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Document Change History			
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1 Introduction and functional overview

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

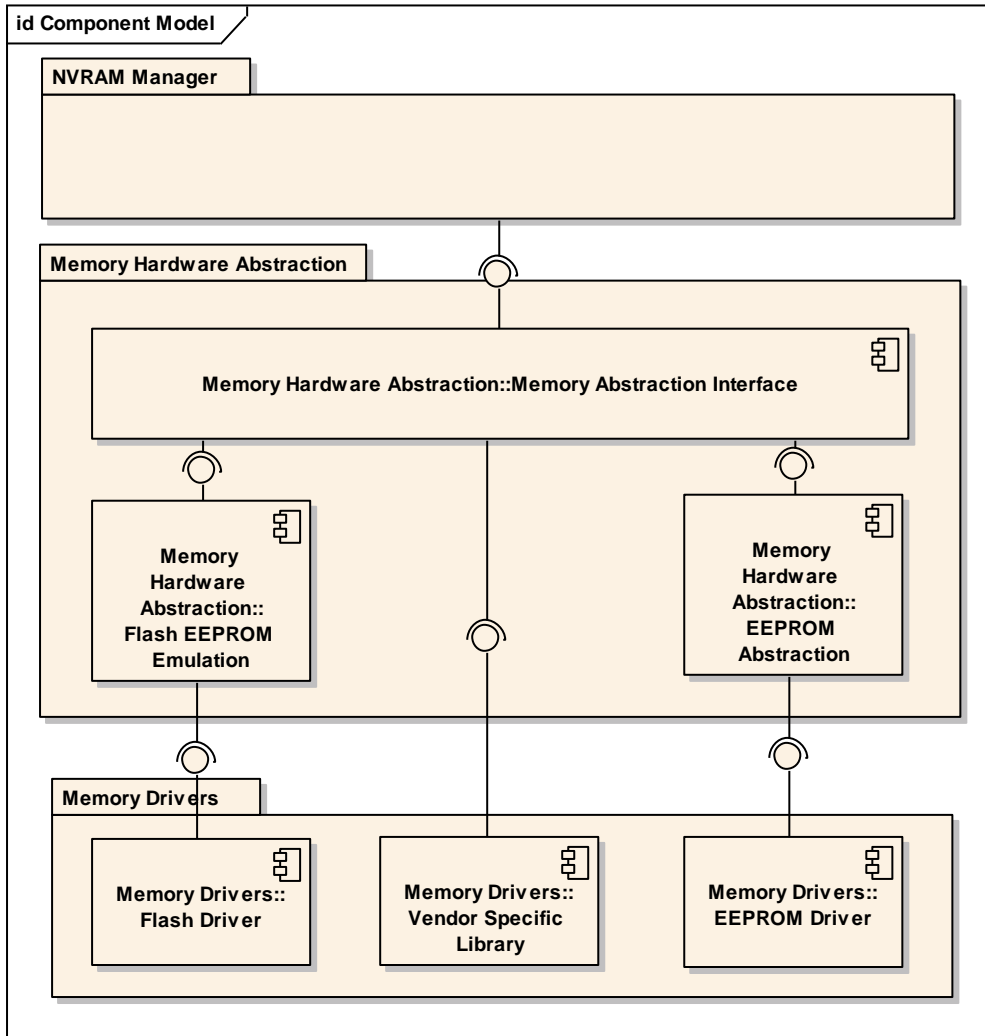


Figure 1: Module overview of memory hardware abstraction layer

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.

Abbreviation / Acronym:	Description:
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. 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 μ 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 μ 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

	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

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_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_00333	For each callback function it shall be specified if it is called from interrupt context or not	SWS_Fee_00999
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	SWS_Fee_00999

	able to shutdown	
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 seperation 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 is forbidden for all AUTOSAR Basic Software Modules	SWS_Fee_00999
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_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_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
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	SWS_Fee_00999

	one module shall be separated into a dedicated header file	
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	SWS_Fee_00005, SWS_Fee_00071,

	shall allow the configuration of the alignment of the start and end addresses of logical blocks	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 shall detect possible data inconsistencies due to aborted / interrupted write operations	SWS_Fee_00023, SWS_Fee_00049, 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	SWS_Fee_00999

	of an EEPROM driver	
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.

