interruption due to RF retuning during multiple SCell activation, if the UE is not capable of *parallelTxPRACH-SRS-PUCCH-PUSCH* for inter-band CA, and PRACH on PUCCH SCell and PUCCH/PUSCH/SRS on other active serving cell are fully or partially overlapping in time, the UE shall transmit PRACH on PUCCH SCell and is allowed to drop or cause interruption to SRS or PUCCH or PUSCH transmission on the SpCell or on any activated SCell. Otherwise, UE is not allowed to drop or cause any interruption of SRS or PUCCH or PUSCH transmission on SpCell or on any activated SCell.

Upon receiving SCell activation command in slot *n,* if the start of the first complete SSB used in the *TX* in the different bands which have SCells being activated after *n*+ are not aligned on time domain among

- SCells in different bands being activated by the same MAC CE if UE does not support per FR gap, or

- SCells in different FR1 bands being activated by the same MAC CE if UE supports per FR gap,

additional interruptions may be expected for the activated serving cells, where

- The number of additional interruptions is no more than the number of FR1 bands which have both SCell being activated for which the activation requirements involve *TFirstSSB\_MAX* *multiple\_scells* with *Trs* and the active serving cell, and

- In each interruption occasion, the interruption length is defined in clause 8.2.2.2.2, and

- Longer activation delay may be expected for multiple SCell activation under one MAC CE with multiple interruptions, and

- *TX* is:

- TFirstSSB, for any scenario where Tactivation\_time multiple\_scells includes TFirstSSB;

- TFirstSSB\_MAX multiple\_scells, for any scenario where Tactivation\_time multiple\_scells includes TFirstSSB\_MAX multiple\_scells;

- Tuncertainty\_MAC+TFineTiming or Tuncertainty\_MAC multiple\_scells+TFineTiming, for any scenario where Tactivation\_time multiple\_scells includes TFineTiming.

Otherwise, no additional interruption is expected due to activation of multiple SCells.

[Starting from the slot specified in clause 4.3 of TS 38.213 [3] (timing for secondary Cell activation/deactivation) and until the UE has completed a first L1-RSRP measurement, the UE shall report lowest valid L1 SS-RSRP range if the UE has available uplink resources to report L1-RSRP for the SCell.]

### 8.3.14 SCell Deactivation Delay Requirement for Activated PUCCH SCell

The requirements in this clause shall apply for the UE configured with one SCell configured with PUCCH in EN-DC, or in standalone NR carrier aggregation, or in NE-DC.

Upon receiving PUCCH SCell deactivation command in slot *n*, the UE shall accomplish the deactivation actions for the PUCCH SCell being deactivated no later than in slot *n +*. The starting point of an interruption window on spCell or any activated SCell, as specified in clause 8.2, shall not occur before slot n+1+ and not occur after slot n+1+, where NR slot length is with respect to the numerology used in the PUCCH SCell being deactivated.

The length of the interruption window may be different for different victim cells, and depends on the applicable scenario and on the frequency band relation between the aggressor cell and the victim cell.

### 8.3.15 SCell Deactivation Delay Requirement for Activated PUCCH SCell with Multiple Downlink SCells

The requirements in this clause shall apply for the UE configured with multiple downlink SCells and one SCell configured with PUCCH in EN-DC, or in standalone NR carrier aggregation, or in NE-DC, provided that,

- in each single CG, there are no other SCell activation, deactivation, addition or release before deactivation is completed for all the SCells deactivated by the single MAC CE in this clause, and

- in EN-DC and NE-DC, there are no E-UTRAN SCell activation, deactivation, addition or release before multiple SCell deactivation is completed in this clause, and

- in EN-DC, NE-DC and standalone NR, UE only receives one single MAC command for multiple SCell deactivation within the deactivation period defined in this clause

Upon receiving SCell deactivation command in slot *n*, the UE shall accomplish the deactivation actions for the SCells (including one SCell configured with PUCCH) being deactivated within the same delay as specified in clause 8.3.12.

The starting point and the end-point of an interruption window on PCell or any activated SCell in MCG for NR standalone mode, or on PSCell or any activated SCell in SCG for EN-DC mode is same as single SCell activation requirement in clause 8.3.12.

### 8.3.16 Fast SCell Activation Delay Requirement for Deactivated SCell

Aperiodic CSI-RS resources can be configured for fast SCell activation. The requirements in this clause shall apply for the UE configured with one downlink SCell in EN-DC, or in standalone NR carrier aggregation or in NE-DC or in NR-DC and when one SCell is being activated. The requirements in this clause shall apply for the UE provided with aperiodic CSI-RS resources for SCell activation for the target SCell.

Note: If UE is allocated A-TRS for fast Scell activation, the UE is not required to use the SSB of the target Scell.

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 , where:

THARQ (in ms) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3]

Tactivation\_time is the SCell activation delay in millisecond.

If the SCell is known and belongs to FR1, Tactivation\_time is:

- TFirstATRS+ 5ms, if the measurement period of the SCell being activated is equal to or smaller than [2400ms].

- TFirstATRS + Tgap + TATRS + 5ms, if the measurement period of the SCell being activated is larger than [2400ms].

Note: The RSs on the activated serving cell in the same band are not required to be transmitted in the same slot as the temporary RS.

Note: UE may report inaccurate non-zero CQI for any activated Cell and being activated SCell during the fast SCell activation procedure only if the RSs on the activated serving cell in the same band are not transmitted in the same slot as the aperiodic CSI-RS for fast SCell activation.

If the SCell is unknown and belongs to FR1, and SCell is contiguous to an active serving cell in the same band, provided that the side condition Ês/Iot ≥ -2dB is fulfilled, Tactivation\_time is:

- TFirstATRS + Tgap + TATRS + 5ms, if the following conditions are met,

- the SCell is contiguous to an active serving cell in the same band, and

- its *ssb-PositionInBurst* is same as the one of contiguous FR1 active serving cell, and

- its SMTC offset is same as the one of contiguous FR1 active serving cell, and

- its RTD with contiguous FR1 active serving cell is smaller than or equal to 260ns with respect to the to-be-activated SCell’s SSB numerology, and its reception power difference with contiguous FR1 active serving cell is smaller than or equal to 6dB;

Note: The RSs on the activated serving cell in the same band are not required to be transmitted in the same slot as the temporary RS.

Note: UE may report inaccurate non-zero CQI for any activated SCell and being activated SCell during the fast SCell activation procedure only if the RSs on the activated serving cell in the same band are not transmitted in the same slot as the aperiodic CSI-RS for fast SCell activation.

If the SCell being activated belongs to FR2 and if there is at least one active serving cell on that FR2 band, then Tactivation\_time is TFirstATRS+ 5ms provided:

- The UE is provided with aperiodic CSI-RS resources for SCell activation for the target SCell, and

- The SSBs in the serving cell(s) and the SSBs in the SCell being activated fulfil the condition defined in clause 3.6.3,

- The parameter *ssb-PositionsInBurst* is same for the serving cell(s) and the SCell.

- SSB is in the same half-frame on the SCell and the contiguous FR2 active serving cell

If the SCell being activated belongs to FR2 and if there is no active serving cell on that FR2 band provided that PCell or PSCell is in FR1 or in FR2, and assuming PDCCH TCI and PDSCH TCI (when applicable) are associated with the triggered aperiodic CSI-RS resources for fast SCell activation, and when the following conditions are fulfillied:

- One of the candidate TCI states configured in TCI-StatesPDCCH-ToAddList has the same QCL source of the triggered A-TRS,

- The QCL source of CSI-RS for CQI reporting is the same as the triggered A-TRS,

- The TCI state for PDCCH/PDSCH is the same as A-TRS remain unchanged during SCell activation,

- If the target SCell belongs to FR2 is known to UE and semi-persistent CSI-RS is used for CSI reporting, then Tactivation\_time is:

- 3ms + max(TFirstATRS + 2ms, Tuncertainty\_SP), where Tuncertainty\_SP=0 if UE receives the SCell activation command and semi-persistent CSI-RS activation command at the same time.

- If the target SCell belongs to FR2 is known to UE and periodic CSI-RS is used for CSI reporting, then Tactivation\_time is:

- max(TFirstATRS + 5ms, Tuncertainty\_RRC + TRRC\_delay-THARQ).

where,

TFirstATRS: is the time to the end of the first complete CSI-RS burst for SCell activation after slot n + , where the CSI-RS burst is defined as four CSI-RS resources in two consecutive slots.

TATRS is the CSI-RS burst for SCell activation where the CSI-RS burst is defined as four CSI-RS resources in two consecutive slots.

Tgap is a gap length between two aperiodic CSI-RS bursts,

- at least 2 slots for 15kHz and 30kHz

- at least 3 slots for 60kHz

Tuncertainty\_RRC is the time period between reception of the RRC configuration message for TCI of periodic CSI-RS for CQI reporting (when applicable) relative to SCell activation command.

Tuncertainty\_SP is the time period between reception of the activation command for semi-persistent CSI-RS resource set for CQI reporting relative to SCell activation command for known case.

TRRC\_delay is the RRC procedure delay as specified in TS38.331 [2].

TCSI\_reporting is the delay (in ms) including uncertainty in acquiring the first available downlink CSI reference resource, UE processing time for CSI reporting and uncertainty in acquiring the first available CSI reporting resources as specified in TS 38.331 [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 clause 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 clause 9.2 and 9.3.

Otherwise SCell in FR1 is unknown.

For the first SCell activation in FR2 bands, the SCell is known if it has been meeting the following conditions:

- During the period equal to 4s for UE supporting power class 1/5 and 3s for UE supporting power class 2/3/4 before UE receives the last activation command for PDCCH TCI, PDSCH TCI (when applicable) and semi-persistent CSI-RS for CQI reporting (when applicable):

- the UE has sent a valid L3-RSRP measurement report with SSB index

- SCell activation command is received after L3-RSRP reporting and no later than the time when UE receives MAC-CE command for TCI activation

- During the period from L3-RSRP reporting to the valid CQI reporting, the reported SSBs with indexes remain detectable according to the cell identification conditions specified in clauses 9.2 and 9.3, and the TCI state is selected based on one of the latest reported SSB indexes.

Otherwise, the first SCell in FR2 band is unknown.

In addition to CSI reporting defined above, UE shall also apply other actions related to the activation command specified in TS 38.331 [2] for a SCell at the first opportunities for the corresponding actions once the SCell is activated.

The starting point of an interruption window on spCell or any activated SCell, as specified in clause 8.2, shall not occur before slot n+1+ and not occur after slot slot n+1+, where NR slot length is with respect to the numerology used in the SCell being activated, and TX is:

- TFirstATRS, for any scenario where Tactivation\_time includes TFirstATRS;

The length of the interruption window may be different for different victim cells, and depends on the applicable scenario and on the frequency band relation between the aggressor cell and the victim cell.

The requirements in this clause and requriements on interruption due to SCell activation in clause 8.x apply provided that the SSB and A-TRS of the to-be-activated SCell is within the first active DL BWP of the Scell.

Starting from slot *n* + THARQ + 3 ms where slot *n* is the slot where SCell activation command is received (as specified in clause 4.3 of TS 38.213 [3]) and until the SCell activation completion at UE, after at least one CSI-RS transmission occasion for the channel measurement and reporting (specified in clause 5.2.2.5 of TS 38.214 [26]), the UE shall report out of range if the UE has available uplink resources to report CQI for the SCell.

## 8.3A SCell Activation and Deactivation Delay in Carriers with CCA

### 8.3A.1 Introduction

This clause defines requirements for the delay within which the UE shall be able to activate a deactivated SCell operating with CCA and deactivate an activated SCell operating with CCA in EN-DC or in standalone NR carrier aggregation.

In the requirements of clause 8.3A, the term SMTC occasion not available at the UE refers to when the SMTC contains SSBs configured by gNB in a cell on a carrier frequency subject to CCA, but the first two successive candidate SSB positions for the same SSB index within the discovery burst transmission window are not available at the UE due to DL CCA failures at gNB during the corresponding period; otherwise the SMTC occasion is considered as available at the UE.

In the requirements of clause 8.3A, the term CSI-RS occasion not available at the UE due to DL CCA failures referes to when the CSI-RS is configured by gNB for the UE but not available at the UE due to DL CCA failures at gNB during the corresponding period.

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

### 8.3A.2 SCell Activation Delay Requirement for Deactivated SCell

The requirements in this clause shall apply for the UE configured with one downlink SCell operating with CCA in EN-DC or in standalone NR carrier aggregation and when one SCell operating with CCA is being activated but none of the RRC parameters *CO-DurationPerCell-r16*, *SlotFormatIndicator*, and *CSI-RS-ValidationWith-DCI-r16* is configured and all of the CSI reporting resources for being-activated SCell are available.

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 + (THARQ + Tactivation\_time\_withCCA + TCSI\_reporting\_withCCA)/*NR\_slot\_length*, where:

- THARQ (in ms) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3]. In the event of UE not being able to transmit the acknowledgment due to UL CCA failures: THARQ is extended to also include the time to all next HARQ feedback transmission and retransmission opportunities, until the time of its successful transmission, as specified in TS 38.213 [3]; no extension of THARQ due to UL CCA failures is allowed for Type 2C UL channel access procedure as defined in TS 37.213 [57].

- Tactivation\_time\_withCCA is the SCell activation delay in millisecond.

- If the SCell is known and belongs to FR1, Tactivation\_time\_withCCA is:

- TFirstSSB + L1\*Trs + 5ms, if the measurement period of the SCell being activated is equal to or smaller than 2400ms.

- TFirstSSB\_MAX + L2,1\*TSMTC\_MAX + (1 +L2,2)\*Trs + 5ms, if the measurement period of the SCell being activated is larger than 2400ms.

- If the SCell is unknown and belongs to FR1, provided that the side condition Ês/Iot ≥ -2 dB is fulfilled and the SCell can be successfully detected in one attempt, Tactivation\_time\_withCCA is:

- TFirstSSB\_MAX + (1 + L3,1)\*TSMTC\_MAX + (2 + L3,2)\*Trs + 5ms.- If the SCell being activated belongs to FR2-2 and if there is at least one active serving cell on that FR2-2 band, if the UE supporting *scellWithoutSSB* is not provided with any SMTC for the target SCell, Tactivation\_time\_withCCA is 3 ms, provided

- the RS (s) of SCell being activated is (are) QCL-TypeD with RS (s) of one active serving cell on that FR2-2 band.

- If the SCell being activated belongs to FR2-2 and if there is no active serving cell on that FR2-2 band provided that PCell or PSCell is in FR1 or in FR2-2:

- If the target SCell is known to UE and semi-persistent CSI-RS is used for CSI reporting, then Tactivation\_time\_withCCA is:

- 3ms + max(Tuncertainty\_MAC + TFineTiming + 2ms, Tuncertainty\_SP), where Tuncertainty\_MAC=0 and Tuncertainty\_SP=0 if UE receives the SCell activation command, semi-persistent CSI-RS activation command and TCI state activation command at the same time.

- If the target SCell is known to UE and periodic CSI-RS is used for CSI reporting, then Tactivation\_time is:

- max(Tuncertainty\_MAC + 5ms + TFineTiming, Tuncertainty\_RRC + TRRC\_delay-THARQ), where Tuncertainty\_MAC=0 if UE receives the SCell activation command and TCI state activation commands at the same time.

- If the PCell/PSCell and the target SCell are configured as FR1-FR2-2 CA or if the PCell/PSCell and the target SCell are in a FR2-2 band pair with independent beam management, and the target SCell is unknown to UE and semi-persistent CSI-RS is used for CSI reporting, provided that the side condition Ês/Iot ≥ -2dB is fulfilled, then Tactivation\_time\_withCCA is:

- 6ms + TFirstSSB\_MAX + (23+[N\*L4,1])\*TSMTC\_MAX + (12+[ N \*L4,2])\*Trs + TL1-RSRP, measure + TL1-RSRP, report + THARQ + max(Tuncertainty\_MAC + TFineTiming + 2ms, Tuncertainty\_SP).

- If the PCell/PSCell and the target SCell are configured as FR1-FR2-2 CA or if the PCell/PSCell and the target SCell are in a FR2-2 band pair with independent beam management, and the target SCell is unknown to UE and periodic CSI-RS is used for CSI reporting, provided that the side condition Ês/Iot ≥ -2dB is fulfilled, then Tactivation\_time\_withCCA is:

- 3ms + TFirstSSB\_MAX + (23+[ N\*L5,1])\*TSMTC\_MAX + (12+[ N \*L5,2])\*Trs + TL1-RSRP, measure + TL1-RSRP, report + max {(THARQ + Tuncertainty\_MAC + 5ms + TFineTiming), (Tuncertainty\_RRC + TRRC\_delay)}.

Where,

TSMTC\_MAX:

- In case of intra-band SCell activation, TSMTC\_MAX is the longest 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, TSMTC\_MAX is the SMTC periodicity of SCell being activated;

- TSMTC\_MAX is bounded to a minimum value of 10ms.

Trs is the SMTC periodicity of the SCell being activated if the UE has been provided with an SMTC configuration for the SCell in SCell addition message, otherwise Trs is the SMTC configured in the measObjectNR having the same SSB frequency and subcarrier spacing. If the UE is not provided SMTC configuration or measurement object on this frequency, the requirement which involves Trs is applied with Trs = 5ms assuming the SSB transmission periodicity is 5ms. There are no requirements if the SSB transmission periodicity is not 5ms

TFirstSSB: is the time to the end of the first complete configured SSB burst indicated by the SMTC after slot n + (THARQ+3ms)/*NR\_slot\_length*

TFirstSSB\_MAX: is the time to the end of first complete configured SSB burst indicated by the SMTC after slot n + (THARQ+3ms)/*NR\_slot\_length* when all active serving cells and SCells being activated or released have configured SSB bursts in the same slot for intra-band scenario. In case of inter-band SCell activation, TFirstSSB\_MAX is the time to the end of the first complete configured SSB burst of the SCell being activated. In FR2-2, the occasion when all active serving cells and SCells being activated or released are transmitting SSB bursts in the same slot.

L1 (L1 ≤ L1,max) is the number of configured SMTC occasions not available at the UE. L1,max = 2 if Trs ≤ 40 ms; otherwise L1,max = 1.

L2,1 (L2,1 ≤ L2,1,max) and L3,1 (L3,1 ≤ L3,1,max) are the numbers of configured SMTC occasions not available at the UE, for a known and unknown SCell activation respectively,

in the SCell being activated, for inter-band scenario, or

in any of the SCells already activated or being activated provided their cell specific reference signals are configured in the same slot, for intra-band scenario

and L2,1,max = 2 if TSMTC\_MAX ≤ 40 ms; otherwise L2,1,max = 1. L3,1,max = 2 if TSMTC\_MAX ≤ 40 ms; otherwise L3,1,max = 1.

L2,2 (L2,2 ≤ L2,2,max) and L3,2 (L3,2 ≤ L3,2,max)are the number of configured SMTC occasions not available at the UE in the SCell being activated. L2,2,max = 2 if Trs ≤ 40 ms; otherwise L2,2,max = 1. L3,2,max = 2 if Trs ≤ 40 ms; otherwise L3,2,max = 1.

N = TBD for an FR2-2 unknown SCell activation.

L4,1 (L4,1 ≤ L4,1,max) and L5,1 (L5,1 ≤ L5,1,max) are the numbers of SMTC occasions groups not available at the UE, for an FR2-2 unknown SCell activation,

in the SCell being activated, for inter-band scenario, or

in any of the SCells already activated or being activated provided their cell specific reference signals are configured in the same slot, for intra-band scenario

and L4,1,max = 2 if TSMTC\_MAX ≤ 40 ms; otherwise L4,1,max = 1. L5,1,max = 2 if TSMTC\_MAX ≤ 40 ms; otherwise L5,1,max = 1.

L4,2 (L4,2 ≤ L4,2,max) and L5,2 (L5,2 ≤ L5,2,max)are the number of SMTC occasions groups not available at the UE in the FR2-2 unknown SCell being activated. L4,2,max = 2 if Trs ≤ 40 ms; otherwise L4,2,max = 1. L5,2,max = 2 if Trs ≤ 40 ms; otherwise L5,2,max = 1.

TFineTiming is the time period between UE finish processing the last activation command for PDCCH TCI, PDSCH TCI (when applicable) and the timing of first complete available SSB corresponding to the TCI state.

TL1-RSRP, measure is L1-RSRP measurement delay TL1-RSRP\_Measurement\_Period\_SSB\_CCA msas defined in clause 9.5A.4.1 with the assumption of M=1.

TL1-RSRP, report is delay of acquiring CSI reporting resources.

Tuncertainty\_MAC is the time period between reception of the last activation command for PDCCH TCI, PDSCH TCI (when applicable) relative to

- SCell activation command for known case;

- First valid L1-RSRP reporting for unknown case.

Tuncertainty\_RRC is the time period between reception of the RRC configuration message for TCI of periodic CSI-RS for CQI reporting (when applicable) relative to

- SCell activation command for known case;

- First valid L1-RSRP reporting for unknown case.

Tuncertainty\_SP is the time period between reception of the activation command for semi-persistent CSI-RS resource set for CQI reporting relative to

- SCell activation command for known case;

- First valid L1-RSRP reporting for unknown case.

TRRC\_delay is the RRC procedure delay as specified in TS38.331 [2].

Longer delays for RRM measurement requirements, and in case of FR2-2 also SSB based RLM/BFD/CBD/L1-RSRP measurement requirements, can be expected during the cell detection time for unknown SCell activation.

When *absoluteFrequencySSB* is not configured in *DownlinkConfigCommon* for target SCell but SMTC for target SCell is configured, no requirement would be applied.

TCSI\_reporting\_withCCA = TCSI\_reporting + TCSI\_ReportingDelay , where

TCSI\_reporting is the delay (in ms) including uncertainty in acquiring the first available downlink CSI reference resource, UE processing time for CSI reporting and uncertainty in acquiring the first available CSI reporting resources as specified in TS 38.331 [2].

TCSI\_ReportingDelay is the additional delay in transmission of CSI reporting due to UL CCA failures at the UE. If there are no uplink resources for reporting the valid CSI, then the UE shall use the next available opportunities for reporting the corresponding valid CSI as specified in TS 38.213 [3].

Upon exceeding any of the maximum numbers L1,max, L2,1,max, L2,2,max, L3,1,max, and L3,2,max of SMTC occasions or CSI-RS occasions, respectively, not available at the UE, the UE shall abandon the SCell activation procedure.

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

- During the period equal to max(5 measCycleSCell,  5 DRX cycles) 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 in the SMTC occasions available at the UE, according to the cell identification conditions specified in clause 9.2A and 9.3A.

- the SSB measured during the period equal to max(5 measCycleSCell, 5 DRX cycles) also remains detectable - the SSB measured during the period equal to max(5 measCycleSCell, 5 DRX cycles) also remains detectable in the SMTC occasions available at the UE during the SCell activation delay according to the cell identification conditions specified in clause 9.2A and 9.3A.

Otherwise SCell operating with CCA in FR1 is unknown.

For the first SCell activation with CCA in FR2-2 bands, the SCell is known if it has been meeting the following conditions:

- During the period equal to 4s for UE supporting power class 1/5 and 3s for UE supporting power class 2/3/4 before UE receives the last activation command for PDCCH TCI, PDSCH TCI (when applicable) and semi-persistent CSI-RS for CQI reporting (when applicable):

- the UE has sent a valid L3-RSRP measurement report with SSB index

- SCell activation command is received after L3-RSRP reporting and no later than the time when UE receives MAC-CE command for TCI activation

- During the period from L3-RSRP reporting to the valid CQI reporting, the reported SSBs with indexes remain detectable according to the cell identification conditions specified in clauses 9.2 and 9.3, and the TCI state is selected based on one of the latest reported SSB indexes.

Otherwise, the first SCell with CCA in FR2-2 band is unknown. The requirement for unknown SCell applies provided that the activation commands for PDCCH TCI, PDSCH TCI (when applicable), semi-persistent CSI-RS for CQI reporting (when applicable), and configuration message for TCI of periodic CSI-RS for CQI reporting (when applicable) are based on the latest valid L1-RSRP reporting.

If the UE has been provided with higher layer in TS 38.331 [2] signaling of *smtc2*prior to the activation command, TSMTC\_Scell follows *smtc1* or *smtc2* according to the physical cell ID of the target cell being activated. TSMTC\_MAX follows *smtc1* or *smtc2* according to the physical cell IDs of the target cells being activated and the active serving cells.

In addition to CSI reporting defined above, UE shall also apply other actions related to the activation command specified in TS 38.331 [2] for a SCell at the first opportunities for the corresponding actions once the SCell is activated.

For intra-band CA, the starting point of an interruption window on SpCell or any activated SCell as specified in clause 8.2, shall not occur before slot n+1+ and not occur after slot n+1+ , where TX is:

- TFirstSSB, for known SCell activation when SCell measurement cycle is equal to or smaller than 160ms;

- TFirstSSB\_MAX + L2,1\* TSMTC\_MAX for known SCell activation when SCell measurement cycle is greater than 160ms;

- TFirstSSB\_MAX + L3,1\* TSMTC\_MAX for unknown SCell activation

For inter-band CA, the starting point of an interruption window on SpCell or any activated SCell as specified in clause 8.2, shall not occur before slot n+1+ and not occur after slot n+1+ , where TX is:

- TFirstSSB, for known SCell activation when SCell measurement cycle is equal to, or smaller than, 160ms.

For intra-band CA,

- While the SCell being activated is known with measurement cycle equal to or smaller than 160ms, no more than one interruption is allowed during SCell activation.

- While the SCell being activated is known with measurement cycle greater than 160ms, up to 1+L2,1 interruptions are allowed during SCell activation,

- While the SCell being activated is unknown, up to 1+L3,1 interruptions are allowed during SCell activation. When L3,1>0, performance degradation may be expected on any activated intra-band victim cells during the SCell activation

- For a single interruption (L=0), interruption window length at SCell activation does not depend on DL CCA failures.

For inter-band CA,

- For any active cell in the same band with the SCell being activated, the interruption requirements (i.e. number of interruptions and starting point of an interruption) for intra-band CA apply.

- For any active cell outside the band with the SCell being activated, a single interruption applies

The number of interruptions and length of each interruption window may be different for different victim cells and depends on the applicable scenario and on the frequency band relation between the aggressor cell and the victim cell. For a single interruption (L=0), the interruption window length at SCell activation does not depend on DL CCA failures.

Starting from slot *n* + THARQ + 3 ms where slot *n* is the slot where SCell activation command is received (as specified in clause 4.3 of TS 38.213 [3]) and until the SCell activation completion at UE, after at least one CSI-RS transmission occasion for the channel measurement and reporting (specified in clause 5.2.2.5 of TS 38.214 [26]), the UE shall report out of range if the UE has available uplink resources to report CQI for the SCell.

Starting from the slot specified in clause 4.3 of TS 38.213 [3] (timing for secondary Cell activation/deactivation) and until the UE has completed a first L1-RSRP measurement, the UE shall report lowest valid L1 SS-RSRP range if the UE has available uplink resources to report L1-RSRP for the SCell.

The requirements in this section do not apply when *sCellDeactivationTimer* [2] is not configured and when Tactivation\_time\_withCCA exceeds 1280 ms.

### 8.3A.3 SCell Deactivation Delay Requirement for Activated SCell

The requirements in this clause shall apply for the UE configured with one downlink SCell operating with CCA in EN-DC or in standalone NR carrier aggregation.

Upon receiving SCell deactivation command in slot *n*, the UE shall accomplish the deactivation actions for the SCell being deactivated no later than in slot *n+*(THARQ +3ms)/*NR\_slot\_length*. The starting point of an interruption window on spCell or any activated SCell, as specified in clause 8.2, shall not occur before slot n+1+ and not occur after slot n+1+, where NR slot length is with respect to the numerology used in the SCell being deactivated.

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 +*. The starting point of an interruption window on spCell or any activated SCell, as specified in clause 8.2, shall not occur before slot n+1 and not occur after slot n+1+, where NR slot length is with respect to the numerology used in the SCell being deactivated.The length of the interruption window may be different for different victim cells, and depends on the applicable scenario and on the frequency band relation between the aggressor cell and the victim cell.

The requirements in this section do not apply when *sCellDeactivationTimer* [2] is not configured and when SCell deactivation delay exceeds 1280 ms.

## 8.4 UE UL carrier RRC reconfiguration delay

### 8.4.1 Introduction

The requirements in this clause 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 TUL\_carrier\_config from the end of slot n.

Where

- Slot n is the last slot overlapping with the PDSCH containing the RRC command.

- TUL\_carrier\_config equals the maximum RRC procedure delay defined in clause 11.2 in TS 36.331 [16] if the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it equals the maximum RRC procedure delay defined in clause 12 in TS 38.331 [2].

### 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 TUL\_carrier\_deconfig from the end of slot n.

Where

- Slot n is the last slot overlapping with the PDSCH containing the RRC command.

- TUL\_carrier\_deconfig equals the maximum RRC procedure delay defined in clause 11.2 in TS 36.331 [16] if the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it equals the maximum RRC procedure delay defined in clause 12 in TS 38.331 [2].

## 8.5 Link Recovery Procedures

### 8.5.1 Introduction

The UE shall assess the downlink radio link quality of a serving cell based on the reference signal in the set  as specified in TS 38.213 [3] in order to detect beam failure on:

- PCell in SA, NR-DC, or NE-DC operation mode,

- PSCell in NR-DC and EN-DC operation mode,

- SCell in SA, NR-DC, NE-DC or EN-DC operation mode,

- Deactivated PSCell in NR-DC and EN-DC operation mode

The RS resource configurations in the set  on PCell, PSCell or deactivated PSCell (if configured with *bfd-and-RLM* with value *true*) can be periodic CSI-RS resources and/or SSBs. RS resource configuration in the set  on SCell shall be periodic CSI-RS. UE is not required to perform beam failure detection outside the active DL BWP. UE is not required to meet the requirements in clause 8.5.2 and 8.5.3 if UE does not have set . UE is not required to perform beam failure detection on a deactivated SCell, and also not required to perform beam failure detection on resources which is implicitly configured for a deactivated SCell. When more than 2 periodic CSI-RS resources on a CC are configured in the set  for current SCell or implicitly configured in the set  for other SCell, it is up to UE implementation to select two of CSI-RS resources in active BWP in current CC to perform beam failure detection. UE is not required to perform beam failure detection on a SCell on which  is not configured.

On each RS resource configuration in the set , the UE shall estimate the radio link quality and compare it to the threshold Qout\_LR for the purpose of accessing downlink radio link quality of the serving cell beams.

When a CORESET that the UE uses for monitoring PDCCH includes two TCI states and the UE is provided *sfnSchemePdcch* set to 'sfnSchemeA' or 'sfnSchemeB', the UE shall estimate a single downlink radio link quality to derive a single SNR and compare it to the single thresholds Qout\_LR for the purpose of accessing downlink radio link quality of the serving cell beams. How to compute the single SNR based on two active TCI states is up to UE implementation.

The threshold Qout\_LR is defined as the level at which the downlink radio level link of a given resource configuration on set  cannot be reliably received and shall correspond to the BLERout = 10% block error rate of a hypothetical PDCCH transmission. For SSB based beam failure detection, Qout\_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, Qout\_LR\_CSI-RS is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.5.3.1-1.

Upon request the UE shall deliver configuration indexes from the set as specified in TS 38.213 [3] , to higher layers, and the corresponding L1-RSRP measurement provided that the measured L1-RSRP is equal to or better than the threshold Qin\_LR, which is indicated by higher layer parameter *rsrp-ThresholdSSB*. The UE applies the Qin\_LR threshold to the L1-RSRP measurement obtained from an SSB. The UE applies the Qin\_LR threshold to the L1-RSRP measurement obtained for a CSI-RS resource after scaling a respective CSI-RS reception power with a value provided by higher layer parameter *powerControlOffsetSS*. The RS resource configurations in the set  can be periodic CSI-RS resources or SSBs or both SSB and CSI-RS resources. UE is not required to perform candidate beam detection outside the active DL BWP. UE is not required to perform candidate beam detection on a SCell on which  is not configured.

For a deactivated SCG, the UE may be provided via an RRC reconfiguration message with *tci-info* for PDCCH/PDSCH reception at the transition from deactivated SCG to activated SCG while the SCG is deactivated. After the reception of the RRC reconfiguration message the UE shall perform the BFD on the PSCellof the deactivated SCG using the TCI states accroding to *tci-info* specified in clause 6.3.2 in TS38.331[2]*.*

#### 8.5.1.1 Introduction of Requirement on Link Recovery Procedures for UE configured with relaxed measurement criteria

For the UE supports *bfd-Relaxation-r17* and configured with dedicated signaling *goodServingCellEvaluationBFD*, which is always configured to the UE when the network enables BFD relaxation for the UE as specified in TS 38.331[2], the relaxed requirements defined in clause 8.5.2.4 for SSB based beam failure detection and the relaxed requirements defined in clause 8.5.3.4 for CSI-RS based beam failure detection are allowed to apply to the relaxed BFD measurements on the serving cell after fulfilling the following conditions:

- for the serving cells in intra-band carrier aggregation configured with SSB-based or CSI-RS based RLM on SpCell together with CSI-RS based BFD on SCell, when

- the good serving cell quality criterion defined in clause 5.7.13.2 of TS 38.331 [2] is fulfilled for the serving cell based on the measurements that are configured for SSB-based or CSI-RS based RLM on SpCell together with CSI-RS based BFD on Scell in the intra-band carrier aggregation if the *lowMobilityEvaluationConnected* is not configured, or

- the UE is also configured with *lowMobilityEvaluationConnected* and both low mobility criterion defined in clause 5.7.13.1 of TS 38.331 [2] is fulfilled for a period of TSearchDeltaP-Connected and good serving cell quality criterion defined in clause 5.7.13.2 of TS 38.331 [2] is fulfilled for the serving cell based on the measurements that are configured for SSB-based or CSI-RS based RLM on SpCell together with CSI-RS based BFD on Scell in the intra-band carrier aggregation.

- for other serving cells, when

- the good serving cell quality criterion defined in clause 5.7.13.2 of TS 38.331 [2] is fulfilled for the serving cell configured with BFD-RS if the *lowMobilityEvaluationConnected* is not configured, or

- the UE is also configured with *lowMobilityEvaluationConnected*, and both low mobility criterion defined in clause 5.7.13.1 of TS 38.331 [2] is fulfilled for a period of TSearchDeltaP-Connected and good serving cell quality criterion defined in clause 5.7.13.2 of TS 38.331 [2] is fulfilled for the serving cell configured with BFD-RS.

otherwise, UE shall apply the requirements defined in clause 8.5.2.2 for SSB based beam failure detection and the requirements defined in clause 8.5.3.2 for CSI-RS based beam failure detection. Note that when multiple resources are configured on a serving cell for RLM or BFD evaluation, the good serving cell quality critierion is considered as fulfilled for the serving cell when any resource configured for the cell fulfills the good serving defined in clause 5.7.13.2 of TS 38.331 [2].

The scenario and RS resource configurations in the set  defined in section 8.5.1 apply for this section.

The UE is no longer allowed to relax BFD measurements and apply the relaxed link recovery procedures provided that at least one of the following conditions is met:

- The timer *beamFailureDetectionTimer* is running.

- No DRX is used or DRX cycle is longer than 80ms

### 8.5.2 Requirements for SSB based beam failure detection

#### 8.5.2.1 Introduction

The requirements in this clause apply for each SSB resource in the set  configured for a serving cell, provided that the SSB configured for beam failure detection is actually transmitted within the UE active DL BWP during the entire evaluation period specified in clause 8.5.2.2. The requirements in this clause could not be applicable if UE is required to perform beam failure detection on more than 1 serving cell per band.

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 | 2 |
| 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 (PRBs) | 24 |
| Sub-carrier spacing (kHz) | Same as the SCS of RMSI CORESET |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| 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  estimated over the last TEvaluate\_BFD\_SSB ms period becomes worse than the threshold Qout\_LR\_SSB within TEvaluate\_BFD\_SSB ms period.

The value of TEvaluate\_BFD\_SSB is defined in Table 8.5.2.2-1 or Table 8.5.2.2-4 (deactivated PSCell) for FR1.

The value of TEvaluate\_BFD\_SSB is defined in Table 8.5.2.2-2 or Table 8.5.2.2-5 (deactivated PSCell) for FR2 with scaling factor N=8 for FR2-1 and N=12 for FR2-2, for FR2 power classes other than power class 6 or for FR2 class 6 when *highSpeedMeasFlagFR2-r17* is not configured.

The value of TEvaluate\_BFD\_SSB is defined in Table 8.5.2.2-3 for FR2 power class 6 UE configured with *highSpeedMeasFlagFR2-r17*.

When concurrent gaps are configured,

- P value for a BFD-RS resource to be measured is defined as

- Ntotal / Noutside\_MG in FR1

- Psharing factor \* Ntotal / Noutside\_MG in FR2 with Navailable = 0

- Ntotal / Navailable in FR2 with Navailable > 0

- For a window W of duration max(TL1, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gaps and per-FR measurement gaps within the same FR as serving cell, and starting at the beginning of any BFD-RS resource occasion:

- Ntotal is the total number of BFD-RS resource occasions within the window, including those overlapped with measurement gap occasions or SMTC occasions within the window, and

- Noutside\_MG is the number of BFD-RS resource occasions that are not overlapped with any measurement gap occasion within the window W

- Navailable is the number of BFD-RS resource occasions that are not overlapped with any measurement gap occasion nor any SMTC occasion within the window W

- TL1 is periodicity of the target BFD-RS.

Otherwise, for a UE not supporting *concurrentMeasGap-r17* or when concurrent gaps are not configured,

For FR1,

- , when in the monitored cell there are GAPs configured for intra-frequency, inter-frequency or inter-RAT measurements, which are overlapping with some but not all occasions of the SSB.

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

For FR2

- , when BFD-RS resource is not overlapped with GAPs and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P = Psharing factor, when the BFD-RS resource is not overlapped with GAP and the BFD-RS resource is fully overlapped with SMTC period (TSSB = TSMTCperiod).

- , when the BFD-RS resource is partially overlapped with GAP and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with GAP and

- TSMTCperiod ≠ xRP or

- TSMTCperiod = xRP and TSSB < 0.5\*TSMTCperiod

- , when the BFD-RS resource is partially overlapped with GAP and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with GAP and TSMTCperiod = xRP and TSSB = 0.5\*TSMTCperiod

- , when the BFD-RS resource is partially overlapped with GAP (TSSB <xRP) and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is partially or fully overlapped with GAP.

- , when the BFD-RS resource is partially overlapped with GAP and the BFD-RS resource is fully overlapped with SMTC occasion (TSSB = TSMTCperiod) and SMTC occasion is partially overlapped with GAP (TSMTCperiod < xRP)

where,

- Psharing factor = 1, if the BFD-RS resource outside gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and,

- not overlapped by the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured.

- Psharing factor = 3, otherwise.

- If the high layer in TS 38.331 [2] signaling of *smtc2* is configured, TSMTCperiod corresponds to the value of higher layer parameter *smtc2*; Otherwise TSMTCperiod corresponds to the value of higher layer parameter *smtc1*. TSMTCperiod is the shortest SMTC period among all CCs in the same FR2 band, given the SMTC offset of all CCs in FR2 provided the same offset.

