# 12 V2X Requirements

## 12.1 Introduction

This clause contains the requirements for the UE capable of V2X sidelink communication when the UE is out of coverage on the carrier used for V2X sidelink operation, as defined in TS 38.304 [1]. The requirements apply when the UE is:

- in any cell selection state, or,

- configured for V2X SL operation on a V2X carrier which is dedicated to only V2X SL operation and configured with only a PCell on WAN carrier.

- configured for inter-band con-current V2X operation.

- configured for intra-band con-current V2X operation with different carriers.

Note: Any cell selection state refers to a UE that is out of network coverage and is not associated with a serving cell on any carrier as defined in TS 38.304 [1].

Note: When a UE in RRC\_CONNECTED state is performing transmissions and/or reception for V2X sidelink communication, the UE shall meet all the requirements specified in Clause 9 assuming that UE has a dedicated RX/TX chain for V2X sidelink communication. Otherwise, the UE may interrup the V2X sidelink communication in order to meet the measurement requirements specified in Clause 9.

This clause also contains the requirements for the UE capable of V2X sidelink communication when the UE is in coverage on the carrier used for V2X sidelink operation, as defined in TS 38.304 [1]. The requirements apply when the UE is:

- configured for intra-band con-current NR V2X cooperation with same carrier.

For UE capable of Public Safety sidelink communication and/or other commercial sidelink commnunication, unless explicitly stated, V2X requirements apply.

## 12.2 UE Transmit Timing

### 12.2.1 Introduction

This clause contains requirements of transmission timing for V2X sidelink communication when:

- GNSS is used as the synchronization reference source;

- NR Cell is used as the synchronization reference source;

- E-UTRAN Cell is used as the synchronization reference source;

- SyncRef UE is used as the synchronization reference source.

### 12.2.2 GNSS as synchronization reference source

The requirements in this subclause are applicable when the reference timing used by the UE for V2X sidelink communication is derived from GNSS.

The sidelink transmissions takes place  before the subframe starting boundary as defined in TS 38.331 [2], where  = 0 and=0.

The transmission timing error for sidelink transmissions shall be less than or equal to ±Te where the timing error limit value Te is defined in Table 12.2.2-1.

Table 12.2.2-1: Te Timing Error Limit

|  |  |
| --- | --- |
| Frequency Range of sidelink | Te\_ |
| FR1 | 12\*64\*Tc |
| Note 1: Tc is the basic timing unit defined in TS 38.211 [6]. | |

### 12.2.3 NR Cell as synchronization reference source

The requirements in this subclause are applicable when the reference timing used for sidelink transmissions is a NR serving cell on a non-V2X sidelink carrier or a V2X sidelink carrier.

The sidelink transmissions takes place  before the reception of the first detected path (in time) of the corresponding downlink frame from the reference cell, where = 0. If uplink transmission and sidelink transmission are in the same band,  is defined in Table 7.1.2-2, otherwise  is 0.

The transmission timing error for sidelink transmissions shall be less than or equal to ±Te where the timing error limit value Te is defined in Table 12.2.3-1.

Table 12.2.3-1: Te Timing Error Limit

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range of sidelink | SCS of SSB signals ( kHz) | SCS of sidelink signals (kHz) | Te |
| FR1 | 15 | 15 | 14\*64\*Tc |
|  |  | 30 | 12\*64\*Tc |
|  |  | 60 | 12\*64\*Tc |
|  | 30 | 15 | 10\*64\*Tc |
|  |  | 30 | 10\*64\*Tc |
|  |  | 60 | 9\*64\*Tc |
| Note 1: Tc is the basic timing unit defined in TS 38.211 [6]. | | | |

### 12.2.4 E-URTAN Cell as synchronization reference source

The requirements in this subclause are applicable when the reference timing used for sidelink transmissions is an E-UTRAN serving cell on a non-V2X sidelink carrier.

The sidelink transmissions takes place  before the reception of the first detected path (in time) of the corresponding E-UTRAN downlink frame from the reference cell, where  = 0 and=0.

The transmission timing error for sidelink transmissions shall be less than or equal to ±Te where the timing error limit value Te is defined in Table 12.2.4-1.

Table 12.2.4-1: Te Timing Error Limit

|  |  |  |
| --- | --- | --- |
| Frequency Range of sidelink | E-UTRAN downlink bandwidth (MHz) | Te\_ |
| FR1 | ≥3 | 14\*64\*Tc |
| Note 1: Tc is the basic timing unit defined in TS 38.211 [6]. | | |

### 12.2.5 SyncRef UE as synchronization reference source

The requirements in this subclause are applicable when the reference timing used for deriving sidelink transmission is from SyncRef UE transmitting sidelink synchronization signals.

The sidelink transmissions takes place  before the reception of the first detected path (in time) of the corresponding timing reference frame from the SyncRef UE, where  = 0 and=0.

The transmission timing error for sidelink transmissions shall be less than or equal to ±Te where the timing error limit value Te is defined in Table 12.2.5-1.

Table 12.2.5-1: Te Timing Error Limit

|  |  |  |
| --- | --- | --- |
| Frequency Range of sidelink | SCS of sidelink signals (kHz) | Te |
| FR1 | 15 | 12\*64\*Tc |
|  | 30 | 8\*64\*Tc |
|  | 60 | 5\*64\*Tc |
| Note 1: Tc is the basic timing unit defined in TS 38.211 [6]. | | |

## 12.3 Initiation/Cease of SLSS Transmissions

### 12.3.1 Introduction

The requirements in this subclause are applicable to the UE capable of V2X sidelink communication when:

- GNSS is used as the synchronization reference source;

- NR Cell is used as the synchronization reference source;

- EUTRAN Cell is used as the synchronization reference source;

- SyncRef UE is used as the synchronization reference source.

#### 12.3.1.1 Initiation/Cease of SLSS transmissions with NR cell as synchronization reference source

The requirements apply when the NR Cell is used as synchronization reference source and when the UE is

- out of coverage on the V2X NR sidelink carrier and in-coverage with a serving cell on a NR non-V2X sidelink carrier, or

- in coverage with a serving cell on a NR V2X sidelink carrier,

and when the conditions for SLSS transmissions specified in TS 38.331[2] are met; *networkControlledSyncTx* is not configured; and *syncTxThreshIC* is included in *SystemInformationBlockType12*. The UE shall be capable of measuring the RSRP of the cell used as synchronization reference source to evaluate to initiate/cease SLSS transmissions within Tevaluate,SLSS

where,

- Tevaluate,SLSS is as specified in Table 12.3.1.1-1 when UE performs SSB based measurements without measurement gaps.

- Tevaluate,SLSS is as specified in Table 12.3.1.1-2 when UE performs SSB based measurements with measurement gaps.

Table 12.3.1.1-1: Tevaluate,SLSS for measurements without measurement gaps when NR cell is used as synchronization reference source (FR1)

|  |  |
| --- | --- |
| DRX cycle in NR cell | Tevaluate,SLSS |
| No DRX | max(400ms, ceil( 2 x 5 x Kp) x SMTC period)Note 1 |
| DRX cycle≤ 320ms | max(400ms, ceil(1.5 x 2 x 5 x Kp) x max(SMTC period, DRX cycle)) |
| DRX cycle>320ms | ceil( 7 x Kp ) x DRX cycle |
| NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified | |

Table 12.3.1.1-2: Tevaluate,SLSS for measurements with measurement gaps when NR cell is used as synchronization reference source (FR1)

|  |  |
| --- | --- |
| DRX cycle in NR cell | Tevaluate,SLSS |
| No DRX | max(400ms, 2 x 5 x max(MGRP, SMTC period)) x CSSFintra |
| DRX cycle≤ 320ms | max(400ms, ceil(2 x 1.5x 5) x max(MGRP, SMTC period,DRX cycle))x CSSFintra |
| DRX cycle>320ms | 7 x max(MGRP, DRX cycle) x CSSFintra |

If higher layer filtering is configured, an additional delay in evaluation to initiate/cease SLSS transmissions can be expected.

For the NR cell as synchronization reference source:

- SS-RSRP related side conditions given in clauses 10.1.2 for FR1, respectively, for a corresponding Band,

- SS-RSRQ related side conditions given in clauses 10.1.7 for FR1, respectively, for a corresponding Band,

- SS-SINR related side conditions given in clauses 10.1.12 for FR1, respectively, for a corresponding Band,

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

#### 12.3.1.2 Initiation/Cease of SLSS transmissions with EUTRAN cell as synchronization reference source

The requirements apply when the EUTRAN Cell is used as synchronization reference source and when the UE is

- out of coverage on the V2X NR sidelink carrier and in-coverage with a serving cell on a LTE non-V2X sidelink carrier,

and when the conditions for SLSS transmissions specified in TS 36.331[16] are met; *networkControlledSyncTx* is not configured; and *syncTxThreshIC* is included in *SystemInformationBlockType28*. The UE shall be capable of measuring the RSRP of the cell used as synchronization reference source to evaluate to initiate/cease SLSS transmissions within Tevaluate,SLSS

where,

- Tevaluate,SLSS = 0.4 seconds when UE is not configured with DRX.

- Tevaluate,SLSS = as specified in Table 12.3.1.2-1 when UE is configured with DRX.

Table 12.3.1.2-1: Tevaluate,SLSS when EUTRAN cell is used as synchronization reference source

|  |  |
| --- | --- |
| DRX cycle length in EUTRAN cell[s] | Tevaluate,SLSS  [s] (number of DRX cycles) |
| ≤0.04 | 0.4 (Note 1) |
| 0.04<DRX-cycle≤2.56 | Note 2 (6) |
| Note1: Number of DRX cycles depends upon the DRX cycle in use  Note2: Time depends upon the DRX cycles in use | |

If higher layer filtering is configured, an additional delay in evaluation to initiate/cease SLSS transmissions can be expected.

For the cell as synchronization reference source:

- RSRP related side conditions given in TS 36.133[15] Clauses 9.1.2.1 and 9.1.2.2 and RSRQ related side conditions given in TS 36.133[15] Clause 9.1.5.1 for a corresponding Band are fulfilled,

- SCH\_RP and SCH Ês/Iot according to TS 36.133[15] Annex B.2.1 for a corresponding Band are fulfilled.

#### 12.3.1.3 Initiation/Cease of SLSS transmissions with GNSS as synchronization reference source

The requirements apply when GNSS is used as synchronization reference source and when the UE is

- out of coverage on the V2X sidelink carrier and in-coverage with a serving cell on a non-V2X sidelink carrier, or

- in coverage with a serving cell on a NR V2X sidelink carrier,

and when the conditions for SLSS transmissions specified in TS 38.331[2] are met; *networkControlledSyncTx* is not configured; and *syncTxThreshIC* is included in *SystemInformationBlockType12* in a NR cell.