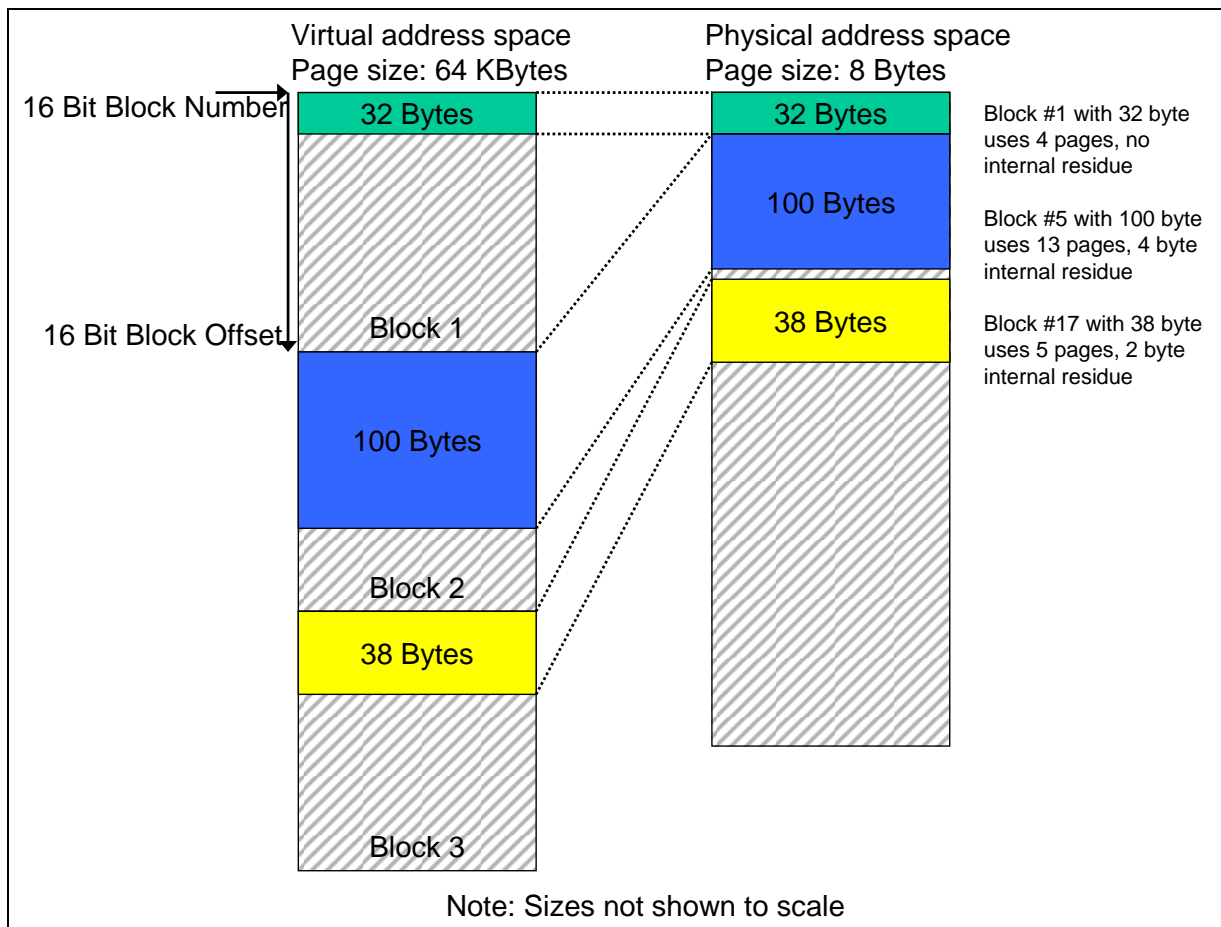


Figure 2: Virtual vs. physical memory layout

[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 MSB's) to this start address (Figure 3).

