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Date	Version	Changed by	Change Description
19.12.2011	3.0.0	AUTOSAR Administration	• Adapted to the 4.x TP API • Removed private types FrTp_ParameterValueType, FrTp_ChangeResultType, FrTp_CancelResultType, FrTp_PduInfoType • Added parameter configPtr to FrArTp_Init • Adapted service IDs of standardized Com Stack API functions
19.04.2011	2.4.0	AUTOSAR Administration	• Added new TP layer status to Table 3 • Corrected inconsistencies of the attributes Synchronicity and Reentrancy for FrTp_CancelTransmitRequest, FrTp_CancelReceiveRequest and FrTp_ChangeParaemterRequest APIs • Added information about selection of FlexRay TP Protocol Engine • Added support for TP receive cancelation • Updated FrTp_ChangeParameter API syntax
15.09.2010	2.3.0	AUTOSAR Administration	• Added FRTP222, FRTP223 • Modified FRTP195 • Use parameter PduInfoType in callback RxIndication • Legal disclaimer revised
23.06.2008	2.2.1	AUTOSAR Administration	Legal disclaimer revised

17.12.2007	2.2.0	AUTOSAR Administration	• Clarified the role and purpose of the functions PduR_FrTpChangeParameterConfirmation() and PduR_FrTpCancelTransmitConfirmation() with respect to the PDU Router. • Document meta information extended • Small layout adaptations made
24.01.2007	2.1.1	AUTOSAR Administration	• "Advice for users" revised • "Revision Information" added
05.12.2006	2.1.0	AUTOSAR Administration	• Correction in Interaction Diagram • Various descriptions adapted in Chapter 10 • Added BSW00435 due to WP112 decision • Changing API FrTp_Transmit • Several wording corrections • Adaptation of chapter 5.4.2 to new SRS Requirement • Legal disclaimer revised
25.04.2006	2.0.0	AUTOSAR Administration	Document structure adapted to common Release 2.0 SWS Template.
19.09.2005	1.0.0	AUTOSAR Administration	Initial Release

Disclaimer

Advice for users

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Table of Contents

1 Introduction and functional overview

This specification describes the functionality, API, and the configuration of the AUTOSAR basic software module FlexRay AUTOSAR Transport Layer (FrArTp).

The FrArTp Layer is between the PDU Router [6] and the FlexRay Interface [5] (see Figure 1, according to [2]). This module's main purpose is segmentation and reassembly of messages that do not fit in one of the assigned Fr N-PDUs.

The PDU Router deploys I-PDUs of AUTOSAR COM or DCM to different communication protocols. The routing through a network system type (e.g. CAN, LIN and FlexRay) depends on the I-PDU identifier. The PDU-Router is also in charge of determining whether a transport protocol has to be used or not.
The FlexRay Interface (FrIf) provides equal mechanisms to access a FlexRay bus channel regardless of its location (µC internal/external). It abstracts from the location of FlexRay controllers (on chip / onboard), the ECU hardware layout and the number of FlexRay drivers. The FrIf is in charge to route received PDUs between the FrArTp, the PDU Router, the FlexRay NM and the XCP.

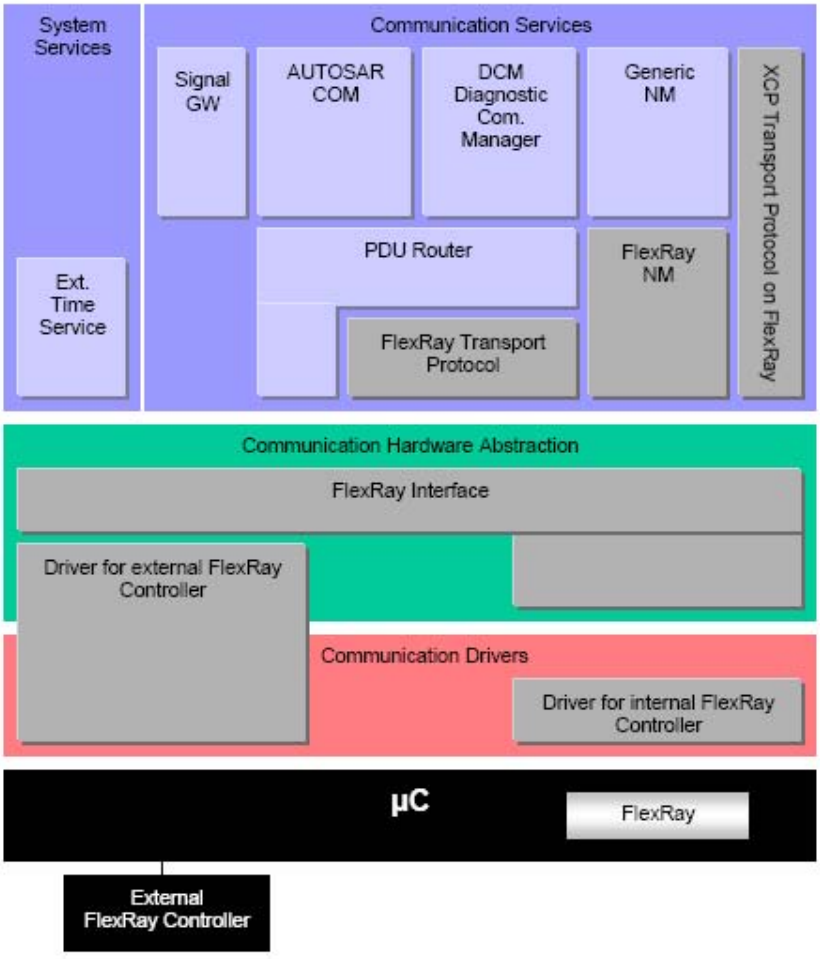


Figure 1: AUTOSAR FlexRay Layered Architecture

Among others, the FlexRay AUTOSAR Transport Layer includes the following features:

- Segmentation of data in send direction
- Collection of data in receive direction
- Control of data flow
- Detection of errors
- Acknowledgement (and Retry)
- 1:1 and 1:n connections
- 2 or 4 Bytes address information
- Transfer of up to 2^{32}-1 Bytes payload

This specification supports only the AUTOSAR FlexRay Transport Protocol derived from ISO 15765-2, which was used as standard in release 3.x and below. Since release 4.0, the standard FlexRay transport layer [11] is compatible to ISO 10681-2. For release 3.2, a back port of the ISO 10681-2 compliant FlexRay transport layer has been created as a separate document named FlexRay ISO Transport Layer. Thus, both in AUTOSAR release 3.2 and 4.0, users must be cautious in choosing which specification to use for FlexRay Transport Layer.

It is an AUTOSAR decision to base on existing standards the specification of basic software module. So the FlexRay AUTOSAR Transport Layer specification is based on the international standard ISO 15765 (Diagnostics on CAN), which is the most used in automotive area.

The basic idea is to have an ISO 15765-2 compliant Transport Layer, which allows by the means of static configuration to add one or more optional features (like acknowledgement) per channel independently of each other. Of course, by adding such a feature the compliance to the ISO specification gets lost for this particular channel.
Additionally, the features are deactivateable at compile time. But if they are compiled in, they are still deacitvateable by static configuration.
The rationale behind some of the provided features is the usage of this transport layer not only for diagnostic purposes but also for Inter-ECU communication.

Since addressing within ISO 15765-2 is specific for the CAN bus system (CAN identifier), it is obvious that another approach is taken within FlexRay AUTOSAR Transport Layer.

Although FlexRay transport protocol is at first set to vehicle diagnostic systems, it has been developed to also deal with requirements from other FlexRay based systems needing a transport layer protocol.

2 Acronyms and abbreviations

Following acronyms and abbreviations have a local scope only and therefore are not contained in the AUTOSAR glossary.

Acronym:	*Description:*
Channel	A group of connections sharing the properties configurable by the parameters in chapter 10.4
Connection	Way of communication between sender / receiver, characterized by the parameters in chapters 10.4. Uniquely identified by the parameter `FRARTP_SDUID`.
Frame	Synonym for Fr N-PDU → One TP Frame cannot be split up into several Fr N-PDUs
Fr L-SDU	This is the SDU of the FlexRay Interface module. It represents the same entity as Fr N-PDU but with the FlexRay Interface module's point of view.
Fr L-SduId	Unique identifier of a SDU within the FlexRay Interface. It is used for referencing Fr L-SDU's routing properties. Consequently, to interact with the FlexRay Interface via its API, an upper layer uses Fr LSduId to refer to an Fr L-SDU Info Structure.
Fr N-PDU	This is a PDU of the FlexRay AUTOSAR Transport Layer, which is given to the FlexRay Interface for Sending. It consists of address information, protocol control information and the payload (Fr N-SDU).
Fr N-SDU	This is the SDU of the FlexRay AUTOSAR Transport Layer. In the AUTOSAR architecture, it is a set of data coming from the PDU Router. Each FR N-SDU is connected to a unique identifier.
Fr N-SDU Info Structure	This is a FlexRay AUTOSAR Transport Layer internal constant structure that contains specific FlexRay AUTOSAR Transport Layer information to process transmission, reception, segmentation and reassembly of the related Fr N-SDU.
Fr N-SduId	Unique identifier of a SDU within the FlexRay AUTOSAR Transport Layer. It is used for referencing FR N-SDU's routing properties. Consequently, to interact with the FlexRay AUTOSAR Transport Layer via its API, an upper layer uses Fr NSduId to refer to an Fr N-SDU Info Structure.
I-PDU	This is the PDU of the AUTOSAR COM module
Message	Synonym for Fr N-SDU
PDU	In layered systems, it refers to a unit of data that is specified in a protocol of a given layer and that consists of user data of that layer (SDU) plus possibly protocol control information of that given layer. In fact, the PDU of layer X is the SDU of its lower layer X-1 (i.e. (X)-PDU = (X-1)-SDU).
SDU	In layered systems, it refers to a set of data that is sent by a user of the services of a given layer, and is transmitted to a peer service user semantically unchanged.

Abbreviation:	*Description:*
AF	Acknowledgement Frame Fr N-PDU
CF	Consecutive Frame Fr N-PDU
Com	AUTOSAR COM module
Dcm	Diagnostic Communication Manager module
FC	Flow Control Fr N-PDU
FF	First Frame Fr N-PDU
Fr	FlexRay Driver module
Fr N-PCI	Protocol Control Information of the transport layer
FrIf	FlexRay Interface
FrArTp	FlexRay AUTOSAR Transport Layer
N_AI	Network Address Information
PDU	Protocol Data Unit
PduR	PDU Router

SDU	Service Data Unit
SF	Single Frame Fr N-PDU
XCP	X (CAN, FlexRay, …) Calibration Protocol

3 Related documentation

3.1 Input documents

[1] List of Basic Software Modules
AUTOSAR_TR_BSWModuleList.pdf

[2] Layered Software Architecture
AUTOSAR_EXP_LayeredSoftwareArchitecture.pdf

[3] General Requirements of Basic Software Modules
AUTOSAR_SRS_BSWGeneral.pdf

[4] Requirements on FlexRay
AUTOSAR_SRS_FlexRay.pdf

[5] Specification of FlexRay Interface
AUTOSAR_SWS_FlexRayInterface.pdf

[6] Specification of PDU Router
AUTOSAR_SWS_PDURouter.pdf

[7] Specification of Communication Stack Types
AUTOSAR_SWS_CommunicationStackTypes.pdf

[8] Specification of Standard Types
AUTOSAR_SWS_StandardTypes.pdf

[9] Specification of Platform Types
AUTOSAR_SWS_PlatformTypes.pdf

[10] AUTOSAR Basic Software Module Description Template,
AUTOSAR_TPS_BSWModuleDescriptionTemplate.pdf

[11] Specification of FlexRay ISO Transport Layer
AUTOSAR_SWS_FlexRayISOTransportLayer.pdf

3.2 Related standards and norms

[12] ISO 15765-2(2003-11-11), Road vehicles — Diagnostics on Controller Area Networks (CAN) — Part2: Network layer services

[13] ISO 10681-2, Road vehicles — Communication on FlexRay — Part2: Communication Layer Services

[14] FlexRay Communications System Protocol Specification Version 2.1

4 Constraints and assumptions

4.1 Limitations

AUTOSAR architecture defines protocol specific transport layer (CanTp, LinTp, Fr[Ar]Tp…). So the FlexRay AUTOSAR Transport Layer covers only FlexRay transport protocol specifics.

The FlexRay AUTOSAR Transport Layer has an interface to a single underlying FlexRay Interface Layer and a single upper PDU Router module.

4.2 Applicability to car domains

The FlexRay AUTOSAR Transport Layer can always be used for applications if the FlexRay protocol was used.

5 Dependencies to other modules

This section sets out relations between the FrArTp and other AUTOSAR basic software modules. It contains brief descriptions of the services, which are required by the FrArTp from other modules or other modules can call at the FrArTp. The following picture gives a brief overview of the interactions.

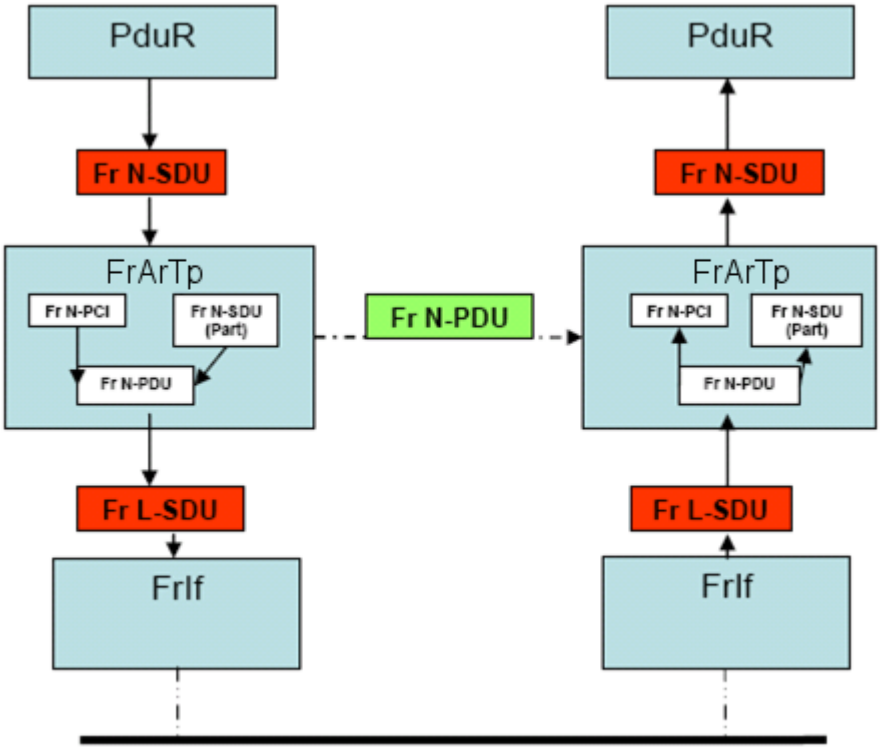


Figure 2: FrArTp interactions

5.1 PduRouter

The following services of the PduRouter are called by the FrArTp:

- *PduR_FrArTpStartOfReception*
  By this API service, the FrArTp indicates to the upper layer (e.g. DCM via PduR) that a new message is being received.
- *PduR_FrArTpCopyRxData*
  By this API service, the FrArTp provides the data of one received segmented message part (Fr N-PDU) to the upper layer.
- *PduR_FrArTpRxIndication*
  By this API service, the FrArTp indicates the completed (un)successful reception of a complete message (Fr N-SDU).

- *PduR_FrArTpCopyTxData*
  By this API service, the FrArTp asks the upper layer (e.g. DCM via PduR) of the message to provide data for the next segmented message part (Fr N-PDU).
- *PduR_FrArTpTxConfirmation*
  By this API service, the FrArTp confirms the (un)successful sending of the complete message (Fr N-SDU) to the actual sender (e. g. DCM). In addition, the FrArTp confirms the (un)successful execution of *FrArTp_CancelTransmit.*

The following services of the FrArTp are called by the PduRouter:

- *FrArTp_Transmit*
  By this API service, the sending of a message (Fr N-SDU) is triggered. The FrArTp will then ask for a transmit buffer and start sending.
- *FrArTp_CancelTransmit*
  By this API service, the sending of a message (Fr N-SDU) is cancelled. This service is optional (per channel).
- *FrArTp_CancelReceive*
  By this API service, the receiving of a message (Fr N-SDU) is cancelled. This service is optional (per channel).
- *FrArTp_ChangeParameter*
  By this API service, some parameters of a channel can be changed. This service is optional (per channel).

5.2 FlexRay Interface

The following services of the FlexRay Interface are called by the FrArTp:

- *FrIf_Transmit*
  By this API service, the sending of a message (Fr N-PDU) is triggered. Depending on configuration on the FlexRay Interface, the Fr N-PDU is sent immediately or after the call of FrArTp_TriggerTransmit.

The following services of the FrArTp are called by the FlexRay Interface:

- *FrArTp_RxIndication*
  By this API service, the FlexRay Interface indicates the reception of an FrArTp frame (Fr N-PDU, please do not mistake this with a FlexRay frame) to the FrArTp. The FrArTp then processes this frame.
- *FrArTp_TxConfirmation*
  By this API service, the FlexRay Interface confirms the sending of the frame containing the Fr N-PDU over the FlexRay network.
- *FrArTp_TriggerTransmit*
  By this API service, the FlexRay Interface makes the FrArTp to copy the Fr N-PDU into the buffer provided by the FlexRay Interface. The FlexRay interface then can start sending the FlexRay frame containing the Fr N-PDU.

5.3 ECU State Manager

The following services of the FrArTp are called by the ECU State Manager (EcuM):

- *FrArTp_Init*
  By this API service, all global variables are initialized and each connection is set into the Idle state.
- *FrArTp_Shutdown*
  By this API service, all pending transport connections are closed, resources are freed and the module is stopped.

5.4 File structure

5.4.1 Code file structure

[FRARTP214]⌈ The Code file structure shall include the following files named:

- FrArTp.c – the source code,
- FrArTp_Lcfg.c – for link time configurable parameters and
- FrArTp_PBcfg.c – for post build time configurable parameters.

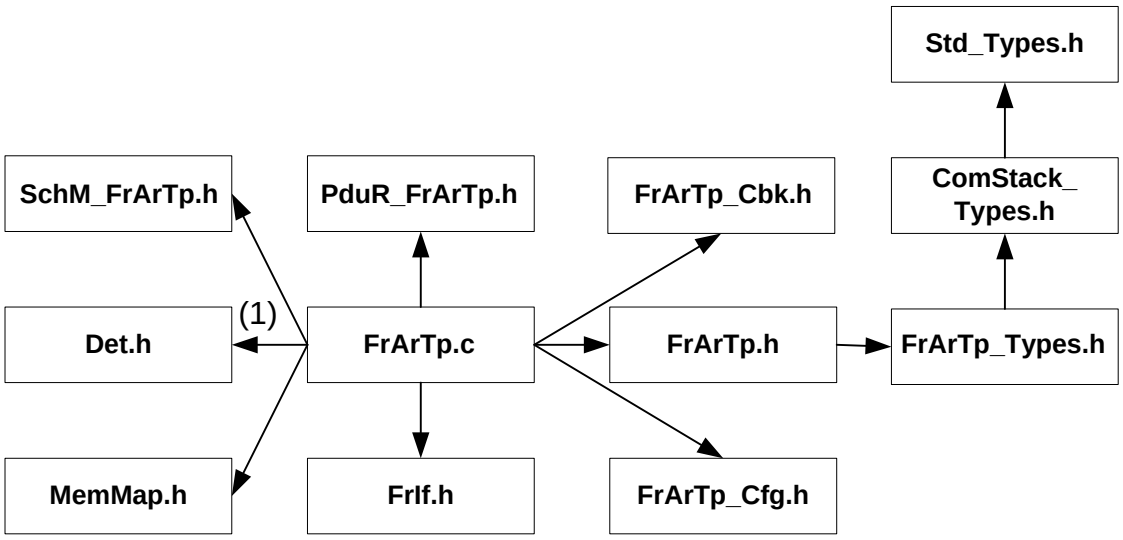
These files shall contain all link time and post-build time configurable parameters.⌋(BSW00381, BSW00383)

5.4.2 Header file structure

[FRARTP195] ⌈The Header file structure shall include the following files named:

- FrArTp.h - general header file
- FrArTp_Cfg.h - pre-compile time configuration parameters
- Det.h – header file of Det
- PduR_FrArTp.h – header file of PduR
- FrIf.h – header file of FrIf
- SchM_FrArTp.h – header file of TP related SchM declarations
- MemMap.h – header file for Memory Mapping
- Std_Types.h – header file for standard types
- ComStack_Types.h – header file for ComStack types
- FrArTp_Types.h – header file for FrArTp specific types⌋(BSW00346, BSW00381, BSW00383, BSW00404, BSW00435, BSW00436)

[FRARTP222] ⌈The FrArTp.h file shall include FrArTp_Types.h⌋()



5.4.3 Design Rules

[FRARTP208] 「The code of the FlexRay AUTOSAR Transport Protocol shall conform to the HIS subset of the MISRA C Standard.」(BSW007)

[FRARTP209] 「Direct use of compiler and platform specific keywords shall be avoided. 」(BSW00306)

[FRARTP210] 「Indicate all global data with read-only purposes by explicitly assigning the `const` keyword. 」(BSW00309)

[FRARTP211] 「It is allowed to use macros instead of functions where source code is used and runtime is critical.」(BSW00330)

[FRARTP212] 「No global data shall be defined in the header files. If global variables have to be used, the definition shall take place in the C file.」(BSW00308)

[FRARTP213] 「The source code of the FlexRay AUTOSAR Transport Protocol module shall not be processor and compiler dependent.」(BSW006)

6 Requirements traceability

Requirement	Satisfied by
-	FRARTP152
-	FRARTP139
-	FRARTP086
-	FRARTP229
-	FRARTP133
-	FRARTP224
-	FRARTP097
-	FRARTP071
-	FRARTP058
-	FRARTP106
-	FRARTP116
-	FRARTP114
-	FRARTP062
-	FRARTP029
-	FRARTP008
-	FRARTP109
-	FRARTP074
-	FRARTP069
-	FRARTP129
-	FRARTP188
-	FRARTP113
-	FRARTP066
-	FRARTP025
-	FRARTP018
-	FRARTP077
-	FRARTP080
-	FRARTP059
-	FRARTP124
-	FRARTP184
-	FRARTP234
-	FRARTP026
-	FRARTP032
-	FRARTP021
-	FRARTP120
-	FRARTP079
-	FRARTP220
-	FRARTP085
-	FRARTP137

-	FRARTP162
-	FRARTP090
-	FRARTP193
-	FRARTP117
-	FRARTP028
-	FRARTP098
-	FRARTP084
-	FRARTP123
-	FRARTP093
-	FRARTP138
-	FRARTP141
-	FRARTP065
-	FRARTP030
-	FRARTP019
-	FRARTP192
-	FRARTP222
-	FRARTP082
-	FRARTP187
-	FRARTP083
-	FRARTP136
-	FRARTP096
-	FRARTP230
-	FRARTP189
-	FRARTP067
-	FRARTP206
-	FRARTP121
-	FRARTP127
-	FRARTP190
-	FRARTP034
-	FRARTP130
-	FRARTP217
-	FRARTP087
-	FRARTP111
-	FRARTP131
-	FRARTP227
-	FRARTP233
-	FRARTP078
-	FRARTP135
-	FRARTP064
-	FRARTP061
-	FRARTP128
-	FRARTP075

-	FRARTP134
-	FRARTP132
-	FRARTP110
-	FRARTP095
-	FRARTP027
-	FRARTP223
-	FRARTP009
-	FRARTP126
-	FRARTP232
-	FRARTP191
-	FRARTP092
-	FRARTP235
-	FRARTP024
-	FRARTP219
-	FRARTP122
-	FRARTP023
-	FRARTP226
-	FRARTP125
-	FRARTP153
-	FRARTP072
-	FRARTP221
-	FRARTP068
-	FRARTP228
-	FRARTP031
-	FRARTP063
-	FRARTP073
-	FRARTP225
-	FRARTP091
-	FRARTP060
-	FRARTP115
-	FRARTP035
-	FRARTP020
-	FRARTP100
-	FRARTP033
-	FRARTP010
-	FRARTP150
-	FRARTP140
-	FRARTP070
-	FRARTP076
-	FRARTP108
-	FRARTP036
-	FRARTP022

-	FRARTP094
-	FRARTP107
-	FRARTP105
BSW00161	FRARTP999
BSW00162	FRARTP999
BSW00172	FRARTP999
BSW00301	FRARTP999
BSW00302	FRARTP999
BSW00306	FRARTP209
BSW00307	FRARTP999
BSW00308	FRARTP212
BSW00309	FRARTP210
BSW00310	FRARTP207
BSW00321	FRARTP999
BSW00323	FRARTP205
BSW00325	FRARTP999
BSW00326	FRARTP999
BSW00330	FRARTP211
BSW00334	FRARTP999
BSW00335	FRARTP999
BSW00336	FRARTP148
BSW00337	FRARTP179
BSW00339	FRARTP999
BSW00341	FRARTP999
BSW00342	FRARTP999
BSW00344	FRARTP999
BSW00346	FRARTP195
BSW00347	FRARTP999
BSW00348	FRARTP999
BSW00369	FRARTP154, FRARTP149
BSW00375	FRARTP999
BSW00381	FRARTP214, FRARTP195
BSW00383	FRARTP214, FRARTP195
BSW00395	FRARTP999
BSW004	FRARTP201
BSW00400	FRARTP999
BSW00404	FRARTP195
BSW00405	FRARTP999
BSW00407	FRARTP202
BSW00409	FRARTP999
BSW00411	FRARTP215
BSW00412	FRARTP999

BSW00415	FRARTP999
BSW00416	FRARTP999
BSW00417	FRARTP999
BSW00419	FRARTP999
BSW00422	FRARTP999
BSW00424	FRARTP203
BSW00425	FRARTP999
BSW00426	FRARTP999
BSW00427	FRARTP999
BSW00428	FRARTP999
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BSW00433	FRARTP999
BSW00434	FRARTP999
BSW00435	FRARTP195
BSW00436	FRARTP195
BSW005	FRARTP999
BSW006	FRARTP213
BSW007	FRARTP208
BSW010	FRARTP999
BSW05075	FRARTP149
BSW05076	FRARTP089, FRARTP088
BSW05082	FRARTP013, FRARTP012
BSW05083	FRARTP015, FRARTP014
BSW05085	FRARTP017, FRARTP016
BSW05088	FRARTP147
BSW05089	FRARTP179
BSW05090	FRARTP104
BSW05093	FRARTP099, FRARTP103
BSW05095	FRARTP011
BSW05129	FRARTP151, FRARTP149
BSW101	FRARTP147
BSW164	FRARTP999
BSW168	FRARTP999
and BSW170	FRARTP999

Document: General Requirements of Basic Software Modules

Requirement	***Satisfied by***
[BSW00160] Human-readable configuration data	Fulfilled by configuration chapter
[BSW00161] Microcontroller abstraction	not applicable
[BSW00162] ECU layout abstraction	not applicable
[BSW00172] Compatibility and documentation of scheduling strategy	not applicable

[BSW003] Version identification	**[FRARTP178]**
[BSW00300] Module naming convention	Fulfilled by API definitions in chapter 8
[BSW00301] Limit imported information	not applicable
[BSW00302] Limit exported information	not applicable
[BSW00304] AUTOSAR integer data types	Fulfilled by API definitions in chapter 8
[BSW00305] Self-defined data types naming convention	Fulfilled by type definitions in chapter 8
[BSW00306] Avoid direct use of compiler and platform specific keywords	[FRARTP209]
[BSW00307] Global variables naming convention	not applicable
[BSW00308] Definition of global data	[FRARTP212]
[BSW00309] Global data with read-only constraint	[FRARTP210]
[BSW00310] API naming convention	[FRARTP207]
[BSW00312] Shared code shall be reentrant	Here the means are described so this is a requirement to implementation
[BSW00314] Separation of interrupt frames and service routines	not applicable
[BSW00318] Format of module version numbers	**[FRARTP178]**
[BSW00321] Enumeration of module version numbers	not applicable
[BSW00323] API parameter checking	[FRARTP205
[BSW00325] Runtime of interrupt service routines	not applicable
[BSW00326] Transition from ISRs to OS tasks	not applicable
[BSW00327] Error values naming convention	Fulfilled by chapter 7.7
[BSW00328] Avoid duplication of code	This is a requirement to implementation
[BSW00329] Avoidance of generic interfaces	not applicable
[BSW00330] Usage of macros / inline functions instead of functions	[FRARTP211]
[BSW00331] Separation of error and status values	Fulfilled by the different types
[BSW00333] Documentation of callback function context	Fulfilled by API definitions in chapter 8
[BSW00334] Provision of XML file	not applicable
[BSW00335] Status values naming convention	not applicable
[BSW00336] Shutdown interface	[FRARTP148]
[BSW00337] Classification of errors	[FRARTP179]
[BSW00338] Detection and Reporting of development errors	[FRARTP177]
[BSW00339] Reporting of production relevant errors and exceptions	not applicable (No productions are available)
[BSW00341] Microcontroller compatibility documentation	not applicable
[BSW00342] Usage of source code and object code	not applicable
[BSW00343] Specification and configuration of time	Fulfilled by configuration chapter
[BSW00344] Reference to link-time configuration	not applicable (no link-time only parameters)
[BSW00345] Configuration at Compile time	[FRARTP177] , **[FRARTP178]**
[BSW00346] Basic set of module files	[FRARTP195]
[BSW00347] Naming separation of different instances of BSW drivers	not applicable For driver only.
[BSW00348] Standard type header	not applicable
[BSW00350] Development error detection keyword	[FRARTP177]
[BSW00353] Platform specific type header	not applicable
[BSW00355] Do not redefine AUTOSAR integer data types	Fulfilled by API definitions in chapter 8
[BSW00357] Standard API return type	Fulfilled by API definitions in chapter 8
[BSW00358] Return type of `init()` functions	Fulfilled by API definitions in chapter 8