- When a measurement gap is configured and the measurement gap is not NCSG,

- a BFD-RS resource or an SMTC occasion is considered to be overlapped with the GAP if it overlaps a measurement gap occasion, and

- xRP = MGRP

- Otherwise, when NCSG measurement gap is configured,

- a BFD-RS resource or an SMTC occasion is considered to be overlapped with the GAP if

- it overlaps the VIL1 or VIL2 of NCSG, or

it overlaps the ML of NCSG in FR2, and there exists a target carrier to be measured within NCSG that is intra-frequency carrier or inter-frequency carrier in the same band as the serving cell, or inter-frequency carrier in different band as the serving cell and UE does not support IBM between the target carrier and the serving cell,

- and

- xRP = VIRP

- If the UE is configured with Pre-MG, a BFD-RS resource or an SMTC occasion is only considered to be overlapped by the Pre-MG if the Pre-MG is activated.

- When concurrent gaps are configured, a BFD-RS or an SMTC occasion is not considered to be overlapped by a gap occasion if the gap occasion is dropped according to 9.1.8.

Longer evaluation period would be expected if the combination of BFD-RS resource, SMTC occasion and GAP configurations does not meet pervious conditionsFor either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer BFD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

Table 8.5.2.2-1: Evaluation period TEvaluate\_BFD\_SSB for FR1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_SSB (ms) |
| no DRX | Max(50, Ceil(5 × P) × TSSB) |
| DRX cycle ≤ 320ms | Max(50, Ceil(7.5 × P) × Max(TDRX,TSSB)) |
| DRX cycle > 320ms | Ceil(5 × P) × TDRX |
| Note: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length. | |

Table 8.5.2.2-2: Evaluation period TEvaluate\_BFD\_SSB for FR2

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_SSB (ms) |
| no DRX | Max(50, Ceil(5 × P × N) × TSSB) |
| DRX cycle ≤ 320ms | Max(50, Ceil(7.5 × P × N) × Max(TDRX,TSSB)) |
| DRX cycle > 320ms | Ceil(5 × P × N) × TDRX |
| Note: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length. | |

Table 8.5.2.2-3: Evaluation period TEvaluate\_BFD\_SSB for FR2 power class 6 UE configured with *highSpeedMeasFlagFR2-r17*

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_SSB (ms) |
| no DRX | Max(50, Ceil(5 × P × N Note2) × TSSB) |
| DRX cycle ≤ 80ms | Max(50, Ceil(7.5 × P × N Note2) × Max(TDRX,TSSB)) |
| Note 1: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length.  Note 2: scaling factor N=2 when *highSpeedMeasFlagFR2-r17* is configured to set1 or scaling factor N=6 when *highSpeedMeasFlagFR2-r17* is configured to set2. | |

Table 8.5.2.2-4: Evaluation period TEvaluate\_BFD\_SSB for deactivated PSCell in FR1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_SSB (ms) |
| no DRX | Ceil(5 × P) × measCyclePscell |
| DRX cycle ≤ 320ms | Ceil(7.5 × P) × Max(measCyclePscell, TDRX) |
| DRX cycle > 320ms | Ceil(5 × P) × Max(measCyclePscell, TDRX) |
| Note: DRX cycle is the configured DRX cycle of the PSCell. measCyclePSCell is the measurement cycle length of the deactivated PSCell. | |

Table 8.5.2.2-5: Evaluation period TEvaluate\_BFD\_SSB for deactivated PSCell in FR2

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_SSB (ms) |
| no DRX | Ceil(5 × P × N) × measCyclePscell |
| DRX cycle ≤ 320ms | Ceil(7.5 × P × N) × Max(measCyclePscell, TDRX) |
| DRX cycle > 320ms | Ceil(5 × P × N) × Max(measCyclePscell, TDRX) |
| Note: DRX cycle is the configured DRX cycle of the PSCell. measCyclePSCell is the measurement cycle length of the deactivated PSCell. | |

#### 8.5.2.3 Measurement restriction for SSB based beam failure detection

The UE is required to be capable of measuring SSB for BFD without measurement gaps. The UE is required to perform the SSB measurements with measurement restrictions as described in the following scenarios.

For FR1, when the SSB for BFD measurement is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, UE shall be able to measure the SSB for BFD measurement without any restriction;

- If SSB and CSI-RS have different SCS,

- If UE supports *simultaneousRxDataSSB-DiffNumerology*, UE shall be able to measure the SSB for BFD measurement without any restriction;

- If UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both SSB for BFD measurement and CSI-RS. Longer measurement period for SSB based BFD measurement is expected, and no requirements are defined.

For FR2, when the SSB for BFD measurement on one CC is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both SSB for BFD measurement and CSI-RS. Longer measurement period for SSB based BFD measurement is expected, and no requirements are defined.

For FR2, when the SSB for BFD measurement on one CC is in the same or adjacent OFDM symbol as SSB from cell with additional PCI for L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both SSBs. Longer measurement period for SSB based BFD is expected, and no requirements are defined.

For FR2, if the network configures same or mixed numerology between SSB for BFD measurement on one FR2 band and CSI-RS for RLM, BFD, CBD, L1-RSRP or L1-SINR measurement on the other FR2 band, UE shall be able to perform the related SSB based measurements in one band without any measurement restrictions on the other band, provided that UE is capable of independent beam management on this FR2 band pair.

#### 8.5.2.4 Minimum requirement of SSB based beam failure detection for UE fulfilling relaxed measurement criteria

This clause contains minimum requirements for SSB based relaxed beam failure detection.

UE shall be able to evaluate whether the downlink radio link quality on the configured SSB resource in set  estimated over the last TEvaluate\_BFD\_SSB\_Relax ms period becomes worse than the threshold Qout\_LR\_SSB within TEvaluate\_BFD\_SSB\_Relax ms period.

The value of TEvaluate\_BFD\_SSB\_Relax is defined in Table 8.5.2.4-1 for FR1.

The value of TEvaluate\_BFD\_SSB\_Relax is defined in Table 8.5.2.4-2 for FR2 with scaling factor N=8

The value of P is defined in clause 8.5.2.2.

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

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer BFD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

Table 8.5.2.4-1: Evaluation period TEvaluate\_BFD\_SSB\_Relax for FR1

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_BFD\_SSB\_Relax (ms)** |
| Max(TDRX, TSSB) ≤ 80 ms | Max(50 × K3, Ceil(7.5 × K1 × P) × Max(TDRX,TSSB)) |
| 80ms＜Max(TDRX, TSSB) ≤ 160 ms | Max(50, Ceil(7.5 × P) × Max(TDRX,TSSB)) |
| Note 1: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length and no longer than 80ms.  Note 2: K1 is the relaxation factor. K1 = 2 for 40ms＜Max(TDRX, TSSB) ≤ 80 ms, K1 = 4 for Max(TDRX, TSSB) ≤ 40 ms  Note 3: K3 is the relaxation factor for the lower bound. K3 = K1, if 1 < K1 ≤ 2; K3 = 1 otherwise. | |

Table 8.5.2.4-2: Evaluation period TEvaluate\_BFD\_SSB\_Relax for FR2

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_BFD\_SSB\_Relax (ms)** |
| Mas(TDRX, TSSB) ≤ 80 ms | Max(50 × K4, Ceil(7.5 × K2 × P × N) × Max(TDRX,TSSB)) |
| 80ms＜Max(TDRX, TSSB) ≤ 160 ms | Max(50, Ceil(7.5 × P× N) × Max(TDRX,TSSB)) |
| Note 1: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length and no longer than 80ms.  Note 2: K2 is the relaxation factor. K2 = 2.  Note 3: K4 is the relaxation factor for the lower bound. K4 = K2, if 1 < K2 ≤ 2; K4 = 1 otherwise. | |

### 8.5.3 Requirements for CSI-RS based beam failure detection

#### 8.5.3.1 Introduction

The requirements in this clause apply for each CSI-RS resource in the set  of resource configurations for a serving cell, provided that the CSI-RS resource(s) in set for beam failure detection are actually transmitted within the UE active DL BWP during the entire evaluation period specified in clause 8.5.3.2. UE is not expected to perform beam failure detection measurements on the CSI-RS configured for BFD if the CSI-RS is not QCL-ed, with QCL-TypeD when applicable, with the RS in the active TCI state of any CORESET configured in the UE active BWP. The requirements in this clause apply when UE is required to perform beam failure detection on no more than 1 serving cell per band.

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 | 2 |
| 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 (PRBs) | 48 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

#### 8.5.3.2 Minimum requirement

UE shall be able to evaluate whether the downlink radio link quality on the CSI-RS resource in set  estimated over the last TEvaluate\_BFD\_CSI-RS ms period becomes worse than the threshold Qout\_LR\_CSI-RS within TEvaluate\_BFD\_CSI-RS ms period.

The value of TEvaluate\_BFD\_CSI-RS is defined in Table 8.5.3.2-1 or Table 8.5.3.2-3 (deactivated PSCell) for FR1.

The value of TEvaluate\_BFD\_CSI-RS is defined in Table 8.5.3.2-2 or Table 8.5.3.2-4 (deactivated PSCell) for FR2 with N=1. The requirements of TEvaluate\_BFD\_CSI-RS apply provided that the CSI-RS for BFD is not in a resource set configured with repetition ON. The requirements shall not apply when the CSI-RS resource in the active TCI state of CORESET is the same CSI-RS resource for BFD and the TCI state information of the CSI-RS resource is not given, wherein the TCI state information means QCL Type-D to SSB for L1-RSRP or CSI-RS with repetition ON.

When concurrent gaps are configured,

- P value for a BFD-RS resource to be measured is defined as

- Ntotal / Noutside\_MG in FR1

- Psharing factor \* Ntotal / Noutside\_MG in FR2 with Navailable = 0

- Ntotal / Navailable in FR2 with Navailable > 0

- For a window W of duration max(TL1, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gaps and per-FR measurement gaps within the same FR as serving cell, and starting at the beginning of any BFD-RS resource occasion:

- Ntotal is the total number of BFD-RS resource occasions within the window, including those overlapped with measurement gap occasions or SMTC occasions within the window, and

- Noutside\_MG is the number of BFD-RS resource occasions that are not overlapped with any measurement gap occasion within the window W

- Navailable is the number of BFD-RS resource occasions that are not overlapped with any measurement gap occasion nor any SMTC occasion within the window W

TL1 is periodicity of the target BFD-RS.

Otherwise, for a UE not supporting *concurrentMeasGap-r17* or when concurrent gaps are not configured,

For FR1,

- , when in the monitored cell there are GAPs configured for intra-frequency, inter-frequency or inter-RAT measurements, which are overlapping with some but not all occasions of the CSI-RS.

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

For FR2,

- P = 1, when the BFD-RS resource is not overlapped with GAP and also not overlapped with SMTC occasion.

- , when the BFD-RS resource is partially overlapped with GAP and the BFD-RS resource is not overlapped with SMTC occasion (TCSI-RS < xRP)

- , when the BFD-RS resource is not overlapped with GAP and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod).

- P = Psharing factor, when the BFD-RS resource is not overlapped with GAP and the BFD-RS resource is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod).

- , when the BFD-RS resource is partially overlapped with GAP and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with GAP and

- TSMTCperiod ≠ xRP or

- TSMTCperiod = xGRP and TCSI-RS < 0.5 × TSMTCperiod

- , when the BFD-RS resource is partially overlapped with GAP and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with GAP and TSMTCperiod = xRP and TCSI-RS = 0.5 × TSMTCperiod

- , when the BFD-RS resource is partially overlapped with GAP (TCSI-RS < xRP) and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is partially or fully overlapped with GAP.

- , when the BFD-RS resource is partially overlapped with [measurement gap] and the BFD-RS resource is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod) and SMTC occasion is partially overlapped with GAP (TSMTCperiod < xRP)

where,

- Psharing factor = 1, if the BFD-RS resource outside gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and,

- not overlapped by the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured.

- Psharing factor = 3, otherwise.

- If the high layer in TS 38.331 [2] signaling of *smtc2* is configured, TSMTCperiod corresponds to the value of higher layer parameter *smtc2*; Otherwise TSMTCperiod corresponds to the value of higher layer parameter *smtc1*. TSMTCperiod is the shortest SMTC period among all CCs in the same FR2 band, provided the SMTC offset of all CCs in FR2 have the same offset.

- When a measurement gap is configured and the measurement gap is not NCSG,

- a BFD-RS resource or an SMTC occasion is considered to be overlapped with the GAP if it overlaps a measurement gap occasion, and

- xRP = MGRP

- Otherwise, when NCSG measurement gap is configured,

- a BFD-RS resource or an SMTC occasion is considered to be overlapped with the GAP if

- it overlaps the VIL1 or VIL2 of NCSG, or

- it overlaps the ML of NCSG in FR2, and there exists a target carrier to be measured within NCSG that is intra-frequency carrier or inter-frequency carrier in the same band as the serving cell, or inter-frequency carrier in different band as the serving cell and UE does not support IBM between the target carrier and the serving cell,

- and

- xRP = VIRP

- If the UE is configured with Pre-MG, a BFD-RS resource or an SMTC occasion is only considered to be overlapped by the Pre-MG if the Pre-MG is activated.

- When concurrent gaps are configured, a BFD-RS or an SMTC occasion is not considered to be overlapped by a gap occasion if the gap occasion is dropped according to 9.1.8.

Note: The overlap between CSI-RS for BFD and SMTC means that CSI-RS for BFD is within the SMTC window duration.

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

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer BFD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of MBFD used in Table 8.5.3.2-1 and Table 8.5.3.2-2 are defined as

- MBFD = 10, if the CSI-RS resource(s) in set  used for BFD is transmitted with Density = 3 and over the bandwidth ≥ 24 PRBs.

The values of PBFD used in Table 8.5.3.2-1 and Table 8.5.3.2-2 are defined as

For each CSI-RS resource in the set  configured for PCell or PSCell in EN-DC or NE-DC or SA; or PCell in NR-DC

- PBFD = 1.

For each CSI-RS resource in the set  configured for PSCell in NR-DC

- PBFD = 2 if UE is configured for beam failure detection on SCell, 1 otherwise.

For each CSI-RS resource in the set  configured for a SCell

- PBFD = Z in EN-DC or NE-DC or SA.

- PBFD = 2\* Z in NR-DC.

- Where Z is the number of band(s) on which UE is performing beam failure detection only for SCell.

Table 8.5.3.2-1: Evaluation period TEvaluate\_BFD\_CSI-RS for FR1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_CSI-RS (ms) |
| no DRX | Max(50, Ceil(MBFD × P × PBFD) × TCSI-RS) |
| DRX cycle ≤ 320ms | Max(50, Ceil(1.5 × MBFD × P × PBFD) × Max(TDRX, TCSI-RS)) |
| DRX cycle > 320ms | Ceil(MBFD × P × PBFD) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length. | |

Table 8.5.3.2-2: Evaluation period TEvaluate\_BFD\_CSI-RS for FR2

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_CSI-RS (ms) |
| no DRX | Max(50, Ceil(MBFD × P × N × PBFD) × TCSI-RS) |
| DRX cycle ≤ 320ms | Max(50, Ceil(1.5 × MBFD × P × N × PBFD) × Max(TDRX, TCSI-RS)) |
| DRX cycle > 320ms | Ceil(MBFD × P × N × PBFD) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length. | |

Table 8.5.3.2-3: Evaluation period TEvaluate\_BFD\_CSI-RS for deactivated PSCell in FR1

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_BFD\_CSI-RS (ms)** |
| no DRX | Ceil(MBFD × P × PBFD) × measCyclePscell |
| DRX cycle ≤ 320ms | Ceil(1.5 × MBFD × P × PBFD) × Max(TDRX, measCyclePscell) |
| DRX cycle > 320ms | Ceil(MBFD × P × PBFD) × Max(TDRX, measCyclePscell) |
| Note: DRX cycle is the configured DRX cycle of the PSCell. measCyclePSCell is the measurement cycle length of the deactivated PSCell. | |

Table 8.5.3.2-4: Evaluation period TEvaluate\_BFD\_CSI-RS for deactivated PSCell in FR2

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_BFD\_CSI-RS (ms)** |
| no DRX | Ceil(MBFD × P × N × PBFD) × measCyclePscell |
| DRX cycle ≤ 320ms | Ceil(1.5 × MBFD × P × N × PBFD) × Max(TDRX, measCyclePscell) |
| DRX cycle > 320ms | Ceil(MBFD × P × N × PBFD) × Max(TDRX, measCyclePscell) |
| Note: DRX cycle is the configured DRX cycle of the PSCell. measCyclePSCell is the measurement cycle length of the deactivated PSCell. | |

#### 8.5.3.3 Measurement restrictions for CSI-RS beam failure detection

The SSB mentioned in this clause can be associated with either the serving cell PCI or a PCI different from serving cell PCI.

The UE is required to be capable of measuring CSI-RS for BFD without measurement gaps. The UE is required to perform the CSI-RS measurements with measurement restrictions as described in the following scenarios.

For both FR1 and FR2, when the CSI-RS for BFD measurement is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, UE is not required to receive CSI-RS for BFD measurement in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for BFD measurement, the UE shall be able to perform CSI-RS measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for BFD measurement, the UE shall be able to perform CSI-RS measurement with restrictions according to its capabilities:

- If the UE supports *simultaneousRxDataSSB-DiffNumerology* the UE shall be able to perform CSI-RS measurement without restrictions.

- If the UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both CSI-RS for BFD measurement and SSB. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.

For FR1, when the CSI-RS for BFD measurement is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, UE shall be able to measure the CSI-RS for BFD measurement without any restriction.

For FR2, when the CSI-RS for BFD measurement on one CC is in the same OFDM symbol as SSB for RLM, BFD or L1-RSRP measurement on the same CC or different CCs in the same band, or in the same symbol as SSB for CBD measurement on the same CC or different CCs in the same band when beam failure is detected, UE is required to measure one of but not both CSI-RS for BFD measurement and SSB. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.

For FR2, when the CSI-RS for BFD measurement on one CC is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band,

- In the following cases, UE is required to measure one of but not both CSI-RS for BFD measurement and the other CSI-RS. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.

- The CSI-RS for BFD measurement or the other CSI-RS in a resource set configured with repetition ON, or

- The other CSI-RS is configured in set  and beam failure is detected, or

- The two CSI-RS-es are not QCL-ed w.r.t. QCL-TypeD, or the QCL information is not known to UE,

- Otherwise, UE shall be able to measure the CSI-RS for BFD measurement without any restriction.

#### 8.5.3.4 Minimum requirement of CSI-RS based beam failure detection for UE fulfilling relaxed measurement criteria

This clause contains the minimum requirements for CSI-RS based relaxed beam failure detection.

UE shall be able to evaluate whether the downlink radio link quality on the CSI-RS resource in set  estimated over the last TEvaluate\_BFD\_CSI-RS\_Relax ms period becomes worse than the threshold Qout\_LR\_CSI-RS within TEvaluate\_BFD\_CSI-RS\_Relax ms period.

The value of TEvaluate\_BFD\_CSI-RS\_Relax is defined in Table 8.5.3.4-1 for FR1.

The value of TEvaluate\_BFD\_CSI-RS\_Relax is defined in Table 8.5.3.4-2 for FR2 with N=1.

The values of P, MBFD and PBFD is defined in clause 8.5.3.2.

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

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

Table 8.5.3.4-1: Evaluation period TEvaluate\_BFD\_CSI-RS\_Relax for FR1

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_BFD\_CSI-RS Relax (ms)** |
| Max(TDRX, TCSI-RS) ≤ 80 ms | Max(50 × K3, Ceil(K1 × 1.5 × MBFD × P × PBFD) × Max(TDRX, TCSI-RS)) |
| Note 1: TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length and no longer than 80ms.  Note 2: K1 is the relaxation factor. K1 = 2 for 40 ms < MAX(TDRX, TCSI-RS) ≤ 80 ms, K1 = 4 for MAX(TDRX, TCSI-RS) ≤ 40 ms  Note 3: K3 is the relaxation factor for the lower bound. K3 = K1, if 1 < K1 ≤ 2; K3 = 1 otherwise. | |

Table 8.5.3.4-2: Evaluation period TEvaluate\_BFD\_CSI-RS\_Relax for FR2

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_BFD\_CSI-RS Relax (ms)** |
| Max(TDRX, TCSI-RS) ≤ 80ms | Max(50 × K4, Ceil(K2 × 1.5 × MBFD × P× N × PBFD) × Max(TDRX, TCSI-RS)) |
| Note 1: TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length and no longer than 80ms.  Note 2: K2 is the relaxation factor. K2 = 2  Note 3: K4 is the relaxation factor for the lower bound. K4 = K2, if 1 < K2 ≤ 2; K4 = 1 otherwise. | |

### 8.5.4 Minimum requirement for L1 indication

When the radio link quality on all the RS resources in set  is worse than Qout\_LR, layer 1 of the UE shall send a beam failure instance indication to the higher layers

The beam failure instance evaluation for the RS resources in set  shall be performed as specified in clause 6 in TS 38.213 [3]. Two successive indications from layer 1 shall be separated by at least TIndication\_interval\_BFD.

When DRX is not used, TIndication\_interval\_BFD is max(2ms, TSSB-RS,M) ) or max(2ms, TCSI-RS,M), where TSSB-RS,M and TCSI-RS,M is the shortest periodicity of all RS resources in set  for the accessed cell, corresponding to either the shortest periodicity of the SSB in the set  or CSI-RS resource in the set .

When DRX is used, for SSB based link quality measurement,

- TIndication\_interval\_BFD = Max(1.5 × DRX\_cycle\_length, 1.5 × TSSB-RS,M), if DRX\_cycle\_length ≤ 320ms,

- TIndication\_interval\_BFD = DRX\_cycle\_length, if DRX\_cycle\_length > 320ms.

When DRX is used, for CSI-RS based link quality measurement,

- TIndication\_interval\_BFD = Max(1.5 × DRX\_cycle\_length, 1.5 × TCSI-RS,M), if DRX\_cycle\_length ≤ 320ms,

- TIndication\_interval\_BFD = DRX\_cycle\_length, if DRX\_cycle\_length > 320ms.

For deactivated PSCell,

when DRX is not used, TIndication\_interval\_BFD is Max (2ms, *measCyclePSCell*).

when DRX is used, for SSB based link quality measurement,

- TIndication\_interval\_BFD = Max (1.5 × DRX\_cycle\_length, 1.5 × *measCyclePSCell*), if DRX\_cycle\_length ≤ 320ms,

- TIndication\_interval\_BFD = Max (DRX\_cycle\_length, *measCyclePSCell*), if DRX\_cycle\_length > 320ms.

When DRX is used, for CSI-RS based link quality measurement,

- TIndication\_interval\_BFD = Max (1.5 × DRX\_cycle\_length, 1.5 × *measCyclePSCell*), if DRX\_cycle\_length ≤ 320ms,

- TIndication\_interval\_BFD = Max (DRX\_cycle\_length, *measCyclePSCell*), if DRX\_cycle\_length > 320ms.

### 8.5.5 Requirements for SSB based candidate beam detection

#### 8.5.5.1 Introduction

The requirements in this clause apply for each SSB resource in the set  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 clause 8.5.5.2. The requirements in this clause apply when UE is required to perform beam failure detection on no more than 1 serving cell per band.

#### 8.5.5.2 Minimum requirement

Upon request the UE shall be able to evaluate whether the L1-RSRP measured on the configured SSB resource in set  estimated over the last TEvaluate\_CBD\_SSB ms period becomes better than the threshold Qin\_LR provided SSB\_RP and SSB Ês/Iot are according to Annex Table B.2.4.1 for a corresponding band.

The UE shall monitor the configured SSB resources using the evaluation period in table 8.5.5.2-1 and 8.5.5.2-2 corresponding to the non-DRX mode, if the configured DRX cycle ≤ 320ms.

The value of TEvaluate\_CBD\_SSB is defined in Table 8.5.5.2-1 for FR1.

The value of TEvaluate\_CBD\_SSB is defined in Table 8.5.5.2-2 for FR2 with scaling factor N=8 for FR2-1 and N=12 for FR2-2.

When concurrent gaps are configured,

- P value for a CBD-RS resource to be measured is defined as

- Ntotal / Noutside\_MG in FR1

- Psharing factor \* Ntotal / Noutside\_MG in FR2 with Navailable = 0

- Ntotal / Navailable in FR2 with Navailable > 0

- For a window W of duration max(TL1, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gaps and per-FR measurement gaps within the same FR as serving cell, and starting at the beginning of any CBD-RS resource occasion:

- Ntotal is the total number of CBD-RS resource occasions within the window, including those overlapped with measurement gap occasions or SMTC occasions within the window, and

- Noutside\_MG is the number of CBD-RS resource occasions that are not overlapped with any measurement gap occasion within the window W

- Navailable is the number of CBD-RS resource occasions that are not overlapped with any measurement gap occasion nor any SMTC occasion within the window W

- TL1 is periodicity of the target CBD-RS.

Otherwise, for a UE not supporting *concurrentMeasGap-r17* or when concurrent gaps are not configured,

For FR1,

- , when in the monitored cell there are GAPs configured for intra-frequency, inter-frequency or inter-RAT measurements, which are overlapping with some but not all occasions of the SSB,

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

For FR2,

- , when candidate beam detection RS is not overlapped with GAP and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P is Psharing factor, when candidate beam detection RS is not overlapped with GAP and candidate beam detection RS is fully overlapped with SMTC period (TSSB = TSMTCperiod).

- , when candidate beam detection RS is partially overlapped with GAP and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with GAP and

- TSMTCperiod ≠ xRP or

- TSMTCperiod = xRP and TSSB < 0.5 × TSMTCperiod

- , when candidate beam detection RS is partially overlapped with GAP and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with GAP and TSMTCperiod = xRP and TSSB = 0.5 × TSMTCperiod

- , when candidate beam detection RS is partially overlapped with GAP and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is partially or fully overlapped with GAP

- , when candidate beam detection RS is partially overlapped with [measurement gap] and candidate beam detection RS is fully overlapped with SMTC occasion (TSSB = TSMTCperiod) and SMTC occasion is partially overlapped with GAP (TSMTCperiod < xRP)

where,

- Psharing factor = 1, if the CBD-RS resource outside gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and,

- not overlapped by the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured.

- Psharing factor = 3, otherwise.

- If the high layer in TS 38.331 [2] signaling of *smtc2*is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1.* TSMTCperiod is the shortest SMTC period among all CCs in the same FR2 band, provided the SMTC offset of all CCs in FR2 have the same offset.

- If the UE is configured with Pre-MG, a CBD-RS resource or an SMTC occasion is only considered to be overlapped by the Pre-MG if the Pre-MG is activated.

- When a measurement gap is configured and the measurement gap is not NCSG,

- a CBD-RS resource or an SMTC occasion is considered to be overlapped with the GAP if it overlaps a measurement gap occasion, and

- xRP = MGRP

- Otherwise, when NCSG is measurement gap configured,

- a CBD-RS resource or an SMTC occasion is considered to be overlapped with the GAP if

- it overlaps the VIL1 or VIL2 of NCSG, or

- it overlaps the ML of NCSG in FR2, and there exists a target carrier to be measured within NCSG that is intra-frequency carrier or inter-frequency carrier in the same band as the serving cell, or inter-frequency carrier in different band as the serving cell and UE does not support IBM between the target carrier and the serving cell,

- and

- xRP = VIRP

- When concurrent gaps are configured, a CBD-RS or an SMTC occasion is not considered to be overlapped by a gap occasion if the gap occasion is dropped according to 9.1.8.

Longer evaluation period would be expected if the combination of the CBD-RS resource, SMTC occasion and GAP configurations does not meet pervious conditions.

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer CBD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of PCBD used in Table 8.5.5.2-1 and Table 8.5.5.2-2 are defined as

For each SSB resource in the set  configured for PCell or PSCell in EN-DC or NE-DC or SA; or PCell in NR-DC

- PCBD = 1.

For each SSB resource in the set  configured for PSCell in NR-DC

- PCBD = 2 if UE is configured for candidate beam detection on SCell, 1 otherwise.

For each SSB resource in the set  configured for a SCell

- PCBD = Z in EN-DC or NE-DC or SA.

- PCBD = 2\* Z in NR-DC.

- Where Z is the number of band(s) on which UE is performing beam failure detection only for SCell

- PCBD is the number of band(s) on which UE is performing candidate beam detection only for SCell.

Table 8.5.5.2-1: Evaluation period TEvaluate\_CBD\_SSB for FR1

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_SSB (ms)** |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(3 × P × PCBD) × TSSB) |
| DRX cycle > 320ms | Ceil(3 × P × PCBD) × TDRX |
| Note: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length. | |

Table 8.5.5.2-2: Evaluation period TEvaluate\_CBD\_SSB for FR2

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_SSB (ms)** |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(3 × P × N × PCBD) × TSSB) |
| DRX cycle > 320ms | Ceil(3 × P × N × PCBD) × TDRX |
| Note: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length. | |

#### 8.5.5.3 Measurement restriction for SSB based candidate beam detection

For FR1, when the SSB for CBD measurement is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, UE shall be able to measure the SSB for CBD measurement without any restrictions;

- If SSB and CSI-RS have different SCS-es,

- If UE supports *simultaneousRxDataSSB-DiffNumerology*, UE shall be able to measure the SSB for CBD measurement without any restriction;

- If UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both SSB for CBD measurement and CSI-RS. Longer measurement period for SSB based CBD measurement is expected, and no requirements are defined.

For FR2, when the SSB for CBD measurement on one CC is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both SSB for CBD measurement and CSI-RS. Longer measurement period for SSB based CBD measurement is expected, and no requirements are defined.

For FR2, when the SSB for CBD measurement on one CC is in the same OFDM symbol as SSB from cell with additional PCI for BFD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both SSBs. Longer measurement period for SSB based CBD measurement is expected, and no requirements are defined.

For FR2, if network configures same or mixed numerology between SSB for CBD measurement on one FR2 band and CSI-RS for RLM, BFD, CBD, L1-RSRP or L1-SINR measurement on the other FR2 band, UE shall be able to perform the related SSB based measurements in one band without any measurement restrictions in the other band, provided that UE is capable of independent beam management on this FR2 band pair.

### 8.5.6 Requirements for CSI-RS based candidate beam detection

#### 8.5.6.1 Introduction

The requirements in this clause apply for each CSI-RS resource in the set  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 clause 8.5.6.2. The requirements in this clause apply when UE is required to perform beam failure detection on no more than 1 serving cell per band.

#### 8.5.6.2 Minimum requirement

Upon request the UE shall be able to evaluate whether the L1-RSRP measured on the configured CSI-RS resource in set  estimated over the last TEvaluate\_CBD\_CSI-RS [ms] period becomes better than the threshold Qin\_LR within TEvaluate\_CBD\_CSI-RS [ms] period provided CSI-RS Ês/Iot is according to Annex Table B.2.4.2 for a corresponding band.

The UE shall monitor the configured CSI-RS resources using the evaluation period in table 8.5.6.2-1 and 8.5.6.2-2 corresponding to the non-DRX mode, if the configured DRX cycle ≤ 320ms.

The value of TEvaluate\_CBD\_CSI-RS is defined in Table 8.5.6.2-1 for FR1.

The value of TEvaluate\_CBD\_CSI-RS is defined in Table 8.5.6.2-2 for FR2 with scaling factor N=8 for FR2-1 and N=12 for FR2-2.

When concurrent gaps are configured,

- P value for a CBD-RS resource to be measured is defined as

- Ntotal / Noutside\_MG in FR1

- Psharing factor \* Ntotal / Noutside\_MG in FR2 with Navailable = 0

- Ntotal / Navailable in FR2 with Navailable > 0

- For a window W of duration max(TL1, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gaps and per-FR measurement gaps within the same FR as serving cell, and starting at the beginning of any CBD-RS resource occasion:

- Ntotal is the total number of CBD-RS resource occasions within the window, including those overlapped with measurement gap occasions or SMTC occasions within the window, and

- Noutside\_MG is the number of CBD-RS resource occasions that are not overlapped with any measurement gap occasion within the window W

- Navailable is the number of CBD-RS resource occasions that are not overlapped with any measurement gap occasion nor any SMTC occasion within the window W

- TL1 is periodicity of the target CBD-RS.

Otherwise, for a UE not supporting *concurrentMeasGap-r17* or when concurrent gaps are not configured,

For FR1,

- , when in the monitored cell there are 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 GAPs overlapping with any occasion of the CSI-RS.

For FR2,

- P = 1, when candidate beam detection RS is not overlapped with GAP and also not overlapped with SMTC occasion.

- when candidate beam detection RS is partially overlapped with GAP and candidate beam detection RS is not overlapped with SMTC occasion (TCSI-RS < xRP)

- , when candidate beam detection RS is not overlapped with GAP and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod).

- P =Psharing factor, when candidate beam detection RS is not overlapped with GAP and candidate beam detection RS is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod).

- ,, when candidate beam detection RS is partially overlapped with GAP and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with GAP and

- TSMTCperiod ≠ xRP or

- TSMTCperiod = xRP and TCSI-RS < 0.5 × TSMTCperiod

- , when candidate beam detection RS is partially overlapped with GAP and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with GAP and TSMTCperiod = xRP and TCSI-RS = 0.5 × TSMTCperiod

- , when candidate beam detection RS is partially overlapped with GAP and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is partially or fully overlapped with GAP

- ,, when candidate beam detection RS is partially overlapped with GAP and candidate beam detection RS is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod) and SMTC occasion is partially overlapped with GAP (TSMTCperiod < xRP)

where,

- Psharing factor = 1, if the CBD-RS resource outside gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and,

- not overlapped by the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured.

- Psharing factor = 3, otherwise.

- If the high layer in TS 38.331 [2] signaling of *smtc2* is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1*. TSMTCperiod is the shortest SMTC period among all CCs in the same FR2 band, provided the SMTC offset of all CCs in FR2 have the same offset.

- If the UE is configured with Pre-MG, a CBD-RS resource or an SMTC occasion is only considered to be overlapped by the Pre-MG if the Pre-MG is activated.

- When a measurement gap is configured and the measurement gap is not NCSG,

- a CBD-RS resource or an SMTC occasion is considered to be overlapped with the GAP if it overlaps the measurement gap occasion, and

- xRP = MGRP

- Otherwise, when NCSG measurement gap is configured,

- a CBD-RS resource or an SMTC occasion is considered to be overlapped with the GAP if

- it overlaps the VIL1 or VIL2 of NCSG, or

- it overlaps the ML of NCSG in FR2, and there exists a target carrier to be measured within NCSG that is intra-frequency carrier or inter-frequency carrier in the same band as the serving cell, or inter-frequency carrier in different band as the serving cell and UE does not support IBM between the target carrier and the serving cell,

- and

- xRP = VIRP

- When concurrent gaps are configured, a CBD-RS or an SMTC occasion is not considered to be overlapped by a gap occasion if the gap occasion is dropped according to 9.1.8.

Note: The overlap between CSI-RS for CBD and SMTC means that CSI-RS for CBD is within the SMTC window duration.

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

Longer evaluation period would be expected if the CSI-RS is on the same OFDM symbols with RLM, BFD, BM-RS, or other CBD-RS, according to the measurement restrictions defined in clause 8.5.6.3.

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer CBD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of MCBD used in Table 8.5.6.2-1 and Table 8.5.6.2-2 are defined as

- MCBD = 3, if the CSI-RS resource configured in the set  is transmitted with Density = 3 and over the bandwidth ≥ 24 PRBs.

The values of PCBD used in Table 8.5.6.2-1 and Table 8.5.6.2-2 are defined as

- For each CSI-RS resource in the set  configured for PCell or PSCell in EN-DC or NE-DC or SA; or PCell in NR-DC

- PCBD = 1.

- For each CSI-RS resource in the set  configured for PSCell in NR-DC

- PCBD = 2 if UE configured for candidate beam detection on SCell, 1 otherwise.

- For each CSI-RS resource in the set  configured for a SCell

- PCBD = Z in EN-DC or NE-DC or SA.

- PCBD = 2\* Z in NR-DC.

- Where Z is the number of band(s) on which UE is performing beam failure detection only for SCell

- PCBD is the number of band(s) on which UE is performing candidate beam detection only for SCell.

Table 8.5.6.2-1: Evaluation period TEvaluate\_CBD\_CSI-RS for FR1

|  |  |
| --- | --- |
| **Configuration** | **TEvaluateC\_CBD\_CSI-RS (ms)** |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(MCBD × P × PCBD) × TCSI-RS) |
| DRX cycle > 320ms | Ceil(MCBD × P × PCBD) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length. | |

Table 8.5.6.2-2: Evaluation period TEvaluate\_CBD\_CSI-RS for FR2

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_CSI-RS (ms)** |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(MCBD × P × N × PCBD) × TCSI-RS) |
| DRX cycle > 320ms | Ceil(MCBD × P × N × PCBD) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length. | |

#### 8.5.6.3 Measurement restriction for CSI-RS based candidate beam detection

The SSB mentioned in this clause can be associated with either the serving cell PCI or a PCI different from serving cell PCI.

For both FR1 and FR2, when the CSI-RS for CBD measurement is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, UE is not required to receive CSI-RS for CBD measurement in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for CBD measurement, the UE shall be able to perform CSI-RS based CBD measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for CBD measurement, the UE shall be able to perform CSI-RS based CBD measurement with restrictions according to its capabilities:

- If the UE supports *simultaneousRxDataSSB-DiffNumerology* the UE shall be able to perform CSI-RS based CBD measurement for without restrictions.

- If the UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both CSI-RS for CBD measurement and SSB. Longer measurement period for CSI-RS based CBD measurement is expected, and no requirements are defined.

For FR1, when the CSI-RS for CBD measurement is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, UE shall be able to measure the CSI-RS for CBD measurement without any restriction.

For FR2, when the CSI-RS for CBD measurement on one CC is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both CSI-RS for CBD measurement and SSB. Longer evaluation period for CSI-RS based CBD measurement is expected, and no requirements are defined.

For FR2, when the CSI-RS for CBD measurement on one CC is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both CSI-RS for CBD measurement and the other CSI-RS. Longer evaluation period for CSI-RS based CBD measurement is expected, and no requirements are defined.

### 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 and CSI-RS configured for BFD with the same SCS as PDSCH or 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 when SSB is configured as BFD. For UEs which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to beam failure detection when SSB is configured as BFD.

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

When intra-band carrier aggregation in FR1 is configured, the scheduling restrictions on FR1 serving PCell or PSCell apply to all serving cells in the same band on the symbols that fully or partially overlap with restricted symbols. 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.

- For the case where no RSs are provided for BFD, or when CSI-RS is configured for BFD is explicitly configured and is type-D QCLed with active TCI state for PDCCH or PDSCH, and the CSI-RS is not in a CSI-RS resource set with repetition ON

- There are no scheduling restrictions due to beam failure detection performed based on the CSI-RS.

- Otherwise

- For FR2-1 or the BFD-RS is not using 480 kHz SCS or 960 kHz SCS on FR2-2, the UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on BFD-RS resource symbols to be measured for beam failure detection.

- For FR2-2 and the BFD-RS is using 480 kHz SCS or 960 kHz SCS, the UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on BFD-RS resource symbols to be measured for beam failure detection, and on one data symbol before each BFD-RS symbol to be measured and one data symbol after each BFD-RS symbol to be measured.

When intra-band carrier aggregation in FR2 is performed, the scheduling restrictions on FR2 serving PCell or PSCell apply to all serving cells in the same band on the symbols that fully or partially overlap with restricted symbols.

