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|-----------------------------------|---|
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| Document Change History |         |                                  |  |
|-------------------------|---------|----------------------------------|--|
| Date                    | Release | Changed by                       | Change Description   |
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| 2013-10-31              | 4.1.2   | AUTOSAR<br>Release<br>Management | <ul style="list-style-type: none"><li>• Timing requirement removed from module's main function</li><li>• "const" qualifier added to prototype of function Fee_Write</li><li>• New configuration parameter FeeMainFunctionPeriod</li><li>• Editorial changes</li><li>• Removed chapter(s) on change documentation</li></ul> |
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| Document Change History |         |                        |   |
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| Date                    | Release | Changed by             | Change Description  |
| 2010-09-30              | 3.1.5   | AUTOSAR Administration | <ul style="list-style-type: none"> <li>Inter-module checks clarified (<a href="#">SWS Fee 00013</a>)</li> <li>Sequence diagram for Fee_Cancel replaced for generated one</li> <li>Naming in <a href="#">ECUC Fee 00150</a> corrected to NVM_DATASET_SELECTION_BIT S</li> <li>Sequence diagram for Fee_Init extended</li> <li>Handling of internal management operations refined (<a href="#">SWS Fee 00022</a>, <a href="#">SWS Fee 00025</a>, <a href="#">SWS Fee 00173</a>, <a href="#">SWS Fee 00174</a>, <a href="#">SWS Fee 00183</a>)</li> <li>Inter module checks detailed (<a href="#">SWS Fee 00013</a>)</li> <li>NvM_Cbk.h added to file include structure (<a href="#">SWS Fee 00002</a>)</li> <li>Ranges for FeeBlockNumber (ECUC_Fee_00150) and FeeBlockSize (ECUC_Fee_00148) adjusted</li> <li>Initialization might not be finished within Fee_Init, state machine adapted accordingly (<a href="#">SWS Fee 00120</a>, <a href="#">SWS Fee 00168</a>, <a href="#">SWS Fee 00169</a>)</li> <li>Handling of internal management operations refined (<a href="#">SWS Fee 00170</a> .. <a href="#">SWS Fee 00182</a> e.a.)</li> </ul> |
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| 2008-08-13              | 3.1.1   | AUTOSAR Administration | <ul style="list-style-type: none"> <li>Legal disclaimer revised</li> </ul>  |

| Document Change History |         |                        |   |
|-------------------------|---------|------------------------|---|
| Date                    | Release | Changed by             | Change Description  |
| 2007-12-21              | 3.0.1   | AUTOSAR Administration | <ul style="list-style-type: none"><li>• Small reformulations resulting from table generation</li><li>• Tables in chapters 8 and 10 generated from UML model</li><li>• Document meta information extended</li><li>• Small layout adaptations made</li></ul>  |
| 2007-01-24              | 2.1.15  | AUTOSAR Administration | <ul style="list-style-type: none"><li>• File include structure updated</li><li>• API of initialization function adapted</li><li>• Range of FEE block numbers adapted</li><li>• Various API descriptions enhanced</li><li>• Legal disclaimer revised</li><li>• Release Notes added</li><li>• “Advice for users” revised</li><li>• “Revision Information” added</li></ul> |
| 2006-05-16              | 2.0     | AUTOSAR Administration | <ul style="list-style-type: none"><li>• Initial release</li></ul>   |

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## Table of Contents

|        |  |    |
|--------|--|----|
| 1      | Introduction and functional overview .....   | 8  |
| 2      | Acronyms and abbreviations.....              | 9  |
| 3      | Related documentation .....                  | 10 |
| 3.1    | Input documents .....                        | 10 |
| 3.2    | Related standards and norms .....            | 10 |
| 3.3    | Related specification.....                   | 11 |
| 4      | Constraints and assumptions.....             | 12 |
| 4.1    | Limitations .....                            | 12 |
| 4.2    | Applicability to car domains .....           | 12 |
| 5      | Dependencies to other modules .....          | 13 |
| 6      | Requirements traceability .....              | 14 |
| 7      | Functional specification.....                | 24 |
| 7.1    | General behavior .....                       | 24 |
| 7.1.1  | Addressing scheme and segmentation .....     | 24 |
| 7.1.2  | Address calculation .....                    | 25 |
| 7.1.3  | Limitation of erase cycles .....             | 27 |
| 7.1.4  | Handling of “immediate” data .....           | 28 |
| 7.1.5  | Managing block correctness information ..... | 28 |
| 7.2    | Error classification .....                   | 29 |
| 7.2.1  | Development Errors.....                      | 29 |
| 7.2.2  | Runtime Errors .....                         | 29 |
| 7.2.3  | Transient Faults.....                        | 30 |
| 7.2.4  | Production Errors.....                       | 30 |
| 7.2.5  | Extended Production Errors .....             | 30 |
| 8      | API specification.....                       | 31 |
| 8.1    | Imported Types .....                         | 31 |
| 8.2    | Type definitions.....                        | 31 |
| 8.3    | Function definitions.....                    | 32 |
| 8.3.1  | Fee_Init.....                                | 32 |
| 8.3.2  | Fee_SetMode .....                            | 32 |
| 8.3.3  | Fee_Read.....                                | 33 |
| 8.3.4  | Fee_Write .....                              | 36 |
| 8.3.5  | Fee_Cancel .....                             | 38 |
| 8.3.6  | Fee_GetStatus .....                          | 39 |
| 8.3.7  | Fee_GetJobResult.....                        | 40 |
| 8.3.8  | Fee_InvalidateBlock .....                    | 42 |
| 8.3.9  | Fee_GetVersionInfo .....                     | 43 |
| 8.3.10 | Fee_EraseImmediateBlock .....                | 44 |
| 8.4    | Call-back notifications.....                 | 46 |
| 8.4.1  | Fee_JobEndNotification .....                 | 46 |
| 8.4.2  | Fee_JobErrorNotification.....                | 47 |

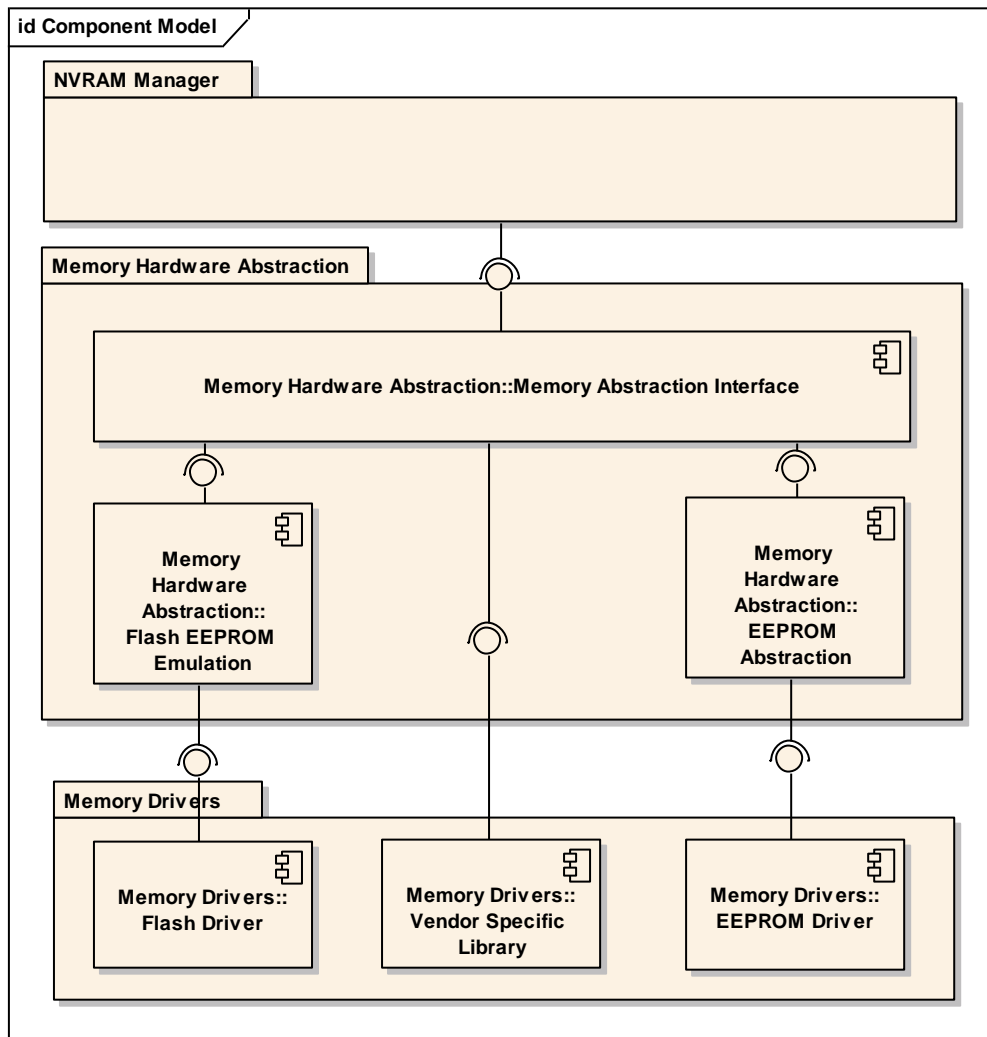
|        |   |    |
|--------|---|----|
| 8.5    | Scheduled functions .....                     | 48 |
| 8.5.1  | Fee_MainFunction .....                        | 48 |
| 8.6    | Expected Interfaces .....                     | 49 |
| 8.6.1  | Mandatory Interfaces .....                    | 49 |
| 8.6.2  | Optional Interfaces .....                     | 50 |
| 8.6.3  | Configurable interfaces .....                 | 50 |
| 9      | Sequence diagrams .....                       | 53 |
| 9.1    | Fee_Init .....                                | 53 |
| 9.2    | Fee_Write .....                               | 54 |
| 9.3    | Fee_Cancel .....                              | 55 |
| 10     | Configuration specification .....             | 57 |
| 10.1   | Containers and configuration parameters ..... | 57 |
| 10.1.1 | Fee .....                                     | 57 |
| 10.1.2 | FeeGeneral .....                              | 58 |
| 10.1.3 | FeeBlockConfiguration .....                   | 61 |
| 10.2   | Published Information .....                   | 64 |
| 10.2.1 | FeePublishedInformation .....                 | 64 |
| 11     | Not applicable requirements .....             | 65 |

## List of Figures

|           |   |    |
|-----------|---|----|
| Figure 1: | Module overview of memory hardware abstraction layer .....          | 8  |
| Figure 2: | Virtual vs. physical memory layout .....                            | 25 |
| Figure 3: | Block number and dataset index .....                                | 27 |
| Figure 4: | Sequence diagram of Fee_Init .....                                  | 53 |
| Figure 5: | Sequence diagram of Fee_Write .....                                 | 54 |
| Figure 6: | Sequence diagram of Fee_Cancel .....                                | 56 |
| Figure 7: | Overview of configuration parameters of Fee .....                   | 58 |
| Figure 8: | Overview of configuration parameters of FeeBlockConfiguration ..... | 63 |

## 1 Introduction and functional overview

This specification describes the functionality, API and configuration of the Flash EEPROM Emulation Module (see Figure 1).



**Figure 1: Module overview of memory hardware abstraction layer**

The Flash EEPROM Emulation (FEE) shall abstract from the device specific addressing scheme and segmentation and provide the upper layers with a virtual addressing scheme and segmentation as well as a “virtually” unlimited number of erase cycles.



## 2 Acronyms and abbreviations

Acronyms and abbreviations which have a local scope and therefore are not contained in the AUTOSAR glossary must appear in a local glossary.

| <b>Abbreviation / Acronym:</b> | <b>Description:</b>  |
|--------------------------------|--|
| EA                             | EEPROM Abstraction   |
| EEPROM                         | Electrically Erasable and Programmable ROM (Read Only Memory)  |
| FEE                            | Flash EEPROM Emulation   |
| LSB                            | Least significant bit / byte (depending on context). Here, "bit" is meant.   |
| MemIf                          | Memory Abstraction Interface   |
| MSB                            | Most significant bit / byte (depending on context). Here, "bit" is meant.  |
| NvM                            | NVRAM Manager  |
| NVRAM                          | Non-volatile RAM (Random Access Memory)  |
| NVRAM block                    | Management unit as seen by the NVRAM Manager   |
| (Logical) block                | Smallest writable / erasable unit as seen by the modules user. Consists of one or more virtual pages.  |
| Virtual page                   | May consist of one or several physical pages to ease handling of logical blocks and address calculation.   |
| Internal residue               | Unused space at the end of the last virtual page if the configured block size isn't an integer multiple of the virtual page size (see Figure 3)).  |
| Virtual address                | Consisting of 16 bit block number and 16 bit offset inside the logical block.  |
| Physical address               | Address information in device specific format (depending on the underlying EEPROM driver and device) that is used to access a logical block.   |
| Dataset                        | Concept of the NVRAM manager: A user addressable array of blocks of the same size.<br>E.g. could be used to provide different configuration settings for the CAN driver (CAN IDs, filter settings, ...) to an ECU which has otherwise identical application software (e.g. door module). |
| Redundant copy                 | Concept of the NVRAM manager: Storing the same information twice to enhance reliability of data storage.   |

### **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 on Basic Software Modules  
AUTOSAR\_SRS\_BSWGeneral.pdf
- [4] General Requirements on SPAL  
AUTOSAR\_SRS\_SPALGeneral.pdf
- [5] Requirements on Memory Hardware Abstraction Layer  
AUTOSAR\_SRS\_MemoryHWAbstractionLayer.doc
- [6] Specification of Default Error Tracer  
AUTOSAR\_SWS\_DefaultErrorTracer.pdf
- [7] Specification of ECU Configuration  
AUTOSAR\_TPS\_ECUConfiguration.pdf
- [8] Basic Software Module Description Template  
AUTOSAR\_TPS\_BSWModuleDescriptionTemplate.pdf
- [9] General Specification of Basic Software Modules  
AUTOSAR\_SWS\_BSWGeneral.pdf

#### **3.2 Related standards and norms**

- [10] AUTOSAR Specification of NVRAM Manager  
AUTOSAR\_SWS\_NVRAMManager.doc
- [11] Specification of Memory Abstraction Interface  
AUTOSAR\_SWS\_MemoryAbstractionInterface.pdf
- [12] Specification of EEPROM Abstraction  
AUTOSAR\_SWS\_EEPROMAbstraction.pdf

### 3.3 Related specification

AUTOSAR provides a General Specification on Basic Software modules [9] (SWS BSW General), which is also valid for Flash EEPROM Emulation.

Thus, the specification SWS BSW General shall be considered as additional and required specification for Flash EEPROM Emulation.

## **4 Constraints and assumptions**

### **4.1 Limitations**

The synchronization of a potential parallel access (e.g. BulkNvDataManager) to the underlying flash driver is not part of this AUTOSAR release.

### **4.2 Applicability to car domains**

No restrictions.

## 5 Dependencies to other modules

This module depends on the capabilities of the underlying flash driver as well as the configuration of the NVRAM manager.