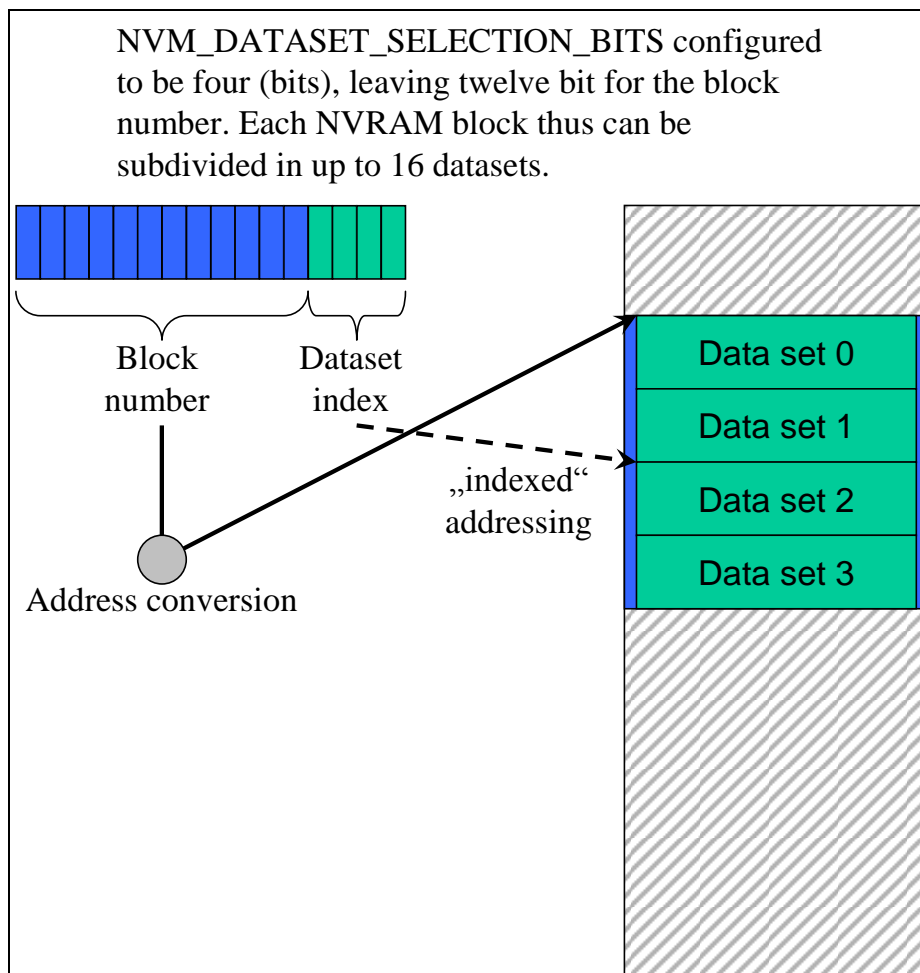


Figure 3: Block number and dataset index

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”¹.] (SRS_MemHwAb_14014)

[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

[SWS_Fee_00010] [The FEE module shall detect the following errors and exceptions depending on its configuration (development/production):

7.2.1 Development Errors

Type or error	Relevance	Related error code	Value [hex]
API service called when module was not initialized	Development	FEE_E_UNINIT	0x01
API service called with invalid block number	Development	FEE_E_INVALID_BLOCK_NO	0x02
API service called with invalid block offset	Development	FEE_E_INVALID_BLOCK_OFS	0x03
API service called with invalid data pointer	Development	FEE_E_PARAM_POINTER	0x04
API service called with invalid length information	Development	FEE_E_INVALID_BLOCK_LEN	0x05
Fee_Init failed.	Development	FEE_E_INIT_FAILED	0x09

] (SRS_BSW_00406, SRS_BSW_00337, SRS_BSW_00386, SRS_BSW_00327, SRS_BSW_00331)

¹ 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.

7.2.2 Runtime Errors

<i>Type or error</i>	<i>Relevance</i>	<i>Related error code</i>	<i>Value [hex]</i>
API service called while module is busy processing a user request	Runtime	FEE_E_BUSY	0x06
Fee_Cancel called while no job was pending.	Runtime	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]

<i>Module</i>	<i>Header File</i>	<i>Imported Type</i>
Fls	Fls.h	Fls_AddressType
	Fls.h	Fls_LengthType
Memlf	Memlf.h	Memlf_JobResultType
	Memlf.h	Memlf_ModeType
	Memlf.h	Memlf_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]

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

](SRS_BSW_00414)

8.3 Function definitions

8.3.1 Fee_Init

[SWS_Fee_00085][

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

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

Parameters (in)	Mode	Desired mode for the underlying flash driver
Parameters (inout)	None	
Parameters (out)	None	
Return value	None	
Description	Function to switch the mode of the underlying Flash Driver	
Available via	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] |

Service Name	Fee_Read
Syntax	<pre>Std_ReturnType Fee_Read (uint16 BlockNumber, uint16 BlockOffset, uint8* DataBufferPtr, uint16 Length)</pre>
Service ID [hex]	0x02
Sync/Async	Asynchronous
Reentrancy	Non Reentrant

Parameters (in)	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
Parameters (inout)	None	
Parameters (out)	DataBufferPtr	Pointer to data buffer
Return value	Std_Return-Type	E_OK: The requested job has been accepted by the module. E_NOT_OK: The requested job has not been accepted by the module.
Description	Service to initiate a read job.	
Available via	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][