When the conditions for SLSS transmissions specified in TS 36.331[16] are met; *networkControlledSyncTx* is not configured; and *syncTxThreshIC* is included in *SystemInformationBlockType28* in a EUTRAN cell.

The requirements in Clause 12.3.1.1 shall apply if the serving cell is a NR cell.

The requirements in Clause 12.3.1.2 shall apply if the serving cell is a EUTRAN cell.

#### 12.3.1.4 Initiation/Cease of SLSS transmissions with SyncRef UE as synchronization reference source

The requirements apply when SyncRef UE is used as synchronization reference source and when the UE is

- in any cell selection state, or

- out of coverage on the V2X sidelink carrier and is associated with a serving cell on a non-V2X sidelink carrier, or

- in coverage with a serving cell on a NR V2X sidelink carrier,

and when the conditions for SLSS transmissions specified in TS 38.331[2] are met and when SyncRef UE is used as synchronization reference source and if *syncTxThreshOoC* is included in the preconfigured V2X parameters.

The UE shall be capable of measuring the PSBCH-RSRP of the selected SyncRef UE used as synchronization reference source and evaluate it to initiate/cease SLSS transmissions within Tevaluate,SLSS, as shown in Table 12.3.1.4-1.

Table 12.3.1.4-1: Tevaluate,SLSS when SyncRef UE is used as synchronization reference source

|  |  |
| --- | --- |
| SL-DRX cycleNote 1 [ms] | Tevaluate,SLSS [ms] |
| No SL-DRX | 4 x S-SSB periods |
| SL-DRX cycle ≤ 160ms | 4 x S-SSB periods |
| SL-DRX cycle > 160ms | 4 x SL-DRX cycle |
| Note 1: If multiple SL-DRX cycles are configured for SL UE, the SL-DRX cycle in the requirement is the shortest one. When the shortest SL-DRX cycle UE used changes, the requirements do not apply to the time of transition. | |

If higher layer filtering for PSBCH-RSRP measurements is pre-configured, an additional delay in evaluation to initiate/cease SLSS transmissions can be expected.

For the selected SyncRef UE as defined in TS 38.331 [2] used to derive transmission timing for V2X sidelink communication:

- PSBCH-RSRP related side conditions given in Clause 12.4 for a corresponding Band are fulfilled,

- V2X S-SSB\_RP and S-SSB Ês/Iot according to Annex B. 4 for a corresponding Band are fulfilled.

## 12.4 Selection / Reselection of V2X Synchronization Reference Source

The requirements defined in this clause do not apply to the UEs that do not support transmission and reception of SLSS.

A SyncRef UE is considered to be detectable when

- PSBCH-RSRP related side conditions given in Clause 10 are fulfilled for a corresponding Band,

- S-SSB\_RP and S-SSB Ês/Iot according to Annex B.4.3 for a corresponding Band are fulfilled.

When GNSS synchronization reference source is configured as the highest priority and

- UE is synchronized to GNSS directly,

- UE shall not drop any V2X SLSS and data transmission for the purpose of selection/reselection to the SyncRef UE.

- UE is synchronized to a SyncRef UE that is synchronized to GNSS directly or in-directly,

- UE shall not drop any V2X data transmission for the purpose of selection/reselection to the SyncRef UE. The UE shall be able to identify newly detectable intra-frequency SyncRef UE within Tdetect,SyncRef UE\_V2X seconds if the SyncRef UE meets the selection / reselection criterion defined in TS 38.331[2]. Tdetect,SyncRef UE\_V2X is defined as 1.6 seconds at S-SSB Ês/Iot ≥ 0 dB, provided that the UE is allowed to drop a maximum of 30% of its SLSS transmissions during Tdetect,SyncRef UE\_V2X for the purpose of selection / reselection to the SyncRef UE.

- in other case

- When UE is in non-SL-DRX

- The UE shall be able to identify newly detectable intra-frequency SyncRef UE within Tdetect,SyncRef UE\_V2X seconds if the SyncRef UE meets the selection / reselection criterion defined in TS 38.331[2]. Tdetect,SyncRef UE\_V2X is defined as 8 seconds at S-SSB Ês/Iot ≥ 0 dB, provided that the UE is allowed to drop a maximum of 6 % of its V2X data and SLSS transmissions during Tdetect,SyncRef UE\_V2X for the purpose of selection / reselection to the SyncRef UE.

- UE is allowed to drop up to 2 slots of its V2X data reception per PSBCH monitoring occasion and overall drop rate shall not exceed 0.3% of its V2X data reception during Tdetect,SyncRef UE\_V2X for the purpose of selection / reselection to the SyncRef UE.

- When UE is in SL-DRX

- UE shall be able to identify newly detectable intra-frequency SyncRef UE within Tdetect,SyncRef UE\_V2X seconds if the SyncRef UE meets the selection / reselection criterion defined in TS 38.331[2]. Tdetect,SyncRef UE\_V2X is defined as 8 seconds at S-SSB Ês/Iot ≥ 0 dB, provided that the V2X UE is allowed to drop a maximum of 6 % of its V2X data and SLSS transmissions for the purpose of selection / reselection to the SyncRef UE.

- UE is allowed to drop up to 2 slots of its V2X data reception per PSBCH monitoring occasion and UE is allowed to drop at most an aggregated window of 24ms of its V2X data reception during Tdetect,SyncRef UE\_V2X for the purpose of selection / reselection to the SyncRef UE.

- The UE is allowed to extend Tdetect,SyncRef UE\_V2X to max(4 x 50 SL-DRX cycle length, 8s) when the following conditions are satisfied over an evaluation period Tevaluate,SLSS in clause 12.3.1.1 if an NR cell is used as synchronization reference source, or Tevaluate,SLSS in clause 12.3.1.2 if an EUTRA cell is used as synchronization reference source, or Tevaluate,SLSS in clause 12.3.1.4 if an SLSS is used as synchronization reference source. If multiple SL-DRX cycles are configured, the SL-DRX cycle length is the longest one.

- SS-RSRP is larger than *syncTxThreshOoC*.

When serving cell/PCell synchronization reference source is configured as the highest priority,

- When UE is in non-SL-DRX

- UE shall be able to identify newly detectable intra-frequency SyncRef UE within Tdetect,SyncRef UE\_V2X seconds if the SyncRef UE meets the selection / reselection criterion defined in TS 38.331[2]. Tdetect,SyncRef UE\_V2X is defined as 8 seconds at SCH Es/Iot ≥ 0 dB, provided that the V2X UE is allowed to drop a maximum of 6 % of its V2X data and SLSS transmissions for the purpose of selection / reselection to the SyncRef UE.

- UE is allowed to drop up to 2 slots of its V2X data reception per PSBCH monitoring occasion and overall drop rate shall not exceed 0.3% of its V2X data reception during Tdetect,SyncRef UE\_V2X for the purpose of selection / reselection to the SyncRef UE.

- When UE is in SL-DRX

- The UE shall be able to identify newly detectable intra-frequency SyncRef UE within Tdetect,SyncRef UE\_V2X seconds if the SyncRef UE meets the selection / reselection criterion defined in TS 38.331[2]. Tdetect,SyncRef UE\_V2X is defined as 8 seconds at SCH Es/Iot ≥ 0 dB, provided that the UE is allowed to drop its V2X data and SLSS transmissions at most in an aggregated window of 480ms during Tdetect,SyncRef UE\_V2X for the purpose of selection / reselection to the SyncRef UE.

- UE is allowed to drop up to 2 slots of its V2X data reception per PSBCH monitoring occasion and UE is allowed to drop at most an aggregated window of 24ms of its V2X data reception during Tdetect,SyncRef UE\_V2X for the purpose of selection / reselection to the SyncRef UE.

- The UE is allowed to extend Tdetect,SyncRef UE\_V2X to max(4 x 50 SL-DRX cycle length, 8s) when the following conditions are satisfied over an evaluation period Tevaluate,SLSS in clause 12.3.1.1 if an NR cell is used as synchronization reference source, or Tevaluate,SLSS in clause 12.3.1.2 if an EUTRA cell is used as synchronization reference source, or Tevaluate,SLSS in clause 12.3.1.4 if an SLSS is used as synchronization reference source. If multiple SL-DRX cycles are configured, the SL-DRX cycle length is the longest one.

- SS-RSRP is larger than *syncTxThreshOoC*.

UE shall be capable of performing PSBCH-RSRP measurements for 3 identified intra-frequency SyncRef UE with the measurement period of Tmeasure,PSBCH-RSRP in Table 12.4-1. It is assumed that the SyncRef UE do not drop or delay any SLSS transmission within the measurement period. Otherwise, the measurement period may be extended.

Table 12.4-1: PSBCH-RSRP measurement period for intra-frequency SyncRef UE

|  |  |
| --- | --- |
| SL-DRX cycleNote 1 [ms] | Tmeasure,PSBCH-RSRP [ms] |
| No SL-DRX | 320 |
| SL-DRX cycle ≤ 160ms | 320 |
| SL-DRX cycle > 160ms | 2 x SL-DRX cycle |
| Note 1: If multiple SL-DRX cycles are configured, the SL-DRX cycle is the shortest one. | |

When UE is synchronized to GNSS directly, before selection / reselection of the new synchronization reference source UE shall evaluate the GNSS synchronization source reliability for at least 20 seconds before changing the synchronization reference from GNSS to another synchronization reference source. UE shall be always synchronized to GNSS directly during the evaluation of GNSS synchronization source reliability.

## 12.5 L1 SL-RSRP measurements

### 12.5.1 Introduction

This clause contains the measurement requirements related to resource reselection and resource pre-emption of the UE capable of V2X sidelink communication.

### 12.5.2 SL-RSRP measurements

The UE physical layer shall be capable of performing the L1 SL-RSRP measurements on the carrier operating V2X sidelink communication for determining the subset of resources to be excluded in PSSCH resource selection in sidelink transmission mode 2. The L1 SL-RSRP measurement period corresponds to one slot and the measurement shall meet the L1 SL-RSRP measurement accuracy requirement in Clause 10. After resource (re-)selection procedure, re-evaluation is performed on the reserved resources by L1 SL-RSRP measurements before transmission of SCI with reservation when the conditions specified in TS 38.214[26] are satisfied.

When the pre-emption mechanism is enabled for the resource pool that UE is monitoring and selecting resource from, after UE selects from the resource not excluded based on L1 SL-RSRP measurement procedure, the UE shall be capable of triggering reselection of already signalled resource(s) as a resource reservation when the conditions specified in TS38.214[26] are satisfied.

