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## Document Change History

| Date | Release | Changed by | Change Description |
|---|---|---|---|
| 2019-11-28 | R19-11 | AUTOSAR Release Management | • Time Validation (draft)<br>• Clarification regarding messages with stuck sequence counter<br>• Clarification regarding cyclic operation entry after timebase startup<br>• Clarification regarding transmission and reception of User Bytes<br>• Changed Document Status from Final to published |
| 2018-10-31 | 4.4.0 | AUTOSAR Release Management | • Modifications to enhance the precision of Global Time Synchronization<br>• Additional minor corrections / clarifications / editorial changes; For details please refer to the Change Documentation |
| 2016-11-30 | 4.3.0 | AUTOSAR Release Management | • Offset message formats changed<br>• Immediate Time Synchronization message transmission<br>• Various enhancements and corrections |
| 2015-07-31 | 4.2.2 | AUTOSAR Release Management | • Error code FRTSYN_E_INVALID_PDU_SDU_ID replaced by FRTSYN_E_INVALID_PDUID<br>• FlexRay communication state handling simplified (FrIf_GetPOCStatus replaced by FrIf_GetState) |
| 2014-10-31 | 4.2.1 | AUTOSAR Release Management | Initial Release |

## Disclaimer

# Table of Contents

# 1 Introduction and functional overview

The FrTSyn module handles the distribution of time information over FlexRay buses.

The FlexRay mechanism is much simpler than the mechanism for CAN since it is based on the fact, that FlexRay nodes are synchronized to each other, otherwise no messages can be transmitted on FlexRay.

Both, Time Master and Time Slaves have the same view on the FlexRay global time. It is therefore just necessary to define the same point in (FlexRay) time and to transmit the time information, which will be valid at that point in (FlexRay) time.

Although this same point in (FlexRay) time could be in theory any FlexRay macrotick within a FlexRay cycle, the start of a FlexRay cycle simplifies this mechanism. In addition, the mechanism does not just use any cycle start but uses the cycle start of the subsequent cycle with cycle counter value 0, i.e. the Time Master transmits time information located in the future.

On FlexRay only one Time Synchronization message is needed.
The Time Master uses its current FlexRay time, i.e. macrotick counter and cycle counter, and the current time, which shall be distributed and calculates the resulting time at the start of the next cycle 0. Once this resulting time has been calculated, it is neither very time critical, when exactly the FlexRay frame is transmitted, nor when it is received and processed.

Every Time Slave receiving the transmitted time information will use it in combination with the current FlexRay macrotick counter and cycle counter to determine the actual master time and set its slave time.

The following Figure shows the Time Synchronization mechanism on FlexRay.

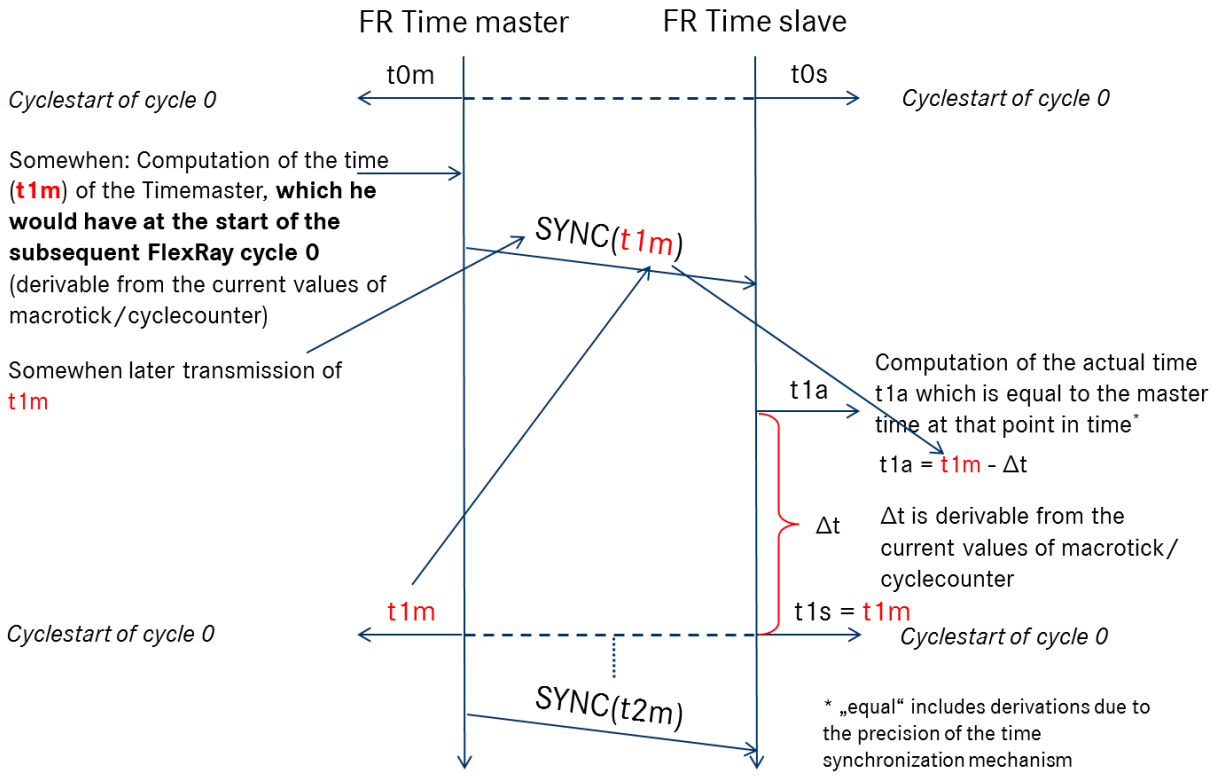



**Figure 1: FlexRay Time Synchronization mechanism**

# 2 Acronyms, Abbreviations, and Definitions

This section lists module local Abbreviations and Definitions. For a complete set of Synchronized Time Base related Abbreviations and Definitions refer to the corresponding chapter in [4].

| Abbreviation / Acronym: | Description |
|---|---|
| (G)TD | (Global) Time Domain |
| (G)TM | (Global) Time Master |
| <Bus>TSyn | A bus specific Time Synchronization module |
| CRC | Cyclic Redundancy Checksum |
| Debounce Time | Minimum gap between two Tx messages with the same PDU |
| DEM | Diagnostic Event Manager |
| DET | Default Error Tracer |
| FR | FlexRay |
| FUP message | Follow-Up message |
| OFNS message | Offset adjustment message |
| OFS message | Offset Synchronization message |
| StbM | Synchronized Time-Base Manager |
| SYNC message | Time Synchronization message |
| TG | Time Gateway |
| Timesync | Time Synchronization |
| TS | Time Slave |
| TSD | Time Sub-domain |

# 3 Related documentation

## 3.1 Input documents

[1] Requirements on Time Synchronization
AUTOSAR_RS_TimeSync.pdf

[2] Layered Software Architecture
AUTOSAR_EXP_LayeredSoftwareArchitecture.pdf

[3] General Specification of Basic Software Modules
AUTOSAR_SWS_BSWGeneral.pdf

[4] Specification of Synchronized Time-Base Manager
AUTOSAR_SWS_SynchronizedTimeBaseManager.pdf

[5] Specification of CRC Routines
AUTOSAR_SWS_CRCLibrary.pdf

[6] Specification of FlexRay Interface
AUTOSAR_SWS_FlexRayInterface.pdf

[7] Specification of Default Error Tracer
AUTOSAR_SWS_DefaultErrorTracer.pdf

[8] Specification of Basic Software Mode Manager
AUTOSAR_SWS_BSWModeManager.pdf

## 3.2 Related specification

AUTOSAR provides a General Specification on Basic Software (SWS BSW General [3]) which is also valid for FrTSyn.

Thus, the General Specification on Basic Software (SWS BSW General) shall be considered additionally and as required specification for FrTSyn.

# 4 Constraints and assumptions

## 4.1 Limitations

Time Masters, Time Gateways and Time Slaves shall work with a Time Base reference clock with a worst-case accuracy of 2µs.

The Time Base in the OFS messages is limited to 32 bit, wherefore the maximum supported time value is 4294967295 seconds ($2^{32}$-1).

## 4.2 Applicability to car domains

Systems requiring a common Time Base to ECUs independent to which bus system the ECU is connected.

# 5 Dependencies to other modules

The Time Synchronization over FlexRay (FrTSyn) has interfaces towards the Synchronized Time-Base Manager (StbM), the FlexRay Interface (FrIf) and the Default Error Tracer (DET).

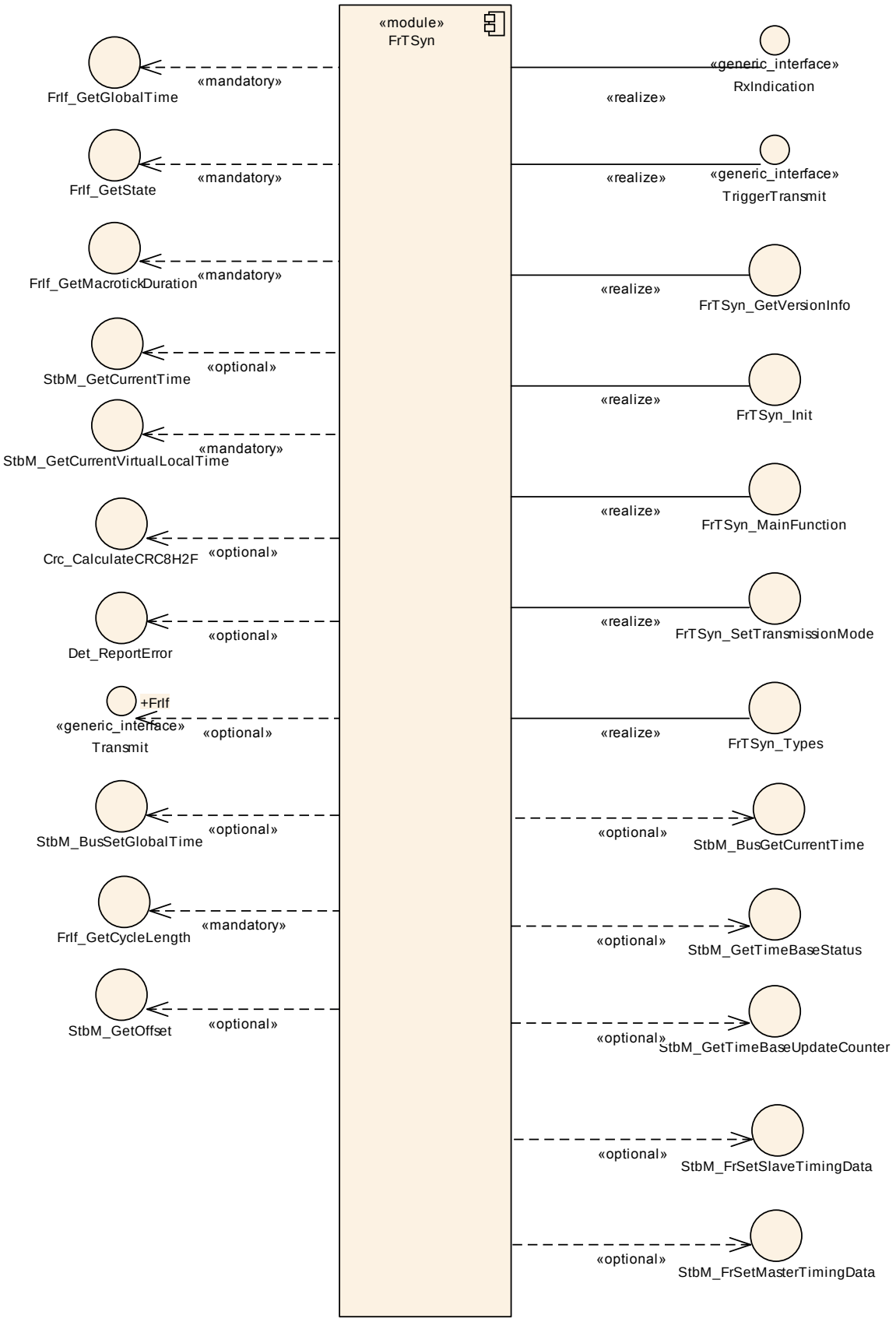



**Figure 2: Module dependencies of the FrTSyn module**

- StbM – Get and set the current time value
- FrIf – Receiving and transmitting messages
- BswM – Coordination of network access (via `FrTSyn_SetTransmissionMode()`)
- DET – Reporting of development errors

## 5.1 File structure

### 5.1.1 Code file structure

For details, refer to the section 5.1.6 "Code file structure" of the SWS BSW General [3].

### 5.1.2 Header file structure

For details, refer to the section 5.1.7 "Header file structure" of the SWS BSW General [3].

# 6 Requirements traceability

| Requirement | Description | Satisfied by |
|---|---|---|
| RS_TS_00003 | The Implementation of Time Synchronization shall initialize the Local Time Base with zero at startup | SWS_FrTSyn_00003, SWS_FrTSyn_00005 |
| RS_TS_00004 | The Implementation of Time Synchronization shall initialize the Global Time Base with a configurable startup value. | SWS_FrTSyn_00003, SWS_FrTSyn_00005 |
| RS_TS_00034 | The Implementation of Time Synchronization shall provide measurement data to the application | SWS_FrTSyn_00092, SWS_FrTSyn_00096, SWS_FrTSyn_00097, SWS_FrTSyn_00098, SWS_FrTSyn_00099, SWS_FrTSyn_00100, SWS_FrTSyn_00101 |
| RS_TS_20039 | The Timesync over FlexRay module shall trigger Time Base Synchronization transmission | SWS_FrTSyn_00019, SWS_FrTSyn_00023, SWS_FrTSyn_00026, SWS_FrTSyn_00027, SWS_FrTSyn_00084, SWS_FrTSyn_00085, SWS_FrTSyn_00086, SWS_FrTSyn_00087, SWS_FrTSyn_00088, SWS_FrTSyn_00089, SWS_FrTSyn_00090, SWS_FrTSyn_00091, SWS_FrTSyn_00093 |
| RS_TS_20040 | The Timesync over FlexRay module shall provide a Time Base after reception of a valid protocol information | SWS_FrTSyn_00041, SWS_FrTSyn_00045, SWS_FrTSyn_00078, SWS_FrTSyn_00094 |
| RS_TS_20041 | The Timesync over FlexRay module shall support means to protect the Time Synchronization protocol | SWS_FrTSyn_00006, SWS_FrTSyn_00014, SWS_FrTSyn_00015, SWS_FrTSyn_00021, SWS_FrTSyn_00025, SWS_FrTSyn_00030, SWS_FrTSyn_00031, SWS_FrTSyn_00035, SWS_FrTSyn_00036, SWS_FrTSyn_00078, SWS_FrTSyn_00079, SWS_FrTSyn_00080 |
| RS_TS_20042 | The Timesync over FlexRay module shall detect and handle timeout and integrity errors in the Time Synchronization protocol | SWS_FrTSyn_00015, SWS_FrTSyn_00038, SWS_FrTSyn_00041, SWS_FrTSyn_00042, SWS_FrTSyn_00045, SWS_FrTSyn_00048, SWS_FrTSyn_00049, SWS_FrTSyn_00050, SWS_FrTSyn_00054, SWS_FrTSyn_00055, SWS_FrTSyn_00057, SWS_FrTSyn_00058, SWS_FrTSyn_00080, SWS_FrTSyn_00081, SWS_FrTSyn_00082, SWS_FrTSyn_00094 |
| RS_TS_20043 | The Timesync over FlexRay module shall support a protocol for precise time measurement and synchronization over FlexRay | SWS_FrTSyn_00007, SWS_FrTSyn_00009, SWS_FrTSyn_00010, SWS_FrTSyn_00014, SWS_FrTSyn_00015, SWS_FrTSyn_00018, SWS_FrTSyn_00019, SWS_FrTSyn_00020, SWS_FrTSyn_00021, SWS_FrTSyn_00026, SWS_FrTSyn_00027, SWS_FrTSyn_00028, SWS_FrTSyn_00030, SWS_FrTSyn_00031, SWS_FrTSyn_00035, SWS_FrTSyn_00036, SWS_FrTSyn_00037, SWS_FrTSyn_00038, SWS_FrTSyn_00039, SWS_FrTSyn_00040, SWS_FrTSyn_00041, SWS_FrTSyn_00046, SWS_FrTSyn_00048, SWS_FrTSyn_00049, |