## 6 Requirements traceability

| Requirement   | Description   | Satisfied by   |
|---------------|---|--|
| RS_BRF_01048  | AUTOSAR module design shall support modules to cooperate in a multitasking environment  | SWS_Fee_00026, SWS_Fee_00035, SWS_Fee_00057, SWS_Fee_00073, SWS_Fee_00074, SWS_Fee_00075, SWS_Fee_00091, SWS_Fee_00097, SWS_Fee_00128, SWS_Fee_00129, SWS_Fee_00133, SWS_Fee_00144, SWS_Fee_00145, SWS_Fee_00146, SWS_Fee_00155, SWS_Fee_00156, SWS_Fee_00158, SWS_Fee_00162, SWS_Fee_00163, SWS_Fee_00164, SWS_Fee_00172, SWS_Fee_00174 |
| RS_BRF_01064  | AUTOSAR BSW shall provide callback functions in order to access upper layer modules   | SWS_Fee_00052, SWS_Fee_00054, SWS_Fee_00055, SWS_Fee_00056, SWS_Fee_00095, SWS_Fee_00096, SWS_Fee_00098, SWS_Fee_00099, SWS_Fee_00142, SWS_Fee_00143   |
| RS_BRF_01076  | AUTOSAR basic software shall perform module local error recovery to the extent possible                                       | SWS_Fee_00187  |
| RS_BRF_01448  | AUTOSAR services shall support mode and state management  | SWS_Fee_00086  |
| RS_BRF_01480  | AUTOSAR shall support software component local modes, ECU global modes, and system wide modes                                 | SWS_Fee_00190  |
| RS_BRF_01812  | AUTOSAR non-volatile memory functionality shall support the prioritization and asynchronous execution of jobs                 | SWS_Fee_00191, SWS_Fee_00193   |
| SRS_BSW_00005 | Modules of the $\mu$ C Abstraction Layer (MCAL) may not have hard coded horizontal interfaces                                 | SWS_Fee_00999  |
| SRS_BSW_00006 | The source code of software modules above the $\mu$ C Abstraction Layer (MCAL) shall not be processor and compiler dependent. | SWS_Fee_00999  |
| SRS_BSW_00007 | All Basic SW Modules written in C language shall conform to the MISRA C 2012 Standard.  | SWS_Fee_00999  |
| SRS_BSW_00009 | All Basic SW Modules shall be documented according  | SWS_Fee_00999  |

|               |  |   |
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|               | to a common standard.  |   |
| SRS_BSW_00010 | The memory consumption of all Basic SW Modules shall be documented for a defined configuration for all supported platforms.                    | SWS_Fee_00999                               |
| SRS_BSW_00101 | The Basic Software Module shall be able to initialize variables and hardware in a separate initialization function                             | SWS_Fee_00085, SWS_Fee_00168, SWS_Fee_00169 |
| SRS_BSW_00160 | Configuration files of AUTOSAR Basic SW module shall be readable for human beings  | SWS_Fee_00999                               |
| SRS_BSW_00161 | The AUTOSAR Basic Software shall provide a microcontroller abstraction layer which provides a standardized interface to higher software layers | SWS_Fee_00999                               |
| SRS_BSW_00164 | The Implementation of interrupt service routines shall be done by the Operating System, complex drivers or modules                             | SWS_Fee_00999                               |
| SRS_BSW_00168 | SW components shall be tested by a function defined in a common API in the Basis-SW  | SWS_Fee_00999                               |
| SRS_BSW_00170 | The AUTOSAR SW Components shall provide information about their dependency from faults, signal qualities, driver demands                       | SWS_Fee_00999                               |
| SRS_BSW_00171 | Optional functionality of a Basic-SW component that is not required in the ECU shall be configurable at pre-compile-time                       | SWS_Fee_00999                               |
| SRS_BSW_00172 | The scheduling strategy that is built inside the Basic Software Modules shall be compatible with the strategy used in the system               | SWS_Fee_00999                               |
| SRS_BSW_00300 | All AUTOSAR Basic Software Modules shall be identified by an unambiguous name  | SWS_Fee_00999                               |
| SRS_BSW_00302 | All AUTOSAR Basic Software Modules shall only export information needed by other modules   | SWS_Fee_00999                               |

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| SRS_BSW_00304 | All AUTOSAR Basic Software Modules shall use the following data types instead of native C data types                                | SWS_Fee_00999   |
| SRS_BSW_00306 | AUTOSAR Basic Software Modules shall be compiler and platform independent   | SWS_Fee_00999   |
| SRS_BSW_00307 | Global variables naming convention  | SWS_Fee_00999   |
| SRS_BSW_00308 | AUTOSAR Basic Software Modules shall not define global data in their header files, but in the C file                                | SWS_Fee_00999   |
| SRS_BSW_00309 | All AUTOSAR Basic Software Modules shall indicate all global data with read-only purposes by explicitly assigning the const keyword | SWS_Fee_00999   |
| SRS_BSW_00312 | Shared code shall be reentrant  | SWS_Fee_00999   |
| SRS_BSW_00314 | All internal driver modules shall separate the interrupt frame definition from the service routine                                  | SWS_Fee_00999   |
| SRS_BSW_00321 | The version numbers of AUTOSAR Basic Software Modules shall be enumerated according specific rules                                  | SWS_Fee_00999   |
| SRS_BSW_00323 | All AUTOSAR Basic Software Modules shall check passed API parameters for validity   | SWS_Fee_00068, SWS_Fee_00134, SWS_Fee_00135, SWS_Fee_00136, SWS_Fee_00137, SWS_Fee_00138, SWS_Fee_00139, SWS_Fee_00140, SWS_Fee_00141, SWS_Fee_00147, SWS_Fee_00999 |
| SRS_BSW_00327 | Error values naming convention  | SWS_Fee_00010   |
| SRS_BSW_00328 | All AUTOSAR Basic Software Modules shall avoid the duplication of code  | SWS_Fee_00999   |
| SRS_BSW_00330 | It shall be allowed to use macros instead of functions where source code is used and runtime is critical                            | SWS_Fee_00999   |
| SRS_BSW_00331 | All Basic Software Modules shall strictly separate error and status information   | SWS_Fee_00010   |
| SRS_BSW_00333 | For each callback function it shall be specified if it is called from interrupt   | SWS_Fee_00999   |



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|               | context or not  |               |
| SRS_BSW_00334 | All Basic Software Modules shall provide an XML file that contains the meta data  | SWS_Fee_00999 |
| SRS_BSW_00336 | Basic SW module shall be able to shutdown   | SWS_Fee_00999 |
| SRS_BSW_00337 | Classification of development errors  | SWS_Fee_00010 |
| SRS_BSW_00339 | Reporting of production relevant error status   | SWS_Fee_00999 |
| SRS_BSW_00341 | Module documentation shall contains all needed informations   | SWS_Fee_00999 |
| SRS_BSW_00342 | It shall be possible to create an AUTOSAR ECU out of modules provided as source code and modules provided as object code, even mixed              | SWS_Fee_00999 |
| SRS_BSW_00344 | BSW Modules shall support link-time configuration   | SWS_Fee_00999 |
| SRS_BSW_00347 | A Naming separation of different instances of BSW drivers shall be in place   | SWS_Fee_00999 |
| SRS_BSW_00348 | All AUTOSAR standard types and constants shall be placed and organized in a standard type header file   | SWS_Fee_00999 |
| SRS_BSW_00353 | All integer type definitions of target and compiler specific scope shall be placed and organized in a single type header                          | SWS_Fee_00999 |
| SRS_BSW_00359 | All AUTOSAR Basic Software Modules callback functions shall avoid return types other than void if possible  | SWS_Fee_00999 |
| SRS_BSW_00360 | AUTOSAR Basic Software Modules callback functions are allowed to have parameters  | SWS_Fee_00999 |
| SRS_BSW_00361 | All mappings of not standardized keywords of compiler specific scope shall be placed and organized in a compiler specific type and keyword header | SWS_Fee_00999 |
| SRS_BSW_00371 | The passing of function pointers as API parameter   | SWS_Fee_00999 |

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|               | is forbidden for all AUTOSAR Basic Software Modules  |  |
| SRS_BSW_00375 | Basic Software Modules shall report wake-up reasons  | SWS_Fee_00999  |
| SRS_BSW_00378 | AUTOSAR shall provide a boolean type   | SWS_Fee_00999  |
| SRS_BSW_00380 | Configuration parameters being stored in memory shall be placed into separate c-files  | SWS_Fee_00999  |
| SRS_BSW_00384 | The Basic Software Module specifications shall specify at least in the description which other modules they require                            | SWS_Fee_00104, SWS_Fee_00105   |
| SRS_BSW_00386 | The BSW shall specify the configuration for detecting an error   | SWS_Fee_00010  |
| SRS_BSW_00392 | Parameters shall have a type   | SWS_Fee_00016, SWS_Fee_00084   |
| SRS_BSW_00398 | The link-time configuration is achieved on object code basis in the stage after compiling and before linking                                   | SWS_Fee_00999  |
| SRS_BSW_00399 | Parameter-sets shall be located in a separate segment and shall be loaded after the code   | SWS_Fee_00999  |
| SRS_BSW_00400 | Parameter shall be selected from multiple sets of parameters after code has been loaded and started  | SWS_Fee_00999  |
| SRS_BSW_00401 | Documentation of multiple instances of configuration parameters shall be available   | SWS_Fee_00999  |
| SRS_BSW_00404 | BSW Modules shall support post-build configuration   | SWS_Fee_00999  |
| SRS_BSW_00405 | BSW Modules shall support multiple configuration sets  | SWS_Fee_00999  |
| SRS_BSW_00406 | A static status variable denoting if a BSW module is initialized shall be initialized with value 0 before any APIs of the BSW module is called | SWS_Fee_00010, SWS_Fee_00034, SWS_Fee_00090, SWS_Fee_00121, SWS_Fee_00122, SWS_Fee_00123, SWS_Fee_00124, SWS_Fee_00125, SWS_Fee_00126, SWS_Fee_00127 |

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| SRS_BSW_00407 | Each BSW module shall provide a function to read out the version information of a dedicated module implementation      | SWS_Fee_00093 |
| SRS_BSW_00412 | -  | SWS_Fee_00999 |
| SRS_BSW_00414 | Init functions shall have a pointer to a configuration structure as single parameter                                   | SWS_Fee_00188 |
| SRS_BSW_00415 | Interfaces which are provided exclusively for one module shall be separated into a dedicated header file               | SWS_Fee_00999 |
| SRS_BSW_00416 | The sequence of modules to be initialized shall be configurable  | SWS_Fee_00999 |
| SRS_BSW_00417 | Software which is not part of the SW-C shall report error events only after the DEM is fully operational.              | SWS_Fee_00999 |
| SRS_BSW_00422 | Pre-de-bouncing of error status information is done within the DEM   | SWS_Fee_00999 |
| SRS_BSW_00423 | BSW modules with AUTOSAR interfaces shall be describable with the means of the SW-C Template                           | SWS_Fee_00999 |
| SRS_BSW_00424 | BSW module main processing functions shall not be allowed to enter a wait state  | SWS_Fee_00999 |
| SRS_BSW_00425 | The BSW module description template shall provide means to model the defined trigger conditions of schedulable objects | SWS_Fee_00999 |
| SRS_BSW_00426 | BSW Modules shall ensure data consistency of data which is shared between BSW modules                                  | SWS_Fee_00999 |
| SRS_BSW_00427 | ISR functions shall be defined and documented in the BSW module description template                                   | SWS_Fee_00999 |
| SRS_BSW_00428 | A BSW module shall state if its main processing function(s) has to be executed in a specific order or sequence         | SWS_Fee_00999 |

|                   |  |  |
|-------------------|--|--|
| SRS_BSW_00429     | Access to OS is restricted   | SWS_Fee_00999  |
| SRS_BSW_00432     | Modules should have separate main processing functions for read/receive and write/transmit data path                             | SWS_Fee_00999  |
| SRS_BSW_00433     | Main processing functions are only allowed to be called from task bodies provided by the BSW Scheduler                           | SWS_Fee_00999  |
| SRS_MemHwAb_14001 | The FEE and EA modules shall allow the configuration of the alignment of the start and end addresses of logical blocks           | SWS_Fee_00005, SWS_Fee_00071, SWS_Fee_00076                |
| SRS_MemHwAb_14002 | The FEE and EA modules shall allow the configuration of a required number of write cycles for each logical block                 | SWS_Fee_00102, SWS_Fee_00103                               |
| SRS_MemHwAb_14005 | The FEE and EA modules shall provide upper layers with a virtual 32bit address space   | SWS_Fee_00076  |
| SRS_MemHwAb_14006 | The start address for a block erase or write operation shall always be aligned to the virtual 64K boundary                       | SWS_Fee_00024  |
| SRS_MemHwAb_14007 | The start address and length for reading a block shall not be limited to a certain alignment                                     | SWS_Fee_00021  |
| SRS_MemHwAb_14009 | The FEE and EA modules shall provide a conversion between the logical linear addresses and the physical memory addresses         | SWS_Fee_00007, SWS_Fee_00036, SWS_Fee_00066, SWS_Fee_00100 |
| SRS_MemHwAb_14010 | The FEE and EA modules shall provide a write service that operates only on complete configured logical blocks                    | SWS_Fee_00025, SWS_Fee_00026, SWS_Fee_00088                |
| SRS_MemHwAb_14012 | Spreading of write access  | SWS_Fee_00102, SWS_Fee_00103                               |
| SRS_MemHwAb_14013 | Writing of immediate data shall not be delayed by internal management operations nor by erasing the memory area to be written to | SWS_Fee_00009, SWS_Fee_00067                               |
| SRS_MemHwAb_14014 | The FEE and EA modules   | SWS_Fee_00023, SWS_Fee_00049,                              |

|                   |   |  |
|-------------------|---|--|
|                   | shall detect possible data inconsistencies due to aborted / interrupted write operations                                      | SWS_Fee_00153, SWS_Fee_00154, SWS_Fee_00159  |
| SRS_MemHwAb_14015 | The FEE and EA modules shall report possible data inconsistencies   | SWS_Fee_00023  |
| SRS_MemHwAb_14016 | The FEE and EA modules shall not return inconsistent data to the caller   | SWS_Fee_00023  |
| SRS_MemHwAb_14017 | The EA module shall extend the functional scope of an EEPROM driver   | SWS_Fee_00999  |
| SRS_MemHwAb_14018 | The FEE module shall extend the functional scope of an internal flash driver  | SWS_Fee_00170  |
| SRS_MemHwAb_14026 | The block numbers 0x0000 and 0xFFFF shall not be used   | SWS_Fee_00006  |
| SRS_MemHwAb_14028 | The FEE and EA modules shall provide a service to invalidate a logical block  | SWS_Fee_00037, SWS_Fee_00075, SWS_Fee_00092, SWS_Fee_00160, SWS_Fee_00165, SWS_Fee_00192 |
| SRS_MemHwAb_14029 | The FEE and EA modules shall provide a read service that allows reading all or part of a logical block                        | SWS_Fee_00022, SWS_Fee_00087   |
| SRS_MemHwAb_14031 | The FEE and EA modules shall provide a service that allows canceling an ongoing asynchronous operation                        | SWS_Fee_00080, SWS_Fee_00081, SWS_Fee_00089, SWS_Fee_00157, SWS_Fee_00184                |
| SRS_MemHwAb_14032 | The FEE and EA modules shall provide an erase service that operates only on complete logical blocks containing immediate data | SWS_Fee_00094, SWS_Fee_00166   |
| SRS_SPAL_00157    | All drivers and handlers of the AUTOSAR Basic Software shall implement notification mechanisms of drivers and handlers        | SWS_Fee_00999  |
| SRS_SPAL_12056    | All driver modules shall allow the static configuration of notification mechanism   | SWS_Fee_00999  |
| SRS_SPAL_12063    | All driver modules shall only support raw value mode  | SWS_Fee_00999  |
| SRS_SPAL_12064    | All driver modules shall raise an error if the change of the operation mode leads to degradation of running operations        | SWS_Fee_00999  |

|                |  |               |
|----------------|--|---------------|
| SRS_SPAL_12067 | All driver modules shall set their wake-up conditions depending on the selected operation mode                         | SWS_Fee_00999 |
| SRS_SPAL_12068 | The modules of the MCAL shall be initialized in a defined sequence   | SWS_Fee_00999 |
| SRS_SPAL_12069 | All drivers of the SPAL that wake up from a wake-up interrupt shall report the wake-up reason                          | SWS_Fee_00999 |
| SRS_SPAL_12077 | All drivers shall provide a non blocking implementation  | SWS_Fee_00999 |
| SRS_SPAL_12078 | The drivers shall be coded in a way that is most efficient in terms of memory and runtime resources                    | SWS_Fee_00999 |
| SRS_SPAL_12092 | The driver's API shall be accessed by its handler or manager   | SWS_Fee_00999 |
| SRS_SPAL_12125 | All driver modules shall only initialize the configured resources  | SWS_Fee_00999 |
| SRS_SPAL_12129 | The ISRs shall be responsible for resetting the interrupt flags and calling the according notification function        | SWS_Fee_00999 |
| SRS_SPAL_12163 | All driver modules shall implement an interface for de-initialization  | SWS_Fee_00999 |
| SRS_SPAL_12263 | The implementation of all driver modules shall allow the configuration of specific module parameter types at link time | SWS_Fee_00999 |
| SRS_SPAL_12265 | Configuration data shall be kept constant  | SWS_Fee_00999 |
| SRS_SPAL_12267 | Wakeup sources shall be initialized by MCAL drivers and/or the MCU driver  | SWS_Fee_00999 |
| SRS_SPAL_12461 | Specific rules regarding initialization of controller registers shall apply to all driver implementations              | SWS_Fee_00999 |
| SRS_SPAL_12462 | The register initialization settings shall be published  | SWS_Fee_00999 |
| SRS_SPAL_12463 | The register initialization settings shall be combined and forwarded   | SWS_Fee_00999 |



## 7 Functional specification

### 7.1 General behavior

#### 7.1.1 Addressing scheme and segmentation

The Flash EEPROM Emulation (FEE) module provides upper layers with a 32bit virtual linear address space and uniform segmentation scheme. This virtual 32bit addresses shall consist of

- a 16bit block number – allowing a (theoretical) number of 65536 logical blocks
- a 16bit block offset – allowing a (theoretical) block size of 64KByte per block

The 16bit block number represents a configurable (virtual) paging mechanism. The values for this address alignment can be derived from that of the underlying flash driver and device. This virtual paging shall be configurable via the parameter `FeeVirtualPageSize`.

