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2019-11-28	R19-11	AUTOSAR Release Management	• Time Validation (draft) • Clarification regarding messages with stuck sequence counter • Clarification regarding cyclic operation entry after timebase startup • Clarification regarding transmission and reception of User Bytes • 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 • 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 • Immediate Time Synchronization message transmission • Various enhancements and corrections

Document Change History

Date	Release	Changed by	Change Description
2015-07-31	4.2.2	AUTOSAR Release Management	• Error code FRTSYN_E_INVALID_PDU_SDU_ID replaced by FRTSYN_E_INVALID_PDUID • 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.

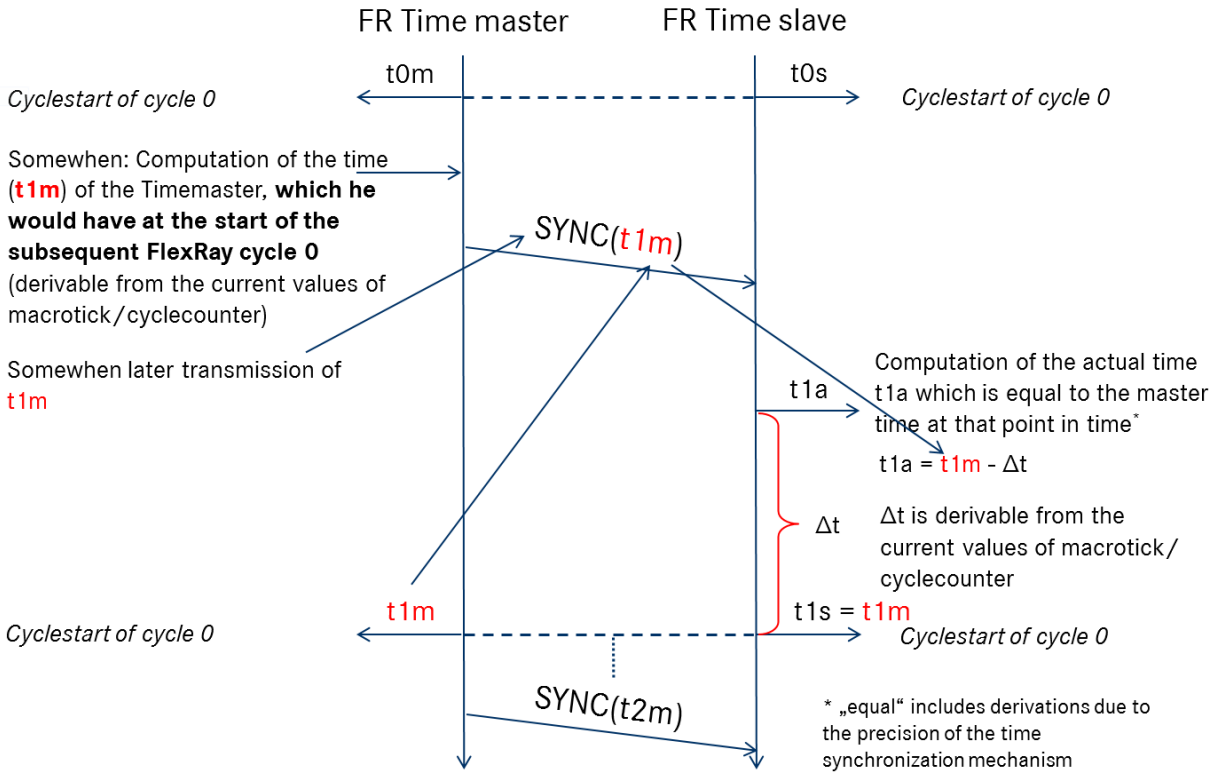


Figure 1: FlexRay Time Synchronization mechanism

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).
- *"CRC secured*" in the context of this document refers to CRC integrity protection mechanism and does not imply that CRC is used as a cybersecurity solution.

4.2 Applicability to car domains

Automotive systems requiring a common Time Base for ECUs regardless of which bus system the ECUs are connected to.

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).