When partial sensing mechanism is enabled for the resource pool that UE is monitoring and selecting resource from, the UE shall be capable of performing the L1 SL-RSRP measurements on the sensing periods specified in TS38.214[26]. When SL-DRX is enabled, the UE shall be capable of performing the L1 SL-RSRP measurements and select resource during SL-DRX active time as specified in TS38.214[26].

## 12.6 Congestion Control measurements

The UE shall be capable of estimating the channel busy ratio for one or more transmission pools indicated by higher layers in TS 38.331[2], based on SL-RSSI measurements provided by the physical layer.

When no sidelink transmissions occur, the UE physical layer shall perform a single-shot SL-RSSI measurement for each sub-channel included in all the slots configured as transmission pools.

The SL-RSSI measurement performed according to this clause shall meet the SL-RSSI measurement accuracy requirements defined in Clause 10.

The UE shall perform channel busy ratio (CBR) measurement based on SL-RSSI measurements as described in TS 38.215 [4].

## 12.7 Interruption

### 12.7.1 Interruptions to WAN due to V2X Sidelink Communication

This clause contains the requirements related to the interruptions on the PCell/serving cell due to V2X sidelink communication.

A UE capable of V2X sidelink communication may indicate its interest (initiation or termination) in V2X sidelink communication to the connected gNodeB using IE *SidelinkUEInformationNR* in TS38.331[2].

The UE is allowed an interruption of up to the duration shown in table 12.7.1-1 on the PCell/serving cell during the RRC reconfiguration procedure that includes the V2X sidelink communication configuration message *SL-ConfigDedicatedNR* in TS 38.331[2] (setup and release). This interruption is for both uplink and downlink of the PCell/serving cell.

Table 12.7.1-1: Interruption length at V2X RRC reconfiguration

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

### 12.7.2 V2X Sidelink Communication Dropping due to synchronization source change

This clause contains the requirements related to the interruptions on the V2X sidelink communication due to synchronization source change.

For NR V2X UE not supporting gNB/eNB as synchronization reference source, UE is allowed to drop LTE and NR V2X SL transmission or reception for up to 1ms when synchronization source is changed, where the drop of  LTE V2X SL transmission or reception applies only to in-device coexistence scenario in TS38.213 [3]:

- From GNSS

- to syncRef UE that is synchronized to GNSS directly/in-directly

- to syncRef UE that has the lowest priority

- From syncRef UE that is synchronized to GNSS directly/in-directly

- to GNSS

- to syncRef UE that has the lowest priority

- From syncRef UE that has the lowest priority

- to GNSS

- to syncRef UE that is synchronized to GNSS directly/in-directly

- to syncRef UE that has the lowest priority

For NR V2X UE supporting gNB/eNB as synchronization reference source, UE is allowed to drop LTE and NR V2X SL transmission or reception for up to 1ms when synchronization source is changed, where the drop of  LTE V2X SL transmission or reception applies only to in-device coexistence scenario in TS38.213 [3]:

- From GNSS

- to syncRef UE that is synchronized to GNSS directly/in-directly

- to gNB/eNB

- to syncRef UE that is synchronized to gNB/eNB directly

- to syncRef UE that is synchronized to gNB/eNB in-directly

- to syncRef UE that has the lowest priority

- From syncRef UE that is synchronized to GNSS directly/in-directly

- to GNSS

- to gNB/eNB

- to syncRef UE that is synchronized to gNB/eNB directly

- to syncRef UE that is synchronized to gNB/eNB in-directly

- to syncRef UE that has the lowest priority

- From gNB or eNB

- to GNSS

- to syncRef UE that is synchronized to GNSS directly/in-directly

- to eNB or gNB

- to syncRef UE that is synchronized to gNB or eNB directly

- to syncRef UE that is synchronized to gNB or eNB in-directly

- to syncRef UE that has the lowest priority

- From syncRef UE that is synchronized to gNB/eNB directly

- to GNSS

- to syncRef UE that is synchronized to GNSS directly/in-directly

- to gNB/eNB

- to syncRef UE that is synchronized to gNB/eNB directly

- to syncRef UE that is synchronized to gNB/eNB in-directly

- to syncRef UE that has the lowest priority

- From syncRef UE that is synchronized to gNB/eNB in-directly

- to GNSS

- to syncRef UE that is synchronized to GNSS directly/in-directly

- to gNB/eNB

- to syncRef UE that is synchronized to gNB/eNB directly

- to syncRef UE that is synchronized to gNB/eNB in-directly

- to syncRef UE that has the lowest priority

- From syncRef UE that has the lowest priority

- to GNSS

- to syncRef UE that is synchronized to GNSS directly

- to syncRef UE that is synchronized to GNSS in-directly

- to gNB/eNB

- to syncRef UE that is synchronized to gNB/eNB directly

- to syncRef UE that is synchronized to gNB/eNB in-directly

- to syncRef UE that has the lowest priority

UE is allowed to interruption any V2X sidelink signals including PSSCH, PSCCH, PSBCH, PSFCH and SLSS signals.

### 12.7.3 Interruptions to WAN due to switching between E-UTRA V2X Sidelink and NR V2X Sidelink

This sub-clause contains the requirements related to the interruptions on the PCell/serving cell due to switching between E-UTRA V2X sidelink and NR V2X sidelink transmissions on a dedicated carrier. It is applicable for UE capable of both NR V2X sidelink and E-UTRA V2X sidelink transmissions in TDM-ed manner.

When a UE capable of switching between E-UTRA V2X sidelink and NR V2X sidelink, the UE is allowed an interruption of up to the duration shown in table 12.7.3-1 on the PCell/serving cell during the E-UTRA V2X sidelink and NR V2X sidelink switch.

This interruption is for both uplink and downlink of the PCell/serving cell.

Table 12.7.3-1: Interruption length due to switching between E-UTRA V2X and NR V2X

|  |  |  |
| --- | --- | --- |
|  | Slot length (ms) | Interruption length (number of slots) |
| 0 | 1 | 2 |
| 1 | 0.5 | 2 |
| 2 | 0.25 | 2 |
| 3 | 0.125 | 3 |

### 12.7.4 Interruptions to WAN at transitions between active and non-active during SL-DRX

Interruption on PCell/serving cell if configured due to V2X transitions between active and non-active during SL-DRX are allowed with up to 1% probability of missed ACK/NACK when the configured SL-DRX cycle is less than 640 ms, and 0.625% probability of missed ACK/NACK is allowed when the configured SL-DRX cycle is 640 ms or longer. When multiple SL-DRX cycles are configured, the shortest SL-DRX cycle is applied. Each interruption shall not exceed X slot as defined in table 12.7.4-1.

Table 12.7.4-1: Interruption length X at transition between active and non-active during SL-DRX

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

For SL-DRX active to inactive state transition, when the UE is in non-DRX or DRX on WAN and V2X is in sidelink resource allocation mode 2, the interruptions in this clause shall not apply when one of the following conditions is met:

- While receiving paging,

- While receiving system information.

In addition, for SL-DRX active to inactive state transition, when the UE is in non-DRX or DRX on WAN and V2X is in sidelink resource allocation mode 2 and SL DRX cycle is less than 320 ms, the interruptions in this clause shall not apply when one of the following conditions is met:

- T310 timer is running for RLF on PCell

- performing candidate beam detection on PCell/serving cell as specfied in section 8.5.5. and 8.5.6

### 12.7.5 Interruptions to V2X sidelink at transitions between active and non-active during DRX

Interruption on V2X sidelink if configured due to PCell transitions between active and non-active during DRX are allowed with up to 1% probability of missed ACK/NACK when the configured DRX cycle is less than 640 ms, and 0.625% probability of missed ACK/NACK is allowed when the configured DRX cycle is 640 ms or longer. It is only applied when HARQ process on V2X sidelink is supported. Each interruption shall not exceed X slot as defined in table 12.7.5-1.

Table 12.7.5-1: Interruption length X at transition between active and non-active during DRX

|  |  |  |  |
| --- | --- | --- | --- |
|  | NR V2X Slot | Interruption length X (slots) | |
|  | length (ms) | Sync | Async |
| 0 | 1 | 1 | 2 |
| 1 | 0.5 | 1 | 2 |
| 2 | 0.25 | 3 | |

### 12.7.6 Interruptions to V2X sidelink due to Active BWP switching Requirement

This clause contains the requirements related to the interruptions on the V2X sidelink due to BWP switch in FDM based intra-band concurrent V2X operation.

The requirements in clause 8.2.2.2.5 shall apply. The interrupted X slot is defined in Table 12.7.6-1.

Table 12.7.6-1: Interruption length X

|  |  |  |
| --- | --- | --- |
|  | NR V2X Slot | Interruption length X (slots) |
|  | length (ms) |  |
| 0 | 1 | 1 |
| 1 | 0.5 | 1 |
| 2 | 0.25 | 3 |

Note: No sidelink communication happens during BWP switching delay period for TDM based intra-band concurrent operation.

### 12.7.7 Interruptions to WAN due to SyncRef UE detection and/or Sensing during SL DRX off duration

This sub-clause contains the requirements related to the interruptions on the PCell/serving cell due to SyncRef UE detection and/or Sensing during SL DRX off duration.

The requirements in clause 12.7.4 shall apply.

### 12.7.8 Interruptions at NR sidelink discovery configuration

This clause contains the requirements related to the interruptions on the PCell/serving cell due to NR sidelink discovery.

A UE capable of NR sidelink discovery may indicate its interest (initiation or termination) in NR sidelink discovery to the connected gNodeB using IE *SidelinkUEInformationNR* in TS38.331[2].

The UE is allowed an interruption of up to the duration shown in Table 12.7.8-1 on the PCell/serving cell during the RRC reconfiguration procedure that includes the NR sidelink discovery configuration message *sl-DiscConfig* in TS 38.331[2] (setup and release). This interruption is for both uplink and downlink of the PCell/serving cell.

12.7.8-1: Interruption length at NR sidelink discovery configuration

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

## 12.8 Reliability of GNSS signal

This clause contains requirements regarding reliability of GNSS signal for the UE capable of V2X sidelink communication under the following additional condition:

- The UE is configured or pre-configured with parameters for enabling the UE to acquire the GNSS synchronization.

If UE considers GNSS is a reliable synchronization reference, the UE shall meet timing accuracy requirement as specified in 12.2 and frequency accuracy requirement as specified in 6.4E of TS38.101-1[18]. Otherwise, the UE shall be capable to select another synchronization reference source.

## 12.9 Scheduling availability

### 12.9.1 Scheduling availability of UE switching between E-UTRA sidelink and NR sidelink

This clause contains the restrictions on the scheduling availability for V2X sidelink due to switching between E-UTRA V2X sidelink and NR V2X sidelink transmission on a dedicated carrier. For the NR V2X sidelink, the assumed number of configured symbols in a slot is 14.

