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1 Introduction and functional overview

This specification describes the functionality, API and configuration of the AUTOSAR Basic Software Module “Memory Abstraction Interface” (MemIf). This module allows the NVRAM manager to access several memory abstraction modules (FEE or EA modules) (see Figure 1).

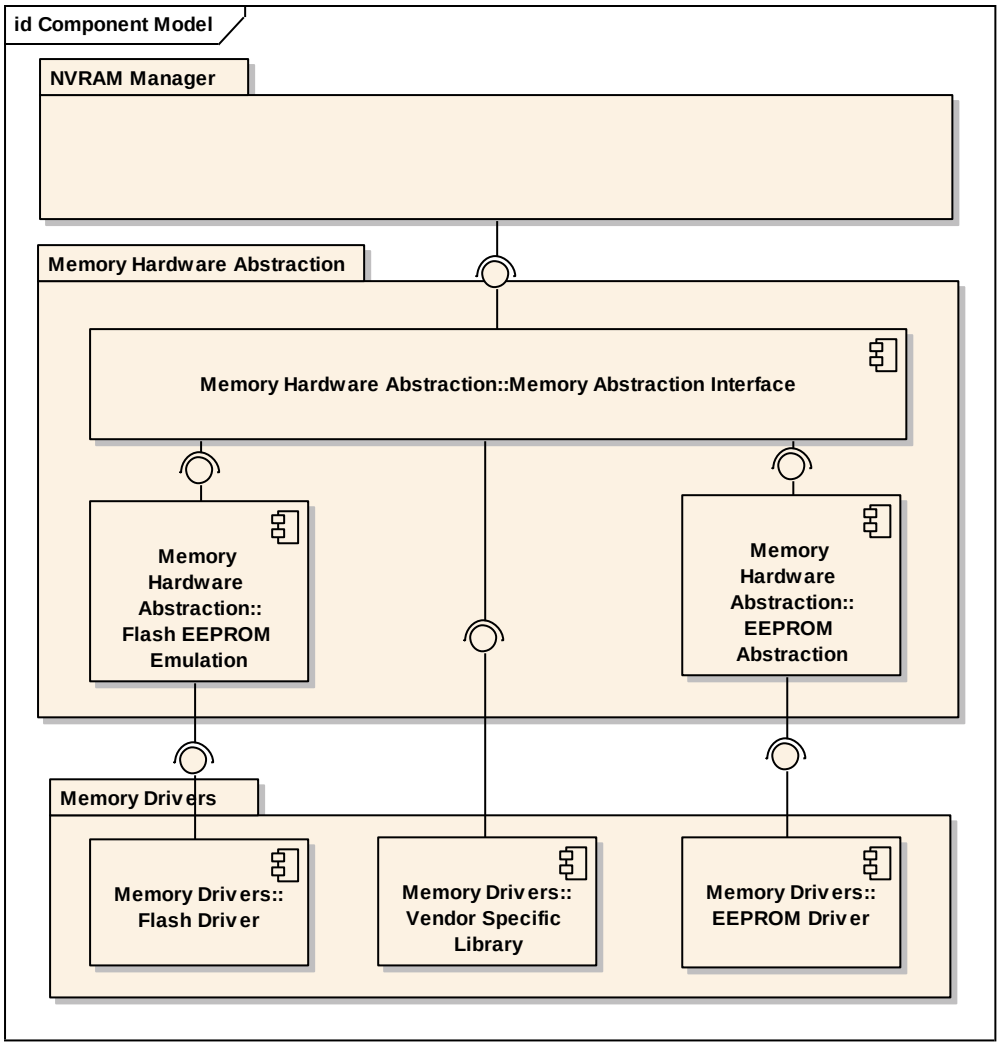

Figure 1: Module overview of memory hardware abstraction layer

The Memory Abstraction Interface (MemIf) shall abstract from the number of underlying FEE or EA modules and provide upper layers with a virtual segmentation on a uniform linear address space.