Service Name	Fee_Write
---------------------	-----------

Syntax	<pre>Std_ReturnType Fee_Write (uint16 BlockNumber, const uint8* DataBufferPtr)</pre>	
Service ID [hex]	0x03	
Sync/Async	Asynchronous	
Reentrancy	Non Reentrant	
Parameters (in)	BlockNumber	Number of logical block, also denoting start address of that block in EEPROM.
	DataBufferPtr	Pointer to data buffer
Parameters (inout)	None	
Parameters (out)	None	
Return value	Std_Return-Type	E_OK: The requested job has been accepted by the module. E_NOT_OK: The requested job has not been accepted by the module.
Description	Service to initiate a write job.	
Available via	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`.] (SRS_MemHwAb_14010)

[SWS_Fee_00174] [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`.] (RS_BRF_01048)

[SWS_Fee_00026] [The FEE module shall execute the write operation asynchronously within the FEE module's main function.] (SRS_MemHwAb_14010, RS_BRF_01048)

[SWS_Fee_00123] [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`.] (SRS_BSW_00406)

[SWS_Fee_00144] [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`.] (RS_BRF_01048)

[SWS_Fee_00138] [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`.] (SRS_BSW_00323)

[SWS_Fee_00139] [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`.] (SRS_BSW_00323)

[SWS_Fee_00163] [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.] (RS_BRF_01048)

8.3.5 Fee_Cancel

[SWS_Fee_00089][

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

Service Name	Fee_GetStatus
--------------	---------------

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

Service Name	Fee_GetJobResult
---------------------	------------------

Syntax	MemIf_JobResultType Fee_GetJobResult (void)	
Service ID [hex]	0x06	
Sync/Async	Synchronous	
Reentrancy	Non Reentrant	
Parameters (in)	None	
Parameters (inout)	None	
Parameters (out)	None	
Return value	MemIf_Job- ResultType	MEMIF_JOB_OK: The last job has been finished successfully. MEMIF_JOB_PENDING: The last job is waiting for execution or currently being executed. MEMIF_JOB_CANCELED: The last job has been canceled (which means it failed). MEMIF_JOB_FAILED: The last job has not been finished successfully (it failed). MEMIF_BLOCK_INCONSISTENT: The requested block is inconsistent, it may contain corrupted data. MEMIF_BLOCK_INVALID: The requested block has been invalidated, the requested read operation can not be performed.
Description	Service to query the result of the last accepted job issued by the upper layer software.	
Available via	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][

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

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

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

Return value	Std_Return-Type	E_OK: The requested job has been accepted by the module. E_NOT_OK - only if DET is enabled: The requested job has not been accepted by the module.
Description	Service to erase a logical block.	
Available via	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]

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

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

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

API Function	Header File	Description
Det_Report- 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_ 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][