**[SWS\_Fee\_00076]** ⌈ The configuration of the Fee module shall be such that the virtual page size (defined in `FeeVirtualPageSize`) is an integer multiple of the physical page size, i.e. it is not allowed to configure a smaller virtual page than the actual physical page size. ⌋(SRS\_MemHwAb\_14001, SRS\_MemHwAb\_14005)

*Note: This specification requirement allows the physical start address of a logical block to be calculated rather than making a lookup table necessary for the address mapping.*

*Example:*

*The size of a virtual page is configured to be eight bytes, thus the address alignment is eight bytes. The logical block with block number 1 is placed at physical address x. The logical block with the block number 2 then would be placed at x+8, block number 3 would be placed at x+16.*

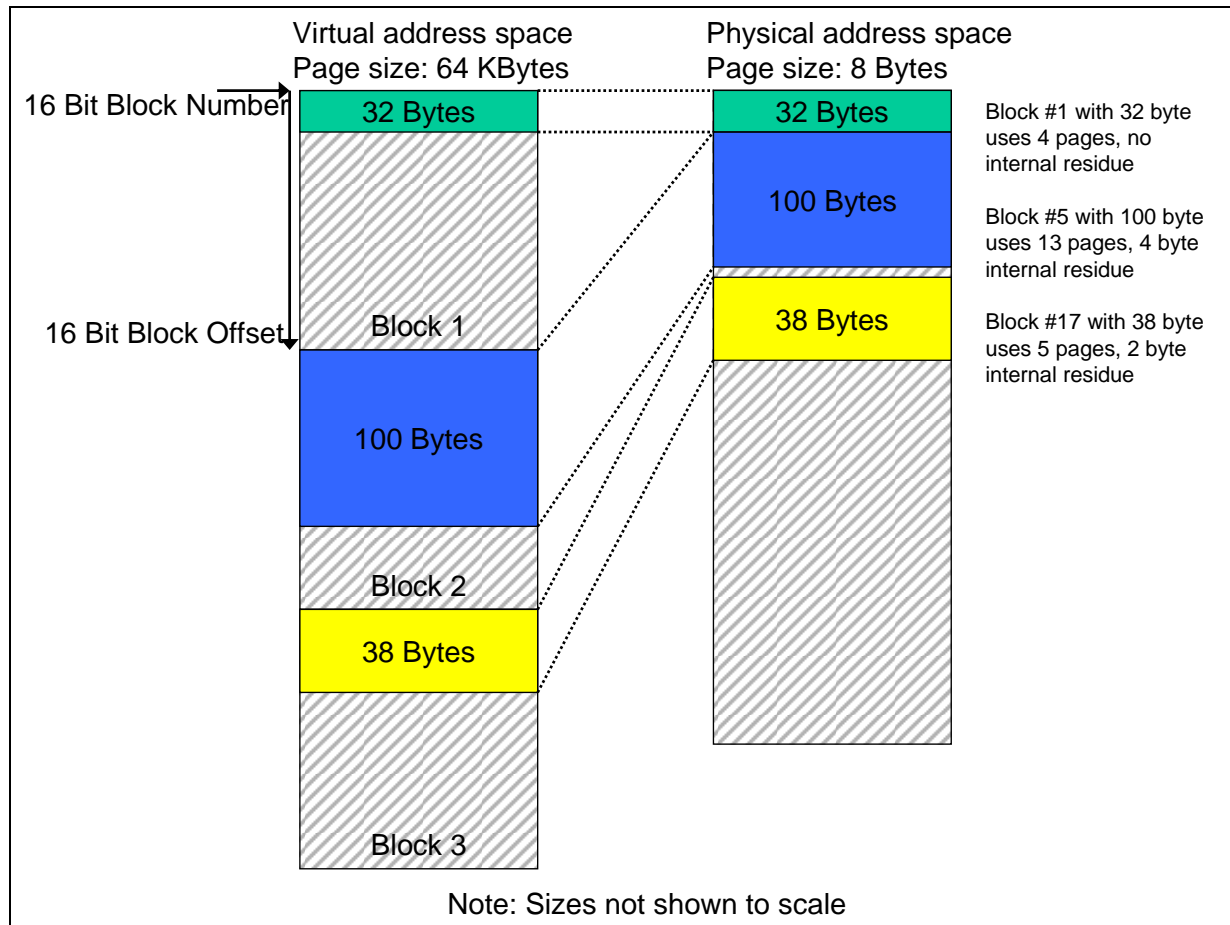
**[SWS\_Fee\_00005]** ⌈ Each configured logical block shall take up an integer multiple of the configured virtual page size (see also Chapter 10.1 configuration parameter `FeeVirtualPageSize`). ⌋(SRS\_MemHwAb\_14001)

*Example:*

*The address alignment / virtual paging is configured to be eight bytes by setting the parameter `FeeVirtualPageSize` accordingly. The logical block number 1 is configured to have a size of 32 bytes (see Figure 2). This logical block would use exactly 4 virtual pages. The next logical block thus would get the block number 5, since block numbers 2, 3 and 4 are “blocked” by the first logical block. This second block is configured to have a size of 100 bytes, taking up 13 virtual pages and*



*leaving 4 bytes of the last page unused. The next available logical block number thus would be 17.*



**Figure 2: Virtual vs. physical memory layout**

**[SWS\_Fee\_00071]** ⌈ Logical blocks must not overlap each other and must not be contained within one another. ⌋(SRS\_MemHwAb\_14001)

**[SWS\_Fee\_00006]** ⌈ The block numbers 0x0000 and 0xFFFF shall not be configurable for a logical block. ⌋(SRS\_MemHwAb\_14026)

### 7.1.2 Address calculation

**[SWS\_Fee\_00007]** ⌈ Depending on the implementation of the FEE module and the exact address format used, the functions of the FEE module shall combine the 16bit block number and 16bit address offset to derive the physical flash address needed for the underlying flash driver. ⌋(SRS\_MemHwAb\_14009)

*Note: The exact address format needed by the underlying flash driver and therefore the mechanism how to derive the physical flash address from the given 16bit block*

*number and 16bit address offset depends on the flash device and the implementation of this module and shall therefore not be standardized.*

**[SWS\_Fee\_00100]** ⌈ Only those bits of the 16bit block number, that do not denote a specific dataset or redundant copy shall be used for address calculation.  
⌋(SRS\_MemHwAb\_14009)

*Note: Since this information is needed by the NVRAM manager, the number of bits to encode this can be configured for the NVRAM manager with the parameter `NVM_DATASET_SELECTION_BITS`.*

*Example:*

*Dataset information is configured to be encoded in the four LSB's of the 16bit block number (allowing for a maximum of 16 datasets per NVRAM block and a total of 4094 NVRAM blocks). An implementer decides to store all datasets of a NVRAM block directly adjacent and using the length of the block and a pointer to access each dataset. To calculate the start address of the block (the address of the first dataset) she/he uses only the 12 MSB's, to access a specific dataset she/he adds the size of the block multiplied by the dataset index (the four LSB's) to this start address (Figure 3).*

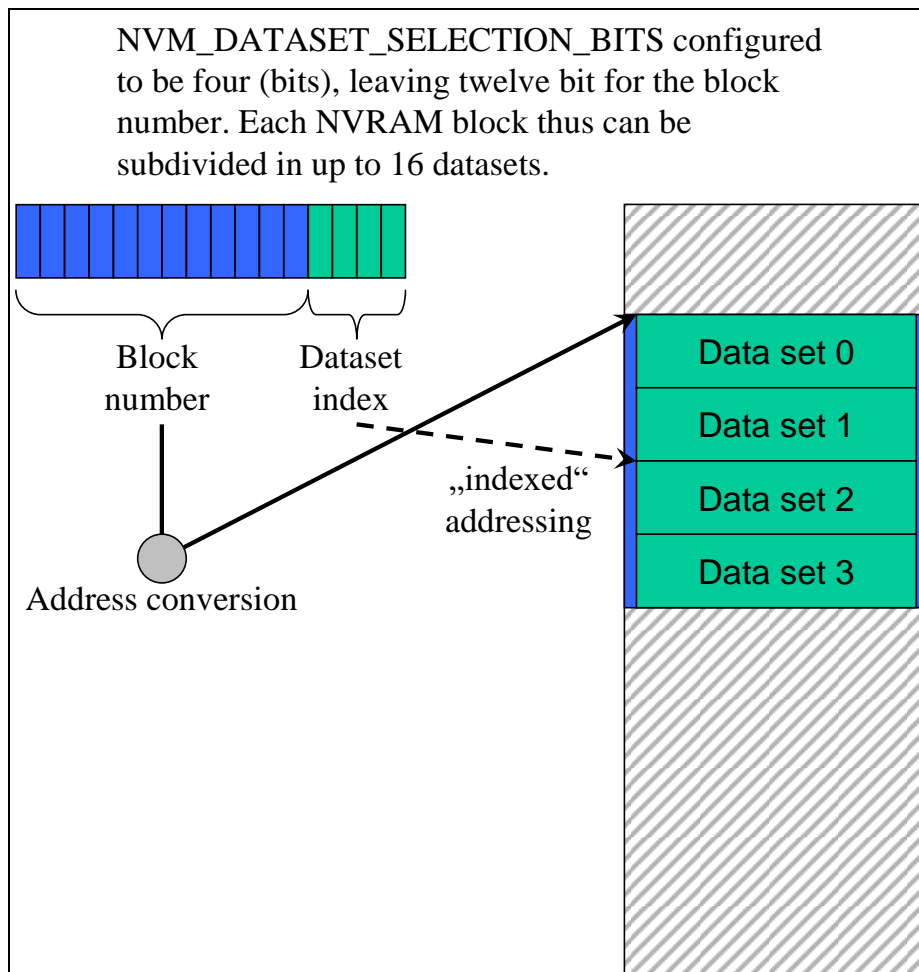


Figure 3: Block number and dataset index

### 7.1.3 Limitation of erase cycles

**[SWS\_Fee\_00102]** ⌈ The configuration of the FEE module shall define the expected number of erase/write cycles for each logical block in the configuration parameter `FeeNumberOfWriteCycles`. ⌋(SRS\_MemHwAb\_14002, SRS\_MemHwAb\_14012)

**[SWS\_Fee\_00103]** ⌈ If the underlying flash device or device driver does not provide at least the configured number of erase/write cycles per physical memory cell, the FEE module shall provide mechanisms to spread the write access such that the physical device is not overstressed. This shall also apply to all management data used internally by the FEE module. ⌋(SRS\_MemHwAb\_14002, SRS\_MemHwAb\_14012)

*Example:*

*The logical block number 1 is configured for an expected 500.000 write cycles, the underlying flash device and device driver are only specified for 100.000 erase cycles. In this case, the FEE module has to provide (at least) five separate memory areas and alternate the access between those areas internally so that each physical memory location is only erased for a maximum of the specified 100.000 cycles.*

#### 7.1.4 Handling of “immediate” data

**[SWS\_Fee\_00009]** ⌈ Blocks containing immediate data have to be written instantaneously, i.e. the FEE module has to ensure that it can write such blocks without the need to erase the corresponding memory area (e.g. by using pre-erased memory) and that the write request is not delayed by currently running module internal management operations. ⌋(SRS\_MemHwAb\_14013)

*Note: An ongoing lower priority read / erase / write or compare job shall be canceled by the NVRAM manager before immediate data is written. The FEE module has only to ensure that this write request can be performed immediately.*

*Note: A running operation on the hardware (e.g. writing one page or erasing one sector) can usually not be aborted once it has been started. The maximum time of the longest hardware operation thus has to be accepted as delay even for immediate data.*

*Example:*

*Three blocks with 10 bytes each have been configured for immediate data. The FEE module / configuration tool reserves these 30 bytes (plus the implementation specific overhead per block / page if needed) for use by this immediate data only. That is, this memory area shall not be used for storage of other data blocks.*

*Now, the NVRAM manager has requested the FEE module to write a data block of 100 bytes. While this block is being written, a situation occurs that one (or several) of the immediate data blocks need to be written. Therefore the NVRAM manager cancels the ongoing write request and subsequently issues the write request for the (first) block containing immediate data. The cancelation of the ongoing write request is performed synchronously by the FEE module and the underlying flash driver (i.e. the write request for the immediate data) can be started without any further delay. However, before the first bytes of immediate data can be written, the FEE module or rather the underlying flash driver have to wait for the end of an ongoing hardware access from the previous write request (e.g. writing of a page, erasing of a sector, transfer via SPI, ...).*

#### 7.1.5 Managing block correctness information

**[SWS\_Fee\_00049]** ⌈ The FEE module shall manage for each block the information, whether this block is correct (i.e. “not corrupted”) from the point of view of the FEE module or not. This information shall only concern the internal handling of the block, not the block’s contents. ⌋(SRS\_MemHwAb\_14014)

**[SWS\_Fee\_00153]** ⌈ When a block write operation is started, the FEE module shall mark the corresponding block as “corrupted”<sup>1</sup>. ⌋(SRS\_MemHwAb\_14014)

---

<sup>1</sup> This does not necessarily mean a write operation on the physical device, if there are other means to detect the consistency of a logical block.

**[SWS\_Fee\_00154]** ⌈ Upon the successful end of the block write operation, the block shall be marked as “not corrupted” (again). ⌋(SRS\_MemHwAb\_14014)

*Note: This internal management information should not be mixed up with the validity information of a block which can be manipulated by using the Fee\_InvalidateBlock service, i.e. the FEE shall be able to distinguish between a corrupted block and a block that has been deliberately invalidated by the upper layer.*

## 7.2 Error classification

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

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

### 7.2.1 Development Errors

**[SWS\_Fee\_00010]**⌈

| Type of error                                      | Related error code      | Error value |
|--|-------------------------|-------------|
| API service called when module was not initialized | FEE_E_UNINIT            | 0x01        |
| API service called with invalid block number       | FEE_E_INVALID_BLOCK_NO  | 0x02        |
| API service called with invalid block offset       | FEE_E_INVALID_BLOCK_OFS | 0x03        |
| API service called with invalid data pointer       | FEE_E_PARAM_POINTER     | 0x04        |
| API service called with invalid length information | FEE_E_INVALID_BLOCK_LEN | 0x05        |

⌋(SRS\_BSW\_00406, SRS\_BSW\_00337, SRS\_BSW\_00386, SRS\_BSW\_00327, SRS\_BSW\_00331)

### 7.2.2 Runtime Errors

**[SWS\_Fee\_91002]**⌈

| Type of error   | Related error code   | Error value |
|---|----------------------|-------------|
| API service called while module is busy processing a user request | FEE_E_BUSY           | 0x06        |
| Fee_Cancel called while no job was pending.                       | FEE_E_INVALID_CANCEL | 0x08        |

⌋()

### **7.2.3 Transient Faults**

There are no transient faults.

### **7.2.4 Production Errors**

There are no production errors.

### **7.2.5 Extended Production Errors**

There are no extended production errors.