When inter-band carrier aggregation in FR2 is performed, there are no scheduling restrictions on FR2 serving cells in the bands due to beam failure detection performed on FR2 serving cell(s) in different band(s), provided that UE is capable of independent beam management on this FR2 band pair. Additionally, there is no scheduling restriction if the UE is configured with different numerology between SSB on one FR2 band and data on the other FR2 band provided the UE is configured for IBM operation for the band pair.

For FR2, if following conditions are met,

- UE has been notified about system information update through paging,

- The gap between UE’s reception of PDCCH that UE monitors in the Type2-PDCCH CSS set and that notifies system information update, and the PDCCH that UE monitors in the Type0-PDCCH CSS set, is greater than 2 slots,

For the SSB and CORESET for RMSI scheduling multiplexing patterns 3, UE is expected to receive the PDCCH that UE monitors in the Type0-PDCCH CSS set, and the corresponding PDSCH, on SSB symbols to be measured for BFD mesurement; and

For the SSB and CORESET for RMSI scheduling multiplexing patterns 2, UE is expected to receive PDSCH that corresponds to the PDCCH that UE monitors in the Type0-PDCCH CSS set, on SSB symbols to be measured for BFD mesurement.

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

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.

### 8.5.8 Scheduling availability of UE during candidate beam detection

Scheduling availability restrictions when the UE is performing L1-RSRP measurement for candidate beam detection are described in the following clauses.

#### 8.5.8.1 Scheduling availability of UE performing L1-RSRP measurement with a same subcarrier spacing as PDSCH/PDCCH on FR1

There are no scheduling restrictions due to L1-RSRP measurement performed on SSB and CSI-RS configured as link recovery detection resource with the same SCS as PDSCH or PDCCH in FR1.

#### 8.5.8.2 Scheduling availability of UE performing L1-RSRP measurement 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 L1-RSRP measurement based on SSB as link recovery detection resource. For UEs which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to L1-RSRP measurement based on SSB configured as link recovery detection resource.

- The UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH, TRS, CSI-RS for tracking or CSI-RS for CQI on SSB symbols to be measured for L1-RSRP.

When intra-band carrier aggregation in FR1 is configured, the scheduling restrictions on one serving cell apply to all other serving cells in the same band on the symbols that fully or partially overlap with the restricted symbols. When inter-band carrier aggregation within FR1 is configured, there are no scheduling restrictions on FR1 serving cell(s) configured in other bands.

#### 8.5.8.3 Scheduling availability of UE performing L1-RSRP measurement on FR2

The following scheduling restriction applies due to candidate beam detection

- For FR2-1 or the reference symbols to be measured for candidate beam detection is not using 480 kHz SCS or 960 kHz SCS on FR2-2, the UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH, CSI-RS for tracking or CSI-RS for CQI on reference symbols to be measured for candidate beam detection.

- For FR2-2 and the reference symbols to be measured for candidate beam detection is using 480 kHz SCS or 960 kHz SCS, the UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH, CSI-RS for tracking or CSI-RS for CQI on reference symbols to be measured for candidate beam detection, and on one data symbol before each reference symbol to be measured for candidate beam detection and one data symbol after each reference symbol to be measured for candidate beam detection.

When intra-band carrier aggregation in FR2 is configured, the scheduling restrictions on to one serving cell apply to all serving cells in the same band on the symbols that fully or partially overlap with restricted symbols.

When inter-band carrier aggregation in FR2 is performed, there are no scheduling restrictions on FR2 serving cells in the bands due to candidate beam detection performed on FR2 serving cell(s) in different band(s), provided that the FR2 serving cell(s) and the FR2 serving cell(s) for candidate beam detection are in a FR2 band pair and UE is capable of independent beam management on this FR2 band pair. Additionally, there is no scheduling restriction if the UE is configured with different numerology between SSB on one FR2 band and data on the other FR2 band provided the UE is configured for IBM operation for the band pair.

For FR2, if following conditions are met,

- UE has been notified about system information update through paging,

- The gap between UE’s reception of PDCCH that UE monitors in the Type2-PDCCH CSS set and that notifies system information update, and the PDCCH that UE monitors in the Type0-PDCCH CSS set, is greater than 2 slots,

For the SSB and CORESET for RMSI scheduling multiplexing patterns 3, UE is expected to receive the PDCCH that UE monitors in the Type0-PDCCH CSS set, and the corresponding PDSCH, on SSB symbols to be measured for CBD mesurement; and

For the SSB and CORESET for RMSI scheduling multiplexing patterns 2, UE is expected to receive PDSCH that corresponds to the PDCCH that UE monitors in the Type0-PDCCH CSS set, on SSB symbols to be measured for CBD mesurement.

#### 8.5.8.4 Scheduling availability of UE performing L1-RSRP measurement on FR1 or FR2 in case of FR1-FR2 inter-band CA and NR-DC

There are no scheduling restrictions on FR1 serving cell(s) due to L1-RSRP measurement performed on FR2 serving cell(s).

There are no scheduling restrictions on FR2 serving cell(s) due to L1-RSRP measurement performed on FR1 serving cell(s).

### 8.5.9 Requirements for Beam Failure Recovery in SCell

#### 8.5.9.1 Introduction

For the UE provided with a configuration of PUCCH transmission with a link recovery request (LRR) as described in clause 9.2.4 in TS 38.213 [3], if beam recovery procedure is triggered for any of SCells, the UE shall transmit SR for UL resouce, followed by MAC CE providing one index for at least one corresponding SCell with radio link quality is worse than Qout,LR, and the index for a periodic CSI-RS configuration or for a SSB provided by higher layer, as described in clause 5.17 of TS38.321 [7], if any, for a corresponding SCell.

For the UE not provided with a configuration of PUCCH transmission with a link recovery request (LRR) as described in clause 9.2.4 in TS 38.213 [3], if beam recovery procedure is triggered for any of SCells, the UE shall transmit preamble for UL-SCH resource application, followed by MAC CE providing one index for at least one corresponding SCell with radio link quality is worse than Qout,LR, and the index for a periodic CSI-RS configuration or for a SSB provided by higher layer, as described in clause 5.17 of TS38.321 [7], if any, for a corresponding SCell.

#### 8.5.9.2 Requirement

Provided that UE is configured by *schedulingRequestIDForBFR* a configuration for LRR in a PUCCH transmission, after BFR is triggered on any of SCells as described in clause 5.17 of TS38.321 [7], UE shall be capable of transmit PUCCH with a LRR within a period of T, where

- T = T1 x Ceil((T2+D) /T1) in which T1, T2 and D are defined as

- T1 is equal to the periodicity of PUCCH configured with *schedulingRequestIDForBFR*.

- T2 = TEvaluate\_CBD is the evaluation period specified in clause 8.5.5 or 8.5.6 for SSB or CSI-RS based candidate beam detection, that is TEvaluate\_CBD\_SSB or TEvaluate\_CBD\_CSI-RS, depending on the applicable reference signal configured for candidate beam detection.

- D = 2ms is the UE Processing time.

### 8.5.10 Minimum requirement at transitions for beam failure detection

When the UE transitions between DRX and no DRX or when DRX cycle periodicity changes, for each BFD-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 BFD-RS resource.

When the UE transitions from a first configuration of BFD resources to a second configuration of BFD resources that is different from the first configuration, for each BFD 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 BFD resource present in the second configuration.

When the UE transitions from a first configuration of active TCI state of the CORESET to a second configuration of active TCI state of the CORESET, for each CSI-RS for BFD present in the second configuration, the UE shall use an evaluation period corresponding to the second configuration from the time of transition.

## 8.5A Link Recovery Procedures when CCA is used on target frequency

### 8.5A.1 Introduction

The requirements for link recovery procedure in the clause apply when CCA is used on a serving frequency on the downlink.

The UE shall assess the downlink radio link quality of a serving cell based on the reference signal in the set as specified in TS 38.213 [3] in order to detect beam failure on:

- PCell in SA operation mode,

- PSCell in EN-DC operation mode.

- PSCell in NR-DC operation mode.

The RS resource configurations in the set can be periodic SSBs. UE is not required to perform beam failure detection outside the active DL BWP. UE is not required to meet the requirements in clause 8.5A.2 and 8.5A.3 if UE does not have set .

On each RS resource configuration in the set , the UE shall estimate the radio link quality and compare it to the threshold Qout\_LR,CCA for the purpose of accessing downlink radio link quality of the serving cell beams.

The threshold Qout\_LR,CCA is defined as the level at which the downlink radio level link of a given resource configuration on set cannot be reliably received and shall correspond to the BLERout,CCA = 10% block error rate of a hypothetical PDCCH transmission. For SSB based beam failure detection, Qout\_LR\_SSB,CCA is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.5A.2.1-1.

Upon request the UE shall deliver configuration indexes from the set as specified in TS 38.213 [3] , to higher layers, and the corresponding L1-RSRP measurement provided that the measured L1-RSRP is equal to or better than the threshold Qin\_LR,CCA, which is indicated by higher layer parameter *rsrp-ThresholdSSB*. The UE applies the Qin\_LR,CCA threshold to the L1-RSRP measurement obtained from an SSB. The RS resource configurations in the set can be periodic SSBs. UE is not required to perform candidate beam detection outside the active DL BWP.

In the requirements of clause 8.5A, the term CBD-RS SSB occasions not available at the UE refers to when the CBD-RS SSB is configured by gNB in a cell on a carrier frequency subject to CCA, but the first two successive candidate SSB positions for the same SSB index within the set of configured CBD-RS resources are not available at the UE due to DL CCA failures at gNB during the corresponding evaluation period; otherwise the CBD-RS SSB is considered as available at the UE.

The requirements in clause 8.5A apply for any *channelAccessMode* configuration [TS 38.331, 2].

### 8.5A.2 Requirements for SSB based beam failure detection

#### 8.5A.2.1 Introduction

The requirements in this clause apply for each SSB resource in the set configured for a serving cell, provided that the SSB configured for beam failure detection is actually transmitted within the UE active DL BWP during the entire evaluation period specified in clause 8.5A.2.2, but occasionally may not be transmitted due to CCA operation.

Table 8.5A.2.1-1: PDCCH transmission parameters for beam failure instance

|  |  |
| --- | --- |
| Attribute | Value for BLER |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| 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 (PRBs) | 24 |
| Sub-carrier spacing (kHz) | Same as the SCS of RMSI CORESET |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

#### 8.5A.2.2 Minimum requirement

UE shall be able to evaluate whether the downlink radio link quality on the configured BFD-RS SSB resource in set estimated over the last TEvaluate\_BFD\_SSB\_CCA ms period becomes worse than the threshold Qout\_LR\_SSB,CCA within TEvaluate\_BFD\_SSB\_CCA ms period.

The value of TEvaluate\_BFD\_SSB\_CCA is defined in Table 8.5A.2.2-1 for FR1.

The value of TEvaluate\_BFD\_SSB\_CCA is defined in Table 8.5A.2.2-2 for FR2-2 with scaling factor N=12.

When concurrent gaps are configured,

- P value for a BFD-RS resource to be measured is defined as Ntotal / Noutside\_MG

- For a window W of duration max(TL1, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gap and per-FR measurement gap within the same FR as serving cell, and starting at the beginning of any BFD-RS resource occasion:

- Ntotal is the total number of BFD-RS resource occasions within the window, including those overlapped with measurement gap occasions within the window, and

- Noutside\_MG is the number of BFD-RS resource occasions that are not overlapped with any measurement gap occasion within the window W

- Otherwise, for a UE not supporting *concurrentMeasGap-r17* or when concurrent gaps are not configured,

- , when in the monitored cell there are GAPs configured for intra-frequency, inter-frequency or inter-RAT measurements, which are overlapping with some but not all occasions of the BFD-RS SSB.

- P=1 when in the monitored cell there are no GAPs overlapping with any occasion of the BFD-RS SSB.

- When a measurement gap is configured and the measurement gap is not NCSG,

- a BFD-RS resource is considered to be overlapped with the GAP if it overlaps a measurement gap occasion, and

- xRP = MGRP

- Otherwise, when NCSG measurement gap is configured,

- a BFD-RS resource is considered to be overlapped with the GAP if it overlaps the VIL1 or VIL2 of NCSG, and

- xRP = VIRP

- When concurrent gaps are configured, a BFD-RS is not considered to be overlapped by a gap occasion if the gap occasion is dropped according to 9.1.8.

For FR2-2,

- , when BFD-RS resource is not overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P = Psharing factor, when the BFD-RS resource is not overlapped with measurement gap and the BFD-RS resource is fully overlapped with SMTC period (TSSB = TSMTCperiod).

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TSSB < 0.5\*TSMTCperiod

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TSSB = 0.5\*TSMTCperiod

- , when the BFD-RS resource is partially overlapped with measurement gap (TSSB <MGRP) and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap.

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is fully overlapped with SMTC occasion (TSSB = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the BFD-RS resource outside measurement gap is

- not overlapped with the SSB symbols indicated by SSB-ToMeasure and K data symbol before each consecutive SSB symbols indicated by SSB-ToMeasure and K data symbol after each consecutive SSB symbols indicated by SSB-ToMeasure, given that SSB-ToMeasure is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and K is defined in clause 9.2.5.3.3, and;

- not overlapped with the RSSI symbols indicated by ss-RSSI-Measurement and K data symbol before each RSSI symbol indicated by ss-RSSI-Measurement and K data symbol after each RSSI symbol indicated by ss-RSSI-Measurement, given that ss-RSSI-Measurement is configured, and K is defined in clause 9.2.5.3.3.

- Psharing factor = 3, otherwise.

where,

If the high layer in TS 38.331 [2] signaling of *smtc2* is configured, TSMTCperiod corresponds to the value of higher layer parameter *smtc2*; Otherwise TSMTCperiod corresponds to the value of higher layer parameter *smtc1*. TSMTCperiod is the shortest SMTC period among all CCs in the same FR2-2 band, given the SMTC offset of all CCs in FR2-2 provided the same offset.

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

If the UE is configured with Pre-MG, a BFD-RS resource is only considered to be overlapped by the Pre-MG if the Pre-MG is activated.

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

Table 8.5A.2.2-1: Evaluation period TEvaluate\_BFD\_SSB\_CCA for FR1

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_BFD\_SSB\_CCA (ms) | |
|  | BFD-RS SSB Es/Iot Note2 ≥ -7 dB | BFD-RS SSB Es/Iot Note2 < -7 dB |
| no DRX | Max(50, Ceil((10 × P) × TSSB)) | Max(50, Ceil((12 × P) × TSSB)) |
| DRX cycle ≤ 320ms | Max(50, Ceil(1.5 × 8 × P) × Max(TDRX,TSSB)) | Max(50, Ceil(1.5 × 10 × P) × Max(TDRX,TSSB)) |
| DRX cycle > 320ms | Ceil(7 × P) × TDRX | Ceil(8 × P) × TDRX |
| Note 1: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length.  Note 2: BFD-RS SSB Es/Iot is the averaged BFD-RS SSB Es/Iot over the most recent previous evaluation period. | | |

Table 8.5A.2.2-2: Evaluation period TEvaluate\_BFD\_SSB\_CCA for FR2-2

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_SSB\_CCA (ms) |
|  |
| no DRX | Max(200, Ceil([12]\*P\* N)\*TSSB) |
| DRX cycle ≤ 320ms | Max(200, Ceil(1.5\*[10]\*P\* N)\*Max(TDRX,TSSB)) |
| DRX cycle > 320ms | Ceil([10]\*P\* N)\*TDRX |
| Note 1: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length. | |

#### 8.5A.2.3 Measurement restriction for SSB based beam failure detection

The UE is required to be capable of measuring SSB for BFD without measurement gaps. The UE is required to perform the SSB measurements with measurement restrictions as described in the following clauses.

For FR1, when the SSB for BFD measurement is in the same OFDM symbol as CSI-RS for BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, UE shall be able to measure the SSB for BFD measurement without any restriction;

- If SSB and CSI-RS have different SCS,

- If UE supports *simultaneousRxDataSSB-DiffNumerology*, UE shall be able to measure the SSB for BFD measurement without any restriction;

- If UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure SSB for BFD measurement.

For FR2-2, when the SSB for BFD measurement on one CC is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both SSB for BFD measurement and CSI-RS. Longer measurement period for SSB based BFD measurement is expected, and no requirements are defined.

### 8.5A.3 Void

### 8.5A.4 Minimum requirement for L1 indication

When the radio link quality on all the RS resources in set is worse than Qout\_LR,CCA, layer 1 of the UE shall send a beam failure instance indication to the higher layers.

The beam failure instance evaluation for the RS resources in set shall be performed as specified in clause 6 in TS 38.213 [3]. Two successive indications from layer 1 shall be separated by at least TIndication\_interval\_BFD\_CCA.

When DRX is not used, TIndication\_interval\_BFD\_CCA is max(2ms, TSSB-RS,M) ), where TSSB-RS,M is the shortest periodicity of all RS resources in set for the accessed cell, corresponding to either the shortest periodicity of the SSB in the set .

When DRX is used, for SSB based link quality measurement,

- TIndication\_interval\_BFD\_CCA = Max(1.5 × DRX\_cycle\_length, 1.5 × TSSB-RS,M), if DRX\_cycle\_length ≤ 320ms,

- TIndication\_interval\_BFD\_CCA = DRX\_cycle\_length, if DRX\_cycle\_length > 320ms.

### 8.5A.5 Requirements for SSB based candidate beam detection

#### 8.5A.5.1 Introduction

The requirements in this clause apply for each CBD-RS SSB resource in the set 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 clause 8.5A.5.2, but occasionally may not be transmitted due to CCA operation.

#### 8.5A.5.2 Minimum requirement

Upon request the UE shall be able to evaluate whether the L1-RSRP measured on the configured CBD-RS SSB resource in set  estimated over the last TEvaluate\_CBD\_SSB\_CCA ms period becomes better than the threshold Qin\_LR,CCA provided SSB\_RP and SSB Ês/Iot are according to Annex Table B.2.4.1 for a corresponding band.

The UE shall monitor the configured SSB resources using the evaluation period in table 8.5A.5.2-1 corresponding to the non-DRX mode, if the configured DRX cycle ≤ 320ms.

The value of TEvaluate\_CBD\_SSB\_CCA is defined in Table 8.5A.5.2-1 for FR1.

The value of TEvaluate\_CBD\_SSB\_CCA is defined in Table 8.5A.5.2-2 for FR2-2 with scaling factor N=TBD.

For FR1,

- For a UE supporting *concurrentMeasGap-r17* and when concurrent gaps are configured,

- P value for a CBD-RS resource to be measured is defined as Ntotal / Noutside\_MG

- For a window W of duration max(TL1, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gaps and per-FR measurement gaps within the same FR as serving cell, and starting at the beginning of any CBD-RS resource occasion:

- Ntotal is the total number of CBD-RS resource occasions within the window, including those overlapped with measurement gap occasions within the window, and

- Noutside\_MG is the number of CBD-RS resource occasions that are not overlapped with any measurement gap occasion within the window W

- Otherwise, for a UE not supporting *concurrentMeasGap-r17* or when concurrent gaps are not configured,

- , when in the monitored cell there are GAPs configured for intra-frequency, inter-frequency or inter-RAT measurements, which are overlapping with some but not all occasions of the CBD-RS SSB,

- P = 1 when in the monitored cell there are no GAPs overlapping with any occasion of the CBD-RS SSB.

For FR2-2,

- , when candidate beam detection RS is not overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P is Psharing factor, when candidate beam detection RS is not overlapped with measurement gap and candidate beam detection RS is fully overlapped with SMTC period (TSSB = TSMTCperiod).

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TSSB < 0.5 × TSMTCperiod

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TSSB = 0.5 × TSMTCperiod

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is fully overlapped with SMTC occasion (TSSB = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the candidate beam detection RS outside measurement gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and TBD data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and TBD data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and;

- not overlapped with the RSSI symbols indicated by *ss-RSSI-Measurement* and TBD data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and TBD data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured

- Psharing factor = 3, otherwise.

where,

- If the high layer in TS 38.331 [2] signaling of *smtc2*is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1.* TSMTCperiod is the shortest SMTC period among all CCs in the same FR2-2 band, provided the SMTC offset of all CCs in FR2-2 have the same offset.

- If the UE is configured with Pre-MG, a CBD-RS resource is only considered to be overlapped by the Pre-MG if the Pre-MG is activated.

- When a measurement gap is configured and the measurement gap is not NCSG,

- a CBD-RS resource is considered to be overlapped with the GAP if it overlaps a measurement gap occasion, and

- xRP = MGRP

- Otherwise, when NCSG measurement gap is configured,

- a CBD-RS resource is considered to be overlapped with the GAP if it overlaps the VIL1 or VIL2 of NCSG, and

- xRP = VIRP

* When concurrent gaps are configured, a CBD-RS is not considered to be overlapped by a gap occasion if the gap occasion is dropped according to9.1.8.

**Table 8.5A.5.2-1: Evaluation period TEvaluate\_CBD\_SSB\_CCA for FR1**

|  |  |
| --- | --- |
| Configuration | TEvaluate\_CBD\_SSB\_CCA (ms) |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil((3 + LCBD) × P) × TSSB) |
| DRX cycle > 320ms | Ceil((3 + LCBD) × P) × TDRX |
| Note 1: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length.  Note 2: When DRX is not configured, LCBD is the number of CBD-RS SSB occasions not available at the UE during TEvaluate\_CBD\_SSB\_CCA where LCBD ≤ LCBD,max. When DRX is configured, LCBD is the number of DRX cycles in which at least one of the CBD-RS SSB occasions not available at the UE during TEvaluate\_CBD\_SSB\_CCA where LCBD ≤ LCBD,max. The UE, which is configured with DRX, is not required to determine the availability of SSB occasions more frequent than  Once per Max(25ms, P \* TSSB) if DRX cycle ≤ 320ms,  Once per P \* TDRX if DRX cycle > 320ms.  Note 3: LCBD,max=7 for Max(TDRX, TSSB) ≤ 40 assuming TDRX=0 for non-DRX,  LCBD,max=5 for 40 < Max(TDRX, TSSB) ≤ 320,  LCBD,max=3 for TDRX > 320.  Note 4 If LCBD>LCBD,max, the UE shall assume no new candidate beams are found for this evaluation period. | |

Table 8.5A.5.2-2: Evaluation period TEvaluate\_CBD\_SSB\_CCA for FR2-2

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_SSB\_CCA (ms)** |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil((3 + LCBD) × P× N) × TSSB) |
| DRX cycle > 320ms | Ceil((3 + LCBD) × P × N) × TDRX |
| Note 1: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length.  Note 2: When DRX is not configured, Lin is the number of CBD-RS SSB occasions group which are not available at the UE during TEvaluate\_CBD\_SSB,CCA, where LCBD ≤ LCBD,max. A CBD-RS SSB occasions group consists of N consecutive CBD-RS SSB occasions, and the CBD-RS SSB occasions group is not available at the UE when at least one CBD-SSB occasion in the group is not transmitted by the gNB. When DRX is configured, Lin is the number of DRX cycles groups which are not available at the UE during TEvaluate\_CBD\_SSB,CCA, where Lin ≤ LCBD,max. A DRX group consists of N DRX cycles, and the DRX group is not available when there is at least one DRX in which at least one CBD-RS SSB occasion is not available. The UE is not required to determine the availability of SSB occasions more frequent than once per DRX cycle length, when configured with DRX.  Note 3: LCBD,max=7 for Max(TDRX, TSSB) ≤ 40 assuming TDRX=0 for non-DRX,  LCBD,max=5 for 40 < Max(TDRX, TSSB) ≤ 320,  LCBD,max=3 for TDRX > 320.  Note 4: If LCBD>LCBD,max, the UE shall assume no new candidate beams are found for this evaluation period. | |

#### 8.5A.5.3 Measurement restriction for SSB based candidate beam detection

For FR1, when the SSB for CBD measurement is in the same OFDM symbol as CSI-RS for BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, UE shall be able to measure the SSB for CBD measurement without any restrictions;

- If SSB and CSI-RS have different SCS-es,

- If UE supports *simultaneousRxDataSSB-DiffNumerology*, UE shall be able to measure the SSB for CBD measurement without any restriction;

- If UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure SSB for CBD measurement.

For FR2-2, when the SSB for CBD measurement on one CC is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both SSB for CBD measurement and CSI-RS. Longer measurement period for SSB based CBD measurement is expected, and no requirements are defined.

### 8.5A.6 Void

### 8.5A.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.

#### 8.5A.7.1 Scheduling availability of UE performing beam failure detection with a same subcarrier spacing as PDSCH/PDCCH

In this clause, the same requirements apply as in Clause 8.5.7.1.

#### 8.5A.7.2 Scheduling availability of UE performing beam failure detection with a different subcarrier spacing than PDSCH/PDCCH

In this clause, the same requirements apply as in Clause 8.5.7.2.

#### 8.5A.7.3 Scheduling availability of UE performing beam failure detection on FR2-2

In this clause, the same requirements apply as in Clause 8.5.7.3.

#### 8.5A.7.4 Scheduling availability of UE performing beam failure detection on FR1 or FR2-2 in case of FR1-FR2-2 inter-band CA and NR DC

In this clause, the same requirements apply as in Clause 8.5.7.4.

### 8.5A.8 Scheduling availability of UE during candidate beam detection

Scheduling availability restrictions when the UE is performing L1-RSRP measurement for candidate beam detection are described in the following clauses.

8.5A.8.1 Scheduling availability of UE performing L1-RSRP measurement with a same subcarrier spacing as PDSCH/PDCCH on FR1

In this clause, the same requirements apply as in Clause 8.5.8.1.

8.5A.8.2 Scheduling availability of UE performing L1-RSRP measurement with a different subcarrier spacing than PDSCH/PDCCH on FR1

In this clause, the same requirements apply as in Clause 8.5.8.2.

#### 8.5A.8.3 Scheduling availability of UE performing L1-RSRP measurement on FR2-2

In this clause, the same requirements apply as in Clause 8.5.8.3.

#### 8.5.8.4 Scheduling availability of UE performing L1-RSRP measurement on FR1 or FR2-2 in case of FR1-FR2-2 inter-band CA and NR-DC

In this clause, the same requirements apply as in Clause 8.5.8.4.

## 8.5B Link Recovery Procedures for Redcap

### 8.5B.1 Introduction

The Redcap UE shall assess the downlink radio link quality of a serving cell based on the reference signal in the set  as specified in TS 38.213 [3] in order to detect beam failure on PCell in SA. The SSB and SMTC in this section applies for both CD-SSB and NCD-SSB if it is not additional specified.

The RS resource configurations in the set  on PCell can be periodic CSI-RS resources and/or SSBs. UE is not required to perform beam failure detection outside the active DL BWP. UE is not required to meet the requirements in clause 8.5B.2 and 8.5B.3 if UE does not have set .

On each RS resource configuration in the set , the UE shall estimate the radio link quality and compare it to the threshold Qout\_LR\_Redcap for the purpose of accessing downlink radio link quality of the serving cell beams.

The threshold Qout\_LR\_Redcap is defined as the level at which the downlink radio level link of a given resource configuration on set  cannot be reliably received and shall correspond to the BLERout = 10% block error rate of a hypothetical PDCCH transmission. For SSB based beam failure detection, Qout\_LR\_SSB is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.5B.2.1-1. For CSI-RS based beam failure detection, Qout\_LR\_CSI-RS is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.5B.3.1-1.

Upon request the UE shall deliver configuration indexes from the set as specified in TS 38.213 [3] , to higher layers, and the corresponding L1-RSRP measurement provided that the measured L1-RSRP is equal to or better than the threshold Qin\_LR\_RedCap , which is indicated by higher layer parameter *rsrp-ThresholdSSB*. The UE applies the Qin\_LR\_RedCap  threshold to the L1-RSRP measurement obtained from an SSB. The UE applies the Qin\_LR\_RedCap threshold to the L1-RSRP measurement obtained for a CSI-RS resource after scaling a respective CSI-RS reception power with a value provided by higher layer parameter *powerControlOffsetSS*. The RS resource configurations in the set  can be periodic CSI-RS resources or SSBs or both SSB and CSI-RS resources. UE is not required to perform candidate beam detection outside the active DL BWP.

### 8.5B.2 Requirements for SSB based beam failure detection for Redcap

#### 8.5B.2.1 Introduction

The requirements in this clause apply for each SSB resource in the set  configured for a serving cell, provided that the SSB configured for beam failure detection is actually transmitted within the UE active DL BWP during the entire evaluation period specified in clause 8.5B.2.2.

Table 8.5B.2.1-1: PDCCH transmission parameters for beam failure instance

|  |  |
| --- | --- |
| Attribute | Value for BLER |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| Aggregation level (CCE) | 16 for 1 Rx UE; 8 for 2 Rx UE |
| 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 (PRBs) | 48 for 1 Rx UE; 24 for 2 Rx UE |
| Sub-carrier spacing (kHz) | Same as the SCS of RMSI CORESET |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |
| Note 1： Note: SCS=60kHz is not applicable for FR1 | |

#### 8.5B.2.2 Minimum requirement

UE shall be able to evaluate whether the downlink radio link quality on the configured SSB resource in set  estimated over the last TEvaluate\_BFD\_SSB\_Redcap ms period becomes worse than the threshold Qout\_LR\_SSB within TEvaluate\_BFD\_SSB\_Redcap ms period.

The value of TEvaluate\_BFD\_SSB\_Redcap is defined in Table 8.5B.2.2-1 for FR1.

The value of TEvaluate\_BFD\_SSB\_Redcap is defined in Table 8.5B.2.2-2 for FR2 with scaling factor N=8

For FR1,

- , 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.

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

For FR2,

- , when BFD-RS resource is not overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P = Psharing factor, when the BFD-RS resource is not overlapped with measurement gap and the BFD-RS resource is fully overlapped with SMTC period (TSSB = TSMTCperiod).

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TSSB < 0.5\*TSMTCperiod

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TSSB = 0.5\*TSMTCperiod

- , when the BFD-RS resource is partially overlapped with measurement gap (TSSB <MGRP) and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap.

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is fully overlapped with SMTC occasion (TSSB = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the BFD-RS resource outside measurement gap is

- not overlapped with the SSB symbols indicated by SSB-ToMeasure and 1 data symbol before each consecutive SSB symbols indicated by SSB-ToMeasure and 1 data symbol after each consecutive SSB symbols indicated by SSB-ToMeasure, given that SSB-ToMeasure is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and;

- not overlapped with the RSSI symbols indicated by ss-RSSI-Measurement and 1 data symbol before each RSSI symbol indicated by ss-RSSI-Measurement and 1 data symbol after each RSSI symbol indicated by ss-RSSI-Measurement, given that ss-RSSI-Measurement is configured.- Psharing factor = 3, otherwise.

where,

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

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

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer BFD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

Table 8.5B.2.2-1: Evaluation period TEvaluate\_BFD\_SSB\_Redcap for FR1

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_BFD\_SSB\_Redcap (ms) for Redcap UE with 2 Rx | TEvaluate\_BFD\_SSB\_Redcap (ms) for 1 Rx Redcap |
| no DRX | Max(50, Ceil(5 × P) × TSSB) | [ Max(50, Ceil(10 × P) × TSSB)] |
| DRX cycle ≤ 320ms | Max(50, Ceil(7.5 × P) × Max(TDRX,TSSB)) | [ Max(50, Ceil(15 × P) × Max(TDRX,TSSB)) ] |
| DRX cycle > 320ms | Ceil(5 × P) × TDRX | [ Ceil(10 × P) × TDRX] |
| Note: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length. | | |

Table 8.5B.2.2-2: Evaluation period TEvaluate\_BFD\_SSB\_Redcap for FR2

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_SSB\_Redcap (ms) |
| no DRX | Max(50, Ceil(5 × P × N) × TSSB) |
| DRX cycle ≤ 320ms | Max(50, Ceil(7.5 × P × N) × Max(TDRX,TSSB)) |
| DRX cycle > 320ms | Ceil(5 × P × N) × TDRX |
| Note: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length. | |

#### 8.5B.2.3 Measurement restriction for SSB based beam failure detection

The UE is required to be capable of measuring SSB for BFD without measurement gaps. The UE is required to perform the SSB measurements with measurement restrictions as described in the following scenarios.

For FR1, when the SSB for BFD measurement is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, UE shall be able to measure the SSB for BFD measurement without any restriction;

- If SSB and CSI-RS have different SCS,

- If UE supports *simultaneousRxDataSSB-DiffNumerology*, UE shall be able to measure the SSB for BFD measurement without any restriction;

- If UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both SSB for BFD measurement and CSI-RS. Longer measurement period for SSB based BFD measurement is expected, and no requirements are defined.

For FR2, when the SSB for BFD measurement on one CC is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC, UE is required to measure one of but not both SSB for BFD measurement and CSI-RS. Longer measurement period for SSB based BFD measurement is expected, and no requirements are defined.

### 8.5B.3 Requirements for CSI-RS based beam failure detection for Redcap

#### 8.5B.3.1 Introduction

The requirements in this clause apply for each CSI-RS resource in the set  of resource configurations for a serving cell, provided that the CSI-RS resource(s) in set for beam failure detection are actually transmitted within the UE active DL BWP during the entire evaluation period specified in clause 8.5B.3.2. UE is not expected to perform beam failure detection measurements on the CSI-RS configured for BFD if the CSI-RS is not QCL-ed, with QCL-TypeD when applicable, with the RS in the active TCI state of any CORESET configured in the UE active BWP.

Table 8.5B.3.1-1: PDCCH transmission parameters for beam failure instance

|  |  |
| --- | --- |
| Attribute | Value for BLER |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| Aggregation level (CCE) | 16 for 1 Rx UE; 8 for 2 Rx UE |
| 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 (PRBs) | 48 for 1 Rx UE; 24 for 2 Rx UE |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |
| Note 1： Note: SCS=60kHz is not applicable for FR1 | |

#### 8.5B.3.2 Minimum requirement

UE shall be able to evaluate whether the downlink radio link quality on the CSI-RS resource in set  estimated over the last TEvaluate\_BFD\_CSI-RS\_Redcap ms period becomes worse than the threshold Qout\_LR\_CSI-RS within TEvaluate\_BFD\_CSI-RS\_Redcap ms period.

The value of TEvaluate\_BFD\_CSI-RS\_Redcap is defined in Table 8.5B.3.2-1 for FR1.

The value of TEvaluate\_BFD\_CSI-RS\_Redcap is defined in Table 8.5B.3.2-2 for FR2 with N=1. The requirements of TEvaluate\_BFD\_CSI-RS\_Redcap apply provided that the CSI-RS for BFD is not in a resource set configured with repetition ON. The requirements shall not apply when the CSI-RS resource in the active TCI state of CORESET is the same CSI-RS resource for BFD and the TCI state information of the CSI-RS resource is not given, wherein the TCI state information means QCL Type-D to SSB for L1-RSRP or CSI-RS with repetition ON.

For FR1,

- , 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.

- 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 the BFD-RS resource is not overlapped with measurement gap and also not overlapped with SMTC occasion.

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is not overlapped with SMTC occasion (TCSI-RS < MGRP)

- , when the BFD-RS resource is not overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod).

- P = Psharing factor, when the BFD-RS resource is not overlapped with measurement gap and the BFD-RS resource is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod).

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TCSI-RS < 0.5 × TSMTCperiod

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TCSI-RS = 0.5 × TSMTCperiod

- , when the BFD-RS resource is partially overlapped with measurement gap (TCSI-RS < MGRP) and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap.

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the BFD-RS resource outside measurement gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and;

- not overlapped with the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured,

- Psharing factor = 3, otherwise.

where,

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

Note: The overlap between CSI-RS for BFD and SMTC means that CSI-RS for BFD is within the SMTC window duration.

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

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer BFD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of MBFD used in Table 8.5B.3.2-1 and Table 8.5B.3.2-2 are defined as

- MBFD = 10, if the CSI-RS resource(s) in set  used for BFD is transmitted with Density = 3 and over the bandwidth ≥ 24 PRBs.

The values of PBFD used in Table 8.5B.3.2-1 and Table 8.5B.3.2-2 are defined as

For each CSI-RS resource in the set  configured for PCell

- PBFD = 1.

Table 8.5B.3.2-1: Evaluation period TEvaluate\_BFD\_CSI-RS\_Redcap for FR1

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_BFD\_CSI-RS\_Redcap (ms) for Redcap UE with 2 Rx | TEvaluate\_BFD\_CSI-RS\_Redcap (ms) for 1 Rx Redcap |
| no DRX | Max(50, Ceil(MBFD × P × PBFD) × TCSI-RS) | Max(50, Ceil(2×MBFD × P × PBFD) × TCSI-RS) |
| DRX cycle ≤ 320ms | Max(50, Ceil(1.5 × MBFD × P × PBFD) × Max(TDRX, TCSI-RS)) | Max(50, Ceil(2×1.5 × MBFD × P × PBFD) × Max(TDRX, TCSI-RS)) |
| DRX cycle > 320ms | Ceil(MBFD × P × PBFD) × TDRX | Ceil(2×MBFD × P × PBFD) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length. | | |

Table 8.5B.3.2-2: Evaluation period TEvaluate\_BFD\_CSI-RS\_Redcap for FR2

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_CSI-RS\_Redcap (ms) |
| no DRX | Max(50, Ceil(MBFD × P × N × PBFD) × TCSI-RS) |
| DRX cycle ≤ 320ms | Max(50, Ceil(1.5 × MBFD × P × N × PBFD) × Max(TDRX, TCSI-RS)) |
| DRX cycle > 320ms | Ceil(MBFD × P × N × PBFD) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length. | |

#### 8.5B.3.3 Measurement restrictions for CSI-RS beam failure detection

The UE is required to be capable of measuring CSI-RS for BFD without measurement gaps. The UE is required to perform the CSI-RS measurements with measurement restrictions as described in the following scenarios.

For both FR1 and FR2, when the CSI-RS for BFD measurement is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, UE is not required to receive CSI-RS for BFD measurement in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for BFD measurement, the UE shall be able to perform CSI-RS measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for BFD measurement, the UE shall be able to perform CSI-RS measurement with restrictions according to its capabilities:

- If the UE supports *simultaneousRxDataSSB-DiffNumerology* the UE shall be able to perform CSI-RS measurement without restrictions.

- If the UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both CSI-RS for BFD measurement and SSB. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.

For FR1, when the CSI-RS for BFD measurement is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, UE shall be able to measure the CSI-RS for BFD measurement without any restriction.

For FR2, when the CSI-RS for BFD measurement on one CC is in the same OFDM symbol as SSB for RLM, BFD or L1-RSRP measurement on the same CC or different CCs in the same band, or in the same symbol as SSB for CBD measurement on the same CC or different CCs in the same band when beam failure is detected, UE is required to measure one of but not both CSI-RS for BFD measurement and SSB. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.

For FR2, when the CSI-RS for BFD measurement on one CC is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band,

- In the following cases, UE is required to measure one of but not both CSI-RS for BFD measurement and the other CSI-RS. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.

- The CSI-RS for BFD measurement or the other CSI-RS in a resource set configured with repetition ON, or

- The other CSI-RS is configured in set  and beam failure is detected, or

- The two CSI-RS-es are not QCL-ed w.r.t. QCL-TypeD, or the QCL information is not known to UE,

- Otherwise, UE shall be able to measure the CSI-RS for BFD measurement without any restriction.

### 8.5B.4 Minimum requirement for L1 indication for Redcap

When the radio link quality on all the RS resources in set  is worse than Qout\_LR\_Redcap, layer 1 of the UE shall send a beam failure instance indication to the higher layers

The beam failure instance evaluation for the RS resources in set  shall be performed as specified in clause 6 in TS 38.213 [3]. Two successive indications from layer 1 shall be separated by at least TIndication\_interval\_BFD\_Redcap.