When switch from E-UTRA V2X sidelink to NR V2X sidelink occurs in NR slot ‘n’,

* UE is not expected to transmit or receive on NR V2X sidelink on the slot ‘n’.

When switch from NR V2X sidelink to E-UTRA V2X sidelink occurs in NR slot ‘n-1’,

* UE is not expected to transmit or receive on NR V2X sidelink on the slot ‘n-1’.

When switch from NR V2X sidelink to E-UTRA V2X sidelink occurs in E-UTRA subframe ‘n’,

* UE is not expected to transmit or receive on E-UTRA V2X sidelink on the subframe ‘n’.

When switch from E-UTRA V2X sidelink to NR V2X sidelink occurs in E-UTRA subframe ‘n-1’,

* UE is not expected to transmit or receive E-UTRA on V2X sidelink on the subframe ‘n-1’.

### 12.9.2 Scheduling availability of UE switching between Uu uplink and V2X sidelink

This clause contains the restrictions on the scheduling availability for V2X sidelink due to switching between Uu uplink and V2X sidelink. For NR V2X sidelink, the assumed number of configured symbols in a slot is 14.

When switch from Uu uplink slot to V2X sidelink slot occurs in sidelink slot ‘n’,

- UE is not expected to transmit or receive on V2X sidelink on the sidelink slot ‘n’.

When switch from V2X sidelink slot to Uu uplink slot occurs in sidelink slot ‘n-1’,

- UE is not expected to transmit or receive on V2X sidelink on the sidelink slot ‘n-1’.

When switch from V2X sidelink slot to Uu uplink slot occurs in Uu slot ‘n’,

- UE is not expected to transmit uplink or receive downlink on the Uu slot ‘n’.

When switch from Uu uplink slot to V2X sidelink slot occurs in Uu slot ‘n-1’,

- UE is not expected to transmit uplink or receive downlink on the Uu slot ‘n-1’.

- UE is not expected to transmit uplink or receive downlink on the Uu slot ‘n-1’.

## 12.10 Selection / Reselection of relay UE

### 12.10.1 Introduction

This section contains the requirements related to selection and reselection of relay UE.

The requirements apply for the selection and reselection of candidate relay UEs that are transmitting relay discovery signals within the resource pool as configured for the remote UE.

### 12.10.2 Selection / Reselection of relay UE

For a remote UE configured by upper layer for relay operation, the remote UE shall search for candidate relay UEs for selection and/or reselection every discovery period which is determined by resource reservation period or SPS transmission periodicity configured by network.

If the remote UE has a selected sidelink relay UE, then the remote UE shall measure the SD-RSRP or SL-RSRP of the selected relay once in every four discovery periods and evaluate if it meets the relay selection criterion as defined in TS 38.331[2] (clause 5.8.15.3).

The remote UE shall measure SD-RSRP or SL-RSRP of the candidate relay UEs every Tmeasure, SL\_Relay\_Intra for relay UEs that are detected and measured according to the measurement rules.

For intra-frequency relay UEs that are detected, but that has not been selected or reselected to, the remote UE shall be capable of evaluating that the intra-frequency relay UE has met selection or reselection criterion defined in TS 38.331[2] (clause 5.8.15.3) within Tevaluate, SL\_Relay\_Intra as specified in table 12.10.2-1.

The minimum requirements are required to meet when the selected and candidate relay UEs are transmitting relay discovery message every discovery period.

Table 12.10.2-1: Tmeasure, SL\_Relay\_Intra and Tevaluate, SL\_Relay\_Intra

|  |  |  |
| --- | --- | --- |
| Discovery Period [s] | Tmeasure,SL\_Relay\_Intra [s] (number of discovery periods) | Tevaluate, SL\_Relay\_Intra [s] (number of discovery periods) |
| 0.04≤Discovery period≤10.24 | Note 1 (4) | Note 1 (16) |
| Note 1: Time depends upon the discovery period which is resource reservation period (in mode 2) or SPS transmission periodicity (in mode 1).  Note 2: SL-RSRP or SD-RSRP can be derived from PSCCH-DMRS and/or PSSCH-DMRS. | | |

# 13 Measurement Performance Requirements for NR gNB

## 13.1 UL-RTOA

### 13.1.1 Report mapping

The reporting range of UL Relative Time of Arrival (UL-RTOA), as defined in Clause 5.2.2 of TS 38.215 [4], is defined from -985024Tc to +985024×Tc. The reporting resolution is uniform across the reporting range and is defined as T = Tc\*2k where k is selected by gNB from the set {0, 1, 2, 3, 4, 5}.

Tc is defined in TS 38.211 [6].

LMF provides a recommended resolution parameter, *timingReportingGranularityFactor* [35]. gNB selects parameter k based on *timingReportingGranularityFactor* [35] and informs the LMF.

The mapping of measured quantity for each reporting resolution (k) is defined in Table 13.1.1-1 to Table 13.1.1-6.

Table 13.1.1-1: UL-RTOA measurement report mapping for reporting resolution of Tc (k=0)

|  |  |  |
| --- | --- | --- |
| Reported Value | Measured Quantity Value | Unit |
| UL\_RTOA\_0000 | -985024 > UL\_RTOA | Tc |
| UL\_RTOA\_0001 | -985024 ≤ UL\_RTOA < -985023 | Tc |
| UL\_RTOA\_0002 | -985023 ≤ UL\_RTOA < -985022 | Tc |
| … | … | … |
| UL\_RTOA\_985023 | -2 ≤ UL\_RTOA < -1 | Tc |
| UL\_RTOA\_985024 | -1 ≤ UL\_RTOA ≤ 0 | Tc |
| UL\_RTOA\_985025 | 0 < UL\_RTOA ≤ 1 | Tc |
| UL\_RTOA\_985026 | 1 < UL\_RTOA ≤ 2 | Tc |
| UL\_RTOA\_985027 | 2 < UL\_RTOA ≤ 3 | Tc |
| … | … | … |
| UL\_RTOA\_1970048 | 985023 < UL\_RTOA ≤ 985024 | Tc |
| UL\_RTOA\_1970049 | 985024 < UL\_RTOA | Tc |

Table 13.1.1-2: UL-RTOA measurement report mapping for reporting resolution of 2Tc (k=1)

|  |  |  |
| --- | --- | --- |
| Reported Value | Measured Quantity Value | Unit |
| UL\_RTOA\_0000 | -985024 > UL\_RTOA | Tc |
| UL\_RTOA\_0001 | -985024 ≤ UL\_RTOA < -985022 | Tc |
| UL\_RTOA\_0002 | -985022 ≤ UL\_RTOA < -985020 | Tc |
| … | … | … |
| UL\_RTOA\_492511 | -4 ≤ UL\_RTOA < -2 | Tc |
| UL\_RTOA\_492512 | -2 ≤ UL\_RTOA ≤ 0 | Tc |
| UL\_RTOA\_492513 | 0 < UL\_RTOA ≤ 2 | Tc |
| UL\_RTOA\_492514 | 2 < UL\_RTOA ≤ 4 | Tc |
| UL\_RTOA\_492515 | 4 < UL\_RTOA ≤ 6 | Tc |
| … | … | … |
| UL\_RTOA\_985024 | 985022 < UL\_RTOA ≤ 985024 | Tc |
| UL\_RTOA\_985025 | 985024 < UL\_RTOA | Tc |

Table 13.1.1-3: UL-RTOA measurement report mapping for reporting resolution of 4Tc (k=2)

|  |  |  |
| --- | --- | --- |
| Reported Value | Measured Quantity Value | Unit |
| UL\_RTOA\_0000 | -985024 > UL\_RTOA | Tc |
| UL\_RTOA\_0001 | -985024 ≤ UL\_RTOA < -985020 | Tc |
| UL\_RTOA\_0002 | -985020 ≤ UL\_RTOA < -985018 | Tc |
| … | … | … |
| UL\_RTOA\_246255 | -8 ≤ UL\_RTOA < -4 | Tc |
| UL\_RTOA\_246256 | -4 ≤ UL\_RTOA ≤ 0 | Tc |
| UL\_RTOA\_246257 | 0 < UL\_RTOA ≤ 4 | Tc |
| UL\_RTOA\_246258 | 4 < UL\_RTOA ≤ 8 | Tc |
| UL\_RTOA\_246259 | 8 < UL\_RTOA ≤ 12 | Tc |
| … | … | … |
| UL\_RTOA\_492512 | 985020 < UL\_RTOA ≤ 985024 | Tc |
| UL\_RTOA\_492513 | 985024 < UL\_RTOA | Tc |

Table 13.1.1-4: UL-RTOA measurement report mapping for reporting resolution of 8Tc (k=3)

|  |  |  |
| --- | --- | --- |
| Reported Value | Measured Quantity Value | Unit |
| UL\_RTOA\_0000 | -985024 > UL\_RTOA | Tc |
| UL\_RTOA\_0001 | -985024 ≤ UL\_RTOA < -985016 | Tc |
| UL\_RTOA\_0002 | -985016 ≤ UL\_RTOA < -985008 | Tc |
| … | … | … |
| UL\_RTOA\_123127 | -16 ≤ UL\_RTOA < -8 | Tc |
| UL\_RTOA\_123128 | -8 ≤ UL\_RTOA ≤ 0 | Tc |
| UL\_RTOA\_123129 | 0 < UL\_RTOA ≤ 8 | Tc |
| UL\_RTOA\_123130 | 8 < UL\_RTOA ≤ 16 | Tc |
| UL\_RTOA\_123131 | 16 < UL\_RTOA ≤ 24 | Tc |
| … | … | … |
| UL\_RTOA\_246256 | 985016 < UL\_RTOA ≤ 985024 | Tc |
| UL\_RTOA\_246257 | 985024 < UL\_RTOA | Tc |

Table 13.1.1-5: UL-RTOA measurement report mapping for reporting resolution of 16Tc (k=4)

|  |  |  |
| --- | --- | --- |
| Reported Value | Measured Quantity Value | Unit |
| UL\_RTOA\_0000 | -985024 > UL\_RTOA | Tc |
| UL\_RTOA\_0001 | -985024 ≤ UL\_RTOA < -985008 | Tc |
| UL\_RTOA\_0002 | -985008 ≤ UL\_RTOA < -984992 | Tc |
| … | … | … |
| UL\_RTOA\_61563 | -32 ≤ UL\_RTOA < -16 | Tc |
| UL\_RTOA\_61564 | -16 ≤ UL\_RTOA ≤ 0 | Tc |
| UL\_RTOA\_61565 | 0 < UL\_RTOA ≤ 16 | Tc |
| UL\_RTOA\_61566 | 16 < UL\_RTOA ≤ 32 | Tc |
| UL\_RTOA\_61567 | 32 < UL\_RTOA ≤ 48 | Tc |
| … | … | … |
| UL\_RTOA\_123128 | 985008 < UL\_RTOA ≤ 985024 | Tc |
| UL\_RTOA\_123129 | 985024 < UL\_RTOA | Tc |