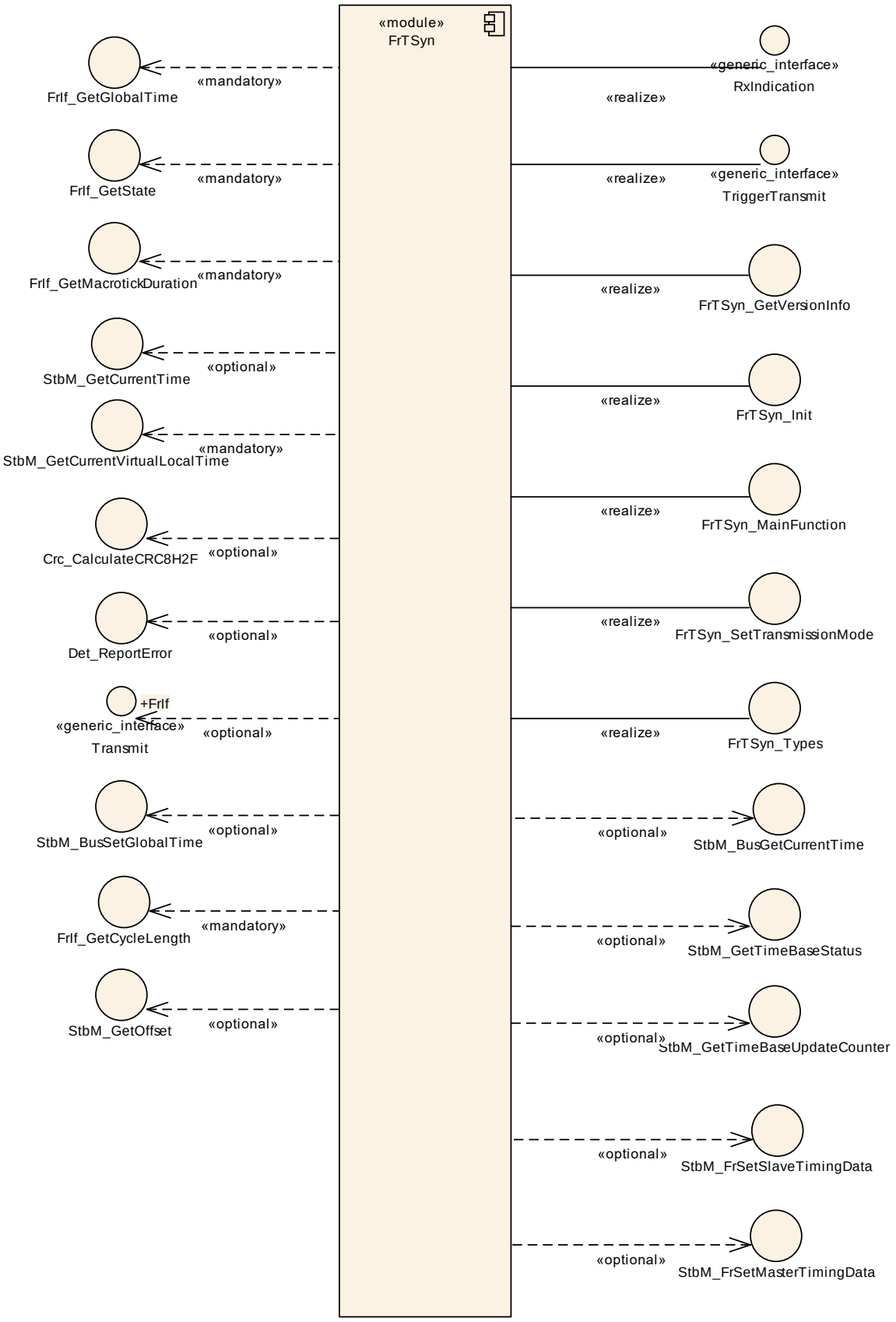


Figure 2: Module dependencies of the FrTSyn module

- 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 0, 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)

7.2.3 Error Handling

[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)

7.3 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.

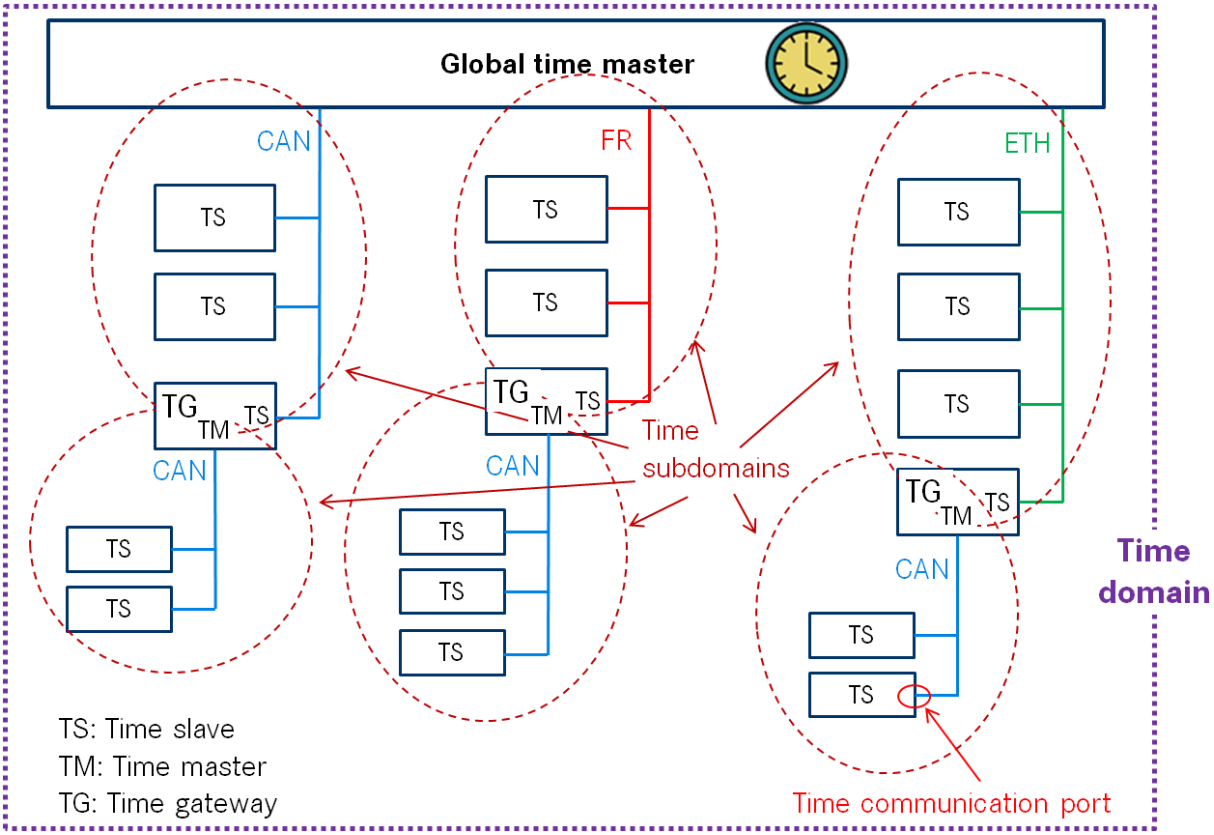


Figure 3: Terminology Example

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 SYNC not CRC secured message
CRC_SUPPORTED	0x20 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 OFS not CRC secured message
CRC_SUPPORTED	0x44 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]⌈
The FrTSyn shall support Time Validation, if `FrTSynTimeValidationSupport` (**ECUC_FrTSyn_00040**) set to `TRUE`.
⌋(RS_TS_00034)

[SWS_FrTSyn_00097]⌈
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]⌈
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]⌈
Upon invocation of `StbM_FrSetSlaveTimingData()` FrTSyn shall pass following values

- the Sequence Counter as received in the Sync message,
- the segment id of the physical channel on which the Sync message has been received (refer to parameter **ECUC_FrTSyn_00042 :** `FrTSynGlobalTimeNetworkSegmentId`)
- `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]⌈
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]⌈
Upon invocation of `StbM_FrSetMasterTimingData()` FrTSyn shall pass the following data

- the Sequence Counter as sent in the `Sync` message

- the segment id of the physical channel on which the Sync message has been sent (refer to parameter **ECUC_FrTSyn_00042 :** `FrTSynGlobalTimeNetworkSegmentId`)
- 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

Section 7.2 "Error Handling" of the document "General Specification of Basic Software Modules" [8] describes the error handling of the Basic Software in detail. Above all, it constitutes a classification scheme consisting of five error types which may occur in BSW modules.