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 it's bit.
MemIf	Memory Abstraction Interface
MSB	Most significant bit / byte (depending on context). Here it's bit.
NvM	NVRAM Manager
NVRAM	Non-volatile RAM (Random Access Memory)
Fast Mode	E.g. during startup / shutdown the underlying driver may be switched into fast mode in order to allow for fast reading / writing in those phases. *Note: Whether this is possible depends on the implementation of the driver and the capabilities of the underlying device. Whether it is done depends on the configuration of the NVRAM manager and thus on the needs of a specific project.*
Slow Mode	During normal operation the underlying driver may be used in slow mode in order to reduce the resource usage in terms of runtime or blocking time of the underlying device / communication media. *Note: Whether this is possible depends on the implementation of the driver and the capabilities of the underlying device. Whether it is done depends on the configuration of the NVRAM manager and thus on the needs of a specific project.*
Vendor specific library	A vendor specific library is an ICC-2 implementation of the FEE/FLS and EA/EEP modules respectively. It provides the same upper layer interface (API) and functionality as the corresponding ICC-3 implementation.

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.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 Development Error Tracer
AUTOSAR_SWS_DevelopmentErrorTracer.pdf

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

3.2 Related standards and norms

[7] Specification of NVRAM Manager
AUTOSAR_SWS_NVRAMManager.doc

[8] Specification of Flash EEPROM Emulation
AUTOSAR_SWS_FlashEEPROMEmulation.pdf

[9] Specification of EEPROM Abstraction
AUTOSAR_SWS_EEPROMAbstraction.pdf

3.3 Related specification

4 Constraints and assumptions

4.1 Limitations

No limitations.

4.2 Applicability to car domains

No restrictions.

5 Dependencies to other modules

5.1 Header File structure

[SWS_MemIf_00002] ⌈The file include structure shall be as follows: ⌋ (SRS_BSW_00381, SRS_BSW_00383; SRS_BSW_00384, SRS_BSW_00346, SRS_BSW_00158, SRS_BSW_00435. SRS_BSW_00436, SRS_BSW_00301)

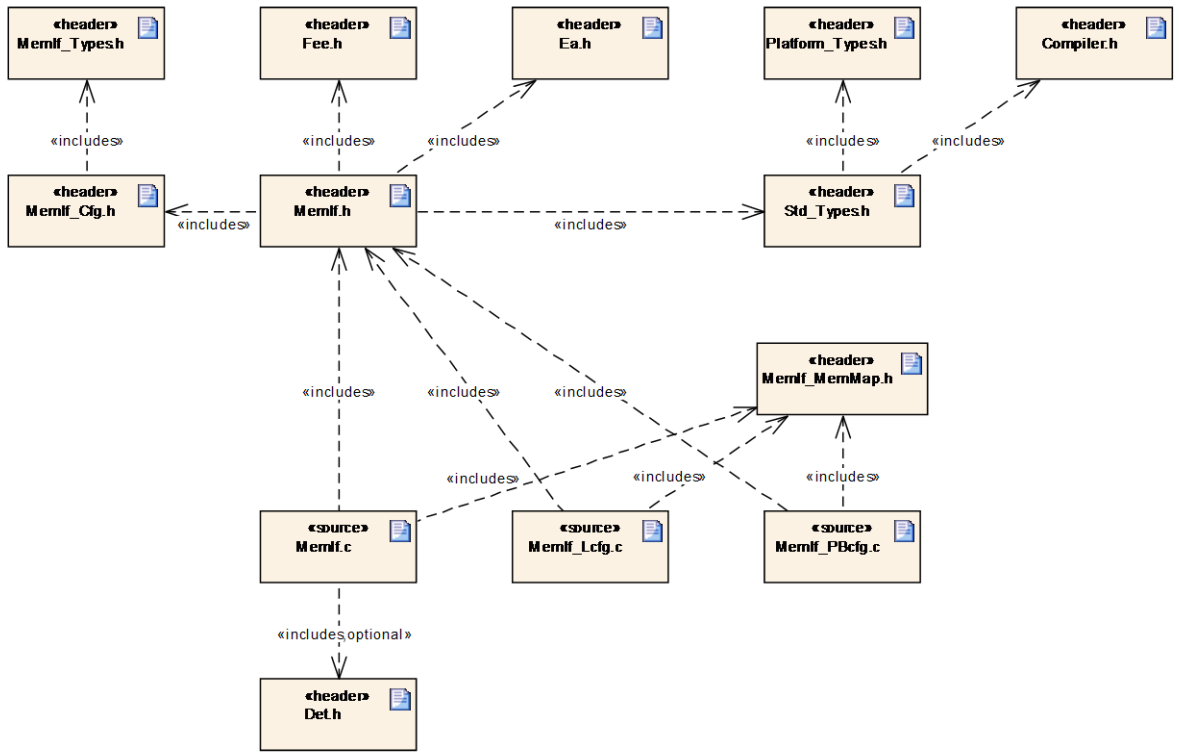

Figure 2: Memory Abstraction Layer File Include Structure

Note: Only header files of such memory abstraction modules (FEE, EA) which are present in a specific implementation / configuration shall be included by the Memory Abstraction Interface.