Table 13.1.1-6: UL-RTOA measurement report mapping for reporting resolution of 32Tc (k=5)

|  |  |  |
| --- | --- | --- |
| Reported Value | Measured Quantity Value | Unit |
| UL\_RTOA\_0000 | -985024 > UL\_RTOA | Tc |
| UL\_RTOA\_0001 | -985024 ≤ UL\_RTOA < -984992 | Tc |
| UL\_RTOA\_0002 | -984992 ≤ UL\_RTOA < -984960 | Tc |
| … | … | … |
| UL\_RTOA\_30781 | -64 ≤ UL\_RTOA < -32 | Tc |
| UL\_RTOA\_30782 | -32 ≤ UL\_RTOA ≤ 0 | Tc |
| UL\_RTOA\_30783 | 0 < UL\_RTOA ≤ 32 | Tc |
| UL\_RTOA\_30784 | 32 < UL\_RTOA ≤ 64 | Tc |
| UL\_RTOA\_30785 | 64 < UL\_RTOA ≤ 96 | Tc |
| … | … | … |
| UL\_RTOA\_61564 | 984992 < UL\_RTOA ≤ 985024 | Tc |
| UL\_RTOA\_61565 | 985024 < UL\_RTOA | Tc |

### 13.1.1A Additional Path Report Mapping for UL-RTOA

The reporting range of additional path reporting for UL Relative Time of Arrival (UL-RTOA), as defined in Clause 5.2.2 of TS 38.215 [4], is defined from -8175×Tc to +8175×Tc. The reporting resolution is uniform across the reporting range and is defined as T = Tc\*2k where k is selected by gNB from the set {0, 1, 2, 3, 4, 5}.

Tc is defined in TS 38.211 [6].

LMF provides a recommended resolution parameter, *timingReportingGranularityFactor* [35]. gNB selects parameter k based on *timingReportingGranularityFactor* [35] and informs the LMF.

The mapping of measured quantity for each reporting resolution (k) is defined in Table 13.1.1A-1 to Table 13.1.1A-6.

Table 13.1.1A-1: UL-RTOA measurement report mapping for resolution of Tc (k=0)

|  |  |  |
| --- | --- | --- |
| Reported Quantity Value,  path\_i | Measured Quantity Value,  Δpath | Unit |
|
| path\_00000 | Δpath < -8175 | Tc |
| path\_00001 | -8175 ≤ Δpath < -8174 | Tc |
| path\_00002 | -8174 ≤ Δpath < -8173 | Tc |
| … | … | … |
| path\_08175 | -1 ≤ Δpath < 0 | Tc |
| path\_08176 | 0 ≤ Δpath < 1 | Tc |
| … | … | … |
| path\_ 16349 | 8173 ≤ Δpath < 8174 | Tc |
| path\_ 16350 | 8174 ≤ Δpath < 8175 | Tc |
| path\_ 16351 | 8175 ≤ Δpath | Tc |

Table 13.1.1A-2: UL-RTOA measurement report mapping for resolution of 2Tc (k=1)

|  |  |  |
| --- | --- | --- |
| Reported Quantity Value,  path\_i | Measured Quantity Value,  Δpath | Unit |
| path\_0000 | Δpath < -8175 | Tc |
| path\_0001 | -8175 ≤ Δpath < -8173 | Tc |
| path\_0002 | -8173 ≤ Δpath < -8171 | Tc |
| … | … | … |
| path\_4088 | -1 ≤ Δpath < 1 | Tc |
| … | … | … |
| path\_8174 | 8171 ≤ Δpath < 8173 | Tc |
| path\_8175 | 8173 ≤ Δpath < 8175 | Tc |
| path\_8176 | 8175 ≤ Δpath | Tc |

Table 13.1.1A-3: UL-RTOA measurement report mapping for resolution of 4Tc (k=2)

|  |  |  |
| --- | --- | --- |
| Reported Quantity Value,  path\_i | Measured Quantity Value,  Δpath | Unit |
| path\_0000 | Δpath < -8174 | Tc |
| path\_0001 | -8174 ≤ Δpath < -8170 | Tc |
| path\_0002 | -8170 ≤ Δpath < -8166 | Tc |
| … | … | … |
| path\_2044 | -2 ≤ Δpath < 2 | Tc |
| … | … | … |
| path\_4086 | 8166 ≤ Δpath < 8170 | Tc |
| path\_4087 | 8170 ≤ Δpath < 8174 | Tc |
| path\_4088 | 8174 ≤ Δpath | Tc |

Table 13.1.1A-4: UL-RTOA measurement report mapping for resolution of 8Tc (k=3)

|  |  |  |
| --- | --- | --- |
| Reported Quantity Value,  path\_i | Measured Quantity Value,  Δpath | Unit |
| path\_0000 | Δpath < -8172 | Tc |
| path\_0001 | -8172 ≤ Δpath < -8164 | Tc |
| path\_0002 | -8164 ≤ Δpath < -8156 | Tc |
| … | … | … |
| path\_1022 | -4 ≤ Δpath < 4 | Tc |
| … | … | … |
| path\_2042 | 8156 ≤ Δpath < 8164 | Tc |
| path\_2043 | 8164 ≤ Δpath < 8172 | Tc |
| path\_2044 | 8172 ≤ Δpath | Tc |

Table 13.1.1A-5: UL-RTOA measurement report mapping for resolution of 16Tc (k=4)

|  |  |  |
| --- | --- | --- |
| Reported Quantity Value,  path\_i | Measured Quantity Value,  Δpath | Unit |
| path\_0000 | Δpath < -8168 | Tc |
| path\_0001 | -8168 ≤ Δpath < -8152 | Tc |
| path\_0002 | -8152 ≤ Δpath < -8136 | Tc |
| … | … | … |
| path\_511 | -8 ≤ Δpath < 8 | Tc |
| … | … | … |
| path\_1020 | 8136 ≤ Δpath < 8152 | Tc |
| path\_1021 | 8152 ≤ Δpath < 8168 | Tc |
| path\_1022 | 8168 ≤ Δpath | Tc |

Table 13.1.1A-6: UL-RTOA measurement report mapping for resolution of 32Tc (k=5)

|  |  |  |
| --- | --- | --- |
| Reported Quantity Value,  path\_i | Measured Quantity Value,  Δpath | Unit |
| path\_000 | Δpath < -8160 | Tc |
| path\_001 | -8160 ≤ Δpath < -8128 | Tc |
| path\_002 | -8128 ≤ Δpath < -8096 | Tc |
| … | … | … |
| path\_256 | 0 ≤ Δpath < 32 | Tc |
| … | … | … |
| path\_509 | 8096 ≤ Δpath < 8128 | Tc |
| path\_510 | 8128 ≤ Δpath < 8160 | Tc |
| path\_511 | 8160 ≤ Δpath | Tc |

## 13.2 gNB Rx-Tx time difference

### 13.2.1 Report mapping

The reporting range of gNB Rx-Tx time difference, as defined in Clause 5.2.3 of TS 38.215 [4], is defined from -985024Tc to +985024×Tc. The reporting resolution is uniform across the reporting range and is defined as T = Tc\*2k where k is selected by gNB from the set {0, 1, 2, 3, 4, 5}.

Tc is defined in TS 38.211 [6].

LMF provides a recommended resolution parameter, *timingReportingGranularityFactor* [35]. gNB selects parameter k based on *timingReportingGranularityFactor* [35] and informs the LMF.

The mapping of measured quantity for each reporting resolution (k) is defined in Table 13.2.1-1 to Table 13.2.1-6.

Table 13.2.1-1: gNB Rx-Tx time difference measurement report mapping for reporting resolution of Tc (k=0)

|  |  |  |
| --- | --- | --- |
| Reported Value | Measured Quantity Value | Unit |
| RX-TX\_0000 | -985024 > RX-TX | Tc |
| RX-TX\_0001 | -985024 ≤ RX-TX < -985023 | Tc |
| RX-TX\_0002 | -985023 ≤ RX-TX < -985022 | Tc |
| … | … | … |
| RX-TX\_985023 | -2 ≤ RX-TX < -1 | Tc |
| RX-TX\_985024 | -1 ≤ RX-TX ≤ 0 | Tc |
| RX-TX\_985025 | 0 < RX-TX ≤ 1 | Tc |
| RX-TX\_985026 | 1 < RX-TX ≤ 2 | Tc |
| RX-TX\_985027 | 2 < RX-TX ≤ 3 | Tc |
| … | … | … |
| RX-TX\_1970048 | 985023 < RX-TX ≤ 985024 | Tc |
| RX-TX\_1970049 | 985024 < RX-TX | Tc |

Table 13.2.1-2: gNB Rx-Tx time difference measurement report mapping for reporting resolution of 2Tc (k=1)

|  |  |  |
| --- | --- | --- |
| Reported Value | Measured Quantity Value | Unit |
| RX-TX\_0000 | -985024 > RX-TX | Tc |
| RX-TX\_0001 | -985024 ≤ RX-TX < -985022 | Tc |
| RX-TX\_0002 | -985022 ≤ RX-TX < -985020 | Tc |
| … | … | … |
| RX-TX\_492511 | -4 ≤ RX-TX < -2 | Tc |
| RX-TX\_492512 | -2 ≤ RX-TX ≤ 0 | Tc |
| RX-TX\_492513 | 0 < RX-TX ≤ 2 | Tc |
| RX-TX\_492514 | 2 < RX-TX ≤ 4 | Tc |
| RX-TX\_492515 | 4 < RX-TX ≤ 6 | Tc |
| … | … | … |
| RX-TX\_985024 | 985022 < RX-TX ≤ 985024 | Tc |
| RX-TX\_985025 | 985024 < RX-TX | Tc |