| | | |
|---|---|---|
| | | SWS_FrTSyn_00050, SWS_FrTSyn_00054, SWS_FrTSyn_00055, SWS_FrTSyn_00056, SWS_FrTSyn_00057, SWS_FrTSyn_00060, SWS_FrTSyn_00061, SWS_FrTSyn_00062, SWS_FrTSyn_00063, SWS_FrTSyn_00064, SWS_FrTSyn_00065, SWS_FrTSyn_00066, SWS_FrTSyn_00069, SWS_FrTSyn_00071, SWS_FrTSyn_00072, SWS_FrTSyn_00074, SWS_FrTSyn_00075, SWS_FrTSyn_00081 |
| RS_TS_20044 | The Timesync over FlexRay module shall use the time measurement and synchronization protocol to transmit and receive an offset value | SWS_FrTSyn_00007, SWS_FrTSyn_00009, SWS_FrTSyn_00010, SWS_FrTSyn_00020, SWS_FrTSyn_00022, SWS_FrTSyn_00023, SWS_FrTSyn_00025, SWS_FrTSyn_00026, SWS_FrTSyn_00027, SWS_FrTSyn_00029, SWS_FrTSyn_00030, SWS_FrTSyn_00031, SWS_FrTSyn_00035, SWS_FrTSyn_00036, SWS_FrTSyn_00037, SWS_FrTSyn_00042, SWS_FrTSyn_00043, SWS_FrTSyn_00044, SWS_FrTSyn_00045, SWS_FrTSyn_00047, SWS_FrTSyn_00048, SWS_FrTSyn_00049, SWS_FrTSyn_00050, SWS_FrTSyn_00054, SWS_FrTSyn_00055, SWS_FrTSyn_00056, SWS_FrTSyn_00057, SWS_FrTSyn_00079, SWS_FrTSyn_00080, SWS_FrTSyn_00082 |
| RS_TS_20045 | The Timesync over FlexRay module shall support user specific data within the time measurement and synchronization protocol | SWS_FrTSyn_00010, SWS_FrTSyn_00011, SWS_FrTSyn_00012, SWS_FrTSyn_00013 |
| RS_TS_20046 | The configuration for Time synchronization over FlexRay shall allow the FlexRay Time Synchronization module to support different roles for a Time Base | SWS_FrTSyn_00077 |
| SRS_BSW_00323 | All AUTOSAR Basic Software Modules shall check passed API parameters for validity | SWS_FrTSyn_00058, SWS_FrTSyn_00067, SWS_FrTSyn_00070, SWS_FrTSyn_00095 |
| SRS_BSW_00337 | Classification of development errors | SWS_FrTSyn_00067, SWS_FrTSyn_00070, SWS_FrTSyn_00095 |
| SRS_BSW_00385 | List possible error notifications | SWS_FrTSyn_00059 |

# 7 Functional specification

This chapter defines the behavior of the Time Synchronization over FlexRay. The API of the module is defined in chapter 8, while the configuration is defined in chapter 10.

## 7.1 Overview

The Time Synchronization over FlexRay is responsible to ensure the collection and distribution of Synchronized Time information across the FlexRay network. It interacts with the StbM and provides all FlexRay specific functions to the StbM. Time Synchronization principles and common wording is described in [4].

## 7.2 Module Handling

This section contains description of auxiliary functionality of the Time Synchronization over FlexRay.

### 7.2.1 Initialization

The Time Synchronization over FlexRay is initialized via `FrTSyn_Init()`. Except for `FrTSyn_GetVersionInfo()` and `FrTSyn_Init()`, the API functions of the Time Synchronization over FlexRay may only be called when the module has been properly initialized.

**[SWS_FrTSyn_00003][**
A call to `FrTSyn_Init()` initializes all internal variables and sets the Time Synchronization over FlexRay to the initialized state.
](RS_TS_00003, RS_TS_00004)

**[SWS_FrTSyn_00005][**
When `FrTSyn_Init()` is called in initialized state, the Time Synchronization over FlexRay shall re-initialize its internal variables.
](RS_TS_00003, RS_TS_00004)

**[SWS_FrTSyn_00006][**
The Sequence Counter (*SC*) shall be initialized with 0.
](RS_TS_20041)

### 7.2.2 FlexRay Interface

**[SWS_FrTSyn_00078][**
The FrTSyn module shall call `FrIf_GetGlobalTime()` only if `FrIf_GetState()` returns `FRIF_STATE_ONLINE`. This is to ensure that `FrIf_GetGlobalTime`

returns valid time information, i.e. that the FlexRay communication controller is synchronous to the FlexRay global time.
](RS_TS_20040, RS_TS_20041)

## 7.3 Message Format

SYNC and OFS messages may share the same FR PDU by using a multiplexed signal group. The multiplexer is located in Byte 0, named "*Type*".

For different Time Domains the same FR PDU may be used if Time Synchronization messages are sent by the same Time Master or Time Gateway.

For different Time Domains different FR PDUs shall be used if Time Synchronization messages are sent by different Time Masters or Time Gateways.

The usage of *CRC* is optional. To ensure a great variability between several time observing units, the configuration decides of how to handle *CRC* secured time synchronization messages if the receiver does not support the *CRC* calculation. Hence it might be possible, that a receiver is just using the given Time Base value, without evaluating the *CRC*.

**[SWS_FrTSyn_00007][**
The byte order for time values inside Time Synchronization messages is "Big Endian".
](RS_TS_20043, RS_TS_20044)

**[SWS_FrTSyn_00009][**
The PayloadLength is 16.
](RS_TS_20043, RS_TS_20044)

**[SWS_FrTSyn_00010][**
Time Synchronization messages contain User Data according to the given message format.
](RS_TS_20043, RS_TS_20044, RS_TS_20045)

**[SWS_FrTSyn_00011][**
User Data shall be read consistently from the incoming Time Synchronization messages.
](RS_TS_20045)

**[SWS_FrTSyn_00012][**
User Data shall be written consistently to outgoing Time Synchronization messages.

If the number of User Data Fields in a Time Synchronization message is greater than the number of User Data Bytes provided by the StbM, the remaining User Data Fields shall be set to 0 (default value).
](RS_TS_20045)

**[SWS_FrTSyn_00013][**

User Data shall be mapped to the `StbM_UserDataType`, whereas the byte number given in the message and by the `StbM_UserDataType` shall match (User Byte 0 mapped to `StbM_UserDataType.userByte0` etc.).
`StbM_UserDataType.userDataLength` shall be set to the Time Synchronization message type specific number of User Bytes.
](RS_TS_20045)

### 7.3.1 SYNC message

**[SWS_FrTSyn_00014][**
SYNC not CRC secured message format:
Byte 0: *Type* = 0x10
Byte 1: User Byte 2, default: 0
Byte 2: *D* = Time Domain 0 to 15 (Bit 7 to Bit 4)
*SC* = Sequence Counter (Bit 3 to Bit 0)
Byte 3: *FCNT* = FlexRay Cycle Counter from 0 to 63 (Bit 7 to Bit 2)
*SGW* (Bit 1)
*SyncToGTM* = 0
*SyncToSubDomain* = 1
reserved (Bit 0), default: 0
Byte 4: User Byte 0, default: 0
Byte 5: User Byte 1, default: 0
Byte 6-11: *SyncTimeSec* = 48 Bit time value in seconds
Byte 12-15: *SyncTimeNSec* = 32 Bit time value in nanoseconds
](RS_TS_20041, RS_TS_20043)

**[SWS_FrTSyn_00015][**
SYNC CRC secured message format:
Byte 0: Type = 0x20
Byte 1: *CRC*
Byte 2: *D* = Time Domain 0 to 15 (Bit 7 to Bit 4)
*SC* = Sequence Counter (Bit 3 to Bit 0)
Byte 3: *FCNT* = FlexRay Cycle Counter from 0 to 63 (Bit 7 to Bit 2)
*SGW* (Bit 1)
*SyncToGTM* = 0
*SyncToSubDomain* = 1
reserved (Bit 0), default: 0
Byte 4: User Byte 0, default: 0
Byte 5: User Byte 1, default: 0
Byte 6-11: *SyncTimeSec* = 48 Bit time value in seconds
Byte 12-15: *SyncTimeNSec* = 32 Bit time value in nanoseconds
](RS_TS_20041, RS_TS_20042, RS_TS_20043)

### 7.3.2 OFS message

Offset messages can be multiplexed with SYNC messages (using the same PDU, etc.).

**[SWS_FrTSyn_00079][**
OFS not CRC secured message format:
Byte 0: *Type* = 0x34
Byte 1: User Byte 2, default: 0
Byte 2: *D* = Time Domain 16 to 31 (Bit 7 to Bit 4)
*SC* = Sequence Counter (Bit 3 to Bit 0)
Byte 3: reserved (Bit 7 to Bit 2), default: 0
*SGW* (Bit 1)
*SyncToGTM* = 0
*SyncToSubDomain* = 1
reserved (Bit 0), default: 0
Byte 4: User Byte 0, default: 0
Byte 5: User Byte 1, default: 0
Byte 6: reserved, default: 0
Byte 7: reserved, default: 0
Byte 8-11: *OfsTimeSec* = 32 Bit offset time value in seconds
Byte 12-15: *OfsTimeNSec* = 32 Bit offset time value in nanoseconds
](RS_TS_20041, RS_TS_20044)

**[SWS_FrTSyn_00080][**
OFS CRC secured message format:
Byte 0: Type = 0x44
Byte 1: *CRC*
Byte 2: *D* = Time Domain 16 to 31 (Bit 7 to Bit 4)
*SC* = Sequence Counter (Bit 3 to Bit 0)
Byte 3: reserved (Bit 7 to Bit 2), default: 0
*SGW* (Bit 1)
*SyncToGTM* = 0
*SyncToSubDomain* = 1
reserved (Bit 0), default: 0
Byte 4: User Byte 0, default: 0
Byte 5: User Byte 1, default: 0
Byte 6: reserved, default: 0
Byte 7: reserved, default: 0
Byte 8-11: *OfsTimeSec* = 32 Bit offset time value in seconds
Byte 12-15: *OfsTimeNSec* = 32 Bit offset time value in nanoseconds
](RS_TS_20041, RS_TS_20042, RS_TS_20044)

## 7.4 Acting as Time Master

A Time Master is an entity which is the master for a certain Time Base and which propagates this Time Base to a set of Time Slaves within a certain segment of a communication network, being a source for this Time Base.
If a Time Master is also the owner of the Global Time Base, the Time Base from which all further Time Bases are derived from, then it is the Global Time Master. A Time Gateway typically consists of one Time Master port which is connected to one or more Time Slaves. When mapping time entities to real ECUs it has to be noted,

that an ECU could be Time Master (or even Global Time Master) for one Time Base and Time Slave for another Time Base.

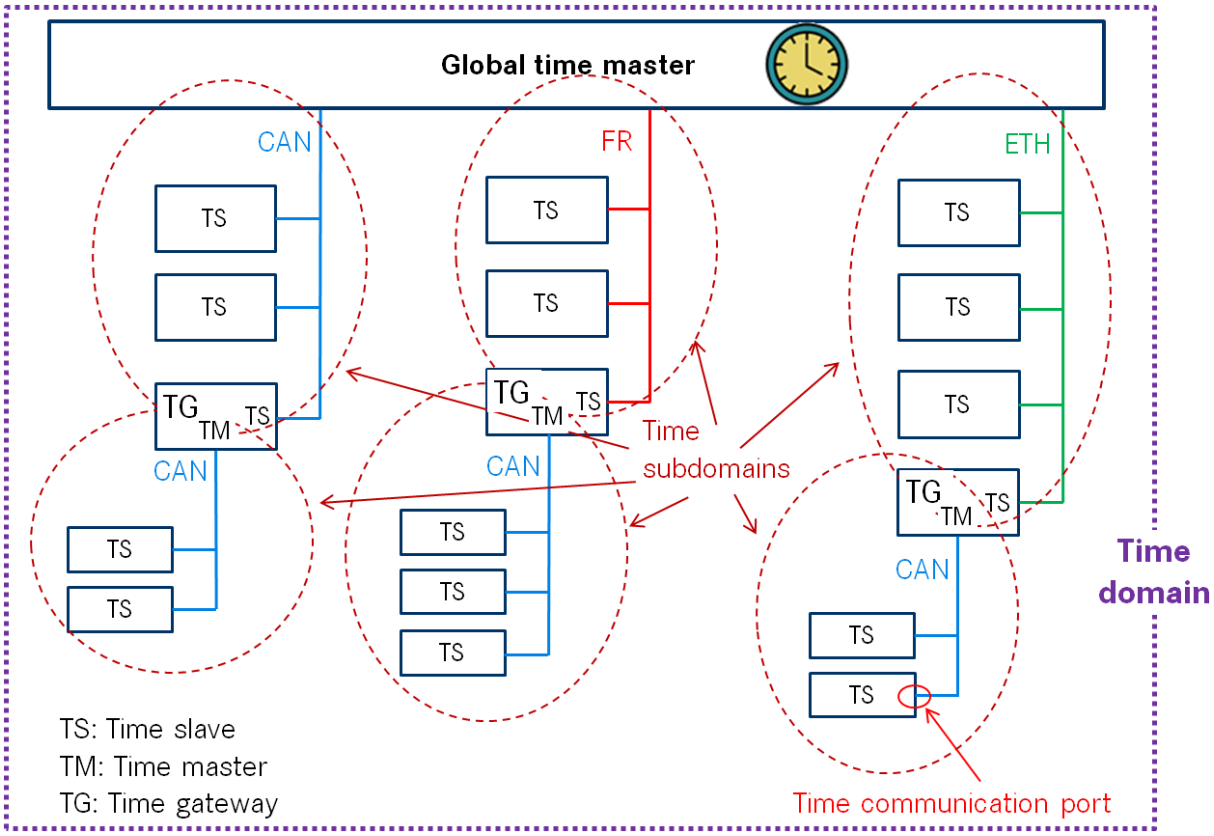



**Figure 3: Terminology Example**

### 7.4.1 SYNC message processing

**[SWS_FrTSyn_00018][**
A Time Synchronization message sequence consists of a SYNC message per Time Domain.
](RS_TS_20043)

**[SWS_FrTSyn_00019][**
For each configured Time Master (`FrTSynGlobalTimeMaster`) the FrTSyn module shall periodically transmit SYNC messages with the cycle `FrTSynGlobalTimeTxPeriod` (**ECUC_FrTSyn_00014 :** ) including the time value, which will be valid at the start of the next FlexRay cycle 0 (see Figure 4) and User Data, if the `GLOBAL_TIME_BASE` bit within the `timeBaseStatus` is set and `FrTSynGlobalTimeTxPeriod` is unequal to 0 and if the associated `cyclicMsgResumeCounter` is not running (see 7.4.5).
The cyclic transmission shall be started in the earliest possible `FrTSyn_MainFunction()` call once the requirements above are fulfilled.
](RS_TS_20039, RS_TS_20043)

**Note:** “earliest possible” means:

- In the next `FrTSyn_MainFunction()`, because `GLOBAL_TIME_BASE` is set outside the `FrTSyn_MainFunction()`.
- In the current `FrTSyn_MainFunction()`, when switching from immediate to cyclic transmission (because this decision is made inside the `FrTSyn_MainFunction()`)

**[SWS_FrTSyn_00021][**
Depending on `FrTSynGlobalTimeTxCrcSecured` (**ECUC_FrTSyn_00013 :** ) the SYNC message shall be of type:

| `FrTSynGlobalTimeTxCrcSecured` | SYNC |
|---|---|
| `CRC_NOT_SUPPORTED` | `0x10`<br>SYNC not CRC secured message |
| `CRC_SUPPORTED` | `0x20`<br>SYNC CRC secured message |

](RS_TS_20041, RS_TS_20043)