## 8 API specification

### 8.1 Imported Types

[SWS\_Fee\_00084]

| Module | Header File | Imported Type       |
|--------|-------------|---------------------|
| Fls    | Fls.h       | Fls_AddressType     |
|        | Fls.h       | Fls_LengthType      |
| MemIf  | MemIf.h     | MemIf_JobResultType |
|        | MemIf.h     | MemIf_ModeType      |
|        | MemIf.h     | MemIf_StatusType    |
| Std    | Std_Types.h | Std_ReturnType      |
|        | Std_Types.h | Std_VersionInfoType |

](SRS\_BSW\_00392)

[SWS\_Fee\_00016] ⌈ The types mentioned in [SWS\\_Fee\\_00084](#) shall not be changed or extended for a specific FEE module or hardware platform. ⌋(SRS\_BSW\_00392)

### 8.2 Type definitions

[SWS\_Fee\_00188]

|                      |   |    |
|----------------------|---|----|
| <b>Name</b>          | Fee_ConfigType                                  |    |
| <b>Kind</b>          | Structure                                       |    |
| <b>Elements</b>      | implementation specific                         |    |
|                      | <b>Type</b>                                     | -- |
|                      | <b>Comment</b>                                  | -- |
| <b>Description</b>   | Configuration data structure of the Fee module. |    |
| <b>Available via</b> | Fee.h   |    |

](SRS\_BSW\_00414)

## 8.3 Function definitions

### 8.3.1 Fee\_Init

[SWS\_Fee\_00085]

|                           |  |  |
|---------------------------|--|--|
| <b>Service Name</b>       | Fee_Init   |  |
| <b>Syntax</b>             | <pre>void Fee_Init (     const Fee_ConfigType* ConfigPtr )</pre> |  |
| <b>Service ID [hex]</b>   | 0x00   |  |
| <b>Sync/Async</b>         | Asynchronous   |  |
| <b>Reentrancy</b>         | Non Reentrant  |  |
| <b>Parameters (in)</b>    | ConfigPtr  | Pointer to the selected configuration set. |
| <b>Parameters (inout)</b> | None   |  |
| <b>Parameters (out)</b>   | None   |  |
| <b>Return value</b>       | None   |  |
| <b>Description</b>        | Service to initialize the FEE module.                            |  |
| <b>Available via</b>      | Fee.h  |  |

](SRS\_BSW\_00101)

[SWS\_Fee\_00168] 「 If initialization is finished within `Fee_Init`, the function `Fee_Init` shall set the module state from `MEMIF_UNINIT` to `MEMIF_IDLE` once initialization has been successfully finished. 」(SRS\_BSW\_00101)

*Note: The FEE module's environment shall not call the function `Fee_Init` during a running operation of the FEE module.*

### 8.3.2 Fee\_SetMode

[SWS\_Fee\_00086]

|                         |   |  |
|-------------------------|---|--|
| <b>Service Name</b>     | Fee_SetMode   |  |
| <b>Syntax</b>           | <pre>void Fee_SetMode (     MemIf_ModeType Mode )</pre> |  |
| <b>Service ID [hex]</b> | 0x01  |  |
| <b>Sync/Async</b>       | Asynchronous  |  |
| <b>Reentrancy</b>       | Non Reentrant   |  |



|                           |  |  |
|---------------------------|--|--|
| <b>Parameters (in)</b>    | Mode   | Desired mode for the underlying flash driver |
| <b>Parameters (inout)</b> | None   |  |
| <b>Parameters (out)</b>   | None   |  |
| <b>Return value</b>       | None   |  |
| <b>Description</b>        | Function to switch the mode of the underlying Flash Driver |  |
| <b>Available via</b>      | Fee.h  |  |

⌋(RS\_BRF\_01448)

**[SWS\_Fee\_00121]** ⌈ If development error detection is enabled for the module: the function `Fee_SetMode` shall check if the module status is `MEMIF_UNINIT`. If this is the case, the function `Fee_SetMode` shall raise the development error `FEE_E_UNINIT` and return to the caller without executing the mode switch.

⌋(SRS\_BSW\_00406)

**[SWS\_Fee\_00170]** ⌈ The function `Fee_SetMode` shall check if the module state is `MEMIF_BUSY`. If this is the case, the function `Fee_SetMode` shall raise the runtime error `FEE_E_BUSY` and return to the caller without executing the mode switch.

⌋(SRS\_MemHwAb\_14018)

**[SWS\_Fee\_00190]**⌈ The function `Fee_SetMode` shall check if the module state is `MEMIF_IDLE` or `MEMIF_BUSY_INTERNAL`. If this is the case the module shall accept the mode change request. The mode change shall be executed asynchronously in the module's main function as soon as the module has finished the internal management operation.⌋(RS\_BRF\_01480)

**[SWS\_Fee\_00191]**⌈ The FEE module shall execute the mode change request asynchronously within the FEE module's main function.⌋(RS\_BRF\_01812)

### 8.3.3 Fee\_Read

**[SWS\_Fee\_00087]**⌈

|                         |  |
|-------------------------|--|
| <b>Service Name</b>     | Fee_Read   |
| <b>Syntax</b>           | <pre>Std_ReturnType Fee_Read (     uint16 BlockNumber,     uint16 BlockOffset,     uint8* DataBufferPtr,     uint16 Length )</pre> |
| <b>Service ID [hex]</b> | 0x02   |

|                           |                                 |  |
|---------------------------|---------------------------------|--|
| <b>Sync/Async</b>         | Asynchronous                    |  |
| <b>Reentrancy</b>         | Non Reentrant                   |  |
| <b>Parameters (in)</b>    | BlockNumber                     | Number of logical block, also denoting start address of that block in flash memory.  |
|                           | BlockOffset                     | Read address offset inside the block   |
|                           | Length                          | Number of bytes to read  |
| <b>Parameters (inout)</b> | None                            |  |
| <b>Parameters (out)</b>   | DataBufferPtr                   | Pointer to data buffer   |
| <b>Return value</b>       | Std_Return-Type                 | E_OK: The requested job has been accepted by the module.<br>E_NOT_OK: The requested job has not been accepted by the module. |
| <b>Description</b>        | Service to initiate a read job. |  |
| <b>Available via</b>      | Fee.h                           |  |

⌋(SRS\_MemHwAb\_14029)

**[SWS\_Fee\_00021]** ⌈ The function `Fee_Read` shall take the block start address and offset and calculate the corresponding memory read address.  
⌋(SRS\_MemHwAb\_14007)

*Note: The address offset and length parameter can take any value within the given types range. This allows reading of an arbitrary number of bytes from an arbitrary start address inside a logical block.*

**[SWS\_Fee\_00022]** ⌈ If the current module status is `MEMIF_IDLE` or if the current module status is `MEMIF_BUSY_INTERNAL`, the function `Fee_Read` shall accept the read request, copy the given / computed parameters to module internal variables, initiate a read job, set the FEE module status to `MEMIF_BUSY`, set the job result to `MEMIF_JOB_PENDING` and return with `E_OK`. ⌋(SRS\_MemHwAb\_14029)

**[SWS\_Fee\_00172]** ⌈ If the current module status is `MEMIF_UNINIT` or `MEMIF_BUSY`, the function `Fee_Read` shall reject the job request and return with `E_NOT_OK`. ⌋(RS\_BRF\_01048)

**[SWS\_Fee\_00073]** ⌈ The FEE module shall execute the read operation asynchronously within the FEE module's main function. ⌋(RS\_BRF\_01048)

**[SWS\_Fee\_00122]** ⌈ If development error detection is enabled for the module: the function `Fee_Read` shall check if the module state is `MEMIF_UNINIT`. If this is the

case, the function `Fee_Read` shall reject the read request, raise the development error `FEE_E_UNINIT` and return with `E_NOT_OK`. `_(SRS_BSW_00406)`

**[SWS\_Fee\_00133]** `┐` The function `Fee_Read` shall check if the module state is `MEMIF_BUSY`. If this is the case, the function `Fee_Read` shall reject the read request, raise the runtime error `FEE_E_BUSY` and return with `E_NOT_OK`. `_(RS_BRF_01048)`

**[SWS\_Fee\_00134]** `┐` If development error detection is enabled for the module: the function `Fee_Read` shall check that the given block number is valid (i.e. it has been configured). If this is not the case, the function `Fee_Read` shall reject the read request, raise the development error `FEE_E_INVALID_BLOCK_NO` and return with `E_NOT_OK`. `_(SRS_BSW_00323)`

**[SWS\_Fee\_00135]** `┐` If development error detection is enabled for the module: the function `Fee_Read` shall check that the given block offset is valid (i.e. that it is less than the block length configured for this block). If this is not the case, the function `Fee_Read` shall reject the read request, raise the development error `FEE_E_INVALID_BLOCK_OFS` and return with `E_NOT_OK`. `_(SRS_BSW_00323)`

**[SWS\_Fee\_00136]** `┐` If development error detection is enabled for the module: the function `Fee_Read` shall check that the given data pointer is valid (i.e. that it is not `NULL`). If this is not the case, the function `Fee_Read` shall reject the read request, raise the development error `FEE_E_PARAM_POINTER` and return with `E_NOT_OK`. `_(SRS_BSW_00323)`

**[SWS\_Fee\_00137]** `┐` If development error detection is enabled for the module: the function `Fee_Read` shall check that the given length information is valid, i.e. that the requested length information plus the block offset do not exceed the block end address (block start address plus configured block length). If this is not the case, the function `Fee_Read` shall reject the read request, raise the development error `FEE_E_INVALID_BLOCK_LEN` and return with `E_NOT_OK`. `_(SRS_BSW_00323)`

**[SWS\_Fee\_00162]** `┐` If a read request is rejected by the function `Fee_Read`, i.e. requirements [SWS\\_Fee\\_00122](#), [SWS\\_Fee\\_00133](#), [SWS\\_Fee\\_00134](#), [SWS\\_Fee\\_00135](#), [SWS\\_Fee\\_00136](#) or [SWS\\_Fee\\_00137](#) apply, the function `Fee_Read` shall not change the current module status or job result. `_(RS_BRF_01048)`

**[SWS\_Fee\_00187]** `┐` If the function `Fls_BlankCheck` is configured (in the flash driver), the function `Fee_Read` shall call the function `Fls_BlankCheck` to determine in advance whether a given memory area can be read without encountering e.g. ECC

errors due to trying to read erased but not programmed flash cells. 」  
(RS\_BRF\_01076)

Note: Whether calling Fls\_BlankCheck from Fee\_Read is necessary or not depends on the underlying hardware and the implementation of the flash driver and shall not be further detailed in this specification. The manual of the flash driver shall contain detailed information, whether Fls\_BlankCheck is required for a certain hardware and driver implementation or not.

### 8.3.4 Fee\_Write

#### [SWS\_Fee\_00088]

|                           |  |  |
|---------------------------|--|--|
| <b>Service Name</b>       | Fee_Write  |  |
| <b>Syntax</b>             | <pre>Std_ReturnType Fee_Write (     uint16 BlockNumber,     const uint8* DataBufferPtr )</pre> |  |
| <b>Service ID [hex]</b>   | 0x03   |  |
| <b>Sync/Async</b>         | Asynchronous   |  |
| <b>Reentrancy</b>         | Non Reentrant  |  |
| <b>Parameters (in)</b>    | BlockNumber  | Number of logical block, also denoting start address of that block in EEPROM.  |
|                           | DataBufferPtr  | Pointer to data buffer   |
| <b>Parameters (inout)</b> | None   |  |
| <b>Parameters (out)</b>   | None   |  |
| <b>Return value</b>       | Std_Return-Type  | E_OK: The requested job has been accepted by the module.<br>E_NOT_OK: The requested job has not been accepted by the module. |
| <b>Description</b>        | Service to initiate a write job.   |  |
| <b>Available via</b>      | Fee.h  |  |

」(SRS\_MemHwAb\_14010)

**[SWS\_Fee\_00024]** 「 The function `Fee_Write` shall take the block start address and calculate the corresponding memory write address. The block address offset shall be fixed to zero. 」(SRS\_MemHwAb\_14006)

**[SWS\_Fee\_00025]** 「 If the current module status is `MEMIF_IDLE` or if the current module status is `MEMIF_BUSY_INTERNAL`, the function `Fee_Write` shall accept the write request, copy the given / computed parameters to module internal variables,

initiate a write job, set the FEE module status to `MEMIF_BUSY`, set the job result to `MEMIF_JOB_PENDING` and return with `E_OK`.  $\downarrow$ (SRS\_MemHwAb\_14010)

**[SWS\_Fee\_00174]**  $\Uparrow$  If the current module status is `MEMIF_UNINIT` or `MEMIF_BUSY`, the function `Fee_Write` shall reject the job request and return with `E_NOT_OK`.  $\downarrow$ (RS\_BRF\_01048)

**[SWS\_Fee\_00026]**  $\Uparrow$  The FEE module shall execute the write operation asynchronously within the FEE module's main function.  $\downarrow$ (SRS\_MemHwAb\_14010, RS\_BRF\_01048)

**[SWS\_Fee\_00123]**  $\Uparrow$  If development error detection is enabled for the module: the function `Fee_Write` shall check if the module state is `MEMIF_UNINIT`. If this is the case, the function `Fee_Write` shall reject the write request, raise the development error `FEE_E_UNINIT` and return with `E_NOT_OK`.  $\downarrow$ (SRS\_BSW\_00406)

**[SWS\_Fee\_00144]**  $\Uparrow$  The function `Fee_Write` shall check if the module state is `MEMIF_BUSY`. If this is the case, the function `Fee_Write` shall reject the write request, raise the runtime error `FEE_E_BUSY` and return with `E_NOT_OK`.  $\downarrow$ (RS\_BRF\_01048)

**[SWS\_Fee\_00138]**  $\Uparrow$  If development error detection is enabled for the module: the function `Fee_Write` shall check that the given block number is valid (i.e. it has been configured). If this is not the case, the function `Fee_Write` shall reject the write request, raise the development error `FEE_E_INVALID_BLOCK_NO` and return with `E_NOT_OK`.  $\downarrow$ (SRS\_BSW\_00323)

**[SWS\_Fee\_00139]**  $\Uparrow$  If development error detection is enabled for the module: the function `Fee_Write` shall check that the given data pointer is valid (i.e. that it is not NULL). If this is not the case, the function `Fee_Write` shall reject the write request, raise the development error `FEE_E_PARAM_POINTER` and return with `E_NOT_OK`.  $\downarrow$ (SRS\_BSW\_00323)

**[SWS\_Fee\_00163]**  $\Uparrow$  If a write request is rejected by the function `Fee_Write`, i.e. requirements [SWS\\_Fee\\_00123](#), [SWS\\_Fee\\_00144](#), [SWS\\_Fee\\_00138](#) or [SWS\\_Fee\\_00139](#) apply, the function `Fee_Write` shall not change the current module status or job result.  $\downarrow$ (RS\_BRF\_01048)

## 8.3.5 Fee\_Cancel

**[SWS\_Fee\_00089]**

|                           |   |
|---------------------------|---|
| <b>Service Name</b>       | Fee_Cancel  |
| <b>Syntax</b>             | <pre>void Fee_Cancel (     void )</pre>                             |
| <b>Service ID [hex]</b>   | 0x04  |
| <b>Sync/Async</b>         | Synchronous   |
| <b>Reentrancy</b>         | Non Reentrant   |
| <b>Parameters (in)</b>    | None  |
| <b>Parameters (inout)</b> | None  |
| <b>Parameters (out)</b>   | None  |
| <b>Return value</b>       | None  |
| <b>Description</b>        | Service to call the cancel function of the underlying flash driver. |
| <b>Available via</b>      | Fee.h   |

](SRS\_MemHwAb\_14031)

*Note: The function `Fee_Cancel` and the cancel function of the underlying flash driver are – from their behaviour – synchronous functions but they are asynchronous w.r.t. an ongoing read, erase or write job in the flash memory. The cancel functions shall only reset their modules internal variables so that a new job can be accepted by the modules. They do not cancel an ongoing job in the hardware and they do not wait for an ongoing job to be finished by the hardware. This might lead to the situation in which the module's state is reported as `MEMIF_IDLE` while there is still an ongoing job being executed by the hardware. Therefore, the flash driver's main function shall check that the hardware is indeed free before starting a new job (see chapter 9.3 for a detailed sequence diagram).*

*Note: The function `Fee_Cancel` should only be used by the NvM to abort a read or write request for an NV block if higher priority data (i.e. immediate data) has to be written.*

**[SWS\_Fee\_00124]** ⌈ If development error detection is enabled for the module: the function `Fee_Cancel` shall check if the module state is `MEMIF_UNINIT`. If this is the case the function `Fee_Cancel` shall raise the development error `FEE_E_UNINIT` and return to the caller without changing any internal variables. ⌋(SRS\_BSW\_00406)

**[SWS\_Fee\_00080]** ⌈ If the current module status is `MEMIF_BUSY` (i.e. the request to cancel a pending job is accepted by the function `Fee_Cancel`), the function

`Fee_Cancel` shall call the cancel function of the underlying flash driver.  
 ⌋(SRS\_MemHwAb\_14031)

**[SWS\_Fee\_00081]** ⌈ If the current module status is `MEMIF_BUSY` (i.e. the request to cancel a pending job is accepted by the function `Fee_Cancel`), the function `Fee_Cancel` shall reset the FEE module's internal variables to make the module ready for a new job request from the upper layer, i.e. it shall set the module status to `MEMIF_IDLE`. ⌋(SRS\_MemHwAb\_14031)

**[SWS\_Fee\_00164]** ⌈ If the current module status is not `MEMIF_BUSY` (i.e. the request to cancel a pending job is rejected by the function `Fee_Cancel`), the function `Fee_Cancel` shall not change the current module status or job result.  
 ⌋(RS\_BRF\_01048)

**[SWS\_Fee\_00184]** ⌈ If the current module status is not `MEMIF_BUSY` (i.e. there is no job to cancel and therefore the request to cancel a pending job is rejected by the function `Fee_Cancel`), the function `Fee_Cancel` shall raise the runtime error `FEE_E_INVALID_CANCEL`. ⌋(SRS\_MemHwAb\_14031)