When DRX is not used, TIndication\_interval\_BFD\_Redcap is max(2ms, TSSB-RS,M) ) or max(2ms, TCSI-RS,M), where TSSB-RS,M and TCSI-RS,M is the shortest periodicity of all RS resources in set  for the accessed cell, corresponding to either the shortest periodicity of the SSB in the set  or CSI-RS resource in the set .

When DRX is used, for SSB based link quality measurement,

- TIndication\_interval\_BFD\_Redcap = Max(1.5 × DRX\_cycle\_length, 1.5 × TSSB-RS,M), if DRX\_cycle\_length ≤ 320ms,

- TIndication\_interval\_BFD\_Redcap = DRX\_cycle\_length, if DRX\_cycle\_length > 320ms.

When DRX is used, for CSI-RS based link quality measurement,

- TIndication\_interval\_BFD\_Redcap = Max(1.5 × DRX\_cycle\_length, 1.5 × TCSI-RS,M), if DRX\_cycle\_length ≤ 320ms,

- TIndication\_interval\_BFD\_Redcap = DRX\_cycle\_length, if DRX\_cycle\_length > 320ms.

For HD-FDD UE, the above conditions and requirements TIndication\_interval\_BFD\_Redcap apply given that for each BFD-RS configuration, at least one BFD-RS sample must fall with DL occasion within an indication perio

### 8.5B.5 Requirements for SSB based candidate beam detection for Redcap

#### 8.5B.5.1 Introduction

The requirements in this clause apply for each SSB resource in the set  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 clause 8.5.5.2.

#### 8.5B.5.2 Minimum requirement

Upon request the UE shall be able to evaluate whether the L1-RSRP measured on the configured SSB resource in set  estimated over the last TEvaluate\_CBD\_SSB ms period becomes better than the threshold Qin\_LR\_RedCap provided SSB\_RP and SSB Ês/Iot are according to Annex Table B.2.4.1 for a corresponding band.

The UE shall monitor the configured SSB resources using the evaluation period in table 8.5B.5.2-1 and 8.5B.5.2-2 corresponding to the non-DRX mode, if the configured DRX cycle ≤ 320ms.

The value of TEvaluate\_CBD\_SSB\_Redcap is defined in Table 8.5B.5.2-1 for FR1.

The value of TEvaluate\_CBD\_SSB\_Redcap is defined in Table 8.5B.5.2-2 for FR2 with scaling factor N=8.

where,

For FR1,

- , 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,

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

For FR2,

- , when candidate beam detection RS is not overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P is Psharing factor, when candidate beam detection RS is not overlapped with measurement gap and candidate beam detection RS is fully overlapped with SMTC period (TSSB = TSMTCperiod).

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TSSB < 0.5 × TSMTCperiod

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TSSB = 0.5 × TSMTCperiod

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is fully overlapped with SMTC occasion (TSSB = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the candidate beam detection RS outside measurement gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and;

- not overlapped with the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured

- Psharing factor = 3, otherwise.

where,

If the high layer in TS 38.331 [2] signaling of *smtc2*is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1.*

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

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer CBD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of PCBD used in Table 8.5.5.2-1 and Table 8.5.5.2-2 are defined as

For each SSB resource in the set  configured for PCell

- PCBD = 1.

Table 8.5B.5.2-1: Evaluation period TEvaluate\_CBD\_SSB\_Redcap for FR1

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_SSB**\_Redcap **(ms)** |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(3 × P × PCBD) × TSSB) |
| DRX cycle > 320ms | Ceil(3 × P × PCBD) × TDRX |
| Note: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length. | |

Table 8.5B.5.2-2: Evaluation period TEvaluate\_CBD\_SSB\_Redcap for FR2

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_SSB**\_Redcap **(ms)** |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(3 × P × N × PCBD) × TSSB) |
| DRX cycle > 320ms | Ceil(3 × P × N × PCBD) × TDRX |
| Note: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length. | |

#### 8.5B.5.3 Measurement restriction for SSB based candidate beam detection

For FR1, when the SSB for CBD measurement is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, UE shall be able to measure the SSB for CBD measurement without any restrictions;

- If SSB and CSI-RS have different SCS-es,

- If UE supports *simultaneousRxDataSSB-DiffNumerology*, UE shall be able to measure the SSB for CBD measurement without any restriction;

- If UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both SSB for CBD measurement and CSI-RS. Longer measurement period for SSB based CBD measurement is expected, and no requirements are defined.

For FR2, when the SSB for CBD measurement on one CC is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC, UE is required to measure one of but not both SSB for CBD measurement and CSI-RS. Longer measurement period for SSB based CBD measurement is expected, and no requirements are defined.

### 8.5B.6 Requirements for CSI-RS based candidate beam detection for Redcap

#### 8.5B.6.1 Introduction

The requirements in this clause apply for each CSI-RS resource in the set  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 clause 8.5B.6.2.

#### 8.5B.6.2 Minimum requirement

Upon request the UE shall be able to evaluate whether the L1-RSRP measured on the configured CSI-RS resource in set  estimated over the last TEvaluate\_CBD\_CSI-RS\_Redcap [ms] period becomes better than the threshold Qin\_LR\_RedCap within TEvaluate\_CBD\_CSI-RS\_Redcap [ms] period provided CSI-RS Ês/Iot is according to Annex Table B.2.4.2 for a corresponding band.

The UE shall monitor the configured CSI-RS resources using the evaluation period in table 8.5B.6.2-1 and 8.5B.6.2-2 corresponding to the non-DRX mode, if the configured DRX cycle ≤ 320ms.

The value of TEvaluate\_CBD\_CSI-RS\_Redcap is defined in Table 8.5B.6.2-1 for FR1.

The value of TEvaluate\_CBD\_CSI-RS\_Redcap is defined in Table 8.5B.6.2-2 for FR2 with scaling factor N=8.

For FR1,

- , 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 candidate beam detection RS is not overlapped with measurement gap and also not overlapped with SMTC occasion.

- when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is not overlapped with SMTC occasion (TCSI-RS < MGRP)

- , when candidate beam detection RS is not overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod).

- P =Psharing factor, when candidate beam detection RS is not overlapped with measurement gap and candidate beam detection RS is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod).

- ,, when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TCSI-RS < 0.5 × TSMTCperiod

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TCSI-RS = 0.5 × TSMTCperiod

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap

- ,, when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the candidate beam detection RS outside measurement gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and;

- not overlapped with the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured.

- Psharing factor = 3, otherwise.

where,

If the high layer in TS 38.331 [2] signaling of *smtc2* is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1*.

Note: The overlap between CSI-RS for CBD and SMTC means that CSI-RS for CBD is within the SMTC window duration.

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

Longer evaluation period would be expected if the CSI-RS is on the same OFDM symbols with RLM, BFD, BM-RS, or other CBD-RS, according to the measurement restrictions defined in clause 8.5.6.3.

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer CBD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of MCBD used in Table 8.5B.6.2-1 and Table 8.5B.6.2-2 are defined as

- MCBD = 3, if the CSI-RS resource configured in the set  is transmitted with Density = 3 and over the bandwidth ≥ 24 PRBs.

The values of PCBD used in Table 8.5B.6.2-1 and Table 8.5B.6.2-2 are defined as

For each CSI-RS resource in the set  configured for PCell

- PCBD = 1.

Table 8.5B.6.2-1: Evaluation period TEvaluate\_CBD\_CSI-RS\_Redcap for FR1

|  |  |
| --- | --- |
| **Configuration** | **TEvaluateC\_CBD\_CSI-RS**\_Redcap **(ms)** |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(MCBD × P × PCBD) × TCSI-RS) |
| DRX cycle > 320ms | Ceil(MCBD × P × PCBD) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length. | |

Table 8.5B.6.2-2: Evaluation period TEvaluate\_CBD\_CSI-RS\_Redcap for FR2

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_CSI-RS**\_Redcap **(ms)** |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(MCBD × P × N × PCBD) × TCSI-RS) |
| DRX cycle > 320ms | Ceil(MCBD × P × N × PCBD) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length. | |

#### 8.5B.6.3 Measurement restriction for CSI-RS based candidate beam detection

For both FR1 and FR2, when the CSI-RS for CBD measurement is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, UE is not required to receive CSI-RS for CBD measurement in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for CBD measurement, the UE shall be able to perform CSI-RS based CBD measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for CBD measurement, the UE shall be able to perform CSI-RS based CBD measurement with restrictions according to its capabilities:

- If the UE supports *simultaneousRxDataSSB-DiffNumerology* the UE shall be able to perform CSI-RS based CBD measurement for without restrictions.

- If the UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both CSI-RS for CBD measurement and SSB. Longer measurement period for CSI-RS based CBD measurement is expected, and no requirements are defined.

For FR1, when the CSI-RS for CBD measurement is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, UE shall be able to measure the CSI-RS for CBD measurement without any restriction.

For FR2, when the CSI-RS for CBD measurement on one CC is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both CSI-RS for CBD measurement and SSB. Longer evaluation period for CSI-RS based CBD measurement is expected, and no requirements are defined.

For FR2, when the CSI-RS for CBD measurement on one CC is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both CSI-RS for CBD measurement and the other CSI-RS. Longer evaluation period for CSI-RS based CBD measurement is expected, and no requirements are defined.

### 8.5B.7 Scheduling availability of UE during beam failure detection for Redcap

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

#### 8.5B.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 and CSI-RS configured for BFD with the same SCS as PDSCH or PDCCH in FR1.

#### 8.5B.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 when SSB is configured as BFD. For UEs which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to beam failure detection when SSB is configured as BFD.

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

#### 8.5B.7.3 Scheduling availability of UE performing beam failure detection on FR2

The following scheduling restriction applies due to beam failure detection.

- For the case where no RSs are provided for BFD, or when CSI-RS is configured for BFD is explicitly configured and is type-D QCLed with active TCI state for PDCCH or PDSCH, and the CSI-RS is not in a CSI-RS resource set with repetition ON

- There are no scheduling restrictions due to beam failure detection performed based on the CSI-RS.

- Otherwise

- The UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on BFD-RS resource symbols to be measured for beam failure detection.

For FR2, if following conditions are met,

- UE has been notified about system information update through paging,

- The gap between UE’s reception of PDCCH that UE monitors in the Type2-PDCCH CSS set and that notifies system information update, and the PDCCH that UE monitors in the Type0-PDCCH CSS set, is greater than 2 slots,

For the SSB and CORESET for RMSI scheduling multiplexing patterns 3, UE is expected to receive the PDCCH that UE monitors in the Type0-PDCCH CSS set, and the corresponding PDSCH, on SSB symbols to be measured for BFD mesurement; and

For the SSB and CORESET for RMSI scheduling multiplexing patterns 2, UE is expected to receive PDSCH that corresponds to the PDCCH that UE monitors in the Type0-PDCCH CSS set, on SSB symbols to be measured for BFD mesurement.

### 8.5B.8 Scheduling availability of UE during candidate beam detection for Redcap

Scheduling availability restrictions when the UE is performing L1-RSRP measurement for candidate beam detection are described in the following clauses.

#### 8.5B.8.1 Scheduling availability of UE performing L1-RSRP measurement with a same subcarrier spacing as PDSCH/PDCCH on FR1

There are no scheduling restrictions due to L1-RSRP measurement performed on SSB and CSI-RS configured as link recovery detection resource with the same SCS as PDSCH or PDCCH in FR1.

#### 8.5B.8.2 Scheduling availability of UE performing L1-RSRP measurement 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 L1-RSRP measurement based on SSB as link recovery detection resource. For UEs which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to L1-RSRP measurement based on SSB configured as link recovery detection resource.

- The UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH, TRS, CSI-RS for tracking or CSI-RS for CQI on SSB symbols to be measured for L1-RSRP.

#### 8.5B.8.3 Scheduling availability of UE performing L1-RSRP measurement on FR2

The following scheduling restriction applies due to candidate beam detection

- The UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH, CSI-RS for tracking or CSI-RS for CQI on reference symbols to be measured for candidate beam detection.

For FR2, if following conditions are met,

- UE has been notified about system information update through paging,

- The gap between UE’s reception of PDCCH that UE monitors in the Type2-PDCCH CSS set and that notifies system information update, and the PDCCH that UE monitors in the Type0-PDCCH CSS set, is greater than 2 slots,

For the SSB and CORESET for RMSI scheduling multiplexing patterns 3, UE is expected to receive the PDCCH that UE monitors in the Type0-PDCCH CSS set, and the corresponding PDSCH, on SSB symbols to be measured for CBD mesurement; and

For the SSB and CORESET for RMSI scheduling multiplexing patterns 2, UE is expected to receive PDSCH that corresponds to the PDCCH that UE monitors in the Type0-PDCCH CSS set, on SSB symbols to be measured for CBD mesurement.

### 8.5B.9 Minimum requirement at transitions for beam failure detection for Redcap

When the UE transitions between BFD CD-SSB resource and BFD NCD-SSB resource due to BWP switching during one evaluation period, the UE shall use an evaluation period that is the maximum of the evaluation period corresponding to the first SSB type and the second SSB type after the BWP switching. Subsequent to this duration, the UE shall use an evaluation period corresponding to the second SSB type for each BFD-RS resource.

The requirements in clause 8.5.10 shall also apply except the scenarios described above.

## 8.5C Link Recovery Procedures for Satellite Access

### 8.5C.1 Introduction

The UE shall assess the downlink radio link quality of a serving cell based on the reference signal in the set  as specified in TS 38.213 [3] in order to detect beam failure on PCell and the UE is configured with only PCell, which is served by satellite access node (SAN).

The RS resource configurations in the set  on PCell can be periodic CSI-RS resources and/or SSBs.

On each RS resource configuration in the set , the UE shall estimate the radio link quality and compare it to the threshold Qout\_LR for the purpose of accessing downlink radio link quality of the serving cell beams.

The threshold Qout\_LR is defined as the level at which the downlink radio level link of a given resource configuration on set e cannot be reliably received and shall correspond to the BLERout = 10% block error rate of a hypothetical PDCCH transmission. For SSB based beam failure detection, Qout\_LR\_SSB is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.5.2.1C-1. For CSI-RS based beam failure detection, Qout\_LR\_CSI-RS is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.5C.3.1-1.

Upon request the UE shall deliver configuration indexes from the set as specified in TS 38.213 [3] , to higher layers, and the corresponding L1-RSRP measurement provided that the measured L1-RSRP is equal to or better than the threshold Qin\_LR, which is indicated by higher layer parameter *rsrp-ThresholdSSB*. The UE applies the Qin\_LR threshold to the L1-RSRP measurement obtained from an SSB. The UE applies the Qin\_LR threshold to the L1-RSRP measurement obtained for a CSI-RS resource after scaling a respective CSI-RS reception power with a value provided by higher layer parameter *powerControlOffsetSS*. The RS resource configurations in the set  can be periodic CSI-RS resources or SSBs or both SSB and CSI-RS resources.

### 8.5C.2 Requirements for SSB based beam failure detection

#### 8.5C.2.1 Introduction

The requirements in this clause apply for each SSB resource in the set e configured for a serving cell, provided that the SSB configured for beam failure detection is actually transmitted within the UE active DL BWP during the entire evaluation period specified in clause 8.5C.2.2.

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

|  |  |
| --- | --- |
| Attribute | Value for BLER |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| 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 (PRBs) | 24 |
| Sub-carrier spacing (kHz) | Same as the SCS of RMSI CORESET |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

#### 8.5C.2.2 Minimum requirement

UE shall be able to evaluate whether the downlink radio link quality on the configured SSB resource in set  estimated over the last TEvaluate\_BFD\_SSB ms period becomes worse than the threshold Qout\_LR\_SSB within TEvaluate\_BFD\_SSB ms period.

The value of TEvaluate\_BFD\_SSB is defined in Table 8.5C.2.2-1 for FR1.

P value for an RLM-RS resource to be measured is defined as

- Psharing factor \* Ntotal / Noutside\_MG with Navailable = 0

- Ntotal / Navailable with Navailable > 0

For a window W of duration max(TL1, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gaps, and starting at the beginning of any RLM-RS resource occasion:

- Ntotal is the total number of RLM-RS resource occasions within the window, including those overlapped with measurement gap occasions or SMTC occasions within the window W, and

- Noutside\_MG is the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion within the window W

- Navailable is

- the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion nor any SMTC occasion within the window W, if UE does not support *parallelMeasurementWithoutRestriction* and LEO satellites are measured for intra-frequency measurement, and

- same as Noutside\_MG, otherwise

- TL1 is periodicity of the target RLM-RS

- Psharing factor = 3.

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

For an FR1serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

Table 8.5C.2.2-1: Evaluation period TEvaluate\_BFD\_SSB for FR1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_SSB (ms) |
| no DRX | Max(50, Ceil(5 ´ P) ´ TSSB) |
| DRX cycle ≤ 320ms | Max(50, Ceil(7.5 ´ P) ´ Max(TDRX,TSSB)) |
| DRX cycle > 320ms | Ceil(5 ´ P) ´ TDRX |
| Note: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length. | |

#### 8.5C.2.3 Measurement restriction for SSB based beam failure detection

The UE is required to be capable of measuring SSB for BFD without measurement gaps. The UE is required to perform the SSB measurements with measurement restrictions as described in the following scenarios.

For FR1, when the SSB for BFD measurement is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, UE shall be able to measure the SSB for BFD measurement without any restriction;

- If SSB and CSI-RS have different SCS,

- If UE supports *simultaneousRxDataSSB-DiffNumerology*, UE shall be able to measure the SSB for BFD measurement without any restriction;

- If UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both SSB for BFD measurement and CSI-RS. Longer measurement period for SSB based BFD measurement is expected, and no requirements are defined.

### 8.5C.3 Requirements for CSI-RS based beam failure detection

#### 8.5C.3.1 Introduction

The requirements in this clause apply for each CSI-RS resource in the set  of resource configurations for a serving cell, provided that the CSI-RS resource(s) in set for beam failure detection are actually transmitted within the UE active DL BWP during the entire evaluation period specified in clause 8.5C.3.2. UE is not expected to perform beam failure detection measurements on the CSI-RS configured for BFD if the CSI-RS is not QCL-ed, with QCL-TypeD when applicable, with the RS in the active TCI state of any CORESET configured in the UE active BWP.

Table 8.5C.3.1-1: PDCCH transmission parameters for beam failure instance

|  |  |
| --- | --- |
| Attribute | Value for BLER |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| 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 (PRBs) | 48 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

#### 8.5C.3.2 Minimum requirement

UE shall be able to evaluate whether the downlink radio link quality on the CSI-RS resource in set  estimated over the last TEvaluate\_BFD\_CSI-RS ms period becomes worse than the threshold Qout\_LR\_CSI-RS within TEvaluate\_BFD\_CSI-RS ms period.

The value of TEvaluate\_BFD\_CSI-RS is defined in Table 8.5C.3.2-1 for FR1.

The requirements of TEvaluate\_BFD\_CSI-RS apply provided that the CSI-RS for BFD is not in a resource set configured with repetition ON. The requirements shall not apply when the CSI-RS resource in the active TCI state of CORESET is the same CSI-RS resource for BFD and the TCI state information of the CSI-RS resource is not given, wherein the TCI state information means QCL Type-D to SSB for L1-RSRP or CSI-RS with repetition ON.

P value for an RLM-RS resource to be measured is defined as

- Psharing factor \* Ntotal / Noutside\_MG with Navailable = 0

- Ntotal / Navailable with Navailable > 0

For a window W of duration max(TL1, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gaps, and starting at the beginning of any RLM-RS resource occasion:

- Ntotal is the total number of RLM-RS resource occasions within the window, including those overlapped with measurement gap occasions or SMTC occasions within the window W, and

- Noutside\_MG is the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion within the window W

- Navailable is

- the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion nor any SMTC occasion within the window W, if UE does not support *parallelMeasurementWithoutRestriction* and LEO satellites are measured for intra-frequency measurement, and

- same as Noutside\_MG, otherwise

- TL1 is periodicity of the target RLM-RS

- Psharing factor = 3.

Note: The overlap between CSI-RS for BFD and SMTC means that CSI-RS for BFD is within the SMTC window duration.

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

For an FR1 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

The values of MBFD used in Table 8.5C.3.2-1 and Table 8.5C.3.2-2 are defined as

- MBFD = 10, if the CSI-RS resource(s) in set  used for BFD is transmitted with Density = 3 and over the bandwidth ≥ 24 PRBs.

The values of PBFD used in Table 8.5C.3.2-1 and Table 8.5C.3.2-2 are defined as

For each CSI-RS resource in the set  configured for PCell SA

- PBFD = 1.

Table 8.5C.3.2-1: Evaluation period TEvaluate\_BFD\_CSI-RS for FR1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_CSI-RS (ms) |
| no DRX | Max(50, Ceil(MBFD ´ P ´ PBFD) ´ TCSI-RS) |
| DRX cycle ≤ 320ms | Max(50, Ceil(1.5 × MBFD ´ P ´ PBFD) ´ Max(TDRX, TCSI-RS)) |
| DRX cycle > 320ms | Ceil(MBFD ´ P ´ PBFD) ´ TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length. | |

#### 8.5C.3.3 Measurement restrictions for CSI-RS beam failure detection

The UE is required to be capable of measuring CSI-RS for BFD without measurement gaps. The UE is required to perform the CSI-RS measurements with measurement restrictions as described in the following scenarios.

For FR1, when the CSI-RS for BFD measurement is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, UE is not required to receive CSI-RS for BFD measurement in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for BFD measurement, the UE shall be able to perform CSI-RS measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for BFD measurement, the UE shall be able to perform CSI-RS measurement with restrictions according to its capabilities:

- If the UE supports *simultaneousRxDataSSB-DiffNumerology* the UE shall be able to perform CSI-RS measurement without restrictions.

- If the UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both CSI-RS for BFD measurement and SSB. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.

For FR1, when the CSI-RS for BFD measurement is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, UE shall be able to measure the CSI-RS for BFD measurement without any restriction.

### 8.5C.4 Minimum requirement for L1 indication

When the radio link quality on all the RS resources in set  is worse than Qout\_LR, layer 1 of the UE shall send a beam failure instance indication to the higher layers

The beam failure instance evaluation for the RS resources in set  shall be performed as specified in clause 6 in TS 38.213 [3]. Two successive indications from layer 1 shall be separated by at least TIndication\_interval\_BFD.

When DRX is not used, TIndication\_interval\_BFD is max(2ms, TSSB-RS,M) ) or max(2ms, TCSI-RS,M), where TSSB-RS,M and TCSI-RS,M is the shortest periodicity of all RS resources in set  for the accessed cell, corresponding to either the shortest periodicity of the SSB in the set  or CSI-RS resource in the set .

When DRX is used, for SSB based link quality measurement,

- TIndication\_interval\_BFD = Max(1.5 × DRX\_cycle\_length, 1.5 × TSSB-RS,M), if DRX\_cycle\_length ≤ 320ms,

- TIndication\_interval\_BFD = DRX\_cycle\_length, if DRX\_cycle\_length > 320ms.

When DRX is used, for CSI-RS based link quality measurement,

- TIndication\_interval\_BFD = Max(1.5 × DRX\_cycle\_length, 1.5 × TCSI-RS,M), if DRX\_cycle\_length ≤ 320ms,

- TIndication\_interval\_BFD = DRX\_cycle\_length, if DRX\_cycle\_length > 320ms.

### 8.5C.5 Requirements for SSB based candidate beam detection

#### 8.5C.5.1 Introduction

The requirements in this clause apply for each SSB resource in the set  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 clause 8.5C.5.2.

#### 8.5C.5.2 Minimum requirement

Upon request the UE shall be able to evaluate whether the L1-RSRP measured on the configured SSB resource in set  estimated over the last TEvaluate\_CBD\_SSB ms period becomes better than the threshold Qin\_LR provided SSB\_RP and SSB Ês/Iot are according to Annex Table B. 2.x.y for a corresponding band.

The UE shall monitor the configured SSB resources using the evaluation period in table 8.5C.5.2-1 and 8.5C.5.2-2 corresponding to the non-DRX mode, if the configured DRX cycle ≤ 320ms.

The value of TEvaluate\_CBD\_SSB is defined in Table 8.5C.5.2-1 for FR1.

where,

P value for an RLM-RS resource to be measured is defined as

- Psharing factor \* Ntotal / Noutside\_MG with Navailable = 0

- Ntotal / Navailable with Navailable > 0

For a window W of duration max(TL1, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gaps, and starting at the beginning of any RLM-RS resource occasion:

- Ntotal is the total number of RLM-RS resource occasions within the window, including those overlapped with measurement gap occasions or SMTC occasions within the window W, and

- Noutside\_MG is the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion within the window W

- Navailable is

- the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion nor any SMTC occasion within the window W, if UE does not support *parallelMeasurementWithoutRestriction* and LEO satellites are measured for intra-frequency measurement, and

- same as Noutside\_MG, otherwise

- TL1 is periodicity of the target RLM-RS

- Psharing factor = 3.

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

For an FR1 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

The values of PCBD used in Table 8.5C.5.2-1 and Table 8.5C.5.2-2 are defined as

For each SSB resource in the set  configured for PCell.

- PCBD = 1.

Table 8.5C.5.2-1: Evaluation period TEvaluate\_CBD\_SSB for FR1

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_SSB (ms)** |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(3 ´ P ´ PCBD) ´ TSSB) |
| DRX cycle > 320ms | Ceil(3 ´ P ´ PCBD) ´ TDRX |
| Note: TSSB is the periodicity of SSB in the set . TDRX is the DRX cycle length. | |

#### 8.5C.5.3 Measurement restriction for SSB based candidate beam detection

For FR1, when the SSB for CBD measurement is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, UE shall be able to measure the SSB for CBD measurement without any restrictions;

- If SSB and CSI-RS have different SCS-es,

- If UE supports *simultaneousRxDataSSB-DiffNumerology*, UE shall be able to measure the SSB for CBD measurement without any restriction;

- If UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both SSB for CBD measurement and CSI-RS. Longer measurement period for SSB based CBD measurement is expected, and no requirements are defined.

### 8.5C.6 Requirements for CSI-RS based candidate beam detection

#### 8.5C.6.1 Introduction

The requirements in this clause apply for each CSI-RS resource in the set  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 clause 8.5C.6.2.

#### 8.5C.6.2 Minimum requirement

Upon request the UE shall be able to evaluate whether the L1-RSRP measured on the configured CSI-RS resource in set  estimated over the last TEvaluate\_CBD\_CSI-RS [ms] period becomes better than the threshold Qin\_LR within TEvaluate\_CBD\_CSI-RS [ms] period provided CSI-RS Ês/Iot is according to Annex Table B.2. x.y for a corresponding band.

The UE shall monitor the configured CSI-RS resources using the evaluation period in table 8.5C.6.2-1 and 8.5C.6.2-2 corresponding to the non-DRX mode, if the configured DRX cycle ≤ 320ms.

The value of TEvaluate\_CBD\_CSI-RS is defined in Table 8.5C.6.2-1 for FR1.

P value for an RLM-RS resource to be measured is defined as

- Psharing factor \* Ntotal / Noutside\_MG with Navailable = 0

- Ntotal / Navailable with Navailable > 0

For a window W of duration max(TL1, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gaps, and starting at the beginning of any RLM-RS resource occasion:

- Ntotal is the total number of RLM-RS resource occasions within the window, including those overlapped with measurement gap occasions or SMTC occasions within the window W, and

- Noutside\_MG is the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion within the window W

- Navailable is

- the number of RLM-RS resource occasions that are not overlapped with any measurement gap occasion nor any SMTC occasion within the window W, if UE does not support *parallelMeasurementWithoutRestriction* and LEO satellites are measured for intra-frequency measurement, and

- same as Noutside\_MG, otherwise

- TL1 is periodicity of the target RLM-RS

- Psharing factor = 3.

Note: The overlap between CSI-RS for CBD and SMTC means that CSI-RS for CBD is within the SMTC window duration.

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

For an FR1 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

The values of MCBD used in Table 8.5C.6.2-1 and Table 8.5C.6.2-2 are defined as

- MCBD = 3, if the CSI-RS resource configured in the set  is transmitted with Density = 3 and over the bandwidth ≥ 24 PRBs.

The values of PCBD used in Table 8.5C.6.2-1 are defined as

For each CSI-RS resource in the set  configured for SA

- PCBD = 1.

Table 8.5C.6.2-1: Evaluation period TEvaluate\_CBD\_CSI-RS for FR1

|  |  |
| --- | --- |
| **Configuration** | **TEvaluateC\_CBD\_CSI-RS (ms)** |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(MCBD ´ P ´ PCBD) ´ TCSI-RS) |
| DRX cycle > 320ms | Ceil(MCBD ´ P ´ PCBD) ´ TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length. | |

#### 8.5C.6.3 Measurement restriction for CSI-RS based candidate beam detection

For both FR1, when the CSI-RS for CBD measurement is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, UE is not required to receive CSI-RS for CBD measurement in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for CBD measurement, the UE shall be able to perform CSI-RS based CBD measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for CBD measurement, the UE shall be able to perform CSI-RS based CBD measurement with restrictions according to its capabilities:

- If the UE supports *simultaneousRxDataSSB-DiffNumerology* the UE shall be able to perform CSI-RS based CBD measurement for without restrictions.

- If the UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both CSI-RS for CBD measurement and SSB. Longer measurement period for CSI-RS based CBD measurement is expected, and no requirements are defined.

For FR1, when the CSI-RS for CBD measurement is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, UE shall be able to measure the CSI-RS for CBD measurement without any restriction.

### 8.5C.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.

#### 8.5C.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 and CSI-RS configured for BFD with the same SCS as PDSCH or PDCCH in FR1.

#### 8.5C.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 when SSB is configured as BFD. For UEs which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to beam failure detection when SSB is configured as BFD.

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

### 8.5C.8 Scheduling availability of UE during candidate beam detection

Scheduling availability restrictions when the UE is performing L1-RSRP measurement for candidate beam detection are described in the following clauses.

#### 8.5C.8.1 Scheduling availability of UE performing L1-RSRP measurement with a same subcarrier spacing as PDSCH/PDCCH on FR1

There are no scheduling restrictions due to L1-RSRP measurement performed on SSB and CSI-RS configured as link recovery detection resource with the same SCS as PDSCH or PDCCH in FR1.

#### 8.5C.8.2 Scheduling availability of UE performing L1-RSRP measurement 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 L1-RSRP measurement based on SSB as link recovery detection resource. For UEs which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to L1-RSRP measurement based on SSB configured as link recovery detection resource.

- The UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH, TRS, CSI-RS for tracking or CSI-RS for CQI on SSB symbols to be measured for L1-RSRP.

### 8.5C.9 Minimum requirement at transitions for beam failure detection

When the UE transitions between DRX and no DRX or when DRX cycle periodicity changes, for each BFD-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 BFD-RS resource.

When the UE transitions from a first configuration of BFD resources to a second configuration of BFD resources that is different from the first configuration, for each BFD 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 BFD resource present in the second configuration.

When the UE transitions from a first configuration of active TCI state of the CORESET to a second configuration of active TCI state of the CORESET, for each CSI-RS for BFD present in the second configuration, the UE shall use an evaluation period corresponding to the second configuration from the time of transition.

## 8.6 Active BWP switch delay

### 8.6.1 Introduction

The requirements in this clause apply for a UE configured PCell or any activated SCell in standalone NR or NE-DC, PCell, PSCell or any activated SCell in MCG or SCG in NR-DC, or PSCell or any activated SCell in SCG in EN-DC. The requirements in this clause also apply for a UE configured with more than one BWP on PCell or any activated SCell with CCA in standalone NR, or PSCell or any activated SCell with CCA in SCG in EN-DC. The requirements in 8.6.4 apply for a UE which is capable of *ul-LBT-FailureDetectionRecovery-r16* configured with more than one UL BWP on PCell with CCA in standalone NR or PSCell with CCA in EN-DC.

UE shall complete the switch of active DL and/or UL BWP within the delay defined in this clause.

### 8.6.2 DCI and timer based BWP switch delay on a single CC

The requirements in this clause only apply to the case that the BWP switch is performed on a single CC with more than one BWP configurations configured.

For DCI-based BWP switch, after the UE receives BWP switching request at DL 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 on the first DL or UL slot occurs right after a time duration of TBWPswitchDelay + Y which starts from the beginning of DL slot n. Where,

- Y=0, if the serving cell where UE receives DCI for BWP switch request is same as the serving cell on which BWP switch occurs.

- Y equals to the length of 1 slot, if the serving cell where UE receives DCI for BWP switch is different from the serving cell on which BWP switch occurs for any involved serving cell. In this scenario, TBWPswitchDelay + Y shall follow the smaller SCS of scheduling cell, scheduled cells before and scheduled cells after active BWP change.If both scheduling cell and scheduled cell are in FR2-2, Y shall follow the SCS of 120 KHz.

The UE is not required to transmit UL signals or receive DL signals until the first DL or UL slot occurs right after a time duration of TBWPswitchDelay which starts from the beginning of DL slot n except DCI triggering BWP switch on the cell where DCI-based BWP switch occurs. The UE is not required to follow the requirements defined in this clause when performing a DCI-based BWP switch between the BWPs in disjoint channel bandwidths or in partially overlapping channel bandwidths.

For timer-based BWP switch, the UE shall start BWP switch at DL slot n, where slot n is the first slot of a DL subframe (FR1) or DL half-subframe (FR2) immediately after a BWP-inactivity timer *bwp-InactivityTimer* [2] 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 on the first DL or UL slot occurs right after a time duration of TBWPswitchDelay which starts from the beginning of DL slot n.

The UE is not required to transmit UL signals or receive DL signals during time duration TBWPswitchDelay after *bwp-InactivityTimer* [2] expires on the cell where timer-based BWP switch occurs.

Depending on UE capability *bwp-SwitchingDelay* [2], UE shall finish BWP switch within the time duration TBWPswitchDelay defined in Table 8.6.2-1.

Table 8.6.2-1: BWP switch delay

|  |  |  |  |
| --- | --- | --- | --- |
|  | NR Slot length | BWP switch delay TBWPswitchDelay (slots) | |
|  | (ms) | Type 1Note 1 | Type 2Note 1 |
| 0 | 1 | 1 | 3 |
| 1 | 0.5 | 2 | 5 |
| 2 | 0.25 | 3 | 9 |
| 3 | 0.125 | 6 | 18 |
| 5 | 0.03125 | 20 | 65 |
| 6 | 0.015625 | 39 | 129 |
| Note 1: Depends on UE capability.  Note 2: If the BWP switch involves changing of SCS, the BWP switch delay is determined by the smaller SCS between the SCS before BWP switch and the SCS after BWP switch. | | | |

Provided the UE does not have the required TCI-state information to receive PDCCH and PDSCH in the new BWP, the UE shall use old TCI-states before the BWP switch until a new MAC CE updating the required TCI-state information for PDCCH and PDSCH is received after the BWP switch.

If UE has the information on the required TCI-state information to receive PDCCH and PDSCH in the new BWP,

- UE shall be able to receive PDCCH and PDSCH with old TCI-states before the delay as specified in Clause 8.10 in the new BWP.

- UE shall be able to receive PDCCH and PDSCH with new TCI-states after the delay as specified in Clause 8.10 in the new BWP.

Provided the UE does not have the required activated TCI-state(s) information to receive PDCCH/ PDSCH and to transmit PUSCH/PUCCH/SRS in the new BWP, the UE shall use old TCI-state(s) before the BWP switch until a new MAC CE updating the required activated TCI-state(s) information is received after the BWP switch.

If the BWP switch is triggered within or outside DRX active time, and one of the two BWPs in a BWP switching is a dormant BWP [TS 38.321, 7], UE shall be able to complete active BWP switching within the time duration of

- TdormantBWPswitchDelay =TBWPswitchDelay+ X, provided that the dormancy indication is received in any of the first 3 OFDM symbols of a slot in the serving cell where DCI for dormancy indication is receiveds, or

- TdormantBWPswitchDelay =TBWPswitchDelay + X + Z, provided that the dormancy indication is received after the first 3 OFDM symbols of a slot in the serving cell where DCI for dormancy indication is received, where

- TBWPswitchDelay is defined in Table 8.6.2-1 corresponding to the smallest value among the SCS of the serving cell where UE receives dormancy indication and the SCSs of the dormant BWP and the active BWP immediately before or after switching the BWP of the serving cell where BWP switching occurs;

- X equals to the length of 1 slot corresponding to the smallest value among the SCS of the serving cell where UE receives dormancy indication and the SCSs of the dormant BWP and the active BWP immediately before or after switching the BWP of the serving cell where BWP switching occurs. If both scheduling cell and scheduled cell are in FR2-2, X shall follow the SCS of 120 KHz.

- Z equals to the length of 1 slot corresponding to the SCS of the serving cell where UE receives dormancy indication.

For DCI-based BWP switch, if the new BWP is a dormant BWP, after the UE receives BWP switching request at DL slot n on a serving cell, UE shall be able to receive CSI-RS (for DL active BWP switch) on the new BWP on the serving cell on which BWP switch on the first DL slot occurs right after a time duration of TdormantBWPswitchDelay which starts from the beginning of DL slot n.

### 8.6.2A DCI based BWP switch delay on multiple CCs

The requirements in this clause only apply to the case when the same type of BWP switch (DCI based BWP switch) is performed on multiple CCs simultaneously or over partially overlapping time period.

#### 8.6.2A.1 Simultaneous DCI based BWP switch delay on multiple CCs

The delay requirements for simultaneous DCI based BWP switch on multiple CCs in this clause apply only if the timing difference among the first symbol of slot carrying DCI for all CCs is received within the MRTD for inter-band CA as defined in clause 7.6.4.

For DCI-based BWP switch on multiple CCs, after the UE receives BWP switching request, UE shall be able to receive PDSCH (for DL active BWP switch) or transmit PUSCH (for UL active BWP switch) on the new BWPs on the serving cells on which BWP switch on the first DL or UL slot occurs right after a time duration of TMultipleBWPswitchDelay which starts from the beginning of DL slot n, where slot n is slot which UE receives the earliest BWP switching request among CCs on which UE is performing simultaneous DCI-based BWP switching.

The UE is not required to transmit UL signals or receive DL signals until the first DL or UL slot occurs right after a time duration of TMultipleBWPswitchDelay which starts from the beginning of DL slot n except DCI triggering BWP switch on the cell where DCI-based BWP switch occurs. The UE is not required to follow the requirements defined in this clause when performing a DCI-based BWP switch between the BWPs in disjoint channel bandwidths or in partially overlapping channel bandwidths on any serving cell.

UE shall finish BWP switch within the time duration TMultipleBWPswitchDelay + Y, which is defined as:

TMultipleBWPswitchDelay = TBWPswitchDelay + D\*(N-1)

Where:

- TBWPswitchDelay is the BWP switching delay on single CC defined in Table 8.6.2-1 depending on UE capability *bwp-SwitchingDelay* [2]. TBWPswitchDelay shall be based on the smallest SCS among SCS of all involved CCs before and after BWP switch. If the BWP switch on multiple CCs results in the change of the SCS on any CC among involved CCs, TBWPswitchDelay should be based on the smallest SCS among all SCS values of all involved CCs.