6 Requirements traceability

Requirement	Description	Satisfied by
-	-	SWS_MemIf_00064
-	-	SWS_MemIf_00065
-	-	SWS_MemIf_00066

Document: General Requirements on Basic Software Modules

Requirement	***Satisfied by***
[SRS_BSW_00344] Reference to link-time configuration	Not applicable (this module does not provide link-time configuration)
[SRS_BSW_00404] Reference to post build time configuration	Not applicable (this module does not provide post build time configuration)
[SRS_BSW_00405] Reference to multiple configuration sets	Not applicable (this module does not support multiple configuration sets)
[SRS_BSW_00345] Pre-compile-time configuration	SWS_MemIf_00025
[SRS_BSW_00159] Tool-based configuration	Not applicable (requirement on configuration, not for the specification)
[SRS_BSW_00167] Static configuration checking	SWS_MemIf_00061, SWS_MemIf_00062, SWS_MemIf_00025
[SRS_BSW_00171] Configurability of optional functionality	SWS_MemIf_00032
[SRS_BSW_00170] Data for reconfiguration of AUTOSAR SW-Components	Not applicable (requirement for SW-C)
[SRS_BSW_00380] Separate C-File for configuration parameters	Not applicable (no link-time or post build time configuration parameters)
[SRS_BSW_00381] Separate configuration header file for pre-compile time parameters	SWS_MemIf_00002
[SRS_BSW_00412] Separate H-File for configuration parameters	Not applicable (no link-time or post build time configuration parameters)
[SRS_BSW_00383] List dependencies of configuration files	SWS_MemIf_00002
[SRS_BSW_00384] List dependencies to other modules	SWS_MemIf_00002
[SRS_BSW_00387] Specify the configuration class of callback function	SWS_MemIf_00048
[SRS_BSW_00388] Introduce containers	SWS_MemIf_00025, SWS_MemIf_00026
[SRS_BSW_00389] Containers shall have names	SWS_MemIf_00025, SWS_MemIf_00026
[SRS_BSW_00390] Parameter content shall be unique within the module	SWS_MemIf_00025
[SRS_BSW_00391] Parameter shall have unique names	SWS_MemIf_00025
[SRS_BSW_00392] Parameters shall have a type	SWS_MemIf_00025
[SRS_BSW_00393] Parameters shall have a	SWS_MemIf_00025