Based on this foundation, the following section specifies particular errors arranged in the respective subsections below.

7.7.1 Development Errors

[SWS_FrTSyn_00059][

Type of error	*Related error code*	*Error value*
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

There are no runtime errors.

7.7.3 Transient Faults

There are no transient faults.

7.7.4 Production Errors

There are no production errors.

7.7.5 Extended Production Errors

There are no extended production errors.

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. 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 (`
	`  const FrTSyn_ConfigType* configPtr`
	`)`	

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. 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 (`
	`  void`
	`)`

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. **Tags:**atp.Status=draft
StbM_Get-CurrentTime	StbM.h	Returns a time value (Local Time Base derived from Global Time Base) in standard format. 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)

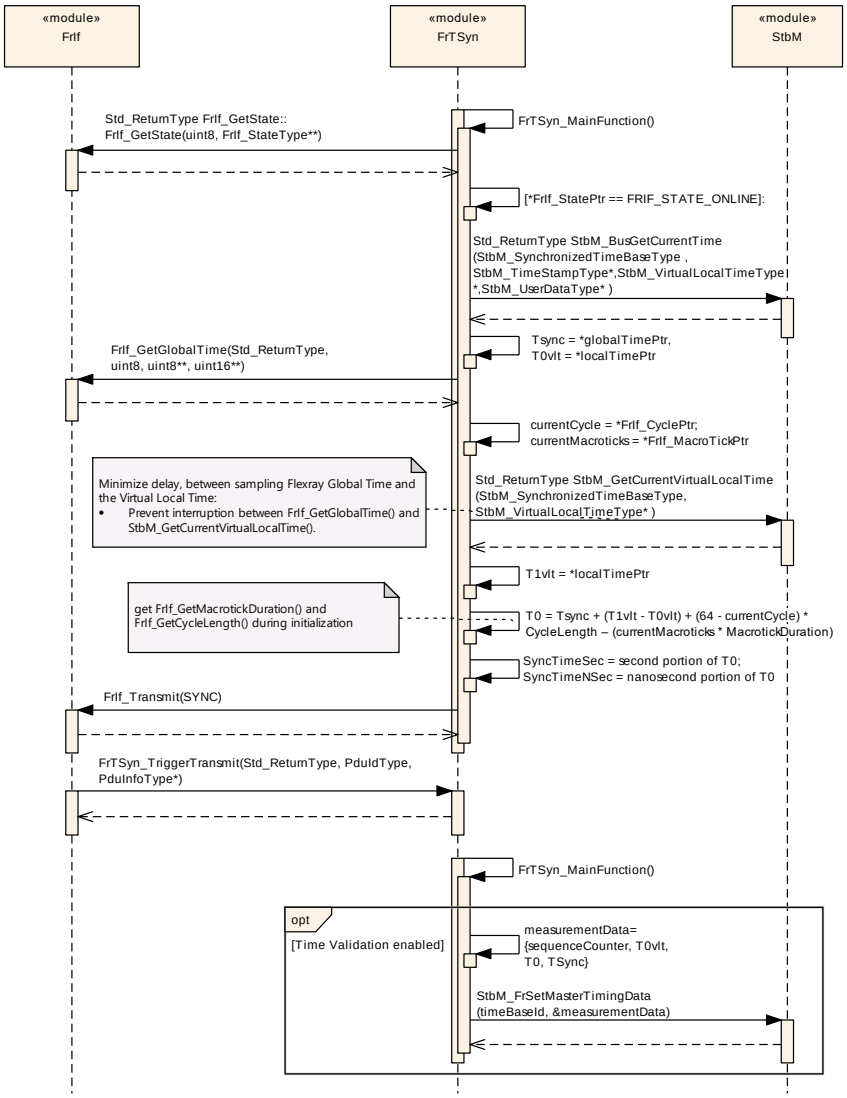


Figure 4: FlexRay Time Synchronization (Time Master)