### 7.4.2 OFS message processing

**[SWS_FrTSyn_00022][**
An offset message sequence consists of an OFS message per Time Domain.
](RS_TS_20044)

**[SWS_FrTSyn_00023][**
For each configured Time Master (`FrTSynGlobalTimeMaster`) the FrTSyn module shall periodically transmit OFS messages with the cycle `FrTSynGlobalTimeTxPeriod` (**ECUC_FrTSyn_00014 :** ) including the Offset Time value and User Data, if the `GLOBAL_TIME_BASE` bit within the `timeBaseStatus` is set and `FrTSynGlobalTimeTxPeriod` is unequal to 0 and if the associated `cyclicMsgResumeCounter` is not running (see 7.4.5).
The cyclic transmission shall be started in the earliest possible `FrTSyn_MainFunction()` call once the requirements above are fulfilled.
](RS_TS_20039, RS_TS_20044)

**Note:** “earliest possible” means:

- In the next `FrTSyn_MainFunction()`, because `GLOBAL_TIME_BASE` is set outside the `FrTSyn_MainFunction()`.
- In the current `FrTSyn_MainFunction()`, when switching from immediate to cyclic transmission (because this decision is made inside the `FrTSyn_MainFunction()`)

**[SWS_FrTSyn_00025][**
Depending on `FrTSynGlobalTimeTxCrcSecured` (**ECUC_FrTSyn_00013 :** ) the OFS message shall be of type:

| FrTSynGlobalTimeTxCrcSecured | OFS |
|---|---|
| CRC_NOT_SUPPORTED | 0x34<br>OFS not CRC secured message |
| CRC_SUPPORTED | 0x44<br>OFS CRC secured message |

](RS_TS_20041, RS_TS_20044)

### 7.4.3 Transmission mode

**[SWS_FrTSyn_00026][**
If FrTSyn_SetTransmissionMode(Controller, Mode) is called and parameter Mode equals FRTSYN_TX_OFF, all transmit requests from FrTSyn shall be omitted on this FlexRay channel.
](RS_TS_20039, RS_TS_20043, RS_TS_20044)

**[SWS_FrTSyn_00027][**
If FrTSyn_SetTransmissionMode(Controller, Mode) is called and parameter Mode equals FRTSYN_TX_ON, all transmit requests from FrTSyn on this FlexRay channel shall be able to be transmitted.
](RS_TS_20039, RS_TS_20043, RS_TS_20044)

### 7.4.4 Debounce Time

**[SWS_FrTSyn_00084][**
If FrTSynGlobalTimeDebounceTime (**ECUC_FrTSyn_00033 :** ) is greater than 0 for a Time Base, FrTSyn shall always do debouncing for the corresponding Timesync PDUs as described below, otherwise FrTSyn shall not do any debouncing.
](RS_TS_20039)

**[SWS_FrTSyn_00085][**
FrTSynGlobalTimeDebounceTime (**ECUC_FrTSyn_00033 :** ) represents the debounce value of a debounceCounter of a Time Base. FrTSyn shall reload the debounceCounter after a Timesync PDU for the corresponding Time Base (SYNC and OFS) has been sent. FrTSyn shall decrement the debounceCounter value on each invocation of FrTSyn_MainFunction(), if no Timesync PDU is transmitted.
](RS_TS_20039)

**[SWS_FrTSyn_00086][**
A new Timesync PDU shall only be sent if the corresponding debounceCounter has a value equal or less than zero.
](RS_TS_20039)

### 7.4.5 Immediate Time Synchronization

In addition to the cyclic Timesync message transmission, an immediate message transmission might be required.

Depending on configuration, the FrTSyn module checks on each `FrTSyn_MainFunction()` call the necessity for a Timesync message transmission for each Time Base, where a Master Port belongs to.

**[SWS_FrTSyn_00087][**
If `FrTSynImmediateTimeSync` (**ECUC_FrTSyn_00031 :** ) is set to `TRUE` for a Time Base, FrTSyn shall check on each `FrTSyn_MainFunction()` call by calling `StbM_GetTimeBaseUpdateCounter()`, if the `timeBaseUpdateCounter` of the corresponding Time Base has changed.
](RS_TS_20039)

**[SWS_FrTSyn_00088][**
If `FrTSynImmediateTimeSync` (**ECUC_FrTSyn_00031 :** ) is set to `TRUE` and the `timeBaseUpdateCounter` of a Time Base has changed and the `GLOBAL_TIME_BASE` bit of the `timeBaseStatus` is set, FrTSyn shall trigger an immediate transmission of Time Synchronization messages for the corresponding Time Base.
](RS_TS_20039)

**Note:** `timeBaseStatus` can be obtained by `StbM_GetTimeBaseStatus()`, `StbM_BusGetCurrentTime()` or `StbM_GetCurrentTime()`.

**Note:** The `debounceCounter` as described in 7.4.4 shall always be considered.

**[SWS_FrTSyn_00089][**
If `FrTSynImmediateTimeSync` (**ECUC_FrTSyn_00031 :** ) is set to `TRUE`, `cyclicMsgResumeCounter` and `FrTSynCyclicMsgResumeTime` (**ECUC_FrTSyn_00032 :** ) shall be considered.
](RS_TS_20039)

**[SWS_FrTSyn_00090][**
`FrTSynCyclicMsgResumeTime` (**ECUC_FrTSyn_00032 :** ) represents the timeout value of a `cyclicMsgResumeCounter` that shall be started when either a SYNC or OFS message has been sent immediately, asynchronous to the cyclic Timesync message transmission. `cyclicMsgResumeCounter` shall be decremented on each invocation of `FrTSyn_MainFunction()`, if no Timesync PDU is transmitted asynchronously.
](RS_TS_20039)

**[SWS_FrTSyn_00091][**
If the `cyclicMsgResumeCounter` has reached a value equal or less than zero, FrTSyn shall resume cyclic Timesync message transmission by sending either a SYNC or OFS message.
](RS_TS_20039)

**[SWS_FrTSyn_00093][**
If the `cyclicMsgResumeCounter` is started, FrTSyn shall stop cyclic Timesync message transmission.

](RS_TS_20039)

### 7.4.6 Calculation and Assembling of Time Synchronization Messages

This chapter describes the workflow, how the items of a Time Synchronization message will be calculated (1st step) and how the message will be assembled (2nd step).

#### 7.4.6.1 Global Time Calculation

**[SWS_FrTSyn_00028][**
The transmitter of a Synchronized Time Base (Time Master) shall perform the following steps to distribute the Synchronized Time Base (refer to Figure 4):

1. Retrieve current Synchronized Time Base's Time Tuple as [$T_{SYNC}$;$T0_{VLT}$] via `StbM_BusGetCurrentTime()`
2. Protect the following two steps against interruptions:
   a. Get `currentCycle` and `currentMacroticks` via `FrIf_GetGlobalTime()`
   b. Retrieve current Virtual Local Time value as $T1_{VLT}$ via `StbM_GetCurrentVirtualLocalTime()`
3. Calculate the (future) time value of the Time Base at the start of the next FlexRay cycle by
   $T0 = T_{SYNC} + (T1_{VLT} - T0_{VLT}) + (64 - $ `currentCycle` $) *$ `CycleLength` $-$ (`currentMacroticks` $*$ `MacrotickDuration`)
4. Calculate *SyncTimeSec* (second portion of T0) and *SyncTimeNSec* (nanosecond portion of T0)

](RS_TS_20043)

**Note:** `CycleLength` and `MacrotickDuration` are given statically by configuration. In order to minimize rounding errors due to the granularity of `MacrotickDuration` (i.e., ns) the calculation uses `CycleLength` instead of the term ("MacroticksPerCycle" * `MacrotickDuration`).

**Note:** It is inevitable to retrieve `currentCycle` and `currentMacroticks` of the FlexRay time and $T1_{VLT}$ of the Virtual Local Time in an atomic way, otherwise any delay between them will worsen the precision by the amount of the delay.

**[SWS_FrTSyn_00029][**
The transmitter of an Offset Time Base (Time Master) shall perform the following steps to distribute the Offset Time Base:

1. Retrieve current Offset Time via `StbM_GetOffset()`
2. Write second portion of the Offset Time to *OfsTimeSec*

3. Write nanosecond portion of the Offset Time to *OfsTimeNSec*

](RS_TS_20044)

#### 7.4.6.2 SGW Calculation

**[SWS_FrTSyn_00020][**
The *SGW* value (Time Gateway synchronization status) shall be retrieved from the Time Base synchronization status. If the `SYNC_TO_GATEWAY` bit within `timeBaseStatus` is not set the *SGW* value shall be *SyncToGTM*. Otherwise the *SGW* value shall be set to *SyncToSubDomain*.
](RS_TS_20043, RS_TS_20044)

#### 7.4.6.3 Sequence Counter Calculation

**[SWS_FrTSyn_00030][**
A Sequence Counter (*SC*) of 4 bit is representing numbers from 0 to 15 per Time Domain. The Sequence Counter shall be independent between SYNC and OFS messages and shall be incremented by 1 on every transmission request of a SYNC or OFS message. It shall wrap around at 15 to 0 again.
](RS_TS_20041, RS_TS_20043, RS_TS_20044)

#### 7.4.6.4 CRC Calculation

**[SWS_FrTSyn_00031][**
The function `Crc_CalculateCRC8H2F()` as defined in [5] shall be used to calculate the *CRC,* if configured.
](RS_TS_20041, RS_TS_20043, RS_TS_20044)

**[SWS_FrTSyn_00035][**
The `DataID` shall be calculated as `DataID = DataIDList[`*SC*`]`, where `DataIDList` (**ECUC_FrTSyn_00023 : ECUC_FrTSyn_00024 :** ) is given by configuration for each message *Type*.
](RS_TS_20041, RS_TS_20043, RS_TS_20044)

**Note:** A specific `DataID` out of a predefined `DataIDList` ensures the identification of data elements of Time Synchronization messages.

**[SWS_FrTSyn_00036][**
The *CRC* shall be calculated over Time Synchronization message *Byte 2* to *Byte 15* and `DataID`, where Byte 2 is applied first, followed by the other bytes in ascending order, and `DataID` last.
](RS_TS_20041, RS_TS_20043, RS_TS_20044)

#### 7.4.6.5 Message Assembling

**[SWS_FrTSyn_00037][**
For each transmission of a Time Synchronization message the FrTSyn module shall assemble the message as follows:

1. Calculate *SC*
2. Copy `currentCycle` (**[SWS_FrTSyn_00028]**) to FCNT (for SYNC message)
3. Calculate *SGW*
4. Copy all data to the appropriate position within the related message
5. Calculate *CRC* (configuration dependent)

](RS_TS_20043, RS_TS_20044)

## 7.5 Acting as Time Slave

A Time Slave is an entity, which is the recipient for a certain Time Base within a certain segment of a communication network, being a consumer for this Time Base.

### 7.5.1 SYNC message processing

**[SWS_FrTSyn_00038][**
The FrTSyn shall only accept a SYNC message with *Type* equal to `0x20` and a correct *CRC* value if `FrTSynRxCrcValidated` is configured to `CRC_VALIDATED`.
](RS_TS_20042, RS_TS_20043)

**[SWS_FrTSyn_00039][**
The FrTSyn shall only accept a SYNC message with *Type* equal to `0x10` if `FrTSynRxCrcValidated` is configured to `CRC_NOT_VALIDATED`.
](RS_TS_20043)

**[SWS_FrTSyn_00040][**
The FrTSyn shall only accept a SYNC message with *Type* equal to `0x10` or `0x20` if `FrTSynRxCrcValidated` is configured to `CRC_IGNORED`.
](RS_TS_20043)

**[SWS_FrTSyn_00081][**
The FrTSyn shall only accept a SYNC message with *Type* equal to `0x10` or a SYNC message with *Type* equal to `0x20` and a correct *CRC* value if `FrTSynRxCrcValidated` is configured to `CRC_OPTIONAL`.
](RS_TS_20042, RS_TS_20043)

**[SWS_FrTSyn_00041][**
For valid SYNC messages a new Time Tuple, consisting of the Global Time value and the associated value of the Virtual Local Time, shall be calculated and forwarded to the StbM module via `StbM_BusSetGlobalTime()` (see Figure 5).
](RS_TS_20040, RS_TS_20042, RS_TS_20043)

### 7.5.2 OFS message processing

**[SWS_FrTSyn_00042][**
The FrTSyn shall only accept an OFS message with *Type* equal to `0x44` and a correct *CRC* value if `FrTSynRxCrcValidated` is configured to `CRC_VALIDATED`.
](RS_TS_20042, RS_TS_20044)

**[SWS_FrTSyn_00043][**
The FrTSyn shall only accept an OFS message with *Type* equal to `0x34` if `FrTSynRxCrcValidated` is configured to `CRC_NOT_VALIDATED`.
](RS_TS_20044)

**[SWS_FrTSyn_00044][**
The FrTSyn shall only accept an OFS message with *Type* equal to `0x34` or `0x44` if `FrTSynRxCrcValidated` is configured to `CRC_IGNORED`.
](RS_TS_20044)

**[SWS_FrTSyn_00082][**
The FrTSyn shall only accept an OFS message with *Type* equal to `0x34` or an OFS message with *Type* equal to `0x44` and a correct *CRC* value if `FrTSynRxCrcValidated` is configured to `CRC_OPTIONAL`.
](RS_TS_20042, RS_TS_20044)

**[SWS_FrTSyn_00045][**
For valid OFS messages a new Time Tuple, consisting of the Offset Time value and the associated value of the Virtual Local Time, shall be calculated (according **[SWS_FrTSyn_00047]**) and forwarded to the StbM module via `StbM_BusSetGlobalTime()`.
](RS_TS_20040, RS_TS_20042, RS_TS_20044)

### 7.5.3 Validation and Disassembling of Time Synchronization Messages

This chapter describes the workflow how the items of a Time Synchronization message will be validated (1st step) and how the message will be disassembled (2nd step).

#### 7.5.3.1 Global Time Calculation

**[SWS_FrTSyn_00046][**
The receiver of a Synchronized Time Base shall perform the following steps to assemble the Synchronized Time Base (refer to Figure 5):

1. On SYNC message RX indication (or in the subsequent `MainFunction` call) store received time value T0 (*SyncTimeSec, SyncTimeNSec*)

2. Protect the following two steps against interruptions:
   a. Get `currentCycle` and `currentMacroticks` via `FrIf_GetGlobalTime()`
   b. Retrieve current Virtual Local Time value as $T1_{VLT}$ via `StbM_GetCurrentVirtualLocalTime()`

3. Calculate Time Tuple [T1; $T1_{VLT}$] to update the Time Slave's local instance of the Time Base:
   a. T1 = T0 + (`CycleLength` * `currentCycle`) + (`MacrotickDuration` * `currentMacroticks`)
   b. If `currentCycle` is greater or equal than the retrieved FCNT value from the transmitter (Time Master), then the calculated value T1 shall be subtracted by 64 times the FR cycle duration:
   T1 = T1 – (`CycleLength` * 64)

](RS_TS_20043)

**Note:** `CycleLength` and `MacrotickDuration` are given statically by configuration. In order to minimize rounding errors due to the granularity of `MacrotickDuration` (i.e., ns) the calculation uses `CycleLength` instead of the term ("MacroticksPerCycle" * `MacrotickDuration`).

**Note:** It is inevitable to retrieve `currentCycle` and `currentMacroticks` of the FlexRay time and $T1_{VLT}$ of the Virtual Local Time atomic, otherwise any delay between them will worsen the precision by the amount of the delay.

**[SWS_FrTSyn_00047][**
The receiver of an Offset Time Base shall perform the following steps to assemble the Offset Time:

1. Get second portion of the Offset Time out of *OfsTimeSec*
2. Get nanosecond portion of the Offset Time out of *OfsTimeNSec*
3. Retrieve current Virtual Local Time value via `StbM_GetCurrentVirtualLocalTime()`

](RS_TS_20044)

#### 7.5.3.2 SGW Calculation

**[SWS_FrTSyn_00094][**
If the *SGW* value (SYNC and OFS) is set to `SyncToSubDomain`, the `SYNC_TO_GATEWAY` bit within `timeBaseStatus` shall be set to `TRUE`. Otherwise, it shall be set to `FALSE`.
](RS_TS_20040, RS_TS_20042)

#### 7.5.3.3 Sequence Counter Validation

**[SWS_FrTSyn_00048][**
The Sequence Counter Jump Width between two consecutive SYNC or two consecutive OFS messages of the same Time Domain shall be greater than 0 and smaller than or equal to `FrTSynGlobalTimeSequenceCounterJumpWidth`. Otherwise a Time Slave shall discard the respective SYNC / OFS message.