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

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

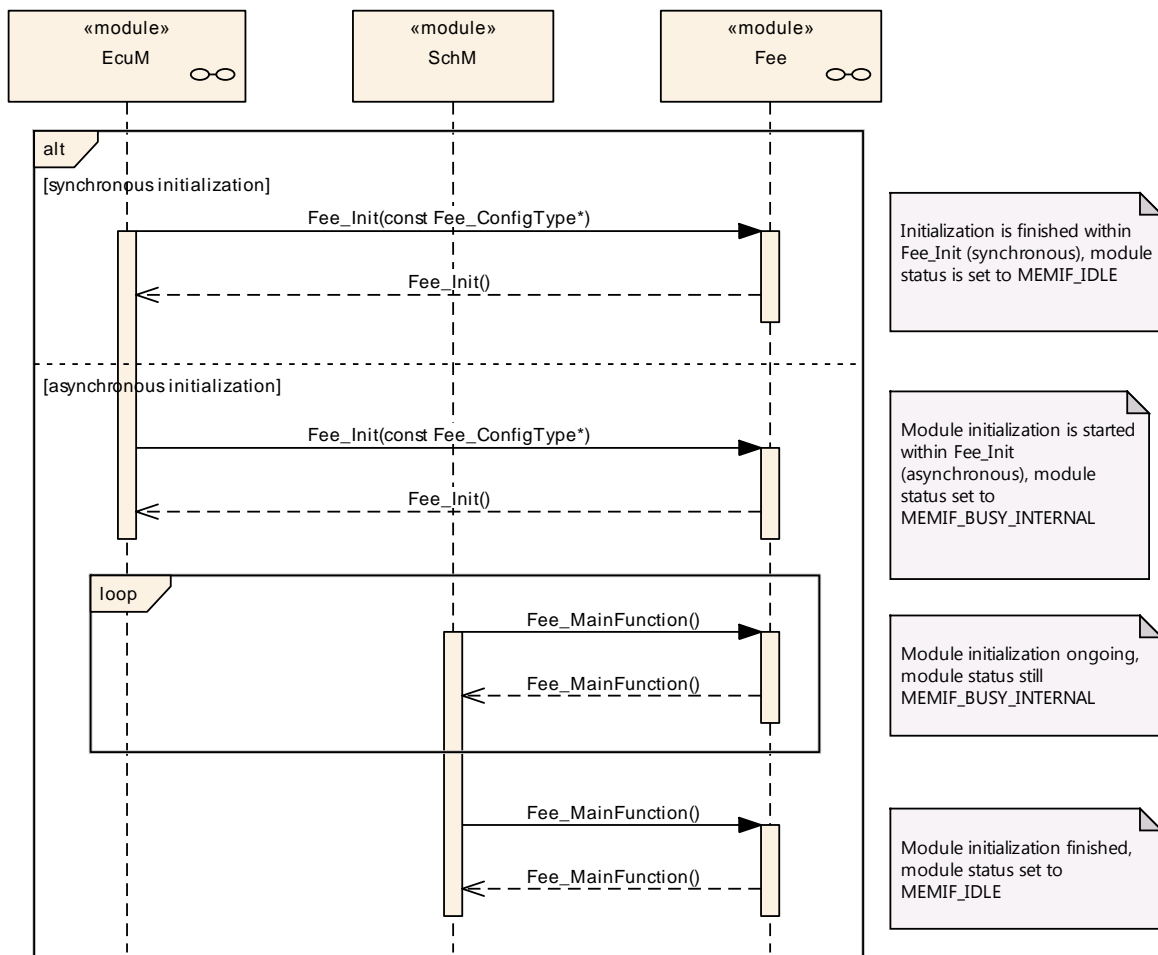


Figure 4: Sequence diagram of Fee_Init

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.