### 8.3.6 Fee\_GetStatus

**[SWS\_Fee\_00090]**⌈

|                           |  |  |
|---------------------------|--|--|
| <b>Service Name</b>       | Fee_GetStatus  |  |
| <b>Syntax</b>             | <pre>MemIf_StatusType Fee_GetStatus (     void )</pre> |  |
| <b>Service ID [hex]</b>   | 0x05   |  |
| <b>Sync/Async</b>         | Synchronous  |  |
| <b>Reentrancy</b>         | Non Reentrant  |  |
| <b>Parameters (in)</b>    | None   |  |
| <b>Parameters (inout)</b> | None   |  |
| <b>Parameters (out)</b>   | None   |  |
| <b>Return value</b>       | MemIf_Status-Type                                      | MEMIF_UNINIT: The FEE module has not been initialized.<br>MEMIF_IDLE: The FEE module is currently idle.<br>MEMIF_BUSY: The FEE module is currently busy.<br>MEMIF_BUSY_INTERNAL: The FEE module is busy with internal management operations. |
| <b>Description</b>        | Service to return the status.                          |  |

|                      |       |
|----------------------|-------|
| <b>Available via</b> | Fee.h |
|----------------------|-------|

⌋(SRS\_BSW\_00406)

**[SWS\_Fee\_00034]** ⌈ The function `Fee_GetStatus` shall return `MEMIF_UNINIT` if the module has not (yet) been initialized. ⌋(SRS\_BSW\_00406)

**[SWS\_Fee\_00128]** ⌈ The function `Fee_GetStatus` shall return `MEMIF_IDLE` if the module is neither processing a request from the upper layer nor is it doing an internal management operation. ⌋(RS\_BRF\_01048)

**[SWS\_Fee\_00129]** ⌈ The function `Fee_GetStatus` shall return `MEMIF_BUSY` if it is currently processing a request from the upper layer. ⌋(RS\_BRF\_01048)

**[SWS\_Fee\_00074]** ⌈ The function `Fee_GetStatus` shall return `MEMIF_BUSY_INTERNAL`, if an internal management operation is currently ongoing. ⌋(RS\_BRF\_01048)

*Note: Internal management operation may e.g. be a re-organization of the used flash memory (garbage collection). This may imply that the underlying device driver is – at least temporarily – busy.*

### 8.3.7 Fee\_GetJobResult

**[SWS\_Fee\_00091]**⌈

|                           |  |  |
|---------------------------|--|--|
| <b>Service Name</b>       | Fee_GetJobResult   |  |
| <b>Syntax</b>             | <pre>MemIf_JobResultType Fee_GetJobResult (     void )</pre> |  |
| <b>Service ID [hex]</b>   | 0x06   |  |
| <b>Sync/Async</b>         | Synchronous  |  |
| <b>Reentrancy</b>         | Non Reentrant  |  |
| <b>Parameters (in)</b>    | None   |  |
| <b>Parameters (inout)</b> | None   |  |
| <b>Parameters (out)</b>   | None   |  |
| <b>Return value</b>       | MemIf_Job-   | MEMIF_JOB_OK: The last job has been finished successfully. |



|                      |  |  |
|----------------------|--|--|
|                      | ResultType   | MEMIF_JOB_PENDING: The last job is waiting for execution or currently being executed.<br>MEMIF_JOB_CANCELED: The last job has been canceled (which means it failed).<br>MEMIF_JOB_FAILED: The last job has not been finished successfully (it failed).<br>MEMIF_BLOCK_INCONSISTENT: The requested block is inconsistent, it may contain corrupted data.<br>MEMIF_BLOCK_INVALID: The requested block has been invalidated, the requested read operation can not be performed. |
| <b>Description</b>   | Service to query the result of the last accepted job issued by the upper layer software. |  |
| <b>Available via</b> | Fee.h  |  |

⌋(RS\_BRF\_01048)

**[SWS\_Fee\_00035]** ⌈ The function `Fee_GetJobResult` shall return `MEMIF_JOB_OK` if the last job has been finished successfully. ⌋(RS\_BRF\_01048)

**[SWS\_Fee\_00156]** ⌈ The function `Fee_GetJobResult` shall return `MEMIF_JOB_PENDING` if the requested job is still waiting for execution or is currently being executed. ⌋(RS\_BRF\_01048)

**[SWS\_Fee\_00157]** ⌈ The function `Fee_GetJobResult` shall return `MEMIF_JOB_CANCELED` if the last job has been canceled by the upper layer. ⌋(SRS\_MemHwAb\_14031)

**[SWS\_Fee\_00158]** ⌈ The function `Fee_GetJobResult` shall return `MEMIF_JOB_FAILED` if the last job has failed. ⌋(RS\_BRF\_01048)

**[SWS\_Fee\_00159]** ⌈ The function `Fee_GetJobResult` shall return `MEMIF_BLOCK_INCONSISTENT` if the requested block is found to be inconsistent (see chapter 7.1.5 for details). ⌋(SRS\_MemHwAb\_14014)

**[SWS\_Fee\_00160]** ⌈ The function `Fee_GetJobResult` shall return `MEMIF_BLOCK_INVALID` if the requested block has been invalidated by the upper layer. ⌋(SRS\_MemHwAb\_14028)

**[SWS\_Fee\_00155]** ⌈ Only those jobs which have been requested directly by the upper layer shall have influence on the job result returned by the function `Fee_GetJobResult`. I.e. jobs which are issued by the FEE module itself in the course of internal management operations shall not alter the job result. ⌋(RS\_BRF\_01048)

**[SWS\_Fee\_00125]** ⌈ If development error detection is enabled for the module: the function `Fee_GetJobResult` shall check if the module state is `MEMIF_UNINIT`. If this is the case, the function `Fee_GetJobResult` shall raise the development error `FEE_E_UNINIT` and return with `MEMIF_JOB_FAILED`. ⌋(SRS\_BSW\_00406)

### 8.3.8 Fee\_InvalidateBlock

**[SWS\_Fee\_00092]**⌈

|                           |  |   |
|---------------------------|--|---|
| <b>Service Name</b>       | Fee_InvalidateBlock  |   |
| <b>Syntax</b>             | <pre>Std_ReturnType Fee_InvalidateBlock (     uint16 BlockNumber )</pre> |   |
| <b>Service ID [hex]</b>   | 0x07   |   |
| <b>Sync/Async</b>         | Asynchronous   |   |
| <b>Reentrancy</b>         | Non Reentrant  |   |
| <b>Parameters (in)</b>    | BlockNumber  | Number of logical block, also denoting start address of that block in flash memory.   |
| <b>Parameters (inout)</b> | None   |   |
| <b>Parameters (out)</b>   | None   |   |
| <b>Return value</b>       | Std_Return-Type  | E_OK: The requested job has been accepted by the module.<br>E_NOT_OK - only if DET is enabled: The requested job has not been accepted by the module. |
| <b>Description</b>        | Service to invalidate a logical block.                                   |   |
| <b>Available via</b>      | Fee.h  |   |

⌋(SRS\_MemHwAb\_14028)

**[SWS\_Fee\_00036]** ⌈ The function `Fee_InvalidateBlock` shall take the block number and calculate the corresponding memory block address. ⌋(SRS\_MemHwAb\_14009)

**[SWS\_Fee\_00037]** ⌈ The function `Fee_InvalidateBlock` shall invalidate the requested block <BlockNumber> by calling the erase function of the underlying device driver and / or by changing some module internal management information accordingly. ⌋(SRS\_MemHwAb\_14028)

*Note: How exactly the requested block is invalidated depends on the module's implementation and will not be further detailed in this specification. The internal*

*management information has to be stored in NV memory since it has to be resistant against resets. What this information is and how it is stored will not be further detailed in this specification.*

**[SWS\_Fee\_00126]** ⌈ If development error detection is enabled for the module: the function `Fee_InvalidateBlock` shall check if the module status is `MEMIF_UNINIT`. If this is the case, the function `Fee_InvalidateBlock` shall reject the invalidation request, raise the development error `FEE_E_UNINIT` and return with `E_NOT_OK`. ⌋(SRS\_BSW\_00406)

**[SWS\_Fee\_00145]** ⌈ The function `Fee_InvalidateBlock` shall check if the module status is `MEMIF_BUSY`. If this is the case, the function `Fee_InvalidateBlock` shall reject the request, raise the runtime error `FEE_E_BUSY` and return with `E_NOT_OK`. ⌋(RS\_BRF\_01048)

**[SWS\_Fee\_00192]**⌈ The function `Fee_InvalidateBlock` shall check if the module state is `MEMIF_IDLE` or `MEMIF_BUSY_INTERNAL`. If this is the case the module shall accept the invalidation request and shall return `E_OK` to the caller. The block invalidation shall be executed asynchronously in the module's main function as soon as the module has finished the internal management operation. ⌋(SRS\_MemHwAb\_14028)

**[SWS\_Fee\_00193]**⌈ The FEE module shall execute the block invalidation request asynchronously within the FEE module's main function.⌋(RS\_BRF\_01812)

**[SWS\_Fee\_00140]** ⌈ If development error detection is enabled for the module: the function `Fee_InvalidateBlock` shall check that the given block number is valid (i.e. it has been configured). If this is not the case, the function `Fee_InvalidateBlock` shall reject the request, raise the development error `FEE_E_INVALID_BLOCK_NO` and return with `E_NOT_OK`. ⌋(SRS\_BSW\_00323)

**[SWS\_Fee\_00165]** ⌈ If an invalidation request is rejected by the function `Fee_InvalidateBlock`, i.e. requirements [SWS\\_Fee\\_00126](#), [SWS\\_Fee\\_00140](#) or [SWS\\_Fee\\_00145](#) apply, the function `Fee_InvalidateBlock` shall not change the current module status or job result. ⌋(SRS\_MemHwAb\_14028)

### 8.3.9 Fee\_GetVersionInfo

**[SWS\_Fee\_00093]**⌈

|                     |                    |
|---------------------|--------------------|
| <b>Service Name</b> | Fee_GetVersionInfo |
|---------------------|--------------------|

|                           |  |  |
|---------------------------|--|--|
| <b>Syntax</b>             | <pre>void Fee_GetVersionInfo (     Std_VersionInfoType* VersionInfoPtr )</pre> |  |
| <b>Service ID [hex]</b>   | 0x08   |  |
| <b>Sync/Async</b>         | Synchronous  |  |
| <b>Reentrancy</b>         | Reentrant  |  |
| <b>Parameters (in)</b>    | None   |  |
| <b>Parameters (inout)</b> | None   |  |
| <b>Parameters (out)</b>   | VersionInfoPtr   | Pointer to standard version information structure. |
| <b>Return value</b>       | None   |  |
| <b>Description</b>        | Service to return the version information of the FEE module.                   |  |
| <b>Available via</b>      | Fee.h  |  |

](SRS\_BSW\_00407)

**[SWS\_Fee\_00147]** ⌈ If development error detection is enabled for the module: the function `Fee_GetVersionInfo` shall check that the given data pointer is valid (i.e. that it is not `NULL`). If this is not the case, the function `Fee_GetVersionInfo` shall raise the development error `FEE_E_PARAM_POINTER`. ⌋(SRS\_BSW\_00323)

### 8.3.10 Fee\_EraseImmediateBlock

**[SWS\_Fee\_00094]**⌈

|                           |  |   |
|---------------------------|--|---|
| <b>Service Name</b>       | Fee_EraseImmediateBlock  |   |
| <b>Syntax</b>             | <pre>Std_ReturnType Fee_EraseImmediateBlock (     uint16 BlockNumber )</pre> |   |
| <b>Service ID [hex]</b>   | 0x09   |   |
| <b>Sync/Async</b>         | Asynchronous   |   |
| <b>Reentrancy</b>         | Non Reentrant  |   |
| <b>Parameters (in)</b>    | BlockNumber  | Number of logical block, also denoting start address of that block in EEPROM. |
| <b>Parameters (inout)</b> | None   |   |
| <b>Parameters (out)</b>   | None   |   |

|                      |                                   |   |
|----------------------|-----------------------------------|---|
| <b>Return value</b>  | Std_Return-Type                   | E_OK: The requested job has been accepted by the module.<br>E_NOT_OK - only if DET is enabled: The requested job has not been accepted by the module. |
| <b>Description</b>   | Service to erase a logical block. |   |
| <b>Available via</b> | Fee.h                             |   |

\_(SRS\_MemHwAb\_14032)

*Note: The function `Fee_EraseImmediateBlock` shall only be called by e.g. diagnostic or similar system service to pre-erase the area for immediate data if necessary.*

**[SWS\_Fee\_00066]** ▮ The function `Fee_EraseImmediateBlock` shall take the block number and calculate the corresponding memory block address.  
\_(SRS\_MemHwAb\_14009)

**[SWS\_Fee\_00067]** ▮ The function `Fee_EraseImmediateBlock` shall ensure that the FEE module can write immediate data. Whether this involves physically erasing a memory area and therefore calling the erase function of the underlying driver depends on the implementation of the module. \_(SRS\_MemHwAb\_14013)

**[SWS\_Fee\_00127]** ▮ If development error detection is enabled for the module: the function `Fee_EraseImmediateBlock` shall check if the module state is `MEMIF_UNINIT`. If this is the case, the function `Fee_EraseImmediateBlock` shall reject the erase request, raise the development error `FEE_E_UNINIT` and return with `E_NOT_OK`. \_(SRS\_BSW\_00406)

**[SWS\_Fee\_00146]** ▮ The function `Fee_EraseImmediateBlock` shall check if the module state is `MEMIF_BUSY`. If this is the case, the function `Fee_EraseImmediateBlock` shall reject the erase request, raise the runtime error `FEE_E_BUSY` and return with `E_NOT_OK`. \_(RS\_BRF\_01048)

**[SWS\_Fee\_00068]** ▮ If development error detection is enabled for the module: the function `Fee_EraseImmediateBlock` shall check whether the addressed logical block is configured as containing immediate data (`FeeImmediateData == TRUE`). If not, the function `Fee_EraseImmediateBlock` shall raise the development error `FEE_E_INVALID_BLOCK_NO` and return `E_NOT_OK` without erasing the addressed logical block. \_(SRS\_BSW\_00323)

**[SWS\_Fee\_00141]** ▮ If development error detection is enabled for the module: the function `Fee_EraseImmediateBlock` shall check that the given block number is valid (i.e. it has been configured). If this is not the case, the function

Fee\_EraseImmediateBlock shall reject the erase request, raise the development error FEE\_E\_INVALID\_BLOCK\_NO and return with E\_NOT\_OK. ](SRS\_BSW\_00323)

[SWS\_Fee\_00166] [ If a erase request is rejected by the function Fee\_EraseImmediateBlock, i.e. requirements [SWS\\_Fee\\_00068](#), [SWS\\_Fee\\_00127](#), [SWS\\_Fee\\_00141](#) or [SWS\\_Fee\\_00146](#) apply, the function Fee\_EraseImmediateBlock shall not change the current module status or job result. ](SRS\_MemHwAb\_14032)

## 8.4 Call-back notifications

This chapter lists all functions provided by the Fee module to lower layer modules.

*Note: Depending on the implementation of the modules making up the NV memory stack, callback routines provided by the FEE module may be called on interrupt level. The implementation of the FEE module therefore has to make sure that the runtime of those routines is reasonably short, i.e. since callbacks may be propagated upward through several software layers. Whether callback routines are allowable / feasible on interrupt level depends on the project specific needs (reaction time) and limitations (runtime in interrupt context). Therefore, system design has to make sure that the configuration of the involved modules meets those requirements.*

### 8.4.1 Fee\_JobEndNotification

[SWS\_Fee\_00095]

|                           |   |
|---------------------------|---|
| <b>Service Name</b>       | Fee_JobEndNotification  |
| <b>Syntax</b>             | void Fee_JobEndNotification (<br>void<br>)  |
| <b>Service ID [hex]</b>   | 0x10  |
| <b>Sync/Async</b>         | Synchronous   |
| <b>Reentrancy</b>         | Non Reentrant   |
| <b>Parameters (in)</b>    | None  |
| <b>Parameters (inout)</b> | None  |
| <b>Parameters (out)</b>   | None  |
| <b>Return value</b>       | None  |
| <b>Description</b>        | Service to report to this module the successful end of an asynchronous operation. |

|                      |       |
|----------------------|-------|
| <b>Available via</b> | Fee.h |
|----------------------|-------|

⌋(RS\_BRF\_01064)

The underlying flash driver shall call the function `Fee_JobEndNotification` to report the successful end of an asynchronous operation.