[BSW00359] Return type of callback functions	Fulfilled by API definitions in chapter 8
[BSW00360] Parameters of callback functions	Fulfilled by API definitions in chapter 8
[BSW00361] Compiler specific language extension header	not applicable
[BSW00369] Do not return development error codes via API	[FRARTP149] - [FRARTP154]
[BSW00370] Separation of callback interface from API	Fulfilled by chapter 8
[BSW00371] Do not pass function pointers via API	Fulfilled by API definitions in chapter 8
[BSW00373] Main processing function naming convention	Fulfilled by API definitions in chapter 8
[BSW00374] Module vendor identification	**[FRARTP178]**
[BSW00375] Notification of wake-up reason	not applicable
[BSW00376] Return type and parameters of main processing functions	Fulfilled by API definitions in chapter 8
[BSW00377] Module specific API return types	Fulfilled by API definitions in chapter 8
[BSW00378] AUTOSAR boolean type	Fulfilled by API definitions in chapter 8
[BSW00379] Module identification	**[FRARTP178]**
[BSW00380] Separate C-Files for configuration parameters	[FRARTP166]
[BSW00381] Separate configuration header file for pre-compile time parameters	[FRARTP195] [FRARTP214]⌈
[BSW00383] List dependencies of configuration files	[FRARTP195] [FRARTP214]⌈
[BSW00384] List dependencies to other modules	Fulfilled by chapter 5
[BSW00385] List possible error notifications	Fulfilled by chapter 7.7
[BSW00386] Configuration for detecting an error	Fulfilled by chapter 10
[BSW00387] Specify the configuration class of callback function	Fulfilled by chapter 8
[BSW00388] Introduce containers	Fulfilled by chapter 10.2
[BSW00389] Containers shall have names	Template requests names, so the requirement is fulfilled
[BSW00390] Parameter content shall be unique within the module	Parameters are unique
[BSW00391] Parameter shall have unique names	Parameters have unique names
[BSW00392] Parameters shall have a type	Template requests type, so the requirement is fulfilled
[BSW00393] Parameters shall have a range	Template requests range, so the requirement is fulfilled
[BSW00394] Specify the scope of the parameters	Template requests scope, so the requirement is fulfilled
[BSW00395] List the required parameters (per parameter)	not applicable
[BSW00396] Configuration classes	Parameter-template requests configuration classes
[BSW00397] Pre-compile-time parameters	This is not a requirement, it is a description
[BSW00398] Link-time parameters	This is not a requirement, it is a description
[BSW00399] Loadable Post-build time parameters	Done by configuration description
[BSW004] Version check	[FRARTP201
[BSW00400] Selectable Post-build time parameters	not applicable
[BSW00401] Documentation of multiple instances of configuration parameters	Fulfilled by configuration chapter
[BSW00402] Published information	**[FRARTP178]**
[BSW00404] Reference to post build time configuration	[FRARTP195]
[BSW00405] Reference to multiple configuration sets	not applicable

[BSW00406] Check module initialization	To perform this check the start up code of the microcontroller has to initialize the status variables. Furthermore E_UNINIT is not defined in the Std_ReturnType
[BSW00407] Function to read out published parameters	[FRARTP202]
[BSW00408] Configuration parameter naming convention	Fulfilled by chapter 10
[BSW00409] Header file for production error code IDs	not applicable
[BSW00410] Compiler switch shall have defined values	Template requests compiler switches with defined values, so the requirement is fulfilled
[BSW00411] Get version info keyword	[FRARTP215]
[BSW00412] Separate H-File for configuration parameters	not applicable, post build time configuration is referenced in the init-function
[BSW00413] Accessing instances of BSW modules	not applicable Only 1 instance of FrArTp allowed.
[BSW00414] Parameter of init function	Fulfilled by API definitions in chapter 8
[BSW00415] User dependent include files	not applicable
[BSW00416] Sequence of initialization	not applicable
[BSW00417] Reporting of Error Events by Non-Basic Software	not applicable
[BSW00419] Separate C-Files for pre-compile time configuration parameters	not applicable
[BSW00422] Pre-Debouncing of production relevant error status	not applicable DEM requirement
[BSW00423] Usage of SW-C template to describe BSW modules with AUTOSAR Interfaces	Template used
[BSW00424] BSW main processing function task allocation	[FRARTP203]
[BSW00425] Trigger conditions for schedulable objects	not applicable
[BSW00426] Exclusive areas in BSW modules	not applicable
[BSW00427] ISR description for BSW modules	not applicable No ISR function
[BSW00428] Execution order dependencies of main processing functions	not applicable FlexRay TP has only one MainFunction

[BSW00429] Restricted BSW OS functionality access	not applicable
[BSW00431] The BSW Scheduler module implements task bodies	not applicable
[BSW00432] Modules should have separate main processing functions for read/receive and write/transmit data path	Fulfilled by chapter 8
[BSW00433] Calling of main processing functions	not applicable
[BSW00434] The Schedule module shall provide an API for exclusive areas	not applicable
[BSW00435] Module Header File Structure for the Basic Software Scheduler	[FRARTP195]
[BSW00436] Module Header File Structure for Memory Mapping	[FRARTP195]
[BSW005] No hard coded horizontal interfaces within MCAL	not applicable
[BSW006] Platform independency	[FRARTP213]
[BSW007] HIS MISRA C	[FRARTP208]
[BSW009] Module User Documentation	Fulfilled by the whole document
[BSW010] Memory resource documentation	not applicable
[BSW101] Initialization interface	[FRARTP147]
[BSW158] Separation of configuration from implementation	Redundant to BSW00346
[BSW159] Automatic configuration	[FRARTP168] - **[FRARTP178]**, [FRARTP180] , [FRARTP181
[BSW164] Implementation of interrupt service routines	not applicable
[BSW167] Static configuration checking	[FRARTP171] [FRARTP174] , [FRARTP180] , [FRARTP181
[BSW168] Diagnostic interface	not applicable
[BSW170] Data for reconfiguration of AUTOSAR SW-components	not applicable
[BSW171] Configurability of optional functionality	[FRARTP168]

Document: AUTOSAR requirements on Basic Software, cluster FlexRay

Requirement	***Satisfied by***
BSW05073 (Usage of ISO 15765-2 and ISO 15765-4 specifications)	Fulfilled by chapter 1
BSW05074 (FlexRay Transport Interfaces)	Fulfilled by chapter 1
BSW05075 (Configuration Independence)	[FRARTP149]
BSW05123 (Configuration Modifiable by a Flashing Process)	[FRARTP166]
BSW05076 (Multiple Logical FlexRay Transport Layer Channels)	[FRARTP088] , [FRARTP089]
BSW05077 (Unique Identifier of N-SDU)	[FRARTP168]
BSW05079 (Transport Connection Properties)	[FRARTP168]
BSW05082 (Acknowledgement without Retry)	[FRARTP168] , [FRARTP012] , [FRARTP013]
BSW05083 (Acknowledgement with Retry)	[FRARTP168] , [FRARTP014] , [FRARTP015]
BSW05085 (Segmented 1:n Connections without Flow Control)	[FRARTP168] , [FRARTP016] , [FRARTP017]
BSW05104 (Default Separation Time)	[FRARTP168]
BSW05088 (FlexRay Transport Layer Initialization)	[FRARTP147]
BSW05089 (FlexRay Transport Layer Availability)	[FRARTP179]
BSW05090 (Support of Optional ISO 15765-2 Service)	[FRARTP104

BSW05093 (Transmit Cancellation)	[FRARTP099- [FRARTP103
BSW05095 (Bandwidth Control)	[FRARTP011]
BSW05129 (Mismatch of Service Call and Connection Properties)	[FRARTP149] - [FRARTP151]

7 Functional specification

[FRARTP008] ⌈The FrArTp offers services for segmentation, transmission with flow control, and reassembly of messages (Fr N-SDUs). Its main purpose is to transfer messages that may or may not fit in a single FlexRay frame.⌋()

[FRARTP201]⌈The FlexRay AUTOSAR TP shall perform a preprocessor-check if its source and header files belong to the same version.⌋(BSW004)

7.1 Overview

[FRARTP009] ⌈Beside the features according to ISO 15765-2 (7 byte data per frame, 4 kByte message length, unsegmented 1:n connections, multiple logical channels concurrently, flow control, service request confirmation) it allows to configure independently of each other the following features for a specific channel at both pre- and post-compile time:

- Acknowledgement (with or without Retry) for 1:1 connections
- Segmented 1:n connections (without flow control)
- Transmission cancellation
- Up to 2^{32}-1 Byte message length⌋()

Additionally the length and the number of the Fr N-PDUs of a connection is configurable. It has to be clear, that the N-PDUs are unique for a channel and for each connection of a channel only N-PDUs having the same length can be chosen.

For the rest of this document, sections or features which are not compliant to ISO 15765-2 will be marked as "**Not compliant to ISO 15765-2**".

7.2 Protocol Processes

There are, as will be shown later on, different types of First Frames and Single Frames. So in the sequence diagrams will always FF or SF be used, regardless of the concrete subtype.

7.2.1 1:1 Connections

This type of connection is the most common in today's automotive applications. Within the FlexRay AUTOSAR Transport Layer the following subtypes are possible.

7.2.1.1 1:1 Connection in a channel without Acknowledgement

[FRARTP010] ⌈Unsegmented Transfer

In case a message does not exceed the possible amount of payload for a SF (which can be derived from the values of FRARTP_PDU_LENGTH, FRARTP_ADRTYPE and FRARTP_LM), there is no need to segment this message.」()

The transfer takes place as illustrated in Figure 3:

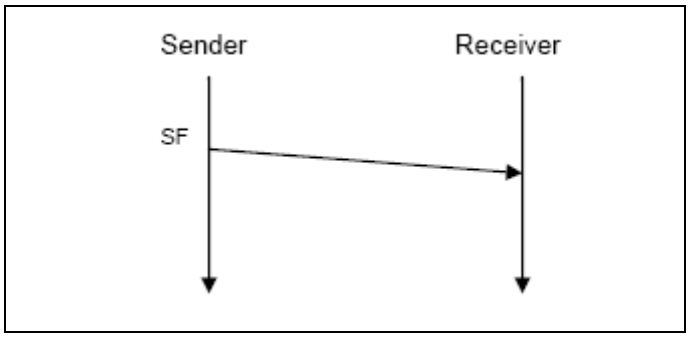


Figure 3: Unsegmented 1:1 transfer without acknowledgement

The sending Transport Layer packs the payload (Fr N-SDU) into an Fr N-PDU and sends it to the receiving Transport Layer. This is done via a Single Frame (SF).

[FRARTP011]「Segmented Transfer

In case a message does not fit into an SF, it needs to be split up into several parts and flow control is applied to control the data flow taking into account the needs of the receiver.」(BSW05095)

In this case, the transfer takes place as shown in Figure 4:

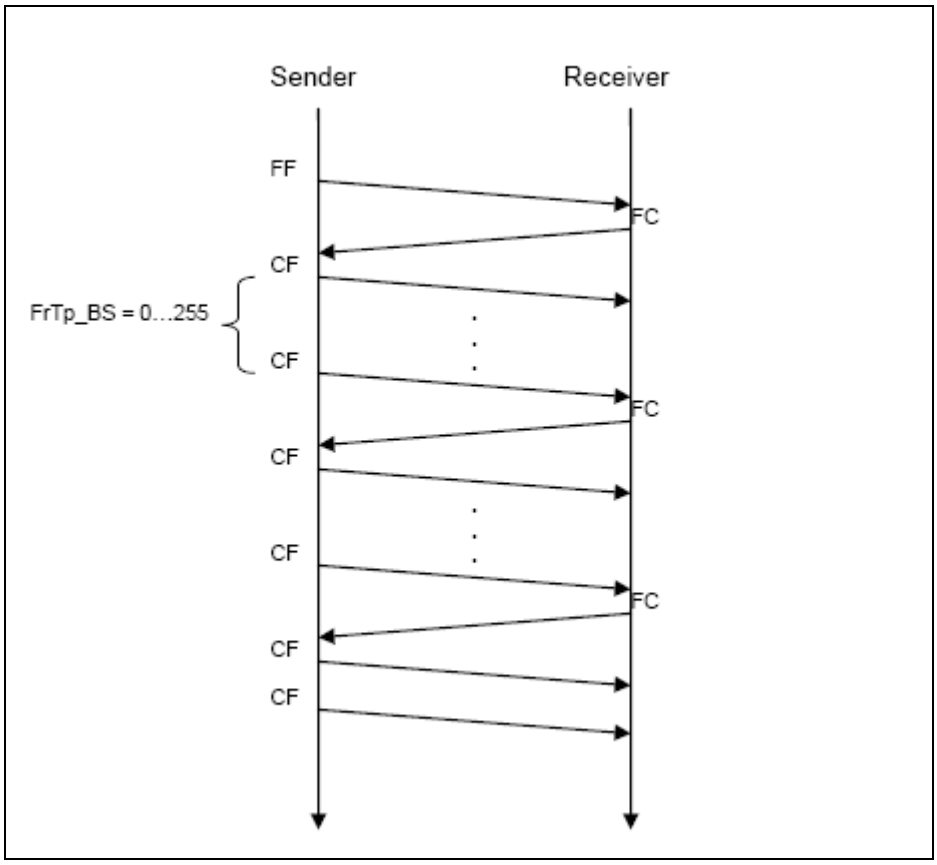


Figure 4: Segmented 1:1 transfer without acknowledgement

The transfer starts with sending a First Frame (FF) from the sender to the receiver. This frame contains the length of the whole message (e. g. 1000 Byte) and even the first data bytes.
The receiving peer reacts to the reception of a FF with sending of a Flow Control frame (FC) back to the sender. This FC frame contains the value of three parameters: FRARTP_FS, FRARTP_BS and FRARTP_STMIN.

FRARTP_FS states the flow status. The possible values are:

- CTS: Clear To Send
  The sender can continue transmitting the message
- WT: Wait
  The sender shall wait for another FC frame.
- OVFLW: Overflow
  The sender shall abort the transfer, because the receiver has not enough buffer for the whole message available.

There shall be a statically defined upper limit (FRARTP_MAX_BUFREQ) for the number of allowed WT's. If this number has been reached, the transmission shall be aborted and within *PduR_FrArTpTxConfirmation* the result NTFRSLT_E_NO_BUFFER shall be returned.

FRARTP_BS specifies the block size. This is the number of Consecutive Frames (CF) the sender is allowed to send between two FC Frames. The possible range is from 0x00 to 0xFF, whereas 0x00 states that no more FC Frames will be transmitted by the receiver, i. e. the whole message shall be sent in one big block.

FRARTP_STMIN quotes the minimum gap between two CFs in milliseconds or micro-seconds. The range from 0x00 to 0x7F specifies the minimum gap in milliseconds, the one from 0xF1 to 0xF9 defines the gap in microseconds (100 µs, 200 µs, …)

The alternating transmission of CF blocks and a FC frame lasts, until the whole message is sent.

The FRARTP_STMIN parameters can be changed during runtime by using the respective API call.

7.2.1.2 1:1 Connection in a channel with Acknowledgement without Retry

This subchapter is **Not compliant to ISO 15765-2** and describes how a simple acknowledgement mechanism looks like.

[FRARTP012]「Unsegmented Transfer

This is mostly done like in section Unsegmented Transfer of chapter 7.2.1.1, except that there is an additional Acknowledge Frame (AF) which is sent from the receiver to the sender. This is illustrated in Figure 5:

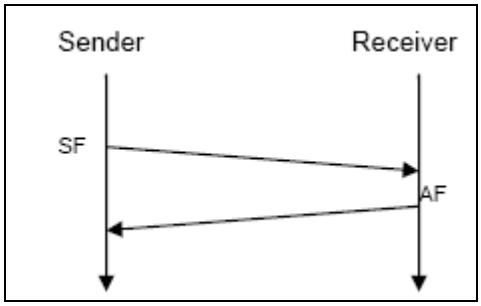


Figure 5: Unsegmented 1:1 transfer with Acknowledgement without Retry」(BSW05082)

The AF contains among others the parameter FRARTP_ACK which has two possible values, Positive Acknowledgement (POS_ACK) or Negative Acknowledgement (NEG_ACK). Thus the sender is informed about the (un)successful reception of a message by the receiving peer. If the FS field of an AF frame (see chapter 7.3.6) contains the value WT, another AF, up to FRARTP_MAX_BUFREQ, will arrive.

[FRARTP013]「Segmented Transfer

This is done very similar to section Segmented Transfer of chapter 7.2.1.1. There are only three differences:
The first difference is the transmission of an AF after the last block, because this one has to be acknowledged as well. This frame is similar to an ordinary Flow Control frame but contains additionally the FRARTP_ACK parameter (for positive or negative acknowledgement) and the sequence number of the first faulty frame of the transmitted block.
The second difference is the transmission of an AF with a negative acknowledgement after a block in which an error occurred. This AF also contains the sequence number of the first faulty or missing frame.
The third difference is, that the block size shall be in the range from 1 to 16 (due to the 4 bit sequence number, see chapter 7.3.4)」(BSW05082)

The procedure can be seen in Figure 6:

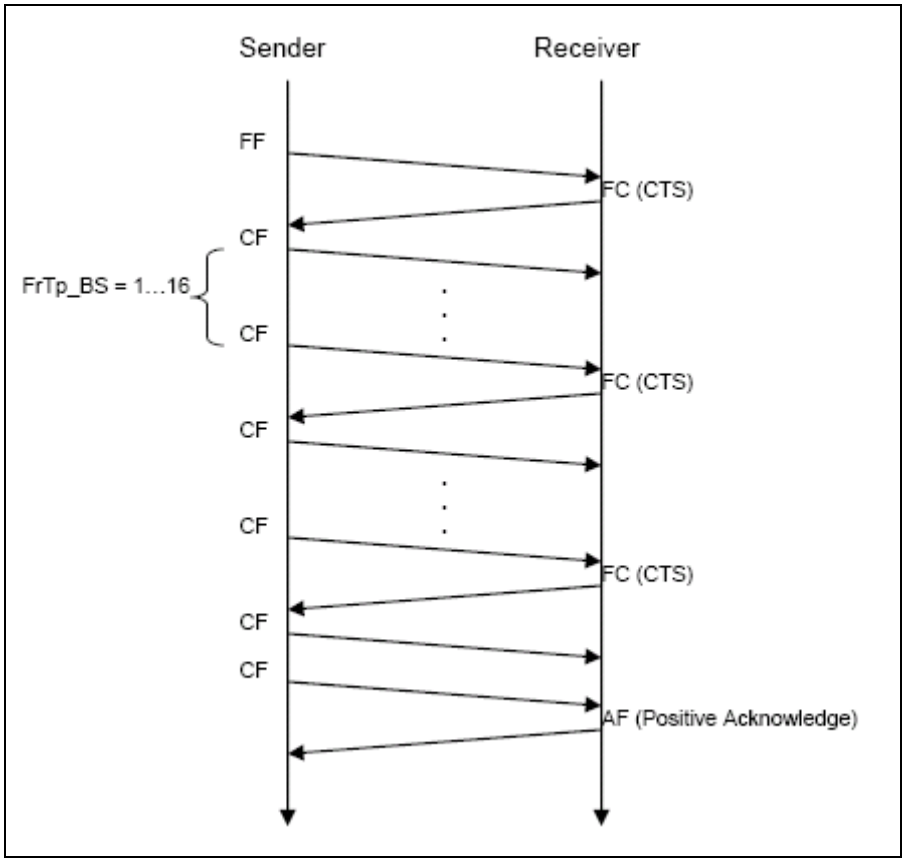


Figure 6: Segmented 1:1 transfer with Acknowledgement without Retry

Obviously, the acknowledgement is done on a “per block” basis, depending on the current block size.
In case of a negative acknowledgement after a block (in that case instead of an FC frame an AF with a negative acknowledgement is sent to the sender and the receiver aborts the reception and indicates an appropriate result to its upper layer (*PduR_FrArTpRxIndication*) the sender aborts the transmission and informs its upper layer (*PduR_FrArTpTxConfirmation*).

7.2.1.3 1:1 Connection in a channel with Acknowledgement with Retry

This subchapter is **Not compliant to ISO**

[FRARTP014] ⌈Unsegmented Transfer
This section is quite similar to the corresponding one in chapter 7.2.1.2. The only difference is that in case of a negative acknowledgement the frame is retransmitted.⌋(BSW05083)

This behaviour is depicted in Figure 7 and Figure 8:

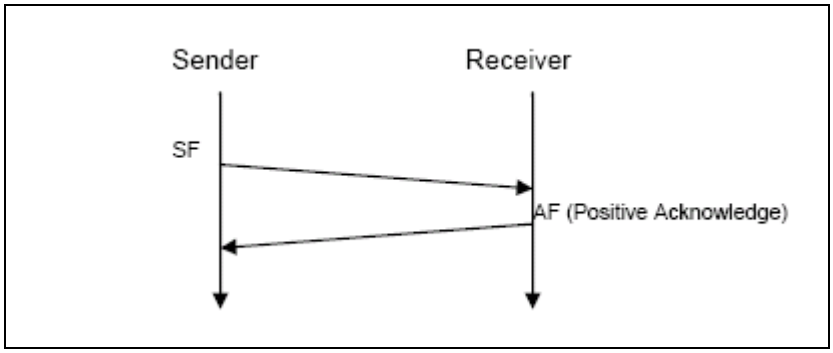


Figure 7: Unsegmented 1:1 transfer, Acknowledgement with Retry configured, Positive Acknowledgement

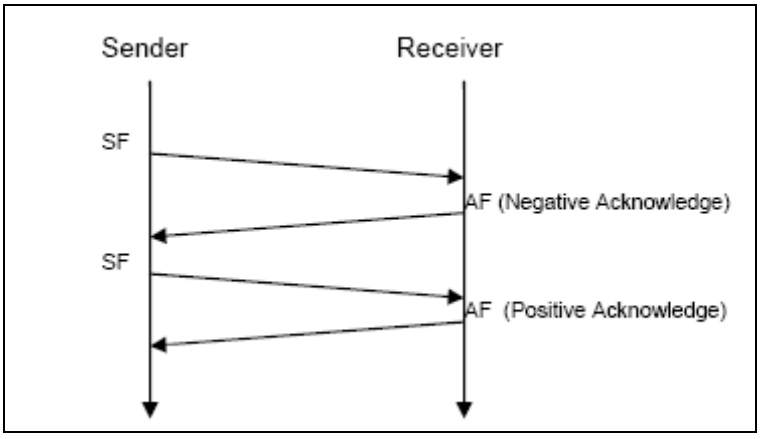


Figure 8: Unsegmented 1:1 transfer, Acknowledgement with Retry configured, Negative Acknowledgement

If in Figure 8 the second try of sending the message also failed, there would be a third one and so on.
In order to prevent infinite retransmissions in the case of a permanent failure, an upper limit (FRARTP_MAX_RN) has to be defined. If the number of retries has reached this value, the transmission of the corresponding message shall be stopped and within *PduR_FrArTpTxConfirmation* and *PduR_FrArTpRxIndication* an adequate result (see chapter 8.2.1) shall be returned.

[FRARTP015]「Segmented Transfer
Compared to the segmented transfer in chapter 7.2.1.2, the difference is the Retry mechanism and, coming with it, the alternating block mechanism.」(BSW05083)

The Retry mechanism works as follows:

In the case a negative acknowledge arrives at the sender, this also contains the sequence number of the first faulty frame in the currently transmitted block. Now the sender transmits, starting with the stated sequence number, all remaining frames of the just transmitted block again.
In order to prevent infinite retransmissions in case of a permanent failure, the parameter FRARTP_MAX_RN limits the retry attempts.

The Retry mechanism is shown in Figure 9 for the case of a block size of 4:

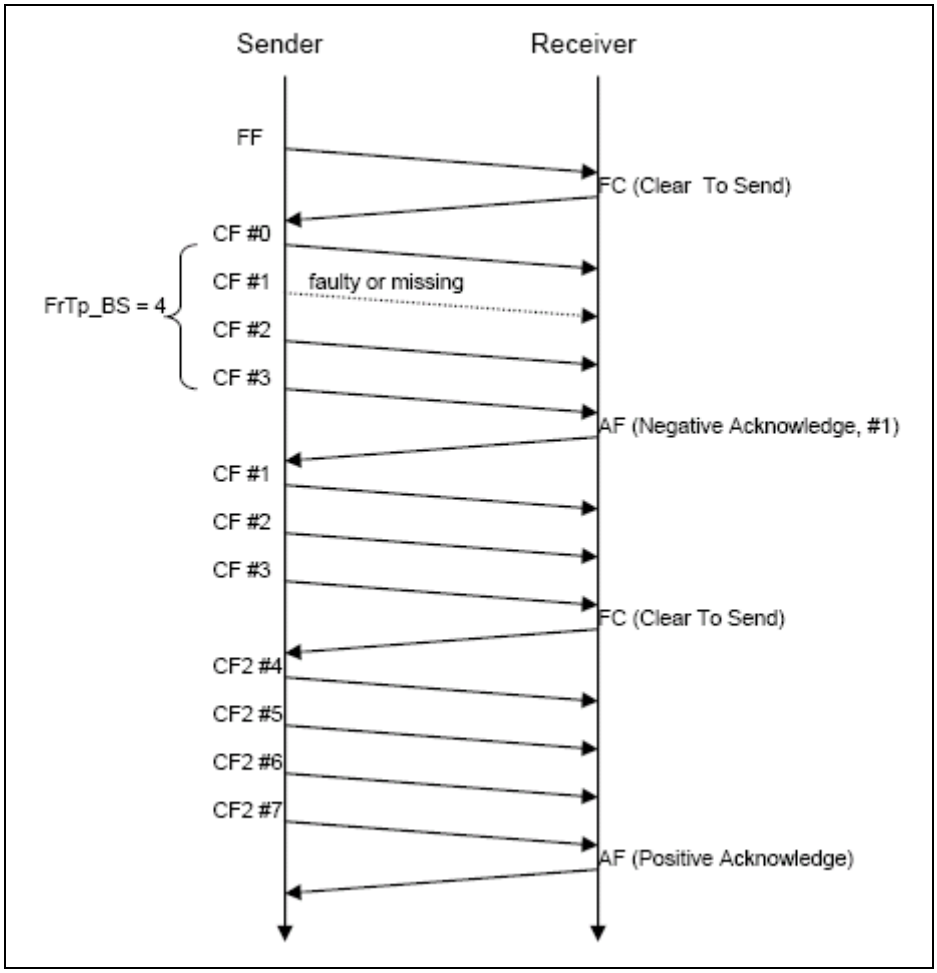


Figure 9: Segmented 1:1 transfer with Acknowledgement with Retry

If the retry starts with a lower sequence number than requested, this shall be tolerated, i. e. all frames until the requested shall be ignored and errors within the ignored frames shall be ignored, too. If it starts with a higher number than requested, this shall lead to another negative acknowledgement after the block end.

Alternating Block Mechanism

[FRARTP235] 「When using the Retry mechanism the FlexRay AR TP transfers blocks using the Alternating Block Mechanism. This works as follows:
The first block is transferred using normal CF frames. The second block is transferred using CF2 frames, the third one with CF frames and so on. When a retry

occurs, a CF block is again transferred with CF frames and, of course, a CF2 block is retried with CF2 frames.」()

This mechanism ensures correct behaviour in case at the block end an FC frame is lost, especially if it is an FC with flow status CTS, by allowing the detection of the unnecessary retries.

7.2.2 1:n Connections

In the case of 1:n connections (1 sender, multiple receivers) there is no further distinction in subtypes (with or without acknowledgement). The reason for this is that the size of the receiving group is often not known a priori, so it is not possible to apply flow control or acknowledgement mechanisms to 1:n connections.
So the only distinction made is between unsegmented and segmented transfer.