9.2 FlexRay Time Synchronization (Time Slave)

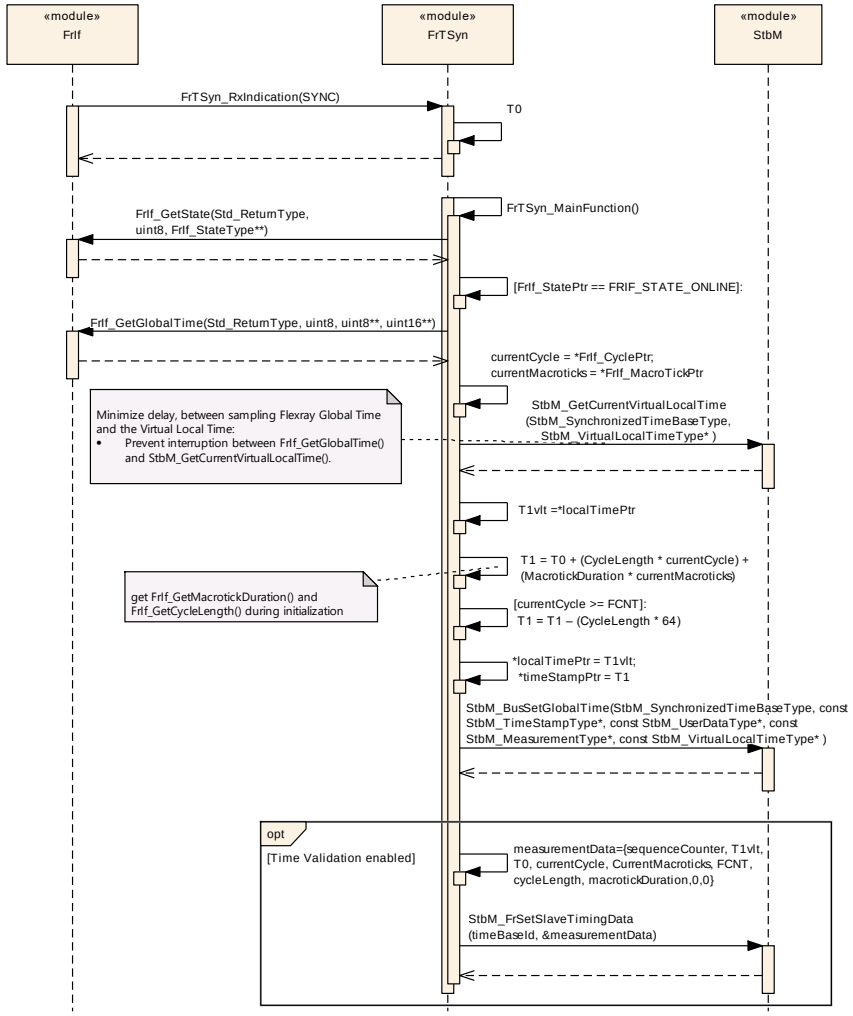


Figure 5: FlexRay Time Synchronization (Time Slave)

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 0.

10.2.1 Variants

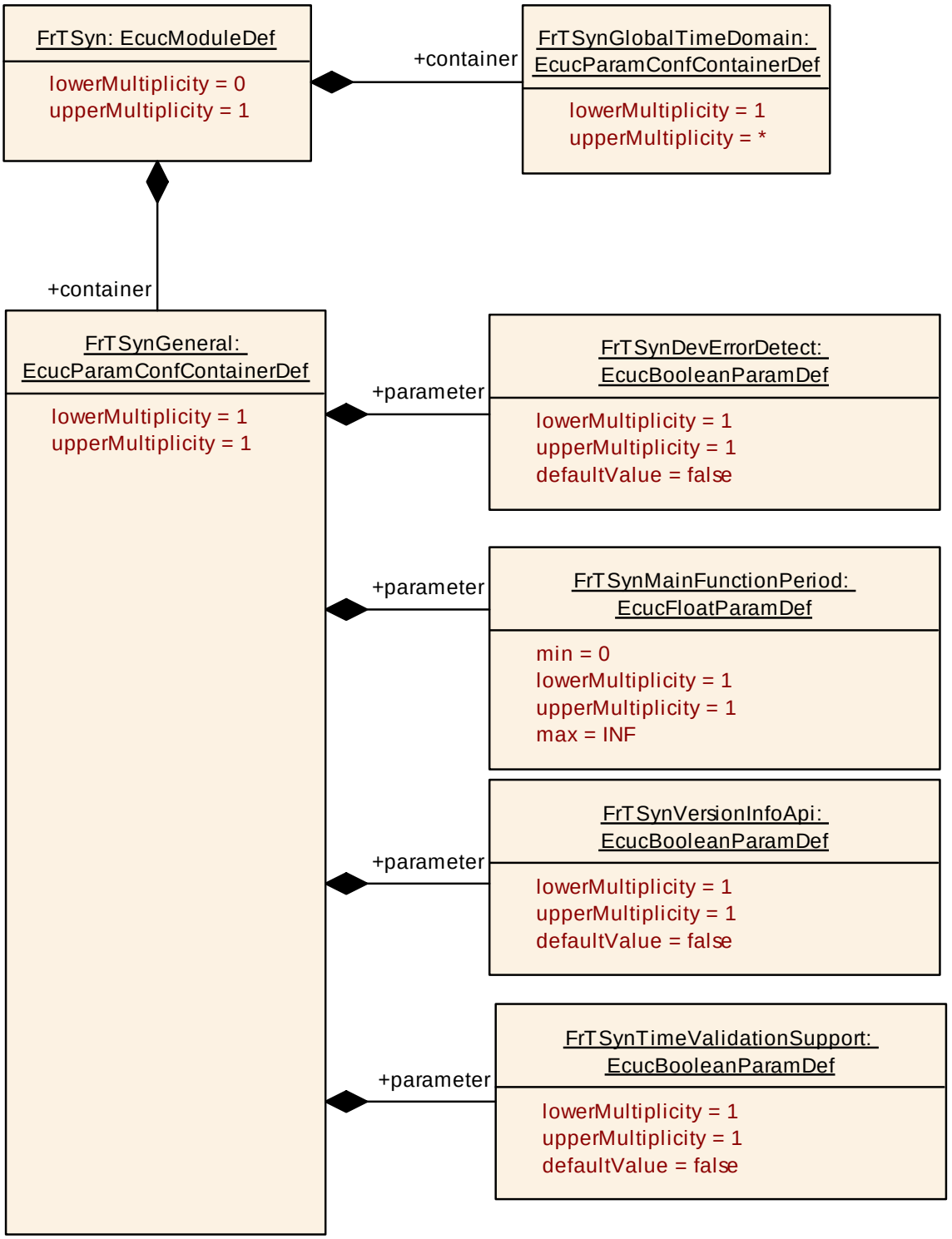
[SWS_FrTSyn_00077][
The Time Synchronization over FlexRay shall support the configuration for Time Master, Time Slave and Time Gateway.
](RS_TS_20046)

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. 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. • 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. • true: Time Validation is enabled. • 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. 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 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_00042 :**		
Name	FrTSynGlobalTimeNetworkSegmentId		
Parent Container	FrTSynGlobalTimeDomain		
Description	This represents the numerical identifier of the network on system level scope where this Global Time has been communicated on.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 255		
Default value	--		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	true		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