range	
[SRS_BSW_00394] Specify the scope of the parameters	SWS_MemIf_00025
[SRS_BSW_00395] List the required parameters (per parameter)	SWS_MemIf_00025
[SRS_BSW_00396] Configuration classes	SWS_MemIf_00025
[SRS_BSW_00397] Pre-compile-time parameters	SWS_MemIf_00025
[SRS_BSW_00398] Link-time parameters	Not applicable (no link-time configuration parameters)
[SRS_BSW_00399] Loadable Post-build time parameters	Not applicable (no post build time configuration parameters)
[SRS_BSW_00400] Selectable Post-build time parameters	Not applicable (no post build time configuration parameters)
[SRS_BSW_00402] Published information	SWS_MemIf_00026
[SRS_BSW_00375] Notification of wake-up reason	Not applicable (this module does not provide wakeup capabilities)
[SRS_BSW_00101] Initialization interface	Not applicable (this module does not need an initialization)
[SRS_BSW_00416] Sequence of Initialization	Not applicable (requirement on system design, not a single module)
[SRS_BSW_00406] Check module initialization	Not applicable (this module does not need an initialization)
[SRS_BSW_00168] Diagnostic Interface of SW components	Not applicable (this module does not provide special diagnostic features)
[SRS_BSW_00407] Function to read out published parameters	SWS_MemIf_00045, SWS_MemIf_00026
[SRS_BSW_00423] Usage of SW-C template to describe BSW modules with AUTOSAR Interfaces	Not applicable (this module does not provide an AUTOSAR interface)
[SRS_BSW_00424] BSW main processing function task allocation	Not applicable (requirement on system design, not on a single module)
[SRS_BSW_00425] Trigger conditions for schedulable objects	Not applicable (requirement on the BSW module description template)
[SRS_BSW_00426] Exclusive areas in BSW modules	Not applicable (no exclusive areas defined in this module)
[SRS_BSW_00427] ISR description for BSW modules	Not applicable (this module does not implement any ISRs)
[SRS_BSW_00428] Execution order dependencies of main processing functions	Not applicable (only one main processing function in this module)
[SRS_BSW_00429] Restricted BSW OS functionality access	Not applicable (this module does not use any OS functionality)
[BSW00431] The BSW Scheduler module implements task bodies	Not applicable (requirement on the BSW scheduler)
[SRS_BSW_00432] Modules should have separate main processing functions for read/receive and write/transmit data path	Not applicable (only one main processing function in this module)
[SRS_BSW_00433] Calling of main processing functions	Not applicable (requirement on system design, not on a single module)
[BSW00434] The Schedule Module shall provide an API for exclusive areas	Not applicable (requirement on the schedule module – this is not it)
[SRS_BSW_00336] Shutdown interface	Not applicable (this module does not need to be shut down)

[SRS_BSW_00337] Classification of errors	SWS_MemIf_00006
[SRS_BSW_00338] Detection and Reporting of development errors	SWS_MemIf_00007, SWS_MemIf_00058
[SRS_BSW_00369] Do not return development error codes via API	SWS_MemIf_00059
[SRS_BSW_00339] Reporting of production relevant error status	Not applicable (this module does not know any production relevant errors)
[BSW00421] Reporting of production relevant error events	Not applicable (no production relevant errors defined for this module)
[SRS_BSW_00422] Debouncing of production relevant error status	Not applicable (requirement on the DEM, not this module)
[BSW00420] Production relevant error event rate detection	Not applicable (requirement on the DEM, not this module)
[SRS_BSW_00417] Reporting of Error Events by Non-Basic Software	Not applicable (requirement on non BSW modules)
[SRS_BSW_00323] API parameter checking	SWS_MemIf_00022
[SRS_BSW_00004] Version check	SWS_MemIf_00061, SWS_MemIf_00062
[SRS_BSW_00409] Header files for production code error IDs	SWS_MemIf_00029
[SRS_BSW_00385] List possible error notificatons	SWS_MemIf_00048
[SRS_BSW_00386] Configuration for detecting an error	SWS_MemIf_00006, SWS_MemIf_00007, SWS_MemIf_00023, SWS_MemIf_00058
[SRS_BSW_00161] Microcontroller abstraction	Not applicable (requirement on AUTOSAR architecture, not a single module)
[SRS_BSW_00162] ECU layout abstraction	Not applicable (requirement on AUTOSAR architecture, not a single module)
[BSW00324] Do not use HIS I/O Library	Not applicable (architecture decision)
[SRS_BSW_00005] No hard coded horizontal interfaces within MCAL	Not applicable (requirement on AUTOSAR architecture, not a single module)
[SRS_BSW_00415] User dependent include files	Not applicable (only one user for this module)
[SRS_BSW_00164] Implementation of interrupt service routines	Not applicable (this module does not implement any ISRs)
[SRS_BSW_00325] Runtime of interrupt service routines	Not applicable (this module does not implement any ISRs or callback routines)
[SRS_BSW_00326] Transition from ISRs to OS tasks	Not applicable (requirement on implementation, not on specification)
[SRS_BSW_00342] Usage of source code and object code	Not applicable (requirement on AUTOSAR architecture, not a single module)
[SRS_BSW_00343] Specification and configuration of time	Not applicable (this module does not provide any timing configuration)
[SRS_BSW_00160] Human-readable configuration data	Not applicable (requirement on documentation, not on specification)
[SRS_BSW_00007] HIS MISRA C	Not applicable (requirement on implementation, not on specification)
[SRS_BSW_00300] Module naming convention	Not applicable (requirement on implementation, not on