[FRARTP016]「Unsegmented Transfer
This is exactly the same like in the section Unsegmented Transfer of chapter 7.2.1.1. The only difference is the multiple receivers instead of one. So the procedure looks like the following:

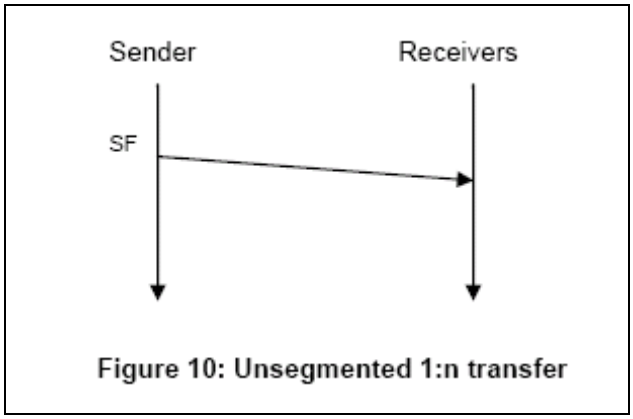


Figure 10: Unsegmented 1:n transfer

One sender sends its message to a group of receivers.」(BSW05085)

[FRARTP017]「Segmented Transfer **Not compliant to ISO 15765-2**
Since no flow control or acknowledgement is possible in this case, a segmented 1:n transfer only consists of a FF and the number of necessary CFs 」(BSW05085)

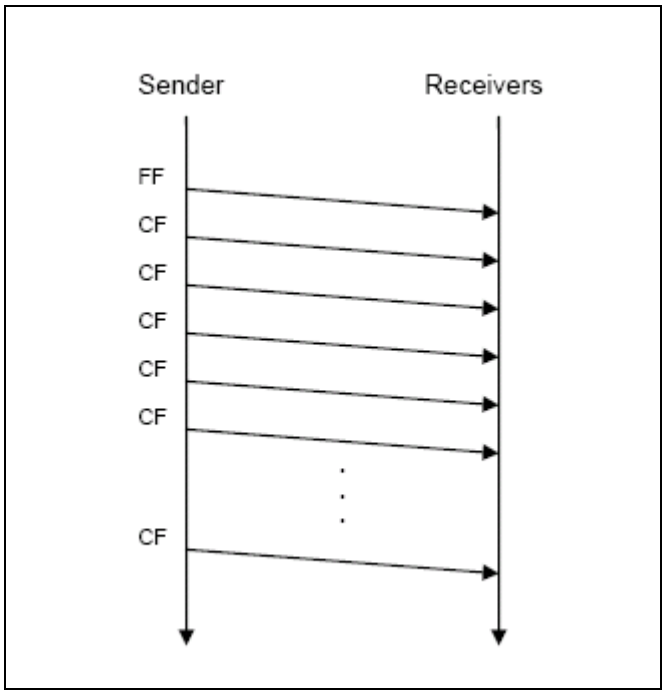


Figure 11: Segmented 1:n transfer

In case an error occurs, the reception will be terminated and the appropriate result will be given within *PduR_FrArTpRxIndication()*.

7.3 Frame Layout

As seen in chapter 7.2 there are different types of frames. A detailed explanation of all the types follows below.

7.3.1 General

[FRARTP018]Γ The general structure of a frame is shown in Figure 12:

Figure 12: Structure of a FlexRay AUTOSAR Transport Layer frame」()

It is common to all frames that they are headed by address information. Depending on static configuration (per channel), in a way whether 1 Byte or 2 Byte addressing is used, this address information consists of 1 Byte for Target Address and 1 Byte for Source Address or 2 Bytes for Target address and 2 Bytes for Source Address. Since it depends on the interpretation of the address information, it is not further specified whether this address information is utilized for the in automotive area so called “Physical” or for “Functional” addressing.

Although in the following it is talked about frames, it must be clear, that these are NOT frames on the FlexRay physical layer but frames within the FlexRay AUTOSAR Transport Layer's point of view. From FlexRay Interface's and below view these frames are just PDUs, so an FrArTp frame is an Fr N-PDU. The mapping of the following Transport Layer frames in FlexRay Physical Layer frames, takes place within the FlexRay Interface.

Please note: In case the FrArTp frame does not require the whole length its PDU (Fr N-PDU) have (e.g. a First Frame or possibly the last Consecutive Frame in a transfer), the remaining space (bits) in the PDU shall be set to 0.

[FRARTP019] ⌈**1 Byte Addressing** Not compliant to ISO 15765-2

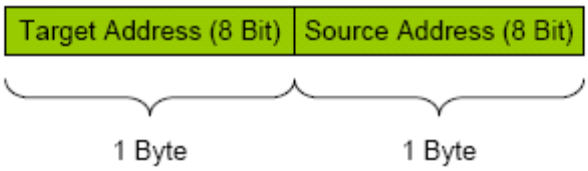


Figure 13: Address header for 1 Byte addressing ⌋()

For both target and source address 1 Byte is provided, so up to 256 receivers are addressable.

[FRARTP020] ⌈**2 Byte Addressing** Not compliant to ISO 15765-2

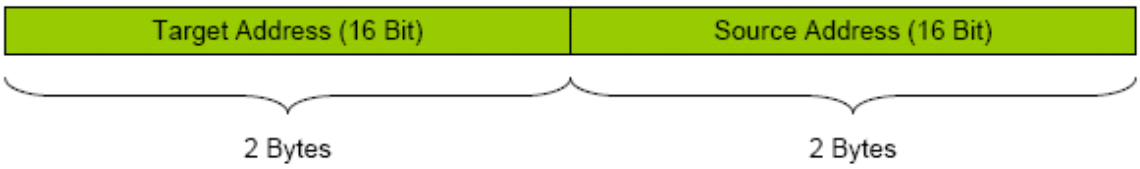


Figure 14: Address header for 2 Byte addressing ⌋()

Looking at this scheme it is possible to address up to 65536 different receivers.

As seen in Figure 12, frames generally consist of the address information, protocol control information and the data. The length and content of the protocol control information (PCI) varies from frame type to frame type.
Before explaining the details of each frame, a short overview is given by the following table (the mentioned bytes and nibbles regard to the PCI):

[FRARTP021] ⌜

ISO 15765-2	Name	1st Nibble	2nd Nibble	2nd Byte	3rd Byte	4th Byte	5th Byte	Description
YES	SF-I	0x0	FRARTP_DL	data	data	data	data	ISO 15765-2 Single Frame
NO	SF-E	0x4	Res (0x0)	FRARTP_DL	data	data	data	Extended Single Frame
YES	FF-I	0x1	FRARTP_DL		data	data	data	ISO 15765-2 First Frame
NO	FF-E	0x5	Res (0x0)	FRARTP_DL				Extended First Frame
YES	CF	0x2	FRARTP_SN	data	data	data	data	ISO 15765-2 Consecutive Frame
NO	CF2	0x6	FRARTP_SN	data	data	data	data	Consecutive Frame used in Retry Channels
YES / NO	FC	0x3	FRARTP_FS	FRARTP_BS	FRARTP_STmin	--	--	(ISO 15765-2) Flow Control Frame
NO	AF	0x7	FRARTP_FS	FRARTP_BS	FRARTP_STmin	FRARTP_ACK (4 Bit) / FRARTP_SN (4 Bit)	--	Acknowledge-ment Frame

Table 1: Overview of the different frames format ⌟()

Note: Unused bytes in this table shall be set to 0x00.

Endianess

In case a protocol value transmitted over the bus consists of more than 1 Byte (e. g. Source Address and Target Address when using 2-Byte addressing), the endianess shall be Most Significant Byte first, Least Significant Byte last.

7.3.2 Single Frames (SF-x)

[FRARTP022] ⌈A SF is sent when a message does not exceed the available amount of payload of this frame type or if ISO 15765-2 compliance is required. To be compliant with ISO 15765-2 on the one hand and to allow using the possibilities of FlexRay on the other hand, there are two types of Single Frames. In ISO 15765-2 compliant channels only SF-I is allowed, in non ISO 15765-2 compliant channels (i. e. FRARTP_LM = FRARTP_L4G) only SF-E is allowed.⌋()

7.3.2.1 ISO 15765-2 Single Frame (SF-I)

[FRARTP023] ⌈A SF-I looks as follows (address information header is not depicted):

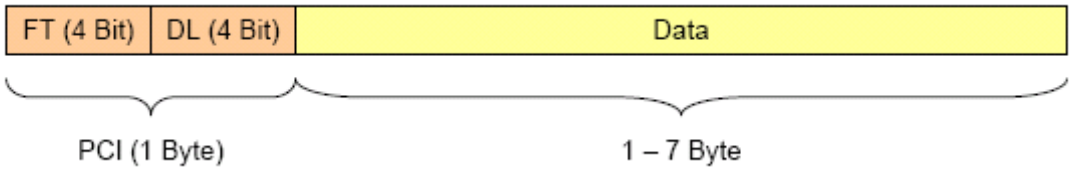


Figure 15: Single Frame ISO 15765-2⌋()

In a SF-I the PCI consists of only one byte. This byte is divided in two parts, called FT (Frame Type) and DL (Data Length). Both parts are 4 Bit long.

The FT field is common to every frame type because it identifies the respective type.

[FRARTP024] ⌈For ISO 15765-2 Single Frames the FT field shall be set to 0x0.⌋()

[FRARTP025] ⌈The DL field states the amount of the actual data bytes, according to ISO 15765-2 the values 0x1 – 0x7 (0x6 in FRARTP_ISO6 mode) are valid, so in an ISO 15765-2 compliant connection the size of the associated Fr N-PDU has to be, depending on the addressing mode, 10 (9) or 12 (11) Bytes long, since the SF has this length.⌋()

[FRARTP026] ⌈The actual frame length can be derived considering the addressing mode and looking in the length statement of the corresponding PduInfoType struct in the configuration.⌋()

[FRARTP027] ⌈Including address information the length of an SF-I reaches from 4 Byte (1 Byte pay-load, 1 Byte addressing) to 12 Bytes.⌋()

[FRARTP028] ⌈ **Error Handling**
DL field:

Incoming SF-I frames with an invalid DL value of 0x0 or higher than 0x7 (0x6 in FRARTP_ISO6 mode) shall be ignored. This shall also be done if a value arrives which is higher than the amount of payload that can be derived from the length statement of the corresponding PduInfoType struct in the configuration and the addressing mode.」()

If acknowledgement is configured, additionally an AF with a negative acknowledgement shall be sent back to the sender in the cases above.

7.3.2.2 Extended Single Frame (SF-E)

This subchapter is **Not compliant to ISO 15765-2**.

[FRARTP029] 「An SF-E allows using the whole possible FlexRay payload of 254 Bytes for an un-segmented transfer. It looks as depicted in Figure 16:

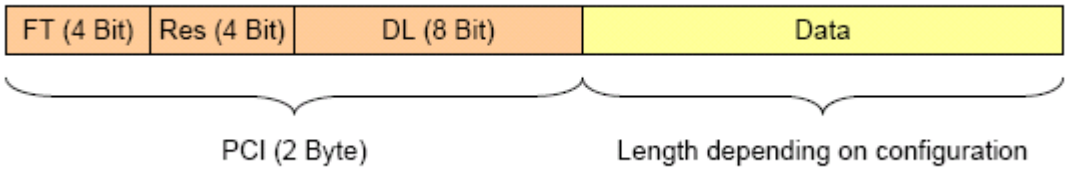


Figure 16: Single Frame Extended」()

[FRARTP030] 「The PCI of an SF-E consists of two bytes. The FT field is 4 Bit long, for an SF-E it shall be set to 0x4. The following nibble is reserved, it shall be set to 0x0.」()

[FRARTP031] 「The next byte is the DL field and states the amount of payload contained in the SF-E. Depending on the configuration of the addressing mode (1 Byte or 2 Byte) and the length of the associated Fr N-PDU, all values except 0x00 and above 0xFA (1 Byte addressing) or above 0xF8 (2 Byte addressing) are valid here.」()

[FRARTP032] 「The minimum length of such a frame is 5 Byte (1 Byte addressing, 1 Byte payload), the maximum is 254 Byte (FlexRay limit according to [14]). The actual frame length can be derived considering the addressing mode and looking in the length statement of the corresponding PDU-Info Struct.」()

[FRARTP033] 「Error Handling

DL field:

If this field contains the value 0x00 or, depending on the addressing mode, a value higher than 0xFA or higher than 0xF8, the SF-E shall be ignored.
If acknowledgement is configured, additionally an AF with a negative acknowledgement shall be sent back to the sender.⌋()

General:
If messages longer than allowed by ISO 15765-2 are not configured (FRARTP_LM) for the corresponding channel, this frame shall be ignored. This shall also be done if a value arrives which is higher than the amount of payload that can be derived from the length statement of the corresponding PDUInfo Struct and the addressing mode or if a value different from 0x0 arrives in the reserved nibble.
If acknowledgement is configured, additionally an AF with a negative acknowledgement shall be sent back to the sender in the cases above.

7.3.3 First Frames (FF-x)

If a message does not fit into a SF it has to be segmented.

[FRARTP034] ⌈The FlexRay AUTOSAR Transport Layer takes the decision whether a message has to be segmented based on the message length, the possibility (depending on per channel configuration) to use SF-E frames and the size of the assigned Fr N-PDU (see also chapter 7.5.1). Therefore to start the transfer of such a long message, a First Frame is used.⌋()

[FRARTP035] ⌈To enable compliance with ISO 15765-2 on the one hand and to allow messages longer than 2^{12}-1 Byte on the other hand, there are several types of First Frames.⌋()

[FRARTP036]⌈ Not compliant to ISO 15765-2
It can be statically per channel configured, whether a First Frame can also start a segmented message in an 1:n connection. ⌋()

7.3.3.1 First Frame ISO 15765-2 (FF-I)

The figure below shows the layout of a FF-I:

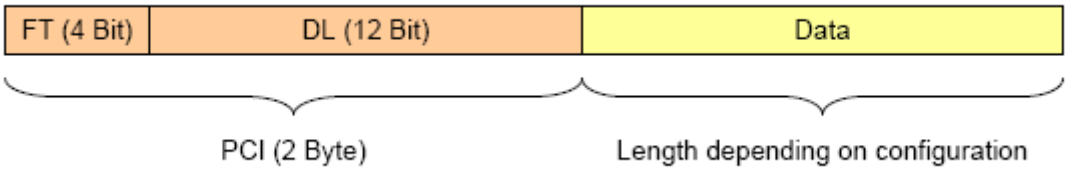


Figure 17: First Frame ISO 15765-2

In an FF-I the PCI consists of 2 Bytes. As in an SF, the FT field is 4 Bit long, the DL field 12 Bit.

[FRARTP037] ⌈For a FF-I, the FT field shall be set to 0x1.⌋()

The DL field contains the length of the whole message. Due to the 12 Bit length of this field, messages up to 2^{12}-1 Bytes can be transferred.

[FRARTP038] ⌈The overall length of a First Frame including address information lasts (depending on the per channel configuration) from 4 Byte to a connection specific maximum.
This maximum on its part depends on the use case (e. g. for communication with CAN for which full ISO 15765-2 compliance is necessary, it will be 10 or 12 (9 or 11 in FRARTP_ISO6 mode) as well as on the size of the associated Fr N-PDU. The actual amount of payload of an FF-I can be derived by considering the addressing

type (1 or 2 Byte) and e. g. looking in the length designation of the corresponding PDU-Info Struct.」()

[FRARTP039]「Error Handling

DL field:
Incoming FF-I frames with DL = 0x000 shall be ignored. Moreover if the DL value is lower than the possible (from the PDU size, the addressing type and the channel specific Long Messages switch derivable) payload of a SF, the frame shall also be ignored.
If acknowledgment is configured, in all the cases above additionally an AF with a negative acknowledgement shall be sent back to the sender.」()

7.3.3.2 First Frame Extended (FF-E)

This subchapter is **Not compliant to ISO 15765-2**.

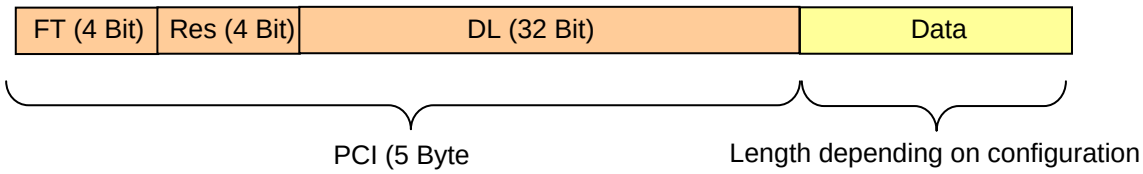


Figure 18: First Frame Extended

In an FF-E the PCI consists of 5 Bytes. The FT field is 4 Bit long, 4 Bits are reserved, the DL field 32 Bit.

[FRARTP054]「The DL field is 4 Byte long, so it allows transporting up to 2^{32}-1 bytes.」()

[FRARTP055]「The FT field is set to 0x5.」()

[FRARTP056]「The Res field (reserved) is set to 0x0.」()

The overall length of an FF-E reaches from 7 Byte to a connection specific maximum which depends on the size of the associated Fr N-PDU.

[FRARTP057]「Error Handling

DL field:
If the FR_DL value is lower than the possible (from the PDU size and the addressing type derivable) payload of an SF, the frame shall be ignored.

If acknowledgement is configured for the corresponding channel, an AF with a negative acknowledgement shall be sent back to the sender.」()

7.3.4 Consecutive Frames

[FRARTP058] ⌈If no error occurred, an FF-x is followed by Consecutive Frames until the whole message is transmitted.⌋()

[FRARTP059] ⌈Not compliant to ISO 15765-2
If configured for the specific channel, a Consecutive Frame can also appear in an 1:n connection.⌋()

As shown below, Consecutive Frames consist of one byte PCI and the payload.

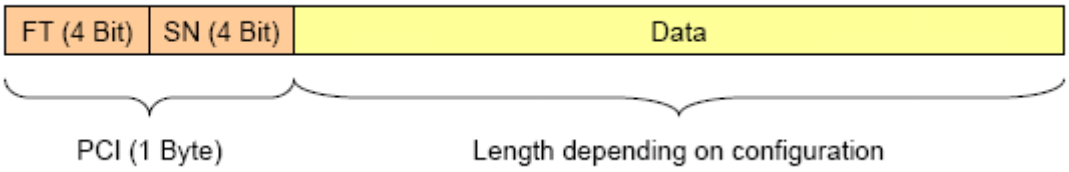


Figure 19: Consecutive Frame

The PCI of a Consecutive Frame consists of one byte which is divided in two 4 Bit parts.

[FRARTP060] ⌈The FT field again states the frame type, for a CF it shall be set to 0x2, for a CF2 it shall be 0x6 (CF2 frames are Not compliant to ISO 15765-2).⌋()

[FRARTP061] ⌈The SN (Sequence Number) field gives the current sequence number of the Consecutive Frame. **Please note that the SN of the CF that immediately follows the FF-x is set to 1** and then incremented with each frame until it wraps around to 0 and so on.⌋()

[FRARTP062] ⌈The overall length of a Consecutive Frame including address information ranges (depending on the per connection configuration) from 4 Byte to a connection specific maximum. This maximum on its part depends on the use case (e. g. for communication with CAN for which full ISO 15765-2 compliance is necessary it will be 10 or 12 (9 or 11 in FRARTP_ISO6 mode) as well as on the size of the associated PDU.
So, the receiving peer can derive the actual data length by looking in the associated PDU-Info Struct und considering the addressing mode.⌋()

[FRARTP063] ⌈**Error Handling**

SN field:

If no acknowledgement is configured, then in case of a wrong SN, i. e. after SN x does not follow SN x+1, the transfer shall be aborted and within *PduR_FrArTpRxIndication* the result NTFRSLT_E_WRONG_SN shall be returned.
If acknowledgment is configured, after the block end a negative acknowledgement shall take place and then the transfer shall be aborted as described above.
If Retry is configured too, then the transfer shall not be aborted but the Retry shall take place (up to FRARTP_MAX_RN times).」()

7.3.5 Flow Control (FC)

[FRARTP064] 「A Flow Control frame is used in segmented 1:1 connections (see chapter 7.2.1.1). Thus it cannot appear in a 1:n connection. It allows the receiver to send information to the sender. It is sent after reception of an FF-x and after the last CF of a block if no error occurred. 」()

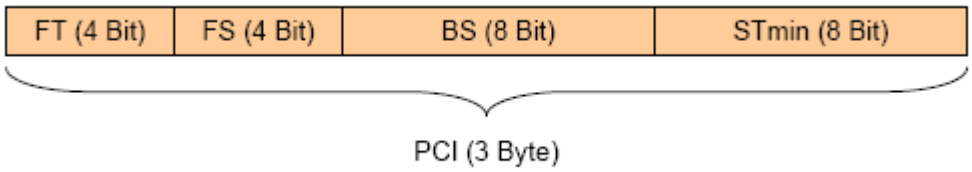


Figure 20: Flow Control frame

[FRARTP065]「 A Flow Control frame only consists of Protocol Control Information.」()

[FRARTP066] 「As usual, the FT field states the frame type, thus for Flow control frames it shall be set to 0x3.」()

[FRARTP067] 「In the FS field the parameter FRARTP_FS is contained. Three different values are possible here (see also chapter 7.2.1.1):

- CTS (value 0x0): Clear To Send
  The sender can continue transmitting the message.
- WT (value 0x1): Wait
  The sender shall wait for another FC frame (and therefore restart its timer FRARTP_TIMEOUT_B). If the number of consecutive Flow Control frames with FRARTP_FS = WT reaches a per channel defined maximum, the transfer shall be aborted.
- OVFLW (value 0x2): Overflow
  The transfer shall be aborted, because the receiver has not enough buffer for the whole message

available (according to the value of the DL field of the FF-x)」()

[FRARTP068] 「BS contains the parameter FRARTP_BS, which states the block size (the number of CFs between the Flow Control frames). If no acknowledgement is configured, all values from 0x00 to 0xFF are valid whereas 0x00 indicates that no more flow control shall take place and the rest of the pending message will be transmitted within one big block. Otherwise, only the values 0x01 – 0x10 are valid.」()

[FRARTP069] 「The last byte contains FRARTP_STMIN, which states the minimum gap between two CFs. The valid values are from 0x00 – 0x7F (Separation Time in milliseconds) and from 0xF1 to 0xF9 (separation time of 100 µs, 200 µs, …).」()

[FRARTP070] 「Depending on addressing configuration, a Flow Control frame is 5 or 7 byte long.」()

[FRARTP071] 「Error Handling

FS:
If acknowledgment with Retry is configured, instead of abortion of the transfer, the frame shall be ignored.」()

BS:
All values are valid if no acknowledgement is configured. Otherwise only the values from 0x1 to 0x10 are valid. If no Retry is configured in the latter case the transfer shall be aborted and *PduR_FrArTpTxConfirmation* shall be called with NTFRSLT_E_NOT_OK, otherwise the frame shall be ignored.

STmin:
The invalid values of this parameter range from 0x80 to 0xF0 and from 0xFA to 0xFF. If such a value is received the value 0x7F shall be taken instead.

7.3.6 Acknowledgement Frame (AF)

This subchapter is **Not compliant to ISO 15765-2**.

[FRARTP072] ⌈If acknowledgement is configured, every block of CFs is in the case of a positive acknowledgement acknowledged by an FC frame (as it is in unacknowledged connections). Additionally an SF-x, the last block of CFs and, in the case of a negative acknowledgement, all other blocks are acknowledged by an AF in 1:1 connections. This frame type cannot appear in a 1:n connection.
This type of frame looks similar to an FC frame (chapter 7.3.5) but it has an additional byte.⌋()

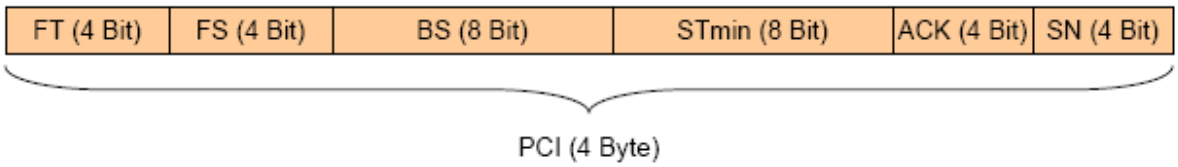


Figure 21: Acknowledgement Frame

[FRARTP073] ⌈This frame is identified by the value 0x7 of the FT field.⌋()

[FRARTP074] ⌈The FRARTP_FS parameter (FS field) is the same as in an FC frame.⌋()

[FRARTP075] ⌈FRARTP_BS (BS field) can only be set to the values 0x01 to 0x10 due to the 4 Bit Sequence Number counter in a CF (chapter 7.3.4).⌋()

[FRARTP076] ⌈STmin is the same as in FC frames.⌋()

[FRARTP077]FRARTP_ACK (ACK field) gives the type of the acknowledgement, Positive (0x0) or Negative (0x1). All other values are reserved.⌋()

[FRARTP078] ⌈FRARTP_SN (SN field) contains the number of the first faulty CF within the last block. All values are valid.⌋()

[FRARTP079] ⌈Depending on addressing type this frame is 6 or 8 Byte long. ⌋()

[FRARTP080] ⌈**Error Handling:**
The following only holds if an AF arrives when it is expected. Otherwise, see chapter 7.3.7.⌋()

FS field:
In a segmented transfer, all values higher than 0x2 shall lead to the abortion of the transfer and *PduR_FrArTpTxConfirmation* shall be called with the result NTFRSLT_E_INVALID_FS.
If additionally Retry is configured, such values shall not lead to the abortion of the transfer but to ignore the frame.

BS field: The value 0x00 and all values higher than 0x10 shall cause the abortion of the transfer and *PduR_FrArTpTxConfirmation* shall be called with the result NTFRSLT_E_NOT_OK.
If additionally Retry is configured, such values shall not lead to the abortion of the transfer but to ignore the frame.

STmin field: The invalid values of this parameter range from 0x80 to 0xF0 and from 0xFA to 0xFF. If such a value is received, the value 0x7F shall be taken instead.

ACK field: Values higher than 0x1 are invalid and shall cause the abortion of the transfer and *PduR_FrArTpTxConfirmation* shall be called with the result NTFRSLT_E_NOT_OK.
If additionally Retry is configured, such values shall not lead to the abortion of the transfer but to ignore the frame.

SN field: If here a value arrives which contains a SN of a CF which has not been transmitted within the block, e. g. block size is 10 and this field has value 12, the transfer shall be aborted and *PduR_FrArTpTxConfirmation* shall be called with the result NTFRSLT_E_WRONG_SN.
If additionally Retry is configured, the transfer shall not be aborted but the frame shall be ignored.

General: If for the channel no acknowledgement is configured, this frame type shall be ignored.
In an unsegmented acknowledged transfer, the expected value for the fields BS, STmin and SN is 0x0. Other values shall be tolerated.

For the FS field there is an exception: In case an AF with negative acknowledgement and FS = OVFLW arrives in an **unsegmented** acknowledged transfer or at the end of an segmented acknowledged transfer at the sender, regardless of Retry being configured or not, the transfer shall be aborted and *PduR_FrArTpTxConfirmation* shall be called with the result NTFRSLT_E_NO_BUFFER.

For a better understanding, the following table depicts the possible combinations (and their meaning) of the FS and ACK field in an Acknowledgment Frame:

Possible combinations of FS and ACK field in Acknowledgement Frames	ACK = 0x0	Meaning / Appearence	Leads to Retry (if configured)	ACK = 0x1	Meaning / Appearence	Leads to Retry (if configured)
FS = CTS	X	Positive Acknowledge after SF or after end of Segmented Transfer	NO	X	Negative Acknowledge after SF or after block end in Segmented Transfer	YES
FS = WT	--	--	NO	X	Negative Acknowledge after SF (if currently no Receive buffer is available)	NO
FS = OVFLW	--	--	NO	X	Negative Acknowledge after SF (if no Receive buffer is available)	NO

Table 2: Possible combinations of FS and ACK field

7.3.7 Error Handling of the FT Field

Not every frame type is accepted at any point in time and in any configuration of a channel/connection. Thus, a detailed description is given below.

[FRARTP082] ⌈A value of the FR_FT field higher than 0x7 shall always be ignored.⌋()

[FRARTP083] ⌈**If the corresponding channel and connection is set to be ISO 15765-2 compliant**, then the following table holds:⌋()

TP Layer Status	***SF-I***	***FF-I (1:1)***	***CF (1:1)***	***FC***	***Other***
Segmented Transmit on same connection within this channel in progress	If reception is in progress within the channel, see corresponding cell below. Otherwise process the SF-I as start of a new reception.	If reception is in progress within the channel, see corresponding cell below. Otherwise process the FF-I as start of a new reception.	If reception is in progress within the channel, see corresponding cell below. Otherwise ignore it.	If awaited then process, otherwise ignore it.	Ignore
Segmented Receive on same connection within this channel in progress	Terminate the current reception, report a *PduR_FrArTpRxIndication* with the result NTFRSLT_E_UNEXP_PDU and process the SF-I as the start of a new reception.	Terminate the current reception, report a *PduR_FrArTpRxIndication* with the result NTFRSLT_E_UNEXP_PDU and process the FF-I as the start of a new reception.	If awaited then process, otherwise ignore	If transmission is in progress within the channel, see corresponding cell above. Otherwise ignore it	Ignore
Idle	Process the SF-I as the start of a new reception	Process the FF-I as the start of a new reception	Ignore	Ignore	Ignore
Segmented Receive on another connection within this channel in progress	Ignore	Ignore	Ignore	Ignore	Ignore

Table 3: FT Error Handling in ISO 15765-2 compliant channels/connections

[FRARTP084] ⌈**Otherwise**, the behaviour is explained below:⌋()

SF-x, FF-x, CF/CF2 and FC: The behaviour shall be as depicted in Table 3 (also for 1:n connections).