**[SWS\_Fee\_00052]** ⌈ The function `Fee_JobEndNotification` shall perform any necessary block management operations and subsequently call the job end notification routine of the upper layer module if configured. ⌋(RS\_BRF\_01064)

**[SWS\_Fee\_00142]** ⌈ If the job result is currently `MEMIF_JOB_PENDING`, the function `Fee_JobEndNotification` shall set the job result to `MEMIF_JOB_OK`, else it shall leave the job result untouched. ⌋(RS\_BRF\_01064)

Note: The function `Fee_JobEndNotification` shall be callable on interrupt level.

#### 8.4.2 Fee\_JobErrorNotification

**[SWS\_Fee\_00096]**⌈

|                           |  |
|---------------------------|--|
| <b>Service Name</b>       | Fee_JobErrorNotification   |
| <b>Syntax</b>             | <pre>void Fee_JobErrorNotification (     void )</pre>                      |
| <b>Service ID [hex]</b>   | 0x11   |
| <b>Sync/Async</b>         | Synchronous  |
| <b>Reentrancy</b>         | Non Reentrant  |
| <b>Parameters (in)</b>    | None   |
| <b>Parameters (inout)</b> | None   |
| <b>Parameters (out)</b>   | None   |
| <b>Return value</b>       | None   |
| <b>Description</b>        | Service to report to this module the failure of an asynchronous operation. |
| <b>Available via</b>      | Fee.h  |

⌋(RS\_BRF\_01064)

The underlying flash driver shall call the function `Fee_JobErrorNotification` to report the failure of an asynchronous operation.

**[SWS\_Fee\_00054]** ⌈The function `Fee_JobErrorNotification` shall perform any necessary block management and error handling operations and subsequently call the job error notification routine of the upper layer module if configured. ⌋(RS\_BRF\_01064)

**[SWS\_Fee\_00143]** ⌈ If the job result is currently `MEMIF_JOB_PENDING`, the function `Fee_JobErrorNotification` shall set the job result to `MEMIF_JOB_FAILED`, else it shall leave the job result untouched. ⌋(RS\_BRF\_01064)

Note: The function `Fee_JobErrorNotification` shall be callable on interrupt level.

## 8.5 Scheduled functions

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

### 8.5.1 Fee\_MainFunction

**[SWS\_Fee\_00097]**⌈

|                         |   |
|-------------------------|---|
| <b>Service Name</b>     | Fee_MainFunction  |
| <b>Syntax</b>           | <pre>void Fee_MainFunction (     void )</pre>   |
| <b>Service ID [hex]</b> | 0x12  |
| <b>Description</b>      | Service to handle the requested read / write / erase jobs and the internal management operations. |
| <b>Available via</b>    | SchM_Fee.h  |

⌋(RS\_BRF\_01048)

**[SWS\_Fee\_00169]** ⌈ If the module initialization (started in the function `Fee_Init`) is completed in the module's main function, the function `Fee_MainFunction` shall set the module status from `MEMIF_UNINIT` to `MEMIF_IDLE` once initialization of the module has been successfully finished. ⌋(SRS\_BSW\_00101)

**[SWS\_Fee\_00057]** ⌈ The function `Fee_MainFunction` shall asynchronously handle the read / write / erase / invalidate jobs requested by the upper layer and internal management operations. ⌋(RS\_BRF\_01048)



**[SWS\_Fee\_00075]** ⌈ The function `Fee_MainFunction` shall check, whether the block requested for reading has been invalidated by the upper layer module. If so, the function `Fee_MainFunction` shall set the job result to `MEMIF_BLOCK_INVALID` and call the error notification routine of the upper layer if configured.  
⌋(RS\_BRF\_01048, SRS\_MemHwAb\_14028)

**[SWS\_Fee\_00023]** ⌈The function `Fee_MainFunction` shall check the consistency of the logical block being read before notifying the caller. If an inconsistency of the read data is detected or if the requested block can't be found, the function `Fee_MainFunction` shall set the job result to `MEMIF_BLOCK_INCONSISTENT` and call the error notification routine of the upper layer if configured.  
⌋(SRS\_MemHwAb\_14014, SRS\_MemHwAb\_14015, SRS\_MemHwAb\_14016)

*Note: In this case, the upper layer must not use the contents of the data buffer.*

## 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 which are required to fulfill the core functionality of the module.

**[SWS\_Fee\_00105]**⌈

| <i>API Function</i>         | <i>Header File</i> | <i>Description</i>  |
|-----------------------------|--------------------|---|
| Det_Report-<br>RuntimeError | Det.h              | Service to report runtime errors. If a callout has been configured then this callout shall be called. |
| Fls_Cancel                  | Fls.h              | Cancels an ongoing job.   |
| Fls_Compare                 | Fls_<br>Com.h      | Compares the contents of an area of flash memory with that of an application data buffer.             |
| Fls_Erase                   | Fls.h              | Erases flash sector(s).   |
| Fls_GetJobResult            | Fls.h              | Returns the result of the last job.   |
| Fls_GetStatus               | Fls.h              | Returns the driver state.   |
| Fls_Read                    | Fls.h              | Reads from flash memory.  |
| Fls_SetMode                 | Fls.h              | Sets the flash driver's operation mode.   |
| Fls_Write                   | Fls.h              | Writes one or more complete flash pages.  |

⌋(SRS\_BSW\_00384)

## 8.6.2 Optional Interfaces

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

### [SWS\_Fee\_00104]

| API Function     | Header File | Description   |
|------------------|-------------|---|
| Det_Report-Error | Det.h       | Service to report development errors.   |
| Fls_Blank-Check  | Fls.h       | The function Fls_BlankCheck shall verify, whether a given memory area has been erased but not (yet) programmed. The function shall limit the maximum number of checked flash cells per main function cycle to the configured value FlsMaxReadNormalMode or FlsMaxReadFastMode respectively. |

](SRS\_BSW\_00384)

## 8.6.3 Configurable interfaces

In this chapter all interfaces are listed where the target function could be configured. The target function is usually a callback function. The names of this kind of interfaces are not fixed because they are configurable.

*Note: Depending on the implementation of the modules making up the NV memory stack, callback routines invoked by the FEE module may be called on interrupt level. The implementor of the module providing these routines therefore has to make sure that their runtime is reasonably short, i.e. since callbacks may be propagated upward through several software layers. Whether callback routines are allowable / feasible on interrupt level depends on the project specific needs (reaction time) and limitations (runtime in interrupt context). Therefore system design has to make sure that the configuration of the involved modules meets those requirements.*

### [SWS\_Fee\_00098]

|                           |   |
|---------------------------|---|
| <b>Service Name</b>       | NvM_JobEndNotification                              |
| <b>Syntax</b>             | <pre>void NvM_JobEndNotification (     void )</pre> |
| <b>Sync/Async</b>         | true  |
| <b>Reentrancy</b>         | Don't care  |
| <b>Parameters (in)</b>    | None  |
| <b>Parameters (inout)</b> | None  |
| <b>Parameters (out)</b>   | None  |
| <b>Return value</b>       | None  |

|                      |       |
|----------------------|-------|
| <b>Description</b>   | --    |
| <b>Available via</b> | Nvm.h |

⌋(RS\_BRF\_01064)

**[SWS\_Fee\_00055]** ⌈ The FEE module shall call the function defined in the configuration parameter `FeeNvmJobEndNotification` upon successful end of an asynchronous operation and after performing all necessary internal management operations:

- Read job finished & OK
- Write job finished & OK & block marked as valid
- Erase job for immediate data finished & OK (see [SWS\\_Fee\\_00067](#))
- Invalidation of memory block finished & OK ⌋(RS\_BRF\_01064)

The function defined in the configuration parameter `FeeNvmJobEndNotification` shall be callable on interrupt level.

**[SWS\_Fee\_00099]**⌈

|                           |   |
|---------------------------|---|
| <b>Service Name</b>       | NvM_JobErrorNotification                              |
| <b>Syntax</b>             | <pre>void NvM_JobErrorNotification (     void )</pre> |
| <b>Sync/Async</b>         | true  |
| <b>Reentrancy</b>         | Don't care  |
| <b>Parameters (in)</b>    | None  |
| <b>Parameters (inout)</b> | None  |
| <b>Parameters (out)</b>   | None  |
| <b>Return value</b>       | None  |
| <b>Description</b>        | --  |
| <b>Available via</b>      | Nvm.h   |

⌋(RS\_BRF\_01064)

**[SWS\_Fee\_00056]** ⌈The FEE module shall call the function defined in the configuration parameter `FeeNvmJobErrorNotification` upon failure of an asynchronous operation and after performing all necessary internal management and error handling operations:

- Read job finished & failed (e.g. block invalid or inconsistent)
- Write job finished & failed & block marked as invalid

- Erase job for immediate data finished & failed (see [SWS\\_Fee\\_00067](#))
- Invalidation of memory block finished & failed (RS\_BRF\_01064)

The function defined in the configuration parameter `FeeNvmJobErrorNotification` shall be callable on interrupt level.

## 9 Sequence diagrams

Note: For a vendor specific library, the following sequence diagrams are valid only insofar as they show the relation to the calling modules (Ecu\_StateManager and memory abstraction interface). The calling relations from a memory abstraction module to an underlying driver are not relevant / binding for a vendor specific library.

### 9.1 Fee\_Init

The following figure shows the call sequence for the `Fee_Init` routine. It is different from that of all other services of this module as it is not called by the NVRAM manager and not called via the memory abstraction interface.

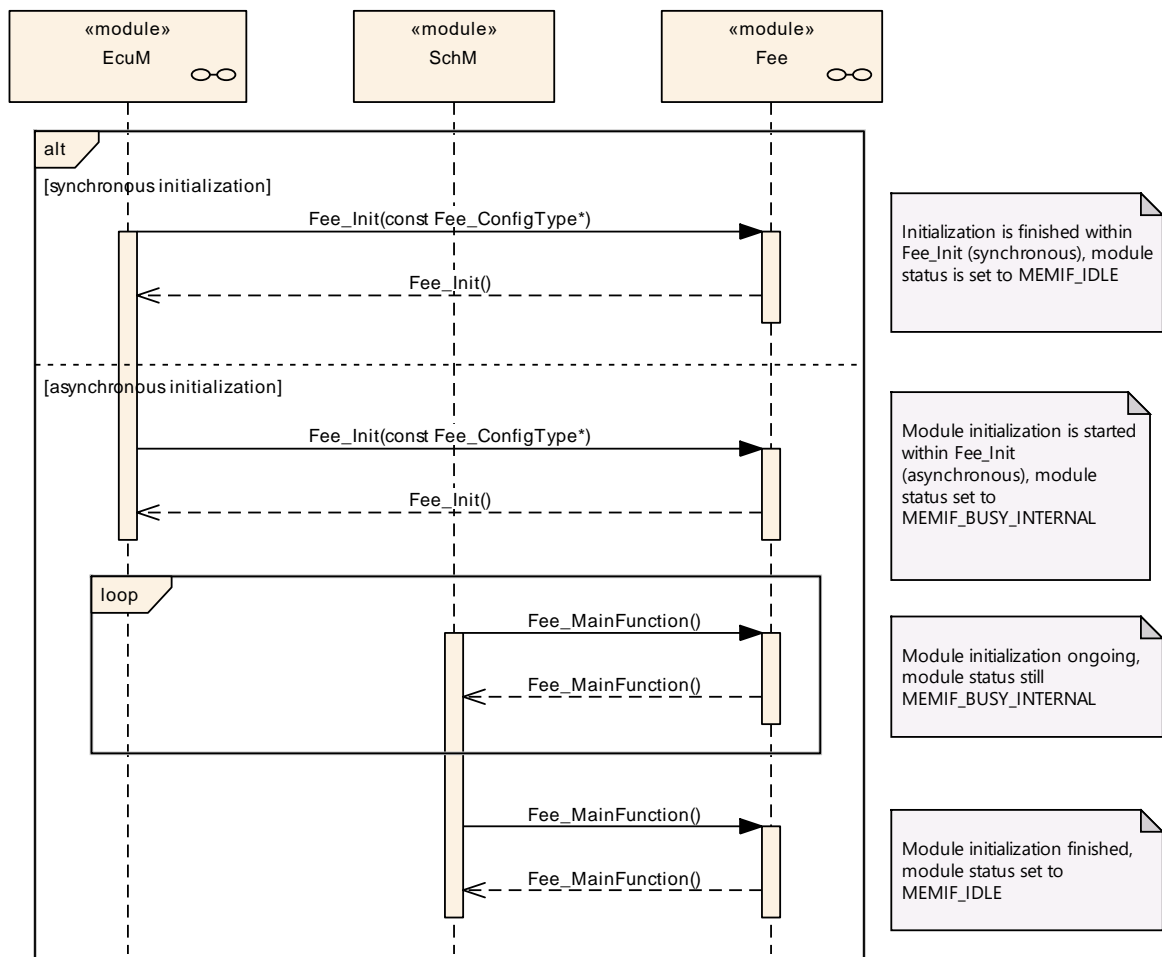


Figure 4: Sequence diagram of `Fee_Init`

## 9.2 Fee\_Write

The following figure shows exemplarily the call sequence for the `Fee_Write` service. This sequence diagram also applies to the other asynchronous services of this module.

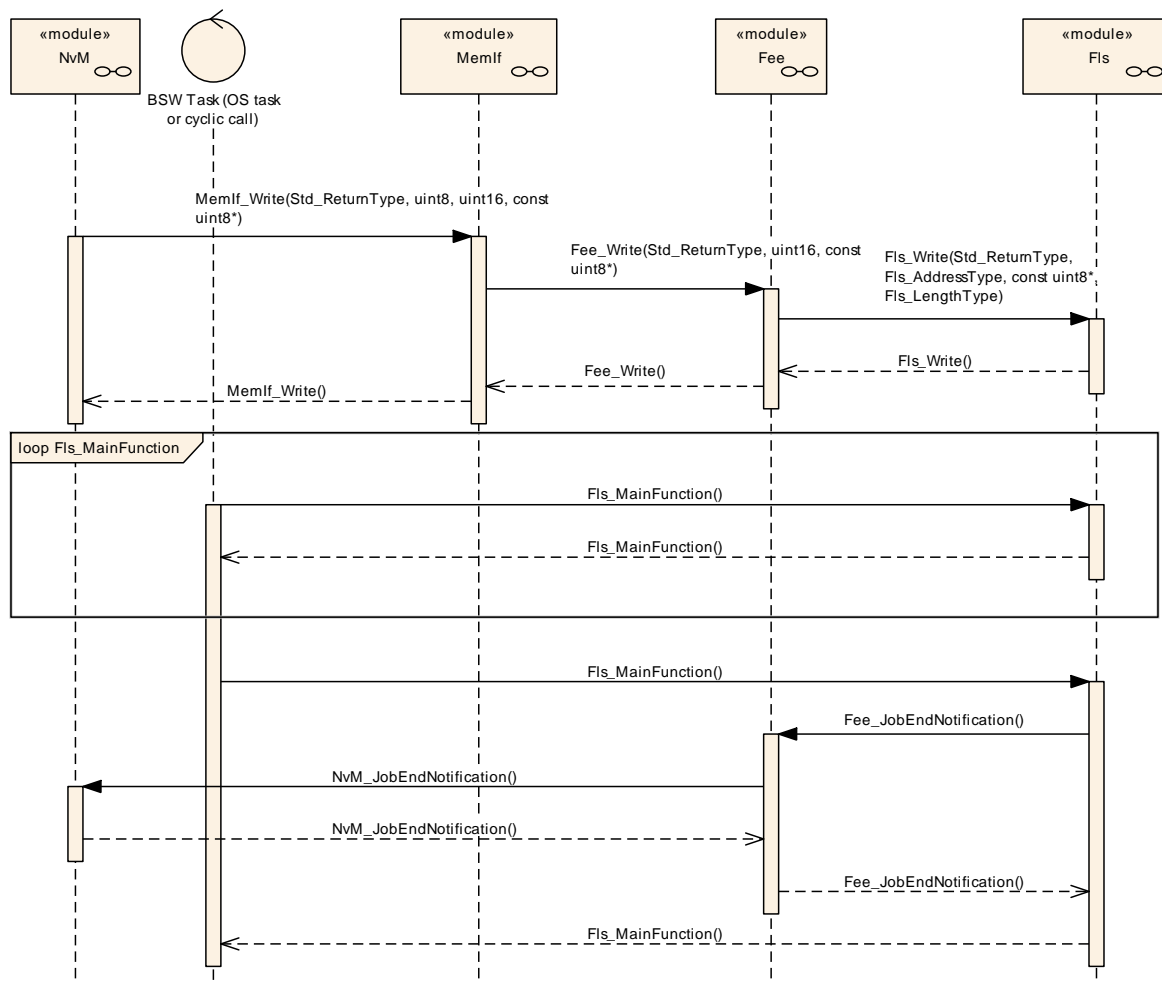


Figure 5: Sequence diagram of `Fee_Write`

### 9.3 Fee\_Cancel

The following figure shows as an example the call sequence for a canceled `Fee_Write` service and a subsequent new `Fee_Write` request. This sequence diagram shows that `Fee_Cancel` is asynchronous w.r.t. the underlying hardware while itself being synchronous.