Table 13.2.1-3: gNB Rx-Tx time difference measurement report mapping for reporting resolution of 4Tc (k=2)

|  |  |  |
| --- | --- | --- |
| Reported Value | Measured Quantity Value | Unit |
| RX-TX\_0000 | -985024 > RX-TX | Tc |
| RX-TX\_0001 | -985024 ≤ RX-TX < -985020 | Tc |
| RX-TX\_0002 | -985020 ≤ RX-TX < -985018 | Tc |
| … | … | … |
| RX-TX\_246255 | -8 ≤ RX-TX < -4 | Tc |
| RX-TX\_246256 | -4 ≤ RX-TX ≤ 0 | Tc |
| RX-TX\_246257 | 0 < RX-TX ≤ 4 | Tc |
| RX-TX\_246258 | 4 < RX-TX ≤ 8 | Tc |
| RX-TX\_246259 | 8 < RX-TX ≤ 12 | Tc |
| … | … | … |
| RX-TX\_492512 | 985020 < RX-TX ≤ 985024 | Tc |
| RX-TX\_492513 | 985024 < RX-TX | Tc |

Table 13.2.1-4: gNB Rx-Tx time difference measurement report mapping for reporting resolution of 8Tc (k=3)

|  |  |  |
| --- | --- | --- |
| Reported Value | Measured Quantity Value | Unit |
| RX-TX\_0000 | -985024 > RX-TX | Tc |
| RX-TX\_0001 | -985024 ≤ RX-TX < -985016 | Tc |
| RX-TX\_0002 | -985016 ≤ RX-TX < -985008 | Tc |
| … | … | … |
| RX-TX\_123127 | -16 ≤ RX-TX < -8 | Tc |
| RX-TX\_123128 | -8 ≤ RX-TX ≤ 0 | Tc |
| RX-TX\_123129 | 0 < RX-TX ≤ 8 | Tc |
| RX-TX\_123130 | 8 < RX-TX ≤ 16 | Tc |
| RX-TX\_123131 | 16 < RX-TX ≤ 24 | Tc |
| … | … | … |
| RX-TX\_246256 | 985016 < RX-TX ≤ 985024 | Tc |
| RX-TX\_246257 | 985024 < RX-TX | Tc |

Table 13.2.1-5: gNB Rx-Tx time difference measurement report mapping for reporting resolution of 16Tc (k=4)

|  |  |  |
| --- | --- | --- |
| Reported Value | Measured Quantity Value | Unit |
| RX-TX\_0000 | -985024 > RX-TX | Tc |
| RX-TX\_0001 | -985024 ≤ RX-TX < -985008 | Tc |
| RX-TX\_0002 | -985008 ≤ RX-TX < -984992 | Tc |
| … | … | … |
| RX-TX\_61563 | -32 ≤ RX-TX < -16 | Tc |
| RX-TX\_61564 | -16 ≤ RX-TX ≤ 0 | Tc |
| RX-TX\_61565 | 0 < RX-TX ≤ 16 | Tc |
| RX-TX\_61566 | 16 < RX-TX ≤ 32 | Tc |
| RX-TX\_61567 | 32 < RX-TX ≤ 48 | Tc |
| … | … | … |
| RX-TX\_123128 | 985008 < RX-TX ≤ 985024 | Tc |
| RX-TX\_123129 | 985024 < RX-TX | Tc |

Table 13.2.1-6: gNB Rx-Tx time difference measurement report mapping for reporting resolution of 32Tc (k=5)

|  |  |  |
| --- | --- | --- |
| Reported Value | Measured Quantity Value | Unit |
| RX-TX\_0000 | -985024 > RX-TX | Tc |
| RX-TX\_0001 | -985024 ≤ RX-TX < -984992 | Tc |
| RX-TX\_0002 | -984992 ≤ RX-TX < -984960 | Tc |
| … | … | … |
| RX-TX\_30781 | -64 ≤ RX-TX < -32 | Tc |
| RX-TX\_30782 | -32 ≤ RX-TX ≤ 0 | Tc |
| RX-TX\_30783 | 0 < RX-TX ≤ 32 | Tc |
| RX-TX\_30784 | 32 < RX-TX ≤ 64 | Tc |
| RX-TX\_30785 | 64 < RX-TX ≤ 96 | Tc |
| … | … | … |
| RX-TX\_61564 | 984992 < RX-TX ≤ 985024 | Tc |
| RX-TX\_61565 | 985024 < RX-TX | Tc |

### 13.2.1A Additional Path Report Mapping for gNB Rx-Tx

The reporting range of additional path for gNB Rx-Tx time difference, as defined in Clause 5.2.3 of TS 38.215 [4], is defined from -8175×Tc to 8175×Tc. The reporting resolution is uniform across the reporting range and is defined as T = Tc\*2k where k is selected by gNB from the set {0, 1, 2, 3, 4, 5}.

Tc is defined in TS 38.211 [6].

LMF provides a recommended resolution parameter, *timingReportingGranularityFactor* [35]. gNB selects parameter k based on *timingReportingGranularityFactor* [35] and informs the LMF.

The mapping of measured quantity for each reporting resolution (k) is defined in Table 13.2.1A-1 to Table 13.2.1A-6.

Table 13.2.1A-1: gNB Rx-Tx time difference measurement report mapping for reporting resolution of Tc (k=0)

|  |  |  |
| --- | --- | --- |
| Reported Quantity Value,  path\_i | Measured Quantity Value,  Δpath | Unit |
|
| path\_00000 | Δpath < -8175 | Tc |
| path\_00001 | -8175 ≤ Δpath < -8174 | Tc |
| path\_00002 | -8174 ≤ Δpath < -8173 | Tc |
| … | … | … |
| path\_08175 | -1 ≤ Δpath < 0 | Tc |
| path\_08176 | 0 ≤ Δpath < 1 | Tc |
| … | … | … |
| path\_ 16349 | 8173 ≤ Δpath < 8174 | Tc |
| path\_ 16350 | 8174 ≤ Δpath < 8175 | Tc |
| path\_ 16351 | 8175 ≤ Δpath | Tc |

Table 13.2.1A-2: gNB Rx-Tx time difference measurement report mapping for reporting resolution of 2Tc (k=1)

|  |  |  |
| --- | --- | --- |
| Reported Quantity Value,  path\_i | Measured Quantity Value,  Δpath | Unit |
| path\_0000 | Δpath < -8175 | Tc |
| path\_0001 | -8175 ≤ Δpath < -8173 | Tc |
| path\_0002 | -8173 ≤ Δpath < -8171 | Tc |
| … | … | … |
| path\_4088 | -1 ≤ Δpath < 1 | Tc |
| … | … | … |
| path\_8174 | 8171 ≤ Δpath < 8173 | Tc |
| path\_8175 | 8173 ≤ Δpath < 8175 | Tc |
| path\_8176 | 8175 ≤ Δpath | Tc |

Table 13.2.1A-3: gNB Rx-Tx time difference measurement report mapping for reporting resolution of 4Tc (k=2)

|  |  |  |
| --- | --- | --- |
| Reported Quantity Value,  path\_i | Measured Quantity Value,  Δpath | Unit |
| path\_0000 | Δpath < -8174 | Tc |
| path\_0001 | -8174 ≤ Δpath < -8170 | Tc |
| path\_0002 | -8170 ≤ Δpath < -8166 | Tc |
| … | … | … |
| path\_2044 | -2 ≤ Δpath < 2 | Tc |
| … | … | … |
| path\_4086 | 8166 ≤ Δpath < 8170 | Tc |
| path\_4087 | 8170 ≤ Δpath < 8174 | Tc |
| path\_4088 | 8174 ≤ Δpath | Tc |

Table 13.2.1A-4: gNB Rx-Tx time difference measurement report mapping for reporting resolution of 8Tc (k=3)

|  |  |  |
| --- | --- | --- |
| Reported Quantity Value,  path\_i | Measured Quantity Value,  Δpath | Unit |
| path\_0000 | Δpath < -8172 | Tc |
| path\_0001 | -8172 ≤ Δpath < -8164 | Tc |
| path\_0002 | -8164 ≤ Δpath < -8156 | Tc |
| … | … | … |
| path\_1022 | -4 ≤ Δpath < 4 | Tc |
| … | … | … |
| path\_2042 | 8156 ≤ Δpath < 8164 | Tc |
| path\_2043 | 8164 ≤ Δpath < 8172 | Tc |
| path\_2044 | 8172 ≤ Δpath | Tc |

Table 13.2.1A-5: gNB Rx-Tx time difference measurement report mapping for reporting resolution of 16Tc (k=4)

|  |  |  |
| --- | --- | --- |
| Reported Quantity Value,  path\_i | Measured Quantity Value,  Δpath | Unit |
| path\_0000 | Δpath < -8168 | Tc |
| path\_0001 | -8168 ≤ Δpath < -8152 | Tc |
| path\_0002 | -8152 ≤ Δpath < -8136 | Tc |
| … | … | … |
| path\_511 | -8 ≤ Δpath < 8 | Tc |
| … | … | … |
| path\_1020 | 8136 ≤ Δpath < 8152 | Tc |
| path\_1021 | 8152 ≤ Δpath < 8168 | Tc |
| path\_1022 | 8168 ≤ Δpath | Tc |

Table 13.2.1A-6: gNB Rx-Tx time difference measurement report mapping for reporting resolution of 32Tc (k=5)

|  |  |  |
| --- | --- | --- |
| Reported Quantity Value,  path\_i | Measured Quantity Value,  Δpath | Unit |
| path\_000 | Δpath < -8160 | Tc |
| path\_001 | -8160 ≤ Δpath < -8128 | Tc |
| path\_002 | -8128 ≤ Δpath < -8096 | Tc |
| … | … | … |
| path\_256 | 0 ≤ Δpath < 32 | Tc |
| … | … | … |
| path\_509 | 8096 ≤ Δpath < 8128 | Tc |
| path\_510 | 8128 ≤ Δpath < 8160 | Tc |
| path\_511 | 8160 ≤ Δpath | Tc |

### 13.2.2 Measurement Accuracy Requirements

#### 13.2.2.1 Introduction

This clause defines accuracy requirements for gNB Rx-Tx time difference measurement in FR1 and FR2. The requirements are applicable for gNB supporting gNB Rx-Tx time difference measurement. The gNB, which declares the support for gNB Rx-Tx time difference measurement also declares that it meets gNB Rx-Tx time difference accuracy requirements at least for one side condition Ês/Iot ≥ +3 dB or Ês/Iot ≥ -13 dB.

13.2.2.2 Requirements

The accuracy requirements for gNB Rx-Tx time difference measurement shall be within ±(X+Y) Tc under the following conditions:

- AWGN propagation conditions.

- The measured signals are in the directions covered by RoAoA of OTA reference sensitivity requirements for gNB type 1-O and 2-O BS

where

- X is defined in Table 13.2.2.2-1 for gNB types 1-C, 1-H and 1-O and in Table 13.2.2.2-2 for gNB type 2-O.

- Y is declared by manufacturer and can be different for different gNB types 1-C, 1-H, 1-O and 2-O.