- D is the incremental delay for each additional CC involved in simultaneous BWP switch and depends on UE capability *bwp-SwitchingMultiCCs-r16* [TS 38.306, 14] for switching between non-dormant BWPs, and *bwp-SwitchingMultiDormancyCCs-r16* for switching between non-dormant and dormant BWPs.

- For UE which is capable of per-FR gap, and no BWP switch involves SCS change, N is the number of CCs in same FR; For UE which is not capable of per-FR gap, or the BWP switches on any CC involves SCS changing, N is the number of CCs undergoing simultaneous BWP switch.

* Y=0, ­if the serving cell where UE receives DCI for BWP switch is same as the serving cell on which BWP switch occurs for each involved serving cell.

Y equals to the length of one slot at smaller SCS of scheduling cell, scheduled cells before and scheduled cells after active BWP change,

- ­if the serving cell where UE receives DCI for BWP switch is different from the serving cell on which BWP switch occurs for any involved serving cell. If both scheduling cell and scheduled cell are in FR2-2, Y shall follow the SCS of 120 KHz. .

Provided the UE does not have the required TCI-state information to receive PDCCH and PDSCH in the new BWP, the UE shall use old TCI-states before the BWP switch until a new MAC CE updating the required TCI-state information for PDCCH and PDSCH is received after the BWP switch.

If UE has the information on the required TCI-state information to receive PDCCH and PDSCH in the new BWP,

- UE shall be able to receive PDCCH and PDSCH with old TCI-states before the delay as specified in Clause 8.10 in the new BWP.

- UE shall be able to receive PDCCH and PDSCH with new TCI-states after the delay as specified in Clause 8.10 in the new BWP.

Provided the UE does not have the required activated TCI-state(s) information to receive PDCCH/ PDSCH and to transmit PUSCH/PUCCH/SRS in the new BWP, the UE shall use old TCI-state(s) before the BWP switch until a new MAC CE updating the required activated TCI-state(s) information is received after the BWP switch.

If the BWP switch is triggered on multiple CCs simultaneously within or outside DRX active time, and one of the two BWPs on each CC in a BWP switching is a dormant BWP [TS 38.321, 7], UE shall be able to complete active BWP switching within the time duration of

- TDormantMultipleBWPswitchDelay = TMultipleBWPswitchDelay+X, provided that the dormancy indication is received in any of the first 3 OFDM symbols of a slot in the serving cell where DCI for dormancy indication is received, or

- TDormantMultipleBWPswitchDelay = TMultipleBWPswitchDelay +X+Z, provided that the dormancy indication is received after the first 3 OFDM symbols of a slot in the serving cell where DCI for dormancy indication is received, where

- TMultipleBWPswitchDelay is defined above corresponding to the smallest value among the SCS of the serving cell where UE receives dormancy indication and the SCSs of the dormant BWP and the active BWP immediately before or after switching the BWP of the serving cell where BWP switching occurs;

- X equals to the length of 1 slot corresponding to the smallest value among the SCS of the serving cell where UE receives dormancy indication and the SCSs of the dormant BWP and the active BWP immediately before or after switching the BWP of the serving cell where BWP switching occurs. If both scheduling cell and scheduled cell are in FR2-2, X shall follow the SCS of 120 KHz.

- Z equals to the length of 1 slot corresponding to the SCS of the serving cell where DCI for dormancy indication is received.

The number of CCs, N, on which the UE can simultaneously switch BWPs while still meeting the requirements, if any, related to allocations on downlink, uplink, or transmission of HARQ-ACK, depends on the UE reported capabilities related to BWP switching, the network configuration and the BWP switch method.

#### 8.6.2A.2 Non-simultaneous DCI based BWP switch delay on multiple CCs

In non-simultaneous case, the DCI-based BWP switch on multiple CCs is triggered over partially overlapping time period between CCs or multiple CCs in different Cell groups. The delay requirements for non-simultaneous DCI based BWP switch on multiple CCs in this clause apply only if:

- the timing difference among the first symbol of slot carrying DCI for all CCs involved in non-simultaneous BWP switch is received exceeds the MRTD for inter-band CA as defined in clause 7.6.4, and

- UE is operating in NR-DC (FR1+FR2), and

- UE is capable of per-FR gap, and

- BWP switch does not involve SCS change

For non-simultaneous DCI based BWP switch on multiple CCs, BWP switching delay requirements defined in clause 8.6.2 apply when BWP switching occurs on single CC in the cell group. BWP switching delay requirements defined in clause 8.6.2A.1 apply when simultaneous BWP switching occurs on multiple CCs in the cell group.

### 8.6.2B Timer based BWP switch delay on multiple CCs

The requirements in this clause only apply to the case when the same type of BWP switch (timer based BWP switch) is performed on multiple CCs simultaneously or over partially overlapping time period.

#### 8.6.2B.1 Simultaneous timer based BWP switch delay on multiple CCs

The delay requirements for simultaneous timer based BWP switch on multiple CCs in this clause apply only if the timing difference among the beginning of the slot where timer based BWP switching starts for all CCs is within the MRTD for inter-band CA as defined in clause 7.6.4.

For timer-based BWP switch on multiple CCs, UE shall start BWP switch at DL slot n, where slot n is the first slot of a DL subframe (in FR1) or DL half-subframe ((in FR2) immediately after the earliest BWP-inactivity timer *bwp-InactivityTimer* [2] expiration occurs on multiple serving cells, 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 BWPs on the serving cells on which BWP switch on the first DL or UL slot occurs right after a time duration of TMultipleBWPswitchDelay which starts from the beginning of DL slot n, where TMultipleBWPswitchDelay is defined in 8.6.2A.1.

The UE is not required to transmit UL signals or receive DL signals during time duration TMultipleBWPswitchDelay after *bwp-InactivityTimer* [2] expires on the cell where timer-based BWP switch occurs.

Provided the UE does not have the required TCI-state information to receive PDCCH and PDSCH in the new BWP, the UE shall use old TCI-states before the BWP switch until a new MAC CE updating the required TCI-state information for PDCCH and PDSCH is received after the BWP switch.

If UE has the information on the required TCI-state information to receive PDCCH and PDSCH in the new BWP,

- UE shall be able to receive PDCCH and PDSCH with old TCI-states before the delay as specified in Clause 8.10 in the new BWP.

- UE shall be able to receive PDCCH and PDSCH with new TCI-states after the delay as specified in Clause 8.10 in the new BWP.

Provided the UE does not have the required activated TCI-state(s) information to receive PDCCH/ PDSCH and to transmit PUSCH/PUCCH/SRS in the new BWP, the UE shall use old TCI-state(s) before the BWP switch until a new MAC CE updating the required activated TCI-state(s) information is received after the BWP switch.

#### 8.6.2B.2 Non-simultaneous timer based BWP switch delay on multiple CCs

In non-simultaneous case, the timer-based BWP switch on multiple CCs is triggered over partially overlapping time period.

The delay requirements for non-simultaneous timer based BWP switch on multiple CCs in this clause apply if the timing difference among the beginning of the slot where timer based BWP switching starts for all CCs is exceeds the MRTD for inter-band CA as defined in clause 7.6.4, and the BWP switch does not involve SCS change. The UE performs the non-simultaneous timer-based BWP switch on the CCs sequentially.

For non-simultaneous timer-based BWP switch, 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 on the first DL or UL slot occurs right after a time duration of TMultipleBWPswitchDelayTotal which starts from the beginning of DL slot n, where slot n is the first slot of a DL subframe (in FR1) or DL half-subframe (in FR2) immediately after the earliest BWP-inactivity timer *bwp-InactivityTimer* [2] expires.

TMultipleBWPswitchDelayTotal = TDelay + TMultipleBWPswitchDelay

Where:

TDelay is the time required to complete the ongoing timer-based BWP switching on other CCs.

TMultipleBWPswitchDelay is the timer-based BWP switch delay on current single CC defined in clause 8.6.2 or simultaneously triggered on multiple CCs defined in clause 8.6.2B.1.

The UE is not required to transmit UL signals or receive DL signals during time duration TMultipleBWPswitchDelayTotal after *bwp-InactivityTimer* [2] expires on the cell where timer-based BWP switch occurs.

Provided the UE does not have the required TCI-state information to receive PDCCH and PDSCH in the new BWP, the UE shall use old TCI-states before the BWP switch until a new MAC CE updating the required TCI-state information for PDCCH and PDSCH is received after the BWP switch.

If UE has the information on the required TCI-state information to receive PDCCH and PDSCH in the new BWP,

- UE shall be able to receive PDCCH and PDSCH with old TCI-states before the delay as specified in Clause 8.10 in the new BWP.

- UE shall be able to receive PDCCH and PDSCH with new TCI-states after the delay as specified in Clause 8.10 in the new BWP.

Provided the UE does not have the required activated TCI-state(s) information to receive PDCCH/ PDSCH and to transmit PUSCH/PUCCH/SRS in the new BWP, the UE shall use old TCI-state(s) before the BWP switch until a new MAC CE updating the required activated TCI-state(s) information is received after the BWP switch.

### 8.6.3 RRC based BWP switch delay on a single CC

The requirements in this clause only apply to the case that the BWP switch is performed on a single CC with one or more than one BWP configuration(s) configured, with

* Active BWP switch or parameter change of its active BWPs for SpCell
* Parameter change of its active BWPs except parameter *firstActiveDownlinkBWP-Id* and *firstActiveUplinkBWP-Id* for SCell

For RRC-based BWP switch, after the UE receives RRC reconfiguration involving active BWP switching or parameter change of its active BWP, UE shall be able to receive PDSCH/PDCCH (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 on the first DL or UL slot right after a time duration of slots which begins from the beginning of DL slot n, where

DL slot n is the last slot overlapping with the PDSCH containing the RRC command, and

is determined by the smaller SCS between the SCS before BWP switch and the SCS after BWP switch if the BWP switch involves changing of SCS.

is the length of the RRC procedure delay in ms as defined in clause 11.2 in TS 36.331 [16] if the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the length of the RRC procedure delay in ms as defined in clause 12 in TS 38.331 [2], and

is the time used by the UE to perform BWP switch.

The UE is not required to transmit UL signals or receive DL signals during the time defined by on the cell where RRC-based BWP switch occurs. When a longer switching delay is allowed. Where is the time between DL data transmission and acknowledgement as specified in TS 38.213 [3].

### 8.6.3A RRC based BWP switch delay on multiple CCs

The requirements in this clause only apply to the case when the same type of BWP switch (RRC based BWP switch) is performed on multiple CCs simultaneously or over partially overlapping time period.

The requirements in this clause shall apply:

* Active BWP switching or parameter change of its active BWPs for SpCell
* Parameter change of its active BWPs except parameter *firstActiveDownlinkBWP-Id* and *firstActiveUplinkBWP-Id* for SCells

#### 8.6.3A.1 Simultaneous RRC based BWP switch delay on multiple CCs

Requirements in this clause apply only if RRC based BWP switching on multiple CCs for NR-CA is triggered by a single RRC command.

For RRC-based BWP switch, after the UE receives RRC reconfiguration involving active BWP switching or parameter change of its active BWPs, UE shall be able to receive PDSCH/PDCCH (for DL active BWP switch) or transmit PUSCH (for UL active BWP switch) on the new BWPs on the serving cells on which BWP switch occurs on the first DL or UL slot right after a time duration of slots which begins from the beginning of DL slot n, where

DL slot n is the last slot overlapping with the PDSCH containing the RRC command, and

are defined in clause 8.6.3, and

for UE which is capable of type 1 BWP switching delay depending on UE capability *bwp-SwitchingDelay* [2]. for UE which is capable of type 2 BWP switching delay depending on UE capability *bwp-SwitchingDelay* [2], where D is the incremental delay for each additional CC involved in simultaneous BWP switch and depends on UE capability [TS 38.306, 14].

N is the number of CCs within the NR-CA configured for performing simultaneous BWP switch.

The UE is not required to transmit UL signals or receive DL signals during the time defined by on the cells where RRC-based BWP switch occurs.

#### 8.6.3A.2 Non-simultaneous RRC based BWP switch delay on multiple CCs

In non-simultaneous case, the RRC-based BWP switch on multiple CCs is triggered over partially overlapping time period in different Cell groups. The delay requirements in this clause apply only if:

BWP switching on multiple CCs in different cell groups are triggered by separate RRC commands, and

UE is operating in NR-DC (FR1+FR2), and

UE is capable of per-FR gap, and

BWP switch does not involve SCS change.

For non-simultaneous RRC-based BWP switch, after the UE receives RRC reconfiguration involving active BWP switching or parameter change of its active BWPs, UE shall be able to receive PDSCH/PDCCH (for DL active BWP switch) or transmit PUSCH (for UL active BWP switch) on the new BWPs on the serving cells on which BWP switch occurs on the first DL or UL slot right after a time duration of slots which begins from the beginning of DL slot n, where

DL slot n is the last slot containing the RRC command,

is the waiting time for RRC based BWP switch which is upper bounded by the ongoing BWP switch time in the first CG defined in clause 8.6.3A.1,

*M* is the number of CCs within the NR-CA configured for performing simultaneous BWP switch in the second CG; M=1 if the BWP switch is performed on single CC,

and are defined in clause 8.6.3, and

is defined in clause 8.6.3A.1.

The UE is not required to transmit UL signals or receive DL signals during the time defined by on the cells in the second CG where RRC-based BWP switch occurs.

### 8.6.4 BWP switch delay on Consistent UL CCA recovery

Upon detection of consistent UL CCA failure is slot#n in SpCell when UE detects *lbt-FailureInstanceMaxCount* number ofCCA failure within *lbt-FailureDetectionTimer*, the UE shall switch the active UL BWP to an UL BWP configured with PRACH occasion and for which consistent CCA failure has not been triggered as defined in TS 38.321 clause 5.21 [7]. The UE shall be ready to transmit PRACH on the new UL BWP of the SpCell on the first UL slot occurs right after slot n+TBWPswitchDelay +1, where TBWPswitchDelay is defined in Table 8.6.2-1. The UE shall finish the UL BWP switch within the time duration TBWPswitchDelay depending on UE capability *bwp-SwitchingDelay* [2].

Note: Additional delay in acquiring the first available RACH occasion will be derived in a way similar to that in handover in clause 6.1B.1.

The UE is not required to transmit UL signals or receive DL signals during time duration TBWPswitchDelay on the SpCell in the UL BWP switch. The UE is not required to follow the requirements defined in this clause when performing a UL BWP switch between the UL BWPs in disjoint channel bandwidths or in partially overlapping channel bandwidths.

## 8.6A Active BWP switch delay for RedCap

### 8.6A.1 Introduction

The requirements in this clause apply for RedCap UE. UE shall complete the switch of active DL and/or UL BWP within the delay defined in this clause.

### 8.6A.2 DCI and timer based BWP switch delay on a single CC

The requirements in this clause only apply to the case that the BWP switch is performed on a single CC with more than one BWP configurations configured.

For DCI-based BWP switch, after the UE receives BWP switching request at DL 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 on the first DL or UL slot occurs right after a time duration of TBWPswitchDelay + Y which starts from the beginning of DL slot n. Where,

- Y=0, if the serving cell where UE receives DCI for BWP switch request is same as the serving cell on which BWP switch occurs.

- Y equals to the length of 1 slot, if the serving cell where UE receives DCI for BWP switch is different from the serving cell on which BWP switch occurs for any involved serving cell. In this scenario, TBWPswitchDelay + Y shall follow the smaller SCS of scheduling cell, scheduled cells before and scheduled cells after active BWP change.

The UE is not required to transmit UL signals or receive DL signals until the first DL or UL slot occurs right after a time duration of TBWPswitchDelay which starts from the beginning of DL slot n except DCI triggering BWP switch on the cell where DCI-based BWP switch occurs. The UE is not required to follow the requirements defined in this clause when performing a DCI-based BWP switch between the BWPs in disjoint channel bandwidths or in partially overlapping channel bandwidths.

For timer-based BWP switch, the UE shall start BWP switch at DL slot n, where slot n is the first slot of a DL subframe (FR1) or DL half-subframe (FR2) immediately after a BWP-inactivity timer *bwp-InactivityTimer* [2] 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 on the first DL or UL slot occurs right after a time duration of TBWPswitchDelay which starts from the beginning of DL slot n.

The UE is not required to transmit UL signals or receive DL signals during time duration TBWPswitchDelay after *bwp-InactivityTimer* [2] expires on the cell where timer-based BWP switch occurs.

Depending on UE capability *bwp-SwitchingDelay* [2], UE shall finish BWP switch within the time duration TBWPswitchDelay defined in Table 8.6.2-1.

Table 8.6A.2-1: BWP switch delay

|  |  |  |  |
| --- | --- | --- | --- |
|  | NR Slot length | BWP switch delay TBWPswitchDelay (slots) | |
|  | (ms) | Type 1Note 1 | Type 2Note 1 |
| 0 | 1 | 1 | 3 |
| 1 | 0.5 | 2 | 5 |
| 2 | 0.25 | 3 | 9 |
| 3 | 0.125 | 6 | 18 |
| Note 1: Depends on UE capability.  Note 2: If the BWP switch involves changing of SCS, the BWP switch delay is determined by the smaller SCS between the SCS before BWP switch and the SCS after BWP switch. | | | |

Provided the UE does not have the required TCI-state information to receive PDCCH and PDSCH in the new BWP, the UE shall use old TCI-states before the BWP switch until a new MAC CE updating the required TCI-state information for PDCCH and PDSCH is received after the BWP switch.

If UE has the information on the required TCI-state information to receive PDCCH and PDSCH in the new BWP,

- UE shall be able to receive PDCCH and PDSCH with old TCI-states before the delay as specified in Clause 8.10 in the new BWP.

- UE shall be able to receive PDCCH and PDSCH with new TCI-states after the delay as specified in Clause 8.10 in the new BWP.

If the BWP switch is triggered within or outside DRX active time, and one of the two BWPs in a BWP switching is a dormant BWP [TS 38.321, 7], UE shall be able to complete active BWP switching within the time duration of

- TdormantBWPswitchDelay =TBWPswitchDelay+ X, provided that the dormancy indication is received in any of the first 3 OFDM symbols of a slot in the serving cell where DCI for dormancy indication is receiveds, or

- TdormantBWPswitchDelay =TBWPswitchDelay + X + Z, provided that the dormancy indication is received after the first 3 OFDM symbols of a slot in the serving cell where DCI for dormancy indication is received, where

- TBWPswitchDelay is defined in Table 8.6.2-1 corresponding to the smallest value among the SCS of the serving cell where UE receives dormancy indication and the SCSs of the dormant BWP and the active BWP immediately before or after switching the BWP of the serving cell where BWP switching occurs;

- X equals to the length of 1 slot corresponding to the smallest value among the SCS of the serving cell where UE receives dormancy indication and the SCSs of the dormant BWP and the active BWP immediately before or after switching the BWP of the serving cell where BWP switching occurs.

- Z equals to the length of 1 slot corresponding to the SCS of the serving cell where UE receives dormancy indication.

For DCI-based BWP switch, if the new BWP is a dormant BWP, after the UE receives BWP switching request at DL slot n on a serving cell, UE shall be able to receive CSI-RS (for DL active BWP switch) on the new BWP on the serving cell on which BWP switch on the first DL slot occurs right after a time duration of TdormantBWPswitchDelay which starts from the beginning of DL slot n.

### 8.6A.3 RRC based BWP switch delay on a single CC

The requirements in this clause only apply to the case that the BWP switch is performed on a single CC with one or more than one BWP configuration(s) configured, with

Active BWP switch or parameter change of its active BWPs for PCell

Parameter change of its active BWPs except parameter *firstActiveDownlinkBWP-Id* and *firstActiveUplinkBWP-Id* for SCell

For RRC-based BWP switch, after the UE receives RRC reconfiguration involving active BWP switching or parameter change of its active BWP, UE shall be able to receive PDSCH/PDCCH (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 on the first DL or UL slot right after a time duration of slots which begins from the beginning of DL slot n, where

DL slot n is the last slot overlapping with the PDSCH containing the RRC command, and

is determined by the smaller SCS between the SCS before BWP switch and the SCS after BWP switch if the BWP switch involves changing of SCS.

is the length of the RRC procedure delay in ms as defined in clause 11.2 in TS 36.331 [16] if the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the length of the RRC procedure delay in ms as defined in clause 12 in TS 38.331 [2], and

is the time used by the UE to perform BWP switch.

The UE is not required to transmit UL signals or receive DL signals during the time defined by on the cell where RRC-based BWP switch occurs. When a longer switching delay is allowed. Where is the time between DL data transmission and acknowledgement as specified in TS 38.213 [3].

## 8.6C Active BWP switch delay for satellite access

*Editor’s note: Applicability of frequency range, CA, DA, duplex mode, inter-RAT measurement, etc is subject to updates/changes based on the scope of the corresponding WID.*

*Editor’s note: Terminology will be further clarified and selected between, e.g. NTN and satellite access, based on further agreements.*

### 8.6C.1 Introduction

The requirements in this clause apply for a UE configured with only PCell, which is served by satellite access node (SAN). The requirements in this clause also apply for a UE configured with more than one BWP on PCell.

UE shall complete the switch of active DL and/or UL BWP within the delay defined in this clause.

### 8.6C.2 DCI and timer based BWP switch delay on a single CC

The requirements in this clause only apply to the case that the BWP switch is performed on a single CC with more than one BWP configurations configured.

For DCI-based BWP switch, after the UE receives BWP switching request at DL 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 on the first DL or UL slot occurs right after a time duration of TBWPswitchDelay + Y which starts from the beginning of DL slot n. Where,

- Y=0, if the serving cell where UE receives DCI for BWP switch request is same as the serving cell on which BWP switch occurs.

- Y equals to the length of 1 slot, if the serving cell where UE receives DCI for BWP switch is different from the serving cell on which BWP switch occurs for any involved serving cell. In this scenario, TBWPswitchDelay + Y shall follow the smaller SCS of scheduling cell, scheduled cells before and scheduled cells after active BWP change.

The UE is not required to transmit UL signals or receive DL signals until the first DL or UL slot occurs right after a time duration of TBWPswitchDelay which starts from the beginning of DL slot n except DCI triggering BWP switch on the cell where DCI-based BWP switch occurs. The UE is not required to follow the requirements defined in this clause when performing a DCI-based BWP switch between the BWPs in disjoint channel bandwidths or in partially overlapping channel bandwidths.

For timer-based BWP switch, the UE shall start BWP switch at DL slot n, where slot n is the first slot of a DL subframe (FR1) immediately after a BWP-inactivity timer *bwp-InactivityTimer* [2] 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 on the first DL or UL slot occurs right after a time duration of TBWPswitchDelay which starts from the beginning of DL slot n.

The UE is not required to transmit UL signals or receive DL signals during time duration TBWPswitchDelay after *bwp-InactivityTimer* [2] expires on the cell where timer-based BWP switch occurs.

Depending on UE capability *bwp-SwitchingDelay* [2], UE shall finish BWP switch within the time duration TBWPswitchDelay defined in Table 8.6C.2-1.

Table 8.6C.2-1: BWP switch delay

|  |  |  |  |
| --- | --- | --- | --- |
|  | NR Slot length | BWP switch delay TBWPswitchDelay (slots) | |
|  | (ms) | Type 1Note 1 | Type 2Note 1 |
| 0 | 1 | 1 | 3 |
| 1 | 0.5 | 2 | 5 |
| 2 | 0.25 | 3 | 9 |
| Note 1: Depends on UE capability.  Note 2: If the BWP switch involves changing of SCS, the BWP switch delay is determined by the smaller SCS between the SCS before BWP switch and the SCS after BWP switch. | | | |

Provided the UE does not have the required TCI-state information to receive PDCCH and PDSCH in the new BWP, the UE shall use old TCI-states before the BWP switch until a new MAC CE updating the required TCI-state information for PDCCH and PDSCH is received after the BWP switch.

If UE has the information on the required TCI-state information to receive PDCCH and PDSCH in the new BWP,

- UE shall be able to receive PDCCH and PDSCH with old TCI-states before the delay as specified in Clause 8.10 in the new BWP.

- UE shall be able to receive PDCCH and PDSCH with new TCI-states after the delay as specified in Clause 8.10 in the new BWP.

If the BWP switch is triggered within or outside DRX active time, and one of the two BWPs in a BWP switching is a dormant BWP [TS 38.321, 7], UE shall be able to complete active BWP switching within the time duration of

- TdormantBWPswitchDelay =TBWPswitchDelay+ X, provided that the dormancy indication is received in any of the first 3 OFDM symbols of a slot in the serving cell where DCI for dormancy indication is receiveds, or

- TdormantBWPswitchDelay =TBWPswitchDelay + X + Z, provided that the dormancy indication is received after the first 3 OFDM symbols of a slot in the serving cell where DCI for dormancy indication is received, where

- TBWPswitchDelay is defined in Table 8.6C.2-1 corresponding to the smallest value among the SCS of the serving cell where UE receives dormancy indication and the SCSs of the dormant BWP and the active BWP immediately before or after switching the BWP of the serving cell where BWP switching occurs.

- X equals to the length of 1 slot corresponding to the smallest value among the SCS of the serving cell where UE receives dormancy indication and the SCSs of the dormant BWP and the active BWP immediately before or after switching the BWP of the serving cell where BWP switching occurs.

- Z equals to the length of 1 slot corresponding to the SCS of the serving cell where UE receives dormancy indication.

For DCI-based BWP switch, if the new BWP is a dormant BWP, after the UE receives BWP switching request at DL slot n on a serving cell, UE shall be able to receive CSI-RS (for DL active BWP switch) on the new BWP on the serving cell on which BWP switch on the first DL slot occurs right after a time duration of TdormantBWPswitchDelay which starts from the beginning of DL slot n.

### 8.6C.3 RRC based BWP switch delay on a single CC

The requirements in this clause only apply to the case that the BWP switch is performed on a single CC with one or more than one BWP configuration(s) configured, with

* Active BWP switch or parameter change of its active BWPs for PCell

For RRC-based BWP switch, after the UE receives RRC reconfiguration involving active BWP switching or parameter change of its active BWP, UE shall be able to receive PDSCH/PDCCH (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 on the first DL or UL slot right after a time duration of slots which begins from the beginning of DL slot n, where

DL slot n is the last slot containing the RRC command, and

is determined by the smaller SCS between the SCS before BWP switch and the SCS after BWP switch if the BWP switch involves changing of SCS.

is the length of the RRC procedure delay in ms as defined in clause 12 in TS 38.331 [2], and

is the time used by the UE to perform BWP switch.

The UE is not required to transmit UL signals or receive DL signals during the time defined by on the cell where RRC-based BWP switch occurs. When a longer switching delay is allowed. Where is the time between DL data transmission and acknowledgement as specified in TS 38.213 [3].

## 8.7 Void

## 8.8 NE-DC: E-UTRAN PSCell Addition and Release Delay

### 8.8.1 Introduction

This clause defines requirements for the delay within which the UE shall be able to configure an E-UTRAN PSCell in NR - E-UTRA dual connectivity. The requirements are applicable to an NR - E-UTRA dual connectivity capable UE.

### 8.8.2 E-UTRAN PSCell Addition Delay Requirement

The requirements in this clause shall apply for the UE, which is configured with PCell, and may also be configured with one or more SCells.

Upon receiving E-UTRAN PSCell addition in subframe *n*, the UE shall be capable to transmit PRACH preamble towards E-UTRAN PSCell no later than in subframe *n* + Tconfig\_EUTRAN-PSCell:

Where:

Tconfig\_EUTRAN-PSCell = TRRC\_delay + Tactivation\_time + 50ms + TE-UTRAN-PSCell\_ DU

TRRC\_delay is the RRC procedure delay as specified in TS 38.331 [2].

Tactivation\_time is the E-UTRAN PSCell activation delay. If the E-UTRAN PSCell is known, then Tactivation\_time is 20ms. If the E-UTRAN PSCell is unknown, then Tactivation\_time is 30ms provided the E-UTRAN PSCell can be successfully detected on the first attempt.

TE-UTRAN-PSCell\_DU is the delay uncertainty in acquiring the first available PRACH occasion in the E-UTRAN PSCell. TE-UTRAN-PSCell\_DU is up to 30ms.

E-UTRAN PSCell is known if it has been meeting the following conditions:

- During the last 5 seconds before the reception of the E-UTRAN PSCell configuration command:

- the UE has sent a valid measurement report for the E-UTRAN PSCell being configured and

- the E-UTRAN PSCell being configured remains detectable according to the cell identification conditions specified in clause 8.8 of TS 36.133 [15],

- E-UTRAN PSCell being configured also remains detectable during the E-UTRAN PSCell configuration delay Tconfig\_EUTRAN-PSCell according to the cell identification conditions specified in clause 8.8 of TS 36.133 [15].

otherwise it is unknown.

The PCell interruption specified in clause 8.2 is allowed only during the RRC reconfiguration procedure [2].

### 8.8.3 E-UTRAN PSCell Release Delay Requirement

also be configured with one or more SCells and/or E-UTRAN SCells.

Upon receiving E-UTRAN PSCell release in subframe *n*, the UE shall accomplish the release actions specified in TS 38.331 [2] no later than in subframe *n+* TRRC\_delay:

Where

TRRC\_delay is the RRC procedure delay as specified in TS 38.331 [2].

The PCell interruption specified in clause 8.2 is allowed only during the RRC reconfiguration procedure [2].

## 8.9 NR-DC: PSCell Addition and Release Delay

### 8.9.1 Introduction

This clause defines requirements for the delay within which the UE shall be able to configure an PSCell in NR dual connectivity. The requirements are applicable to an NR dual connectivity capable UE.

### 8.9.2 PSCell Addition Delay Requirement

The requirements in this clause shall apply for the UE configured with only PCell in FR1.

Upon receiving PSCell addition in subframe *n*, the UE shall be capable to transmit PRACH preamble towards PSCell in FR2 no later than in subframe *n* + Tconfig\_PSCell Upon receiving PSCell addition in subframe *n*, the UE shall be capable to transmit PRACH preamble towards PSCell in FR2 no later than in slot :

where:

Tconfig\_PSCell = TRRC\_delay + Tprocessing + Tsearch + T∆ + TPSCell\_ DU + 2 ms

TRRC\_delay is the RRC procedure delay as specified in TS 38.331 [2].

Tprocessing is the SW processing time needed by UE, including RF warm up period. Tprocessing = 40 ms.

Tsearch is the time for AGC settling and PSS/SSS detection. If the target cell is known, Tsearch = 0 ms. If the target cell is unknown and the target cell Ês/Iot ≥ -2dB, Tsearch = 3\*N\* Trs ms. N = 8 when the target cell is in FR2-1, and N = 12 when the target cell is in FR2-2

T∆ is time for fine time tracking and acquiring full timing information of the target cell. T∆ = 1\*Trs ms for a known or unknown PSCell.

TPSCell\_ DU is the delay uncertainty in acquiring the first available PRACH occasion in the PSCell. TPSCell\_ DU is up to the summation of SSB to PRACH occasion association period and 10 ms. SSB to PRACH occasion associated period is defined in Table 8.1-1 of TS 38.213 [3].

Trs is the SMTC periodicity of the target cell if the UE has been provided with an SMTC configuration for the target cell in PSCell addition message, otherwise Trs is the SMTC configured in the measObjectNR having the same SSB frequency and subcarrier spacing. If the UE is not provided SMTC configuration or measurement object on this frequency, the requirement in this clause is applied with Trs = 5 ms assuming the SSB transmission periodicity is 5 ms. There is no requirement if the SSB transmission periodicity is not 5 ms.

In FR1 and FR2, the PSCell is known if it has been meeting the following conditions:

- During the last 5 seconds before the reception of the PSCell configuration command:

- the UE has sent a valid measurement report for the PSCell being configured and

- One of the SSBs measured from the PSCell being configured remains detectable according to the cell identification conditions specified in clause 9.3.

- One of the SSBs measured from PSCell being configured also remains detectable during the PSCell configuration delay Tconfig\_PSCell according to the cell identification conditions specified in clause 9.3.

otherwise it is unknown.

The PCell interruption specified in clause 8.2 is allowed only during the RRC reconfiguration procedure [2].

### 8.9.3 PSCell Release Delay Requirement

The requirements in this clause shall apply for a UE which is configured with PCell and one PSCell.

Upon receiving PSCell release in subframe *n*, the UE shall accomplish the release actions specified in TS 38.331 [2] no later than in slot :

where

TRRC\_delay is the RRC procedure delay as specified in TS 38.331 [2].

The PCell interruption specified in clause 8.2 is allowed only during the RRC reconfiguration procedure [2].

## 8.9A Conditional PSCell Addition Delay

### 8.9A.1 Introduction

This clause defines requirements for the delay within which the UE shall be able to perform conditional PSCell addition in EN-DC or NR-DC. The requirements in this clause are applicable to EN-DC and NR-DC.

### 8.9A.2 Conditional PSCell Addition Delay Requirement

The requirements in this clause shall apply for the UE configured with only PCell in FR1.

Upon receiving conditional PSCell addition in subframe *n*, the UE shall be capable to transmit PRACH preamble towards PSCell no later than in subframe *n* + Tconfig\_PSCell\_Addition\_Conditional:

Where:

Tconfig\_PSCell\_Addition\_Conditional = TRRC\_delay + TEvent\_DU + Tmeasure + TUE\_preparation + Tprocessing + T∆ + TPSCell\_ DU + 2 ms

TRRC\_delay is the RRC processing delay defined in Clause 11.2 in 36.331 [16] which is the corresponding RRC message embedded in E-UTRA RRC message, otherwise it is the RRC procedure delay defined in clause 12 in TS 38.331 [2] for processing the conditional PSCell addition command.

TEvent\_DU is the delay uncertainty which is the time from when the UE successfully decodes a conditional PSCell addition command until a condition exists at the measurement reference point which will trigger the conditional PSCell addition.

Tmeasure is the measurements time stated in clause 8.9A.2.1.

TUE\_preparation is the UE preparation time for conditional PSCell addition, and starts after UE realizes the condition of PSCell addition is met and identity of the PSCell is determined. TUE\_preparation is up to 10 ms.

Tprocessing is the SW processing time needed by UE, including RF warm up period. Tprocessing = 20 ms when PSCell is in FR1, and Tprocessing = 40 ms when PSCell is in FR2.

T∆ is time for fine time tracking and acquiring full timing information of the target cell. T∆ = 1\*Trs ms.

TPSCell\_ DU is the delay uncertainty in acquiring the first available PRACH occasion in the PSCell. TPSCell\_ DU is up to the summation of SSB to PRACH occasion association period and 10 ms. SSB to PRACH occasion associated period is defined in Table 8.1-1 of TS 38.213 [3].

Trs is the SMTC periodicity of the target cell if the UE has been provided with an SMTC configuration for the target cell in PSCell addition message, otherwise Trs is the SMTC configured in the measObjectNR having the same SSB frequency and subcarrier spacing. If the UE is not provided SMTC configuration or measurement object on this frequency, the requirement in this clause is applied with Trs = 5 ms assuming the SSB transmission periodicity is 5 ms. There is no requirement if the SSB transmission periodicity is not 5 ms.

The PCell interruption specified in clause 8.2 is allowed only after the UE starts to execute a conditional PSCell addition.

#### 8.9A.2.1 Measurement time

The measurement time delay is defined from the end of TEvent\_DU until UE executes a PSCell addition and interruption time starts.

The measurement time delay measured without Time To Trigger (TTT) and L3 filtering shall be less than Tidentify\_inter\_with\_index defined in clause 9.3.4. When TTT or L3 filtering is used an additional delay can be expected.

A cell is detectable only if at least one SSB measured from the cell being configured remains detectable during the time period Tidentify\_inter\_with\_index for PSCell addition. If a cell, which has been detectable at least for the time period Tidentify\_inter\_with\_index for PSCell addition, becomes undetectable for a period and then the cell becomes detectable again and triggers a PSCell addition, the measurement time delay shall be less than TSSB\_measurement\_period\_inter provided the timing to that cell has not changed more than ± 3200/ Tc while the measurement gap has not been available and the L3 filter has not been used, where *µ* is the SCS configuration as defined in clause 4.2 of TS 38.211 [3]. When L3 filtering is used, an additional delay can be expected.

## 8.9B NR-DC: PSCell Addition and Release Delay in Carriers with CCA

### 8.9B.1 Introduction

This clause defines requirements for the delay within which the UE shall be able to configure an PSCell in FR2-2 with CCA in NR dual connectivity. The requirements are applicable to an NR dual connectivity capable UE.

### 8.9B.2 PSCell Addition Delay Requirement

The requirements in this clause shall apply for the UE configured with only PCell in FR1.

Upon receiving PSCell addition in subframe *n*, the UE shall be capable to transmit PRACH preamble towards PSCell in FR2-2 no later than in slot :

where:

Tconfig\_PSCell\_CCA = TRRC\_delay + Tprocessing + Tsearch\_CCA + T∆\_CCA + TPSCell\_ DU + 2 ms

TRRC\_delay is the RRC procedure delay as specified in TS 38.331 [2].

Tprocessing is the SW processing time needed by UE, including RF warm up period. Tprocessing = 40 ms.

Tsearch\_CCA is the time for AGC settling and PSS/SSS detection. If the target cell is known, Tsearch = 0 ms. If the target cell is unknown and the target cell Ês/Iot ≥ -2dB, Tsearch = (3\*N+L1\*N) \* Trs ms, where L1 is the number of SMTC occasions groups with at least one SSB/SMTC occasion in the group is not transmitted by the gNB during the AGC settling and PSS/SSS detection. L1, max=TBD, N is the Rx beam sweeping factor for FR2-2.

T∆\_CCA is time for fine time tracking and acquiring full timing information of the target cell. T∆ = (1+L2) \*Trs ms for a known or unknown PSCell, where L2 is the number of SMTC occasions not avaible at the UE during the time tracking period. L2, max =TBD.

TPSCell\_ DU is the interruption uncertainty due to the random access procedure when sending PRACH to the new cell. TPSCell\_ DU can be up to: (1+ L3) \* TSSB,RO + 10 ms where TSSB,RO is the SSB to PRACH occasion association period as defined in Table 8.1-1 of TS 38.213 [3] and L3 is the number of consecutive SSB to PRACH occasion association periods during which no PRACH occasion is available for PRACH transmission due to UL CCA failure. L3 = 0 for Type 3 UL channel access procedure as defined in TS 37.213 [33]. L3 = 0 if *ra-ChannelAccess-r17* is not configured in FR2-2.

Trs is the SMTC periodicity of the target cell if the UE has been provided with an SMTC configuration for the target cell in PSCell addition message, otherwise Trs is the SMTC configured in the *measObjectNR* having the same SSB frequency and subcarrier spacing. If the UE is not provided SMTC configuration or measurement object on this frequency, the requirement in this clause is applied with Trs = 5 ms assuming the SSB transmission periodicity is 5 ms. There is no requirement if the SSB transmission periodicity is not 5 ms.

NOTE 1: The interruption time considering the potential extensions caused by L1,L2, L3 and by the UL CCA failure detection/recovery mechanism is limited by the T304 timer. The UE behaviour at the T304 timer expiry is detailed in TS 38.331 [2].

In FR2-2, the PSCell is known if it has been meeting the following conditions:

- During the last 5 seconds before the reception of the PSCell configuration command:

- the UE has sent a valid measurement report for the PSCell being configured and

- One of the SSBs measured from the PSCell being configured remains detectable according to the cell identification conditions specified in clause 9.3A.

- One of the SSBs measured from PSCell being configured also remains detectable during the PSCell configuration delay Tconfig\_PSCell\_CCA according to the cell identification conditions specified in clause 9.3A.

otherwise it is unknown.