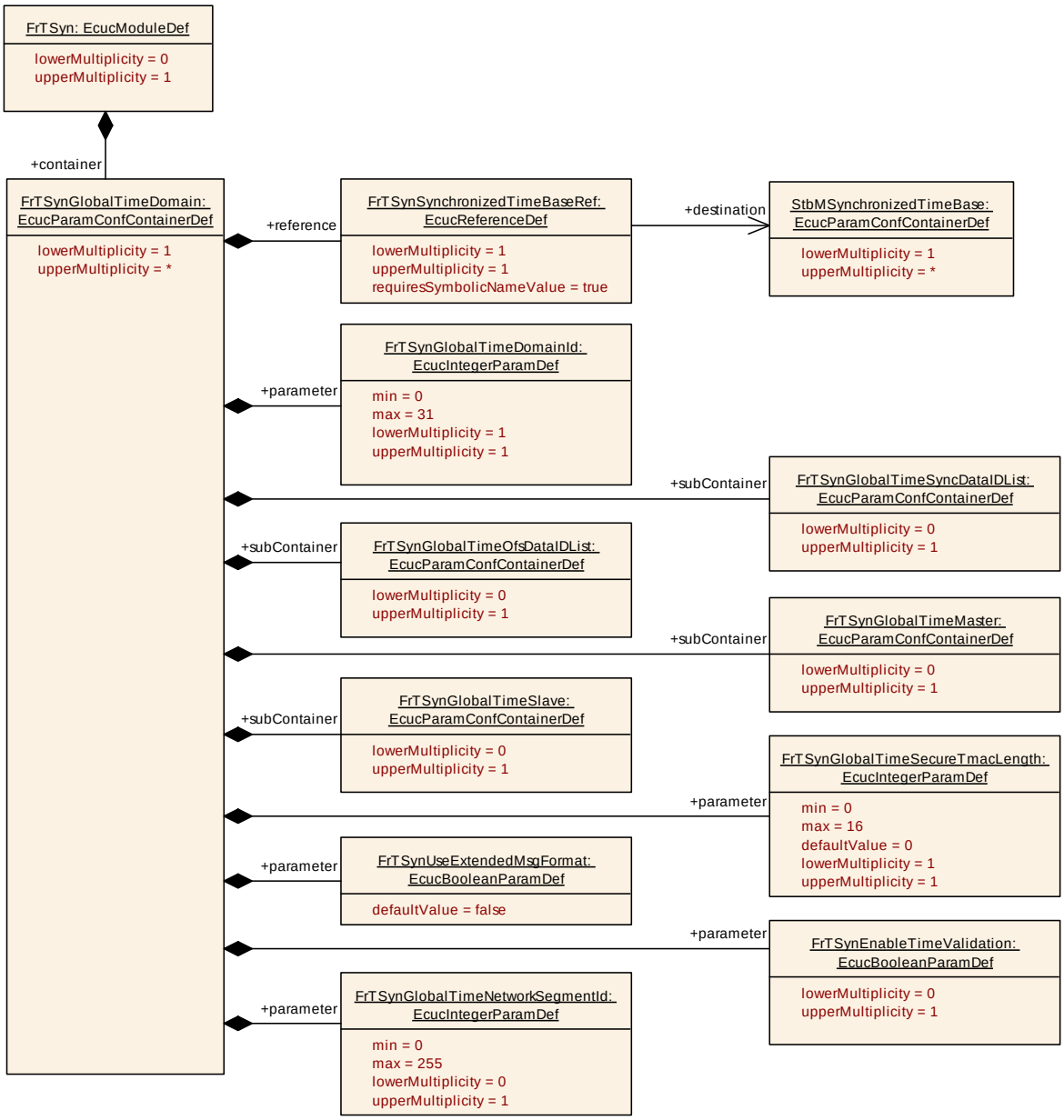
SWS Item	**ECUC_FrTSyn_00034 :**		
Name	FrTSynGlobalTimeSecureTmacLength		
Parent Container	FrTSynGlobalTimeDomain		
Description	Represents the number of bytes for the used Truncated Message Authentication Code (TMAC). If 0, no message authentication will be used. **Tags:** atp.Status=draft		
Multiplicity	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) • false: use always 16 byte for Timesync messages **Tags:** 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.