Note: The measurement accuracy requirements in Table 13.2.2.2-1 and Table 13.2.2.2-2 are defined under an assumption that gNB is not mandated to perform receive beam sweeping.

Table 13.2.2.2-1: gNB Rx-Tx time difference absolute accuracy in FR1 for gNB type 1-C, 1-H and 1-O

|  |  |  |  |
| --- | --- | --- | --- |
| Accuracy | SRS Ês/Iot | SCS | SRS bandwidth range |
| Unit: Tc | Unit: dB | Unit: kHz | Unit: RB |
| 123 | ≥ -13 | 15 | 44 ≤ BW ≤ 84 |
| 48 | 88 ≤ BW ≤ 168 |
| 17 | 176 ≤ BW |
| 122 | ≥ +3 | 24 ≤ BW ≤ 40 |
| 62 | 44 ≤ BW ≤ 84 |
| 32 | 88 ≤ BW ≤ 168 |
| 16 | 176 ≤ BW |
| 42 | ≥ -13 | 30 | 48 ≤ BW ≤ 84 |
| 24 | 88 ≤ BW ≤ 168 |
| 8 | 176 ≤ BW |
| 32 | ≥ +3 | 48 ≤ BW ≤ 84 |
| 17 | 88 ≤ BW ≤ 168 |
| 9 | 176 ≤ BW |
| 21 | ≥ -13 | 60 | 48 ≤ BW ≤ 84 |
| 12 | 88 ≤ BW |
| 16 | ≥ +3 | 48 ≤ BW ≤ 84 |
| 9 | 88 ≤ BW |

Table 13.2.2.2-2: gNB Rx-Tx time difference absolute accuracy in FR2 for gNB type 2-O

|  |  |  |  |
| --- | --- | --- | --- |
| Accuracy | SRS Ês/Iot | SCS | SRS bandwidth range |
| Unit: Tc | Unit: dB | Unit: kHz | Unit: RB |
| 9 | ≥ -13 | 60 | 132 ≤ BW ≤ 168 |
| 8 | 176 ≤ BW |
| 9 | ≥ +3 | 132 ≤ BW ≤ 168 |
| 8 | 176 ≤ BW |
| 22 | ≥ -13 | 120 | 32 ≤ BW ≤ 40 |
| 15 | 44 ≤ BW ≤ 84 |
| 8 | 88 ≤ BW |
| 16 | ≥ +3 | 32 ≤ BW ≤ 40 |
| 9 | 44 ≤ BW ≤ 84 |
| 8 | 88 ≤ BW |

## 13.3 UL SRS RSRP measurement

### 13.3.1 Report mapping

The reporting range of UL SRS RSRP, as defined in clause 5.2.5 of 38.215 [4], is defined from -156dBm to -31dBm with resolution 1dB.

The mapping of measured quantity is defined in Table 13.3.1-1. The range in the signalling may be larger than the guaranteed accuracy range.

Table 13.3.1-1: UL SRS RSRP report mapping

|  |  |  |
| --- | --- | --- |
| Reported value | Measured quantity value | Unit |
| SRS\_RSRP\_0 | SRS-RSRP<-156 | dBm |
| SRS\_RSRP\_1 | -156≤SRS-RSRP<-155 | dBm |
| SRS\_RSRP\_2 | -155≤SRS-RSRP<-154 | dBm |
| SRS\_RSRP\_3 | -154≤SRS-RSRP<-153 | dBm |
| SRS\_RSRP\_4 | -153≤SRS-RSRP<-152 | dBm |
| SRS\_RSRP\_5 | -152≤SRS-RSRP<-151 | dBm |
| SRS\_RSRP\_6 | -151≤SRS-RSRP<-150 | dBm |
| SRS\_RSRP\_7 | -150≤SRS-RSRP<-149 | dBm |
| SRS\_RSRP\_8 | -149≤SRS-RSRP<-148 | dBm |
| SRS\_RSRP\_9 | -148≤SRS-RSRP<-147 | dBm |
| SRS\_RSRP\_10 | -147≤SRS-RSRP<-146 | dBm |
| SRS\_RSRP\_11 | -146≤SRS-RSRP<-145 | dBm |
| SRS\_RSRP\_12 | -145≤SRS-RSRP<-144 | dBm |
| SRS\_RSRP\_13 | -144≤SRS-RSRP<-143 | dBm |
| SRS\_RSRP\_14 | -143≤SRS-RSRP<-142 | dBm |
| SRS\_RSRP\_15 | -142≤SRS-RSRP<-141 | dBm |
| SRS\_RSRP\_16 | -141≤SRS-RSRP<-140 | dBm |
| SRS\_RSRP\_17 | -140≤SRS-RSRP<-139 | dBm |
| SRS\_RSRP\_18 | -139≤SRS-RSRP<-138 | dBm |
| … | … | … |
| SRS\_RSRP\_111 | -46≤SRS-RSRP<-45 | dBm |
| SRS\_RSRP\_112 | -45≤SRS-RSRP<-44 | dBm |
| SRS\_RSRP\_113 | -44≤SRS-RSRP<-43 | dBm |
| SRS\_RSRP\_114 | -43≤SRS-RSRP<-42 | dBm |
| SRS\_RSRP\_115 | -42≤SRS-RSRP<-41 | dBm |
| SRS\_RSRP\_116 | -41≤SRS-RSRP<-40 | dBm |
| SRS\_RSRP\_117 | -40≤SRS-RSRP<-39 | dBm |
| SRS\_RSRP\_118 | -39≤SRS-RSRP<-38 | dBm |
| SRS\_RSRP\_119 | -38≤SRS-RSRP<-37 | dBm |
| SRS\_RSRP\_120 | -37≤SRS-RSRP<-36 | dBm |
| SRS\_RSRP\_121 | -36≤SRS-RSRP<-35 | dBm |
| SRS\_RSRP\_122 | -35≤SRS-RSRP<-34 | dBm |
| SRS\_RSRP\_123 | -34≤SRS-RSRP<-33 | dBm |
| SRS\_RSRP\_124 | -33≤SRS-RSRP<-32 | dBm |
| SRS\_RSRP\_125 | -32≤SRS-RSRP<-31 | dBm |
| SRS\_RSRP\_126 | -31≤SRS-RSRP | dBm |

### 13.3.2 Measurement accuracy requirements

#### 13.3.2.1 Introduction

This clause defines accuracy requirements for SRS-RSRP measurement in FR1 and FR2. The requirements are applicable for gNB supporting SRS-RSRP measurement. The gNB, which declares the support for SRS-RSRP measurement also declares that it meets SRS-RSRP accuracy requirements at least for one side condition Ês/Iot ≥ +3 dB or Ês/Iot ≥ -13 dB.

#### 13.3.2.2 Requirements

The accuracy requirements in Table 13.3.2.2-1, Table 13.3.2.2-2 and Table 13.3.2.2-3 are valid under the following conditions:

- AWGN propagation conditions.

- The measured signals are in the directions covered by RoAoA of OTA reference sensitivity requirements for gNB type 1-O and 2-O BS

Note: The measurement accuracy requirements in Table 13.3.2.2-1, Table 13.3.2.2-2 and Table 13.3.2.2-3 are defined under an assumption that gNB is not mandated to perform receive beam sweeping.

Table 13.3.2.2-1 gNB SRS-RSRP absolute accuracy requirements in FR1 for gNB type 1-C

|  |  |  |
| --- | --- | --- |
| Accuracy | Conditions | |
| SRS Ês/Iot | SRS bandwidth range |
|
| dB | dB | RB |
| ±4 | Ês/Iot ≥ +3 | 24 ≤ BW < 48 |
| ±4 | 48 ≤ BW < 132 |
| ±4 | 132 ≤ BW |
| ±6.5 | Ês/Iot ≥ -13 | 48 ≤ BW < 132 |
| ±5.5 | 132 ≤ BW |

Table 13.3.2.2-2 gNB SRS-RSRP absolute accuracy requirements in FR1 for gNB type 1-H and 1-O

|  |  |  |
| --- | --- | --- |
| Accuracy | Conditions | |
| SRS Ês/Iot | SRS bandwidth range |
|
| dB | dB | RB |
| ±5.5 | Ês/Iot ≥ +3 | 24 ≤ BW < 48 |
| ±5.5 | 48 ≤ BW < 132 |
| ±5.5 | 132 ≤ BW |
| ±8 | Ês/Iot ≥ -13 | 48 ≤ BW < 132 |
| ±7 | 132 ≤ BW |

Table 13.3.2.2-3 gNB SRS-RSRP absolute accuracy requirements in FR2 for gNB type 2-O

|  |  |  |
| --- | --- | --- |
| Accuracy | Conditions | |
| SRS Ês/Iot | SRS bandwidth range |
|
| dB | dB | RB |
| ±5.5 | Ês/Iot ≥ +3 | 32 ≤ BW < 64 |
| ±5.5 | 64 ≤ BW < 132 |
| ±5.5 | 132 ≤ BW |
| ±8 | Ês/Iot ≥ -13 | 64 ≤ BW < 132 |
| ±7 | 132 ≤ BW |

### 13.4 AoA/ZoA

### 13.4.1 Report mapping

The reporting range of UL Angle of Arrival (UL-AoA), as defined in Clause 5.2.4 of TS 38.215 [4], is defined from -180 degree to +180 degree for azimuth angle of arrival (A-AoA). The reporting resolution is 0.1 degree.

The reporting range of UL Angle of Arrival, as defined in Clause 5.2.4 of TS 38.215 [4], is defined from 0 degree to +180 degree for zenith angle of arrival (Z-AoA). The reporting resolution is 0.1 degree.

The mapping of A-AoA measured quantity is defined in Table 13.4.1-1. The mapping of Z-AoA measured quantity is defined in Table 13.4.1-2.