The PCell interruption specified in clause 8.2 is allowed only during the RRC reconfiguration procedure [2].

### 8.9B.3 PSCell Release Delay Requirement

The requirements in this clause shall apply for a UE which is configured with PCell in FR1 and one PSCell in FR2-2.

Upon receiving PSCell release in subframe *n*, the UE shall accomplish the release actions specified in TS 38.331 [2] no later than in slot :

where

- TRRC\_delay is the RRC procedure delay as specified in TS 38.331 [2].

The PCell interruption specified in clause 8.2 is allowed only during the RRC reconfiguration procedure [2].

## 8.10 Active TCI state switching delay

8.10.1 Introduction

The requirements in this clause apply for a UE configured with one or more TCI state configurations on serving cell in MR-DC or standalone NR. UE shall complete the switch of active TCI state within the delay defined in this clause.

8.10.2 Known conditions for TCI state

The TCI state is known if the following conditions are met:

- During the period from the last transmission of the RS resource used for the L1-RSRP measurement reporting for the target TCI state to the completion of active TCI state switch, where the RS resource for L1-RSRP measurement is the RS in target TCI state or QCLed to the target TCI state

- TCI state switch command is received within 1280 ms upon the last transmission of the RS resource for beam reporting or measurement

- The UE has sent at least 1 L1-RSRP report for the target TCI state before the TCI state switch command

- The TCI state remains detectable during the TCI state switching period

- The SSB associated with the TCI state remain detectable during the TCI switching period

- SNR of the TCI state ≥ -3dB

Otherwise, the TCI state is unknown.

8.10.3 MAC-CE based TCI state switch delay

If the target TCI state is known, upon receiving PDSCH carrying MAC-CE activation command in slot n, UE shall be able to receive PDCCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ THARQ + + TOk\*(Tfirst-SSB + TSSB-proc) / *NR slot length*. The UE shall be able to receive PDCCH with the old TCI state until slot n+ THARQ + .Where THARQ is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3];

- Tfirst-SSB is time to first SSB transmission after MAC CE command is decoded by the UE; The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state

- TSSB-proc = 2 ms;

- TOk = 1 if target TCI state is not in the active TCI state list for PDSCH, 0 otherwise.

If the target TCI state is unknown, upon receiving PDSCH carrying MAC-CE activation command in slot n, UE shall be able to receive PDCCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ THARQ + + TL1-RSRP +TOuk\*(Tfirst-SSB+ TSSB-proc) / *NR slot length*. The UE shall be able to receive PDCCH with the old TCI state until slot n+ THARQ + .

Where

- T L1-RSRP = 0 in FR1 or when the TCI state switching not involving QCL-TypeD in FR2. Otherwise,

- T L1-RSRP is the time for Rx beam refinement in FR2, defined as

- TL1-RSPR\_Measurement\_Period\_SSB for SSB as specified in clause 9.5.4.1,

- with the assumption of M=1

- with TReport = 0

- TL1-RSRP\_Measurement\_Period\_CSI-RS for CSI-RS as specified in clause 9.5.4.2

- configured with higher layer parameter *repetition* set to ON

- with the assumption of M=1 for periodic CSI-RS

- for aperiodic CSI-RS if number of resources in resource set at least equal to *MaxNumberRxBeam*

- with TReport = 0

- TOuk = 1 for CSI-RS based L1-RSRP measurement, and 0 for SSB based L1-RSRP measurement when TCI state switching involves QCL-TypeD

- TOuk = 1 when TCI state switching involves other QCL types only

- Tfirst-SSB is time to first SSB transmission after L1-RSRP measurement when TCI state switching involves QCL-TypeD;

- Tfirst-SSB is time to first SSB transmission after MAC CE command is decoded by the UE for other QCL types;

- The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state

### 8.10.3A MAC-CE based TCI state switch delay in HST FR2 scenarios

For FR2 power class 6 UE*,* if the target TCI state is known, upon receiving PDSCH carrying MAC-CE activation command in slot n, UE shall be able to receive PDCCH with target TCI state of the serving cell on which TCI state switch occurs at the symbol m of the first slot that is after slot n+ THARQ + + TOk\*(Tfirst-SSB + TSSB-proc + Trs + Trs-proc) / *NR slot length*. The UE shall be able to receive PDCCH with the old TCI state until slot n+ THARQ + .Where THARQ is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3];

- Tfirst-SSB is time to first SSB transmission after MAC CE command is decoded by the UE;

- TSSB-proc = 2 ms;

- Trs is time to the first TRS or SSB transmission after the SSB transmission in the definition of Tfirst-SSB is processed by the UE;

- Trs-proc = 2 ms;

- TOk = 1, m = 0 if target TCI state is not in the active TCI state list for PDSCH; otherwise TOk = 0, m = 1.

For FR2 power class 6 UE, if the target TCI state is unknown, the same requirement for unknown target TCI state case specified in clause 8.10.3 applies.

### 8.10.4 DCI based TCI state switch delay

If the target TCI state is known, when a UE is configured with the higher layer parameter *tci-PresentInDCI* which is set as 'enabled'for the CORESET scheduling PDSCH at slot n, UE shall be able to receive PDSCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+*timeDurationForQCL*, where, *timeDurationForQCL* is the time required by the UE to perform PDCCH reception and applying spatial QCL information received in DCI for PDSCH processing as described in TS 38.214 [26], the value of *timeDurationForQCL* is defined in TS 38.331 [2].

The known condition for TCI state defined in clause 8.10.2 is applied.

### 8.10.5 RRC based TCI state switch delay

If the target TCI state is known, UE shall be able to receive PDCCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ (TRRC\_processing +TOk\*(Tfirst-SSB + TSSB-proc)) / *NR slot length*, The UE is not required to receive PDCCH/PDSCH/CSI-RS or transmit PUCCH/PUSCH until the end of switching period.

Where

- Slot n is the last slot overlapping with the PDSCH carrying RRC activation command.

- TRRC\_processing is the RRC processing delay defined in Clause 11.2 of TS 36.331 [16] if the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the RRC processing delay defined in Clause 12 of TS 38.331 [2].

- Tfirst-SSB is time to first SSB transmission after RRC processing by the UE; The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state.

- TSSB-proc and TOk are defined in clause 8.10.3.

If the target TCI state is unknown, UE shall be able to receive PDCCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ (TRRC\_processing  +TL1-RSRP +TOuk\*(Tfirst-SSB + TSSB-proc)) / *NR slot length*, The UE is not required to receive PDCCH/PDSCH/CSI-RS or transmit PUCCH/PUSCH until the end of switching period.

Where

- Slot n is the last slot overlapping with the PDSCH carrying RRC activation command.

- TRRC\_processing is the RRC processing delay defined in Clause 11.2 of TS 36.331 [16] if the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the RRC processing delay defined in Clause 12 of TS 38.331 [2].

- Tfirst-SSB is time to first SSB transmission after L1-RSRP measurement when TCI state switching involves QCL-TypeD;

- Tfirst-SSB is time to first SSB transmission after RRC processing time at the UE for other QCL types;

- The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state

- TL1-RSRP, TOuk and TSSB-proc are defined in clause 8.10.3.

The requirements for RRC based TCI state switch delay apply when only 1 TCI state is configured in RRC TCI state list. When a longer switching delay is allowed. Where is the time between DL data transmission and acknowledgement as specified in TS 38.213 [3].

### 8.10.6 Active TCI state list update delay

If the target TCI state is known, upon receiving PDSCH carrying MAC-CE active TCI state list update at slot n, UE shall be able to receive PDCCH to schedule PDSCH with the new target TCI state at the first slot that is after n+ THARQ + +TOk\*(Tfirst-SSB + TSSB-proc) / *NR slot length*. Where THARQ, Tfirst-SSB, TSSB-proc and TOk are defined in clause 8.10.3.

## 8.10A Active TCI state switching delay with CCA

### 8.10A.1 Introduction

The requirements in this clause apply for a UE configured with one or more TCI state configurations on serving cell in EN-DC with PSCell on a carrier frequency with CCA or SA NR with PCell on a carrier frequency with CCA. UE shall complete the switch of active TCI state within the delay defined in this clause.

In the requirements of clause 8.10A, the term SSB occasion not available at the UE refers to when the SSB is configured by gNB in a cell on a carrier frequency subject to CCA, but the first two successive candidate SSB positions for the same SSB index within the discovery burst transmission window are not available at the UE due to DL CCA failures at gNB during the corresponding period; otherwise the SSB occasion is considered as available at the UE.

### 8.10A.2 Known conditions for TCI state

The TCI state is known if the following conditions are met:

- During the period from the last transmission of the RS resource used for the L1-RSRP measurement reporting for the target TCI state to the completion of active TCI state switch, where the RS resource for L1-RSRP measurement is the RS in target TCI state or QCLed to the target TCI state

- TCI state switch command is received within 1280 ms of the last transmission of the RS resource for beam reporting or measurement

- The UE has sent at least 1 L1-RSRP report for the target TCI state before the TCI state switch command

- The TCI state remain detectable during the TCI state switching period in the SSB occasions available at the UE

- The SSB associated with the TCI state remain detectable during the TCI switching period in the SSB occasions available at the UE

- SNR of the TCI state is ≥ -3dB

Otherwise, the TCI state is unknown.

### 8.10A.3 MAC-CE based TCI state switch delay

If the target TCI state is known, upon receiving PDSCH carrying MAC-CE activation command at slot n, UE shall be able to receive PDCCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ +(THARQ +TOk\*(Tfirst-SSB + TSSB-proc+TSSB\*LMAC,known)) */NR slot length*. The UE shall be able to receive on the old TCI state until slot n + + (THARQ +TOk\*(Tfirst-SSB+ TSSB\*LMAC,known)) / *NR slot length*, where

THARQ (in ms) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3]. In the event of UE not being able to transmit the acknowledgment due to UL CCA failures: THARQ is extended to also include the time to all next HARQ feedback transmissions and retransmission opportunities, until the time of its successful transmission, as specified in TS 38.213 [3]; no extension of THARQ due to UL CCA failures is allowed for Type 2C UL channel access in TS 37.213;

Tfirst-SSB is time to first SSB transmission occasion after MAC CE command is decoded by the UE, during which some SSB occasions may not be available at the UE due to DL CCA failures;

The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state;

TSSB-proc = 2 ms;

TOk = 1 if target TCI state is not in the active TCI state list for PDSCH, 0 otherwise;

TSSB = ssb-periodicityServingCell;

LMAC,known≤ LMAC,known,max is the corresponding number of SSB occasions not available at the UE;

LMAC,known,max =2 for TSSB≤40 ms, LMAC,known,max =1 for TSSB>40 ms.

If the target TCI state is unknown, upon receiving PDSCH carrying MAC-CE activation command at slot n, UE shall be able to receive PDCCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ + (THARQ+ TL1-RSRP +TOuk\*(Tfirst-SSB+ TSSB-proc+TSSB\*LMAC,unknown)) / *NR slot length*. The UE shall be able to receive on the old TCI state until slot n+ + (THARQ+TOuk\*(Tfirst-SSB+ TSSB\*LMAC,unknown)) / *NR slot length*,

Where:

- LMAC,unknown≤LMAC,unknown,max is the corresponding number of SSB occasions groups not available at the UE;

- LMAC,unknown,max = 2 for TSSB≤40 ms, LMAC,unknown,max = 1 for TSSB>40 ms;

- TOuk = 1.

- T L1-RSRP = 0 in FR1 or when the TCI state switching not involving QCL-TypeD in FR2-2. Otherwise,

- T L1-RSRP is the time for Rx beam refinement in FR2-2, defined as

- TL1-RSPR\_Measurement\_Period\_SSB\_CCA for SSB as specified in clause 9.5A.4.1,

- with the assumption of M=1

- with TReport = 0

- TOuk = 0 for SSB based L1-RSRP measurement when TCI state switching involves QCL-TypeD

- TOuk = 1 when TCI state switching involves other QCL types only

- Tfirst-SSB is time to first SSB transmission after L1-RSRP measurement when TCI state switching involves QCL-TypeD;

- Tfirst-SSB is time to first SSB transmission after MAC CE command is decoded by the UE for other QCL types;

- The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state

### 8.10A.4 DCI based TCI state switch delay

If the target TCI state is known, when a UE is configured with the higher layer parameter *tci-PresentInDCI* which is set as 'enabled'for the CORESET scheduling the PDSCH at slot n, UE shall be able to receive PDSCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+*timeDurationForQCL*, where, *timeDurationForQCL* is the time required by the UE to perform PDCCH reception and applying spatial QCL information received in DCI for PDSCH processing as described in TS 38.214 [26], the value of *timeDurationForQCL* is defined in TS 38.306 [14].

The known condition for TCI state defined in clause 8.10A.2 is applied.

### 8.10A.5 RRC based TCI state switch delay

If the target TCI state is known, UE shall be able to receive PDCCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ (TRRC\_processing  +TOk\*(Tfirst-SSB + TSSB-proc+ TSSB\*LRRC,known)) / *NR slot length*. The UE is not required to receive PDCCH/PDSCH/CSI-RS or transmit PUCCH/PUSCH until the end of switching period.

Where

- Slot n is last slot overlapping with the PDSCH carrying RRC activation command.

- TRRC\_processing is the RRC processing delay defined in Clause 11.2 of 36.331 [16] is the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the RRC processing delay defined in Clause 12 of TS38.331 [2]

- Tfirst-SSB is time to first SSB transmission occasion after RRC processing by the UE, during which some of the SSB occasions may not be availabledue to DL CCA failures;

- The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state;

- LRRC,known≤ LRRC,known,max is the corresponding number of SSB occasions not available at the UE;

- LRRC,known,max =2 for TSSB ≤ 40 ms, LRRC,known,max =1 for TSSB>40 ms.

- TSSB-proc, TOk, and TSSB are as defined in clause 8.10A.3.

If the target TCI state is unknown, UE shall be able to receive PDCCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ (TRRC\_processing  +TL1-RSRP +TOuk\*(Tfirst-SSB+ TSSB-proc+TSSB\*LRRC,unknown) ) / *NR slot length*. The UE is not required to receive PDCCH/PDSCH/CSI-RS or transmit PUCCH/PUSCH until the end of switching period.

Where,

- Slot n is the last slot overlapping with the PDSCH carrying RRC activation command.

- TRRC\_processing is the RRC processing delay defined in Clause 11.2 of 36.331 [16] is the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the RRC processing delay defined in Clause 12 of TS38.331 [2].

- Tfirst-SSB is time to first SSB transmission after L1-RSRP measurement when TCI state switching involves QCL-TypeD;

- Tfirst-SSB is time to first SSB transmission occasion after RRC processing time at the UE for other QCL types, during which some SSB occasions may not be available at the UE due to DL CCA failures;

- The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state;

- LRRC,unknown≤LRRC,unknown,max is the corresponding number of SSB occasions not available at the UE;

- LRRC,unknown,max = 2 for TSSB ≤40 ms, LRRC,unknown,max = 1 for TSSB>40 ms.

- TL1-RSRP, TOuk, TSSB-proc, and TSSB are as defined in clause 8.10A.3

The requirements for RRC based TCI state switch delay apply when only 1 TCI state is configured in RRC TCI state list. When a longer switching delay is allowed. Where is the time between DL data transmission and acknowledgement as specified in TS 38.213 [3].

### 8.10A.6 Active TCI state list update delay

If the target TCI state is known, upon receiving PDSCH carrying MAC-CE active TCI state list update at slot n, UE shall be able to receive PDCCH to schedule PDSCH with the new target TCI state at the first slot that is after n+ + (THARQ +TOk\*(Tfirst-SSB + TSSB-proc+TSSB\*LMAC,known)) / *NR slot length*. Where THARQ, Tfirst-SSB, TSSB-proc , TSSB, LMAC,known and TOk are as defined in clause 8.10A.3.

## 8.10B Active TCI state switching delay for RedCap

### 8.10B.1 Introduction

The requirements in this clause apply for a RedCap UE configured with one or more TCI state configurations on serving cell in standalone NR. UE shall complete the switch of active TCI state within the delay defined in this clause.

### 8.10B.2 Known conditions for TCI state

The TCI state is known if the following conditions are met:

- During the period from the last transmission of the RS resource used for the L1-RSRP measurement reporting for the target TCI state to the completion of active TCI state switch, where the RS resource for L1-RSRP measurement is the RS in target TCI state or QCLed to the target TCI state

- TCI state switch command is received within 1280 ms upon the last transmission of the RS resource for beam reporting or measurement

- The UE has sent at least 1 L1-RSRP report for the target TCI state before the TCI state switch command

- The TCI state remains detectable during the TCI state switching period

- The SSB associated with the TCI state remain detectable during the TCI switching period

- SNR of the TCI state ≥ -3dB

Otherwise, the TCI state is unknown.

### 8.10B.3 MAC-CE based TCI state switch delay

If the target TCI state is known, upon receiving PDSCH carrying MAC-CE activation command in slot n, UE shall be able to receive PDCCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ THARQ + + TOk\*(Tfirst-SSB + TSSB-proc) / *NR slot length*. The UE shall be able to receive PDCCH with the old TCI state until slot n+ THARQ + .Where THARQ is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3];

- Tfirst-SSB is time to first SSB transmission after MAC CE command is decoded by the UE; The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state

- TSSB-proc = 2 ms;

- TOk = 1 if target TCI state is not in the active TCI state list for PDSCH, 0 otherwise.

If the target TCI state is unknown, upon receiving PDSCH carrying MAC-CE activation command in slot n, UE shall be able to receive PDCCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ THARQ + + TL1-RSRP +TOuk\*(Tfirst-SSB+ TSSB-proc) / *NR slot length*. The UE shall be able to receive PDCCH with the old TCI state until slot n+ THARQ + .

Where

- T L1-RSRP = 0 in FR1 or when the TCI state switching not involving QCL-TypeD in FR2. Otherwise,

- T L1-RSRP is the time for Rx beam refinement in FR2, defined as

- TL1-RSPR\_Measurement\_Period\_SSB\_RedCap for SSB as specified in clause 9.5B.4.1,

- with the assumption of M=1

- with TReport = 0

- TL1-RSRP\_Measurement\_Period\_CSI-RS\_RedCap for CSI-RS as specified in clause 9.5B.4.2

- configured with higher layer parameter *repetition* set to ON

- with the assumption of M=1 for periodic CSI-RS

- for aperiodic CSI-RS if number of resources in resource set at least equal to *MaxNumberRxBeam*

- with TReport = 0

- TOuk = 1 for CSI-RS based L1-RSRP measurement, and 0 for SSB based L1-RSRP measurement when TCI state switching involves QCL-TypeD

- TOuk = 1 when TCI state switching involves other QCL types only

- Tfirst-SSB is time to first SSB transmission after L1-RSRP measurement when TCI state switching involves QCL-TypeD;

- Tfirst-SSB is time to first SSB transmission after MAC CE command is decoded by the UE for other QCL types;

- The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state

### 8.10B.4 DCI based TCI state switch delay

If the target TCI state is known, when a UE is configured with the higher layer parameter *tci-PresentInDCI* which is set as 'enabled'for the CORESET scheduling PDSCH at slot n, UE shall be able to receive PDSCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+*timeDurationForQCL*, where, *timeDurationForQCL* is the time required by the UE to perform PDCCH reception and applying spatial QCL information received in DCI for PDSCH processing as described in TS 38.214 [26], the value of *timeDurationForQCL* is defined in TS 38.331 [2].

The known condition for TCI state defined in clause 8.10.2 is applied.

### 8.10B.5 RRC based TCI state switch delay

If the target TCI state is known, UE shall be able to receive PDCCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ (TRRC\_processing +TOk\*(Tfirst-SSB + TSSB-proc)) / *NR slot length*, The UE is not required to receive PDCCH/PDSCH/CSI-RS or transmit PUCCH/PUSCH until the end of switching period.

Where

- Slot n is the last slot overlapping with the PDSCH carrying RRC activation command.

- TRRC\_processing is the RRC processing delay defined in Clause 11.2 of TS 36.331 [16] if the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the RRC processing delay defined in Clause 12 of TS 38.331 [2].

- Tfirst-SSB is time to first SSB transmission after RRC processing by the UE; The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state.

- TSSB-proc and TOk are defined in clause 8.10.3.

If the target TCI state is unknown, UE shall be able to receive PDCCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ (TRRC\_processing  +TL1-RSRP +TOuk\*(Tfirst-SSB + TSSB-proc)) / *NR slot length*, The UE is not required to receive PDCCH/PDSCH/CSI-RS or transmit PUCCH/PUSCH until the end of switching period.

Where

- Slot n is the last slot overlapping with the PDSCH carrying RRC activation command.

- TRRC\_processing is the RRC processing delay defined in Clause 11.2 of TS 36.331 [16] if the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the RRC processing delay defined in Clause 12 of TS 38.331 [2].

- Tfirst-SSB is time to first SSB transmission after L1-RSRP measurement when TCI state switching involves QCL-TypeD;

- Tfirst-SSB is time to first SSB transmission after RRC processing time at the UE for other QCL types;

- The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state

- TL1-RSRP, TOuk and TSSB-proc are defined in clause 8.10.3.

The requirements for RRC based TCI state switch delay apply when only 1 TCI state is configured in RRC TCI state list. When a longer switching delay is allowed. Where is the time between DL data transmission and acknowledgement as specified in TS 38.213 [3].

### 8.10B.6 Active TCI state list update delay

If the target TCI state is known, upon receiving PDSCH carrying MAC-CE active TCI state list update at slot n, UE shall be able to receive PDCCH to schedule PDSCH with the new target TCI state at the first slot that is after n+ THARQ + +TOk\*(Tfirst-SSB + TSSB-proc) / *NR slot length*. Where THARQ, Tfirst-SSB, TSSB-proc and TOk are defined in clause 8.10.3.

## 8.10C Active TCI state switching delay for satellite access

### 8.10C.1 Introduction

The requirements in this clause apply for a UE configured with one or more TCI state configurations on Pcell in satellite access. UE shall complete the switch of active TCI state within the delay defined in this clause.

### 8.10C.2 MAC-CE based TCI state switch delay

Upon receiving PDSCH carrying MAC-CE activation command in slot n, UE shall be able to receive PDCCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ THARQ + + TOk\*(Tfirst-SSB + TSSB-proc) / *NR slot length*. The UE shall be able to receive PDCCH with the old TCI state until slot n+ THARQ + .Where THARQ is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3];

- Tfirst-SSB is time to first SSB transmission after MAC CE command is decoded by the UE; The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state

- TSSB-proc = 2 ms;

- TOk = 1 if target TCI state is not in the active TCI state list for PDSCH, 0 otherwise.

### 8.10C.4 DCI based TCI state switch delay

When a UE is configured with the higher layer parameter *tci-PresentInDCI* which is set as 'enabled'for the CORESET scheduling PDSCH at slot n, UE shall be able to receive PDSCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+*timeDurationForQCL*, where, *timeDurationForQCL* is the time required by the UE to perform PDCCH reception and applying spatial QCL information received in DCI for PDSCH processing as described in TS 38.214 [26], the value of *timeDurationForQCL* is defined in TS 38.331 [2].

### 8.10C.5 RRC based TCI state switch delay

UE shall be able to receive PDCCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ (TRRC\_processing +TOk\*(Tfirst-SSB + TSSB-proc)) / *NR slot length*, The UE is not required to receive PDCCH/PDSCH/CSI-RS or transmit PUCCH/PUSCH until the end of switching period.

Where

- Slot n is the last slot overlapping with the PDSCH carrying RRC activation command.

- TRRC\_processing is the RRC processing delay defined in Clause 12 of TS 38.331 [2].

- Tfirst-SSB is time to first SSB transmission after RRC processing by the UE; The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state.

- TSSB-proc and TOk are defined in clause 8.10C.2.

The requirements for RRC based TCI state switch delay apply when only 1 TCI state is configured in RRC TCI state list. When a longer switching delay is allowed. Where is the time between DL data transmission and acknowledgement as specified in TS 38.213 [3].

### 8.10C.6 Active TCI state list update delay

Upon receiving PDSCH carrying MAC-CE active TCI state list update at slot n, UE shall be able to receive PDCCH to schedule PDSCH with the new target TCI state at the first slot that is after n+ THARQ + +TOk\*(Tfirst-SSB + TSSB-proc) / *NR slot length*. Where THARQ, Tfirst-SSB, TSSB-proc and TOk are defined in clause 8.10C.2.

## 8.11 PSCell Change

This clause defines requirements for the delay within which the UE shall be able to change PSCell to other cell in EN-DC or NR-DC. The requirements in this clause are applicable to EN-DC and NR-DC.

The UE shall be capable of transmitting PRACH preamble towards the target PSCell no later than specified in clause 8.9.2 for the case of NR-DC and in TS 36.133 clause 7.31.2 for the case of EN-DC,, where the following values for slot n, Tprocessing  and TRRC\_delay shall override the existing ones:

- Slot n is the last slot overlapping with the PDSCH containing PSCell change,

- Tprocessing = 20 ms when source and target cells are in the same FR,

- Tprocessing = 40 ms when source and target cells are in different FRs.

- TRRC\_delay is the RRC procedure delay as specified in TS 36.331 [16] if the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the RRC procedure delay as specified in TS 38.331 [2].

If the SMTC periodicity of the target cell is not provided within the PSCell change message, and measObjectNRs having the same SSB frequency and subcarrier spacing configured by MN and SN have different SMTC, Trs is the periodicity of one of the SMTC which is up to UE implementation.

The target PSCell is known if it has been meeting the conditions in clause 8.9.2 for the case of NR-DC and in TS36.133 clause 7.31.2 for the case of EN-DC.

The interruption on PCell and other serving cells specified in TS36.133 clause 7.32.2.1 for EN-DC and in TS38.133 clause 8.2.4.2.1 for NR-DC is allowed only during the RRC reconfiguration procedure [2].

## 8.11A PSCell Change in Carriers with CCA

This clause defines requirements for the delay within which the UE shall be able to change PSCell in FR2-2 with CCA to other cell in NR-DC. The requirements in this clause are applicable to NR-DC.

The UE shall be capable of transmitting PRACH preamble towards the target PSCell no later than specified in clause 8.9A.2 for the case of NR-DC, where the following values for slot n, Tprocessing and TRRC\_delay shall override the existing ones:

- Slot n is the last slot overlapping with the PDSCH containing PSCell change,

- Tprocessing = 20 ms when source and target cells are in the same FR,

- Tprocessing = 40 ms when source and target cells are in different FRs.

- TRRC\_delay is the RRC procedure delay as specified in TS 38.331 [2].

If the SMTC periodicity of the target cell is not provided within the PSCell change message, and measObjectNRs having the same SSB frequency and subcarrier spacing configured by MN and SN have different SMTC, Trs is the periodicity of one of the SMTC which is up to UE implementation.

The target PSCell is known if it has been meeting the conditions in clause 8.9A.2 for the case of NR-DC.

The interruption on PCell and other serving cells specified in TS38.133 clause 8.2.4.2.1 for NR-DC is allowed only during the RRC reconfiguration procedure [2].

## 8.11B Conditional PSCell Change

### 8.11B.1 Introduction

This clause defines requirements for the delay within which the UE shall be able to perform conditional PSCell change in EN-DC or NR-DC. The requirements in this clause are applicable to EN-DC and NR-DC.

### 8.11B.2 Conditoinal PSCell Change delay

The requirements in this clause shall apply for the UE configured with only PCell in FR1.

The UE shall be capable to transmit PRACH preamble towards the new target PSCell no later than in slot *n* + Tconfig\_PSCell\_Conditional:

Where:

- Slot n is the last slot overlapping with the PDSCH containing conditional PSCell change.

- Tconfig\_PSCell\_Conditional = TRRC\_delay + TEvent\_DU + Tmeasure + TUE\_preparation + Tprocessing + T∆ + TPSCell\_ DU + 2 ms

- TRRC\_delay is the RRC processing delay defined in Clause 11.2 in 36.331 [16] is the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the RRC procedure delay defined in clause 12 in TS 38.331 [2] for processing the conditional PSCell change command.

- TEvent\_DU is the delay uncertainty which is the time from when the UE successfully decodes a conditional PSCell change command until a condition exists at the measurement reference point which will trigger the conditional PSCell change.

- Tmeasure is the measurements time stated in clause 8.11B.2.1.

- TUE\_preparation is the UE preparation time for conditional PSCell change, and starts after UE realizes the condition of PSCell change is met and identity of new PSCell is determined. TUE\_preparation is up to 10ms.

- Tprocessing is the SW processing time needed by UE, including RF warm up period. Tprocessing = 20 ms when source and target cells are in the same FR, and Tprocessing = 40 ms when source and target cells are in different FRs.

- T∆ is time for fine time tracking and acquiring full timing information of the target cell. T∆ = 1\*Trs ms.

- Trs is the SMTC periodicity of the target cell if the UE has been provided with an SMTC configuration for the target cell in PSCell addition message, otherwise Trs is the SMTC configured in the measObjectNR having the same SSB frequency and subcarrier spacing. If the UE is not provided SMTC configuration or measurement object on this frequency, the requirement in this clause is applied with Trs = 5 ms assuming the SSB transmission periodicity is 5 ms. There is no requirement if the SSB transmission periodicity is not 5 ms.

- TPSCell\_ DU is the delay uncertainty in acquiring the first available PRACH occasion in the PSCell. TPSCell\_ DU is up to the summation of SSB to PRACH occasion association period and 10 ms. SSB to PRACH occasion associated period is defined in Table 8.1-1 of TS 38.213 [3].

The PCell interruption specified in clause 8.2 is allowed only after the UE starts to execute a conditional PSCell change.

#### 8.11B.2.1 Measurement time

The measurement time delay is defined from the end of TEvent\_DU until UE executes a PSCell change to a target cell and interruption time starts.

For intra-frequency PSCell change, the measurement time delay measured without Time To Trigger (TTT) and L3 filtering shall be less than Tidentify intra with index or Tidentify\_intra\_without\_index defined in clause 9.2.5.1 or clause 9.2.6.2.

For inter-frequency PSCell change, the measurement time delay measured without Time To Trigger (TTT) and L3 filtering shall be less than Tidentify\_inter\_without\_index or Tidentify\_inter\_with\_index defined in clause 9.3.4. When TTT or L3 filtering is used an additional delay can be expected.

A cell is detectable only if at least one SSB measured from the cell being configured remains detectable during the time period Tidentify\_intra\_without\_index or Tidentify\_intra\_with\_index for intra-frequency PSCell change or the time period Tidentify\_inter\_without\_index or Tidentify\_inter\_with\_index for inter-frequency PSCell change. If a cell, which has been detectable at least for the time period Tidentify\_intra\_without\_index or Tidentify\_intra\_with\_index for intra-frequency PSCell change or the time period Tidentify\_inter\_without\_index or Tidentify\_inter\_with\_index for inter-frequency PSCell change, becomes undetectable for a period and then the cell becomes detectable again and triggers a PSCell change, the measurement time delay shall be less than TSSB\_measurement\_period\_intra or TSSB\_measurement\_period\_inter provided the timing to that cell has not changed more than ± 3200/ Tc while the measurement gap has not been available and the L3 filter has not been used, where *µ* is the SCS configuration as defined in clause 4.2 of TS 38.211 [3]. When L3 filtering is used, an additional delay can be expected.

## 8.11D Conditional PSCell Change in Carriers with CCA

### 8.11D.1 Introduction

This clause defines requirements for the delay within which the UE shall be able to perform conditional PSCell in FR2-2 with CCA change in NR-DC. The requirements in this clause are applicable to NR-DC.

### 8.11D.2 Conditional PSCell Change delay

The requirements in this clause shall apply for the UE configured with only PCell in FR1.

The UE shall be capable to transmit PRACH preamble towards the new target PSCell no later than in slot :

Where:

- Slot n is the last slot overlapping with the PDSCH containing conditional PSCell change.

- Tconfig\_PSCell\_Conditional = TRRC\_delay + TEvent\_DU + Tmeasure\_CCA + TUE\_preparation + Tprocessing + T∆\_CCA + TPSCell\_ DU + 2 ms

- TRRC\_delay is the RRC procedure delay defined in clause 12 in TS 38.331 [2] for processing the conditional PSCell change command.

- TEvent\_DU is the delay uncertainty which is the time from when the UE successfully decodes a conditional PSCell change command until a condition exists at the measurement reference point which will trigger the conditional PSCell change.

- Tmeasure\_CCA is the measurements time stated in clause 8.11D.2.1.

- TUE\_preparation is the UE preparation time for conditional PSCell change, and starts after UE realizes the condition of PSCell change is met and identity of new PSCell is determined. TUE\_preparation is up to 10ms.

- Tprocessing is the SW processing time needed by UE, including RF warm up period. Tprocessing = 20 ms when source and target cells are in the same FR, and Tprocessing = 40 ms when source and target cells are in different FRs.

- T∆\_CCA is time for fine time tracking and acquiring full timing information of the target cell. T∆ = (1+L2) \*Trs ms, where L2 is the number of SMTC occasions not avaible at the UE during the time tracking period. L2, max =TBD.

- Trs is the SMTC periodicity of the target cell if the UE has been provided with an SMTC configuration for the target cell in PSCell addition message, otherwise Trs is the SMTC configured in the measObjectNR having the same SSB frequency and subcarrier spacing. If the UE is not provided SMTC configuration or measurement object on this frequency, the requirement in this clause is applied with Trs = 5 ms assuming the SSB transmission periodicity is 5 ms. There is no requirement if the SSB transmission periodicity is not 5 ms.

- TPSCell\_ DU is the interruption uncertainty due to the random access procedure when sending PRACH to the new cell. TPSCell\_ DU can be up to: (1+ L3) \* TSSB,RO + 10 ms where TSSB,RO is the SSB to PRACH occasion association period as defined in Table 8.1-1 of TS 38.213 [3] and L3 is the number of consecutive SSB to PRACH occasion association periods during which no PRACH occasion is available for PRACH transmission due to UL CCA failure. L3 = 0 for Type 3 UL channel access procedure as defined in TS 37.213 [33].

NOTE 1: The interruption time considering the potential extensions caused by L2, L3 and by the UL CCA failure detection/recovery mechanism is limited by the T304 timer. The UE behaviour at the T304 timer expiry is detailed in TS 38.331 [2].

The PCell interruption specified in clause 8.2 is allowed only after the UE starts to execute a conditional PSCell change.

#### 8.11D.2.1 Measurement time

The measurement time delay is defined from the end of TEvent\_DU until UE executes a PSCell change to a target cell and interruption time starts.

For intra-frequency PSCell change, the measurement time delay measured without Time To Trigger (TTT) and L3 filtering shall be less than Tidentify intra\_cca with index or Tidentify\_intra\_cca\_without\_index defined in clause 9.2A.5.1 or clause 9.2A.6.2.

For inter-frequency PSCell change, the measurement time delay measured without Time To Trigger (TTT) and L3 filtering shall be less than Tidentify\_inter\_cca\_without\_index or Tidentify\_inter\_cca\_with\_index defined in clause 9.3A.4. When TTT or L3 filtering is used an additional delay can be expected.

A cell is detectable only if at least one SSB measured from the cell being configured remains detectable during the time period Tidentify\_intra\_cca\_without\_index or Tidentify\_intra\_cca\_with\_index for intra-frequency PSCell change or the time period Tidentify\_inter\_cca\_without\_index or Tidentify\_inter\_cca\_with\_index for inter-frequency PSCell change. If a cell, which has been detectable at least for the time period Tidentify\_intra\_cca\_without\_index or Tidentify\_intra\_cca\_with\_index for intra-frequency PSCell change or the time period Tidentify\_inter\_cca\_without\_index or Tidentify\_inter\_cca\_with\_index for inter-frequency PSCell change, becomes undetectable for a period and then the cell becomes detectable again and triggers a PSCell change, the measurement time delay shall be less than TSSB\_measurement\_period\_intra\_cca or TSSB\_measurement\_period\_inter\_cca provided the timing to that cell has not changed more than ± 3200 Tc while the 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.

## 8.12 Uplink spatial relation switch delay

### 8.12.1 Introduction

The requirements in this clause apply for a UE configured with one or more spatial relation configurations on serving cell in MR-DC or standalone NR. There is no requirement when the UE is requested to switch to a spatial relation with the higher layer parameter *spatialRelationInfo* associated to SRS. UE shall complete the switch of active spatial relation within the delay defined in this clause when the UE is requested to switch to a spatial relation with the higher layer parameter *spatialRelationInfo* associated to a DL RS.

### 8.12.2 Known conditions for spatial relation when associated with DL-RS

The spatial relation associated to DL RS is known if the following conditions are met:

- During the period from the last transmission of the DL RS resource used for the L1-RSRP measurement reporting for the target spatial relation to the completion of active spatial relation switch, where the DL RS resource for L1-RSRP measurement is the DL RS in target spatial relation or QCLed to the target spatial relation with QCL type-D.

- Spatial relation switch command is received within 1280 ms upon the last transmission of the DL RS resource for beam reporting or measurement

- The UE has sent at least 1 L1-RSRP report for the target spatial relation before the spatial relation switch command

- The DL RS configured in spatial relation remains detectable during the spatial relation switching period

- SNR of the DL RS configured in spatial relation ≥ -3dB

- The SSB associated with the spatial relation remain detectable during the spatial relation switching period

- SNR of the SSB associated with the spatial relation ≥ -3dB

Otherwise, the spatial relation is unknown.

### 8.12.3 MAC-CE based spatial relation switch delay

If the target spatial relation associated to DL RS is known, upon receiving PDSCH carrying MAC-CE activation command in slot n, for UL spatial relation switch for PUCCH or semi-persistent SRS transmission of serving cell with a target UL spatial relation, the UE shall be able to transmit PUCCH or semi-persistent SRS with the target UL spatial relation in the slot n+ THARQ + + 1 when *beamCorrespondenceWithoutUL-BeamSweeping* is set to 1 where THARQ is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3].

If the target spatial relation associated to DL RS is unknown, upon receiving PDSCH carrying MAC-CE activation command in slot n, for UL spatial relation switch for PUCCH or semi-persistent SRS transmission of serving cell with a target UL spatial relation, the UE shall be able to transmit PUCCH or semi-persistent SRS with the target UL spatial relation in the slot n+ THARQ + + TL1-RSRP+1 when *beamCorrespondenceWithoutUL-BeamSweeping* is set to 1.

Where

- THARQ is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3],

- T L1-RSRP is the time for Rx beam refinement in FR2, defined as

- TL1-RSPR\_Measurement\_Period\_SSB for SSB as specified in clause 9.5.4.1,

- with the assumption of M=1

- with TReport = 0

- TL1-RSRP\_Measurement\_Period\_CSI-RS for CSI-RS as specified in clause 9.5.4.2

- configured with higher layer parameter *repetition* set to ON

- with the assumption of M=1 for periodic CSI-RS

- for aperiodic CSI-RS if number of resources in resource set at least equal to *MaxNumberRxBeam*

- with TReport = 0

The UE shall be able to transmit with the old UL spatial relation until slot n+ THARQ + .

When the UL spatial relation info switch for PUCCH changes both the associated DL RS and *pucch-PathlossReferenceRS* with the same MAC-CE activation, and if both the DL RS and *pucch-PathlossReferenceRS* are known as specified in clause 8.12.2 and 8.14.2 respectively, the UE shall be able to transmit PUCCH with the target UL spatial relation after the delay specified in clause 8.14.3. If either the associated DL RS or *pucch-PathlossReferenceRS* are unknown, a longer switching delay is allowed. The UE is not required to transmit PUCCH with the target UL spatial relation until the DL RS and pathloss reference RS switch are completed.