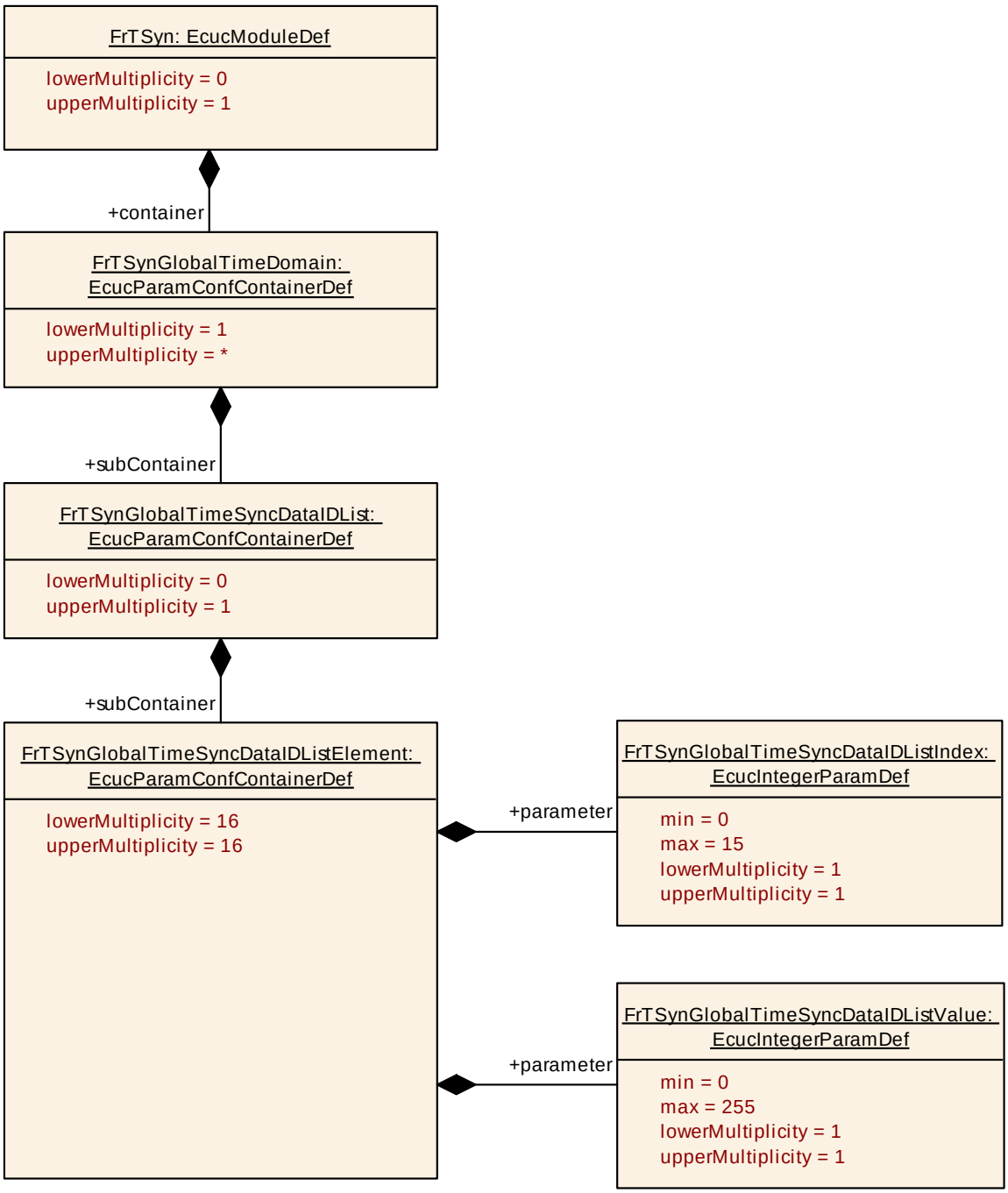


10.2.5 FrTSynGlobalTimeSyncDataIDList

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		

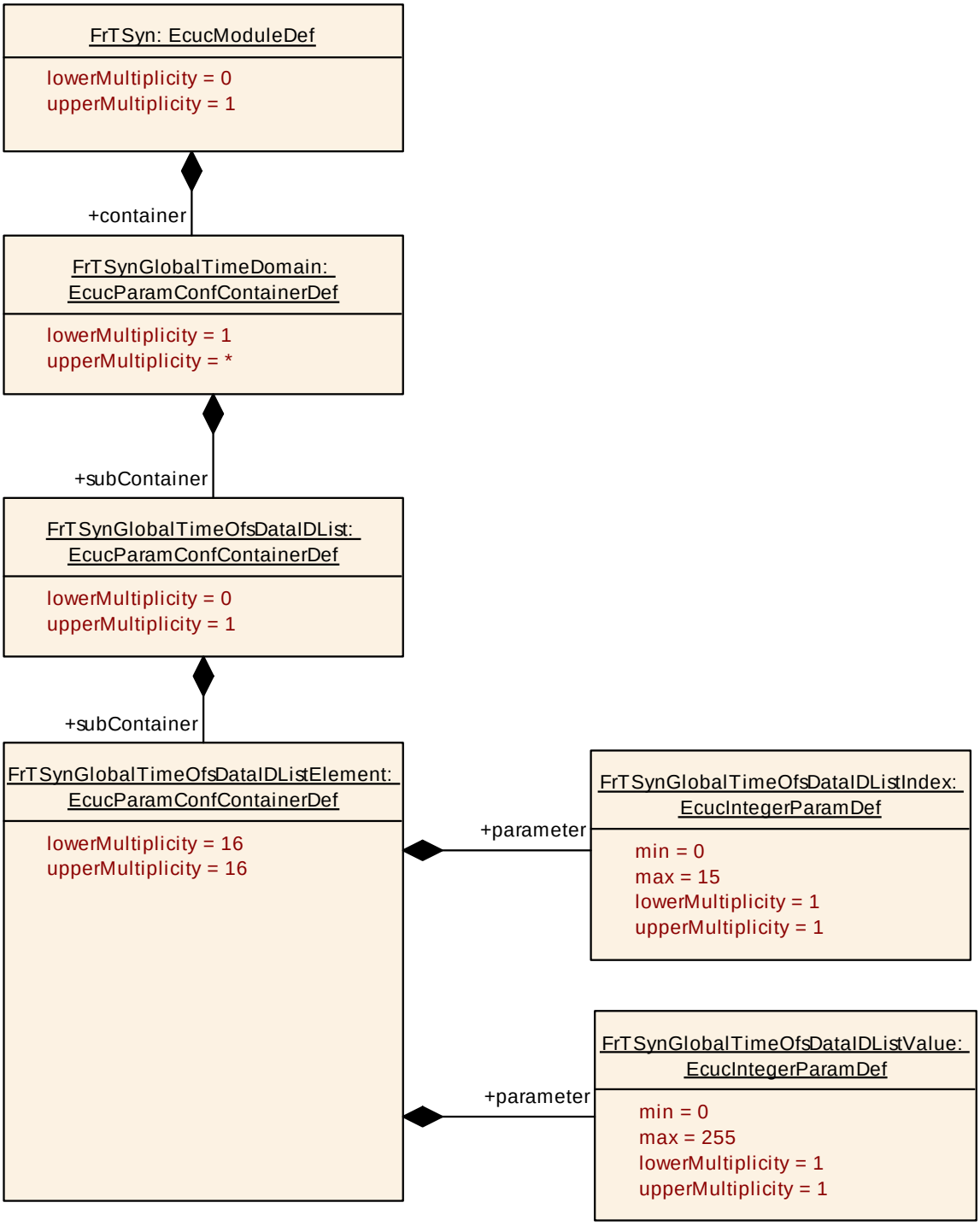
No Included Containers

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 Class	*Pre-compile time*	X	All Variants
	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		