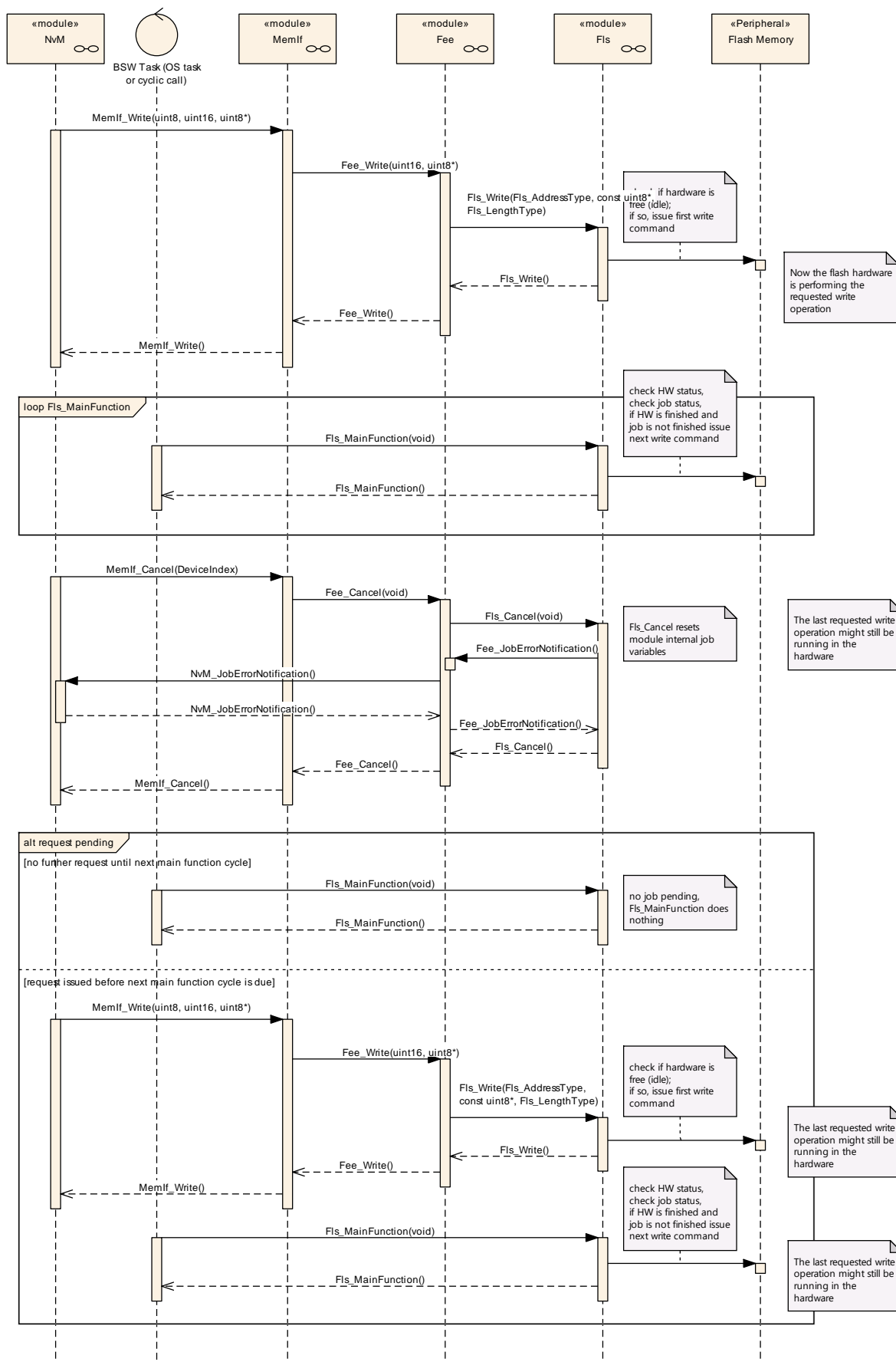


Figure 6: Sequence diagram of Fee\_Cancel



## 10 Configuration specification

### 10.1 Containers and configuration parameters

The following chapters summarize all configuration parameters. The detailed meaning of the parameters are described in Chapter 7 and Chapter 8.

#### 10.1.1 Fee

|                                   |   |
|-----------------------------------|---|
| <b>SWS Item</b>                   | <b>ECUC_Fee_00154 :</b>                                   |
| <b>Module Name</b>                | <i>Fee</i>  |
| <b>Module Description</b>         | Configuration of the Fee (Flash EEPROM Emulation) module. |
| <b>Post-Build Variant Support</b> | false   |
| <b>Supported Config Variants</b>  | VARIANT-PRE-COMPILE                                       |

| <b>Included Containers</b> |                     |   |
|----------------------------|---------------------|---|
| <b>Container Name</b>      | <b>Multiplicity</b> | <b>Scope / Dependency</b>   |
| FeeBlockConfiguration      | 1..*                | Configuration of block specific parameters for the Flash EEPROM Emulation module.   |
| FeeGeneral                 | 1                   | Container for general parameters. These parameters are not specific to a block.   |
| FeePublishedInformation    | 1                   | Additional published parameters not covered by CommonPublishedInformation container.<br>Note that these parameters do not have any configuration class setting, since they are published information. |

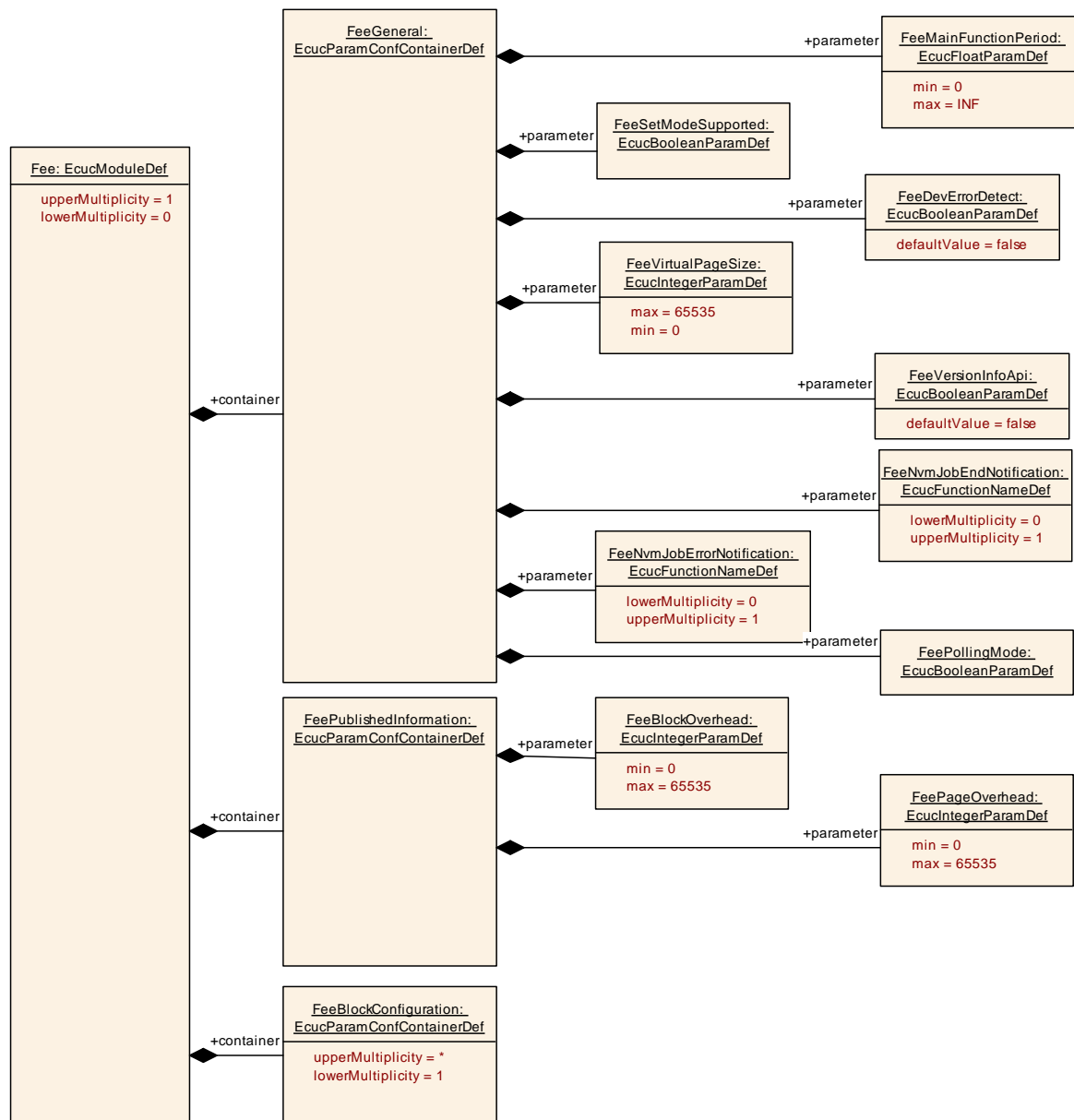


Figure 7: Overview of configuration parameters of Fee

## 10.1.2 FeeGeneral

|                                 |   |
|---------------------------------|---|
| <b>SWS Item</b>                 | <b>ECUC_Fee_00039 :</b>   |
| <b>Container Name</b>           | FeeGeneral  |
| <b>Parent Container</b>         | Fee   |
| <b>Description</b>              | Container for general parameters. These parameters are not specific to a block. |
| <b>Configuration Parameters</b> |   |

|                         |  |
|-------------------------|--|
| <b>SWS Item</b>         | <b>ECUC_Fee_00111 :</b>  |
| <b>Name</b>             | FeeDevErrorDetect  |
| <b>Parent Container</b> | FeeGeneral   |
| <b>Description</b>      | Switches the development error detection and notification on or off. |

|                                  |  |    |              |
|----------------------------------|--|----|--------------|
|                                  | <ul style="list-style-type: none"> <li>true: detection and notification is enabled.</li> <li>false: detection and notification is disabled.</li> </ul> |    |              |
| <b>Multiplicity</b>              | 1  |    |              |
| <b>Type</b>                      | EcucBooleanParamDef  |    |              |
| <b>Default value</b>             | false  |    |              |
| <b>Post-Build Variant Value</b>  | false  |    |              |
| <b>Value Configuration Class</b> | <b>Pre-compile time</b>  | X  | All Variants |
|                                  | <b>Link time</b>   | -- |              |
|                                  | <b>Post-build time</b>   | -- |              |
| <b>Scope / Dependency</b>        | scope: local   |    |              |

|                                  |  |    |              |
|----------------------------------|--|----|--------------|
| <b>SWS Item</b>                  | <b>ECUC_Fee_00153 :</b>  |    |              |
| <b>Name</b>                      | FeeMainFunctionPeriod  |    |              |
| <b>Parent Container</b>          | FeeGeneral   |    |              |
| <b>Description</b>               | The period between successive calls to the main function in seconds. |    |              |
| <b>Multiplicity</b>              | 1  |    |              |
| <b>Type</b>                      | EcucFloatParamDef  |    |              |
| <b>Range</b>                     | ]0 .. INF[   |    |              |
| <b>Default value</b>             | --   |    |              |
| <b>Post-Build Variant Value</b>  | false  |    |              |
| <b>Value Configuration Class</b> | <b>Pre-compile time</b>  | X  | All Variants |
|                                  | <b>Link time</b>   | -- |              |
|                                  | <b>Post-build time</b>   | -- |              |
| <b>Scope / Dependency</b>        | scope: ECU   |    |              |

|   |   |    |              |
|---|---|----|--------------|
| <b>SWS Item</b>                         | <b>ECUC_Fee_00112 :</b>   |    |              |
| <b>Name</b>                             | FeeNvmJobEndNotification  |    |              |
| <b>Parent Container</b>                 | FeeGeneral  |    |              |
| <b>Description</b>                      | Mapped to the job end notification routine provided by the upper layer module (NvM_JobEndNotification). |    |              |
| <b>Multiplicity</b>                     | 0..1  |    |              |
| <b>Type</b>                             | EcucFunctionNameDef   |    |              |
| <b>Default value</b>                    | --  |    |              |
| <b>maxLength</b>                        | --  |    |              |
| <b>minLength</b>                        | --  |    |              |
| <b>regularExpression</b>                | --  |    |              |
| <b>Post-Build Variant Multiplicity</b>  | false   |    |              |
| <b>Post-Build Variant Value</b>         | false   |    |              |
| <b>Multiplicity Configuration Class</b> | <b>Pre-compile time</b>   | X  | All Variants |
|   | <b>Link time</b>  | -- |              |
|   | <b>Post-build time</b>  | -- |              |
| <b>Value Configuration Class</b>        | <b>Pre-compile time</b>   | X  | All Variants |
|   | <b>Link time</b>  | -- |              |
|   | <b>Post-build time</b>  | -- |              |
| <b>Scope / Dependency</b>               | scope: local  |    |              |

|                         |   |  |  |
|-------------------------|---|--|--|
| <b>SWS Item</b>         | <b>ECUC_Fee_00113 :</b>   |  |  |
| <b>Name</b>             | FeeNvmJobErrorNotification  |  |  |
| <b>Parent Container</b> | FeeGeneral  |  |  |
| <b>Description</b>      | Mapped to the job error notification routine provided by the upper layer module (NvM_JobErrorNotification). |  |  |
| <b>Multiplicity</b>     | 0..1  |  |  |
| <b>Type</b>             | EcucFunctionNameDef   |  |  |

|   |                         |    |              |
|---|-------------------------|----|--------------|
| <b>Default value</b>                    | --                      |    |              |
| <b>maxLength</b>                        | --                      |    |              |
| <b>minLength</b>                        | --                      |    |              |
| <b>regularExpression</b>                | --                      |    |              |
| <b>Post-Build Variant Multiplicity</b>  | false                   |    |              |
| <b>Post-Build Variant Value</b>         | false                   |    |              |
| <b>Multiplicity Configuration Class</b> | <b>Pre-compile time</b> | X  | All Variants |
|   | <b>Link time</b>        | -- |              |
|   | <b>Post-build time</b>  | -- |              |
| <b>Value Configuration Class</b>        | <b>Pre-compile time</b> | X  | All Variants |
|   | <b>Link time</b>        | -- |              |
|   | <b>Post-build time</b>  | -- |              |
| <b>Scope / Dependency</b>               | scope: local            |    |              |

|                                  |  |    |              |
|----------------------------------|--|----|--------------|
| <b>SWS Item</b>                  | <b>ECUC_Fee_00114 :</b>  |    |              |
| <b>Name</b>                      | FeePollingMode   |    |              |
| <b>Parent Container</b>          | FeeGeneral   |    |              |
| <b>Description</b>               | <p>Pre-processor switch to enable and disable the polling mode for this module.</p> <p>true: Polling mode enabled, callback functions (provided to FLS module) disabled.</p> <p>false: Polling mode disabled, callback functions (provided to FLS module) enabled.</p> |    |              |
| <b>Multiplicity</b>              | 1  |    |              |
| <b>Type</b>                      | EcucBooleanParamDef  |    |              |
| <b>Default value</b>             | --   |    |              |
| <b>Post-Build Variant Value</b>  | false  |    |              |
| <b>Value Configuration Class</b> | <b>Pre-compile time</b>  | X  | All Variants |
|                                  | <b>Link time</b>   | -- |              |
|                                  | <b>Post-build time</b>   | -- |              |
| <b>Scope / Dependency</b>        | scope: local   |    |              |

|                                  |  |    |              |
|----------------------------------|--|----|--------------|
| <b>SWS Item</b>                  | <b>ECUC_Fee_00119 :</b>  |    |              |
| <b>Name</b>                      | FeeSetModeSupported  |    |              |
| <b>Parent Container</b>          | FeeGeneral   |    |              |
| <b>Description</b>               | <p>Compiler switch to enable/disable the 'SetMode' functionality of the FEE module.</p> <p>TRUE: SetMode functionality supported / code present,<br/>FALSE: SetMode functionality not supported / code not present.</p> <p>Note:<br/>This configuration setting has to be consistent with that of all underlying flash device drivers (configuration parameter FIsSetModeApi).</p> |    |              |
| <b>Multiplicity</b>              | 1  |    |              |
| <b>Type</b>                      | EcucBooleanParamDef  |    |              |
| <b>Default value</b>             | --   |    |              |
| <b>Post-Build Variant Value</b>  | false  |    |              |
| <b>Value Configuration Class</b> | <b>Pre-compile time</b>  | X  | All Variants |
|                                  | <b>Link time</b>   | -- |              |
|                                  | <b>Post-build time</b>   | -- |              |
| <b>Scope / Dependency</b>        | scope: local   |    |              |