### 8.12.4 DCI based spatial relation switch delay

If the target spatial relation associated to DL RS is known, when a UE receives the DCI triggering aperiodic SRS at slot n with the higher layer parameter *spatialRelationInfo*, UE shall be able to transmit aperiodic SRS with target spatial relation of the serving cell on which spatial relation switch occurs in the slot+1, where, *k* is configured via higher layer parameter *slotOffset*[2]for each triggered SRS resources set and is based on the subcarrier spacing of the triggered SRS transmission, *µSRS* and *µPDCCH* are the subcarrier spacing configurations for triggered SRS and PDCCH carrying the triggering command respectively in TS 38.214 [26].

The known condition for spatial relation associated to DL RS defined in clause 8.12.2 is applied.

### 8.12.5 RRC based spatial relation switch delay

If the target spatial relation associated to DL RS is known, UE shall be able to transmit target periodic SRS with spatial relation of the serving cell on which periodic SRS with spatial relation reconfigured in the slot n+ TRRC\_processing /*NR slot length* +1 when *beamCorrespondenceWithoutUL-BeamSweeping* is set to 1.

Where

- Slot n is the last slot overlapping with the PDSCH carrying RRC activation command,

- TRRC\_processing is the RRC processing delay defined in 36.331 [16] is the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the RRC processing delay defined in TS38.331 [2].

If the target spatial relation associated to DL RS is unknown, UE shall be able to transmit target periodic SRS with spatial relation of the serving cell on which periodic SRS with spatial relation reconfigured in the slot n+ TRRC\_processing /*NR slot length* + TL1-RSRP +1 when *beamCorrespondenceWithoutUL-BeamSweeping* is set to 1.

Where

- Slot n is the last slot overlapping with the PDSCH carrying RRC activation command,

- TRRC\_processing is the RRC processing delay defined in 36.331 [16] is the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the RRC processing delay defined in TS38.331 [2].

- TL1-RSRP is defined in clause 8.12.3

## 8.12A Uplink spatial relation switch delay for RedCap

### 8.12A.1 Introduction

The requirements in this clause apply for a RedCap UE configured with one or more spatial relation configurations on serving cell in standalone NR. There is no requirement when the UE is requested to switch to a spatial relation with the higher layer parameter *spatialRelationInfo* associated to SRS. UE shall complete the switch of active spatial relation within the delay defined in this clause when the UE is requested to switch to a spatial relation with the higher layer parameter *spatialRelationInfo* associated to a DL RS.

### 8.12A.2 Known conditions for spatial relation when associated with DL-RS

The spatial relation associated to DL RS is known if the following conditions are met:

- During the period from the last transmission of the DL RS resource used for the L1-RSRP measurement reporting for the target spatial relation to the completion of active spatial relation, where the DL RS resource for L1-RSRP measurement is the DL RS in target spatial relation or QCLed to the target spatial relation with QCL type-D.

- Spatial relation switch command is received within 1280 ms upon the last transmission of the DL RS resource for beam reporting or measurement

- The UE has sent at least 1 L1-RSRP report for the target spatial relation before the spatial relation switch command

- The DL RS configured in spatial relation remains detectable during the spatial relation switching period

- SNR of the DL RS configured in spatial relation ≥ -3dB

- The SSB associated with the spatial relation remain detectable during the spatial relation switching period

- SNR of the SSB associated with the spatial relation ≥ -3dB

Otherwise, the spatial relation is unknown.

### 8.12A.3 MAC-CE based spatial relation switch delay

If the target spatial relation associated to DL RS is known and UE is configured with uplink resources for transmission on target spatial relation, upon receiving PDSCH carrying MAC-CE activation command in slot n, for UL spatial relation switch for PUCCH or semi-persistent SRS transmission of serving cell with a target UL spatial relation, the UE shall be able to transmit PUCCH or semi-persistent SRS with the target UL spatial relation no later than slot n+ THARQ + + 1 when *beamCorrespondenceWithoutUL-BeamSweeping* is set to 1 where THARQ is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3].

If the target spatial relation associated to DL RS is unknown and UE is configured with uplink resources for transmission on target spatial relation, upon receiving PDSCH carrying MAC-CE activation command in slot n, for UL spatial relation switch for PUCCH or semi-persistent SRS transmission of serving cell with a target UL spatial relation, the UE shall be able to transmit PUCCH or semi-persistent SRS with the target UL spatial relation no later than slot n+ THARQ + + TL1-RSRP+1 when *beamCorrespondenceWithoutUL-BeamSweeping* is set to 1.

Where

- THARQ is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3],

- T L1-RSRP is the time for Rx beam refinement in FR2, defined as

- TL1-RSRP\_Measurement\_Period\_SSB\_RedCap for SSB as specified in clause 9.5B,

- with the assumption of M=1

- with TReport = 0

- TL1-RSRP\_Measurement\_Period\_CSI-RS\_RedCap for CSI-RS as specified in clause 9.5.4.2

- configured with higher layer parameter *repetition* set to ON

- with the assumption of M=1 for periodic CSI-RS

- for aperiodic CSI-RS if number of resources in resource set at least equal to *MaxNumberRxBeam*

- with TReport = 0

The UE shall be able to transmit with the old UL spatial relation until slot n+ THARQ + .

For RedCap UE in HD-FDD mode, if a downlink reception overlaps with PUCCH or semi-persistent SRS transmission of the serving cell with the target UL spatial relation then the UE is allowed to postpone the uplink transmission.

When the UL spatial relation info switch for PUCCH changes both the associated DL RS and *pucch-PathlossReferenceRS* with the same MAC-CE activation, and if both the DL RS and *pucch-PathlossReferenceRS* are known as specified in clause 8.12A.2 and 8.14.2 respectively, the UE shall be able to transmit PUCCH with the target UL spatial relation after the delay specified in clause 8.14.3. If either the associated DL RS or *pucch-PathlossReferenceRS* are unknown, a longer switching delay is allowed. The UE is not required to transmit PUCCH with the target UL spatial relation until the DL RS and pathloss reference RS switch are completed.

### 8.12A.4 DCI based spatial relation switch delay

If the target spatial relation associated to DL RS is known and UE is configured with uplink resources for transmission on target spatial relation, when a UE receives the DCI triggering aperiodic SRS at slot n with the higher layer parameter *spatialRelationInfo*, UE shall be able to transmit aperiodic SRS with target spatial relation of the serving cell on which spatial relation switch occurs no later than slot+1, where, *k* is configured via higher layer parameter *slotOffset*[2]for each triggered SRS resources set and is based on the subcarrier spacing of the triggered SRS transmission, *µSRS* and *µPDCCH* are the subcarrier spacing configurations for triggered SRS and PDCCH carrying the triggering command respectively in TS 38.214 [26].

For RedCap UE in HD-FDD mode, if a downlink reception overlaps with aperiodic SRS with target spatial relation of the serving cell then the UE is allowed to postpone the uplink transmission.

The known condition for spatial relation associated to DL RS defined in clause 8.12A.2 is applied.

### 8.12A.5 RRC based spatial relation switch delay

If the target spatial relation associated to DL RS is known and UE is configured with uplink resources for transmission on target spatial relation, UE shall be able to transmit target periodic SRS with spatial relation of the serving cell on which periodic SRS with spatial relation reconfigured no later than slot n+ TRRC\_processing /*NR slot length* +1 when *beamCorrespondenceWithoutUL-BeamSweeping* is set to 1.

Where

- Slot n is the last slot overlapping with the PDSCH carrying RRC activation command,

- TRRC\_processing is the RRC processing delay defined in 36.331 [16] is the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the RRC processing delay defined in TS38.331 [2].

If the target spatial relation associated to DL RS is unknown and UE is configured with uplink resources for transmission on target spatial relation, UE shall be able to transmit target periodic SRS with spatial relation of the serving cell on which periodic SRS with spatial relation reconfigured no later than slot n+ TRRC\_processing /*NR slot length* + TL1-RSRP +1 when *beamCorrespondenceWithoutUL-BeamSweeping* is set to 1.

Where

- Slot n is the last slot overlapping with the PDSCH carrying RRC activation command,

- TRRC\_processing is the RRC processing delay defined in 36.331 [16] is the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the RRC processing delay defined in TS38.331 [2].

- TL1-RSRP is defined in clause 8.12A.3

For RedCap UE in HD-FDD mode, if a downlink reception overlaps with target periodic SRS with spatial relation of the serving cell with periodic SRS with spatial relation reconfigured then the UE is allowed to postpone the uplink transmission.

## 8.12C Uplink spatial relation switch delay for satellite access

UL Spatial relation switch delay requirements do not apply for satellite access in FR1.

### 8.12C.1 Void

### 8.12C.2 Void

### 8.12C.3 Void

### 8.12C.4 Void

### 8.12C.5 Void

## 8.13 UE-specific CBW change

### 8.13.1 Introduction

The requirements in this clause apply for a UE receives reconfiguration of *offsetToCarrier* or *carrierBandwidth* to change channel bandwidth.

### 8.13.2 UE-specific CBW change delay

After the UE receives RRC reconfiguration involving *offsetToCarrier* or *carrierBandwidth* change on the old CBW, UE shall be able to receive PDSCH/PDCCH on the DL BWP with BWP ID firstActiveDownlinkBWP-Id or transmit PUSCH on the UL BWP with BWP ID firstActiveUplinkBWP-Id of the new CBW right after a time duration of slots which begins from the beginning of DL slot n, where

DL slot n is the last slot overlapping with the PDSCH containing the RRC command, and

is the length of the RRC procedure delay in millisecond as defined in clause 11.2 in TS 36.331 [6] is the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the length of the RRC procedure delay in millisecond as defined in clause 12 in TS 38.331 [2], and

is the time used by the UE to perform CBW change.

The UE is not required to transmit UL signals or receive DL signals during the above defined time duration on the cell where UE-specific CBW change occurs. When a longer switching delay is allowed. Where is the time between DL data transmission and acknowledgement as specified in TS 38.213 [3].

## 8.13A UE-specific CBW change for RedCap

### 8.13A.1 Introduction

The requirements in this clause apply for a RedCap UE receives reconfiguration of *offsetToCarrier* or *carrierBandwidth* to change channel bandwidth.

### 8.13A.2 UE-specific CBW change delay

After the UE receives RRC reconfiguration involving *offsetToCarrier* or *carrierBandwidth* change on the old CBW, UE shall be able to receive PDSCH/PDCCH on an active DL BWP or transmit PUSCH on an active UL BWP of the new CBW right after a time duration of slots which begins from the beginning of DL slot n, where

DL slot n is the last slot overlapping with the PDSCH containing the RRC command, and

is the length of the RRC procedure delay in millisecond as defined in clause 11.2 in TS 36.331 [6] is the corresponding RRC message is embedded in E-UTRA RRC message, otherwise it is the length of the RRC procedure delay in millisecond as defined in clause 12 in TS 38.331 [2], and

is the time used by the UE to perform CBW change.

The UE is not required to transmit UL signals or receive DL signals during the above defined time duration on the cell where UE-specific CBW change occurs. When a longer switching delay is allowed. Where is the time between DL data transmission and acknowledgement as specified in TS 38.213 [3].

## 8.13C UE-specific CBW change for satellite access

*Editor’s note: Applicability of frequency range, CA, DA, duplex mode, inter-RAT measurement, etc is subject to updates/changes based on the scope of the corresponding WID.*

*Editor’s note: Terminology will be further clarified and selected between, e.g. NTN and satellite access, based on further agreements.*

### 8.13C.1 Introduction

The requirements in this clause apply for a UE receives reconfiguration of *offsetToCarrier* or *carrierBandwidth* to change channel bandwidth.

### 8.13C.2 UE-specific CBW change delay

After the UE receives RRC reconfiguration involving *offsetToCarrier* or *carrierBandwidth* change on the old CBW, UE shall be able to receive PDSCH/PDCCH on an active DL BWP or transmit PUSCH on an active UL BWP of the new CBW right after a time duration of slots which begins from the beginning of DL slot n, where

DL slot n is the last slot containing the RRC command, and

is the length of the RRC procedure delay in millisecond as defined in clause 12 in TS 38.331 [2], and

is the time used by the UE to perform CBW change.

The UE is not required to transmit UL signals or receive DL signals during the above defined time duration on the cell where UE-specific CBW change occurs. When a longer switching delay is allowed. Where is the time between DL data transmission and acknowledgement as specified in TS 38.213 [3].

## 8.14 Pathloss reference signal switching delay

### 8.14.1 Introduction

The requirements in this clause apply for pathloss reference signal activated or updated on serving cell in MR-DC or standalone NR in clause 7.1.1 in TS 38.213 [3].

UE shall complete the switch of pathloss reference signal within the delay defined in this clause.

### 8.14.2 Known conditions for pathloss reference signal

In FR2, the pathloss reference signal is known if the following conditions are met during the period between the last transmission of the RS resource used for L1-RSRP measurement reporting and the completion of pathloss reference signal switch, where the RS resource is the target pathloss reference signal or QCLed (with Type D) to the target pathloss reference signal.

- Pathloss reference signal switch command is received within 1280 ms upon the last transmission of the RS resource for beam reporting or measurement

- The UE has sent at least 1 L1-RSRP report for the target pathloss reference signal before the pathloss reference signal switch command

- The target pathloss reference signal remains detectable during the pathloss reference signal switching period

- SNR of the target pathloss reference signal≥-3dB

- The associated SSBs with the target pathloss reference signal remain detectable during the pathloss reference signal switching period

- SNR of the associated SSB ≥-3dB

In FR1, the pathloss reference signal is known if the following conditions are met

- The target pathloss reference signal remains detectable during the pathloss reference signal switching period

- SNR of the target pathloss reference signal≥-3dB

Otherwise, the pathloss reference signal is unknown.

### 8.14.3 MAC-CE based pathloss reference signal switch delay

The requirements in this clause apply for a UE to update a pathloss reference signal by MAC-CE for PUCCH, PUSCH, semi-persistent SRS and aperiodic SRS.

If the target pathloss reference signal is known, upon receiving PDSCH carrying MAC-CE activation in slot n, UE shall be able to apply the target pathloss reference signal of the serving cell on which pathloss reference signal switch occurs no later than the slot *n* + + . The UE shall be able to apply old pathloss reference signals until the slot n + + . Where

- is the timing between pathloss reference MAC-CE activation command and acknowledgement as specified in TS 38.321 [7].

- NM= 1, if the target PL-RS is not maintained by the UE, 0 otherwise.

In FR2, if the target pathloss reference signal is SSB, the requirements in this clause shall apply when the target pathloss reference signal is maintained by the UE.

- is the periodicity of the target pathloss reference signal which would be SSB or NZP CSI-RS.

- PL-RS is maintained provided:

- There are no more than 4 different RS activated as PL-RS per serving cell among all active spatial relations for PUSCH/PUCCH/SRS transmissions.

- The target pathloss reference signal remains detectable during TCI state switching period

- SNR of the target pathloss reference signal≥-3dB

- The associated SSBs with the target pathloss reference signal remain detectable during the TCI state switching period.

- SNR of the associated SSB ≥-3dB

Note: longer application time is expected if measurement sample is not available due to measurement gap, DRX or other UE activities.

Note: longer application time is expected if the pathloss reference signal is unknown.

## 8.14C Pathloss reference signal switching delay for satellite access

*Editor’s note: Applicability of frequency range, CA, DA, duplex mode, inter-RAT measurement, etc is subject to updates/changes based on the scope of the corresponding WID.*

*Editor’s note: Terminology will be further clarified and selected between, e.g. NTN and satellite access, based on further agreements.*

### 8.14C.1 Introduction

The requirements in this clause apply for pathloss reference signal activated or updated on PCell in clause 7.1.1 in TS 38.213 [3] and the UE is configured with only PCell, which is served by satellite access node (SAN).

UE shall complete the switch of pathloss reference signal within the delay defined in this clause.

### 8.14C.2 Known conditions for pathloss reference signal

The pathloss reference signal is known if the following conditions are met during the period between the last transmission of the RS resource used for L1-RSRP measurement reporting and the completion of pathloss reference signal switch, where the RS resource is the target pathloss reference signal or QCLed (with Type D) to the target pathloss reference signal.

- Pathloss reference signal switch command is received within 1280 ms upon the last transmission of the RS resource for beam reporting or measurement

- The UE has sent at least 1 L1-RSRP report for the target pathloss reference signal before the pathloss reference signal switch command

- The target pathloss reference signal remains detectable during the pathloss reference signal switching period

- SNR of the target pathloss reference signal≥-3dB

- The associated SSBs with the target pathloss reference signal remain detectable during the pathloss reference signal switching period

- SNR of the associated SSB ≥-3dB

Otherwise, the pathloss reference signal is unknown.

### 8.14C.3 MAC-CE based pathloss reference signal switch delay

The requirements in this clause apply for a UE to update a pathloss reference signal by MAC-CE for PUCCH, PUSCH, semi-persistent SRS and aperiodic SRS.

If the target pathloss reference signal is known, upon receiving PDSCH carrying MAC-CE activation in slot n, UE shall be able to apply the target pathloss reference signal of the serving cell on which pathloss reference signal switch occurs no later than the slot *n* + + . The UE shall be able to apply old pathloss reference signals until the slot n + + . Where

- is the timing between pathloss reference MAC-CE activation command and acknowledgement as specified in TS 38.321 [7].

- NM= 1, if the target PL-RS is not maintained by the UE, 0 otherwise.

- is the periodicity of the target pathloss reference signal which would be SSB or NZP CSI-RS.

Note: longer application time is expected if measurement sample is not available due to measurement gap, DRX or other UE activities.

Note: longer application time is expected if the pathloss reference signal is unknown.

## 8.15 Active downlink TCI state switching delay for unified TCI

### 8.15.1 Introduction

The requirements in this clause apply for a UE configured with *DLorJoint-TCIState* configurations for DL channels on a serving cell. Further the requirements also apply for all the list of serving cells in *simultaneousU-TCI-UpdateList1, simultaneousU-TCI-UpdateList2, simultaneousU-TCI-UpdateList3, simultaneousU-TCI-UpdateList4* in MR-DC or standalone NR provided all serving cells in the list are configured with the same serving cell and BWP in *unifiedTCI-StateRef-r17*. UE shall complete the switch of active downlink TCI state within the delay defined in this clause.

When the target DL TCI state refers to an additional PCI different from the serving cell PCI in which this DL TCI-State is configured, the requirements in this clause are applicable provided that following conditions are met:

- Active BWP of the serving cell and a cell with the additional PCI are the same

- Center frequency, SCS and SFN offset of a cell with the additional PCI are as the same as serving cell - The cell with the additional PCI is known to the UE.

A cell with the additional PCI is known if the following conditions are met:

- During the last 5s before L1-RSRP measurement is configured, the UE has sent a valid L3 measurement report for the cell with the additional PCI

- Timing offset between serving cell and the cell with the additional PCI is within CP of the corresponding SCS

Otherwise, the cell with the additional PCI is unknown.

8.15.2 Known conditions for downlink TCI state

The downlink TCI state is known if the following conditions are met:

- During the period from the last transmission of the RS resource used for the L1-RSRP measurement reporting for the target downlink TCI state to the completion of active downlink TCI state switch, where the RS resource for L1-RSRP measurement is the RS in target downlink TCI state or QCLed to the target downlink TCI state

- Downlink TCI state switch command is received within 1280 ms upon the last transmission of the RS resource for beam reporting or measurement

- The UE has sent at least 1 L1-RSRP report for the target downlink TCI state before the downlink TCI state switch command

- The target downlink TCI state remains detectable during the downlink TCI state switching period

- The SSB associated with the downlink TCI state remain detectable during the downlink TCI switching period

- SNR of the downlink TCI state ≥ -3dB

- The SSB can be associated with either the serving cell PCI or a PCI different from serving cell PCI.

Otherwise, the downlink TCI state is unknown.

8.15.3 MAC-CE based downlink TCI state switch delay

The requirements in this clause shall apply for DL TCI state switch using separate DL TCI state or joint TCI state of unified TCI state switch framework.

In case that source RS in DL TCI state or joint TCI state is associated with a PCI different from that of the serving cell, the requirements in this clause shall apply if the cell with different PCI satisfies the known cell condition defined in 8.15.1. If the known cell condition is not met, longer delay may be expected.

In case of joint TCI state switch, if the target PL-RS is not maintained, UE is not expected to receive on DL based on the target TCI state before UE completes the DL and UL TCI state switch.

If the target TCI state is known, upon receiving PDSCH carrying MAC-CE activation command in slot n, UE shall be able to receive UE-dedicated PDCCH/PDSCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ THARQ + + TOk\*(Tfirst-SSB + TSSB-proc) / *NR slot length*. The UE shall be able to receive UE-dedicated PDCCH/PDSCH with the old TCI state until slot n+ THARQ + where THARQ (in slot) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3];

- Tfirst-SSB is time to first SSB transmission after MAC CE command is decoded by the UE; The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state

- TSSB-proc = 2 ms;

- TOk = 1 if target TCI state is not in the active TCI state list for PDSCH/PDCCH, 0 otherwise.

If the target TCI state is unknown, upon receiving PDSCH carrying MAC-CE activation command in slot n, UE shall be able to receive UE-dedicated PDCCH/PDSCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n+ THARQ + + (TL1-RSRP +TOuk\*(Tfirst-SSB+ TSSB-proc)) / *NR slot length*. The UE shall be able to receive UE-dedicated PDCCH/PDSCH with the old TCI state until slot n+ THARQ + .

Where

- T L1-RSRP = 0 in FR1 or when the TCI state switching not involving QCL-TypeD in FR2. Otherwise,

- T L1-RSRP is the time for Rx beam refinement in FR2, defined as

- TL1-RSPR\_Measurement\_Period\_SSB for SSB as specified in clause 9.5.4.1,

- with the assumption of M=1

- with TReport = 0

- TL1-RSRP\_Measurement\_Period\_CSI-RS for CSI-RS as specified in clause 9.5.4.2

- CSI-RS based L1-RSRP measurement only apply for TCI state switch when source RS is associated with serving cell

- configured with higher layer parameter *repetition* set to ON

- with the assumption of M=1 for periodic CSI-RS

- for aperiodic CSI-RS if number of resources in resource set at least equal to *MaxNumberRxBeam*

- with TReport = 0

- TOuk = 1 for CSI-RS based L1-RSRP measurement, and 0 for SSB based L1-RSRP measurement when TCI state switching involves QCL-TypeD

- TOuk = 1 when TCI state switching involves other QCL types only

- Tfirst-SSB is time to first SSB transmission after L1-RSRP measurement when TCI state switching involves QCL-TypeD;

- Tfirst-SSB is time to first SSB transmission after MAC CE command is decoded by the UE for other QCL types;

- The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state

### 8.15.4 DCI based downlink TCI state switch delay

When a UE is configured with the higher layer parameter with *DLorJointTCIState* or *UL-TCIState,* activated with TCI states for downlink transmission by MAC CE indication of more than one codepoints, and receives DCI format 1\_1/1\_2 with or without DL assignment providing indicated TCI-State or TCI state pair in the active TCI list for a CC, the UE transmits a PUCCH with HARQ-ACK information corresponding to the DCI carrying the TCI-State indication.

If the target TCI state is known, the downlink TCI switching to the indicated DL TCI state or joint TCI state in the DCI format shall be completed starting from the first slot that is at least *BeamAppTime-r17* symbols after the last symbol of the PUCCH carrying HARQ-ACK in response to the DCI triggering TCI state activation. The first slot and the *BeamAppTime-r17* symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication. The value of *BeamAppTime-r17* is defined in TS 38.331 [2]. The known condition for TCI state defined in clause 8.15.2 is applied.

### 8.15.5 Active Downlink TCI state list update delay

The requirements specified in this clause are applicable if

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*separate*’, and a MAC CE activates more than one target separate TCIs, and at least one DL TCI is included, or

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*joint*’, and a MAC CE activates more than one target joint TCI.

If all the target TCI states in the active TCI state list are known, upon receiving PDSCH carrying MAC-CE active TCI state list update at slot n, UE shall be able to receive PDCCH or PDSCH with the new target TCI states at the first slot that is after

n + THARQ + + TOk\*(Tfirst-SSB\_List + TSSB-proc) / *NR slot length*.

If a subset of the target TCI states in the active TCI state list are unknown, upon receiving PDSCH carrying MAC-CE active TCI state list update at slot n, UE shall be able to receive UE-dedicated PDCCH or PDSCH with the new target TCI states at the first slot that is after

n+ THARQ + + (TL1-RSRP\_list +TOuk\*(Tfirst-SSB\_List+ TSSB-proc)) / *NR slot length*.

If all target TCI states in the active TCI state list are unknown, the requirements specified in this clause are not applicable.

Where

- TL1-RSRP\_List is the longest L1 measurement time (TL1-RSRP) of the source RS among the unknown target TCI states, where TL1-RSRP is specified in clause 8.15.3

- If the number of cells associated with the target TCI states in the active TCI list is 2, and time to first SSBs associated to the TCIs are overlapped in FR2,

- Tfirst-SSB\_List = Tfirst-SSB\_SC + min(TSSB\_SC ,TSSB\_CDP).

- If the number of cells associated with the target TCI states in the active TCI list is 2, and time to first SSBs associated to the TCIs are not overlapped in FR1 or FR2,

- Tfirst-SSB\_List = max(Tfirst-SSB\_SC , Tfirst-SSB\_CDP)

*-* Otherwise,

- Tfirst-SSB\_List = Tfirst-SSB\_SC.

- TSSB\_SC is the SSB periodicity of serving cell.

- TSSB\_CDP is the SSB periodicity of cell with different PCI from serving cell.

- Tfirst-SSB\_SC is the Tfirst-SSB from serving cell

- Tfirst-SSB\_CDP is the Tfirst-SSB from cell with different PCI from serving cell.

- THARQ, Tfirst-SSB, TSSB-proc , TOk, TOuk are defined in clause 8.15.3. TSSB is the SSB periodicity.

When UE receives PDSCH carrying MAC-CE for active TCI state list update, and

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*joint*’, or

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*separate*’, while the target TCI list comprises at least one DL TCIs and at least one UL TCIs,

UE is not expected to receive on DL based on the target TCI state before UE completes the DL and UL TCI state list update.

## 8.16 Active uplink TCI state switching delay for unified TCI

### 8.16.1 Introduction

The requirements in this clause apply for a UE configured with *DLorJoint-TCIState* (if unifiedTCI-StateType is indicated as *Joint*) or *UL-TCIState* configurations for UL channels/signals on a serving cell. Further the requirements also apply for all the list of serving cells in *simultaneousU-TCI-UpdateList1, simultaneousU-TCI-UpdateList2, simultaneousU-TCI-UpdateList3, simultaneousU-TCI-UpdateList4* in MR-DC or standalone NR provided all serving cells in the list are configured with the same serving cell and BWP in *unifiedTCI-StateRef-r17*. There is no requirement when the UE is requested to switch to a TCI state with the higher layer parameter *UL-TCIState* associated to SRS. UE shall complete the switch of active uplink TCI state within the delay defined in this clause when the UE is requested to switch to a TCI state with the higher layer parameter *DLorJointTCIState* or *UL-TCIState* associated to a DL RS.

PL-RS may be associated with or included in UL TCI state or joint TCI state. The requirements in this clause shall apply if either of the following conditions are met:

- PL-RS is identical to source RS in UL TCI state or joint TCI state

- PL-RS and source RS in UL TCI state or joint TCI state are QCL-Type D

When the target UL TCI state refers to an additional PCI different from serving cell PCI in which this UL TCI state is configured, the requirements in this clause are applicable provided that the following conditions are met:

- Active BWP of the serving cell and a cell with the additional PCI are the same

- Center frequency, SCS and SFN offset of a cell with the additional PCI are as the same as serving cell

- The cell with the additional PCI is known to the UE.

A cell with the additional PCI is known if the following conditions are met:

- During the last 5s before L1-RSRP measurement is configured, the UE has sent a valid L3 measurement report for the cell with the additional PCI

- Timing offset between serving cell and the cell with the additional PCI is within CP of the corresponding SCS

- The SSB from the cell with the additional PCI remains detectable according to the cell identification requirements specified in clause 9.2

Otherwise, the cell with the additional PCI is unknown.

8.16.2 Known conditions for uplink TCI state

The uplink TCI state is known if the following conditions are met:

- During the period from the last transmission of the RS resource used for the L1-RSRP measurement reporting for the target uplink TCI state to the completion of active uplink TCI state switch, where the RS resource for L1-RSRP measurement is the RS in target uplink TCI state or QCLed to the target uplink TCI state

- Uplink TCI state switch command is received within 1280 ms upon the last transmission of the RS resource for beam reporting or measurement

- The UE has sent at least 1 L1-RSRP report for the target uplink TCI state before the uplink TCI state switch command

- The RS configured in target uplink TCI state remains detectable during the uplink TCI state switching period

- SNR of the RS configured in target uplink TCI state ≥ -3dB

- The target uplink TCI state remains detectable during the uplink TCI state switching period

- The SSB associated with the uplink TCI state remain detectable during the uplink TCI switching period

- SNR of the uplink TCI state ≥ -3dB

- The SSB can be associated with either the serving cell PCI or a PCI different from serving cell PCI.

Otherwise, the uplink TCI state is unknown.

8.16.3 MAC-CE based uplink TCI state switch delay

The requirements in this clause shall apply for UL TCI state switch using separate UL TCI state or joint TCI state of unified TCI state switch framework.

In case that source RS in UL TCI state or joint TCI state is associated with a PCI different from that of the serving cell, the requirements in this clause shall apply if the cell with different PCI satisfies the known cell condition defined in 8.16.1. If the known cell condition is not met, longer delay may be expected.

In case of joint TCI state switch, UE is not expected to transmit on UL based on the target TCI state before UE completes the DL and UL TCI state switch.

For separate UL TCI state switch or joint TCI state switch for PUCCH or PUSCH, or semi-persistent/aperiodic/periodic SRS, when *beamCorrespondenceWithoutUL-BeamSweeping* is set to 1, upon receiving PDSCH carrying MAC-CE activation command in slot n on serving cell,

- If target TCI state is known,

- The UE shall be able to transmit uplink signal with the target TCI state in the slot n+THARQ + + NM*\** (Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms) / *NR slot length*.

- If target TCI state is unknown,

- The UE shall be able to transmit uplink signal with the target TCI state in the slot n+THARQ + *+* (TL1-RSRP+ Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms) / *NR slot length*.

- The UE shall be able to transmit with the old UL TCI state until slot n+ THARQ + .

Where,

- THARQ (in slot) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3].

- NM = 1, if the target PL-RS is not maintained by the UE, 0 otherwise.

In FR2, in case that the target PL-RS associated with or included in the target UL or joint TCI state is SSB, the requirements in this clause shall apply when this target PL-RS is maintained by the UE.

- PL-RS is maintained provided:

- the target PL-RS is associated with or included in the UL or joint TCI states in the active TCI list for PUSCH/PUCCH/SRS transmissions

- There are no more than 4 different RS activated as PL-RS per serving cell among all active UL TCI states (UL or joint TCI state) for PUSCH/PUCCH/SRS transmissions

- The target pathloss reference signal remains detectable during TCI state switching period

- SNR of the target pathloss reference signal≥-3dB

- The associated SSBs with the target pathloss reference signal remain detectable during the TCI state switching period.

- SNR of the associated SSB ≥-3dB

- Tfirst\_target-PL-RS is time to first pathloss RS transmission after L1-RSRP measurement when target TCI state is unknown.

- Tfirst\_target-PL-RS is time to first pathloss RS transmission after MAC CE command is decoded by the UE for known TCI State.

- Ttarget\_PL-RS is the periodicity of the target pathloss reference signal which would be SSB or NZP CSI-RS when PL-RS is associated with serving cell

- Ttarget\_PL-RS is the periodicity of the target pathloss reference signal which would be SSB when PL-RS is associated with PCI different from serving cell

- T L1-RSRP is the time for Rx beam refinement in FR2, defined as

- TL1-RSPR\_Measurement\_Period\_SSB for SSB as specified in clause 9.5.4.1,

- with the assumption of M=1

- with TReport = 0

- TL1-RSRP\_Measurement\_Period\_CSI-RS for CSI-RS as specified in clause 9.5.4.2

- CSI-RS based L1-RSRP measurement only apply for TCI state switch when source RS is associated with serving cell

- configured with higher layer parameter *repetition* set to ON

- with the assumption of M=1 for periodic CSI-RS

- for aperiodic CSI-RS if number of resources in resource set at least equal to *MaxNumberRxBeam*

- with TReport = 0

The requirements specified in this clause are applicable if no more than 4 different RSs are activated as PL-RS per serving cell among all active UL (or joint) TCI states.

### 8.16.4 DCI based uplink TCI state switch delay

When a UE is configured with the higher layer parameter with *DLorJointTCIState* or *UL-TCIState,* activated with TCI states for uplink transmission by MAC CE indication of more than one codepoints, and receives DCI format 1\_1/1\_2 with or without DL assignment providing indicated TCI-State or TCI state pair in the active TCI list for a CC, the UE transmits a PUCCH with HARQ-ACK information corresponding to the DCI carrying the TCI-State indication.

The requirements in this clause are applicable only if the DCI format indicating UL TCI state or joint TCI state switch is received by UE when

- target TCI state is known, and

- target TCI state is in active TCI state list, and

- target PL-RS is maintained as defined in clause 8.16.3

If the target TCI state is known, the uplink TCI switching to the indicated UL TCI state or joint TCI state in the DCI format shall be completed starting from the first slot that is at least *BeamAppTime-r17* symbols after the last symbol of the PUCCH carrying HARQ-ACK in response to the DCI triggering TCI state activation. The first slot and the *beamAppTime-r17*symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication. The value of *beamAppTime-r17*is defined in TS 38.331 [2]. The known condition for TCI state defined in clause 8.16.2 is applied.

If a PL-RS is associated with or included in UL TCI state or joint TCI state, the UL TCI switching and PL-RS switching shall be completed at the same time.

### 8.16.5 Active Uplink TCI state list update delay

The requirements specified in this clause are applicable if

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*separate*’, and a MAC CE activates more than one target separate TCIs, and at least one UL TCI is included, or

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*joint*’, and a MAC CE activates more than one target joint TCI.

If all the target TCI states in the active TCI state list are known, upon receiving PDSCH carrying MAC-CE active TCI state list update at slot n, UE shall be able to transmit PUCCH, PUSCH or SRS with the new target TCI states at the first slot that is after

n + THARQ + + NM \* (Tfirst\_target-PL-RS\_List + 4 \* Ttarget\_PL-RS\_List + 2ms) / *NR slot length*,

If a subset of target TCI states in the active TCI state list are unknown, upon receiving PDSCH carrying MAC-CE active TCI state list update at slot n, UE shall be able to transmit PUCCH, PUSCH or SRS with the new target TCI states at the first slot that is after

n+THARQ + *+* (TL1-RSRP\_List+ Tfirst\_target-PL-RS\_List + 4\*Ttarget\_PL-RS\_List + 2ms) / *NR slot length*

If all target TCI states in the active TCI state list are unknown, the requirements specified in this clause are not applicable.

Where

- If all TCIs are known,

- if the target PL-RS associated with or included in any UL TCI is not maintained, NM = 1; Where maintained PL-RS is defined in clause 8.16.3

- if a subset of target TCI states in the active TCI state list are unknown,

- TL1-RSRP\_List = is the longest L1 measurement time (TL1-RSRP) of the source RS among the unknown target TCI states , where TL1-RSRP is specified in clause 8.16.3

- if the number of cells associated with the target TCI states in the active TCI list is 2, and time to first PL-RS associated to the TCIs are overlapped in FR2,

- Tfirst\_target-PL-RS\_List = Tfirst\_target-PL-RS\_SC + min(Ttarget-PL-RS\_SC , Ttarget-PL-RS\_CDP) ;

- Ttarget-PL-RS\_List = 2 \* Ttarget-PL-RS\_SC, if Ttarget-PL-RS\_SC = Ttarget-PL-RS\_CDP

- Ttarget-PL-RS\_List = max(Ttarget-PL-RS\_SC , Ttarget-PL-RS\_CDP), if Ttarget-PL-RS\_SC ≠ Ttarget-PL-RS\_CDP

- if the number of cells associated with the target TCI states in the active TCI list is 2, and time to first PL-RS associated to the TCIs are not overlapped in FR2,

- Tfirst\_target-PL-RS\_List = max (Tfirst\_target-PL-RS\_SC, Tfirst\_target-PL-RS\_SC);

- Ttarget-PL-RS\_List = max(Ttarget-PL-RS\_SC , Ttarget-PL-RS\_CDP)

- Otherwise,

- Tfirst\_target-PL-RS\_List = Tfirst\_target-PL-RS\_SC

- Ttarget-PL-RS\_List = Ttarget-PL-RS\_SC.

- Tfirst\_target-PL-RS\_SC is Tfirst\_target-PL-RS for serving cell

- Tfirst\_target-PL-RS\_CDP is Tfirst\_target-PL-RS for cell with different PCI from serving cell

- Ttarget-PL-RS\_SC is Ttarget-PL-RS for serving cell

- Ttarget-PL-RS\_CDP is Ttarget-PL-RS for cell with different PCI from serving cell- THARQ, Tfirst\_target-PL-RS, Ttarget-PL-RS are defined in clause 8.16.3.

The requirements specified in this clause do not apply if more than 4 different RSs are activated as PL-RS per serving cell among all active UL (or joint) TCI states.

When UE receives PDSCH carrying MAC-CE for active TCI state list update, and

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*joint*’, or

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*separate*’, while the target TCI list comprises at least one DL TCIs and at least one UL TCIs,

UE is not expected to transmit on UL based on the target TCI before UE completes the DL and UL TCI list update.

The requirements in this clause are applicable when the source RS of the active UL TCI state is a DL-RS and this DL-RS is included as one of the source RSs in the DL active TCI list.

## 8.17 SCG Activation and Deactivation Delay

### 8.17.1 Introduction

This clause defines requirements for the delay within which the UE shall be able to activate one SCG and deactivate on SCG.

The requirements shall apply for NR-DC with an NR PCell, PSCell or SCell.

### 8.17.2 SCG Activation Delay Requirement

The requirements in this clause shall apply for the UE configured with one deactivated SCG in NR-DC and when PScell in one SCG is being activated.

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

Upon receiving SCG activation command in slot *n*, the UE shall be capable to transmit PRACH preamble or PUCCH or PUSCH towards PSCell no later than in slot ,

where:

Tactivation\_time = TRRC\_delay + Tprocessing + Tsearch + T∆ + TIU + 2 ms

TRRC\_delay is the RRC procedure delay as specified in TS 38.331 [2].

Tprocessing is the SW processing time needed by UE, including RF warm up period. When PSCell is activated from deactivated state, if any PSCell parameter is modified, Tprocessing = 20ms. Otherwise, Tprocessing = 5 ms. Tsearch is the time for AGC settling and PSS/SSS detection.

Tsearch is the time for AGC settling and PSS/SSS detection.

For RACH based PSCell activation, if the target cell is a known NR FR2 PSCell, Tsearch = 0 ms. If the target cell is an unknown FR2 PSCell and Es/Iot ≥ -2 dB, then Tsearch = 24\* Trs ms.