The ignoring of an FF-E shall be according to the value of FRARTP_LM.

Regarding CF and CF2 frames there is a special error handling in case Retry is configured (otherwise CF2 frames are ignored):
If the sender starts a block with another frame than expected, i. e. CF instead of CF2 or CF2 instead of CF, then the sender is doing a Retry which has not been requested by the receiver (maybe because of loosing the FC-CTS frame on the bus). So the receiver always has to remember the old block size and send another FC-CTS at the end of this retransmitted block. Errors in the unnecessarily retransmitted block shall be ignored.

AF: If no acknowledgement is activated this frame shall be ignored. Otherwise on the receiver side or in idle state, these frames shall be ignored, too. On the sender side, the behaviour in case of an incoming AF shall be the following:

- If an AF arrives when it is expected, the action is as described in chapter 7.2.1.3 and in section error handling of chapter 7.3.6.
- If a non-faulty AF with positive acknowledgement arrives during a block, it shall be ignored.
- If a non-faulty AF with negative acknowledgement arrives during a block, it shall be processed depending on the activation of the Retry mechanism. If no Retry is configured the transfer shall be aborted. Otherwise the AF shall be processed, i. e. starting with the stated sequence number the Retry shall take place.
- If a faulty AF arrives during a block, it shall be ignored.

7.3.8 Addressing Errors

[FRARTP085] ⌈SF-x:

No restrictions.⌋()

[FRARTP086] ⌈FF-x and CF:

If not explicitly configured (by the parameter FRARTP_GRPSEG) for the particular channel, a FF-x or CF in a 1:n connection shall be ignored.⌋()

[FRARTP087] ⌈FC and AF:

These frame types are not allowed to appear in 1:n connections, thus they shall be ignored in that case. ⌋()

7.4 Channels and Connections

Within the FlexRay AUTOSAR Transport Layer, a two-level abstraction concept for communica-tion exists: channels and connections.

7.4.1 Channel

A channel is a group of connections sharing several properties, e. g. acknowledge-ment, Retry, long messages etc. (see chapter 10.4).

[FRARTP191] ⌈The FlexRay AUTOSAR Transport Layer supports several channels. These channels can work concurrently, thus each of them requires its own state machine and management data structures and its own PDU-IDs. The array FRARTP_PDU defines the PDUs for sending and receiving data. The PDU FRARTP_PDU_FC defines the PDU which can be used for transmitting Flow Control or Acknowledgement Frames (especially with large TP PDUs this is an advantage, because the Flow Control or Acknowledgement Frames need only to be as large as necessary and not e. g. 150 Bytes too as the other TP frames (PDUs)). The TP also accepts incoming Flow Controls / Acknowledges on an ID out of FRARTP_PDU, so it is not prescribed to use this special PDU (because this generates more effort in scheduling the TP PDU). This is determined by the switch FRARTP_USE_PDU_FC. Furthermore each channel can have different properties so for each channel its own configuration data is needed.⌋()

[FRARTP088] ⌈The FlexRay AUTOSAR Transport Layer shall be implemented to support multiple channels. This means that an implementation shall provide at least up to 32 channels being able to work concurrently. The exact number shall be configurable by a compile switch, named FRARTP_CHAN_NUM.⌋(BSW05076)

7.4.2 Connection

A connection within a channel identifies the sender and the receiver(s) of this particu-lar communication. A connection can belong to only one channel and inherits all the properties of its channel. Additionally there are some properties which are configu-rable for each connection independently e.g. the ID of the to be used FrArTp PDUs of the corresponding channel (see chapter 10.4). Within a channel the different connections do not work concurrently (with the exception of being able to provide Full Duplex capacity), only connections located in different channels can work concurrently, since there is a dedicated state machine for each channel.

[FRARTP184] ⌈The FlexRay AUTOSAR Transport Layer shall be implemented to support a post compile time per channel configurable number of connections. The exact number shall be configurable by the channel parameter FRARTP_CON_NUM.

Additionally depending on FRARTP_USE_PDU_FC for sending / receiving Flow Control or Acknowledgement Frames the PDU FRARTP_PDU_FC is used.」()

[FRARTP089] 「Two or more connections with both the same sender address AND the same receiver address are ONLY supported if these two connections are located in pairwise different channels. The N-SDU Ids (FRARTP_SDUID) have to be unique over all channels!」(BSW05076)

The following picture illustrates the relationship between connections and channels:

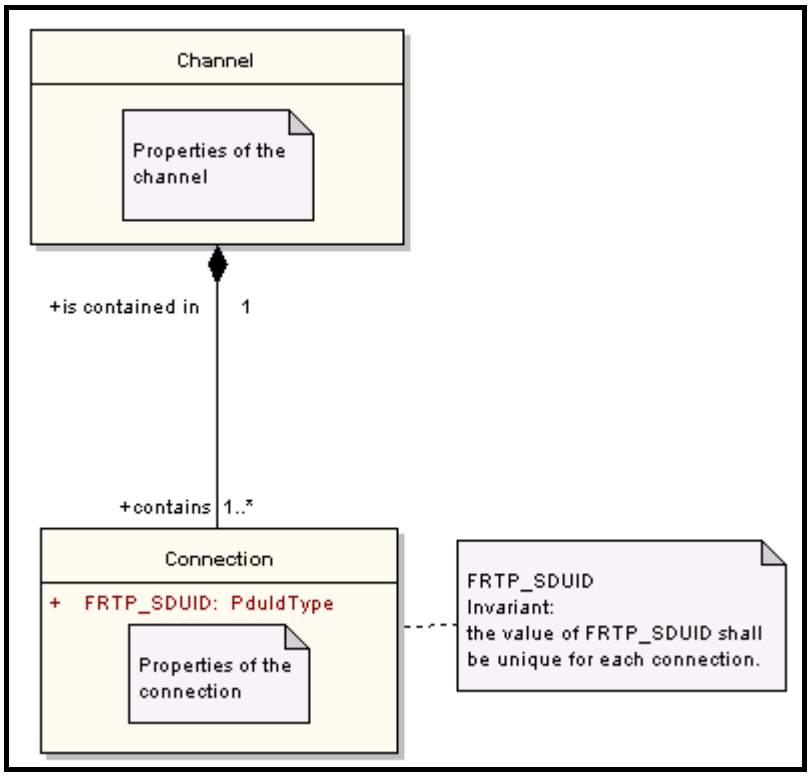


Figure 22: Relationship between channels and connections

7.4.3 Required Buffer within a Channel

Since the Transport Layer has to store the contents of a received PDU when it cannot be provided to the PduR immediately, there is some amount of buffer needed. The size of this buffer is max*(Length of PDU$_i$)*, where i iterates over all PDUs configured for the respective channel.

7.4.4 Identifying a Channel at Reception of an N-PDU

As mentioned above, each channel has its own PDU-IDs, thus the PDU-ID shall be utilized to identify the corresponding channel. This is necessary in order to determine whether the contained TP frame uses 2 or 4 byte addressing.

7.4.5 Full Duplex and Half Duplex

[FRARTP192] ⌈The FlexRay AUTOSAR Transport Layer is intended to provide Full Duplex capacity in each channel (Full Duplex within a channel means: If a connection is transmitting messages, it shall be possible that within another or the same connection a reception is possible, too). So in Full Duplex channels, the sending "part" and the receiving "part" of the statemachine shall be able to work concurrently, even within the same connection.
Because of the Full Duplex capacity of a channel, a situation in which the currently sending "part" of the local channel sends an FF-x or last CF of a block (which has to be sent in the PDU having the TxConfirmation configured, see [FRARTP174] and [FRARTP188]) and the currently receiving "part" of the local channel transmits an FC or AF (which has also to be sent in the PDU having the TxConfirmation configured) could arise.
In this situation both "parts" of the channel have to be synchronized, e. g. the receiving part shall not send the FC (or AF) until the transmitting part has got the TxConfirmation for the PDU.⌋()

In case the implementation shall only support Half Duplex Channels, Table 3 has to be slightly modified. These modifications can be found in the corresponding table in [12].

[FRARTP193] ⌈**However, please be aware of the following issues concerning Half Duplex Channels:** Imagine a Transmission has been initiated and an FF-x already been sent. Now the local peer is waiting for an FC frame.
Unfortunately, within the same channel a remote peer has also started a segmented Transmission and thus also sent an FF-x nearly simultaneously (NOTE: Simultaneously means with respect to the mapping of the TP PDUs into FlexRay cells, so "simultaneously" can mean "with a time-lag up to a few milliseconds").
According to [12], the (at both peers) incoming FF-x has to be ignored, thus a timeout of Timer BS will occur on both sides.
If additionally Retry is configured for the channel, both sides will try again after a configurable amount of time. In order not to produce this "FF-x Crash" again, the timeouts on both sides have to be different with the respect to the scheduling of the PDUs of each side. Thus it can be necessary to configure a difference of several milliseconds between both wait times. In larger networks quite a big gap between the timeout times might arise and complex consistence checks between the individual wait times could be necessary.⌋()

7.5 Further Principles of Working

7.5.1 Decision of Segmentation

[FRARTP090]As mentioned earlier in this specification, there are several factors influencing the decision of the FrArTp to segment a message (Fr N-SDU) or not.
The values of the following parameters play a role hereby:
FRARTP_PDU_LENGTH, FRARTP_LM, FRARTP_ADRTYPE, FRARTP_MULT_REC, FRARTP_GRPSEG and the length of the to be transmitted message (Fr N-SDU).」()

[FRARTP091]FRARTP_PDU_LENGTH states the length of a TP frame (Fr N-PDU) on the physical layer. The amount of bytes of FRARTP_PDU_LENGTH which is usable for payload, i. e. for the Fr N-SDU, depends on the length of the PCI of the used frames, i. e. if two or four bytes (FRARTP_ADRTYPE) are needed to state to address information. The frames which are allowed to be utilized and the payload they can carry depend on the value of FRARTP_LM (e.g. SF-E is allowed or not, SF-I can carry 7 or 6 bytes etc.). In case the connection is an 1:n connection (FRARTP_MULT_REC) the parameter FRARTP_GRPSEG states whether segmentation is allowed or not.
With all these information and the length of the to-be-transmitted Fr N-SDU the FrArTp can decide whether it has to segment the Fr N-SDU or not.」()

7.5.2 Multiple Fr N-PDUs for one connection, mapping of Fr N-PDU to a connection

[FRARTP092]「If more than one Fr N-PDU is utilized for the Fr N-SDU within a connection, the FlexRay AUTOSAR Transport Layer shall use them in ascending order.
This is necessary to avoid CFs coming out of order in a segmented transfer (see also chapter 10.4.6).」()

[FRARTP188]「In order to allow high bandwidth and being able to prevent out-of-order arriving of FrArTp frames (which are not necessarily FlexRay frames!) a Tx Confirmation from the FlexRay Interface shall be given only each time when having sent the last Fr N-PDU of the group of PDUs the respective connection uses (see also [FRARTP182]). This together with [FRARTP174] allows reaching the above mentioned goals.
Please note:
Only PDUs of the same size shall be used within a connection, the FrArTp does not deal with CFs of different size in a connection.
Therefore it is necessary to configure a TxConfirmation in the FlexRay Interface for exactly one PDU (the one with the highest ID) of each size used in the respective channel (see also [FRARTP182]).」()

[FRARTP189] ⌈In the case of using more than one Fr N-PDU for a connection, the Timer AS (chapter 10.4.1) starts to run after calling *FrIf_Transmit()* for the first PDU of the group.⌋()

[FRARTP190] ⌈In the case of using more than one Fr N-PDU for a connection and sending a message (or the remainder of a message) which is not long enough for needing all Fr N-PDUs of the connection, the necessary number of PDUs, starting with the smallest ID, shall be skipped (e. g. if PDUs 4, 5, 6, 7 belong to a connection and currently only 2 PDUs are needed, then PDU 6 and 7 shall be used for sending). This is necessary since the TxConfirmation configured for the last PDU of the group (see [FRARTP188]) is needed to stop Timer AS. Of course this holds also for sending FC or ACK frames (i. e. for these the PDU having the TxConfirmation configured shall be used). The AS Timer has to be started on the first used PDU.⌋()

[FRARTP093] ⌈The mapping of the arrived frame (Fr N-PDU) is done by comparing the Target Address (see [FRARTP019] , [FRARTP020]) of the received frame with the Local Address (see [FRARTP168] FRARTP_LA) of the local connections (of the channel identified by the means of the PDU-Id) and comparing the Source Address (see [FRARTP019] , [FRARTP020]) of the received frame with the Remote Address (see [FRARTP168] FRARTP_RA) of the local connections (of the channel identified by the means of the PDU-ID). If both fit within a connection, the frame shall be processed for this connection, otherwise the frame will be ignored.⌋()

7.5.3 Sending and Receiving within the same connection (Fr N-SDU Id)

[FRARTP094] ⌈The FlexRay AUTOSAR Transport Layer shall be implemented to support both sending and receiving within one connection at one peer (do not mistake this with full duplex). So the same connection can be utilized for sending and receiving.
To explain it more in detail, imagine a connection being in idle state. If now the call *FrArTp_Transmit()* occurs, the local peer becomes the sender in this connection (Source Address of TP frame = FRARTP_LA, Target Address of TP frame = FRARTP_RA). Otherwise, if an *FrArTp_RxIndication()* for an Fr N-PDU Id which is mapped on the Fr N-SDU Id of this connection occurred, it would become the receiver (Source Address of TP frame = FRARTP_RA, Target Address of TP frame = FRARTP_LA).⌋()

This feature is intended for connections in which sometimes one peer has to send data and sometimes the other in order not to need two connections in this case.

7.5.4 Behavior on Timeouts and Errors when calling the FlexRay Interface

[FRARTP095] ⌈The behavior in case a timeout occurs depends on the value of FRARTP_ACKTYPE, i.e. what kind of acknowledgement is configured for the corresponding channel.⌋()

Please note that the behavior in case of a FrIf error (return value E_NOT_OK of *FrIf_Transmit*) shall be in all three following cases the same as if the AS / AR timer expires (of course the result in *PduR_FrArTpTxConfirmation* / *PduR_FrArTpRxIndication* shall be NTFRSLT_E_NOT_OK). For Start and Stop of the different timers see chapter 10.4.1.

7.5.4.1 No Acknowledgement configured for the Channel

[FRARTP096] ⌈In this case, the behavior shall be as described in [12], i.e.:

- If the AS timer (FRARTP_TIMEOUT_AS) expires, depending on the value of FRARTP_MAX_AS, sending shall be retried (because of still remaining attempts) or the transmission shall be aborted and within *PduR_TxConfirmation* the result NTFRSLT_E_TIMEOUT_A shall be returned.
- If the AR timer (FRARTP_TIMEOUT_AR) expires, depending on the value of FRARTP_MAX_AR, sending shall be retried (because of still remaining attempts) or the transmission shall be aborted and within *PduR_RxIndication* the result NTFRSLT_E_TIMEOUT_A shall be returned.
- If the BS timer (FRARTP_TIMEOUT_BS) expires, the transmission shall be aborted and within *PduR_TxConfirmation* the result NTFRSLT_E_TIMEOUT_BS shall be returned.
- If the CR timer (FRARTP_TIMEOUT_CR) expires, the transmission shall be aborted and within *PduR_RxIndication* the result NTFRSLT_E_TIMEOUT_CR shall be returned. If previously in the current block a sequence error ocurrred, at the blockend this error shall be reported in *PduR_RxIndication*. ⌋()

7.5.4.2 Acknowledgement without Retry configured for the Channel

This subchapter is **Not compliant to ISO 15765-2**.

[FRARTP097]⌈In this case, the behavior is the following:

- In case of a timeout of timer AS, AR or BS, the behavior shall be as mentioned in chapter 7.5.4.1.
- If the CR timer (FRARTP_TIMEOUT_CR) expires, an AF with negative acknowledgement shall be sent, the transmission shall be aborted and within *PduR_RxIndication* the result NTFRSLT_E_TIMEOUT_CR shall be returned. If previously in the current block a sequence error ocurrred, at the blockend this error will be reported in *PduR_RxIndication*.⌋()

7.5.4.3 Acknowledgement with Retry configured for the Channel

This subchapter is **Not compliant to ISO 15765-2**.

[FRARTP098] ⌈In this case, the behavior shall be the following:

- In case of a timeout of timer AS or AR, the behavior shall be as mentioned in chapter 7.5.4.1.
- If the BS timer (FRARTP_TIMEOUT_BS) expires, the sender shall retransmit the whole block up to FRARTP_MAX_RN times. After that, the transmission shall be aborted and within *PduR_TxConfirmation* the result NTFRSLT_E_TIMEOUT_BS shall be returned.
- If the CR timer (FRARTP_TIMEOUT_CR) expires, the receiver shall send an AF with negative acknowledgement and the sequence number of the missed CF. This shall be done up to FRARTP_MAX_RN times. After that, the transmission shall be aborted and within *PduR_RxIndication* the result NTFRSLT_E_TIMEOUT_CR shall be returned. If previously in the current block a sequence error ocurrred, at the block end this error will be reported in *PduR_RxIndication*.⌋()

7.5.5 Transmit Cancellation

[FRARTP099] This feature can be (de)activated by static configuration (parameter FRARTP_TC). Transmit Cancellation is triggered by the call of *FrArTp_CancelTransmit*.
This call shall set the TC_REQUEST flag of the corresponding channel).
In order to allow a fast cancellation, this flag has to be checked twice at the sender side:
Every time before trying to get a new Tx buffer and every time before calling *FrIf_Transmit*.
On receiver side, the cancelled transmission will be detected by timeouts (e.g. not responding a required FlowControl etc.)⌋(BSW05093)

[FRARTP100] The service works at the sender side of a connection as follows:

- If no transmit request is pending for the corresponding connection, there is nothing to do.
- If a request is pending but the transmission has not been started, the corresponding TC_REQUEST flag (see chapter 7.5.9.2) shall be set. Thus the transfer won't take place.
- If the transmission already has been started, the corresponding TC_REQUEST flag (see chapter 7.5.9.2) shall be set.⌋()

Note that the last option is only possible in a segmented transfer, because in an unsegmented transfer there is only one frame to be sent and after the call of *FrIf_Transmit* there is no possibility to stop the sending.

[FRARTP103] ⌈Please note, that if a transfer was cancelled by the call of *FrArTp_CancelTransmit*, *PduR_FrArTpTxConfirmation* with Results set to NTFRSLT_E_CANCELLATION_OK shall be called.⌋(BSW05093)

7.5.6 Receive Cancellation

[FRARTP224] ⌈If development error detection is enabled the function FrArTp_CancelReceive shall check the validity of FrArTpRxSduId parameter.⌋()

[FRARTP225] ⌈If the FrArTpRxSduId parameter value is invalid, the FrArTp_CancelReceive function shall raise the development error FRARTP_E_PARAM_ID and return E_NOT_OK. ⌋()

[FRARTP226] ⌈The FrArTp shall abort the reception of the current N-SDU if the service FrArTp_CancelReceive provides a valid FrArTpRxSduId.⌋()

[FRARTP227] ⌈The FrArTp shall reject the request for receive cancellation in case of an

a) unsegmented reception or
b) in case the FrArTp is in the process of receiving the LastFrame of the N-SDU

and shall return E_NOT_OK.⌋()

[FRARTP228] ⌈If the FrArTp_CancelReceive service has been successfully executed the FrArTp shall call the PduR_FrArTpRxIndication with notification result NTFRSLT_E_CANCELATION_OK.⌋()

7.5.7 Parameter Changing

[FRARTP104] ⌈The FlexRay AUTOSAR Transport Layer also supports the in [12] mentioned optional service for changing the parameter `FRARTP_STMIN` by the API call *FrArTp_ChangeParameter*. A change is not possible during an ongoing reception, *FrArTp_ChangeParameter* returns E_NOT_OK in this case. ⌋(BSW05090)

7.5.8 Buffer Requests, Block Size and WAIT-Frames

The FlexRay AUTOSAR Transport Layer does not provide message buffers, neither for sending nor for receiving. Instead, it provides received data and requests transmitted data chunk wise from/to the upper layer.

[FRARTP221] ⌈When a new reception is initiated by the reception of a FF or SF, the TP checks for the availability of the associated channel and then calls *PduR_FrArTpStartOfReception* to inform the upper layer of the expected message size, and to retrieve information about the currently available buffer. When this call succeeds, the connection is set to established, and *PduR_FrArTpCopyRxData* is called to provide the payload of the frame to the upper layer. ⌋()

[FRARTP230] ⌈When a new transmission is initiated by the call of *FrArTp_Transmit*, the TP checks for the availability of the associated channel, and sets the connection to established. Then the TP calls *PduR_FrArTpCopyTxData* to acquire the data for the SF or FF and following CFs.⌋()

[FRARTP105] ⌈Depending on the message length and configuration of the FrArTp a segmented or an unsegmented transfer will take place.⌋()

[FRARTP232] ⌈The API function *PduR_FrArTpCopyTxData* has a parameter named `retry`, which is a pointer to a structure of type `RetryInfoType`. When Retry is disabled, this retry parameter shall always be set to `NULL`. Otherwise, the referenced `RetryInfoType` structure shall be used to handle retries.⌋()

7.5.8.1 Unsegmented Transfer

[FRARTP106] ⌈At the sender side, this principle works as follows:

1. PduR calls the service *FrArTp_Transmit*.
2. The FrArTp shall call *PduR_FrArTpCopyTxData* in order to get all the data bytes of the SF-x. `retry.TpDataState` shall be set to `TP_CONFPENDING` when Retry is enabled.⌋()

[FRARTP107] ⌈If *PduR_FrArTpCopyTxData* for the SF-x returns `BUFREQ_E_BUSY`, the call shall be repeated after waiting for FRARTP_TIME_BUFFER seconds, but no more than FRARTP_MAX_BUFREQ times. When the return value is `BUFREQ_E_NOT_OK` or when `BUFREQ_E_BUSY` was returned too often, the transfer shall be aborted by calling *PduR_FrArTpTxConfirmation* with `NTFRSLT_E_NO_BUFFER`.⌋()

[FRARTP233] ⌈If Retry is enabled, the SF-x shall be sent again after reception of a negative AF. The buffer in the upper layer is only freed after reception of a positive AF by the call to *PduR_FrArTpTxConfirmation* with NTFRSLT_OK.⌋()

[FRARTP108] ⌈At the receiver side, the principle works as follows:

1. FrIf calls the service *FrArTp_RxIndication*.
2. The FrArTp shall call *PduR_FrArTpStartOfReception* to prepare reception.
3. The FrArTp shall call *PduR_FrArTpCopyRxData* to forward SF data.⌋()

[FRARTP109] ⌈If *PduR_FrArTpCopyRxData* for the SF-x returns BUFREQ_E_BUSY, the call shall be repeated after waiting for FRARTP_TIME_BUFFER seconds, but no more than FRARTP_MAX_BUFREQ times. When the return value is BUFREQ_E_NOT_OK or BUFREQ_E_OVFL or when BUFREQ_E_BUSY was returned too often, the transfer shall be aborted and *PduR_FrArTpRxIndication* shall be called with NTFRSLT_E_NO_BUFFER.
In case of failing to copy the received data, an AF with a negative acknowledgement is sent back to the sender. The appropriate value of FS shall be set as specified in Table 2.⌋()

7.5.8.2 Segmented Transfer

[FRARTP110] ⌈At the sender side, this principle works as follows:

1. PduR calls the service *FrArTp_Transmit*.
2. The FrArTp shall call *PduR_FrArTpCopyTxData* in order to get the data bytes of the FF and following CFs.⌋()

[FRARTP111] ⌈When Retry is enabled, the TP sends the FF-x without data. After reception of an FC, the data for the first CF is acquired with `retry.TpDataState` set to TP_DATACONF. For the following CFs, `retry.TpDataState` shall be set to TP_CONFPENDING.⌋()

[FRARTP234] ⌈When Retry is enabled, after reception of a negative AF, the last block must be retransmitted. To achieve this, the data for the first CF of the block is aquired with `retry.TpDataState` set to TP_DATARETRY, and `retry.TxTpDataCnt` contains the size of the previously sent block in bytes. The buffer of the last block in the upper layer is only freed after reception of a positive AF by the call to *PduR_FrArTpTxConfirmation* with NTFRSLT_OK .⌋()

[FRARTP113] ⌈If *PduR_FrArTpCopyTxData* for the FF-x (Retry not configured) or any of the CFs returns BUFREQ_E_BUSY, the call shall be repeated after waiting for FRARTP_TIME_BUFFER seconds, but no more than FRARTP_MAX_BUFREQ times. When the return value is BUFREQ_E_NOT_OK or when BUFREQ_E_BUSY was returned too often, the transfer shall be aborted by calling *PduR_FrArTpTxConfirmation* with NTFRSLT_E_NO_BUFFER.⌋()

[FRARTP114] ⌈At the receiver side, this principle works as follows:

1. FrIf calls the service *FrArTp_RxIndication*.
2. The FrArTp shall call *PduR_FrArTpStartOfReception* to prepare reception.
3. The FrArTp shall call *PduR_FrArTpCopyRxData* to forward FF and CF data.⌋()

[FRARTP115] ⌈The block size is constant. The value is configured via FRARTP_MAXBS, and can be changed via the API *FrArTp_ChangeParameter*.⌋()

[FRARTP116] ⌈If *PduR_FrArTpCopyRxData* for the FF-x (Retry not configured) or any of the CFs returns BUFREQ_E_BUSY, the call shall be repeated after waiting for FRARTP_TIME_BUFFER seconds, but no more than FRARTP_MAX_BUFREQ times. When the return value is BUFREQ_E_NOT_OK or BUFREQ_E_OVFL or when BUFREQ_E_BUSY was returned too often, the transfer shall be aborted and *PduR_FrArTpRxIndication* shall be called with NTFRSLT_E_NO_BUFFER.
In case of failing to copy the received data, an AF with a negative acknowledgement is sent back to the sender. The appropriate value of FS shall be set as specified in Table 2.⌋()

[FRARTP117] ⌈In case of failing to copy the received data, or when a sequence number is missing, the remaining CFs of the current block shall be discarded, and an AF with a negative acknowledgement shall be sent back to the sender. The appropriate value of FS shall be set as specified in Table 2.⌋()

7.5.8.3 Buffer Locking

At the sender side, the originator of the transmission (e.g. DCM or COM) shall not change the buffer after a successful Transmit call until the connection is closed by a call to TxConfirmation. When a cyclic buffer is used, the data in this buffer must be kept until they are explicitly freed by the `retry` parameter of *PduR_FrArTpCopyTxData*.

At the receiver side, the final receiver of the data (e.g. DCM or COM) shall not change the buffer after a successful call to StartOfReception until the connection is closed by a call to *PduR_FrArTpRxIndication*). When a cyclic buffer is used, each block successfully copied via *PduR_FrArTpCopyRxData* shall be taken as final.

7.5.8.4 Data Bytes in First Frames

[FRARTP120] ⌈**Not compliant to ISO 15765-2**
As stated in 7.5.8.2, if acknowledgement with Retry is configured for the corresponding channel, no payload is sent within an FF-x if a segmented transfer takes place. This is necessary to backwards compatibility to the AR3 FrTp on bus level.⌋()

[FRARTP121] ⌈If acknowledgment without Retry (or no acknowledgement) is configured, there are data bytes within an FF-x.⌋()

7.5.9 Counters, Flags and Actions

7.5.9.1 Counters

[FRARTP122] ⌈There are several counters to count the different Retry attempts. Each counter has its individual maximum value in order give much flexibility here. Each of these counters is reset every time when the corresponding retry is successful.⌋()

[FRARTP123] ⌈**counter_RN**
This counter counts the sending retries initiated due to a frame error, e. g. bad SN in a CF.
It is limited by the value of FRARTP_MAX_RN.⌋()

[FRARTP124] ⌈**counter_BUFREQ**
This counter counts the copy retries initiated due to unsuccessful copying of Tx or Rx data to/from the upper layer (depending on the return value of the corresponding copy data function, see chapter 7.5.8). On reception side, when the copying fails at a block border or the buffer would be too small for another block, it determines the maximum number of wait frames.
It is limited by the value of FRARTP_MAX_BUFREQ.⌋()

[FRARTP125]⌈ **counter_WT**
This counter counts the arriving WAIT frames.
It is limited by the value of FRARTP_MAX_BUFREQ.⌋()

[FRARTP126] ⌈**counter_FRIF**
This counter counts the attempts to send a Fr N-PDU via *FrIf_Transmit()* in case this call returns E_NOT_OK.
It is limited by the value of FRARTP_MAX_FRIF.⌋()

[FRARTP127] ⌈counter_AR

This counter counts the attempts to send an Fr N-PDU (FC, AF), by resetting Timer AR, in case a timeout of Timer AR occurs.