The `FrTSynGlobalTimeSequenceCounterJumpWidth` value 0 is not allowed.
](RS_TS_20042, RS_TS_20043, RS_TS_20044)

**[SWS_FrTSyn_00049][**
Upon reception of a SYNC (or OFS) message a Time Slave shall check the Sequence Counter of the received message per Time Domain against the configured value of `FrTSynGlobalTimeSequenceCounterJumpWidth` (according to **[SWS_FrTSyn_00048]**), unless it is the first message

- at Startup or
- after a Time Base update timeout has been detected (`TIMEOUT` bit set in Time Base synchronization status `timeBaseStatus`).

](RS_TS_20042, RS_TS_20043, RS_TS_20044)

**Note:** There are scenarios where it makes sense to skip the check of the Sequence Counter Jump Width, e.g. at startup (Time Slaves start asynchronously to the Time Master) or after a message timeout to allow for Sequence Counter (re-)synchronization. In case of a timeout the error has been detected already by the timeout monitoring, there is no benefit in generating a subsequent error by the jump width check.

**Note:** According to **[SWS_FrTSyn_00048]** the Sequence Counter validation will still discard messages with a Sequence Counter Jump Width being zero (i.e., stuck Sequence Counter) during Time Base update timeout.

#### 7.5.3.4 CRC Validation

**[SWS_FrTSyn_00050][**
The function `Crc_CalculateCRC8H2F()` as defined in [5] shall be used to validate the *CRC,* if configured.
](RS_TS_20042, RS_TS_20043, RS_TS_20044)

**[SWS_FrTSyn_00054][**
The `DataID` shall be calculated as `DataID = DataIDList[`*SC*`]`, where `DataIDList` is given by configuration for each message *Type*.
](RS_TS_20042, RS_TS_20043, RS_TS_20044)

**Note:** A specific `DataID` out of a predefined `DataIDList` ensures the identification of data elements of Time Synchronization messages.

**[SWS_FrTSyn_00055][**
The *CRC* shall be calculated over Time Synchronization message *Byte 2* to *Byte 15* and `DataID`, where Byte 2 is applied first, followed by the other bytes in ascending order, and `DataID` last.
](RS_TS_20042, RS_TS_20043, RS_TS_20044)

#### 7.5.3.5 Message Disassembling

**[SWS_FrTSyn_00056][**
For each received Time Synchronization message the FrTSyn shall validate the message as follows (all conditions must match):

1. *Type* matches depending on the `FrTSynRxCrcValidated` parameter
2. *SC* value is within the accepted range (refer to **[SWS_FrTSyn_00048]** and **[SWS_FrTSyn_00049]**)
3. *D* matches to the defined Time Domain range for each *Type*
4. *D* matches to one of the configured Time Domains
5. *SyncTimeNSec* (SYNC message) or *OfsTimeNSec* (OFS message) matches the defined range of `StbM_TimeStampType.nanoseconds`.
6. *CRC* (including `DataID`) matches depending on the `FrTSynRxCrcValidated` parameter.

](RS_TS_20043, RS_TS_20044)

**[SWS_FrTSyn_00057][**
For each received Time Synchronization message the FrTSyn shall disassemble the message after successful validation **[SWS_FrTSyn_00056]**.
](RS_TS_20042, RS_TS_20043, RS_TS_20044)

## 7.6 Time Recording

### 7.6.1 Global Time Measurement Support

**[SWS_FrTSyn_00092][**
On an invocation of `StbM_BusSetGlobalTime()` the member `PathDelay` of the `measureDataPtr` structure shall be set to 0.
](RS_TS_00034)

### 7.6.2 Time Validation

**[SWS_FrTSyn_00096]{DRAFT}[**
The FrTSyn shall support Time Validation, if `FrTSynTimeValidationSupport` (**ECUC_FrTSyn_00040**) set to `TRUE`.
] (RS_TS_00034)

**[SWS_FrTSyn_00097]{DRAFT}[**
If

- `FrTSynTimeValidationSupport` is enabled and
- `FrTSynEnableTimeValidation` for the Time Domain is enabled

FrTSyn shall do time recording for Time Validation for that Time Domain
] (RS_TS_00034)

**[SWS_FrTSyn_00098]{DRAFT}[**
If

- time recording for Time Validation is enabled for a Time Domain (refer to **[SWS_FrTSyn_00096]** and **[SWS_FrTSyn_00097]**) and
- FrTSyn is configured as Time Slave for that Time Domain,

FrTSyn shall call `StbM_FrSetSlaveTimingData()` upon successful reception of a SYNC message (refer to
Figure 5).

`StbM_FrSetSlaveTimingData()` shall be called after `StbM_BusSetGlobalTime()`.
] (RS_TS_00034)

**Note:** `StbM_BusSetGlobalTime()` shall be called first, because it updates the Synclocal Time Tuple (refer to [4]), which is required by `StbM_FrSetSlaveTimingData()`.

**[SWS_FrTSyn_00099]{DRAFT}[**
Upon invocation of `StbM_FrSetSlaveTimingData()` FrTSyn shall pass following values

- the Sequence Counter as received in the Sync message,
- `currentCycle` and `currentMacroticks` and `FCNT` as read upon reception of the Sync message (refer to step 2 in **[SWS_FrTSyn_00046]**),
- `CycleLength and MacrotickDuration`
- the Sync ingress timestamp T1VLT as retrieved in step 1 in **[SWS_FrTSyn_00046]**)
- T0 as received in the `Sync` Message (refer to step 1 in **[SWS_FrTSyn_00046]**),

by the parameter `measureDataPtr`.

Struct members

- `measureDataPtr->referenceLocalTimestamp` and
- `measureDataPtr->refrenceGlobalTimestamp`

shall be passed as 0.
] (RS_TS_00034)

**Note**: `CycleLength` and `MacrotickDuration` are statically configured parameters and are returned by `FrIf_GetCycleLength` and `FrIf_GetMacroTickDuration`, respectively.

**Note**: The FrTSyn passes 0 to avoid undefined values. The structure members `referenceLocalTimestamp` and `referenceGlobalTimestamp` will be set by the StbM `StbM_FrSetSlaveTimingData()` internally (refer to **SWS_StbM_00471** in [4]).

**[SWS_FrTSyn_00100]{DRAFT}[**
If

- time recording for Time Validation is enabled for a Time Domain (refer to **[SWS_FrTSyn_00096]** and **[SWS_FrTSyn_00097]**) and
- FrTSyn is configured as Time Master for that Time Domain,

FrTSyn shall call `StbM_FrSetMasterTimingData()` upon successful transmission of a `SYNC` message (refer to Figure 4).
] (RS_TS_00034)

**[SWS_FrTSyn_00101]{DRAFT}[**
Upon invocation of `StbM_FrSetMasterTimingData()` FrTSyn shall pass the following data

- the Sequence Counter as sent in the `Sync` message
- the reference timestamp $T1_{VLT}$ (refer to step 2 In **[SWS_FrTSyn_00028]**),
- T0 as sent in the `Sync` Message (refer to step 3 In **[SWS_FrTSyn_00028]**),

by the parameter `measureDataPtr`.
] (RS_TS_00034)

## 7.7 Error Classification

This chapter lists and classifies all errors that can be detected by this software module. Each error is classified to relevance (development / production) and the related error code (unique label for the error). For development errors this table also specifies the unique values, which correspond to the error codes.

**[SWS_FrTSyn_00058][**
On errors and exceptions, the FrTSyn module shall not modify its current module state but shall simply report the error event.
](RS_TS_20042, SRS_BSW_00323)

### 7.7.1 Development Errors

The detection of development errors is configurable (see section 10.2, `FrTSynDevErrorDetect`).

**[SWS_FrTSyn_00059][**
FrTSyn shall use following development errors:

| *Type or error* | *Related error code* | *Value [hex]* |
|---|---|---|
| API service called with wrong PDU or SDU. | `FRTSYN_E_INVALID_PDUID` | `0x01` |
| API service used in un-initialized state | `FRTSYN_E_UNINIT` | `0x20` |
| A pointer is invalid | `FRTSYN_E_NULL_POINTER` | `0x21` |
| FrTSyn initialization failed | `FRTSYN_E_INIT_FAILED` | `0x22` |
| API called with invalid parameter | `FRTSYN_E_PARAM` | `0x23` |
| Invalid Controller index | `FRTSYN_E_INV_CTRL_IDX` | `0x24` |

](SRS_BSW_00385)

### 7.7.2 Runtime Errors

No Runtime Errors defined.

### 7.7.3 Transient Faults

No Transient Faults defined.

### 7.7.4 Production Errors

No Production Errors defined.

### 7.7.5 Extended Production Errors

No Extended Production Errors defined.

# 8 API specification

## 8.1 API

### 8.1.1 Imported types

In this section all types included from the following modules are listed:

**[SWS_FrTSyn_00060]**[

| *Module* | *Header File* | *Imported Type* |
|---|---|---|
| ComStack_Types | ComStack_Types.h | PduIdType |
| | ComStack_Types.h | PduInfoType |
| | ComStack_Types.h | PduLengthType |
| FrIf | FrIf.h | FrIf_StateType |
| StbM | Rte_StbM_Type.h | StbM_FrTimeMasterMeasurementType |
| | Rte_StbM_Type.h | StbM_FrTimeSlaveMeasurementType |
| | Rte_StbM_Type.h | StbM_SynchronizedTimeBaseType |
| | Rte_StbM_Type.h | StbM_TimeBaseStatusType |
| | Rte_StbM_Type.h | StbM_TimeStampShortType |
| | Rte_StbM_Type.h | StbM_TimeStampType |
| | Rte_StbM_Type.h | StbM_UserDataType |
| | StbM.h | StbM_MeasurementType |
| | StbM.h | StbM_VirtualLocalTimeType |
| Std | Std_Types.h | Std_ReturnType |
| | Std_Types.h | Std_VersionInfoType |

](RS_TS_20043)

### 8.1.2 Type definitions

#### 8.1.2.1 FrTSyn_ConfigType

**[SWS_FrTSyn_00061]**[

| *Name* | FrTSyn_ConfigType |
|---|---|

| | | |
|---|---|---|
| ***Kind*** | Structure | |
| ***Elements*** | implementation specific | |
| | ***Type*** | -- |
| | ***Comment*** | -- |
| ***Description*** | This is the base type for the configuration of the Time Synchronization over FlexRay. A pointer to an instance of this structure will be used in the initialization of the Time Synchronization over FlexRay.<br>The content of this structure is defined in chapter 10 Configuration specification. | |
| ***Available via*** | FrTSyn.h | |

](RS_TS_20043)

#### 8.1.2.2 FrTSyn_TransmissionModeType

**[SWS_FrTSyn_00062]**[

| | | | |
|---|---|---|---|
| ***Name*** | FrTSyn_TransmissionModeType | | |
| ***Kind*** | Enumeration | | |
| ***Range*** | FRTSYN_TX_OFF | -- | Transmission Disabled |
| | FRTSYN_TX_ON | -- | Transmission Enabled |
| ***Description*** | Handles the enabling and disabling of the transmission mode | | |
| ***Available via*** | FrTSyn.h | | |

](RS_TS_20043)

### 8.1.3 Function definitions

#### 8.1.3.1 FrTSyn_Init

**[SWS_FrTSyn_00063]**[

| | | |
|---|---|---|
| ***Service Name*** | FrTSyn_Init | |
| ***Syntax*** | `void FrTSyn_Init (`<br>`  const FrTSyn_ConfigType* configPtr`<br>`)` | |
| ***Service ID [hex]*** | 0x01 | |
| ***Sync/Async*** | Synchronous | |
| ***Reentrancy*** | Non Reentrant | |
| ***Parameters (in)*** | configPtr | Pointer to selected configuration structure |

| | |
|---|---|
| ***Parameters (inout)*** | None |
| ***Parameters (out)*** | None |
| ***Return value*** | None |
| ***Description*** | This function initializes the Time Synchronization over FlexRay. |
| ***Available via*** | FrTSyn.h |

](RS_TS_20043)

See section 7.2.1 for details.

#### 8.1.3.2 FrTSyn_GetVersionInfo

**[SWS_FrTSyn_00064]**[

| | | |
|---|---|---|
| ***Service Name*** | FrTSyn_GetVersionInfo | |
| ***Syntax*** | `void FrTSyn_GetVersionInfo ( Std_VersionInfoType* versioninfo )` | |
| ***Service ID [hex]*** | 0x02 | |
| ***Sync/Async*** | Synchronous | |
| ***Reentrancy*** | Non Reentrant | |
| ***Parameters (in)*** | None | |
| ***Parameters (inout)*** | None | |
| ***Parameters (out)*** | versioninfo | Pointer to where to store the version information of this module. |
| ***Return value*** | None | |
| ***Description*** | Returns the version information of this module. | |
| ***Available via*** | FrTSyn.h | |

](RS_TS_20043)

#### 8.1.3.3 FrTSyn_SetTransmissionMode

**[SWS_FrTSyn_00065]**[

| | |
|---|---|
| ***Service Name*** | FrTSyn_SetTransmissionMode |
| ***Syntax*** | `void FrTSyn_SetTransmissionMode ( uint8 CtrlIdx, FrTSyn_TransmissionModeType Mode )` |
| ***Service ID [hex]*** | 0x03 |

| | | |
|---|---|---|
| ***Sync/Async*** | Synchronous | |
| ***Reentrancy*** | Non Reentrant | |
| ***Parameters (in)*** | CtrlIdx | Index of the FlexRay channel |
| | Mode | FRTSYN_TX_OFF FRTSYN_TX_ON |
| ***Parameters (inout)*** | None | |
| ***Parameters (out)*** | None | |
| ***Return value*** | None | |
| ***Description*** | This API is used to turn on and off the TX capabilities of the FrTSyn. | |
| ***Available via*** | FrTSyn.h | |

](RS_TS_20043)

**[SWS_FrTSyn_00095]**[
The function `FrTSyn_SetTransmissionMode()` shall inform the DET, if development error detection is enabled (`FrTSynDevErrorDetect` is set to `TRUE`) and if function call has failed because of the following reasons:

- Invalid `CtrlIdx` (`FRTSYN_E_INV_CTRL_IDX`)
- Invalid `Mode` (`FRTSYN_E_PARAM`)

](SRS_BSW_00323, SRS_BSW_00337)

### 8.1.4 Call-back notifications

This is a list of functions provided for other modules.

#### 8.1.4.1 FrTSyn_RxIndication

**[SWS_FrTSyn_00066]**[

| | | |
|---|---|---|
| ***Service Name*** | FrTSyn_RxIndication | |
| ***Syntax*** | `void FrTSyn_RxIndication ( PduIdType RxPduId, const PduInfoType* PduInfoPtr )` | |
| ***Service ID [hex]*** | 0x42 | |
| ***Sync/Async*** | Synchronous | |
| ***Reentrancy*** | Reentrant for different PduIds. Non reentrant for the same PduId. | |
| ***Parameters (in)*** | RxPduId | ID of the received PDU. |
| | Pdu | Contains the length (SduLength) of the received PDU, a pointer to a |

| | | |
|---|---|---|
| | InfoPtr | buffer (SduDataPtr) containing the PDU, and the MetaData related to this PDU. |
| ***Parameters (inout)*** | None | |
| ***Parameters (out)*** | None | |
| ***Return value*** | None | |
| ***Description*** | Indication of a received PDU from a lower layer communication interface module. | |
| ***Available via*** | FrTSyn.h | |

](RS_TS_20043)

**Note:** The callback function `FrTSyn_RxIndication` called by the FR Interface and implemented by the FrTSyn module. It is called in case of a receive indication event of the FR Driver.

**[SWS_FrTSyn_00067][**
The callback function `FrTSyn_RxIndication()` shall inform the DET, if development error detection is enabled (`FrTSynDevErrorDetect` is set to TRUE) and if function call has failed because of the following reasons:

- Invalid PDU ID (`FRTSYN_E_INVALID_PDUID`)
- `PduInfoPtr` or `SduDataPtr` equals `NULL_PTR` (`FRTSYN_E_NULL_POINTER`)

](SRS_BSW_00323, SRS_BSW_00337)

**Caveats** of `FrTSyn_RxIndication()`:

- The FrTSyn module is initialized correctly.