For RACH-less based PSCell activation, if RLM and BFD are configured and TCI state is known, Tsearch = 0 ms if the target cell is a known FR2 PScell. There are no requirements if PSCell is unknown.

T∆ is time for fine time tracking and acquiring full timing information of the target PSCell. T∆ = 1\*Trs ms.

TIU: When RACH based PSCell activation is configured, it is the delay uncertainty in acquiring the first available PRACH occasion in the PSCell. TIU is up to the summation of SSB to PRACH occasion association period and 10 ms. SSB to PRACH occasion associated period is defined in Table 8.1-1 of TS 38.213 [3].

When RACH-less based PSCell activation is configured, it is the uncertainty in acquiring the first PUSCH transmission occasion [or SR on PUCCH].

Trs is the SMTC periodicity of the PSCell if the UE has been provided with an SMTC configuration for the target cell in SCG activation command, otherwise Trs is the SMTC configured in the measObjectNR having the same SSB frequency and subcarrier spacing. If the UE is not provided SMTC configuration or measurement object on this frequency, the requirement in this clause is applied with Trs = 5 ms assuming the SSB transmission periodicity is 5 ms. There is no requirement if the SSB transmission periodicity is not 5.

In FR2, the PSCell is known if it has been meeting the following conditions:

- During the last 5 seconds before the reception of the SCG activation command:

- the UE has sent a valid measurement report for the PSCell being activated and

- One of the SSBs measured from the PSCell being activated remains detectable according to the cell identification conditions specified in clause 9.3.

- One of the SSBs measured from PSCell being activated also remains detectable during the PSCell activation delay Tactivation\_time according to the cell identification conditions specified in clause 9.3.

otherwise it is unknown.

If the UE is configured to perform BFD while the SCG is deactivated

- The TCI state is known if the following conditions are met:

- During the period from the PSCell deactivation to the completion of PSCell activation, while PSCell was deactivated,

- UE has not detected beam failure

- Otherwise, the TCI state is unknown.

The PCell interruption specified in clause 8.2 is allowed only during the RRC reconfiguration procedure [2].

### 8.17.3 SCG Deactivation Delay Requirement

The requirements in this clause shall apply for a UE which is configured with at least PCell and PScell.

Upon receiving RRC-based SCG deactivation command in subframe *n*, the UE shall accomplish the deactivationactions specified in TS 38.331 [2] no later than in slot :

where

TRRC\_delay is the RRC procedure delay as specified in TS 38.331 [2].

The PCell interruption specified in clause 8.2 is allowed only during the RRC reconfiguration procedure [2].

## 8.18 TRP specific Link Recovery Procedures

### 8.18.1 Introduction

The UE shall assess the downlink radio link quality of a serving cell based on the reference signal provided in the two sets and as specified in TS 38.213 [3] in order to detect beam failure on:

- PCell in SA, NR-DC, or NE-DC operation mode,

- PSCell in NR-DC and EN-DC operation mode,

- SCell in SA, NR-DC, NE-DC or EN-DC operation mode.

The RS resource configurations in the two sets and on PCell or PSCell can be periodic CSI-RS resources and/or SSBs. RS resource configuration in the two sets and on SCell shall be periodic CSI-RS. UE is not required to perform beam failure detection outside the active DL BWP. UE is not required to meet the requirements in clause 8.18.2 and 8.18.3 if UE does not have configured sets and . UE is not required to perform beam failure detection on a deactivated SCell, and also not required to perform beam failure detection on resources which is implicitly configured for a deactivated SCell. UE is not required to perform beam failure detection on a SCell on which and is not configured.

If *additionalPCIList* is configured for the serving cell, the SSBs in sets and can be associated to the same additional PCI other than serving cell PCI.

On each RS resource configuration in the two sets and , the UE shall estimate the radio link quality and compare it to the threshold Qout\_LR for the purpose of accessing downlink radio link quality of the serving cell.

The threshold Qout\_LR is defined as the level at which the downlink radio level link of a given resource configuration on two sets and cannot be reliably received and shall correspond to the BLERout = 10% block error rate of a hypothetical PDCCH transmission. For SSB based beam failure detection, Qout\_LR\_SSB is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.518.2.1-1. For CSI-RS based beam failure detection, Qout\_LR\_CSI-RS is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.181.3.1-1.

Upon request the UE shall deliver configuration indexes from the two sets and as specified in TS 38.213 [3] , to higher layers, and the corresponding L1-RSRP measurement provided that the measured L1-RSRP is equal to or better than the threshold Qin\_LR, which is indicated by higher layer parameter *rsrp-ThresholdSSB*. The UE applies the Qin\_LR threshold to the L1-RSRP measurement obtained from an SSB. The UE applies the Qin\_LR threshold to the L1-RSRP measurement obtained for a CSI-RS resource after scaling a respective CSI-RS reception power with a value provided by higher layer parameter *powerControlOffsetSS*. The RS resource configurations in the two sets and can be periodic CSI-RS resources or SSBs or both SSB and CSI-RS resources. UE is not required to perform candidate beam detection outside the active DL BWP. UE is not required to perform candidate beam detection on a SCell on which and is not configured.

### 8.18.2 Requirements for TRP specific SSB based beam failure detection

#### 8.18.2.1 Introduction

The requirements in this clause apply for each SSB resource in the set two sets and configured for a serving cell, provided that the SSB configured for beam failure detection is actually transmitted within the UE active DL BWP during the entire evaluation period specified in clause 8.18.2.2. The SSB(s) in set can be associated with an additionalPCI other than serving cell PCI.

Table 8.18.2.1-1: PDCCH transmission parameters for beam failure instance

|  |  |
| --- | --- |
| Attribute | Value for BLER |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| 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 (PRBs) | 24 |
| Sub-carrier spacing (kHz) | Same as the SCS of RMSI CORESET |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

#### 8.18.2.2 Minimum requirement

UE shall be able to evaluate whether the downlink radio link quality on the configured SSB resource in two sets and estimated over the last TEvaluate\_BFD\_SSB ms period becomes worse than the threshold Qout\_LR\_SSB within TEvaluate\_BFD\_SSB ms period.

The value of TEvaluate\_BFD\_SSB is defined in Table 8.18.2.2-1 for FR1.

The value of TEvaluate\_BFD\_SSB is defined in Table 8.18.2.2-2 for FR2 with scaling factor N=8

For FR1,

- , 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.

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

For FR2,

- , when BFD-RS resource is not overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P = Psharing factor, when the BFD-RS resource is not overlapped with measurement gap and the BFD-RS resource is fully overlapped with SMTC period (TSSB = TSMTCperiod).

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TSSB < 0.5\*TSMTCperiod

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TSSB = 0.5\*TSMTCperiod

- , when the BFD-RS resource is partially overlapped with measurement gap (TSSB <MGRP) and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap.

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is fully overlapped with SMTC occasion (TSSB = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the BFD-RS resource outside measurement gap is

- not overlapped with the SSB symbols indicated by SSB-ToMeasure and 1 data symbol before each consecutive SSB symbols indicated by SSB-ToMeasure and 1 data symbol after each consecutive SSB symbols indicated by SSB-ToMeasure, given that SSB-ToMeasure is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and;

- not overlapped with the RSSI symbols indicated by ss-RSSI-Measurement and 1 data symbol before each RSSI symbol indicated by ss-RSSI-Measurement and 1 data symbol after each RSSI symbol indicated by ss-RSSI-Measurement, given that ss-RSSI-Measurement is configured.

- Psharing factor = 3, otherwise.

where,

If the high layer in TS 38.331 [2] signaling of *smtc2* is configured, TSMTCperiod corresponds to the value of higher layer parameter *smtc2*; Otherwise TSMTCperiod corresponds to the value of higher layer parameter *smtc1*. TSMTCperiod is the shortest SMTC period among all CCs in the same FR2 band, given the SMTC offset of all CCs in FR2 provided the same offset.

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

For either an FR1 or FR2 serving cell, longer BFD evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer BFD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of PTRP defined in table 8.18.2.2-2 is defined as 2, if SSB/CSI-RS resource in the two sets and are overlapped, else it is 1.

Table 8.18.2.2-1: Evaluation period TEvaluate\_BFD\_SSB for FR1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_SSB (ms) |
| no DRX | Max(50, Ceil(5 × P) × TSSB) |
| DRX cycle ≤ 320ms | Max(50, Ceil(7.5 × P) × Max(TDRX,TSSB)) |
| DRX cycle > 320ms | Ceil(5 × P) × TDRX |
| Note: TSSB is the periodicity of SSB in the two sets and . TDRX is the DRX cycle length. | |

Table 8.18.2.2-2: Evaluation period TEvaluate\_BFD\_SSB for FR2

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_SSB (ms) |
| no DRX | Max(50, Ceil(5 × P × N\*PTRP) × TSSB) |
| DRX cycle ≤ 320ms | Max(50, Ceil(7.5 × P × N\*PTRP) × Max(TDRX,TSSB)) |
| DRX cycle > 320ms | Ceil(5 × P × N\*PTRP) × TDRX |
| Note: TSSB is the periodicity of SSB in the two sets and . TDRX is the DRX cycle length. | |

#### 8.18.2.3 Measurement restriction for SSB based beam failure detection

The UE is required to be capable of measuring SSB for BFD without measurement gaps. The UE is required to perform the SSB measurements with measurement restrictions as described in the following scenarios.

For FR1, when the SSB for BFD measurement is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, UE shall be able to measure the SSB for BFD measurement without any restriction;

- If SSB and CSI-RS have different SCS,

- If UE supports *simultaneousRxDataSSB-DiffNumerology*, UE shall be able to measure the SSB for BFD measurement without any restriction.

- If UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both SSB for BFD measurement and CSI-RS. Longer measurement period for SSB based BFD measurement is expected, and no requirements are defined.

For FR2, when the SSB for BFD measurement on one CC is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both SSB for BFD measurement and CSI-RS. Longer measurement period for SSB based BFD measurement is expected, and no requirements are defined. When the SSB and CSI-RS for BFD measurements are from different sets and , UE shall be able to perform measure both SSB and CSI-RS for BFD measurements.

For FR2, when the SSB for BFD measurement on one CC is in the same or adjacent OFDM symbol as SSB with a different PCI for RLM, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both SSBs with the two different PCIs. Longer measurement period for SSB based BFD is expected, and no requirements are defined.

For FR2, if the network configures same or mixed numerology between SSB for BFD measurement on one FR2 band and CSI-RS for RLM, BFD, CBD, L1-RSRP or L1-SINR measurement on the other FR2 band, UE shall be able to perform the related SSB based measurements in one band without any measurement restrictions on the other band, provided that UE is capable of independent beam management on this FR2 band pair.

### 8.18.3 Requirements for CSI-RS based beam failure detection

#### 8.18.3.1 Introduction

The requirements in this clause apply for each CSI-RS resource in the two sets and of resource configurations for a serving cell, provided that the CSI-RS resource(s) in two sets and for beam failure detection are actually transmitted within the UE active DL BWP during the entire evaluation period specified in clause 8.18.3.2. UE is not expected to perform beam failure detection measurements on the CSI-RS configured for BFD if the CSI-RS is not QCL-ed, with QCL-TypeD when applicable, with the RS in the active TCI state of any CORESET configured in the UE active BWP.

Table 8.18.3.1-1: PDCCH transmission parameters for beam failure instance

|  |  |
| --- | --- |
| Attribute | Value for BLER |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| 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 (PRBs) | 48 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

#### 8.18.3.2 Minimum requirement

UE shall be able to evaluate whether the downlink radio link quality on the CSI-RS resource in two sets and estimated over the last TEvaluate\_BFD\_CSI-RS ms period becomes worse than the threshold Qout\_LR\_CSI-RS within TEvaluate\_BFD\_CSI-RS ms period.

The value of TEvaluate\_BFD\_CSI-RS is defined in Table 8.18.3.2-1 for FR1.

The value of TEvaluate\_BFD\_CSI-RS is defined in Table 8.18.3.2-2 for FR2 with N=1. The requirements of TEvaluate\_BFD\_CSI-RS apply provided that the CSI-RS for BFD is not in a resource set configured with repetition ON. The requirements shall not apply when the CSI-RS resource in the active TCI state of CORESET is the same CSI-RS resource for BFD and the TCI state information of the CSI-RS resource is not given, wherein the TCI state information means QCL Type-D to SSB for L1-RSRP or CSI-RS with repetition ON.

For FR1,

- , 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.

- 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 the BFD-RS resource is not overlapped with measurement gap and also not overlapped with SMTC occasion.

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is not overlapped with SMTC occasion (TCSI-RS < MGRP)

- , when the BFD-RS resource is not overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod).

- P = Psharing factor, when the BFD-RS resource is not overlapped with measurement gap and the BFD-RS resource is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod).

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TCSI-RS < 0.5 × TSMTCperiod

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TCSI-RS = 0.5 × TSMTCperiod

- , when the BFD-RS resource is partially overlapped with measurement gap (TCSI-RS < MGRP) and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap.

- , when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the BFD-RS resource outside measurement gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and;

- not overlapped with the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured,

- Psharing factor = 3, otherwise.

where,

If the high layer in TS 38.331 [2] signaling of *smtc2* is configured, TSMTCperiod corresponds to the value of higher layer parameter *smtc2*; Otherwise TSMTCperiod corresponds to the value of higher layer parameter *smtc1*. TSMTCperiod is the shortest SMTC period among all CCs in the same FR2 band, provided the SMTC offset of all CCs in FR2 have the same offset.

Note: The overlap between CSI-RS for BFD and SMTC means that CSI-RS for BFD is within the SMTC window duration.

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

For either an FR1 or FR2 serving cell, longer BFD evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer BFD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of MBFD used in Table 8.18.3.2-1 and Table 8.18.3.2-2 are defined as

- MBFD = 10, if the CSI-RS resource(s) in the two sets and used for BFD is transmitted with Density = 3 and over the bandwidth ≥ 24 PRBs.

The values of PBFD used in Table 8.18.3.2-1 and Table 8.18.3.2-2 are defined as

For each CSI-RS resource in the two sets and configured for PCell or PSCell in EN-DC or NE-DC or SA; or PCell in NR-DC

- PBFD = 1.

For each CSI-RS resource in the two sets and configured for PSCell in NR-DC

PBFD = 2 if UE is configured for beam failure detection on SCell, 1 otherwise.

For each CSI-RS resource in the two sets and configured for a SCell

- PBFD = Z in EN-DC or NE-DC or SA.

- PBFD = 2\* Z in NR-DC.

Where Z is the number of band(s) on which UE is performing beam failure detection only for SCell.

The values of PTRP define in table 8.518.3.2-2 is defined as 2,if SSB/CSI-RS resource in the two sets and are overalapped, else it is 1.

Table 8.18.2-1: Evaluation period TEvaluate\_BFD\_CSI-RS for FR1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_CSI-RS (ms) |
| no DRX | Max(50, Ceil(MBFD × P × PBFD) × TCSI-RS) |
| DRX cycle ≤ 320ms | Max(50, Ceil(1.5 × MBFD × P × PBFD) × Max(TDRX, TCSI-RS)) |
| DRX cycle > 320ms | Ceil(MBFD × P × PBFD) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the two sets and . TDRX is the DRX cycle length. | |

**Table 8.18.3.2-2: Evaluation period TEvaluate\_BFD\_CSI-RS for FR2**

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_CSI-RS (ms) |
| no DRX | Max(50, Ceil(MBFD × P × N × PBFD\*PTRP) × TCSI-RS) |
| DRX cycle ≤ 320ms | Max(50, Ceil(1.5 × MBFD × P × N × PBFD\*PTRP) × Max(TDRX, TCSI-RS)) |
| DRX cycle > 320ms | Ceil(MBFD × P × N × PBFD\*PTRP) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the two sets and . TDRX is the DRX cycle length. | |

#### 8.18.3.3 Measurement restrictions for CSI-RS beam failure detection

The SSB mentioned in this clause can be associated with either the serving cell PCI or a PCI different from serving cell PCI.

The UE is required to be capable of measuring CSI-RS for BFD without measurement gaps. The UE is required to perform the CSI-RS measurements with measurement restrictions as described in the following scenarios.

For both FR1 and FR2, when the CSI-RS for BFD measurement is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, UE is not required to receive CSI-RS for BFD measurement in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for BFD measurement, the UE shall be able to perform CSI-RS measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for BFD measurement, the UE shall be able to perform CSI-RS measurement with restrictions according to its capabilities:

- If the UE supports *simultaneousRxDataSSB-DiffNumerology* the UE shall be able to perform CSI-RS measurement without restrictions.

- If the UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both CSI-RS for BFD measurement and SSB. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.

For FR1, when the CSI-RS for BFD measurement is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, UE shall be able to measure the CSI-RS for BFD measurement without any restriction.

For FR2, when the CSI-RS for BFD measurement on one CC is in the same OFDM symbol as SSB for RLM, BFD or L1-RSRP measurement on the same CC or different CCs in the same band, or in the same symbol as SSB for CBD measurement on the same CC or different CCs in the same band when beam failure is detected, UE is required to measure one of but not both CSI-RS for BFD measurement and SSB. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.

For FR2, when the CSI-RS for BFD measurement on one CC is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band,

- In the following cases, UE is required to measure one of but not both CSI-RS for BFD measurement and the other CSI-RS. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.

- The CSI-RS for BFD measurement or the other CSI-RS in a resource set configured with repetition ON, or

- The other CSI-RS is configured in two sets and and beam failure is detected, or

- The two CSI-RS-es are not QCL-ed w.r.t. QCL-TypeD, or the QCL information is not known to UE,

- Otherwise, UE shall be able to measure the CSI-RS for BFD measurement without any restriction.

When two CSI-RSs for BFD measurements are from different sets and , UE shall be able to perform measure both CSI-RSs for BFD measurements.

### 8.18.4 Minimum requirement for L1 indication

When more than one TRP is configured with different resource set for each TRP, requirements specified in 8.5.4 shall apply for each TRP.

### 8.18.5 Requirements for SSB based candidate beam detection

#### 8.18.5.1 Introduction

The requirements in this clause apply for each SSB resource in the sets and configured for a serving cell, provided that the SSBs configured for candidate beam detection (CBD) are actually transmitted within UE active DL BWP during the entire evaluation period specified in clause 8.18.5.2. The SSB(s) in set can be associated with an additional PCI other than serving PCI.

#### 8.18.5.2 Minimum requirement

Upon request the UE shall be able to evaluate whether the L1-RSRP measured on the configured SSB resource in the two sets and ,estimated over the last TEvaluate\_CBD\_SSB ms period becomes better than the threshold Qin\_LR provided SSB\_RP and SSB Ês/Iot are according to Annex Table B.2.4.1 for a corresponding band.

The UE shall monitor the configured SSB resources using the evaluation period in table 8.18.5.2-1 and 8.18.5.2-2 corresponding to the non-DRX mode, if the configured DRX cycle ≤ 320ms.

The value of TEvaluate\_CBD\_SSB is defined in Table 8.18.5.2-1 for FR1.

The value of TEvaluate\_CBD\_SSB is defined in Table 8.18.5.2-2 for FR2 with scaling factor N=8.

For FR1,

- , 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,

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

For FR2,

- , when candidate beam detection RS is not overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P is Psharing factor, when candidate beam detection RS is not overlapped with measurement gap and candidate beam detection RS is fully overlapped with SMTC period (TSSB = TSMTCperiod).

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TSSB < 0.5 × TSMTCperiod

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TSSB = 0.5 × TSMTCperiod

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is fully overlapped with SMTC occasion (TSSB = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the candidate beam detection RS outside measurement gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and;

- not overlapped with the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured

- Psharing factor = 3, otherwise.

where,

If the high layer in TS 38.331 [2] signaling of *smtc2*is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1.* TSMTCperiod is the shortest SMTC period among all CCs in the same FR2 band, provided the SMTC offset of all CCs in FR2 have the same offset.

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

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer CBD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of PCBD used in Table 8.18.5.2-1 and Table 8.18.5.2-2 are defined as

For each SSB resource in the sets and configured for PCell or PSCell in EN-DC or NE-DC or SA; or PCell in NR-DC

- PCBD = 1.

For each SSB resource in the sets and configured for PSCell in NR-DC

- PCBD = 2 if UE is configured for candidate beam detection on SCell, 1 otherwise.

For each SSB resource in the sets and configured for a SCell

- PCBD = Z in EN-DC or NE-DC or SA.

- PCBD = 2\* Z in NR-DC.

Where Z is the number of band(s) on which UE is performing beam failure detection only for SCell

- PCBD is the number of band(s) on which UE is performing candidate beam detection only for SCell.

The values of PTRP defined in table 8.18.5.2-2 is defined as 2, if SSB/CSI-RS resource in the two sets and are overlapped, else it is 1.

**Table 8.18.5.2-1: Evaluation period TEvaluate\_CBD\_SSB for FR1**

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_SSB (ms)** |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(3 × P × PCBD) × TSSB) |
| DRX cycle > 320ms | Ceil(3 × P × PCBD) × TDRX |
| Note: TSSB is the periodicity of SSB in the two sets and . TDRX is the DRX cycle length. | |

**Table 8.18.5.2-2: Evaluation period TEvaluate\_CBD\_SSB for FR2**

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_SSB (ms)** |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(3 × P × N × PCBD × PTRP) × TSSB) |
| DRX cycle > 320ms | Ceil(3 × P × N × PCBD × PTRP) × TDRX |
| Note: TSSB is the periodicity of SSB in the two sets and . TDRX is the DRX cycle length. | |

#### 8.18.5.3 Measurement restriction for SSB based candidate beam detection

For FR1, when the SSB for CBD measurement is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, UE shall be able to measure the SSB for CBD measurement without any restrictions.

- If SSB and CSI-RS have different SCS-es,

- If UE supports *simultaneousRxDataSSB-DiffNumerology*, UE shall be able to measure the SSB for CBD measurement without any restriction.

- If UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both SSB for CBD measurement and CSI-RS. Longer measurement period for SSB based CBD measurement is expected, and no requirements are defined.

For FR2, when the SSB for CBD measurement on one CC is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both SSB for CBD measurement and CSI-RS. Longer measurement period for SSB based CBD measurement is expected, and no requirements are defined. When the SSB and CSI-RS for CBD measurements are from different sets and , UE shall be able to measure both SSB and CSI-RS for CBD measurements.

For FR2, when the SSB for CBD measurement on one CC is in the same OFDM symbol as SSB with a different PCI for RLM, BFD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both SSBs with the two different PCIs. Longer measurement period for SSB based CBD measurement is expected, and no requirements are defined.

For FR2, if network configures same or mixed numerology between SSB for CBD measurement on one FR2 band and CSI-RS for RLM, BFD, CBD, L1-RSRP or L1-SINR measurement on the other FR2 band, UE shall be able to perform the related SSB based measurements in one band without any measurement restrictions in the other band, provided that UE is capable of independent beam management on this FR2 band pair.

### 8.18.6 Requirements for CSI-RS based candidate beam detection

#### 8.18.6.1 Introduction

The requirements in this clause apply for each CSI-RS resource in the sets and 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 clause 8.18.6.2.

#### 8.18.6.2 Minimum requirement

Upon request the UE shall be able to evaluate whether the L1-RSRP measured on the configured CSI-RS resource in sets and estimated over the last TEvaluate\_CBD\_CSI-RS [ms] period becomes better than the threshold Qin\_LR within TEvaluate\_CBD\_CSI-RS [ms] period provided CSI-RS Ês/Iot is according to Annex Table B.2.4.2 for a corresponding band.

The UE shall monitor the configured CSI-RS resources using the evaluation period in table 8.18.6.2-1 and 8.18.6.2-2 corresponding to the non-DRX mode, if the configured DRX cycle ≤ 320ms.

The value of TEvaluate\_CBD\_CSI-RS is defined in Table 8.18.6.2-1 for FR1.

The value of TEvaluate\_CBD\_CSI-RS is defined in Table 8.18.6.2-2 for FR2 with scaling factor N=8.

For FR1,

- , 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 candidate beam detection RS is not overlapped with measurement gap and also not overlapped with SMTC occasion.

- when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is not overlapped with SMTC occasion (TCSI-RS < MGRP)

- , when candidate beam detection RS is not overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod).

- P =Psharing factor, when candidate beam detection RS is not overlapped with measurement gap and candidate beam detection RS is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod).

- ,, when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TCSI-RS < 0.5 × TSMTCperiod

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TCSI-RS = 0.5 × TSMTCperiod

- , when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap

- ,, when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the candidate beam detection RS outside measurement gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and;

- not overlapped with the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured.

- Psharing factor = 3, otherwise.

where,

If the high layer in TS 38.331 [2] signaling of *smtc2* is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1*. TSMTCperiod is the shortest SMTC period among all CCs in the same FR2 band, provided the SMTC offset of all CCs in FR2 have the same offset.

Note: The overlap between CSI-RS for CBD and SMTC means that CSI-RS for CBD is within the SMTC window duration.

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

Longer evaluation period would be expected if the CSI-RS is on the same OFDM symbols with RLM, BFD, BM-RS, or other CBD-RS, according to the measurement restrictions defined in clause 8.18.6.3.

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer CBD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of MCBD used in Table 8.18.6.2-1 and Table 8.18.6.2-2 are defined as

- MCBD = 3, if the CSI-RS resource configured in the sets and is transmitted with Density = 3 and over the bandwidth ≥ 24 PRBs.

The values of PCBD used in Table 8.18.6.2-1 and Table 8.18.6.2-2 are defined as

For each CSI-RS resource in the sets and configured for PCell or PSCell in EN-DC or NE-DC or SA; or PCell in NR-DC

- PCBD = 1.

For each CSI-RS resource in the sets and configured for PSCell in NR-DC

- PCBD = 2 if UE configured for candidate beam detection on SCell, 1 otherwise.

For each CSI-RS resource in the sets and configured for a SCell

- PCBD = Z in EN-DC or NE-DC or SA.

- PCBD = 2\* Z in NR-DC.

Where Z is the number of band(s) on which UE is performing beam failure detection only for SCell

- PCBD is the number of band(s) on which UE is performing candidate beam detection only for SCell.

The values of PTRP defined in table 8.18.6.2-2 is defined as 2, if SSB/CSI-RS resource in the two sets and are overlapped, else it is 1.

**Table 8.18.6.2-1: Evaluation period TEvaluate\_CBD\_CSI-RS for FR1**

|  |  |
| --- | --- |
| **Configuration** | **TEvaluateC\_CBD\_CSI-RS (ms)** |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(MCBD × P × PCBD) × TCSI-RS) |
| DRX cycle > 320ms | Ceil(MCBD × P × PCBD) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the two sets and . TDRX is the DRX cycle length. | |

**Table 8.18.6.2-2: Evaluation period TEvaluate\_CBD\_CSI-RS for FR2**

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_CSI-RS (ms)** |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(MCBD × P × N × PCBD × PTRP) × TCSI-RS) |
| DRX cycle > 320ms | Ceil(MCBD × P × N × PCBD × PTRP) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the two sets and . TDRX is the DRX cycle length. | |

#### 8.18.6.3 Measurement restriction for CSI-RS based candidate beam detection

The SSB mentioned in this clause can be associated with either the serving cell PCI or a PCI different from serving cell PCI.

For both FR1 and FR2, when the CSI-RS for CBD measurement is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, UE is not required to receive CSI-RS for CBD measurement in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for CBD measurement, the UE shall be able to perform CSI-RS based CBD measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for CBD measurement, the UE shall be able to perform CSI-RS based CBD measurement with restrictions according to its capabilities:

- If the UE supports *simultaneousRxDataSSB-DiffNumerology* the UE shall be able to perform CSI-RS based CBD measurement for without restrictions.

- If the UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both CSI-RS for CBD measurement and SSB. Longer measurement period for CSI-RS based CBD measurement is expected, and no requirements are defined.

For FR1, when the CSI-RS for CBD measurement is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, UE shall be able to measure the CSI-RS for CBD measurement without any restriction.

For FR2, when the CSI-RS for CBD measurement on one CC is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both CSI-RS for CBD measurement and SSB. Longer evaluation period for CSI-RS based CBD measurement is expected, and no requirements are defined.

For FR2, when the CSI-RS for CBD measurement on one CC is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both CSI-RS for CBD measurement and the other CSI-RS. Longer evaluation period for CSI-RS based CBD measurement is expected, and no requirements are defined. When two CSI-RSs for CBD measurements are from different sets and , UE shall be able to measure both CSI-RSs for CBD measurements.

### 8.18.7 Requirements for TRP specific Beam Failure Recovery

#### 8.18.7.1 Introduction

For the UE provided with a configuration of PUCCH transmission with a link recovery request (LRR) as described in clause 9.2.4 in TS 38.213 [3], if beam recovery procedure is triggered for any of the TRPs, the UE shall transmit SR for UL resouce, followed by MAC CE providing beam index for the corresponding TRP whose radio link quality is worse than Qout,LR. The index, , provided in the TRP specific BFR MAC CE is provided by higher layer for a periodic CSI-RS configuration or for a SSB, as described in clause 5.17 of TS38.321 [7].

For the UE not provided with a configuration of PUCCH transmission with a link recovery request (LRR) as described in clause 9.2.4 in TS 38.213 [3], if beam recovery procedure is triggered for any of TRPs, the UE shall transmit preamble for UL-SCH resource application, followed by MAC CE providing one index for the corresponding TRP whose radio link quality is worse than Qout,LR, and the index for a periodic CSI-RS configuration or for a SSB provided by higher layer, as described in clause 5.17 of TS38.321 [7], if any, for a corresponding TRP.

#### 8.18.7.2 Requirement

Provided that UE is configured by *schedulingRequestID-BFR-r17* and/or *schedulingRequestID-BFR2-r17*for BFR set 1 (i.e., TRP1) and BFR set 2 (i.e., TRP2) respectively*,* a configuration for LRR in a PUCCH transmission, after BFR is triggered on any of the TRPs as described in clause 5.17 of TS38.321 [7], UE shall be capable of transmit PUCCH with a LRR within a period of T on any of the TRPs where BFR running.Where:

- T = T1 x Ceil((T2+D) /T1) in which T1, T2 and D are defined as

- T1 is equal to the periodicity of PUCCH configured with *schedulingRequestID-BFR-r17 for* BFR set 1 schedulingRequestID-BFR2-r17 for BFR set 2..

- T2 = TEvaluate\_CBD is the evaluation period specified in clause 8.18.5 or 8.18.6 for SSB or CSI-RS based candidate beam detection, that is TEvaluate\_CBD\_SSB or TEvaluate\_CBD\_CSI-RS, depending on the applicable reference signal configured for candidate beam detection.

- D = [2ms] is the UE Processing time.

### 8.18.8 Scheduling availability of UE during TRP specific beam failure detection

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

#### 8.18.8.1 Scheduling availability of UE performing TRP specific beam failure detection with a same subcarrier spacing as PDSCH/PDCCH on FR1

There are no scheduling restrictions due to TRP specific beam failure detection performed on SSB and CSI-RS configured for BFD with the same SCS as PDSCH or PDCCH in FR1.

#### 8.18.8.2 Scheduling availability of UE performing TRP specific 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 TRP specific beam failure detection when SSB is configured as BFD. For UEs which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to TRP specific beam failure detection when SSB is configured as BFD.

- The UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on SSB symbols to be measured for TRP specific beam failure detection.

When intra-band carrier aggregation in FR1 is configured, the scheduling restrictions on FR1 serving PCell or PSCell apply to all serving cells in the same band on the symbols that fully or partially overlap with restricted symbols. 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.

#### 8.18.8.3 Scheduling availability of UE performing TRP specific beam failure detection on FR2

The following scheduling restriction applies due to TRP specific beam failure detection.

- For the case where no RSs are provided for BFD, or when CSI-RS is configured for BFD is explicitly configured and is type-D QCLed with active TCI state for PDCCH or PDSCH, and the CSI-RS is not in a CSI-RS resource set with repetition ON

- There are no scheduling restrictions due to TRP specific beam failure detection performed based on the CSI-RS.

- Otherwise

- The UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on BFD-RS resource symbols to be measured for TRP specific beam failure detection.

When intra-band carrier aggregation in FR2 is performed, the scheduling restrictions on FR2 serving PCell or PSCell apply to all serving cells in the same band on the symbols that fully or partially overlap with restricted symbols.

When inter-band carrier aggregation in FR2 is performed, there are no scheduling restrictions on FR2 serving cells in the bands due to beam failure detection performed on FR2 serving cell(s) in different band(s), provided that UE is capable of independent beam management on this FR2 band pair. Additionally, there is no scheduling restriction if the UE is configured with different numerology between SSB on one FR2 band and data on the other FR2 band provided the UE is configured for IBM operation for the band pair.

For FR2, if following conditions are met,

- UE has been notified about system information update through paging,

- The gap between UE’s reception of PDCCH that UE monitors in the Type2-PDCCH CSS set and that notifies system information update, and the PDCCH that UE monitors in the Type0-PDCCH CSS set, is greater than 2 slots,

For the SSB and CORESET for RMSI scheduling multiplexing patterns 3, UE is expected to receive the PDCCH that UE monitors in the Type0-PDCCH CSS set, and the corresponding PDSCH, on SSB symbols to be measured for BFD mesurement; and

For the SSB and CORESET for RMSI scheduling multiplexing patterns 2, UE is expected to receive PDSCH that corresponds to the PDCCH that UE monitors in the Type0-PDCCH CSS set, on SSB symbols to be measured for BFD mesurement.

#### 8.18.8.4 Scheduling availability of UE performing TRP specific beam failure detection on FR1 or FR2 in case of FR1-FR2 inter-band CA and NR DC

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

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

### 8.18.9 Scheduling availability of UE during TRP specific candidate beam detection

Scheduling availability restrictions when the UE is performing L1-RSRP measurement for TRP specific candidate beam detection are described in the following clauses.

#### 8.18.9.1 Scheduling availability of UE performing L1-RSRP measurement with a same subcarrier spacing as PDSCH/PDCCH on FR1

There are no scheduling restrictions due to L1-RSRP measurement performed on SSB and CSI-RS configured as TRP specific link recovery detection resource with the same SCS as PDSCH or PDCCH in FR1.

#### 8.18.9.2 Scheduling availability of UE performing L1-RSRP measurement 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 L1-RSRP measurement based on SSB as TRP specific link recovery detection resource. For UEs which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to L1-RSRP measurement based on SSB configured as TRP specific link recovery detection resource.

- The UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH, TRS, CSI-RS for tracking or CSI-RS for CQI on SSB symbols to be measured for L1-RSRP.

When intra-band carrier aggregation in FR1 is configured, the scheduling restrictions on one serving cell apply to all other serving cells in the same band on the symbols that fully or partially overlap with the restricted symbols. When inter-band carrier aggregation within FR1 is configured, there are no scheduling restrictions on FR1 serving cell(s) configured in other bands.

#### 8.18.9.3 Scheduling availability of UE performing L1-RSRP measurement on FR2

The following scheduling restriction applies due to TRP specific candidate beam detection

- The UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH, CSI-RS for tracking or CSI-RS for CQI on reference symbols to be measured for TRP specific candidate beam detection.

When intra-band carrier aggregation in FR2 is configured, the scheduling restrictions on to one serving cell apply to all serving cells in the same band on the symbols that fully or partially overlap with restricted symbols.

When inter-band carrier aggregation in FR2 is performed, there are no scheduling restrictions on FR2 serving cells in the bands due to candidate beam detection performed on FR2 serving cell(s) in different band(s), provided that the FR2 serving cell(s) and the FR2 serving cell(s) for candidate beam detection are in a FR2 band pair and UE is capable of independent beam management on this FR2 band pair. Additionally, there is no scheduling restriction if the UE is configured with different numerology between SSB on one FR2 band and data on the other FR2 band provided the UE is configured for IBM operation for the band pair.

For FR2, if following conditions are met,

- UE has been notified about system information update through paging,

- The gap between UE’s reception of PDCCH that UE monitors in the Type2-PDCCH CSS set and that notifies system information update, and the PDCCH that UE monitors in the Type0-PDCCH CSS set, is greater than 2 slots,

For the SSB and CORESET for RMSI scheduling multiplexing patterns 3, UE is expected to receive the PDCCH that UE monitors in the Type0-PDCCH CSS set, and the corresponding PDSCH, on SSB symbols to be measured for CBD mesurement; and

For the SSB and CORESET for RMSI scheduling multiplexing patterns 2, UE is expected to receive PDSCH that corresponds to the PDCCH that UE monitors in the Type0-PDCCH CSS set, on SSB symbols to be measured for CBD mesurement.

#### 8.18.9.4 Scheduling availability of UE performing L1-RSRP measurement on FR1 or FR2 in case of FR1-FR2 inter-band CA and NR-DC

There are no scheduling restrictions on FR1 serving cell(s) due to L1-RSRP measurement performed on FR2 serving cell(s).

There are no scheduling restrictions on FR2 serving cell(s) due to L1-RSRP measurement performed on FR1 serving cell(s).

## 8.19 Pre-configured measurement gap activation/deactivation delay

### 8.19.1 Introduction

The requirements in this clause apply for a UE configured with PCell or any activated SCell in standalone NR.

UE shall complete the activation/deactivation of pre-configured measurement gap within the delay defined in this clause.

### 8.19.2 Pre-configured measurement gap activation/deactivation upon DCI/timer-based BWP switch

#### 8.19.2.1 Activation/deactivation upon DCI/timer-based BWP switch delay on a single CC

The requirements in this clause only apply to the case that the DCI/timer-based BWP switch is performed on a single CC with more than one BWP configurations configured on the CC.

When BWP switch occurs, which results in status change of pre-configured measurement gap according to clause 9.1.7, UE shall be able to finish pre-configured activation or deactivation within 5 ms after the completion of the active BWP switch. The active BWP switch delay for single CC is defined in clause 8.6.2. Activation/deactivation of Pre-MG takes effect from the first complete MG occasion after the activation and deactivation delay. If the end of activation/deactivation of Pre-MG is within a gap occasion, the Pre-MG status shall not be changed immediately. Instead, the Pre-MG status shall be changed prior to the next gap occasion.

### 8.19.3 Pre-configured measurement gap activation/deactivation upon SCell activation/deactivation

The requirements in this clause apply when one SCell or multiple SCells are activated/deactivated.

When one SCell or multiple SCells are activated/deactivated, which results in status change of pre-configured measurement gap according to clause 9.1.7, UE shall be able to finish pre-configured activation or deactivation within 5 ms after the completion of SCell(s) activation/deactivation. The SCell(s) activation/deactivation delay for is defined in clause 8.3. Activation/deactivation of Pre-MG takes effect from the first complete MG occasion after the SCell(s) activation/deactivation delay. If the end of activation/deactivation of Pre-MG is within a gap occasion, the Pre-MG status shall not be changed immediately. Instead, the Pre-MG status shall be changed prior to the next gap occasion.

### 8.19.4 Pre-configured measurement gap activation/deactivation upon RRC reconfiguration

The requirements in this clause apply when UE capable of autonomous activation/deactivation mechanism receives RRC reconfiguration to:

- Add/remove of any measurement object(s), or

- Add/release/change a SCell under CA, or

- Switch active BWP or update parameters of its active BWP.

If the aforementioned RRC reconfiguration results in status change of pre-configured measurement gap according to clause 9.1.7, UE shall be able to finish pre-configured activation or deactivation within 5 ms after RRC processing delay specified in [2]. If the end of activation/deactivation of Pre-MG is within a gap occasion, the Pre-MG status shall not be changed immediately. Instead, the Pre-MG status shall be changed prior to the next gap occasion.