Table 13.4.1-1: Azimuth Angle of Arrival (A-AoA) measurement report mapping

|  |  |  |
| --- | --- | --- |
| Reported value | Measured quantity value (A-AoA) | Unit |
| A-AoA\_0 | -180 ≤ A-AoA < -179.9 | degree |
| A-AoA\_1 | -179.9 ≤ A-AoA < -179.8 | degree |
| A-AoA\_2 | -179.8 ≤ A-AoA < -179.7 | degree |
| … | … | … |
| A-AoA\_1798 | -0.2 ≤ A-AoA < -0.1 | degree |
| A-AoA\_1799 | -0.1 ≤ A-AoA < 0 | degree |
| A-AoA\_1800 | 0 ≤ A-AoA < 0.1 | degree |
| A-AoA\_1801 | 0.1 ≤ A-AoA < 0.2 | degree |
| A-AoA\_1802 | 0.2 ≤ A-AoA < 0.3 | degree |
| … | … | … |
| A-AoA\_3598 | 179.8 ≤ A-AoA < 179.9 | degree |
| A-AoA\_3599 | 179.9 ≤ A-AoA < 180 | degree |

Table 13.4.1-2: Zenith Angle of Arrival (Z-AoA) measurement report mapping

|  |  |  |
| --- | --- | --- |
| Reported value | Measured quantity value (Z-AoA) | Unit |
| Z-AoA\_0 | 0 ≤ Z-AoA < 0.1 | degree |
| Z-AoA \_1 | 0.1 ≤ Z-AoA < 0.2 | degree |
| Z-AoA \_2 | 0.2 ≤ Z-AoA < 0.3 | degree |
| … | … | … |
| Z-AoA \_1798 | 179.8 ≤ Z-AoA < 179.9 | degree |
| Z-AoA \_1799 | 179.9 ≤ Z-AoA ≤ 180 | degree |

## 13.5 Timing advance (TADV)

### 13.5.1 Report mapping

The reporting range of TADV, as defined in Clause 5.2.7 of TS 38.215 [4], is defined from 0 to 3150848 Tc with 128 Tc resolution for timing advance less or equal to 262144 Tc, and 512 Tc for timing advance greater than 262144 Tc.

Tc is defined in TS 38.211 [6].

The mapping of measured quantity is defined in Table 13.5.1-1.

Table 13.5.1-1: TADV measurement report mapping

|  |  |  |
| --- | --- | --- |
| **Reported value** | **Measured quantity value** | **Unit** |
| TIME\_ADVANCE\_00 | TADV < 128 | Tc |
| TIME\_ADVANCE\_01 | 128 ≤ TADV < 256 | Tc |
| TIME\_ADVANCE\_02 | 256 ≤ TADV < 384 | Tc |
| … | … | … |
| TIME\_ADVANCE\_2046 | 261888 ≤ TADV < 262016 | Tc |
| TIME\_ADVANCE\_2047 | 262016 ≤ TADV < 262144 | Tc |
| TIME\_ADVANCE\_2048 | 262144 ≤ TADV < 262656 | Tc |
| TIME\_ADVANCE\_2049 | 262656 ≤ TADV < 263168 | Tc |
| … | … | … |
| TIME\_ADVANCE\_7688 | 3149824 ≤ TADV < 3150336 | Tc |
| TIME\_ADVANCE\_7689 | 3150336 ≤ TADV < 3150848 | Tc |
| TIME\_ADVANCE\_7690 | 3150848 ≤ TADV | Tc |

NOTE: For report mapping, TADV is equal to (gNB Rx – Tx time difference) + NTA\_offset, where NTA\_offset is based on the information *n-TimingAdvanceOffset* as specified in TS 38.331 [2].

## 13.6 UL SRS RSRPP measurement

### 13.6.1 Report mapping

The reporting range of UL SRS RSRPP, as defined in clause 5.2.5 of 38.215 [4], is defined from -156dBm to -31dBm with resolution 1dB.

The mapping of measured quantity is defined in Table 13.6.1-1. The range in the signalling may be larger than the guaranteed accuracy range.

Table 13.6.1-1: UL SRS RSRPP report mapping

|  |  |  |
| --- | --- | --- |
| Reported value | Measured quantity value | Unit |
| SRS\_RSRPP\_0 | SRS-RSRPP<-156 | dBm |
| SRS\_RSRPP\_1 | -156≤SRS-RSRPP<-155 | dBm |
| SRS\_RSRPP\_2 | -155≤SRS-RSRPP<-154 | dBm |
| SRS\_RSRPP\_3 | -154≤SRS-RSRPP<-153 | dBm |
| SRS\_RSRPP\_4 | -153≤SRS-RSRPP<-152 | dBm |
| SRS\_RSRPP\_5 | -152≤SRS-RSRPP<-151 | dBm |
| SRS\_RSRPP\_6 | -151≤SRS-RSRPP<-150 | dBm |
| SRS\_RSRPP\_7 | -150≤SRS-RSRPP<-149 | dBm |
| SRS\_RSRPP\_8 | -149≤SRS-RSRPP<-148 | dBm |
| SRS\_RSRPP\_9 | -148≤SRS-RSRPP<-147 | dBm |
| SRS\_RSRPP\_10 | -147≤SRS-RSRPP<-146 | dBm |
| SRS\_RSRPP\_11 | -146≤SRS-RSRPP<-145 | dBm |
| SRS\_RSRPP\_12 | -145≤SRS-RSRPP<-144 | dBm |
| SRS\_RSRPP\_13 | -144≤SRS-RSRPP<-143 | dBm |
| SRS\_RSRPP\_14 | -143≤SRS-RSRPP<-142 | dBm |
| SRS\_RSRPP\_15 | -142≤SRS-RSRPP<-141 | dBm |
| SRS\_RSRPP\_16 | -141≤SRS-RSRPP<-140 | dBm |
| SRS\_RSRPP\_17 | -140≤SRS-RSRPP<-139 | dBm |
| SRS\_RSRPP\_18 | -139≤SRS-RSRPP<-138 | dBm |
| … | … | … |
| SRS\_RSRPP\_111 | -46≤SRS-RSRPP<-45 | dBm |
| SRS\_RSRPP\_112 | -45≤SRS-RSRPP<-44 | dBm |
| SRS\_RSRPP\_113 | -44≤SRS-RSRPP<-43 | dBm |
| SRS\_RSRPP\_114 | -43≤SRS-RSRPP<-42 | dBm |
| SRS\_RSRPP\_115 | -42≤SRS-RSRPP<-41 | dBm |
| SRS\_RSRPP\_116 | -41≤SRS-RSRPP<-40 | dBm |
| SRS\_RSRPP\_117 | -40≤SRS-RSRPP<-39 | dBm |
| SRS\_RSRPP\_118 | -39≤SRS-RSRPP<-38 | dBm |
| SRS\_RSRPP\_119 | -38≤SRS-RSRPP<-37 | dBm |
| SRS\_RSRPP\_120 | -37≤SRS-RSRPP<-36 | dBm |
| SRS\_RSRPP\_121 | -36≤SRS-RSRPP<-35 | dBm |
| SRS\_RSRPP\_122 | -35≤SRS-RSRPP<-34 | dBm |
| SRS\_RSRPP\_123 | -34≤SRS-RSRPP<-33 | dBm |
| SRS\_RSRPP\_124 | -33≤SRS-RSRPP<-32 | dBm |
| SRS\_RSRPP\_125 | -32≤SRS-RSRPP<-31 | dBm |
| SRS\_RSRPP\_126 | -31≤SRS-RSRPP | dBm |

## 13.7 gNB Rx-Tx time difference measurements for RTT-based PDC

### 13.7.1 Report mapping

The reporting range of gNB Rx-Tx time difference, as defined in Clause 5.2.3 of TS 38.215 [4], is defined from -985024Tc to +985024×Tc. The reporting resolution is uniform across the reporting range and is defined as Tc\*32.

Tc is defined in TS 38.211 [6].

The mapping of measured quantity is defined in Table 13.7.1-1.

Table 13.7.1-1: gNB Rx-Tx time difference measurement report mapping

|  |  |  |
| --- | --- | --- |
| Reported Value | Measured Quantity Value | Unit |
| RX-TX\_0000 | -985024 > RX-TX | Tc |
| RX-TX\_0001 | -985024 ≤ RX-TX < -984992 | Tc |
| RX-TX\_0002 | -984992 ≤ RX-TX < -984960 | Tc |
| … | … | … |
| RX-TX\_30781 | -64 ≤ RX-TX < -32 | Tc |
| RX-TX\_30782 | -32 ≤ RX-TX ≤ 0 | Tc |
| RX-TX\_30783 | 0 < RX-TX ≤ 32 | Tc |
| RX-TX\_30784 | 32 < RX-TX ≤ 64 | Tc |
| RX-TX\_30785 | 64 < RX-TX ≤ 96 | Tc |
| … | … | … |
| RX-TX\_61564 | 984992 < RX-TX ≤ 985024 | Tc |
| RX-TX\_61565 | 985024 < RX-TX | Tc |

### 13.7.2 Measurement Accuracy Requirements

#### 13.7.2.1 Introduction

This clause defines accuracy requirements for gNB Rx-Tx time difference measurement in FR1 and FR2. The requirements are applicable for gNB supporting gNB Rx-Tx time difference measurement for RTT-based PDC.

#### 13.7.2.2 Requirements

The accuracy requirements for gNB Rx-Tx time difference measurement for RTT-based PDC shall be within ±(X+Y) Tc under the following conditions:

- AWGN propagation conditions.

- The measured signals are in the directions covered by RoAoA of OTA reference sensitivity requirements for gNB type 1-O and 2-O BS

where

- X is defined in Table 13.7.2.2-1 for gNB types 1-C, 1-H and 1-O and in Table 13.7.2.2-2 for gNB type 2-O.

- Y is declared by manufacturer and can be different for different gNB types 1-C, 1-H, 1-O and 2-O.

Note: The measurement accuracy requirements in Table 13.7.2.2-1 and Table 13.7.2.2-2 are defined under an assumption that gNB is not mandated to perform receive beam sweeping.

Table 13.7.2.2-1: gNB Rx-Tx time difference absolute accuracy in FR1 for gNB type 1-C, 1-H and 1-O

|  |  |  |  |
| --- | --- | --- | --- |
| Accuracy | SRS Ês/Iot | SCS | SRS bandwidth range |
| Unit: Tc | Unit: dB | Unit: kHz | Unit: RB |
| 122 | ≥ +3 | 15 | 24 ≤ BW ≤ 40 |
| 62 | 44 ≤ BW ≤ 84 |
| 32 | 88 ≤ BW ≤ 168 |
| 16 | 176 ≤ BW |
| 32 | 30 | 48 ≤ BW ≤ 84 |
| 17 | 88 ≤ BW ≤ 168 |
| 9 | 176 ≤ BW |
| 16 | 60 | 48 ≤ BW ≤ 84 |
| 9 | 88 ≤ BW |

Table 13.7.2.2-2: gNB Rx-Tx time difference absolute accuracy in FR2 for gNB type 2-O

|  |  |  |  |
| --- | --- | --- | --- |
| Accuracy | SRS Ês/Iot | SCS | SRS bandwidth range |
| Unit: Tc | Unit: dB | Unit: kHz | Unit: RB |
| 9 | ≥ +3 | 60 | 132 ≤ BW ≤ 168 |
| 8 | 176 ≤ BW |
| 16 | 120 | 32 ≤ BW ≤ 40 |
| 9 | 44 ≤ BW ≤ 84 |
| 8 | 88 ≤ BW |