### 8.1.4.2 FrTSyn_TriggerTransmit

**[SWS_FrTSyn_00069][**

| | | |
|---|---|---|
| ***Service Name*** | FrTSyn_TriggerTransmit | |
| ***Syntax*** | `Std_ReturnType FrTSyn_TriggerTransmit ( PduIdType TxPduId, PduInfoType* PduInfoPtr )` | |
| ***Service ID [hex]*** | 0x41 | |
| ***Sync/Async*** | Synchronous | |
| ***Reentrancy*** | Reentrant for different PduIds. Non reentrant for the same PduId. | |
| ***Parameters (in)*** | TxPduId | ID of the SDU that is requested to be transmitted. |

| | | |
|---|---|---|
| ***Parameters (inout)*** | PduInfoPtr | Contains a pointer to a buffer (SduDataPtr) to where the SDU data shall be copied, and the available buffer size in SduLengh. On return, the service will indicate the length of the copied SDU data in SduLength. |
| ***Parameters (out)*** | None | |
| ***Return value*** | Std_-Return-Type | E_OK: SDU has been copied and SduLength indicates the number of copied bytes.<br>E_NOT_OK: No SDU data has been copied. PduInfoPtr must not be used since it may contain a NULL pointer or point to invalid data. |
| ***Description*** | Within this API, the upper layer module (called module) shall check whether the available data fits into the buffer size reported by PduInfoPtr->SduLength. If it fits, it shall copy its data into the buffer provided by PduInfoPtr->SduDataPtr and update the length of the actual copied data in PduInfoPtr->SduLength. If not, it returns E_ NOT_OK without changing PduInfoPtr. | |
| ***Available via*** | FrTSyn.h | |

](RS_TS_20043)

**Note:** The function `FrTSyn_TriggerTransmit()` might be called by the FrTSyn module's environment in an interrupt context.

**[SWS_FrTSyn_00070][**
The callback function `FrTSyn_TriggerTransmit()` shall inform the DET, if development error detection is enabled (`FrTSynDevErrorDetect` is set to `TRUE`) and if function call has failed because of the following reasons:

- Invalid PDU ID (`FRTSYN_E_INVALID_PDUID`)
- `PduInfoPtr` or `SduDataPtr` equals `NULL_PTR` (`FRTSYN_E_NULL_POINTER`)

](SRS_BSW_00323, SRS_BSW_00337)

### 8.1.5 Scheduled functions

These functions are directly called by the Basic Software Scheduler. The following functions shall have no return value and no parameters. All functions shall be non-reentrant.

#### 8.1.5.1 FrTSyn_MainFunction

**[SWS_FrTSyn_00071][**

| | |
|---|---|
| ***Service Name*** | FrTSyn_MainFunction |
| ***Syntax*** | `void FrTSyn_MainFunction (`<br>`  void`<br>`)` |
| ***Service ID [hex]*** | 0x04 |
| ***Description*** | Main function for cyclic call / resp. Timesync message transmission |

| *Available via* | FrTSyn_SchM.h |
|---|---|

](RS_TS_20043)

**[SWS_FrTSyn_00072][**
The frequency of invocations of `FrTSyn_MainFunction()` is determined by the configuration parameter `FrTSynMainFunctionPeriod` (refer to **ECUC_FrTSyn_00016 :** ).
](RS_TS_20043)

### 8.1.6 Expected Interfaces

In this section, all interfaces required by other modules are listed.

#### 8.1.6.1 Mandatory Interfaces

This section defines all interfaces that are required to fulfill a mandatory functionality of the module.

**[SWS_FrTSyn_00074]**[

| *API Function* | *Header File* | *Description* |
|---|---|---|
| FrIf_GetCycle-Length | FrIf.h | This API returns the configured time of the configuration parameter "GdCycle" in nanoseconds for the FlexRay controller with index Fr If_CtrlIdx. |
| FrIf_GetGlobalTime | FrIf.h | Wraps the FlexRay Driver API function Fr_GetGlobalTime(). Important Note: FrIf_GetGlobalTime may be called within an exclusive area. |
| FrIf_GetMacrotick-Duration | FrIf.h | Retrieves the Duration of a Macrotick in ns |
| FrIf_GetState | FrIf.h | Get current FrIf state. |
| StbM_GetCurrent-VirtualLocalTime | StbM.h | Returns the Virtual Local Time of the referenced Time Base. |

](RS_TS_20043)

#### 8.1.6.2 Optional Interfaces

This section defines all interfaces that are required to fulfill an optional functionality of the module.

**[SWS_FrTSyn_00075]**[

| *API Function* | *Header File* | *Description* |
|---|---|---|
| Crc_CalculateC-RC8H2F | Crc.h | This service makes a CRC8 calculation with the Polynomial 0x2F on Crc_Length |
| Det_ReportError | Det.h | Service to report development errors. |
| FrIf_Transmit | FrIf.h | Requests transmission of a PDU. |
| StbM_BusGet-CurrentTime | StbM.h | Returns the current Time Tuple, status and User Data of the Time Base. |
| StbM_BusSet-GlobalTime | StbM.h | Allows the Time Base Provider Modules to forward a new Global Time tuple (i.e., the Received Time Tuple) to the StbM. |
| StbM_FrSet-MasterTiming- | StbM_Eth TSyn.h | Provides Flexray Timesyn module specific data for a Time Master to the StbM. |

| | | |
|---|---|---|
| Data | | **Tags:**atp.Status=draft |
| StbM_FrSet-SlaveTimingData | StbM_FrTSyn.h | Allows the FrTSyn Module to forward Flexray specific details to the StbM.<br>**Tags:**atp.Status=draft |
| StbM_Get-CurrentTime | StbM.h | Returns a time value (Local Time Base derived from Global Time Base) in standard format.<br>Note: This API shall be called with locked interrupts / within an Exclusive Area to prevent interruption (i.e., the risk that the time stamp is outdated on return of the function call). |
| StbM_GetOffset | StbM.h | Allows the Timesync Modules to get the current Offset Time and User Data. |
| StbM_GetTime-BaseStatus | StbM.h | Returns detailed status information for a Synchronized (or Pure Local) Time Base and, if called for an Offset Time Base, for the Offset Time Base and the underlying Synchronized Time Base. |
| StbM_GetTime-BaseUpdate-Counter | StbM.h | Allows the Timesync Modules to detect, whether a Time Base should be transmitted immediately in the subsequent <Bus>TSyn_Main Function() cycle. |

](RS_TS_20043)

# 9 Sequence diagrams

## 9.1 FlexRay Time Synchronization (Time Master)

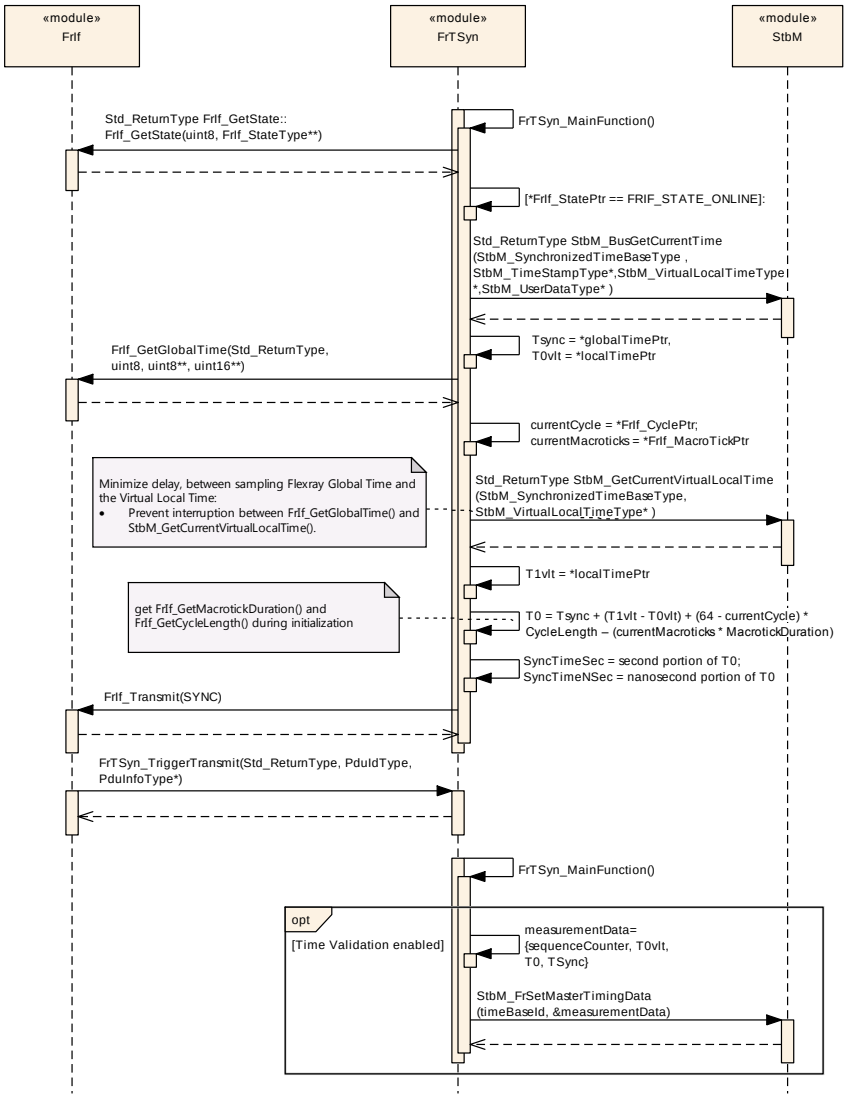



**Figure 4: FlexRay Time Synchronization (Time Master)**

## 9.2 FlexRay Time Synchronization (Time Slave)

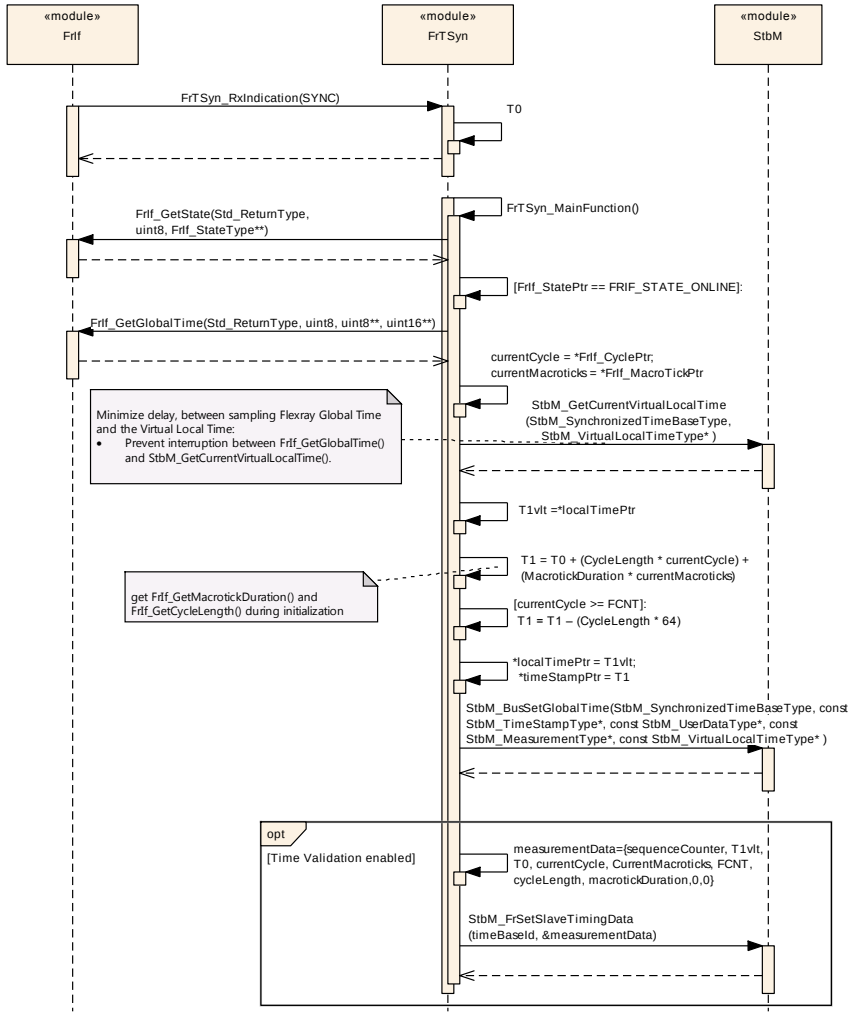



**Figure 5: FlexRay Time Synchronization (Time Slave)**

# 10 Configuration specification

In general, this chapter defines configuration parameters and their clustering into containers. In order to support the specification section 10.1 describes fundamentals. It also specifies a template (table) you shall use for the parameter specification. We intend to leave section 10.1 in the specification to guarantee comprehension.

Section 10.2 specifies the structure (containers) and the parameters of the Time Synchronization over FlexRay.

Section 10.3 specifies published information of the Time Synchronization over FlexRay.

## 10.1 How to read this chapter

For details, refer to the chapter 10.1 “Introduction to configuration specification” in *SWS_BSWGeneral*.

## 10.2 Containers and configuration parameters

The following sections summarize all configuration parameters of the Time Synchronization over FlexRay. The detailed meaning of the parameters is described in chapters 7 and 8.

### 10.2.1 Variants

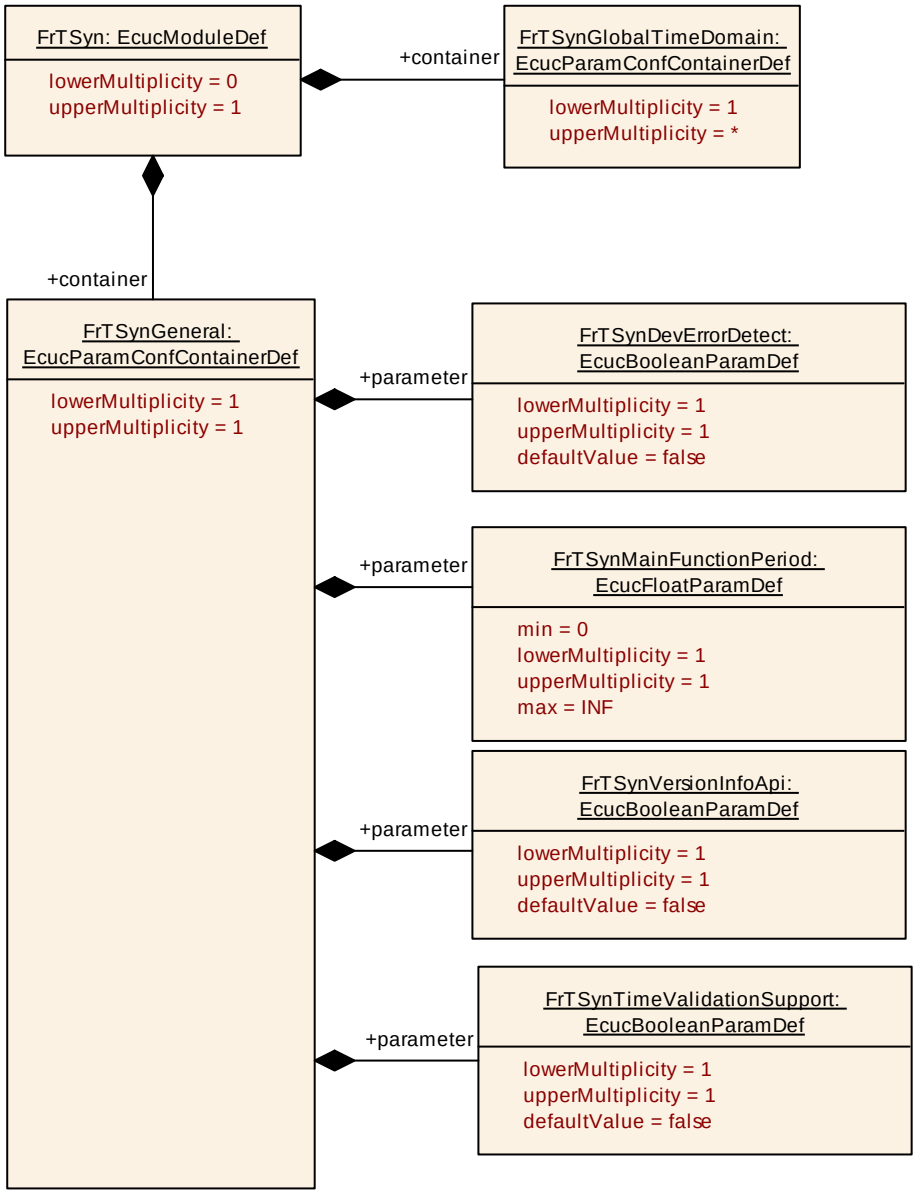
**[SWS_FrTSyn_00077][**
The Time Synchronization over FlexRay shall support the configuration for Time Master, Time Slave and Time Gateway.
](RS_TS_20046)

The module supports different post-build variants (previously known as post-build selectable configuration sets), but not post-build loadable configuration.