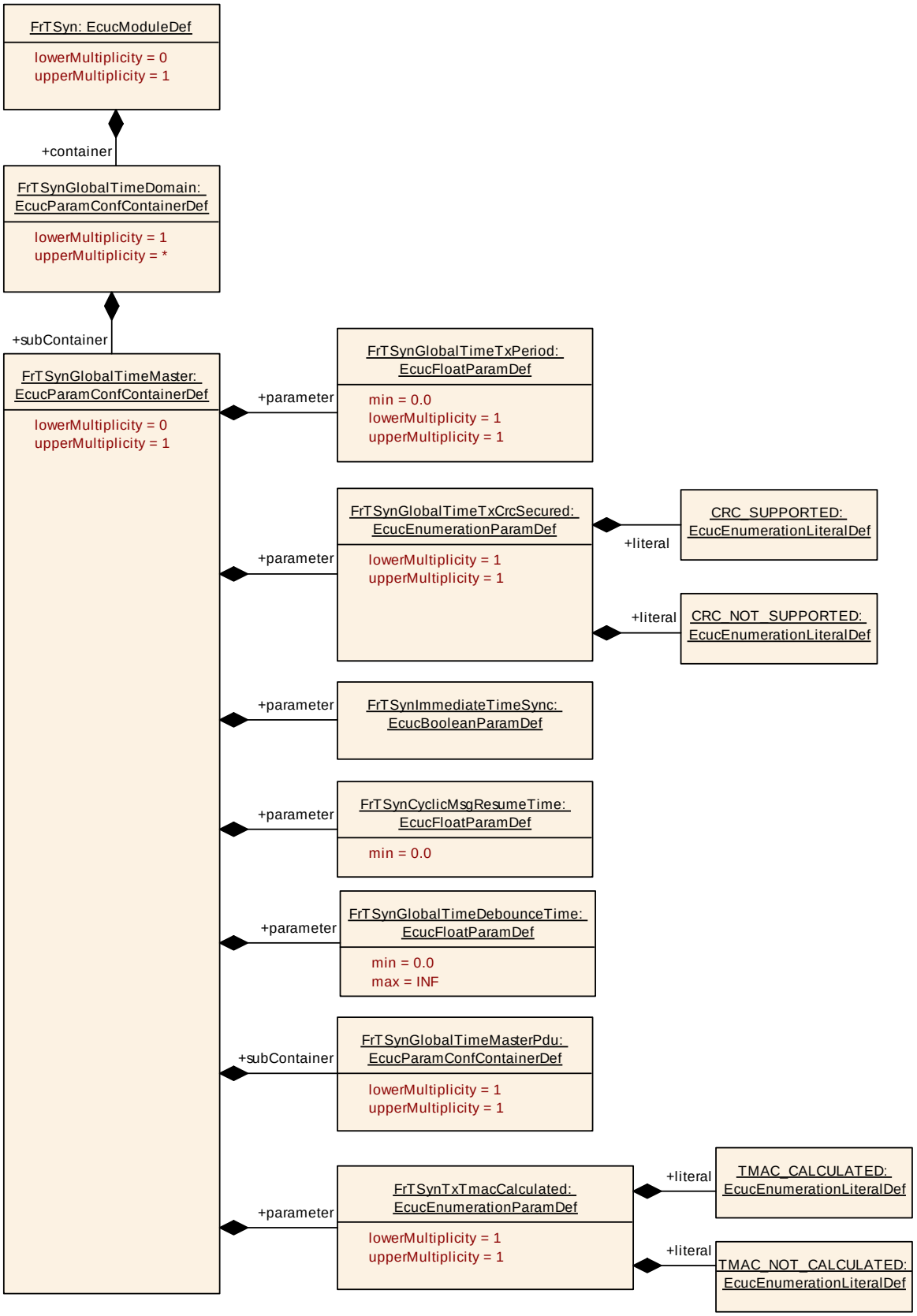
SWS Item	**ECUC_FrTSyn_00014 :**
Name	FrTSynGlobalTimeTxPeriod
Parent Container	FrTSynGlobalTimeMaster
Description	This represents the TX period. Unit: seconds
Multiplicity	1
Type	EcucFloatParamDef

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. **Tags:** 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	false		
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. Unit: seconds **Tags:** 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. Unit:seconds **Tags:** 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		