	specification)
[SRS_BSW_00413] Accessing instances of BSW modules	Requirement can not be implemented in R2.0 timeframe.
[SRS_BSW_00347] Naming separation of different instances of BSW drivers	Not applicable (requirement on the implementation, not on the specification)
[SRS_BSW_00305] Self-defined data types naming convention	Chapter 8.2
[SRS_BSW_00307] Global variables naming convention	Not applicable (requirement on the implementation, not on the specification)
[SRS_BSW_00310] API naming convention	Chapter 8.3
[SRS_BSW_00373] Main processing function naming convention	Not applicable (this module does not provide a scheduled function)
[SRS_BSW_00327] Error values naming convention	SWS_MemIf_00006
[SRS_BSW_00335] Status values naming convention	Chapter 8.2.1
[SRS_BSW_00350] Development error detection keyword	SWS_MemIf_00007, SWS_MemIf_00058, SWS_MemIf_00025
[SRS_BSW_00408] Configuration parameter naming convention	SWS_MemIf_00025
[SRS_BSW_00410] Compiler switches shall have defined values	SWS_MemIf_00025
[SRS_BSW_00411] Get version info keyword	SWS_MemIf_00025
[SRS_BSW_00346] Basic set of module files	SWS_MemIf_00002
[SRS_BSW_00158] Separation of configuration from implementation	SWS_MemIf_00002
[SRS_BSW_00314] Separation of interrupt frames and service routines	Not applicable (this module does not implement any ISRs)
[SRS_BSW_00370] Separation of callback interface from API	Not applicable (this module does not implement any callback routines)
[SRS_BSW_00435] Module Header File Structure for the Basic Software Scheduler	SWS_MemIf_00002
[SRS_BSW_00436] Module Header File Structure for the Basic Software Memory Mapping	SWS_MemIf_00002
[SRS_BSW_00348] Standard type header	Not applicable (requirement on the standard header file)
[SRS_BSW_00353] Platform specific type header	Not applicable (requirement on the platform specific header file)
[SRS_BSW_00361] Compiler specific language extension header	Not applicable (requirement on the compiler specific header file)
[SRS_BSW_00301] Limit imported information	SWS_MemIf_00002
[SRS_BSW_00302] Limit exported information	Not applicable (requirement on the implementation, not on the specification)
[SRS_BSW_00328] Avoid duplication of code	Not applicable (requirement on the implementation, not on the specification)
[SRS_BSW_00312] Shared code shall be reentrant	Not applicable (requirement on the implementation, not on the specification)
[SRS_BSW_00006] Platform independency	Not applicable (this is a module of the microcontroller abstraction layer)
[SRS_BSW_00357] Standard API return type	Chapter 8.3.2, Chapter 8.3.2.1. Chapter 8.3.6, Chapter 8.3.8

[SRS_BSW_00377] Module specific API return types	Chapter 8.3.4, Chapter 8.3.5
[SRS_BSW_00304] AUTOSAR integer data types	Not applicable (requirement on implementation, not for specification)
[SRS_BSW_00355] Do not redefine AUTOSAR integer data types	Not applicable (requirement on implementation, not for specification)
[SRS_BSW_00378] AUTOSAR boolean type	Not applicable (requirement on implementation, not for specification)
[SRS_BSW_00306] Avoid direct use of compiler and platform specific keywords	Not applicable (requirement on implementation, not for specification)
[SRS_BSW_00308] Definition of global data	Not applicable (requirement on implementation, not for specification)
[SRS_BSW_00309] Global data with read-only constraint	Not applicable (requirement on implementation, not for specification)
[SRS_BSW_00371] Do not pass function pointers via API	Not applicable (no function pointers in this specification)
[SRS_BSW_00358] Return type of init() functions	Not applicable (this module does not provide an initialization function)
[SRS_BSW_00414] Parameter of init function	Not applicable (this module does not provide an initialization function)
[SRS_BSW_00376] Return type and parameters of main processing functions	Not applicable (this module does not provide a scheduled function)
[SRS_BSW_00359] Return type of callback functions	Not applicable (this module does not provide any callback routines)
[SRS_BSW_00360] Parameters of callback functions	Not applicable (this module does not provide any callback routines)
[SRS_BSW_00329] Avoidance of generic interfaces	Chapter 8.3 (explicit interfaces defined)
[SRS_BSW_00330] Usage of macros / inline functions instead of functions	Not applicable (requirement on implementation, not for specification)
[SRS_BSW_00331] Separation of error and status values	SWS_MemIf_00059
[SRS_BSW_00009] Module User Documentation	Not applicable (requirement on documentation, not on specification)
[SRS_BSW_00401] Documentation of multiple instances of configuration parameters	Not applicable (all configuration parameters are single instance only)
[SRS_BSW_00172] Compatibility and documentation of scheduling strategy	Not applicable (no internal scheduling policy)
[SRS_BSW_00010] Memory resource documentation	Not applicable (requirement on documentation, not on specification)
[SRS_BSW_00333] Documentation of callback function context	Not applicable (requirement on documentation, not for specifciation)
[SRS_BSW_00374] Module vendor identification	SWS_MemIf_00026