|                 |                         |  |  |
|-----------------|-------------------------|--|--|
| <b>SWS Item</b> | <b>ECUC_Fee_00115 :</b> |  |  |
| <b>Name</b>     | FeeVersionInfoApi       |  |  |

|                                  |   |    |              |
|----------------------------------|---|----|--------------|
| <b>Parent Container</b>          | FeeGeneral  |    |              |
| <b>Description</b>               | Pre-processor switch to enable / disable the API to read out the modules version information.<br>true: Version info API enabled.<br>false: Version info API disabled. |    |              |
| <b>Multiplicity</b>              | 1   |    |              |
| <b>Type</b>                      | EcucBooleanParamDef   |    |              |
| <b>Default value</b>             | false   |    |              |
| <b>Post-Build Variant Value</b>  | false   |    |              |
| <b>Value Configuration Class</b> | <b>Pre-compile time</b>   | X  | All Variants |
|                                  | <b>Link time</b>  | -- |              |
|                                  | <b>Post-build time</b>  | -- |              |
| <b>Scope / Dependency</b>        | scope: local  |    |              |

|                                  |   |    |              |
|----------------------------------|---|----|--------------|
| <b>SWS Item</b>                  | <b>ECUC_Fee_00116 :</b>                                     |    |              |
| <b>Name</b>                      | FeeVirtualPageSize  |    |              |
| <b>Parent Container</b>          | FeeGeneral  |    |              |
| <b>Description</b>               | The size in bytes to which logical blocks shall be aligned. |    |              |
| <b>Multiplicity</b>              | 1   |    |              |
| <b>Type</b>                      | EcucIntegerParamDef   |    |              |
| <b>Range</b>                     | 0 .. 65535  |    |              |
| <b>Default value</b>             | --  |    |              |
| <b>Post-Build Variant Value</b>  | false   |    |              |
| <b>Value Configuration Class</b> | <b>Pre-compile time</b>                                     | X  | All Variants |
|                                  | <b>Link time</b>  | -- |              |
|                                  | <b>Post-build time</b>                                      | -- |              |
| <b>Scope / Dependency</b>        | scope: local  |    |              |

#### No Included Containers

### 10.1.3 FeeBlockConfiguration

|                                 |   |  |  |
|---------------------------------|---|--|--|
| <b>SWS Item</b>                 | <b>ECUC_Fee_00040 :</b>   |  |  |
| <b>Container Name</b>           | FeeBlockConfiguration   |  |  |
| <b>Parent Container</b>         | Fee   |  |  |
| <b>Description</b>              | Configuration of block specific parameters for the Flash EEPROM Emulation module. |  |  |
| <b>Configuration Parameters</b> |   |  |  |

|                         |  |  |  |
|-------------------------|--|--|--|
| <b>SWS Item</b>         | <b>ECUC_Fee_00150 :</b>  |  |  |
| <b>Name</b>             | FeeBlockNumber   |  |  |
| <b>Parent Container</b> | FeeBlockConfiguration  |  |  |
| <b>Description</b>      | Block identifier (handle).<br>0x0000 and 0xFFFF shall not be used for block numbers (see FEE006).<br><br>Range:<br>min = 2 <sup>NVM_DATASET_SELECTION_BITS</sup><br>max = 0xFFFF - 2 <sup>NVM_DATASET_SELECTION_BITS</sup><br><br>Note: Depending on the number of bits set aside for dataset selection several other block numbers shall also be left out to ease implementation. |  |  |
| <b>Multiplicity</b>     | 1  |  |  |
| <b>Type</b>             | EcucIntegerParamDef (Symbolic Name generated for this parameter)   |  |  |
| <b>Range</b>            | 1 .. 65534   |  |  |

|                                  |                         |    |              |
|----------------------------------|-------------------------|----|--------------|
| <b>Default value</b>             | --                      |    |              |
| <b>Post-Build Variant Value</b>  | false                   |    |              |
| <b>Value Configuration Class</b> | <b>Pre-compile time</b> | X  | All Variants |
|                                  | <b>Link time</b>        | -- |              |
|                                  | <b>Post-build time</b>  | -- |              |
| <b>Scope / Dependency</b>        | scope: ECU              |    |              |

|                                  |                                   |    |              |
|----------------------------------|-----------------------------------|----|--------------|
| <b>SWS Item</b>                  | <b>ECUC_Fee_00148 :</b>           |    |              |
| <b>Name</b>                      | FeeBlockSize                      |    |              |
| <b>Parent Container</b>          | FeeBlockConfiguration             |    |              |
| <b>Description</b>               | Size of a logical block in bytes. |    |              |
| <b>Multiplicity</b>              | 1                                 |    |              |
| <b>Type</b>                      | EcucIntegerParamDef               |    |              |
| <b>Range</b>                     | 1 .. 65535                        |    |              |
| <b>Default value</b>             | --                                |    |              |
| <b>Post-Build Variant Value</b>  | false                             |    |              |
| <b>Value Configuration Class</b> | <b>Pre-compile time</b>           | X  | All Variants |
|                                  | <b>Link time</b>                  | -- |              |
|                                  | <b>Post-build time</b>            | -- |              |
| <b>Scope / Dependency</b>        | scope: ECU                        |    |              |

|                                  |   |    |              |
|----------------------------------|---|----|--------------|
| <b>SWS Item</b>                  | <b>ECUC_Fee_00151 :</b>   |    |              |
| <b>Name</b>                      | FeeImmediateData  |    |              |
| <b>Parent Container</b>          | FeeBlockConfiguration   |    |              |
| <b>Description</b>               | Marker for high priority data.<br>true: Block contains immediate data.<br>false: Block does not contain immediate data. |    |              |
| <b>Multiplicity</b>              | 1   |    |              |
| <b>Type</b>                      | EcucBooleanParamDef   |    |              |
| <b>Default value</b>             | --  |    |              |
| <b>Post-Build Variant Value</b>  | false   |    |              |
| <b>Value Configuration Class</b> | <b>Pre-compile time</b>   | X  | All Variants |
|                                  | <b>Link time</b>  | -- |              |
|                                  | <b>Post-build time</b>  | -- |              |
| <b>Scope / Dependency</b>        | scope: ECU  |    |              |

|                                  |   |    |              |
|----------------------------------|---|----|--------------|
| <b>SWS Item</b>                  | <b>ECUC_Fee_00110 :</b>                         |    |              |
| <b>Name</b>                      | FeeNumberOfWriteCycles                          |    |              |
| <b>Parent Container</b>          | FeeBlockConfiguration                           |    |              |
| <b>Description</b>               | Number of write cycles required for this block. |    |              |
| <b>Multiplicity</b>              | 1   |    |              |
| <b>Type</b>                      | EcucIntegerParamDef                             |    |              |
| <b>Range</b>                     | 0 .. 4294967295                                 |    |              |
| <b>Default value</b>             | --  |    |              |
| <b>Post-Build Variant Value</b>  | false   |    |              |
| <b>Value Configuration Class</b> | <b>Pre-compile time</b>                         | X  | All Variants |
|                                  | <b>Link time</b>                                | -- |              |
|                                  | <b>Post-build time</b>                          | -- |              |
| <b>Scope / Dependency</b>        | scope: local                                    |    |              |

|                         |  |  |  |
|-------------------------|--|--|--|
| <b>SWS Item</b>         | <b>ECUC_Fee_00149 :</b>                          |  |  |
| <b>Name</b>             | FeeDeviceIndex                                   |  |  |
| <b>Parent Container</b> | FeeBlockConfiguration                            |  |  |
| <b>Description</b>      | Reference to the device this block is stored in. |  |  |
| <b>Multiplicity</b>     | 1  |  |  |
| <b>Type</b>             | Symbolic name reference to [ FlsGeneral ]        |  |  |

|                                  |   |    |              |
|----------------------------------|---|----|--------------|
| <b>Post-Build Variant Value</b>  | false   |    |              |
| <b>Value Configuration Class</b> | <b>Pre-compile time</b>   | X  | All Variants |
|                                  | <b>Link time</b>  | -- |              |
|                                  | <b>Post-build time</b>  | -- |              |
| <b>Scope / Dependency</b>        | scope: local<br>dependency: This information is needed by the NVRAM manager respectively the Memory Abstraction Interface to address a certain logical block. It is listed in this specification to give a complete overview over all block related configuration parameters. |    |              |

#### No Included Containers

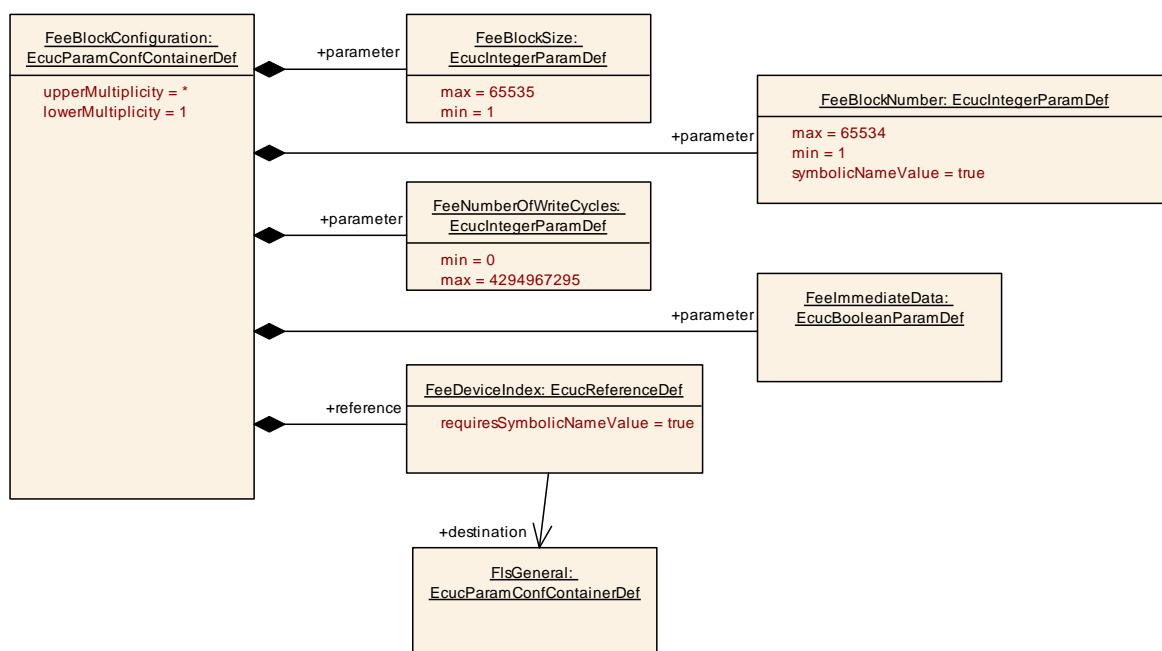


Figure 8: Overview of configuration parameters of FeeBlockConfiguration

## 10.2 Published Information

### 10.2.1 FeePublishedInformation

|                                 |   |
|---------------------------------|---|
| <b>SWS Item</b>                 | <b>ECUC_Fee_00043 :</b>   |
| <b>Container Name</b>           | FeePublishedInformation   |
| <b>Parent Container</b>         | Fee   |
| <b>Description</b>              | Additional published parameters not covered by CommonPublishedInformation container.<br><br>Note that these parameters do not have any configuration class setting, since they are published information. |
| <b>Configuration Parameters</b> |   |

|                                  |   |   |              |
|----------------------------------|---|---|--------------|
| <b>SWS Item</b>                  | <b>ECUC_Fee_00117 :</b>   |   |              |
| <b>Name</b>                      | FeeBlockOverhead  |   |              |
| <b>Parent Container</b>          | FeePublishedInformation   |   |              |
| <b>Description</b>               | Management overhead per logical block in bytes.<br>Note: If the management overhead depends on the block size or block location a formula has to be provided that allows the configurator to calculate the management overhead correctly. |   |              |
| <b>Multiplicity</b>              | 1   |   |              |
| <b>Type</b>                      | EcucIntegerParamDef   |   |              |
| <b>Range</b>                     | 0 .. 65535  |   |              |
| <b>Default value</b>             | --  |   |              |
| <b>Post-Build Variant Value</b>  | false   |   |              |
| <b>Value Configuration Class</b> | <b>Published Information</b>  | X | All Variants |
| <b>Scope / Dependency</b>        | scope: local  |   |              |

|                                  |  |   |              |
|----------------------------------|--|---|--------------|
| <b>SWS Item</b>                  | <b>ECUC_Fee_00118 :</b>  |   |              |
| <b>Name</b>                      | FeePageOverhead  |   |              |
| <b>Parent Container</b>          | FeePublishedInformation  |   |              |
| <b>Description</b>               | Management overhead per page in bytes.<br>Note: If the management overhead depends on the block size or block location a formula has to be provided that allows the configurator to calculate the management overhead correctly. |   |              |
| <b>Multiplicity</b>              | 1  |   |              |
| <b>Type</b>                      | EcucIntegerParamDef  |   |              |
| <b>Range</b>                     | 0 .. 65535   |   |              |
| <b>Default value</b>             | --   |   |              |
| <b>Post-Build Variant Value</b>  | false  |   |              |
| <b>Value Configuration Class</b> | <b>Published Information</b>   | X | All Variants |
| <b>Scope / Dependency</b>        | scope: local   |   |              |

|                               |
|-------------------------------|
| <b>No Included Containers</b> |
|-------------------------------|



## 11 Not applicable requirements

**[SWS\_Fee\_00999]** 「 These requirements are not applicable to this specification. 」

(SRS\_BSW\_00344, SRS\_BSW\_00404, SRS\_BSW\_00405, SRS\_BSW\_00171,  
SRS\_BSW\_00170, SRS\_BSW\_00380, SRS\_BSW\_00412, SRS\_BSW\_00398,  
SRS\_BSW\_00399, SRS\_BSW\_00400, SRS\_BSW\_00375, SRS\_BSW\_00416,  
SRS\_BSW\_00168, SRS\_BSW\_00423, SRS\_BSW\_00424, SRS\_BSW\_00425,  
SRS\_BSW\_00426, SRS\_BSW\_00427, SRS\_BSW\_00428, SRS\_BSW\_00429,  
SRS\_BSW\_00432, SRS\_BSW\_00433, SRS\_BSW\_00336, SRS\_BSW\_00339,  
SRS\_BSW\_00422, SRS\_BSW\_00417, SRS\_BSW\_00323, SRS\_BSW\_00161,  
SRS\_BSW\_00005, SRS\_BSW\_00415, SRS\_BSW\_00164, SRS\_BSW\_00342,  
SRS\_BSW\_00160, SRS\_BSW\_00007, SRS\_BSW\_00300, SRS\_BSW\_00347,  
SRS\_BSW\_00307, SRS\_BSW\_00314, SRS\_BSW\_00348, SRS\_BSW\_00353,  
SRS\_BSW\_00361, SRS\_BSW\_00302, SRS\_BSW\_00328, SRS\_BSW\_00312,  
SRS\_BSW\_00006, SRS\_BSW\_00304, SRS\_BSW\_00378, SRS\_BSW\_00306,  
SRS\_BSW\_00308, SRS\_BSW\_00309, SRS\_BSW\_00371, SRS\_BSW\_00359,  
SRS\_BSW\_00360, SRS\_BSW\_00330, SRS\_BSW\_00009, SRS\_BSW\_00401,  
SRS\_BSW\_00172, SRS\_BSW\_00010, SRS\_BSW\_00333, SRS\_BSW\_00321,  
SRS\_BSW\_00341, SRS\_BSW\_00334, SRS\_SPAL\_12263, SRS\_SPAL\_12056,  
SRS\_SPAL\_12267, SRS\_SPAL\_12125, SRS\_SPAL\_12163, SRS\_SPAL\_12461,  
SRS\_SPAL\_12462, SRS\_SPAL\_12463, SRS\_SPAL\_12068, SRS\_SPAL\_12069,  
SRS\_SPAL\_00157, SRS\_SPAL\_12063, SRS\_SPAL\_12129, SRS\_SPAL\_12064,  
SRS\_SPAL\_12067, SRS\_SPAL\_12077, SRS\_SPAL\_12078, SRS\_SPAL\_12092,  
SRS\_SPAL\_12265, SRS\_MemHwAb\_14017)