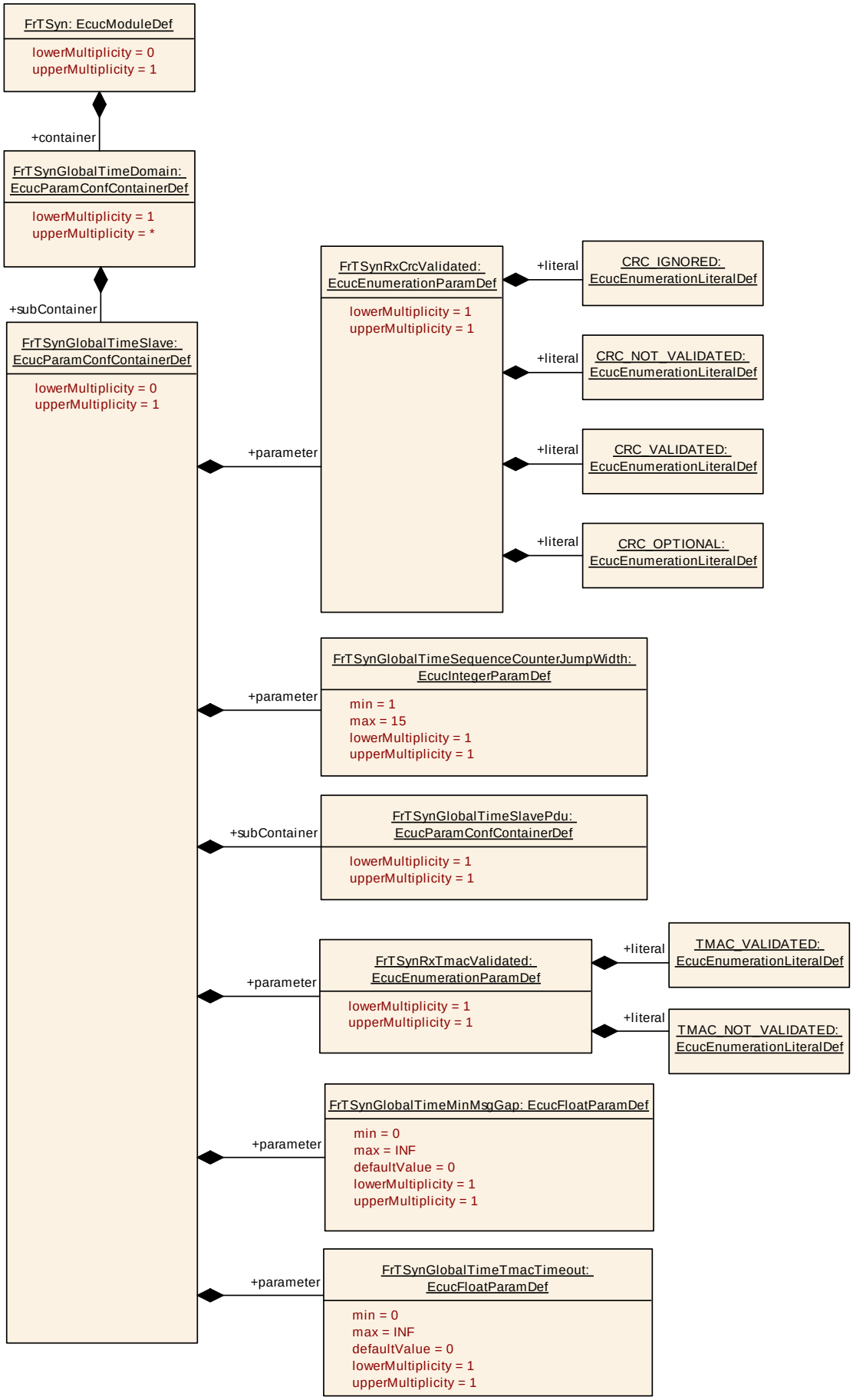
SWS Item	**ECUC_FrTSyn_00017 :**

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. **Tags:** 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

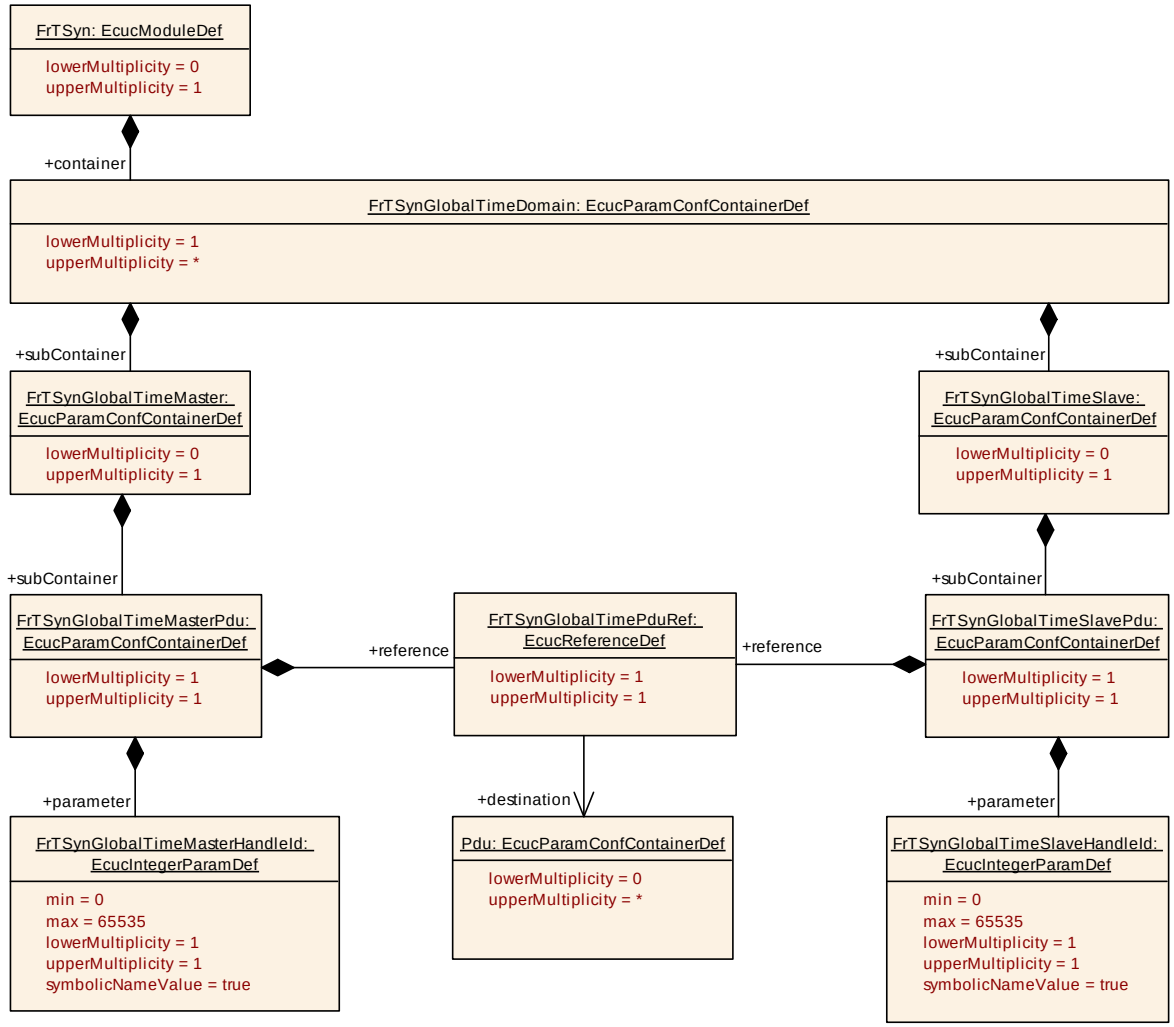
10.2.12 FrTSynGlobalTimeSlavePdu

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	false		
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*.