[SRS_BSW_00379] Module identification	SWS_MemIf_00026
[SRS_BSW_00003] Version identification	SWS_MemIf_00026
[SRS_BSW_00318] Format of module version numbers	SWS_MemIf_00026
[SRS_BSW_00321] Enumeration of module version numbers	Not applicable (requirement on implementation, not for specification)
[SRS_BSW_00341] Microcontroller compatibility documentation	Not applicable (requirement on documentation, not on specification)
[SRS_BSW_00334] Provision of XML file	Not applicable (requirement on documentation, not on specification)

Document: General Requirements on SPAL

Requirement	***Satisfied by***
[SRS_SPAL_12263] Object code compatible configuration concept	Not applicable (this module does not provide post-compile time parameters)
[SRS_SPAL_12056] Configuration of notification mechanisms	Not applicable (this module does not support any notification mechanisms)
[SRS_SPAL_12267] Configuration of wake-up sources	Not applicable (this module does not provide any wakeup capabilities)
[SRS_SPAL_12057] Driver module initialization	Not applicable (this module does not provide an initialization routine)
[SRS_SPAL_12125] Initialization of hardware resources	Not applicable (this module has no direct hardware access)
[SRS_SPAL_12163] Driver module de-initialization	Not applicable (this module does not provide an de-initialization routine)
[BSW12058] Individual initialization of overall registers	Not applicable (this module has no direct hardware access)
[BSW12059] General initialization of overall registers	Not applicable (this module has no direct hardware access)
[BSW12060] Responsibility for initialization of one-time writable registers	Not applicable (this module has no direct hardware access)
[SRS_SPAL_12461] Responsibility for register initialization	Not applicable (this module has no direct hardware access)
[SRS_SPAL_12462] Provide settings for register initialization	Not applicable (this module has no direct hardware access)
[SRS_SPAL_12463] Combine and forward settings for register initialization	Not applicable (this module has no direct hardware access)
[BSW12062] Selection of static configuration sets	Not applicable (this module does not provide an initialization routine)
[SRS_SPAL_12068] MCAL initialization sequence	Not applicable (this module does not provide an initialization routine)
[SRS_SPAL_12069] Wake-up notification of ECU State Manager	Not applicable (this module does not provide any wakeup capabilities)
[SRS_SPAL_00157] Notification mechanisms of drivers and handlers	Not applicable (this module does not support any notification

	mechanisms)
[BSW12155] Prototypes of callback functions	Not applicable (this module does not provide any callback routines)
[SRS_SPAL_12169] Control of operation mode	Chapter 8.3.1
[SRS_SPAL_12063] Raw value mode	Not applicable (this module does not handle any data)
[SRS_SPAL_12075] Use of application buffers	Not applicable (this module does not handle any data)
[SRS_SPAL_12129] Resetting of interrupt flags	Not applicable (this module does not implement any ISRs)
[SRS_SPAL_12064] Change of operation mode during running operation	Not applicable (this module is only an interface for underlying modules)
[SRS_SPAL_12448] Behavior after development error detection	SWS_MemIf_00023
[SRS_SPAL_12067] Setting of wake-up conditions	Not applicable (this module does not provide any wakeup capabilities)
[SRS_SPAL_12077] Non-blocking implementation	Not applicable (this module does not provide any schedulable routines)
[SRS_SPAL_12078] Runtime and memory efficiency	SWS_MemIf_00019, SWS_MemIf_00020
[SRS_SPAL_12092] Access to drivers	Not applicable (requirement on system architecture not for one module)
[SRS_SPAL_12265] Configuration data shall be kept constant	Not applicable (this module does not have post-compile time configuration data)
[SRS_SPAL_12264] Specification of configuration items	SWS_MemIf_00025, SWS_MemIf_00026
[BSW12081] Use HIS requirements as input	Not applicable (no corresponding HIS requirements available)