### 10.2.2 FrTSyn

| | |
|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00001 :** |
| ***Module Name*** | *FrTSyn* |
| ***Module Description*** | This represents the specific configuration variant for the TSyn on Flexray. |
| ***Post-Build Variant Support*** | true |
| ***Supported Config Variants*** | VARIANT-PRE-COMPILE |

| ***Included Containers*** | | |
|---|---|---|
| ***Container Name*** | ***Multiplicity*** | ***Scope / Dependency*** |
| FrTSynGeneral | 1 | This container holds the general parameters of the Flexray-specific Synchronized Time-base Manager |
| FrTSynGlobalTimeDomain | 1..* | This represents the existence of a global time domain on Flexray. The FrTSyn module can administrate several global time domains at the same time that in itself form a hierarchy of domains and sub-domains.<br>If the FrTSyn exists it is assumed that at least one global time domain exists. |




### 10.2.3 FrTSynGeneral

| ***SWS Item*** | **ECUC_FrTSyn_00003 :** |
|---|---|
| ***Container Name*** | FrTSynGeneral |
| ***Parent Container*** | FrTSyn |
| ***Description*** | This container holds the general parameters of the Flexray-specific Synchronized Time-base Manager |
| ***Configuration Parameters*** | |

| ***SWS Item*** | **ECUC_FrTSyn_00002 :** |
|---|---|
| ***Name*** | FrTSynDevErrorDetect |
| ***Parent Container*** | FrTSynGeneral |
| ***Description*** | Switches the development error detection and notification on or off.<br>• true: detection and notification is enabled. |

| | | | |
|---|---|---|---|
| | • false: detection and notification is disabled. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucBooleanParamDef | | |
| ***Default value*** | false | | |
| ***Post-Build Variant Value*** | false | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00016 :** | | |
| ***Name*** | FrTSynMainFunctionPeriod | | |
| ***Parent Container*** | FrTSynGeneral | | |
| ***Description*** | Schedule period of the main function FrTSyn_MainFunction. Unit: [s]. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucFloatParamDef | | |
| ***Range*** | ]0 .. INF[ | | |
| ***Default value*** | -- | | |
| ***Post-Build Variant Value*** | false | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00040 :** | | |
| ***Name*** | FrTSynTimeValidationSupport | | |
| ***Parent Container*** | FrTSynGeneral | | |
| ***Description*** | Switches support for Time Validation on or off.<br>▪ true: Time Validation is enabled.<br>▪ false:Time Validation is disabled. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucBooleanParamDef | | |
| ***Default value*** | false | | |
| ***Post-Build Variant Value*** | false | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00019 :** | | |
| ***Name*** | FrTSynVersionInfoApi | | |
| ***Parent Container*** | FrTSynGeneral | | |
| ***Description*** | Activate/Deactivate the version information API (FrTSyn_GetVersionInfo). True: version information API activated False: version information API deactivated. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucBooleanParamDef | | |
| ***Default value*** | false | | |
| ***Post-Build Variant Value*** | false | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| *No Included Containers* |
|---|

### 10.2.4 FrTSynGlobalTimeDomain

| *SWS Item* | **ECUC_FrTSyn_00004 :** |
|---|---|
| *Container Name* | FrTSynGlobalTimeDomain |
| *Parent Container* | FrTSyn |
| *Description* | This represents the existence of a global time domain on Flexray. The FrTSyn module can administrate several global time domains at the same time that in itself form a hierarchy of domains and sub-domains.<br><br>If the FrTSyn exists it is assumed that at least one global time domain exists. |
| *Configuration Parameters* | |

| *SWS Item* | **ECUC_FrTSyn_00041 :** | | |
|---|---|---|---|
| *Name* | FrTSynEnableTimeValidation | | |
| *Parent Container* | FrTSynGlobalTimeDomain | | |
| *Description* | Enables/disables time recording for Time Validation for a specific Time Domain. | | |
| *Multiplicity* | 0..1 | | |
| *Type* | EcucBooleanParamDef | | |
| *Default value* | -- | | |
| *Post-Build Variant Value* | false | | |
| *Value Configuration Class* | *Pre-compile time* | X | All Variants |
| | *Link time* | -- | |
| | *Post-build time* | -- | |
| *Scope / Dependency* | scope: local<br>dependency: Only valid if FrTSynTimeValidationSupport is TRUE. Value set according to parameter StbMEnableTimeValidation of the referenced Time Base in the StbM. | | |

| *SWS Item* | **ECUC_FrTSyn_00005 :** | | |
|---|---|---|---|
| *Name* | FrTSynGlobalTimeDomainId | | |
| *Parent Container* | FrTSynGlobalTimeDomain | | |
| *Description* | The global time domain ID. | | |
| *Multiplicity* | 1 | | |
| *Type* | EcucIntegerParamDef | | |
| *Range* | 0 .. 31 | | |
| *Default value* | -- | | |
| *Post-Build Variant Value* | false | | |
| *Value Configuration Class* | *Pre-compile time* | X | All Variants |
| | *Link time* | -- | |
| | *Post-build time* | -- | |
| *Scope / Dependency* | scope: local | | |

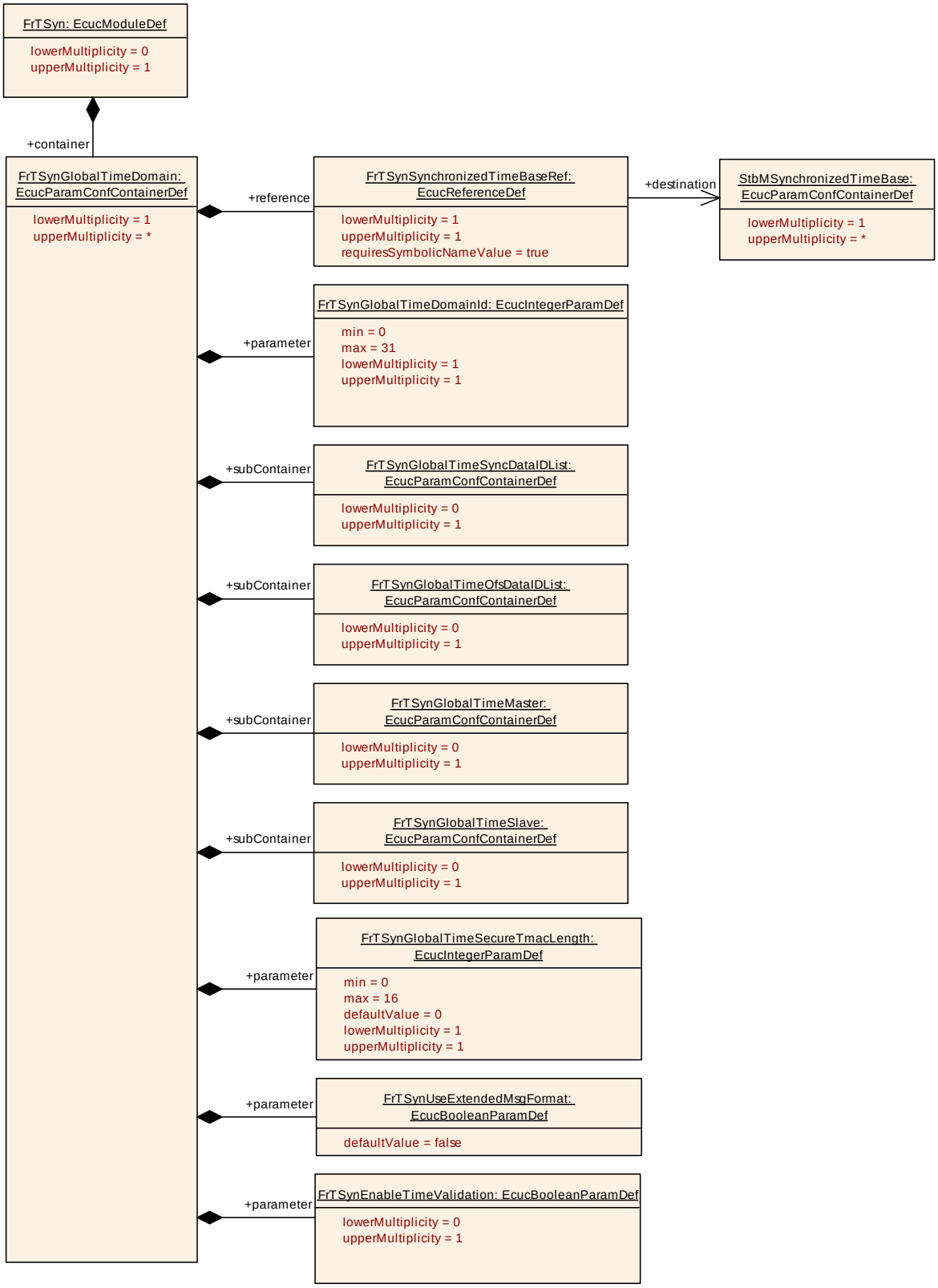
| *SWS Item* | **ECUC_FrTSyn_00034 :** |
|---|---|
| *Name* | FrTSynGlobalTimeSecureTmacLength |
| *Parent Container* | FrTSynGlobalTimeDomain |
| *Description* | Represents the number of bytes for the used Truncated Message Authentication Code (TMAC). If 0, no message authentication will be used.<br>**Tags:** |

| | | | |
|---|---|---|---|
| | atp.Status=draft | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucIntegerParamDef | | |
| ***Range*** | 0 .. 16 | | |
| ***Default value*** | 0 | | |
| ***Post-Build Variant Value*** | false | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00035 :** | | |
| ***Name*** | FrTSynUseExtendedMsgFormat | | |
| ***Parent Container*** | FrTSynGlobalTimeDomain | | |
| ***Description*** | • true: use at least 32 byte for Timesync messages (depending on configuration)<br>• false: use always 16 byte for Timesync messages<br>**Tags:**<br>atp.Status=draft | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucBooleanParamDef | | |
| ***Default value*** | false | | |
| ***Post-Build Variant Value*** | false | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00018 :** | | |
| ***Name*** | FrTSynSynchronizedTimeBaseRef | | |
| ***Parent Container*** | FrTSynGlobalTimeDomain | | |
| ***Description*** | Mandatory reference to the required synchronized time-base. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | Symbolic name reference to [ StbMSynchronizedTimeBase ] | | |
| ***Post-Build Variant Value*** | false | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| ***Included Containers*** | | |
|---|---|---|
| ***Container Name*** | ***Multiplicity*** | ***Scope / Dependency*** |
| FrTSynGlobalTimeMaster | 0..1 | Configuration of the global time master. Each global time domain is required to have exactly one global time master. This master may or may not exist on the configured ECU. |
| FrTSynGlobalTimeOfsDataIDList | 0..1 | The DataIDList for OFS messages ensures the identification of data elements due to CRC calculation and message authentication process. |
| FrTSynGlobalTimeSlave | 0..1 | This represents the time slave for the enclosing global time domain. |
| FrTSynGlobalTimeSyncDataIDList | 0..1 | The DataIDList for SYNC messages ensures the identification of data elements due to CRC calculation and message authentication process. |

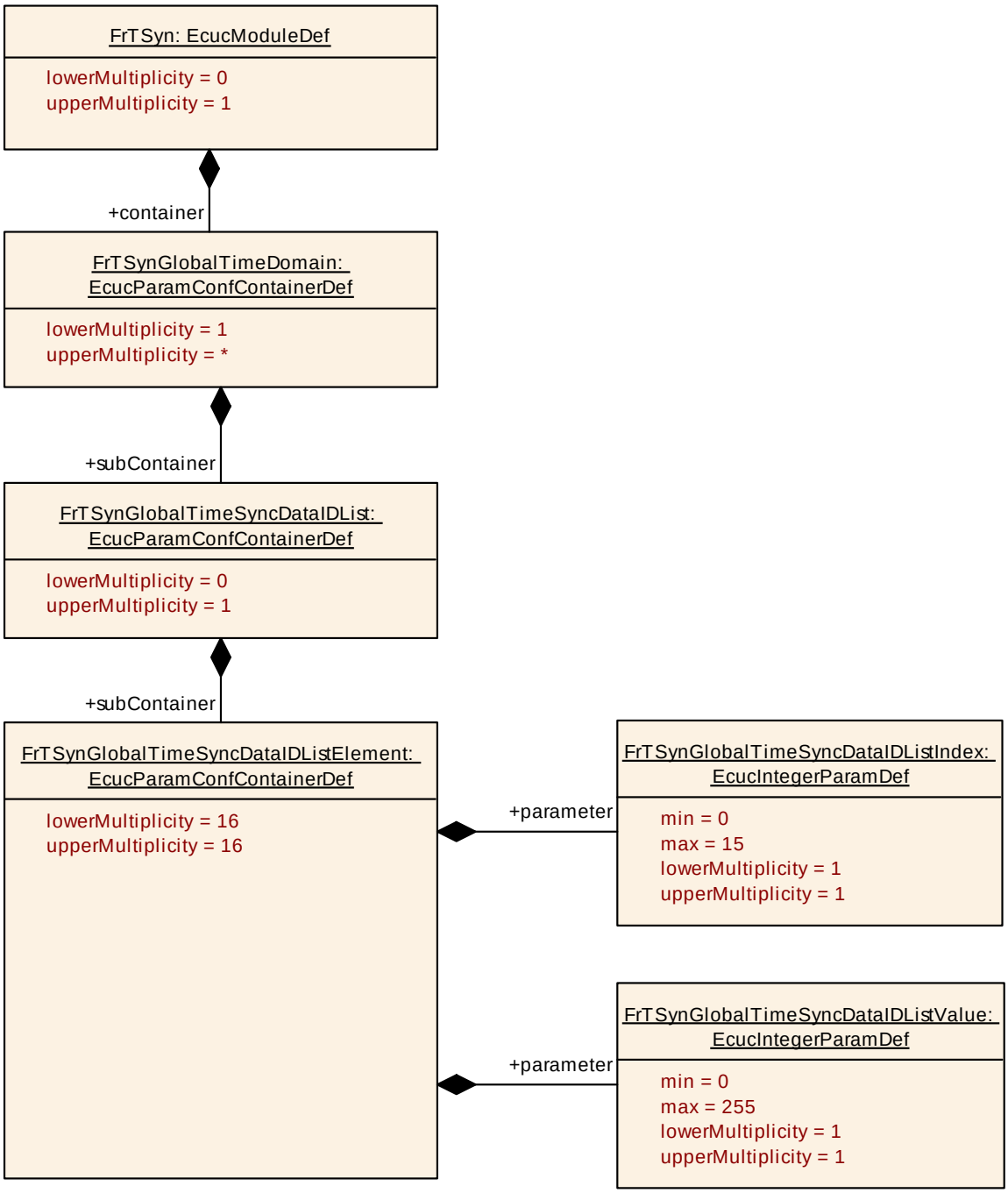



## 10.2.5 FrTSynGlobalTimeSyncDataIDList

| *SWS Item* | ECUC_FrTSyn_00023 : |
|---|---|

| | | | |
|---|---|---|---|
| ***Container Name*** | FrTSynGlobalTimeSyncDataIDList | | |
| ***Parent Container*** | FrTSynGlobalTimeDomain | | |
| ***Description*** | The DataIDList for SYNC messages ensures the identification of data elements due to CRC calculation and message authentication process. | | |
| ***Post-Build Variant Multiplicity*** | true | | |
| ***Multiplicity Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Configuration Parameters*** | | | |

| ***Included Containers*** | | |
|---|---|---|
| ***Container Name*** | ***Multiplicity*** | ***Scope / Dependency*** |
| FrTSynGlobalTimeSyncDataIDListElement | 16 | Element of the DataIDList for SYNC messages ensures the identification of data elements due to CRC calculation and message authentication process. |