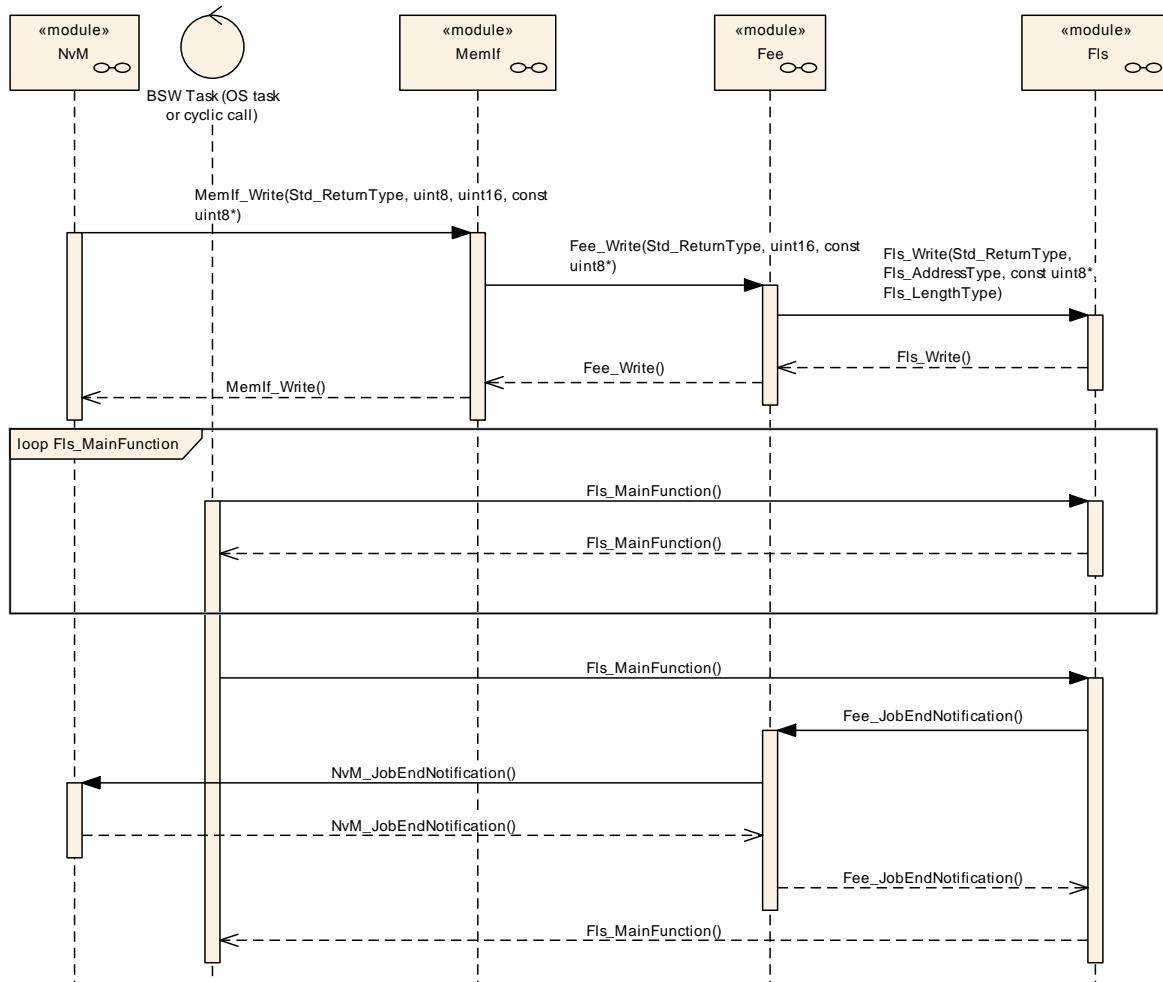


Figure 5: Sequence diagram of `Fee_Write`

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.