It is limited by the value of FRARTP_MAX_AR.⌋()

[FRARTP128] ⌈counter_AS

This counter counts the attempts to send an Fr N-PDU (SF-x, FF-x, CF,), by resetting Timer AS, in case a timeout of Timer AS occurs.

It is limited by the value of FRARTP_MAX_AS.⌋()

[FRARTP129] ⌈counter_BS

This counter counts, depending on retry configuration, the retries to send the last block or SF again in case a timeout of the timer BS occurs. Another point of view is that this counter counts the timeouts of the timer BS.

It is limited by the value of FRARTP_MAX_RN.⌋()

[FRARTP130] ⌈counter_CR

This counter counts, depending on retry configuration, the retries to send an AF in case a timeout of the Timer CR occurs.

It is limited by the value of FRARTP_MAX_RN.⌋()

7.5.9.2 Flags

There will be several flags within this software module (see sequence diagrams in chapter 9). In order not to go too deep into implementation details, they are described only briefly in the following.

[FRARTP131] ⌈TX_PDU_AVAILABLE flag

This flag exists for every connection. It is set by the call *FrArTp_Transmit* and indicates the availability of the Fr N-SDU for the corresponding connection. Thus, it can be considered when processing the Tx request. It is cleared before the call of *PduR_FrArTpTxConfirmation*.⌋()

[FRARTP132] ⌈RX_PDU_AVAILABLE flag

This flag exists for every Fr N-PDU that is configured to be received by the FlexRay AUTOSAR Transport Layer, so there can be more than one such flag in a connection. It is set by the call *FrArTp_RxIndication* and indicates the availability of the Fr N-PDU for the corresponding connection. Thus, it can be considered when processing the Rx indication. In an unsegmented transfer, it is cleared before the call of *PduR_FrArTpRxIndication*. In segmented one it is cleared when finished processing the Fr N-PDU.⌋()

[FRARTP133] ⌈TC_REQUEST flag

This flag exists for every channel. It is set by the call of *FrArTp_CancelTransmit*() (if the service returns E_OK) and processed before asking for a new buffer or before sending (*FrIf_Transmit* or *FrArTp_TriggerTransmit*) a frame. The flag is cleared after processing the cancellation request.⌋()

[FRARTP134] ⌈ERROR flag

This flag exists for every Fr N-PDU within a channel, so there can be more than one such flag in a connection. It is set by the call *FrArTp_RxIndication* when an error in the received frame is detected. The reaction on these errors will be as described in sections “Error Handling” throughout chapter 7.3.

When receiving an Fr N-PDU without an error, this flag shall be cleared.⌋()

[FRARTP135] ⌈ERROR_OCCURRED flag

This flag exists for every channel. It indicates that an error occurred during a segmented reception in order to react appropriate at the block end. It is cleared after the reaction (Retry, Negative Acknowledgement, Abortion) at the block end.⌋()

7.5.9.3 Actionsx

There are three main actions within this software module to be done.

[FRARTP136] ⌈Sending

Sending is initiated by the call of *FrArTp_Transmit*. Then all sending related mechanisms described in this document are executed. It is finished when the TX_PDU_AVAILABLE flag is cleared.⌋()

[FRARTP137] ⌈Receiving

Receiving is initiated by the call of *FrArTp_RxIndication*. Then all receiving related mechanisms described in this document are executed. It is finished when the RX_PDU_AVAILABLE flag is cleared, no timeouts have occurred and no ERROR flag is set, i. e. when every ongoing reception either has been completed or aborted.⌋()

[FRARTP138] ⌈Timeout supervision

Timeout supervision has always to be done within the sending and receiving related mechanisms. The reaction on timeouts can be found in chapter 7.5.4. When no more timeout to supervise is left, this action can be stopped.⌋()

7.5.10 Ignored Frames

[FRARTP139] ⌈Throughout this specification many times the ignoring of frames is mentioned. Please note that an ignored frame does never affect a timer, i.e. never causes the restarting of a timer.⌋()

[FRARTP140] ⌈The only exception is at the receiver side when retry is configured and due to an erroneous frame an AF with negative acknowledgement is sent and therefore it is waited for the retry frame(s). In this case, the timer CR will be reset by the erroneous frame.⌋()

7.6 Buffer Access Modes in the FlexRay Interface

[FRARTP187] ⌈The FlexRay AUTOSAR Transport Layer software module shall be implemented being able to work both with PDUs configured (in the FlexRay Interface) for Immediate Buffer Access and for Decoupled Buffer Access, i. e. it shall reuse its channel specific temporary buffers, in case the local peer is the sender, not before the TxConfirmation for the respective PDU group has been arrived.
In the receiving case, from the FlexRay AUTOSAR Transport Layers point of view there is no difference between an Fr N-PDU being configured for Decoupled Buffer Access or Immediate Buffer Access.⌋()

7.7 Error classification

This chapter lists and classifies all the errors that can be detected within this software module.

[FRARTP179] ⌈Error classification table

Type or error	*Relevance*	*Related error code*	*Value*
API service called before initializing the module	Development	FRARTP_E_NOT_INIT	0x1
API service called with NULL pointer	Development	FRARTP_E_NULL_PTR	0x2
API service called with not allowed parameter value	Development	FRARTP_WRONG_PARAM_VAL	0x3

⌋(BSW00337, BSW05089)

7.8 Error detection

[FRARTP217] ⌈The detection of development errors is configurable (*ON* / *OFF*) at pre-compile time.

The switch FRARTP_DEV_ERROR_DETECT (see chapter 10) shall activate or deactivate the detection of all development errors.」()

[FRARTP205] 「If the FRARTP_DEV_ERROR_DETECT switch is enabled API parameter checking is enabled. The detailed description of the detected errors can be found in chapter 7.7 and chapter 8.」(BSW00323)

7.9 Error notification

[FRARTP206] 「Detected development errors shall be reported to the *Det_ReportError* service of the Development Error Tracer (DET) if the pre-processor switch FRARTP_DEV_ERROR_DETECT is set (see chapter 10).」()

8 API specification

8.1 Imported types

[FRARTP141] ⌈The following types are defined within AUTOSAR and used for the FlexRay AUTOSAR Transport Layer:

Module	*Imported Type*
ComStack_Types	BufReq_ReturnType
	NotifResultType
	PduIdType
	PduInfoType
	PduLengthType
	RetryInfoType
	TPParameterType
Std_Types	Std_ReturnType
	Std_VersionInfoType

⌋()

8.2 Type definitions

[FRARTP223] ⌈The following FrArTp specific types shall be defined in FrArTp_Types.h:

Name:	`FrArTp_ConfigType`	
Type:	`Structure`	
Range:	`implementation specific`	--
Description:	This is the base type for the configuration of the FlexRay Transport Protocol. A pointer to an instance of this structure will be used in the initialization of the FlexRay Transport Protocol. The outline of the structure is defined in chapter 10 Configuration Specification.	

⌋()

8.3 Function definitions

This is a list of functions provided for upper layer modules.

[FRARTP207] ⌈Here is the API Naming convention for the FrArTp services:

- The service name format is FrArTp_<ServiceName>(…)
- <ServiceName>: is the name of the service primitive with first letter of each word upper case and consecutive letters lower case⌋(BSW00310)

8.3.1 Standard functions

8.3.1.1 FrArTp_GetVersionInfo

[FRARTP215] ⌈

Service name:	FrArTp_GetVersionInfo	
Syntax:	`void FrArTp_GetVersionInfo( Std_VersionInfoType* versioninfo )`	
Service ID[hex]:	0x27	
Sync/Async:	Synchronous	
Reentrancy:	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.	

⌋(BSW00411)

[FRARTP202] ⌈This service returns the version information of this module. The version information includes:

- Module Id
- Vendor Id
- Vendor specific version numbers.⌋(BSW00407)

This function shall be pre compile time configurable On/Off by the configuration parameter: FRARTP_VERSION_INFO_API

Configuration: FRARTP_VERSION_INFO_API

8.3.2 Initialization and Shutdown

8.3.2.1 FrArTp_Init

[FRARTP147] ⌈

Service name:	FrArTp_Init	
Syntax:	`void FrArTp_Init( const FrArTp_ConfigType* configPtr )`	
Service ID[hex]:	0x00	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	configPtr	Pointer to FlexRay Transport Protocol configuration.
Parameters (inout):	None	
Parameters (out):	None	
Return value:	None	
Description:	This service initializes all global variables of the FlexRay AUTOSAR Transport Layer and sets all states to idle. It has no return value because software errors in initialisation data shall be detected during configuration time (e.g. by configuration tool).	

」(BSW101, BSW05088)

Caveats: The call of this service is mandatory before using the FrArTp for further processing.

8.3.2.2 FrArTp_Shutdown

[FRARTP148] 「

Service name:	FrArTp_Shutdown

Syntax:	`void FrArTp_Shutdown(`
	`  void`
	`)`

Service ID[hex]:	0x01
Sync/Async:	Synchronous
Reentrancy:	Non Reentrant
Parameters (in):	None
Parameters (inout):	None
Parameters (out):	None
Return value:	None
Description:	This service closes all pending transport protocol connections by simply stopping operation, frees all resources and stops the FrArTp Module

」(BSW00336)

8.3.3 Normal Operation

8.3.3.1 FrArTp_Transmit

[FRARTP149] 「

Service name:	FrArTp_Transmit	

Syntax:	`Std_ReturnType FrArTp_Transmit(`
	`  PduIdType FrArTpTxSduId,`
	`  const PduInfoType* FrArTpTxSduInfoPtr`
	`)`	

Service ID[hex]:	0x02	
Sync/Async:	Asynchronous	
Reentrancy:	Reentrant	
Parameters (in):	FrArTpTxSduId	This parameter contains the unique identifier of the FrArTp N-SDU to be transmitted.
	FrArTpTxSduInfoPtr	Tx N-SDU Information Structure which contains a) pointer to the FrArTp Tx N-SDU b) the length of the FrArTp Tx N-SDU
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: The request has been accepted E_NOT_OK: The request has not been accepted, e. g. parameter check has failed or no FrArTpChannel resource is free.
Description:	This service is utilized to request the transfer of data. It sets a flag for indicating that a transmit request is present.	

	This function has to be called with FrArTp's SDU-Id, i.e. the upper layer has to translate its own PDU-Id into the FrArTp's SDU-ID for the corresponding message. Within the provided FrArTpSduInfoPtr only SduLength is valid (no data)! If this function returns E_OK then there will arise an call of PduR_FrArTpCopyTxData in order to get data for sending.

⌋(BSW00369, BSW05075, BSW05129)

8.3.3.2 FrArTp_CancelTransmit

[FRARTP150] ⌈

Service name:	FrArTp_CancelTransmit	
Syntax:	`Std_ReturnType FrArTp_CancelTransmit( PduIdType FrArTpTxSduId )`	
Service ID[hex]:	0x03	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	FrArTpTxSduId	This parameter contains the unique identifier of the transmitted Fr N-SDU which has to be canceled.
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: Transmit cancellation request of the specified Fr N-SDU is accepted. E_NOT_OK: Transmit cancellation request of the specified Fr N-SDU is rejected for an unsegmented data transmission.
Description:	This service primitive is used to cancel the transfer of pending Fr N-SDUs. The connection is identified by FrArTpTxSduId. When the function returns, no transmission is in progress anymore with the given N-SDU identifier.	

⌋()

Caveats:
If a cancel request is accepted and cancelling a transfer on the sender side, the function PduR_FrArTpTxConfirmation with Result set to NTFRSLT_E_CANCELLATION_OK shall be called after finishing (successfully or not) the cancellation.

8.3.3.3 FrArTp_CancelReceive

[FRARTP229] ⌈

Service name:	FrArTp_CancelReceive	
Syntax:	`Std_ReturnType FrArTp_CancelReceive( PduIdType FrArTpRxSduId )`	
Service ID[hex]:	0x08	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	FrArTpRxSduId	SDU-Id of currently ongoing reception

Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: Reception was terminated sucessfully. E_NOT_OK: Reception was not terminated.
Description:	By calling this API with the corresponding RxSduId the currently ongoing data reception is terminated immediately. When the function returns, no reception is in progress anymore with the given N-SDU identifier. If a cancellation was performed, the user will be informed by FrArTpRxIndication.	

⌋()

8.3.3.4 FrArTp_ChangeParameter

[FRARTP151] ⌈

Service name:	FrArTp_ChangeParameter	
Syntax:	`Std_ReturnType FrArTp_ChangeParameter( PduIdType id, TPParameterType parameter, uint16 value )`	
Service ID[hex]:	0x04	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	id	Identification of the I-PDU to which the parameter the request shall affect.
	parameter	The selected parameter that the request shall change.
	value	The value that the request shall change to. Range: $0000 - $00FF
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: request is accepted E_NOT_OK: request is not accepted
Description:	Request to change transport protocol parameter BandwithControl.	

⌋(BSW05129)

Caveats: According to ISO 15765-2 this is not possible to change the value of the parameter during an ongoing reception.

8.4 Call-back notifications

8.4.1 FrArTp_TriggerTransmit

[FRARTP154] ⌈

Service name:	FrArTp_TriggerTransmit
Syntax:	`Std_ReturnType FrArTp_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.
	PduInfoPtr	Contains a pointer to a buffer (SduDataPtr) to where the SDU shall be copied to. On return, the service will indicate the length of the copied SDU data in SduLength.
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: SDU has been copied and SduLength indicates the number of copied bytes. E_NOT_OK: No SDU has been copied. PduInfoPtr must not be used since it may contain a NULL pointer or point to invalid data.
Description:	The lower layer communication module requests the buffer of the SDU for transmission from the upper layer module.	

」(BSW00369)

Caveats: This function might be called in interrupt context

8.4.2 FrArTp_RxIndication

[FRARTP152] 「

Service name:	FrArTp_RxIndication	
Syntax:	void FrArTp_RxIndication(PduIdType RxPduId, 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 I-PDU.
	PduInfoPtr	Contains the length (SduLength) of the received I-PDU and a pointer to a buffer (SduDataPtr) containing the I-PDU.
Parameters (inout):	None	
Parameters (out):	None	
Return value:	None	
Description:	Indication of a received I-PDU from a lower layer communication module.	

」()

8.4.3 FrArTp_TxConfirmation

[FRARTP153] ⌈

Service name:	FrArTp_TxConfirmation

Syntax:	`void FrArTp_TxConfirmation(`
	`  PduIdType TxPduId`
	`)`

Service ID[hex]:	0x40
Sync/Async:	Synchronous
Reentrancy:	Reentrant for different PduIds. Non reentrant for the same PduId.
Parameters (in):	TxPduId — ID of the I-PDU that has been transmitted.
Parameters (inout):	None
Parameters (out):	None
Return value:	None
Description:	The lower layer communication module confirms the transmission of an I-PDU.

⌋()

8.5 Scheduled functions

8.5.1 FrArTp_MainFunction

[FRARTP162] ⌈

Service name:	FrArTp_MainFunction

Syntax:	`void FrArTp_MainFunction(`
	`  void`
	`)`

Service ID[hex]:	0x10
Timing:	FIXED_CYCLIC
Description:	Schedules the FlexRay TP. (Entry point for scheduling)

⌋()

[FRARTP203] ⌈The main function for scheduling the TP (Entry point for scheduling)⌋(BSW00424)

This function shall be called directly by the Basic Software Scheduler (BswM).

Terms and definitions:
Fixed cyclic: Fixed cyclic means that one cycle time is defined at configuration and shall not be changed because functionality is requiring that fixed timing (e.g. filters).
Variable cyclic: Variable cyclic means that the cycle times are defined at configuration, but might be mode dependent and therefore vary during runtime.
On pre condition: On pre condition means that no cycle time can be defined. The function will be called when conditions are fulfilled. Alternatively, the function may be called cyclically however the cycle time will be assigned dynamically during runtime by other modules.

8.6 Expected Interfaces

In this chapter, all interfaces required from other modules are listed.

8.6.1 Mandatory Interfaces

This chapter defines all interfaces that are required to fulfill the core functionality of the module.

[FRARTP219] ⌈

API function	*Description*
FrIf_Transmit	Requests the sending of a PDU.
PduR_FrArTpCopyRxData	This function is called when a transport protocol module has data to copy for the receiving module. Several calls may be made during one transportation of an I-PDU. The service shall provide the currently available buffer size when invoked with info.SduLength equal to 0.
PduR_FrArTpCopyTxData	This function is called by the transport protocol module to query the transmit data of an I-PDU segment. Each call to this function copies the next part of the transmit data until TpDataState indicates TP_DATARETRY. In this case the API restarts to copy the data beginning at the location indicated by TpTxDataCnt. The service shall provide the size of the remaining data when invoked with info.SduLength equal to 0.
PduR_FrArTpRxIndication	Called by the transport protocol module after an I-PDU has been received successfully or when an error occurred. It is also used to confirm cancellation of an I-PDU.
PduR_FrArTpStartOfReception	This function will be called by the transport protocol module at the start of receiving an I-PDU. The I-PDU might be fragmented into multiple N-PDUs (FF with one or more following CFs) or might consist of a single N-PDU (SF). The service shall provide the currently available maximum buffer size when invoked with TpSduLength equal to 0.
PduR_FrArTpTxConfirmation	This function is called by a transport protocol module after the I-PDU has been transmitted on its network, the result will reveal if the transmission was successful or not.

⌋()

8.6.2 Optional Interfaces

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

[FRARTP220] ⌈

API function	*Description*
Det_ReportError	Service to report development errors.

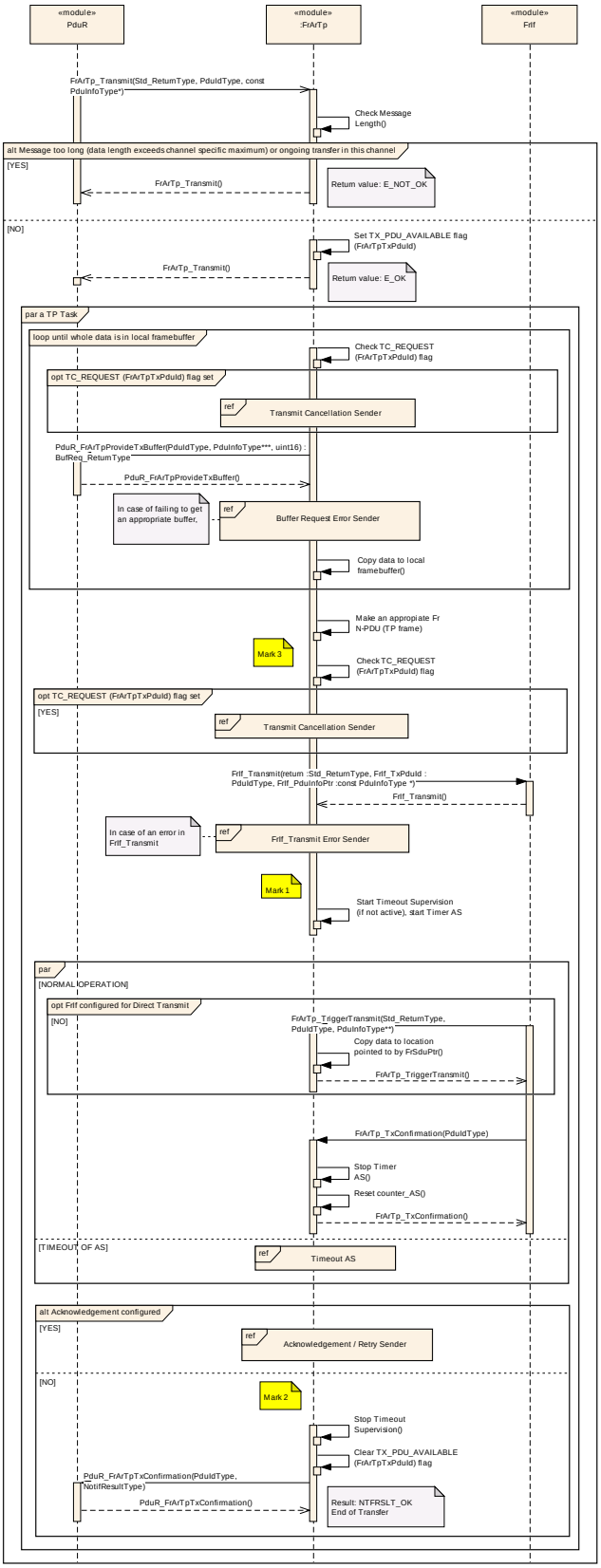
⌋()

9 Sequence diagrams

Although the following sequence diagrams are quite detailed, they do not depict every detail. Thus, they should be seen as an addendum to this specification.

9.1 Sending

9.1.1 Unsegmented Sending



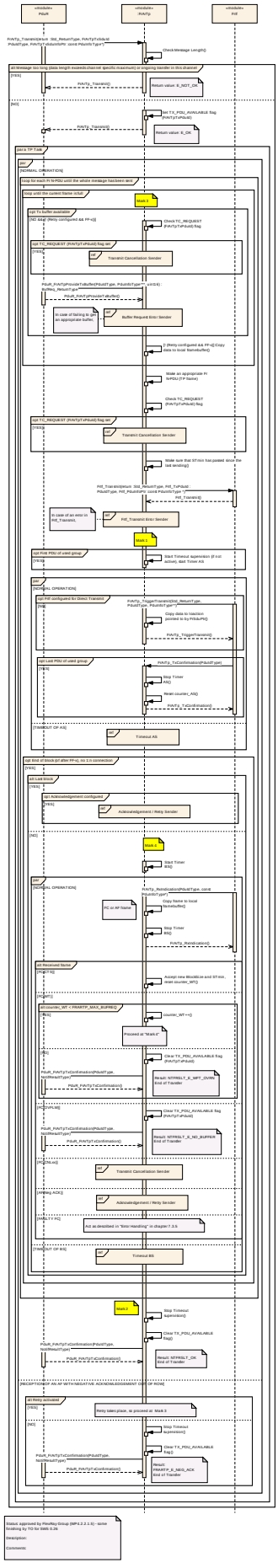
Status: POSTPONED TO AUTOSAR R2.1 !!!

Some finishing by TO for SWS 0.26
Details see "FlexRay UML Sequence Diagrams - Change History.doc"
2006-04-12: Update by BMW_TK to match Frlf SWS V1.2.5
2006-04-13: Update by DECOMSYS_TGAL to match Frlf SWS V1.2.5
2006-04-24: Minor changes and corrections by BMW_TK
2006-04-27: Adaptation to Fr SWS V1.0.15
2007-11-22: Minor changes by BMW_MZ

Description:

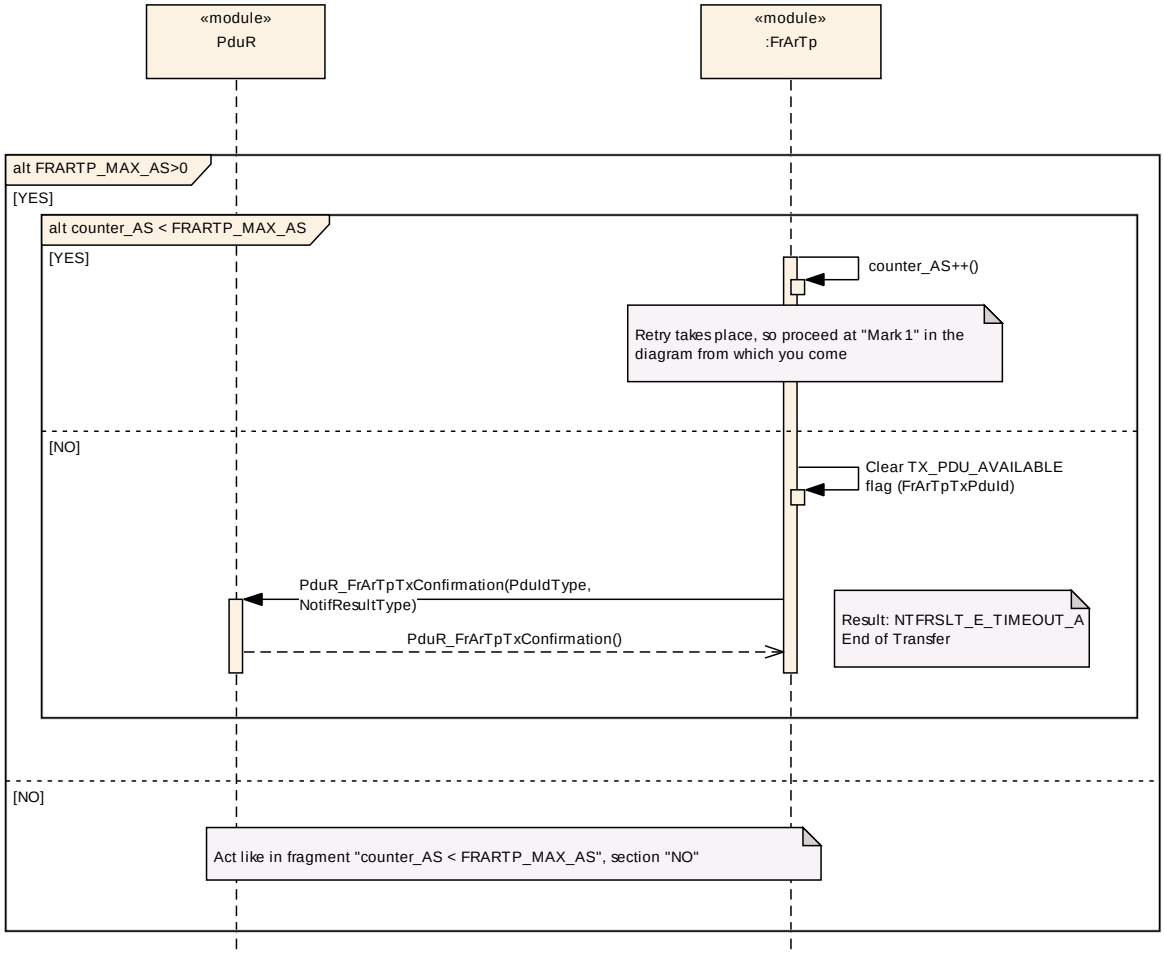
Comments:

9.1.2 Segmented Sending

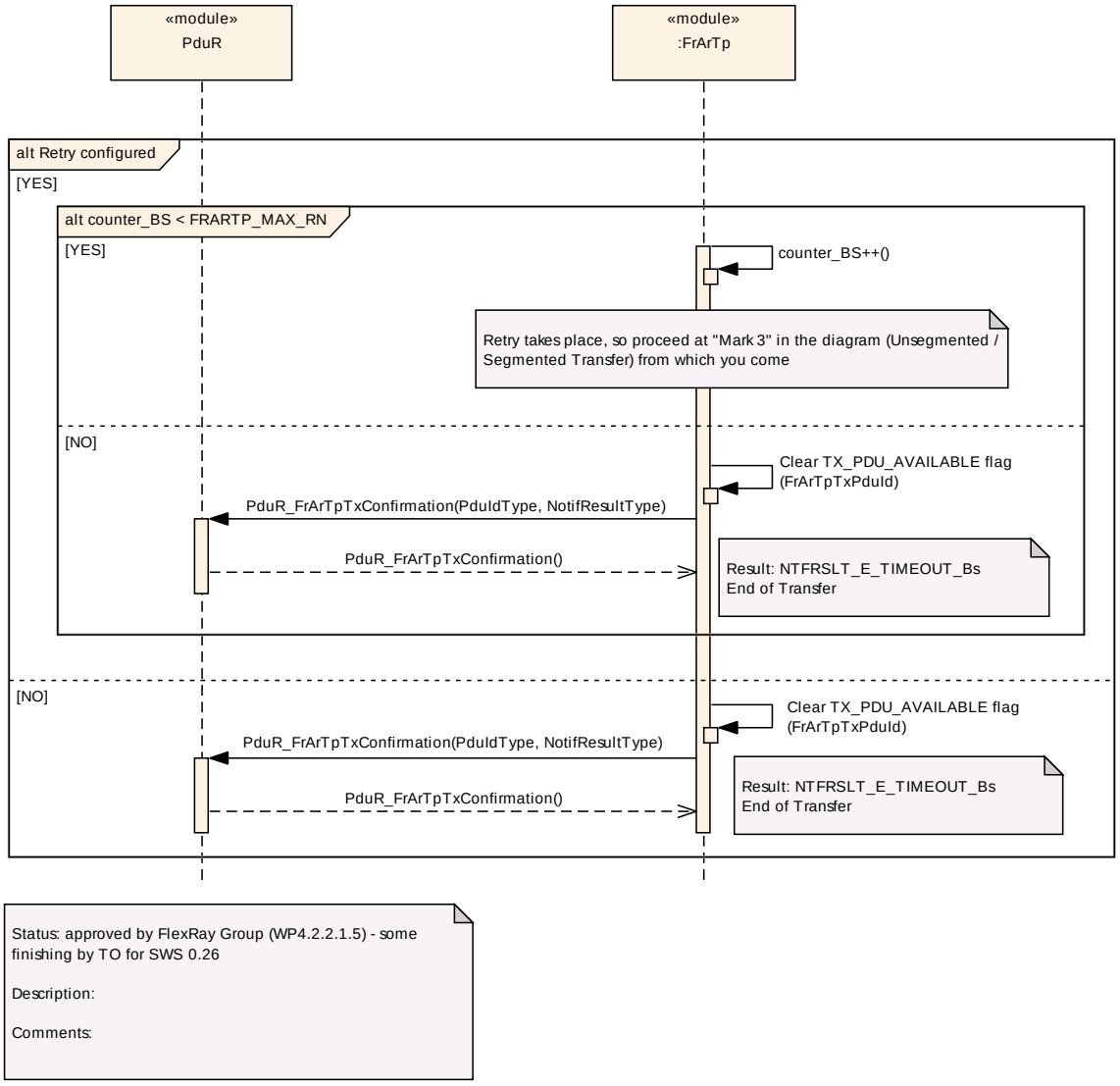


9.1.3 Others

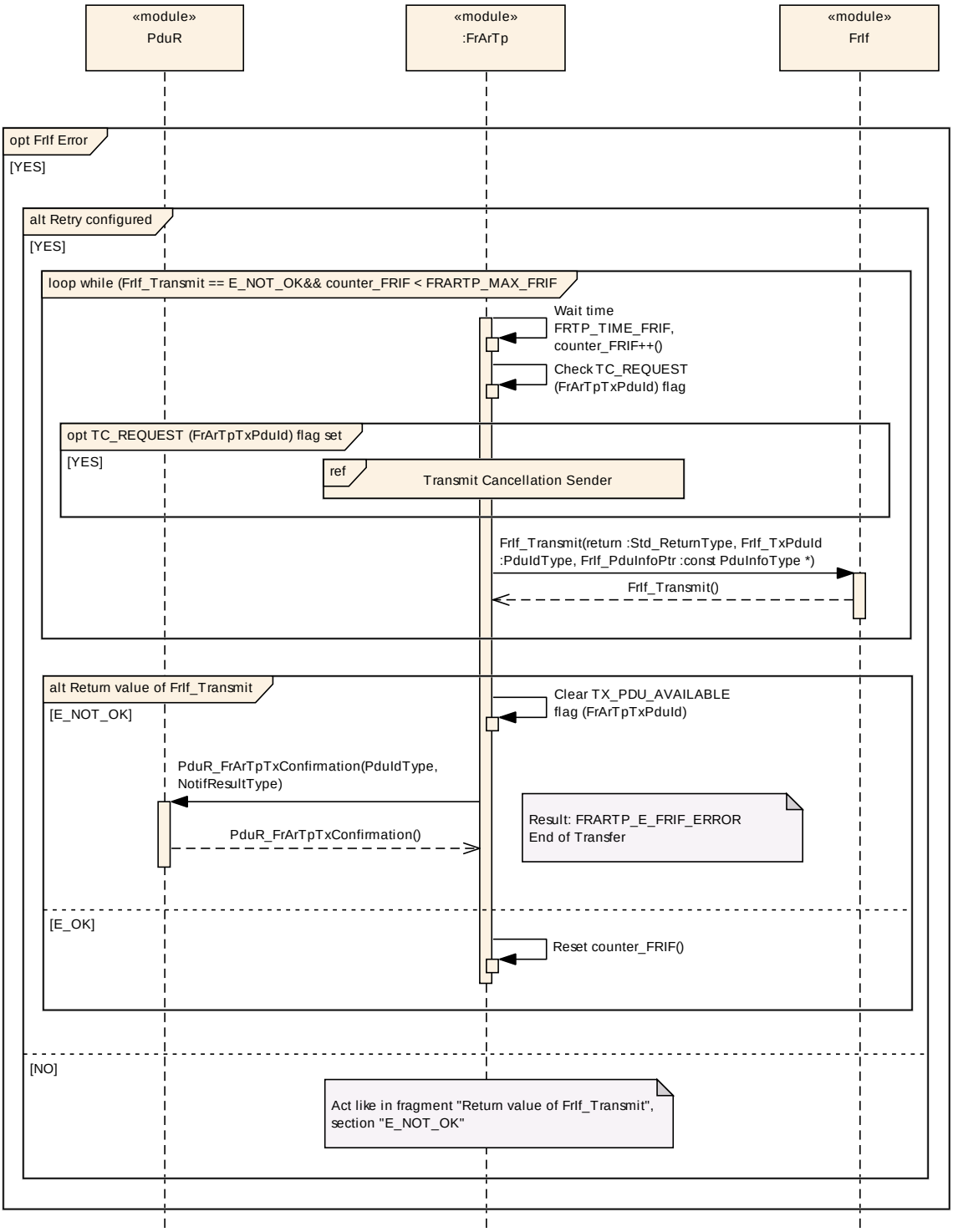
9.1.3.1 Timeout AS



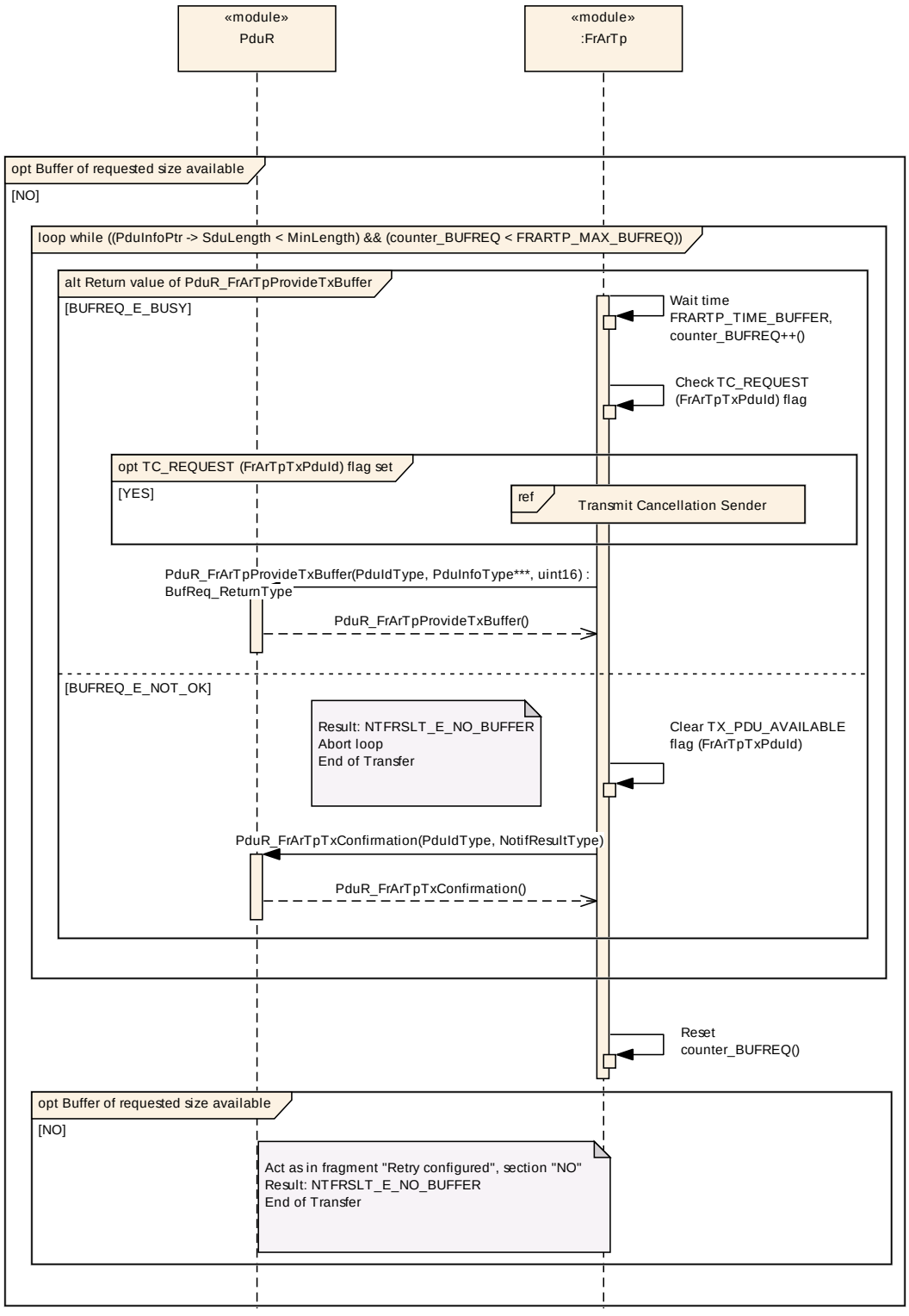
9.1.3.2 Timeout BS



9.1.3.3 FrIf_Transmit Error Sender



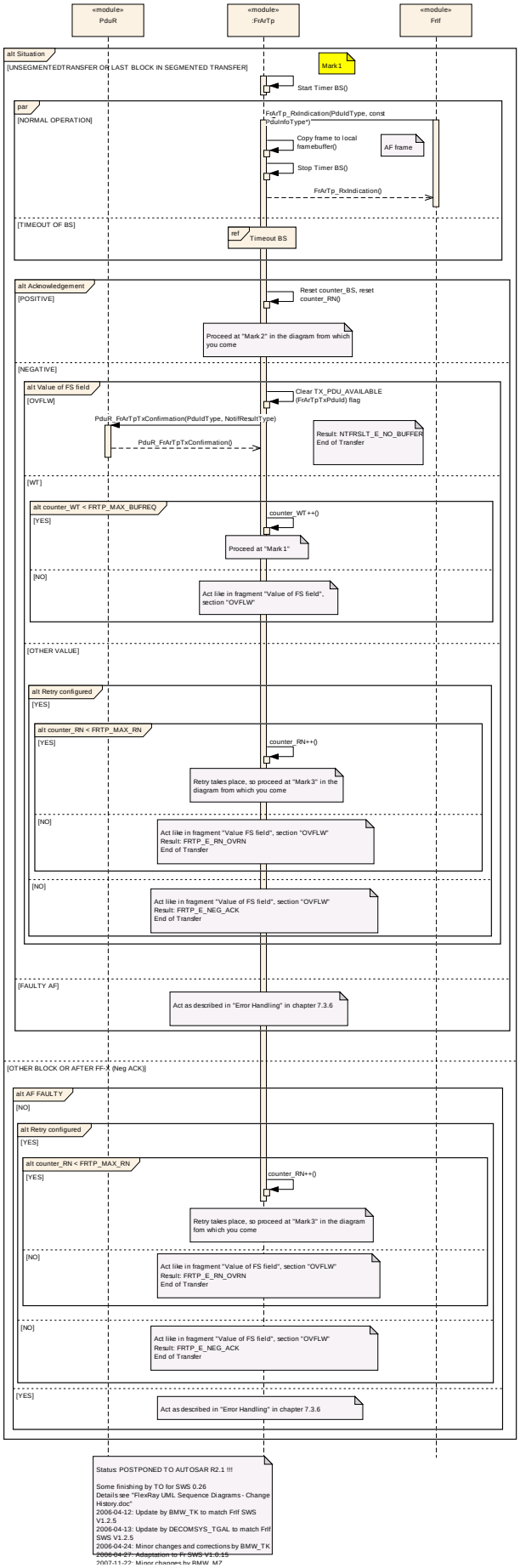
9.1.3.4 Buffer Request Error Sender



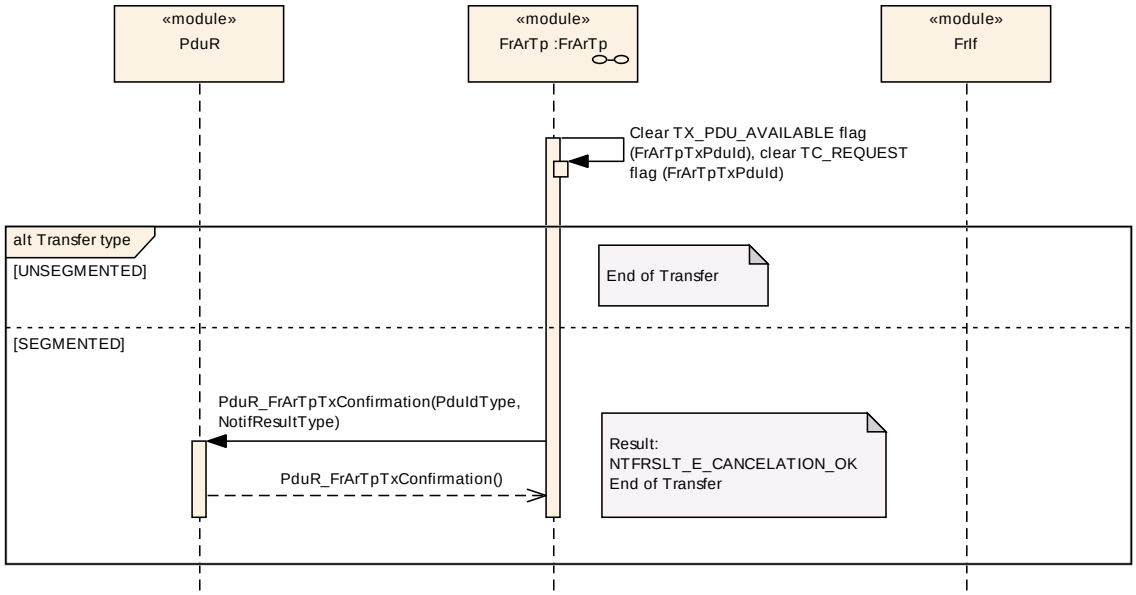
Status: POSTPONED TO AUTOSAR R2.1 !!!

Some finishing by TO for SWS 0.26
Details see "FlexRay UML Sequence Diagrams - Change History.doc"
2006-04-12: Update by BMW_TK to match FrIf SWS V1.2.5
2006-04-13: Update by DECOMSYS_TGAL to match FrIf SWS V1.2.5
2006-04-24: Minor changes and corrections by BMW_TK
~~2006-04-27: Adaptation to Fr SWS V1.0.15~~
2007-11-22: Minor changes by BMW_MZ

9.1.3.5 Acknowledgement / Retry Sender

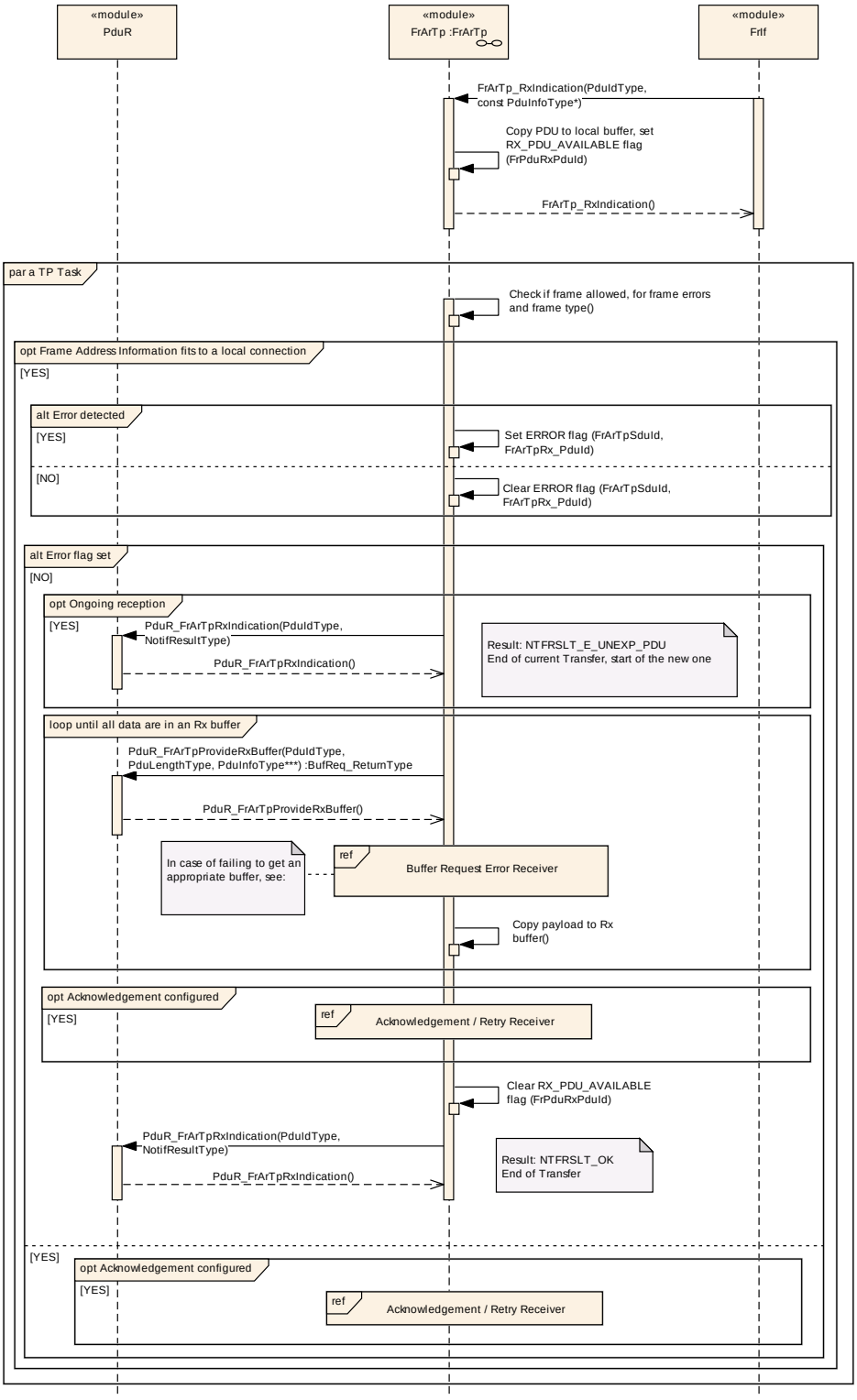

«module»
PduR
«module»
:FrArTp
«module»
FrIf
alt Situation
[UNSEGMENTEDTRANSFER OR LAST BLOCK IN SEGMENTED TRANSFER]
Mark1
Start Timer BS()
par
[NORMAL OPERATION]
FrArTp_RxIndication(PduIdType, const PduInfoType*)
Copy frame to local framebuffer()
AF frame
Stop Timer BS()
FrArTp_RxIndication()
[TIMEOUT OF BS]
ref
Timeout BS
alt Acknowledgement
[POSITIVE]
Reset counter_BS, reset counter_RN()
Proceed at "Mark 2" in the diagram from which you come
[NEGATIVE]
alt Value of FS field
[OVFLW]
Clear TX_PDU_AVAILABLE (FrArTpTxPduId) flag
PduR_FrArTpTxConfirmation(PduIdType, NotifResultType)
PduR_FrArTpTxConfirmation()
Result: NTFRSLT_E_NO_BUFFER
End of Transfer
[WT]
alt counter_WT < FRTP_MAX_BUFREQ
[YES]
counter_WT++()
Proceed at "Mark 1"
[NO]
Act like in fragment "Value of FS field", section "OVFLW"
[OTHER VALUE]
alt Retry configured
[YES]
alt counter_RN < FRTP_MAX_RN
[YES]
counter_RN++()
Retry takes place, so proceed at "Mark 3" in the diagram from which you come
[NO]
Act like in fragment "Value FS field", section "OVFLW"
Result: FRTP_E_RN_OVRN
End of Transfer
[NO]
Act like in fragment "Value of FS field", section "OVFLW"
Result: FRTP_E_NEG_ACK
End of Transfer
[FAULTY AF]
Act as described in "Error Handling" in chapter 7.3.6
[OTHER BLOCK OR AFTER FF-X (Neg ACK)]
alt AF FAULTY
[NO]
alt Retry configured
[YES]
alt counter_RN < FRTP_MAX_RN
[YES]
counter_RN++()
Retry takes place, so proceed at "Mark 3" in the diagram fom which you come
[NO]
Act like in fragment "Value of FS field", section "OVFLW"
Result: FRTP_E_RN_OVRN
End of Transfer
[NO]
Act like in fragment "Value of FS field", section "OVFLW"
Result: FRTP_E_NEG_ACK
End of Transfer
[YES]
Act as described in "Error Handling" in chapter 7.3.6
Status: POSTPONED TO AUTOSAR R2.1 !!!
Some finishing by TO for SWS 0.26
Details see "FlexRay UML Sequence Diagrams - Change History.doc"
2006-04-12: Update by BMW_TK to match FrIf SWS V1.2.5
2006-04-13: Update by DECOMSYS_TGAL to match FrIf SWS V1.2.5
2006-04-24: Minor changes and corrections by BMW_TK
~~2006-04-27: Adaptation to Fr SWS V1.0.15~~
2007-11-22: Minor changes by BMW_MZ

9.1.3.6 Transmit Cancellation



9.2 Receiving

9.2.1 Unsegmented Receiving



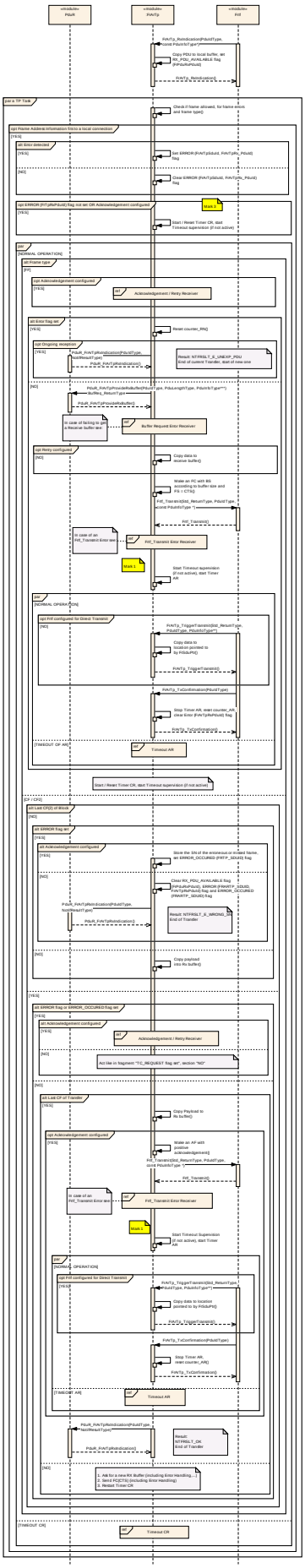
Status: POSTPONED TO AUTOSAR R2.1 !!!

Some finishing by TO for SWS 0.26
Details see "FlexRay UML Sequence Diagrams - Change History.doc"
2006-04-12: Update by BMW_TK to match Frlf SWS V1.2.5
2006-04-13: Update by DECOMSYS_TGAL to match Frlf SWS V1.2.5
2006-04-24: Minor changes and corrections by BMW_TK
2006-04-27: Adaptation to Fr SWS V1.0.15
2007-11-22: Minor changes by BMW_MZ

Description:

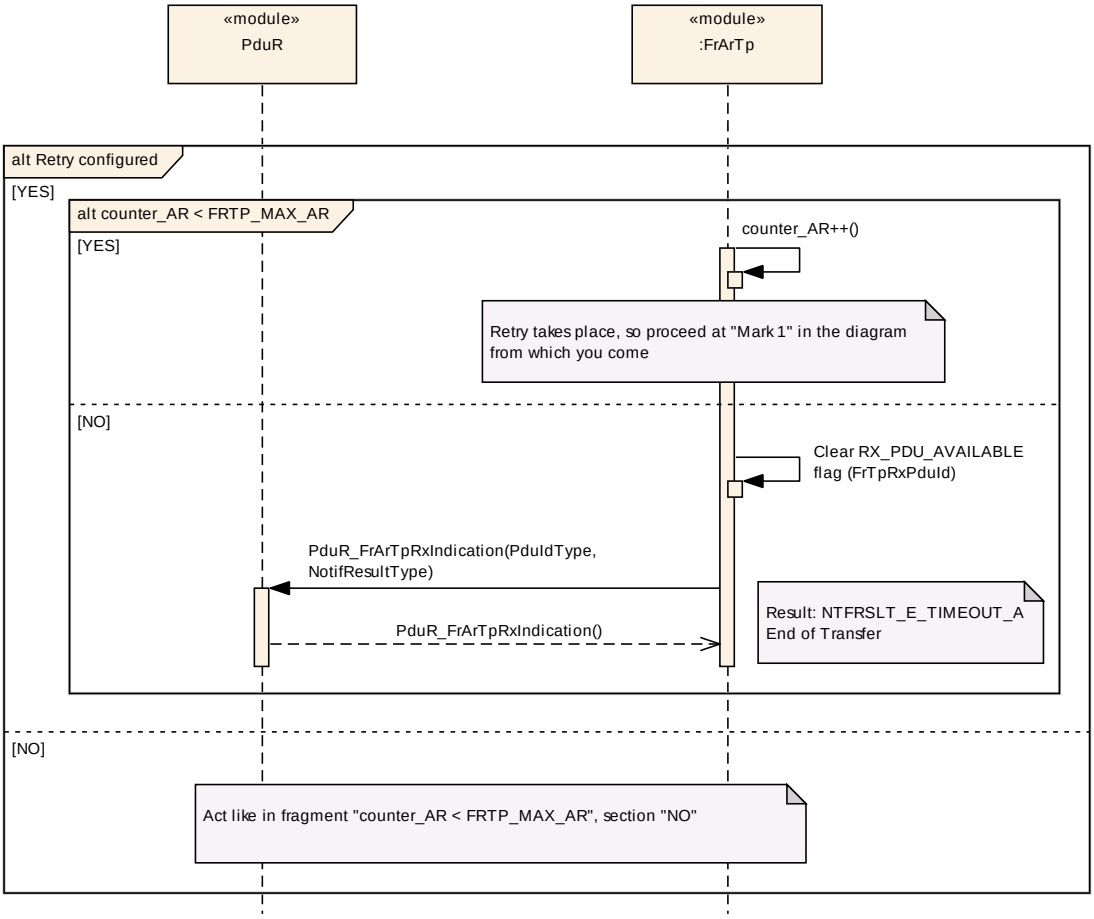
Comments:

9.2.2 Segmented Receiving

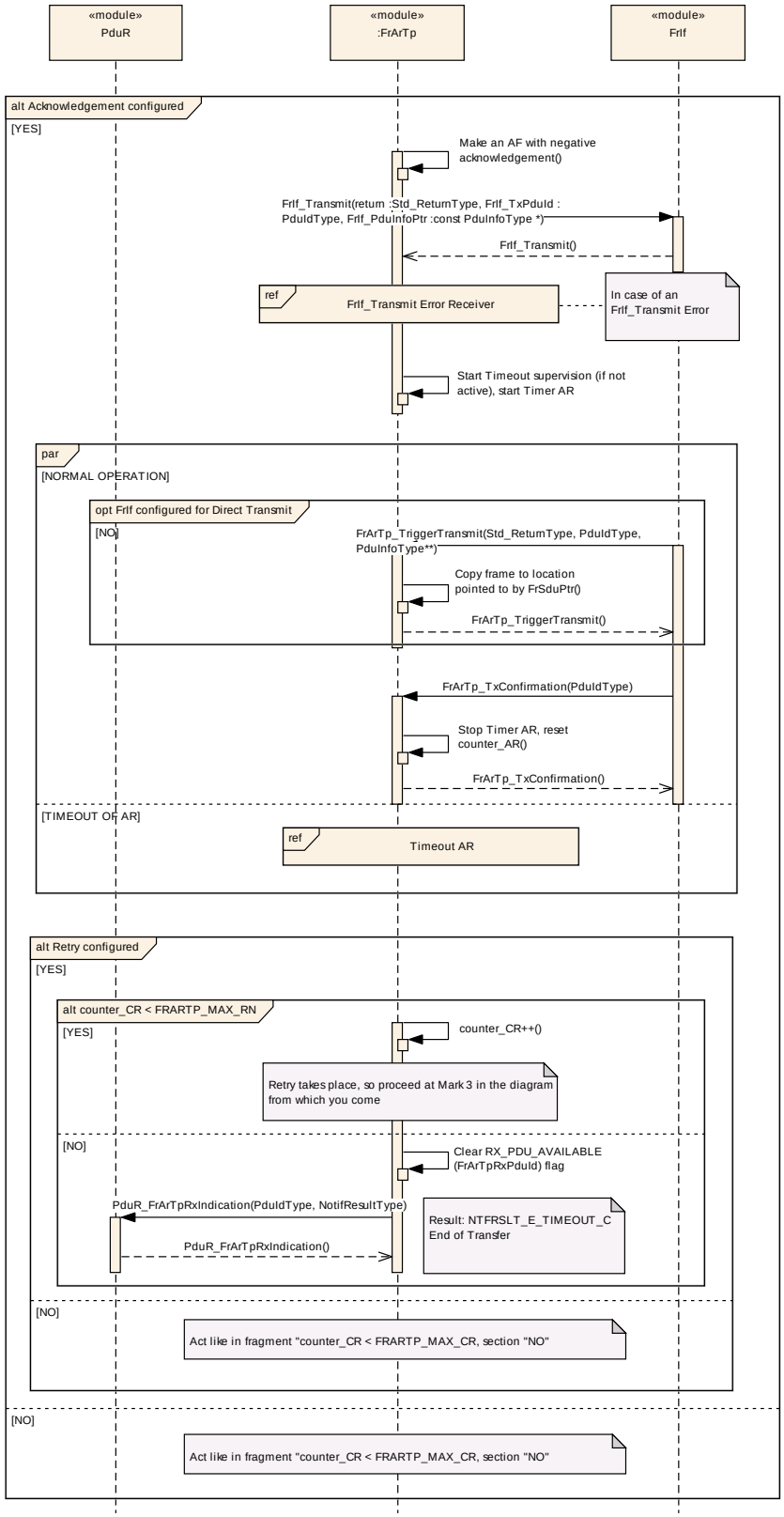


9.2.3 Others

9.2.3.1 Timeout AR



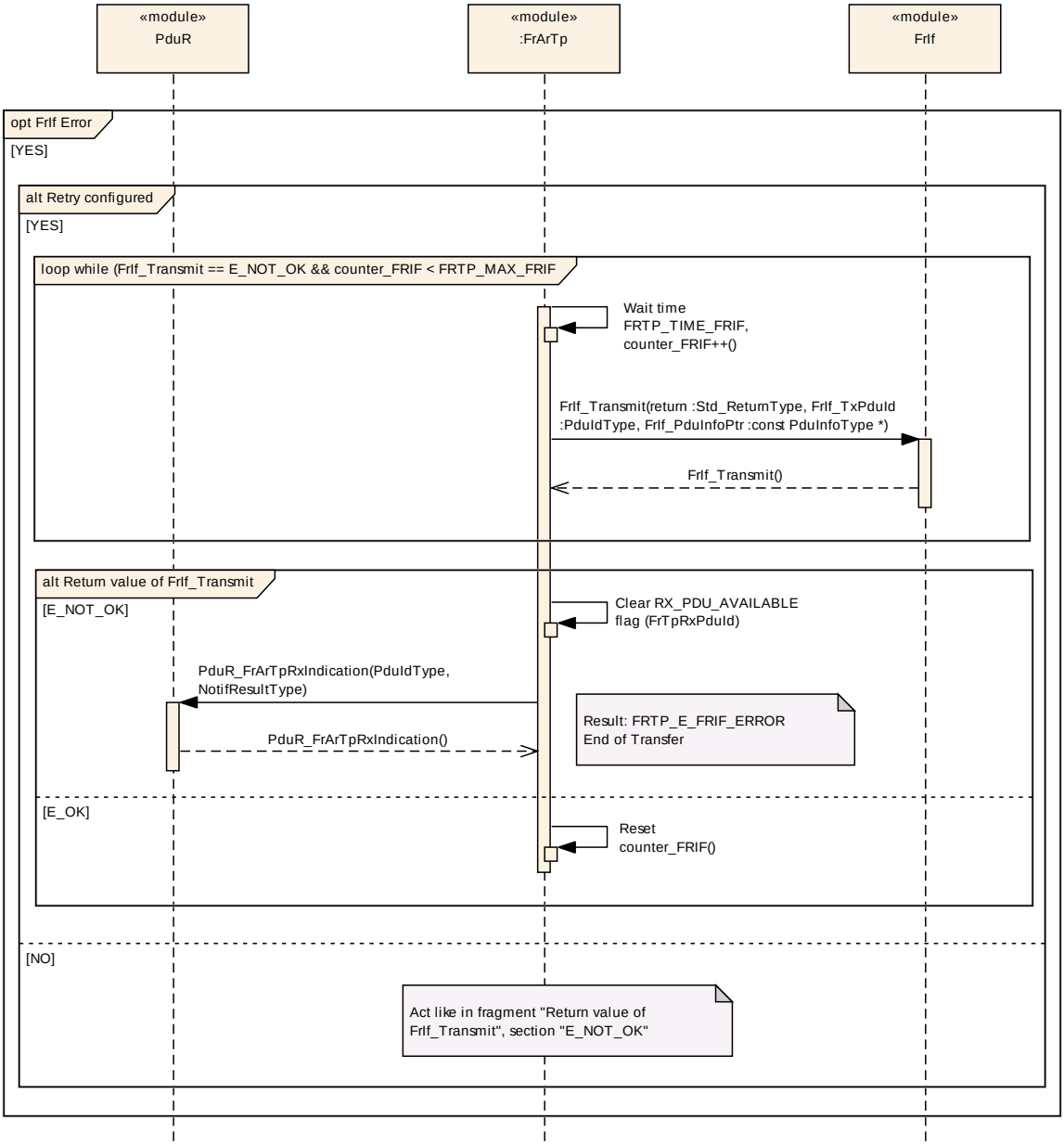
9.2.3.2 Timeout CR



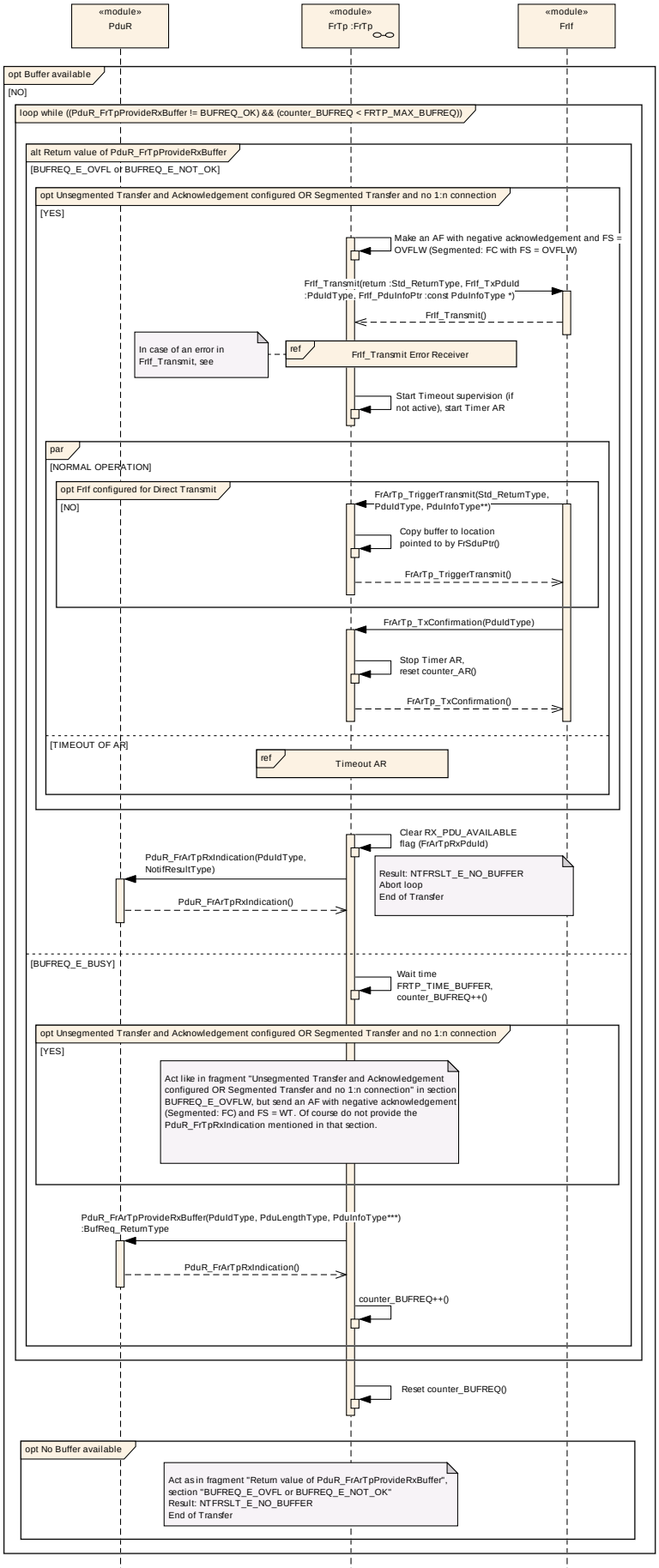
Status: POSTPONED TO AUTOSAR R2.1 !!!

Some finishing by TO for SWS 0.26
Details see "FlexRay UML Sequence Diagrams - Change History.doc"
2006-04-12: Update by BMW_TK to match Frlf SWS V1.2.5
2006-04-13: Update by DECOMSYS_TGAL to match Frlf SWS V1.2.5
2006-04-24: Minor changes and corrections by BMW_TK
2006-04-27: Adaptation to Fr SWS V1.0.15
2007-11-22: Minor changes by BMW_MZ

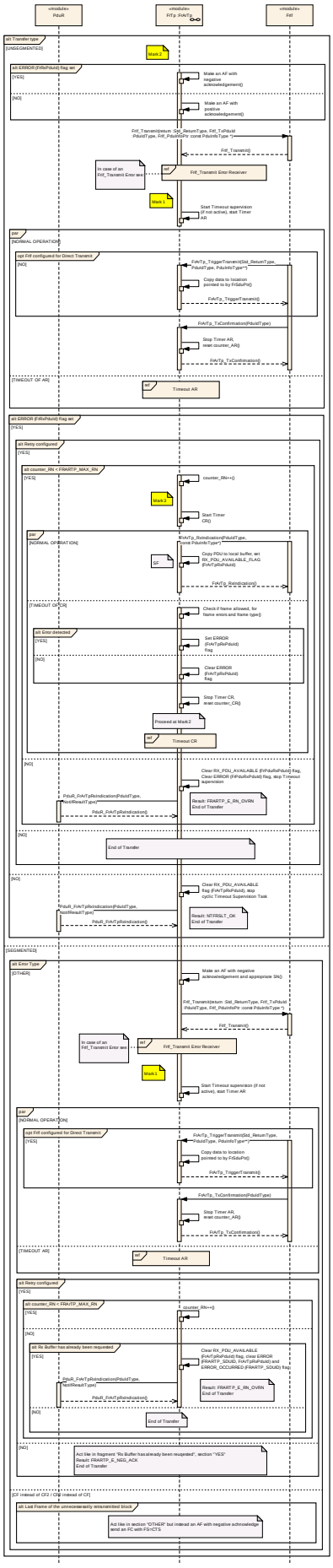
9.2.3.3 FrIf_Transmit Error Receiver



9.2.3.4 Buffer Request Error Receiver


«module»
PduR
«module»
FrTp :FrTp
«module»
Frlf
opt Buffer available
[NO]
loop while ((PduR_FrTpProvideRxBuffer != BUFREQ_OK) && (counter_BUFREQ < FRTP_MAX_BUFREQ))
alt Return value of PduR_FrTpProvideRxBuffer
[BUFREQ_E_OVFL of BUFREQ_E_NOT_OK]
opt Unsegmented Transfer and Acknowledgement configured OR Segmented Transfer and no 1:n connection
[YES]
Make an AF with negative acknowledgement and FS = OVFLW (Segmented: FC with FS = OVFLW)
Frlf_Transmit(return :Std_ReturnType, Frlf_TxPduId :PduIdType, Frlf_PduInfoPtr :const PduInfoType *)
Frlf_Transmit()
In case of an error in Frlf_Transmit, see
ref
Frlf_Transmit Error Receiver
Start Timeout supervision (if not active), start Timer AR
par
[NORMAL OPERATION]
opt Frlf configured for Direct Transmit
[NO]
FrArTp_TriggerTransmit(Std_ReturnType, PduIdType, PduInfoType**)
Copy buffer to location pointed to by FrSduPtr()
FrArTp_TriggerTransmit()
FrArTp_TxConfirmation(PduIdType)
Stop Timer AR, reset counter_AR()
FrArTp_TxConfirmation()
[TIMEOUT OF AR]
ref
Timeout AR
Clear RX_PDU_AVAILABLE flag (FrArTpRxPduId)
PduR_FrArTpRxIndication(PduIdType, NotifResultType)
Result: NTFRSLT_E_NO_BUFFER
Abort loop
End of Transfer
PduR_FrArTpRxIndication()
[BUFREQ_E_BUSY]
Wait time FRTP_TIME_BUFFER, counter_BUFREQ++()
opt Unsegmented Transfer and Acknowledgement configured OR Segmented Transfer and no 1:n connection
[YES]
Act like in fragment "Unsegmented Transfer and Acknowledgement configured OR Segmented Transfer and no 1:n connection" in section BUFREQ_E_OVFLW, but send an AF with negative acknowledgement (Segmented: FC) and FS = WT. Of course do not provide the PduR_FrTpRxIndication mentioned in that section.
PduR_FrArTpProvideRxBuffer(PduIdType, PduLengthType, PduInfoType***) :BufReq_ReturnType
PduR_FrArTpRxIndication()
counter_BUFREQ++()
Reset counter_BUFREQ()
opt No Buffer available
Act as in fragment "Return value of PduR_FrArTpProvideRxBuffer", section "BUFREQ_E_OVFL or BUFREQ_E_NOT_OK"
Result: NTFRSLT_E_NO_BUFFER
End of Transfer

9.2.3.5 Acknowledgement / Retry Receiver



10 Configuration specification

[FRARTP199] 「In general, this chapter defines configuration parameters and their clustering into containers. In order to support the specification Chapter 10.1 describes fundamentals. It also specifies a template (table) you shall use for the parameter specification. We intend to leave Chapter 10.1 in the specification to guarantee comprehension.」()

Chapter 10.2 specifies the structure (containers) and the parameters of the module FlexRay AUTOSAR Transport Layer.

Chapter 10.3 specifies published information of the module FlexRay AUTOSAR Transport Layer

10.1 How to read this chapter

In addition to this section, it is highly recommended to read the documents:

- AUTOSAR Layered Software Architecture.
- AUTOSAR ECU Configuration Specification. This document describes the AUTOSAR configuration methodology and the AUTOSAR configuration metamodel in detail.

The following is only a short survey of the topic and it will not replace the ECU Configuration Specification document.

10.1.1 Configuration and configuration parameters

Configuration parameters define the variability of the generic part(s) of an implementation of a module. This means that only generic or configurable module implementation can be adapted to the environment (software/hardware) in use during system and/or ECU configuration.

The configuration of parameters can be achieved at different times during the software process: before compile time, before link time or after build time. In the following, the term “configuration class” (of a parameter) shall be used in order to refer to a specific configuration point in time.

10.1.2 Variants

Yes

10.1.3 Containers

Containers structure the set of configuration parameters. This means:

- *all* configuration parameters are kept in containers.
- (sub-) containers can reference (sub-) containers. It is possible to assign a multiplicity to these references. The multiplicity then defines the possible number of instances of the contained parameters.

10.1.4 Specification template for configuration parameters

The following tables consist of three sections:

- the general section
- the configuration parameter section
- the section of included/referenced containers

Pre-compile time - specifies whether the configuration parameter shall be of configuration class *Pre-compile time* or not

Label	***Description***
x	The configuration parameter shall be of configuration class *Pre-compile time*.
--	The configuration parameter shall never be of configuration class *Pre-compile time*.

Link time - specifies whether the configuration parameter shall be of configuration class *Link time* or not

Label	***Description***
x	The configuration parameter shall be of configuration class *Link time*.
--	The configuration parameter shall never be of configuration class *Link time*.

Post Build - specifies whether the configuration parameter shall be of configuration class *Post Build* or not

Label	***Description***
x	The configuration parameter shall be of configuration class *Post Build* and no specific implementation is required.
L	*Loadable* - the configuration parameter shall be of configuration class *Post Build* and only one configuration parameter set resides in the ECU.
M	*Multiple* - the configuration parameter shall be of configuration class *Post Build* and is selected out of a set of multiple parameters by passing a dedicated pointer to the init function of the module.
--	The configuration parameter shall never be of configuration class *Post Build*.

10.2 Containers and configuration parameters

The following chapters summarize all configuration parameters. The detailed meanings of the parameters describe Chapters 7 and Chapter 8.

The following picture gives an overview about the configuration.

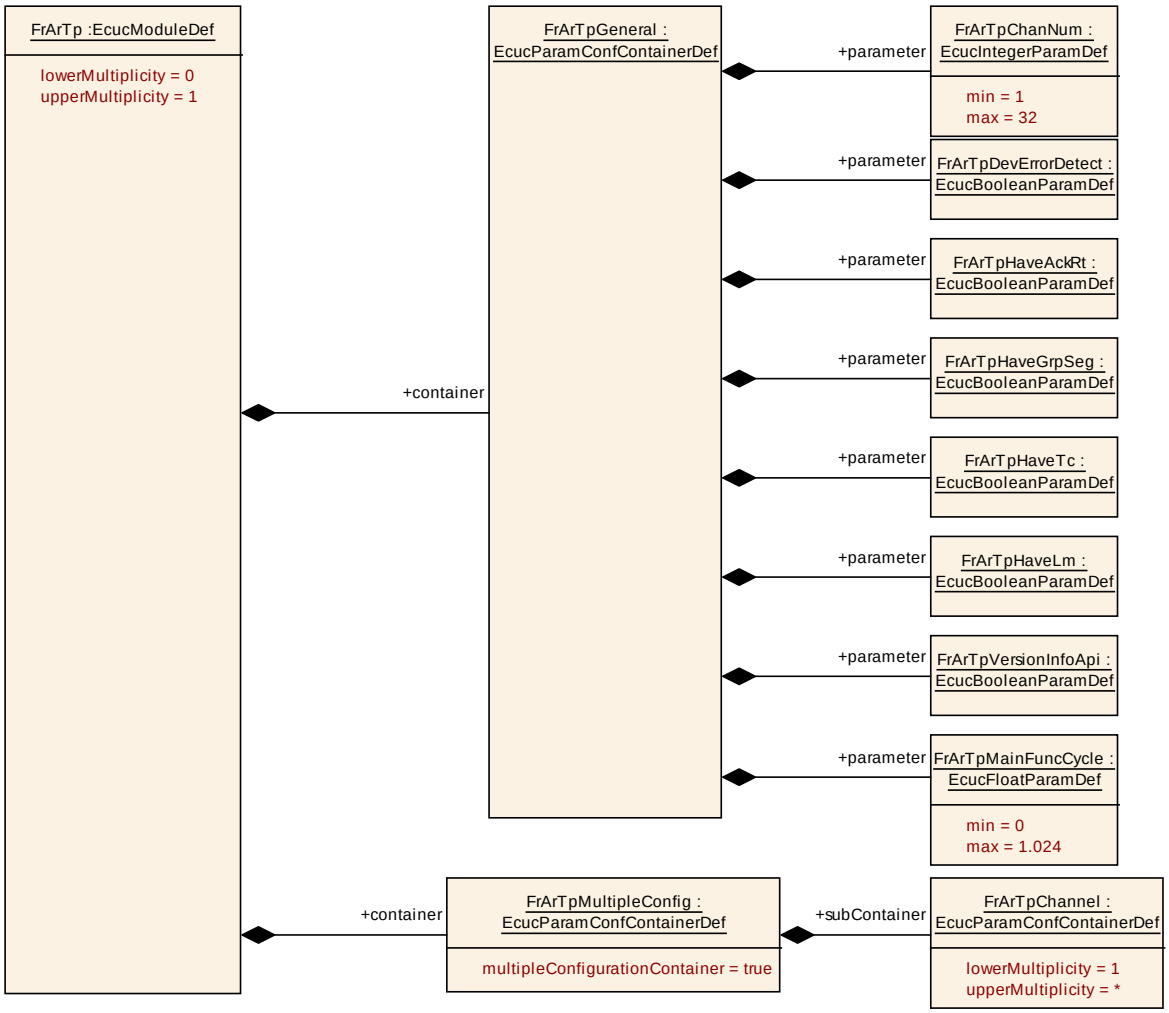


Figure 23: Overview over FrArTp configuration

10.2.1 Variants

Variant 1: Pre Compile time

Variant 2: Mixture of Pre Compile time and Post Build Time Parameters

10.2.2 FrArTp

SWS Item	**FRARTP001_Conf :**
Module Name	*FrArTp*
Module Description	Configuration of the FrArTp (FlexRay Transport Protocol) module.

Included Containers		
Container Name	**Multiplicity**	**Scope / Dependency**
FrArTpGeneral	1	This container contains the general configuration (parameters) of the FlexRay TP.
FrArTpMultipleConfig	1	This container holds one or several multiple configuration sets.

10.2.3 FrArTpGeneral

SWS Item	FRARTP012_Conf :
Container Name	FrArTpGeneral{FRARTP_GENERAL}
Description	This container contains the general configuration (parameters) of the FlexRay TP.
Configuration Parameters	

SWS Item	FRARTP004_Conf :		
Name	FrArTpChanNum {FRARTP_CHAN_NUM}		
Description	Preprocessor switch for defining the number of concurrent channels the module supports. Up to 32 channels shall be definable here.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	1 .. 32		
Default value	--		
ConfigurationClass	Pre-compile time	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	FRARTP011_Conf :		
Name	FrArTpDevErrorDetect {FRARTP_DEV_ERROR_DETECT}		
Description	Preprocessor switch for enabling development error detection.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	Pre-compile time	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	FRARTP014_Conf :		
Name	FrArTpHaveAckRt {FRARTP_HAVE_ACKRT}		
Description	Preprocessor switch for enabling the Acknowledgement and retry mechanisms.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	Pre-compile time	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	FRARTP015_Conf :
Name	FrArTpHaveGrpSeg {FRTP_HAVE_GRPSEG}
Description	Preprocessor switch for enabling segmentation of 1:n

	messages.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	**FRARTP016_Conf :**		
Name	FrArTpHaveLm {FRARTP_HAVE_LM}		
Description	Preprocessor switch for enabling the mechanism for message longer than allowed by.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	**FRARTP017_Conf :**		
Name	FrArTpHaveTc {FRARTP_HAVE_TC}		
Description	Preprocessor switch for enabling Transmit Cancellation.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

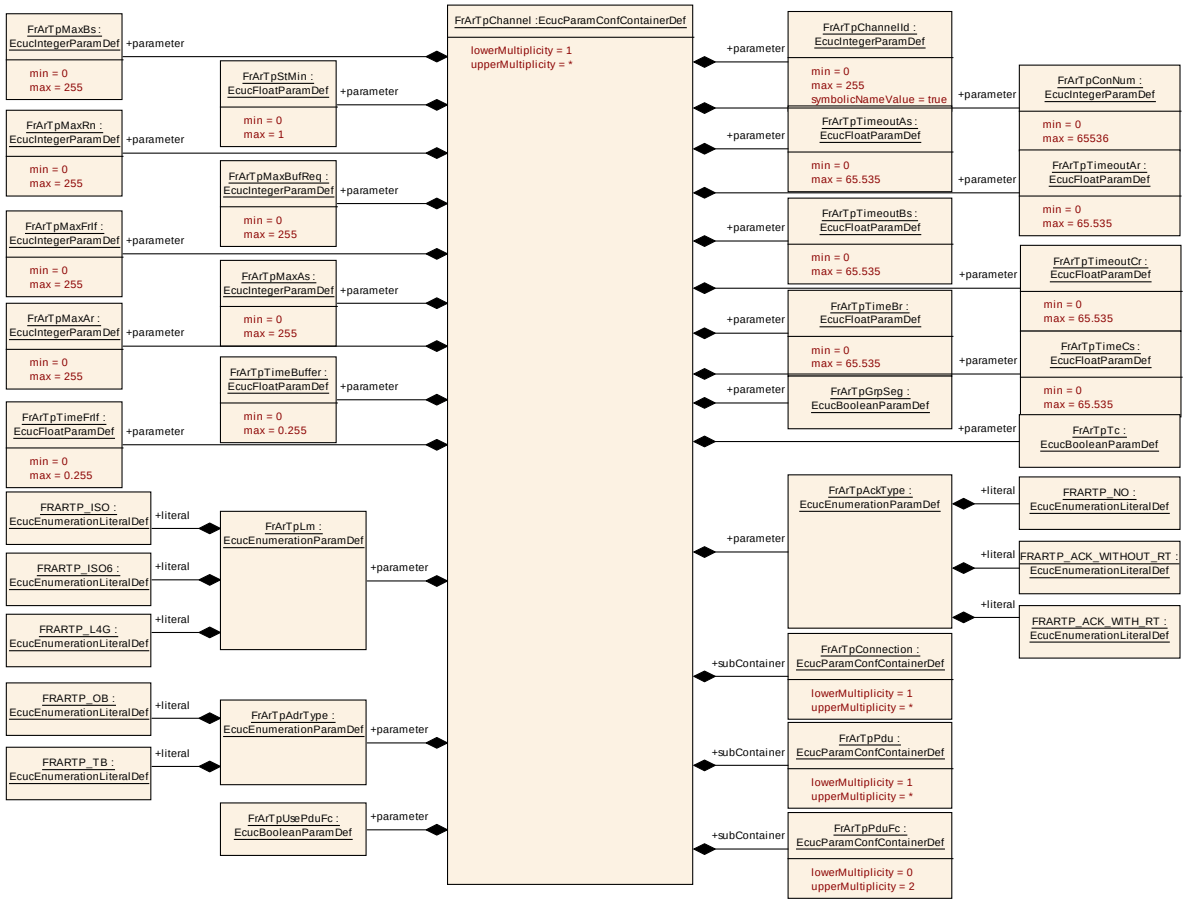
SWS Item	**FRARTP020_Conf :**		
Name	FrArTpMainFuncCycle {FRARTP_MAINFUNC_CYCLE}		
Description	This parameter contains the calling period of the TPs Main Function. The parameter is specified in seconds.		
Multiplicity	1		
Type	EcucFloatParamDef		
Range	`0 .. 1.024`		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP054_Conf :**		
Name	FrArTpVersionInfoApi {FRARTP_VERSION_INFO_API}		
Description	Preprocessor switch for enabling the Version info API.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

No Included Containers

[FRARTP186] 「All parameters within chapter 10.2.2 are global and, of course, only present once for the whole software module.」()

[FRARTP177] 「global configuration」(BSW00338, BSW00345, BSW00350)



10.2.4 FrArTpChannel

SWS Item	**FRARTP005_Conf :**
Container Name	FrArTpChannel{FRARTP_CHANNEL}
Description	This container contains the configuration (parameters) of one FlexRay TP channel.
Configuration Parameters	

SWS Item	**FRARTP002_Conf :**	
Name	FrArTpAckType {FRARTP_ACKTYPE}	
Description	This parameter defines the type of acknowledgement which is used for the specific channel.	
Multiplicity	1	
Type	EcucEnumerationParamDef	
Range	FRARTP_ACK_WITHOUT_RT	Acknowledgement without retry

	FRARTP_ACK_WITH_RT	Acknowledgement with retry	
	FRARTP_NO	No acknowledgement	
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP008_Conf :**		
Name	FrArTpAdrType {FRARTP_ADRTYPE}		
Description	This parameter states the addressing type this connection has. The meanings of the values are one byte and two byte.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	FRARTP_OB	One Byte	
	FRARTP_TB	Two Bytes	
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP006_Conf :**		
Name	FrArTpChannelId {FRARTP_CHANNEL_ID}		
Description	The Id of the channel.		
Multiplicity	1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	0 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP007_Conf :**		
Name	FrArTpConNum {FRARTP_CON_NUM}		
Description	This parameter states the number of connections used in this channel. At least 256 shall be configurable here.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 65536		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP013_Conf :**
Name	FrArTpGrpSeg {FRARTP_GRPSEG}
Description	Here can be specified, whether segmentation within a 1:n connection is allowed or not.
Multiplicity	1
Type	EcucBooleanParamDef

Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP019_Conf :**		
Name	FrArTpLm {FRARTP_LM}		
Description	This specifies the maximum message length for the particular channel.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	FRARTP_ISO	Up to (2**12)-1 Byte message length (No FF-Ex or SF-E or AF shall be used and recognized)	
	FRARTP_ISO6	As ISO, but the maximum payload length is limited to 6 byte (SF-I, FF-I, CF). This is necessary to route TP on CAN when using Extended Addressing or Mixed Addressing on CAN.	
	FRARTP_L4G	SF-E allowed (SF of arbitrary length depending on FrArTpPduLength), up to (2**32)-1 byte message length (all FF-x allowed).	
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP021_Conf :**		
Name	FrArTpMaxAr {FRARTP_MAX_AR}		
Description	This parameter defines the maximum number of trying to send a frame when a TIMEOUT AR occurs (depending on whether retry is configured).		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP022_Conf :**		
Name	FrArTpMaxAs {FRARTP_MAX_AS}		
Description	This parameter defines the maximum number of trying t osend a frame when a TIMEOUT AS occurs (depending on whether retry is configured)		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP023_Conf :**		
Name	FrArTpMaxBs {FRARTP_MAXBS}		
Description	This parameter defines number of consecutive CFs between two FCs (block size). Valid values are 1 .. 16 when retry is activated, and 0 .. 255 otherwise.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP024_Conf :**		
Name	FrArTpMaxBufReq {FRARTP_MAX_BUFREQ}		
Description	This parameter defines the maximum number of times the FrArTp should send a wait frame FC(WT). It is also used to limit the number of retries for PduR_FrArTpCopyTxData and PduR_FrArTpCopyRxData when no timer is active.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP025_Conf :**		
Name	FrArTpMaxFrIf {FRARTP_MAX_FRIF}		
Description	This parameter defines the maximum number of trying to send a frame when the FrIf returns an error.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP026_Conf :**		
Name	FrArTpMaxRn {FRARTP_MAX_RN}		
Description	This parameter defines the maximum number of retries (if retry is configured for the particular channel).		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP042_Conf :**		
Name	FrArTpStMin {FRARTP_STMIN}		
Description	This parameter defines the minimum amount of time between two succeeding CFs in seconds. Valid values are 0, 100µs, 200µs .. 900µs, 1ms, 2ms .. 127ms. The value can be changed at runtime using the FrArTp_ChangeParameter interface.		
Multiplicity	1		
Type	EcucFloatParamDef		
Range	`0 .. 1`		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP043_Conf :**		
Name	FrArTpTc {FRARTP_TC}		
Description	With this switch Transmit Cancellation can be turned on or off for this channel.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP044_Conf :**		
Name	FrArTpTimeBr {FRARTP_TIME_BR}		
Description	This parameter defines the time in seconds between receiving the last CF of a block or an FF-x (or SF-x) and sending out an FC or AF. It is obvious that FRARTP_TIME_BR + FRARTP_TIMEOUT_AR < FRARTP_TIMEOUT_BS must hold (because the transmission duration on the bus has also to be considered). This parameter is defined in ISO 15765-2. It is contained in the configuration as a performance requirement.		
Multiplicity	1		
Type	EcucFloatParamDef		
Range	`0 .. 65.535`		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency			

SWS Item	**FRARTP045_Conf :**	
Name	FrArTpTimeBuffer {FRARTP_TIME_BUFFER}	
Description	This parameter defines the time in seconds of waiting for the next try (if retry is activated) to get a Tx or Rx buffer.	
Multiplicity	1	
Type	EcucFloatParamDef	
Range	`0 .. 0.255`	

Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP046_Conf :**		
Name	FrArTpTimeCs {FRARTP_TIME_CS}		
Description	This parameter defines the time in seconds between the sending of two consecutive CFs or between reception of an FC or AF and sending of the next CF . It is obvious that FRARTP_TIME_CS + FRARTP_TIMEOUT_AS < FRARTP_TIMEOUT_CR must hold (because the transmission duration on the bus has also to be considered). This parameter is defined in ISO 15765-2. It is contained in the configuration as a performance requirement.		
Multiplicity	1		
Type	EcucFloatParamDef		
Range	`0 .. 65.535`		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency			

SWS Item	**FRARTP047_Conf :**		
Name	FrArTpTimeFrIf {FRARTP_TIME_FRIF}		
Description	This parameter defines the time in seconds of waiting for the next try (if retry is activated) to send via FrIf_Transmit.		
Multiplicity	1		
Type	EcucFloatParamDef		
Range	`0 .. 0.255`		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP048_Conf :**		
Name	FrArTpTimeoutAr {FRARTP_TIMEOUT_AR}		
Description	This parameter states the timeout in seconds between the PDU transmit request of the Transport Layer to the FlexRay Interface and the corresponding confirmation of the FlexRay Interface on the receiver side (for FC or AF).		
Multiplicity	1		
Type	EcucFloatParamDef		
Range	`0 .. 65.535`		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP049_Conf :**

Name	FrArTpTimeoutAs {FRARTP_TIMEOUT_AS}		
Description	This parameter states the timeout in seconds between the PDU transmit request for the first PDU of the group used in the current connection of the Transport Layer to the FlexRay Interface and the corresponding confirmation of the FlexRay Interface (when having sent the last PDU of the group used in this connection) on the sender side (SF-x, FF-x, CF).		
Multiplicity	1		
Type	EcucFloatParamDef		
Range	`0 .. 65.535`		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP050_Conf :**		
Name	FrArTpTimeoutBs {FRARTP_TIMEOUT_BS}		
Description	This parameter defines the timeout in seconds for waiting for an FC or AF on the sender side in a 1:1 connection.		
Multiplicity	1		
Type	EcucFloatParamDef		
Range	`0 .. 65.535`		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP051_Conf :**		
Name	FrArTpTimeoutCr {FRARTP_TIMEOUT_CR}		
Description	This parameter defines the timeout value in seconds for waiting for a CF or FF-x (in case of retry) after receiving the last CF or after sending an FC or AF on the receiver side.		
Multiplicity	1		
Type	EcucFloatParamDef		
Range	`0 .. 65.535`		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

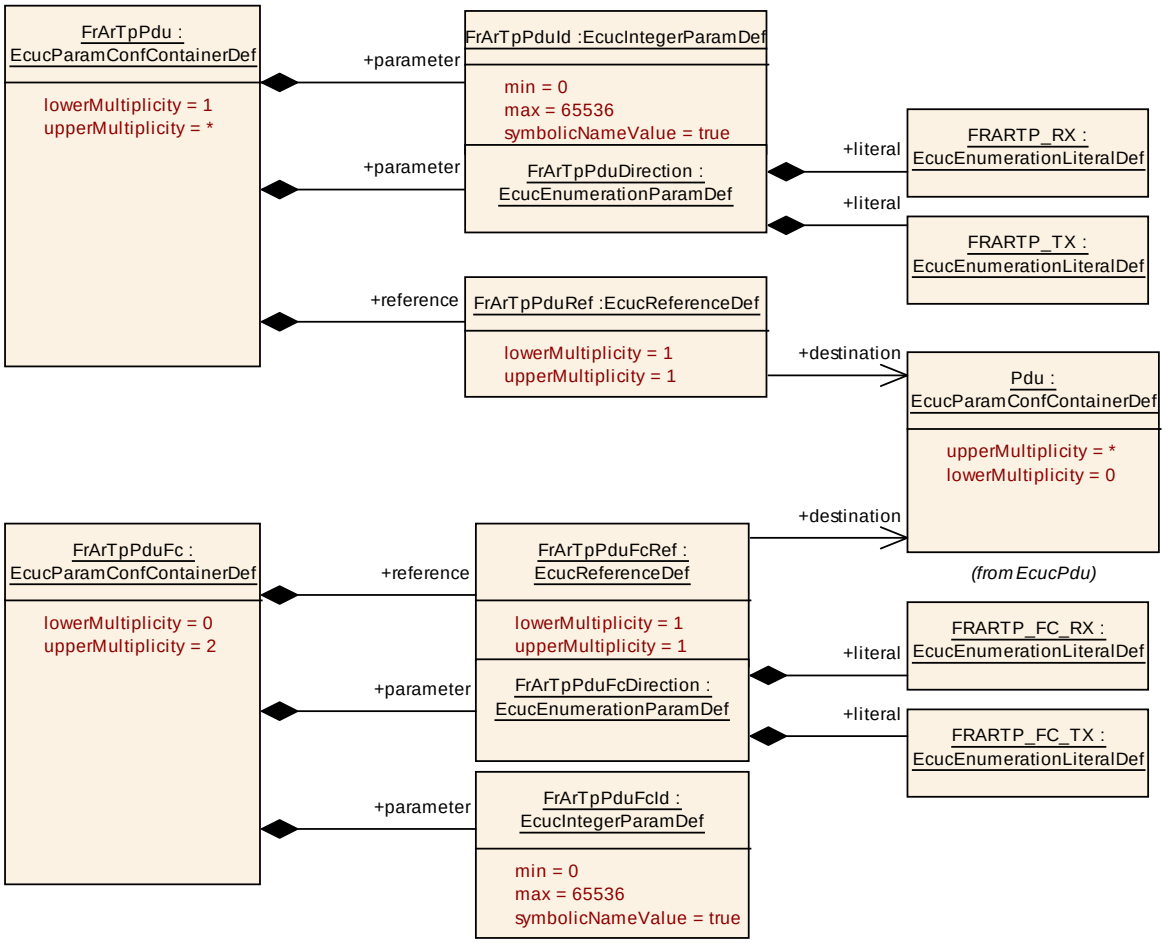
SWS Item	**FRARTP053_Conf :**		
Name	FrArTpUsePduFc {FRARTP_USE_PDU_FC}		
Description	This switch defines, whether within this channel the dedicated FC/ACK PDU (FrArTpPduFc) shall be used or not. If this is not used FC / ACK frames are sent using the normal IDs, otherwise only FrArTpPduFc shall be used for sending / receiving FC / ACK frames.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE

	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
FrArTpConnection	1..*	This container contains the configuration (parameters) of one FlexRay TP connection. A connection can only belong to one channel.
FrArTpPdu	1..*	Container to hold the PDU parameters. ImplementationType: PduInfoType
FrArTpPduFc	0..2	This is the identifier of the FlexRay Interface PDUs (Fr N-PDU, Fr L-SDU) in which the Transport Layer Flow Control and Acknowledgement Frames of this channel should be transmitted. ImplementationType: PduInfoType

[FRARTP166] ⌈All parameters within this chapter are present for each channel and read-only. They shall be placed outside the source code of the module in order to be modifiable by a flashing process without re-flashing the code itself.⌋(BSW00380, BSW05123)

[FRARTP183] ⌈
Performance Requirements according to [12]
The two parameters, `FRARTP_TIME_BR` and `FRARTP_TIME_CS`, are **not software configuration parameters**, they are contained in [12] as performance requirements. They are just for information.⌋()



10.2.5 FrArTpPdu

SWS Item	**FRARTP029_Conf :**
Container Name	FrArTpPdu{FRARTP_PDU}
Description	Container to hold the PDU parameters. ImplementationType: PduInfoType
Configuration Parameters	

SWS Item	**FRARTP030_Conf :**		
Name	FrArTpPduDirection {FRARTP_PDU_DIRECTION}		
Description	This parameter defines the direction of the PDU.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	FRARTP_RX	Received PDU	
	FRARTP_TX	Transmitted PDU	
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency			

SWS Item	**FRARTP035_Conf :**
Name	FrArTpPduId {FRARTP_PDU_ID}
Description	This is the identifier of the FlexRay Interface PDUs (Fr N-PDU, Fr L-SDU) in which the Transport Layer Frames of this channel should be transmitted.

	ImplementationType: PduIdType		
Multiplicity	1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	0 .. 65536		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP036_Conf :**		
Name	FrArTpPduRef {FRARTP_PDU_REF}		
Description	--		
Multiplicity	1		
Type	Reference to [Pdu]		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency			

No Included Containers

10.2.6 FrArTpPduFc

SWS Item	**FRARTP031_Conf :**
Container Name	FrArTpPduFc{FRARTP_PDU_FC}
Description	This is the identifier of the FlexRay Interface PDUs (Fr N-PDU, Fr L-SDU) in which the Transport Layer Flow Control and Acknowledgement Frames of this channel should be transmitted. ImplementationType: PduInfoType
Configuration Parameters	

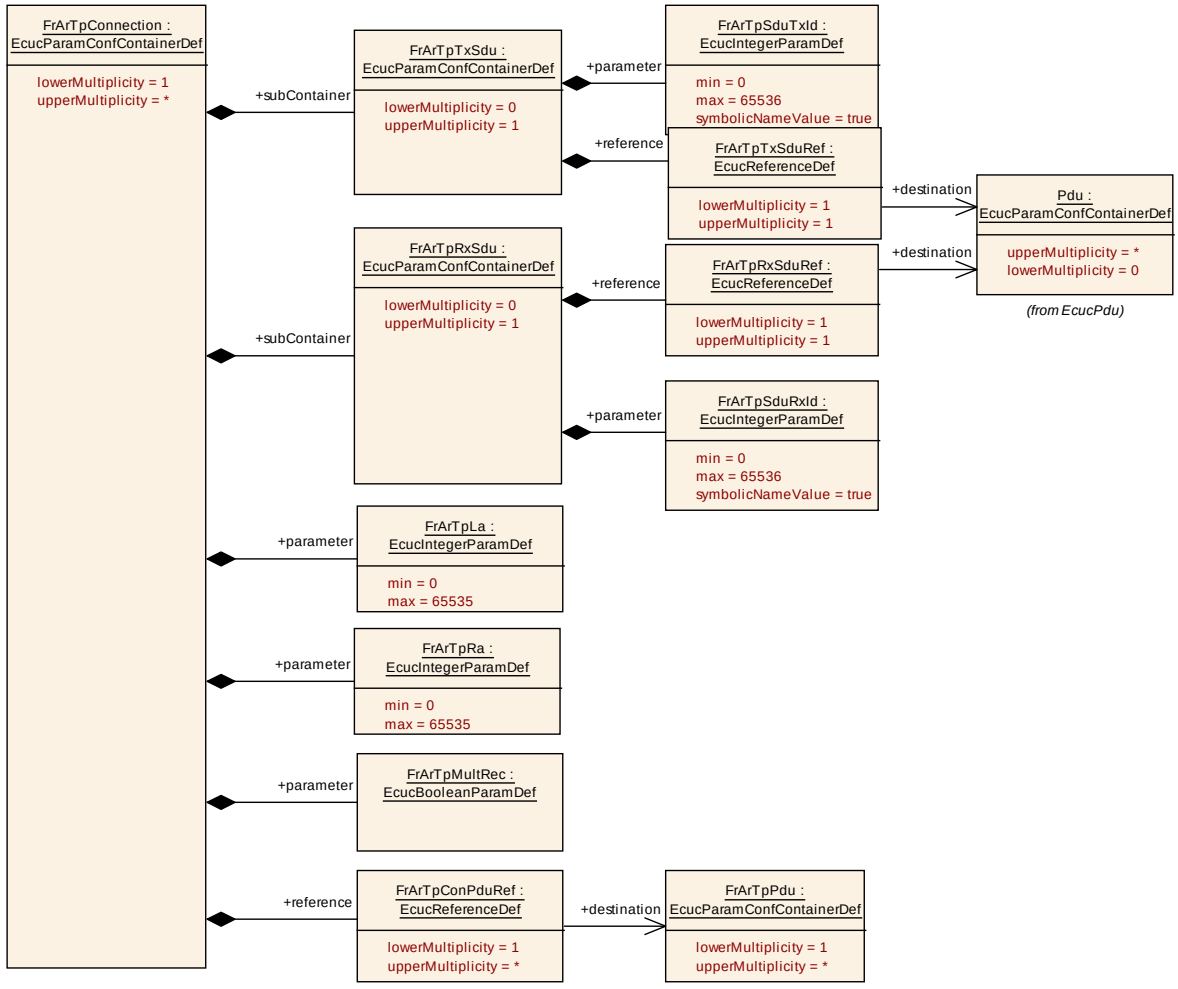
SWS Item	**FRARTP032_Conf :**		
Name	FrArTpPduFcDirection {FRARTP_PDU_FC_DIRECTION}		
Description	This parameter defines the direction of the PDU.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	FRARTP_FC_RX		Received flow control PDU
	FRARTP_FC_TX		Transmitted flow control PDU
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency			

SWS Item	**FRARTP033_Conf :**
Name	FrArTpPduFcId {FRARTP_PDU_FC_ID}
Description	This is the identifier of the FlexRay Interface PDUs (Fr N-PDU, Fr L-SDU) in which the Transport Layer Flow Control and Acknowledgement Frames of this channel should be transmitted.
Multiplicity	1

Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	0 .. 65536		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP034_Conf :**		
Name	FrArTpPduFcRef {FRARTP_PDU_FC_REF}		
Description	--		
Multiplicity	1		
Type	Reference to [Pdu]		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency			

No Included Containers



10.2.7 FrArTpConnection

SWS Item	**FRARTP010_Conf :**
Container Name	FrArTpConnection{FRARTP_CONNECTION_CONFIGURATION}
Description	This container contains the configuration (parameters) of one FlexRay TP connection. A connection can only belong to one channel.
Configuration Parameters	

SWS Item	**FRARTP018_Conf :**		
Name	FrArTpLa {FRARTP_LA}		
Description	This parameter defines the Local Address for the respective connection. When the local instance is the sender, this is the Source Address within the TP frame. When the local instance is the receiver, this is the Target Address within the TP frame. Note that in case of 1 byte addressing only the values from 0x0000 - 0x00FF are valid.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 65535		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP027_Conf :**		
Name	FrArTpMultRec {FRARTP_MULT_REC}		
Description	This parameter defines, whether this connection is an 1:1 ('false') or an 1:n ('true') connection. Of course, if the channel to which the connection is configured has retry or acknowledgement enabled, no retry or acknowledgement will occur in case the connection is an 1:n connection.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP037_Conf :**		
Name	FrArTpRa {FRARTP_RA}		
Description	This parameter defines the Remote Address for the respective connection. When the local instance is the sender, this is the Target Address within the TP frame. When the local instance is the receiver, this is the Source Address within the TP frame. Note that in case of 1 byte addressing only the values from 0x0000 - 0x00FF are valid.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 65535		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	

	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP009_Conf :**		
Name	FrArTpConPduRef {FRARTP_CON_PDU}		
Description	Each value defines a PDU to be used for this connection. Thus each value is a PDU-ID given in FrArTpPdu and this array cannot be longer than the array FrArTpPdu. Please note: Only PDUs of the same size shall be used within a connection. Of course the PDU having the TxConfirmation configured has to be used by every connection.		
Multiplicity	1..*		
Type	Reference to [FrArTpPdu]		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
FrArTpRxSdu	0..1	Describes the Rx SDU
FrArTpTxSdu	0..1	Describes the Tx SDU

[FRARTP185] ⌈All parameters within this chapter are present for each connection and read-only. They shall be placed outside the source code of the module in order to be modifiable by a flashing process without re-flashing the code itself.⌋()

[FRARTP168] ⌈ Parameters⌋(BSW159, BSW171, BSW05077, BSW05079, BSW05082, BSW05083, BSW05085, BSW05104)

10.2.8 FrArTpTxSdu

SWS Item	**FRARTP055_Conf :**
Container Name	FrArTpTxSdu{FRARTP_TX_SDU}
Description	Describes the Tx SDU
Configuration Parameters	

SWS Item	**FRARTP041_Conf :**	
Name	FrArTpSduTxId {FRARTP_SDU_TX_ID}	
Description	This is a unique identifier for a received or a to be transmitted message. With this (and by means of e.g. a lookup table) the PDU Router can route the message appropriately without dealing with the particularities of the Transport Layer. This parameter can also be seen as the identifier of a connection. ImplementationType: PduIdType	
Multiplicity	1	
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)	
Range	0 .. 65536	

Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP052_Conf :**		
Name	FrArTpTxSduRef {FRARTP_TX_SDU_REF}		
Description	Reference to a PDU in the global PDU structure.		
Multiplicity	1		
Type	Reference to [Pdu]		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency			

No Included Containers

10.2.9 FrArTpRxSdu

SWS Item	**FRARTP038_Conf :**
Container Name	FrArTpRxSdu{FRARTP_RX_SDU}
Description	Describes the Rx SDU
Configuration Parameters	

SWS Item	**FRARTP040_Conf :**		
Name	FrArTpSduRxId {FRARTP_SDU_RX_ID}		
Description	This is a unique identifier for a received message. This Id is used in the CancelReceive API call. ImplementationType: PduIdType		
Multiplicity	1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	0 .. 65536		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**FRARTP039_Conf :**		
Name	FrArTpRxSduRef {FRARTP_RX_SDU_REF}		
Description	Reference to a PDU in the global PDU structure.		
Multiplicity	1		
Type	Reference to [Pdu]		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency			

No Included Containers

10.2.10 FrArTpMultipleConfig

SWS Item	**FRARTP028_Conf :**
Container Name	FrArTpMultipleConfig{FRARTP_MULTIPLE_CONFIG} [Multi Config Container]

Description	This container holds one or several multiple configuration sets.
Configuration Parameters	

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
FrArTpChannel	1..*	This container contains the configuration (parameters) of one FlexRay TP channel.

10.3 Published Information

[FRARTP178]「The standardized common published parameters as required by BSW00402 in the General Requirements on Basic Software Modules [3] shall be published within the header file of this module and need to be provided in the BSW Module Description. The according module abbreviation can be found in the List of Basic Software Modules [1].」(BSW003, BSW00318, BSW00345, BSW00374, BSW00379, BSW00402, BSW159)

Additional module-specific published parameters are listed below if applicable.

10.4 Important Issues on Configuration

10.4.1 Start and Stop of the Timing Parameters of Chapter 10.2.3

[FRARTP169]「The table below gives an overview when the time of each of these parameters start to run and when it is stopped. Note that if SF-x is mentioned it is meant in the case acknowledgement is configured (the same for AF).」()

[FRARTP170]「For 1:n connections only the parameters `FRARTP_TIMEOUT_AS`, `FRARTP_TIME_CS` (only CF) and `FRARTP_TIMEOUT_CR` (only CF) hold, since no flow control or acknowledgement is allowed in that case.」()

Timing Parameter	***Start***	***Stop***
`FRARTP_TIMEOUT_AS`	*FrIf_Transmit* (first PDU of the group used by the current connection)	*FrArTp_TxConfirmation* (for the last PDU of the group used by the current connection)
`FRARTP_TIMEOUT_AR`	*FrIf_Transmit* (FC or AF)	*FrArTp_TxConfirmation*

		(FC or AF)
FRARTP_TIMEOUT_BS	*FrArTp_TxConfirmation* (SF-x, FF-x or last CF of a block), *FrArTp_RxIndication* (FC or AF, both in case of FR_FS = WAIT)	*FrArTp_RxIndication* (FC or AF)
FRARTP_TIME_BR	*FrArTp_RxIndication* (FF-x, last CF of a block or SF-x), *FrArTp_TxConfirmation (FC or AF, both in case of FR_FS = WAIT)*	*FrIf_Transmit* (FC or AF)
FRARTP_TIMEOUT_CR	*FrArTp_RxIndication* (CF), *FrArTp_TxConfirmation* (FC or AF)	*FrArTp_RxIndication* (CF or SF-x, FF-x (the latter two in case of retry))
FRARTP_TIME_CS	*FrArTp_TxConfirmation* (CF), *FrArTp_RxIndication* (FC or AF (not after the last one))	*FrIf_Transmit* (CF)

Table 4: Start and Stop of the different timeouts and times

10.4.2 How to get an ISO 15765-2 compliant Channel / Connection

[FRARTP171] ⌈To achieve ISO 15765-2 compliance within a channel/connection, there are restrictions for some parameters. Those marked with a "*" are only relevant, if the features are compiled in (see chapter 10.2.2).⌋()

These and those are explained in the table below:

Parameter	*Allowed values*
FRARTP_ACKTYPE (*)	'FRARTP_NO'
FRARTP_GRPSEG (*)	false
FRARTP_TC (*)	false
FRARTP_LM (*)	'FRARTP_ISO', 'FRARTP_ISO6'
FRARTP_PDU_LENGTH	9 [FRARTP_ADRTYPE == FRARTP_OB, FRARTP_LM == FRARTP_ISO6], 10 [FRARTP_ADRTYPE == FRARTP_OB, FRARTP_LM == FRARTP_ISO], 11 [FRARTP_ADRTYPE == FRARTP_TB, FRARTP_LM == FRARTP_ISO6], 12 [FRARTP_ADRTYPE == FRARTP_TB, FRARTP_LM == FRARTP_ISO]

Table 5: Parameter Setting for ISO 15765-2 compliance

All not mentioned parameters can have arbitrary values.

10.4.3 Dependencies among the Parameters

[FRARTP172] ⌈There are several dependencies among the connection specific and channel specific configuration parameters:⌋()

- If FRARTP_MULT_REC sets the connection to be a 1:1 connection, then the value of FRARTP_GRPSEG does not play a role for this connection since it is only relevant for 1:n connections.
- If FRARTP_MULT_REC sets the connection to be a 1:n connection, then the values of FRARTP_ACKTYPE, FRARTP_MAXBS and FRARTP_MAX_RN do not play a role for this connection since they are only relevant for 1:1 connections.
- If FRARTP_MULT_REC sets the connection to be a 1:n connection or FRARTP_ACK does not activate retry (FRARTP_NO, FRARTP_ACK_WITHOUT_RT) then the value of FRARTP_MAXBS does not play a role for this connections since it is only relevant in 1:1 connections within channels with retry being activated.

10.4.4 Timing Constraints

The following Constraints shall hold for the Timing parameters:

1. V_E + FRARTP_TIME_BR + (FRARTP_TIMEOUT_AR * FRARTP_MAX_AR) + V_S < FRARTP_TIMEOUT_BS
2. V_S + FRARTP_TIME_CS + (FRARTP_TIMEOUT_AS * FRARTP_MAX_AS)+ V_E < FRARTP_TIMEOUT_CR

Where V_E is the time from starting the BS timer until recognition of the frame in the receiver TP and V_S is the time from starting the CR timer until recognition of the frame in the sender TP.

If retry is enabled, the following constraint should hold, too:

FRARTP_TIMEOUT_BS + (FRARTP_TIMEOUT_AS * FRARTP_MAX_AS) + V_E < FRARTP_TIMEOUT_CR

10.4.5 Configuration Requirements on the FlexRay AUTOSAR Transport Layer

[FRARTP173] 「Both the parameter FRARTP_MAX_BUFREQ and FRARTP_MAX_RN have to have the same value in the sender and the receiver peer. This is necessary because they manifest in bus communication. So it can be avoided waiting for another FC(WT) or retry at the receiver side or doing additional ones at the sender side.」()

[FRARTP180] 「It has to be assured, that FRARTP_STMIN < FRARTP_TIMEOUT_CR since there will always be a timeout of the latter one otherwise.」(BSW159)

[FRARTP181] ⌈The configuration of a connection and a channel shall be, of course, the same at the sender and the receiver side. Only the values of FRARTP_LA and FRARTP_RA are swapped.⌋(BSW159)

10.4.6 Configuration Requirements on the FlexRay Interface

[FRARTP174] ⌈If more than one Fr N-PDU is used for one Fr N-SDU within a connection, the FrIf shall guarantee, that the Fr N-PDUs (Fr L-SDUs) are scheduled (sent over the bus) in the same order the FlexRay AUTOSAR Transport Layer uses them, i.e. in ascending order regarding the Fr-N-PDU IDs used in the FlexRay AUTOSAR Transport Layer. Furthermore, these PDUs shall be scheduled with the same frequency and within one Job (concerning the Joblist) in the FlexRay Interface (since the reading of the PDU-Available Information for all PDUs of a connection has to be atomic.)
This is necessary to avoid CFs coming out of order in a segmented transfer.⌋()

[FRARTP175] ⌈For every FrArTp L-SDU the PDU-Update/Valid Information of the FrIf shall be activated.
This is necessary to avoid Rx-Indication at the FrArTp for in the current transfer not used Fr N-PDUs or if e. g. in every 2nd FlexRay bus cycle an Fr N-PDU is scheduled.⌋()

[FRARTP176] ⌈For every FrArTp L-SDU no FrIf Trigger Transmit counter shall be utilized, i. e. the limit of the respective counter shall be 1. This is necessary in order to avoid multiple calls of *FrArTp_TriggerTransmit* for the same Fr N-PDU in case e. g. a retry is necessary due to an timeout of the AS / AR timer.⌋()

[FRARTP182] ⌈For the group of FrArTp L-SDUs used by a specific connection of the FrArTp, a Tx Confirmation shall be configured in order to stop the AS / AR timer at the right point in time. This shall be done by configuring the Tx Confirmation to be given each time after sending of the last FrArTp L-SDU (regarding to the order of using the FrArTp_L-SDUs in the FrArTp) of the group.
Since a connection can only use PDUs of the same length, for each group of PDUs used by a channel (where a group is identified by the length of its PDUs) exactly 1 PDU of each group shall have a TxConfirmation configured. This has to be the PDU with the highest ID within the respective group (because the FrArTp uses the PDUs in ascending order).⌋()

Example:
If a connection uses FrArTp N-PDUs 1, 2, 3 and the message length requires 8 FrArTp N-PDUs to be sent, then 1, 2 and 3 are sent, a TxConfirmation is given, again 1, 2, 3 is sent, again a TxConfirmation is given, 2 and 3 are sent and a TxConfirmation is given.

11 Not applicable requirements

[FRARTP999]「These requirements are not applicable to this specification.」
(BSW00161, BSW00162, BSW00172, BSW00301, BSW00302, BSW00307, BSW00321, BSW00325, BSW00326, BSW00334, BSW00335, BSW00339, BSW00341, BSW00342, BSW00344, BSW00347, BSW00348, BSW00375, BSW00395, BSW00400, BSW00405, BSW00409, BSW00412, BSW00415, BSW00416, BSW00417, BSW00419, BSW00422, BSW00425, BSW00426, BSW00427, BSW00428, BSW00429, BSW00431, BSW00433, BSW00434, BSW005, BSW010, BSW164, BSW168, and BSW170)