### 10.2.6 FrTSynGlobalTimeSyncDataIDListElement

| ***SWS Item*** | **ECUC_FrTSyn_00025 :** |
|---|---|
| ***Container Name*** | FrTSynGlobalTimeSyncDataIDListElement |
| ***Parent Container*** | FrTSynGlobalTimeSyncDataIDList |
| ***Description*** | Element of the DataIDList for SYNC messages ensures the identification of data elements due to CRC calculation and message authentication process. |
| ***Configuration Parameters*** | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00026 :** | | |
| ***Name*** | FrTSynGlobalTimeSyncDataIDListIndex | | |
| ***Parent Container*** | FrTSynGlobalTimeSyncDataIDListElement | | |
| ***Description*** | Index of the DataIDList for SYNC messages ensures the identification of data elements due to CRC calculation and message authentication process. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucIntegerParamDef | | |
| ***Range*** | 0 .. 15 | | |
| ***Default value*** | -- | | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00027 :** | | |
| ***Name*** | FrTSynGlobalTimeSyncDataIDListValue | | |
| ***Parent Container*** | FrTSynGlobalTimeSyncDataIDListElement | | |
| ***Description*** | Value of the DataIDList for SYNC messages ensures the identification of data elements due to CRC calculation and message authentication process. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucIntegerParamDef | | |
| ***Range*** | 0 .. 255 | | |
| ***Default value*** | -- | | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

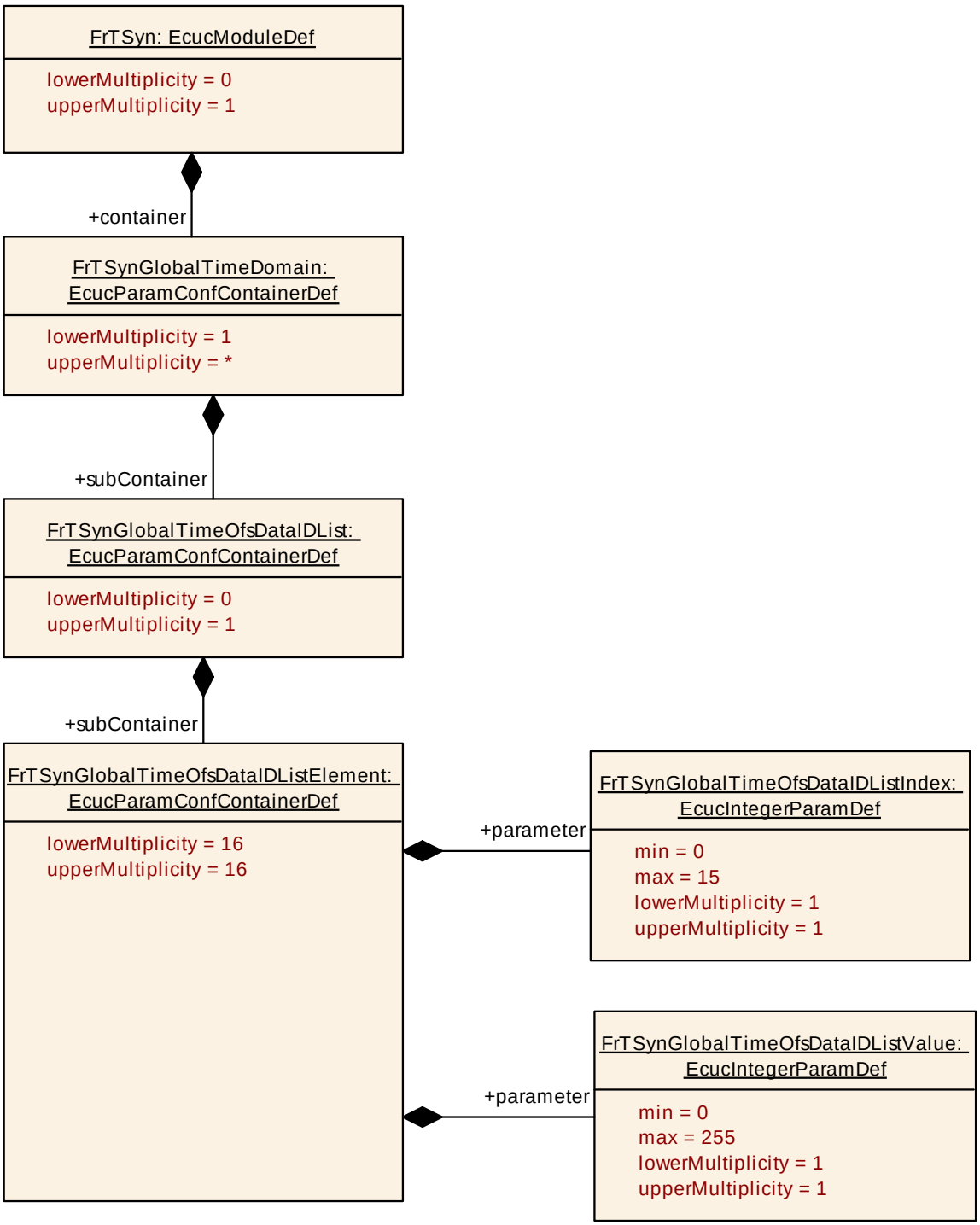
| |
|---|
| ***No Included Containers*** |

## 10.2.7 FrTSynGlobalTimeOfsDataIDList

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00024 :** | | |
| ***Container Name*** | FrTSynGlobalTimeOfsDataIDList | | |
| ***Parent Container*** | FrTSynGlobalTimeDomain | | |
| ***Description*** | The DataIDList for OFS messages ensures the identification of data elements due to CRC calculation and message authentication process. | | |
| ***Post-Build Variant Multiplicity*** | true | | |
| ***Multiplicity Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Configuration Parameters*** | | | |

| ***Included Containers*** | | |
|---|---|---|
| ***Container Name*** | ***Multiplicity*** | ***Scope / Dependency*** |
| FrTSynGlobalTimeOfsDataIDListElement | 16 | Element of the DataIDList for OFS messages ensures the identification of data elements due to |

| | | |
|---|---|---|
| | | CRC calculation and message authentication process. |




### 10.2.8 FrTSynGlobalTimeOfsDataIDListElement

| *SWS Item* | ECUC_FrTSyn_00028 : |
|---|---|

| | |
|---|---|
| ***Container Name*** | FrTSynGlobalTimeOfsDataIDListElement |
| ***Parent Container*** | FrTSynGlobalTimeOfsDataIDList |
| ***Description*** | Element of the DataIDList for OFS messages ensures the identification of data elements due to CRC calculation and message authentication process. |
| ***Configuration Parameters*** | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00029 :** | | |
| ***Name*** | FrTSynGlobalTimeOfsDataIDListIndex | | |
| ***Parent Container*** | FrTSynGlobalTimeOfsDataIDListElement | | |
| ***Description*** | Index of the DataIDList for OFS messages ensures the identification of data elements due to CRC calculation and message authentication process. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucIntegerParamDef | | |
| ***Range*** | 0 .. 15 | | |
| ***Default value*** | -- | | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00030 :** | | |
| ***Name*** | FrTSynGlobalTimeOfsDataIDListValue | | |
| ***Parent Container*** | FrTSynGlobalTimeOfsDataIDListElement | | |
| ***Description*** | Value of the DataIDList for OFS messages ensures the identification of data elements due to CRC calculation and message authentication process. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucIntegerParamDef | | |
| ***Range*** | 0 .. 255 | | |
| ***Default value*** | -- | | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| |
|---|
| ***No Included Containers*** |

## 10.2.9 FrTSynGlobalTimeMaster

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00006 :** | | |
| ***Container Name*** | FrTSynGlobalTimeMaster | | |
| ***Parent Container*** | FrTSynGlobalTimeDomain | | |
| ***Description*** | Configuration of the global time master. Each global time domain is required to have exactly one global time master. This master may or may not exist on the configured ECU. | | |
| ***Post-Build Variant Multiplicity*** | true | | |
| ***Multiplicity Configuration*** | ***Pre-compile time*** | X | All Variants |

| | | | |
|---|---|---|---|
| ***Class*** | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Configuration Parameters*** | | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00032 :** | | |
| ***Name*** | FrTSynCyclicMsgResumeTime | | |
| ***Parent Container*** | FrTSynGlobalTimeMaster | | |
| ***Description*** | Defines the time where the 1st regular cycle time based message transmission takes place, after an immediate transmission before. Unit: seconds | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucFloatParamDef | | |
| ***Range*** | [0 .. INF] | | |
| ***Default value*** | -- | | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00033 :** | | |
| ***Name*** | FrTSynGlobalTimeDebounceTime | | |
| ***Parent Container*** | FrTSynGlobalTimeMaster | | |
| ***Description*** | This represents the configuration of a TX debounce time for SYNC and OFS messages compared to a message before with the same PDU. Unit: seconds | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucFloatParamDef | | |
| ***Range*** | [0 .. INF[ | | |
| ***Default value*** | -- | | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00013 :** | | |
| ***Name*** | FrTSynGlobalTimeTxCrcSecured | | |
| ***Parent Container*** | FrTSynGlobalTimeMaster | | |
| ***Description*** | This represents the configuration of whether or not CRC is supported. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucEnumerationParamDef | | |
| ***Range*** | CRC_NOT_SUPPORTED | | This represents a configuration where CRC is not supported. |
| | CRC_SUPPORTED | | This represents a configuration where CRC is supported. |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

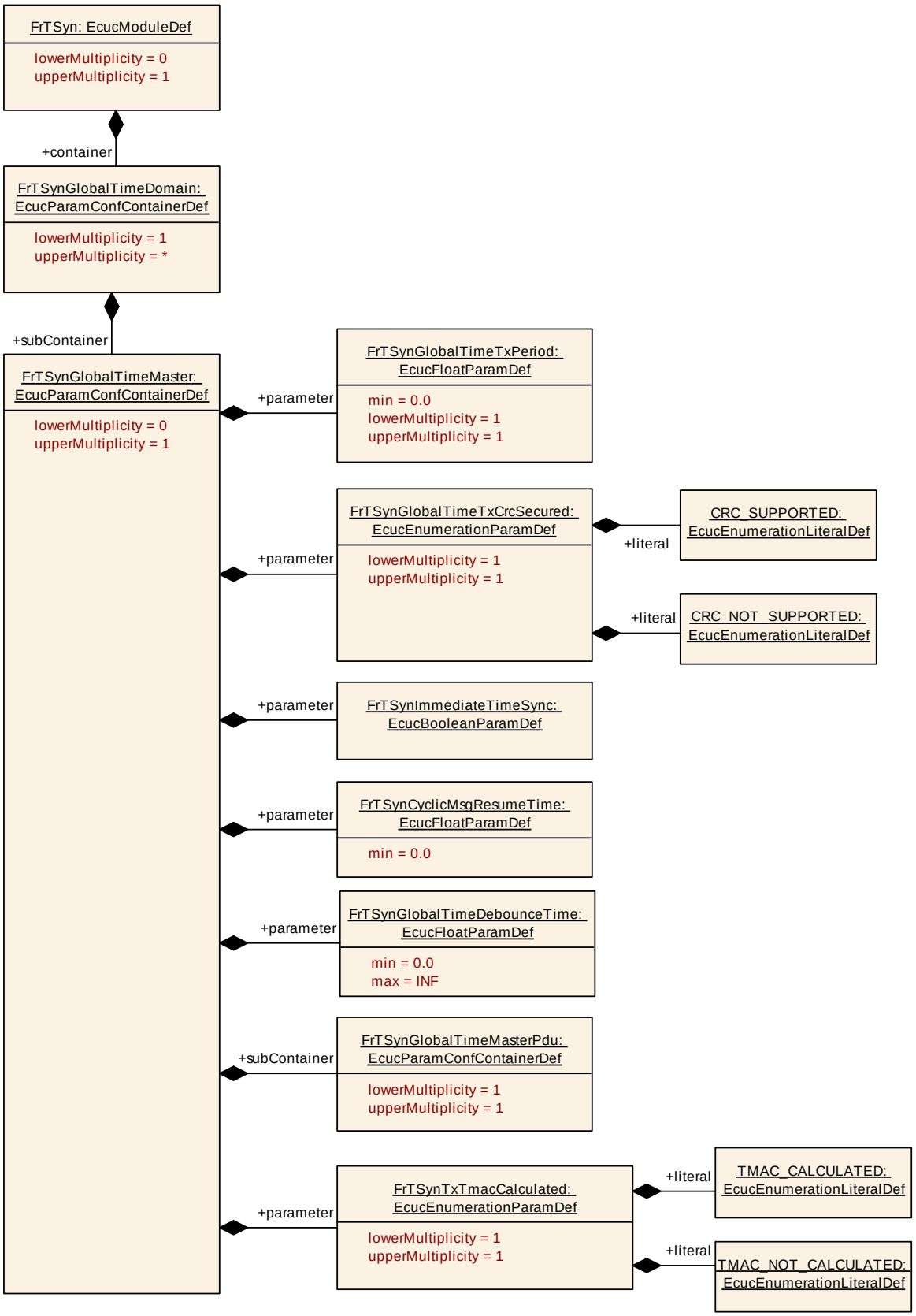
| | |
|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00014 :** |

| | | | |
|---|---|---|---|
| ***Name*** | FrTSynGlobalTimeTxPeriod | | |
| ***Parent Container*** | FrTSynGlobalTimeMaster | | |
| ***Description*** | This represents the TX period. Unit: seconds | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucFloatParamDef | | |
| ***Range*** | [0 .. INF] | | |
| ***Default value*** | -- | | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00031 :** | | |
| ***Name*** | FrTSynImmediateTimeSync | | |
| ***Parent Container*** | FrTSynGlobalTimeMaster | | |
| ***Description*** | Enables/Disables the cyclic polling of StbM_GetTimeBaseUpdateCounter() within FrTSyn_MainFunction(). | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucBooleanParamDef | | |
| ***Default value*** | -- | | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00036 :** | | |
| ***Name*** | FrTSynTxTmacCalculated | | |
| ***Parent Container*** | FrTSynGlobalTimeMaster | | |
| ***Description*** | This parameter controls whether or not TMAC calculation shall be supported.<br>**Tags:**<br>atp.Status=draft | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucEnumerationParamDef | | |
| ***Range*** | TMAC_CALCULATED | The Timesync module shall calculate the TMAC. | |
| | TMAC_NOT_CALCULATED | The Timesync module shall not calculate any TMAC. | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| ***Included Containers*** | | |
|---|---|---|
| ***Container Name*** | ***Multiplicity*** | ***Scope / Dependency*** |
| FrTSynGlobalTimeMasterPdu | 1 | This container carries all properties required to configure the PDU sent by the global time master for the given global time domain. |


FrTSyn: EcucModuleDef
lowerMultiplicity = 0
upperMultiplicity = 1
+container
FrTSynGlobalTimeDomain: EcucParamConfContainerDef
lowerMultiplicity = 1
upperMultiplicity = *
+subContainer
FrTSynGlobalTimeMaster: EcucParamConfContainerDef
lowerMultiplicity = 0
upperMultiplicity = 1
+parameter
FrTSynGlobalTimeTxPeriod: EcucFloatParamDef
min = 0.0
lowerMultiplicity = 1
upperMultiplicity = 1
+parameter
FrTSynGlobalTimeTxCrcSecured: EcucEnumerationParamDef
lowerMultiplicity = 1
upperMultiplicity = 1
+literal
CRC_SUPPORTED: EcucEnumerationLiteralDef
+literal
CRC_NOT_SUPPORTED: EcucEnumerationLiteralDef
+parameter
FrTSynImmediateTimeSync: EcucBooleanParamDef
+parameter
FrTSynCyclicMsgResumeTime: EcucFloatParamDef
min = 0.0
+parameter
FrTSynGlobalTimeDebounceTime: EcucFloatParamDef
min = 0.0
max = INF
+subContainer
FrTSynGlobalTimeMasterPdu: EcucParamConfContainerDef
lowerMultiplicity = 1
upperMultiplicity = 1
+parameter
FrTSynTxTmacCalculated: EcucEnumerationParamDef
lowerMultiplicity = 1
upperMultiplicity = 1
+literal
TMAC_CALCULATED: EcucEnumerationLiteralDef
+literal
TMAC_NOT_CALCULATED: EcucEnumerationLiteralDef