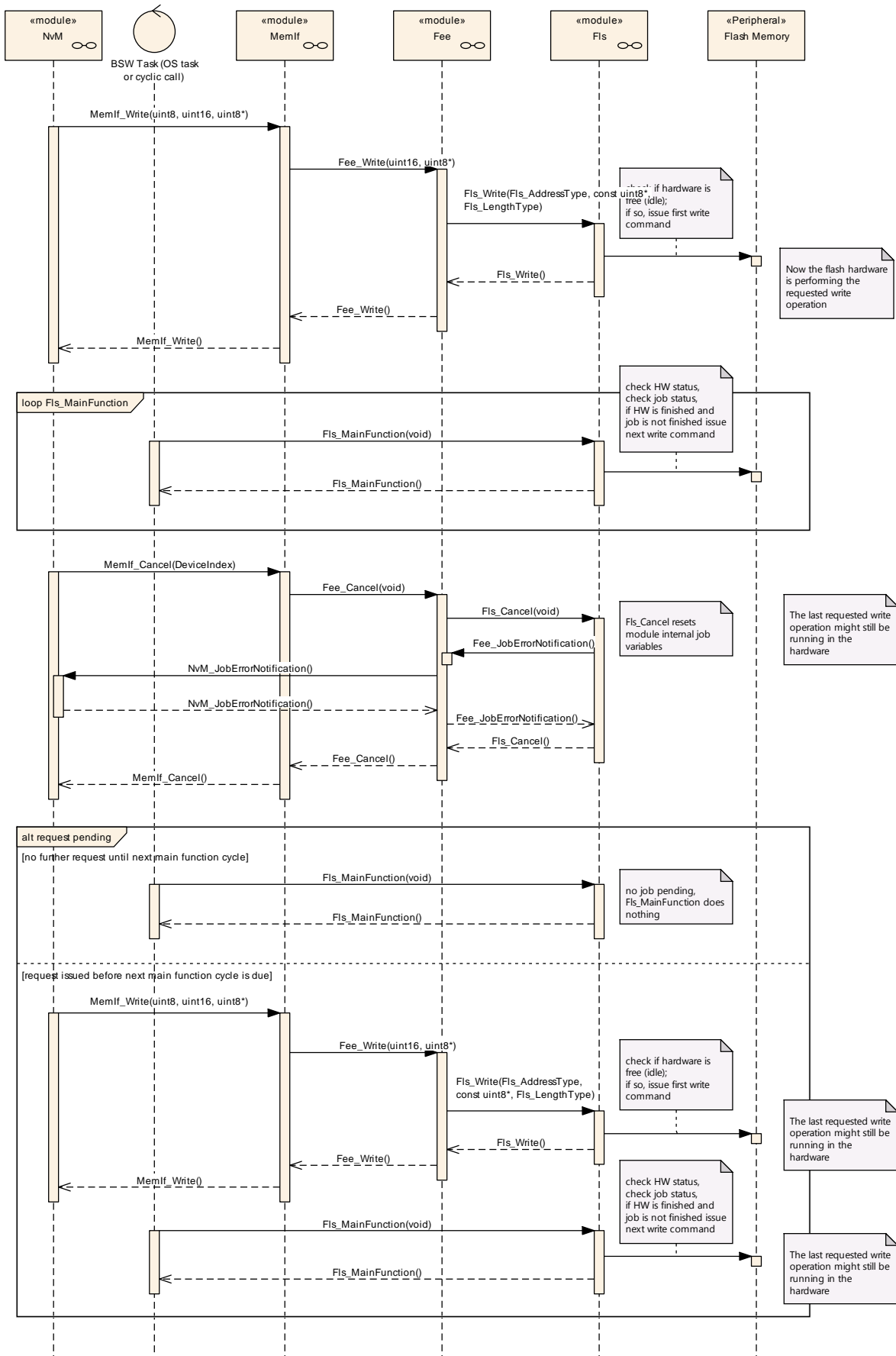


Figure 6: Sequence diagram of Fee_Cancel

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

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

Included Containers		
Container Name	Multiplicity	Scope / Dependency
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. Note that these parameters do not have any configuration class setting, since they are published information.

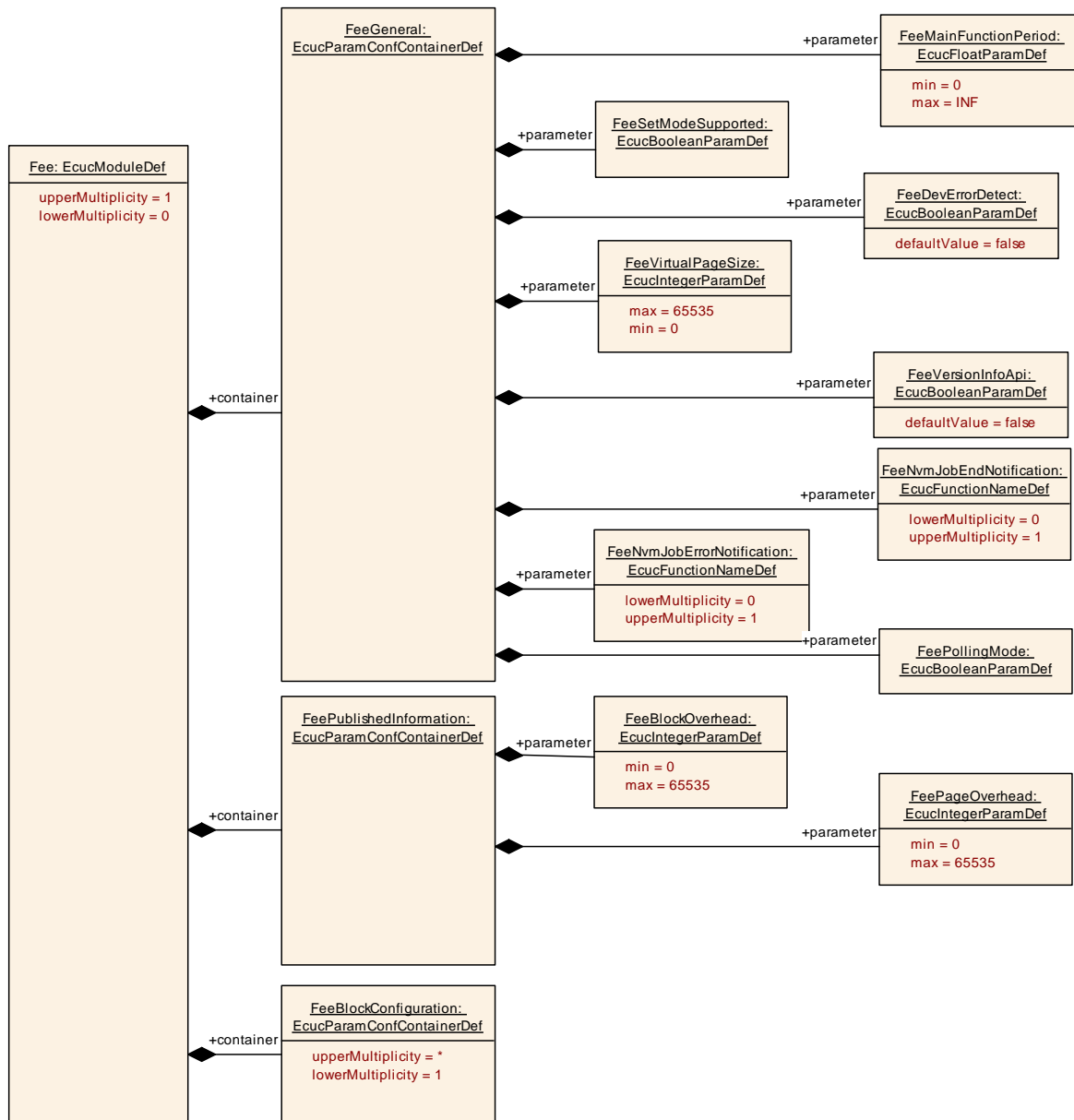


Figure 7: Overview of configuration parameters of Fee

10.1.2 FeeGeneral

SWS Item	ECUC_Fee_00039 :
Container Name	FeeGeneral
Parent Container	Fee
Description	Container for general parameters. These parameters are not specific to a block.
Configuration Parameters	

SWS Item	ECUC_Fee_00111 :
Name	FeeDevErrorDetect
Parent Container	FeeGeneral
Description	Switches the development error detection and notification on or off.