### 10.2.10 FrTSynGlobalTimeMasterPdu

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00008 :** | | |
| ***Container Name*** | FrTSynGlobalTimeMasterPdu | | |
| ***Parent Container*** | FrTSynGlobalTimeMaster | | |
| ***Description*** | This container carries all properties required to configure the PDU sent by the global time master for the given global time domain. | | |
| ***Configuration Parameters*** | | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00007 :** | | |
| ***Name*** | FrTSynGlobalTimeMasterHandleId | | |
| ***Parent Container*** | FrTSynGlobalTimeMasterPdu | | |
| ***Description*** | This represents the handle ID of the PDU that contains the global time information. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucIntegerParamDef (Symbolic Name generated for this parameter) | | |
| ***Range*** | 0 .. 65535 | | |
| ***Default value*** | -- | | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00020 :** | | |
| ***Name*** | FrTSynGlobalTimePduRef | | |
| ***Parent Container*** | FrTSynGlobalTimeMasterPdu | | |
| ***Description*** | This represents the reference to the Pdu taken to transmit the global time information. The global time master of a global time domain acts as the sender of the Pdu while all the time slaves are supposed to receive the Pdu. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | Reference to [ Pdu ] | | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| |
|---|
| ***No Included Containers*** |

### 10.2.11 FrTSynGlobalTimeSlave

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00010 :** | | |
| ***Container Name*** | FrTSynGlobalTimeSlave | | |
| ***Parent Container*** | FrTSynGlobalTimeDomain | | |
| ***Description*** | This represents the time slave for the enclosing global time domain. | | |
| ***Post-Build Variant Multiplicity*** | true | | |
| ***Multiplicity Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |

| | | | |
|---|---|---|---|
| | ***Post-build time*** | -- | |
| ***Configuration Parameters*** | | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00038 :** | | |
| ***Name*** | FrTSynGlobalTimeMinMsgGap | | |
| ***Parent Container*** | FrTSynGlobalTimeSlave | | |
| ***Description*** | This parameter represents the configuration of a minimum message gap time for received SYNC and OFS messages compared to a message before with the same PDU. If PDUs are received more often in between than this parameter allows, they shall be ignored.<br>Unit: seconds<br>**Tags:**<br>atp.Status=draft | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucFloatParamDef | | |
| ***Range*** | [0 .. INF] | | |
| ***Default value*** | 0 | | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00022 :** | | |
| ***Name*** | FrTSynGlobalTimeSequenceCounterJumpWidth | | |
| ***Parent Container*** | FrTSynGlobalTimeSlave | | |
| ***Description*** | The SequenceCounterJumpWidth specifies the maximum allowed gap of the Sequence Counter between two SYNC resp. two OFS messages. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucIntegerParamDef | | |
| ***Range*** | 1 .. 15 | | |
| ***Default value*** | -- | | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

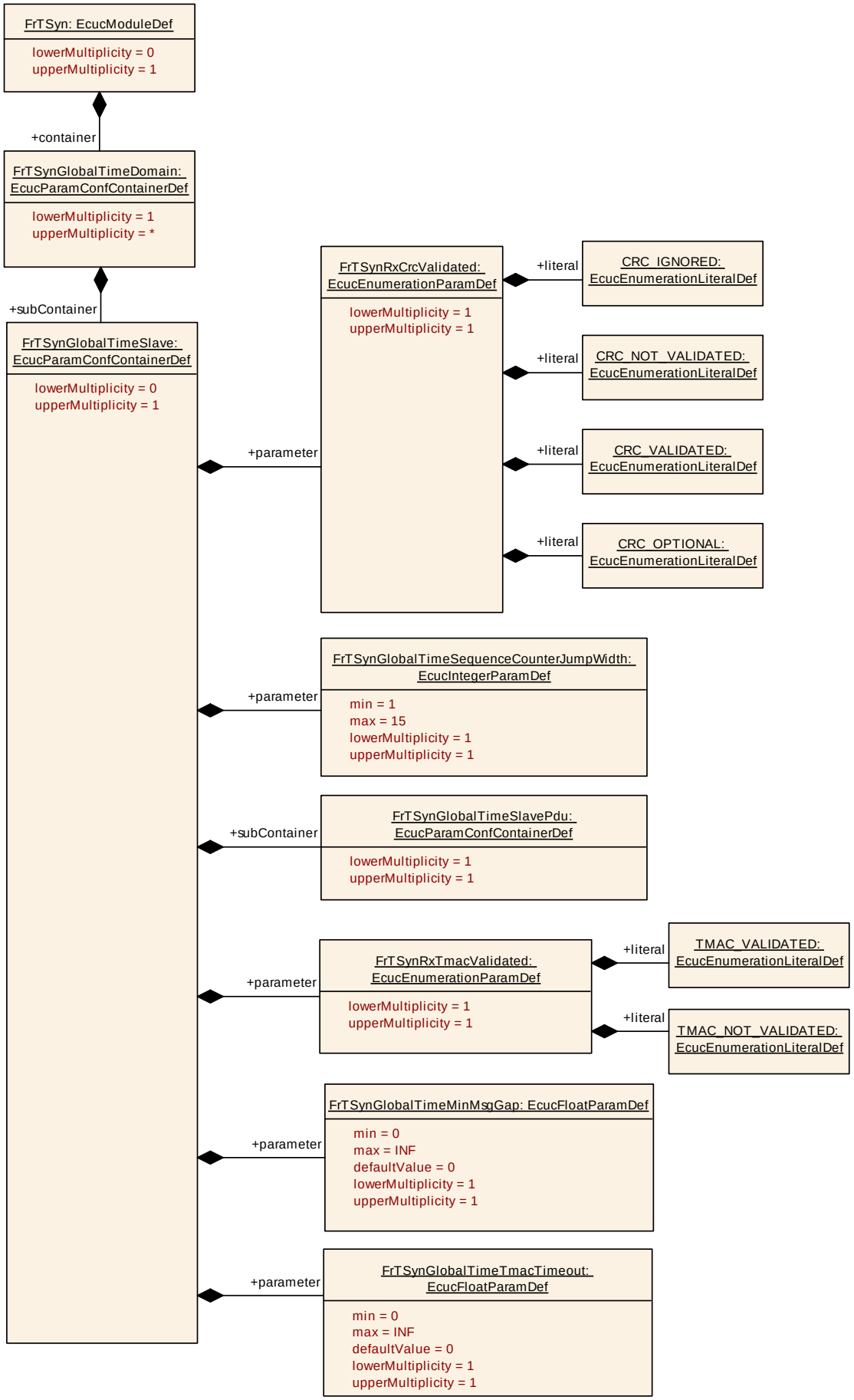
| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00039 :** | | |
| ***Name*** | FrTSynGlobalTimeTmacTimeout | | |
| ***Parent Container*** | FrTSynGlobalTimeSlave | | |
| ***Description*** | Rx timeout for the TMAC message.<br>Unit:seconds<br>**Tags:**<br>atp.Status=draft | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucFloatParamDef | | |
| ***Range*** | [0 .. INF] | | |
| ***Default value*** | 0 | | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | |
|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00017 :** |

| | | | |
|---|---|---|---|
| ***Name*** | FrTSynRxCrcValidated | | |
| ***Parent Container*** | FrTSynGlobalTimeSlave | | |
| ***Description*** | This parameter controls whether or not CRC validation shall be supported. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucEnumerationParamDef | | |
| ***Range*** | CRC_IGNORED | The Timesync module accepts Time Synchronization messages, which are CRC secured (without actually validating the CRC) and those, which are not CRC secured. That means, the Timesync module ignores the CRC. | |
| | CRC_NOT_VALIDATED | The Timesync module accepts only Time Synchronization messages, which are not CRC secured. All other Time Synchronization messages are ignored. | |
| | CRC_OPTIONAL | The Timesync module accepts only Time Synchronization messages which are not CRC secured and Time Synchronization messages which are CRC secured and have the correct CRC. All other Time Synchronization messages are ignored. | |
| | CRC_VALIDATED | The Timesync module accepts only Time Synchronization messages, which are CRC secured and have the correct CRC. All other Time Synchronization messages are ignored. | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00037 :** | | |
| ***Name*** | FrTSynRxTmacValidated | | |
| ***Parent Container*** | FrTSynGlobalTimeSlave | | |
| ***Description*** | This parameter controls whether or not TMAC validation shall be supported.<br>**Tags:**<br>atp.Status=draft | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucEnumerationParamDef | | |
| ***Range*** | TMAC_NOT_VALIDATED | The Timesync module shall not validate the TMAC. | |
| | TMAC_VALIDATED | The Timesync module shall validate the TMAC. | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| *Included Containers* | | |
|---|---|---|
| ***Container Name*** | ***Multiplicity*** | ***Scope / Dependency*** |
| FrTSynGlobalTimeSlavePdu | 1 | This container carries all properties required to configure the PDU received by the time slave for the given global time domain. |


FrTSyn: EcucModuleDef
lowerMultiplicity = 0
upperMultiplicity = 1
+container
FrTSynGlobalTimeDomain: EcucParamConfContainerDef
lowerMultiplicity = 1
upperMultiplicity = *
+subContainer
FrTSynGlobalTimeSlave: EcucParamConfContainerDef
lowerMultiplicity = 0
upperMultiplicity = 1
+parameter
FrTSynRxCrcValidated: EcucEnumerationParamDef
lowerMultiplicity = 1
upperMultiplicity = 1
+literal
CRC_IGNORED: EcucEnumerationLiteralDef
+literal
CRC_NOT_VALIDATED: EcucEnumerationLiteralDef
+literal
CRC_VALIDATED: EcucEnumerationLiteralDef
+literal
CRC_OPTIONAL: EcucEnumerationLiteralDef
+parameter
FrTSynGlobalTimeSequenceCounterJumpWidth: EcucIntegerParamDef
min = 1
max = 15
lowerMultiplicity = 1
upperMultiplicity = 1
+subContainer
FrTSynGlobalTimeSlavePdu: EcucParamConfContainerDef
lowerMultiplicity = 1
upperMultiplicity = 1
+parameter
FrTSynRxTmacValidated: EcucEnumerationParamDef
lowerMultiplicity = 1
upperMultiplicity = 1
+literal
TMAC_VALIDATED: EcucEnumerationLiteralDef
+literal
TMAC_NOT_VALIDATED: EcucEnumerationLiteralDef
+parameter
FrTSynGlobalTimeMinMsgGap: EcucFloatParamDef
min = 0
max = INF
defaultValue = 0
lowerMultiplicity = 1
upperMultiplicity = 1
+parameter
FrTSynGlobalTimeTmacTimeout: EcucFloatParamDef
min = 0
max = INF
defaultValue = 0
lowerMultiplicity = 1
upperMultiplicity = 1

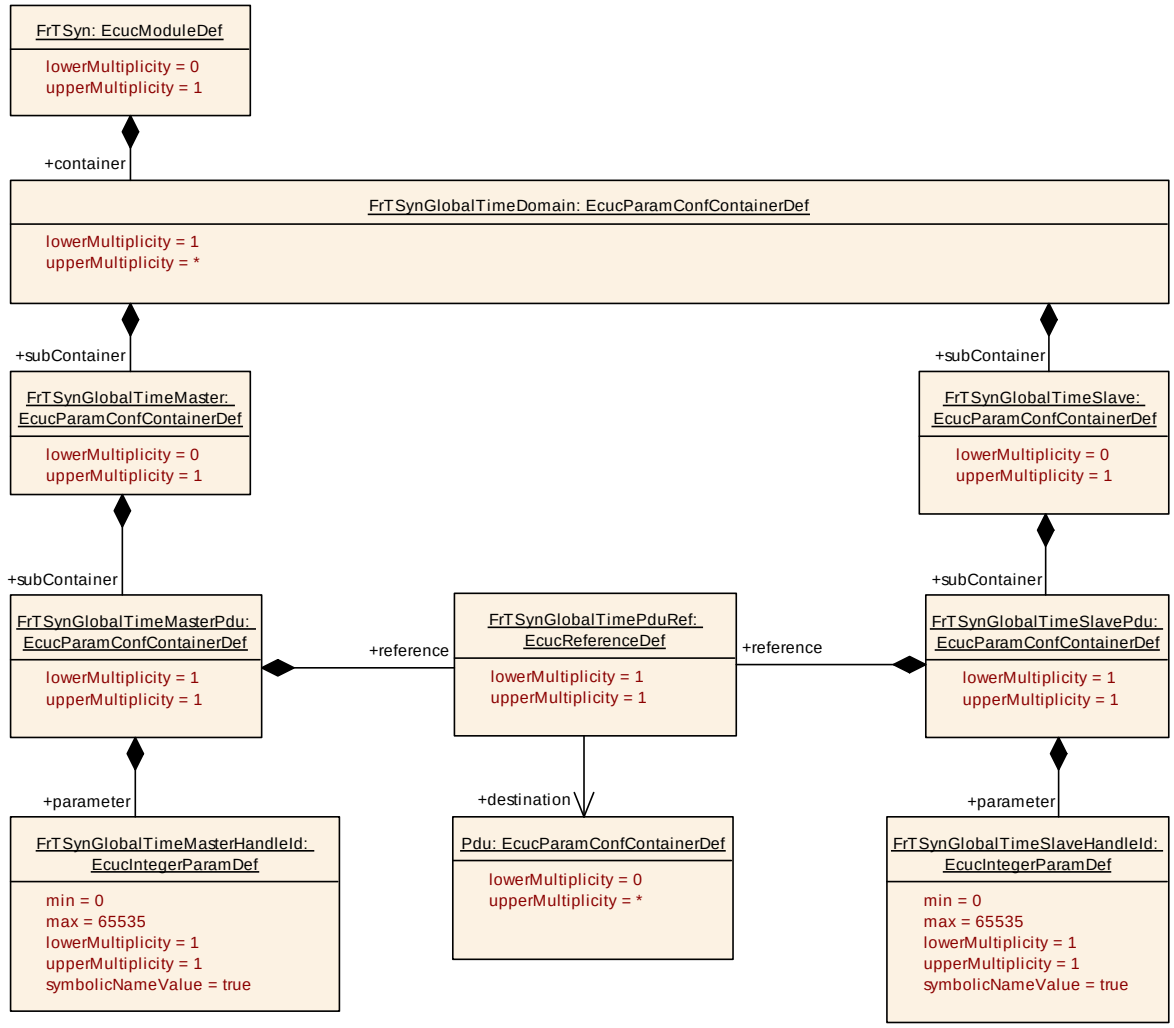
### 10.2.12 FrTSynGlobalTimeSlavePdu

| | |
|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00012 :** |
| ***Container Name*** | FrTSynGlobalTimeSlavePdu |
| ***Parent Container*** | FrTSynGlobalTimeSlave |
| ***Description*** | This container carries all properties required to configure the PDU received by the time slave for the given global time domain. |
| ***Configuration Parameters*** | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00011 :** | | |
| ***Name*** | FrTSynGlobalTimeSlaveHandleId | | |
| ***Parent Container*** | FrTSynGlobalTimeSlavePdu | | |
| ***Description*** | This represents the handle ID of the PDU that contains the global time information. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | EcucIntegerParamDef (Symbolic Name generated for this parameter) | | |
| ***Range*** | 0 .. 65535 | | |
| ***Default value*** | -- | | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| | | | |
|---|---|---|---|
| ***SWS Item*** | **ECUC_FrTSyn_00021 :** | | |
| ***Name*** | FrTSynGlobalTimePduRef | | |
| ***Parent Container*** | FrTSynGlobalTimeSlavePdu | | |
| ***Description*** | This represents the reference to the Pdu taken to transmit the global time information. The global time master of a global time domain acts as the sender of the Pdu while all the time slaves are supposed to receive the Pdu. | | |
| ***Multiplicity*** | 1 | | |
| ***Type*** | Reference to [ Pdu ] | | |
| ***Post-Build Variant Value*** | true | | |
| ***Value Configuration Class*** | ***Pre-compile time*** | X | All Variants |
| | ***Link time*** | -- | |
| | ***Post-build time*** | -- | |
| ***Scope / Dependency*** | scope: local | | |

| |
|---|
| ***No Included Containers*** |




## 10.3 Published Information

For details, refer to the chapter 10.3 “Published Information” in *SWS_BSWGeneral*.