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

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

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

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

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

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

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

SWS Item	ECUC_Fee_00115 :		
Name	FeeVersionInfoApi		

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

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

No Included Containers

10.1.3 FeeBlockConfiguration

SWS Item	ECUC_Fee_00040 :		
Container Name	FeeBlockConfiguration		
Parent Container	Fee		
Description	Configuration of block specific parameters for the Flash EEPROM Emulation module.		
Configuration Parameters			

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

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

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

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

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

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

Post-Build Variant Value	false		
Value Configuration Class	Pre-compile time	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local 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

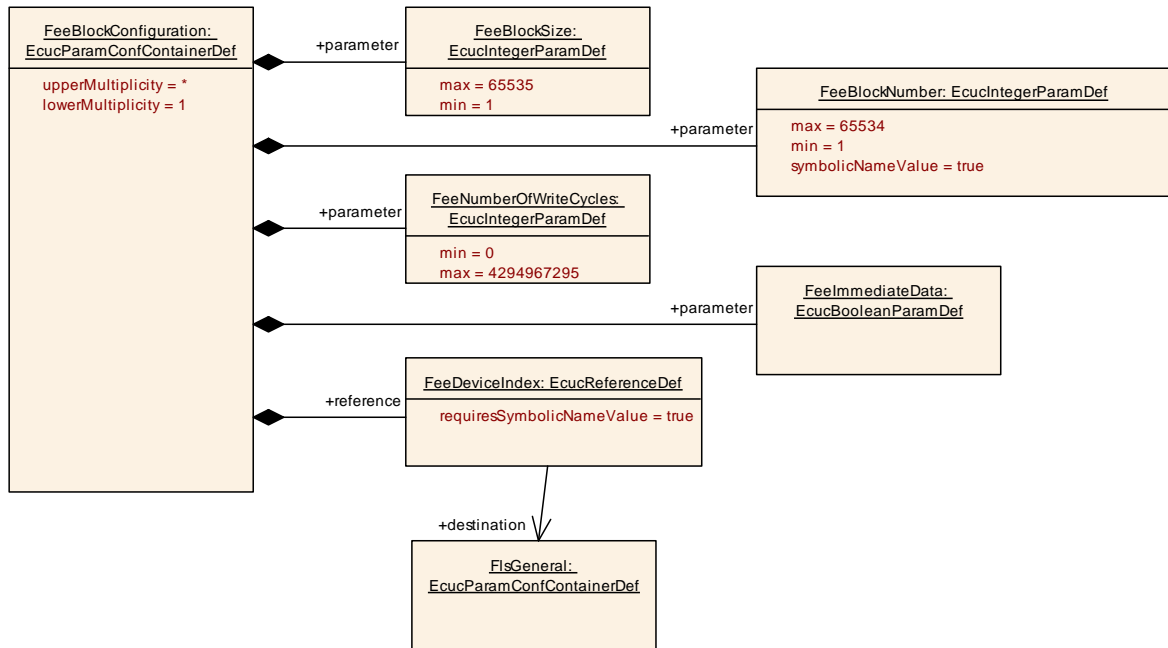


Figure 8: Overview of configuration parameters of FeeBlockConfiguration

10.2 Published Information

10.2.1 FeePublishedInformation

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

SWS Item	ECUC_Fee_00117 :
Name	FeeBlockOverhead
Parent Container	FeePublishedInformation
Description	Management overhead per logical block in bytes. 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.
Multiplicity	1
Type	EcucIntegerParamDef
Range	0 .. 65535
Default value	--
Post-Build Variant Value	false
Value Configuration Class	Published Information X All Variants
Scope / Dependency	scope: local

SWS Item	ECUC_Fee_00118 :
Name	FeePageOverhead
Parent Container	FeePublishedInformation
Description	Management overhead per page in bytes. 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.
Multiplicity	1
Type	EcucIntegerParamDef
Range	0 .. 65535
Default value	--
Post-Build Variant Value	false
Value Configuration Class	Published Information X All Variants
Scope / Dependency	scope: local

No Included Containers

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)