Document: Requirements on Memory Abstraction Interface

Requirement	***Satisfied by***
SRS_MemHwAb_14019 Provide uniform access to underlying memory abstraction modules	SWS_MemIf_00017
SRS_MemHwAb_14020 Selection of underlying memory abstraction modules	SWS_MemIf_00018
SRS_MemHwAb_14021 Number of underlying memory abstraction modules	SWS_MemIf_00018, SWS_MemIf_00019, SWS_MemIf_00020, SWS_MemIf_00022, SWS_MemIf_00025
SRS_MemHwAb_14022 Preserving of functionality	SWS_MemIf_00017
SRS_MemHwAb_14023 Parameter checking	SWS_MemIf_00061, SWS_MemIf_00062, SWS_MemIf_00022
SRS_MemHwAb_14024 Preserving of timing behavior	Not applicable
SRS_MemHwAb_14025 Efficient implementation	SWS_MemIf_00019, SWS_MemIf_00020

7 Functional specification

7.1 Error classification

[SWS_MemIf_00006] ⌈The following errors and exceptions shall be detectable by the Memory Abstraction Interface depending on its configuration (development/production):

Type or error	*Relevance*	*Related error code*	*Value [hex]*
API service called with wrong device index parameter	Development	MEMIF_E_PARAM_DEVICE	0x01
API service called with NULL pointer argument	Development	MEMIF_E_PARAM_POINTER	0x02

⌋(SRS_BSW_00337, SRS_BSW_00386, SRS_BSW_00327)

8 API specification

8.1 Imported types

8.1.1 Standard types

In this chapter, all types included from the following files are listed:

[SWS_MemIf_00037]⌈

Module	*Imported Type*
Std_Types	Std_ReturnType
	Std_VersionInfoType

⌋()

8.2 Type definitions

[SWS_MemIf_00010] ⌈The types specified in this chapter shall not be changed or extended for a specific memory abstraction module or hardware platform. ⌋()

[SWS_MemIf_00011] ⌈The data type for the memory device index shall be uint8. The lowest value to be used for this device index shall be 0. The allowed range of indices thus shall be `0..MEMIF_NUMBER_OF_DEVICES-1`. ⌋()

8.2.1 MemIf_StatusType

[SWS_MemIf_00064]⌈

Name:	`MemIf_StatusType`	
Type:	`Enumeration`	
Range:	`MEMIF_UNINIT`	The underlying abstraction module or device driver has not been initialized (yet).
	`MEMIF_IDLE`	The underlying abstraction module or device driver is currently idle.
	`MEMIF_BUSY`	The underlying abstraction module or device driver is currently busy.
	`MEMIF_BUSY_INTERNAL`	The underlying abstraction module is busy with internal management operations. The underlying device driver can be busy or idle.
Description:	Denotes the current status of the underlying abstraction module and device drive.	

⌋()

8.2.2 MemIf_JobResultType

[SWS_MemIf_00065]⌈

Name:	`MemIf_JobResultType`	
Type:	`Enumeration`	
Range:	`MEMIF_JOB_OK`	The job has been finished successfully.

	MEMIF_JOB_FAILED	The job has not been finished successfully.
	MEMIF_JOB_PENDING	The job has not yet been finished.
	MEMIF_JOB_CANCELED	The job has been canceled.
	MEMIF_BLOCK_INCONSISTENT	The requested block is inconsistent, it may contain corrupted data.
	MEMIF_BLOCK_INVALID	The requested block has been marked as invalid, the requested operation can not be performed.
Description:	Denotes the result of the last job.	

⌋()

8.2.3 MemIf_ModeType

[SWS_MemIf_00066]⌈

Name:	MemIf_ModeType	
Type:	Enumeration	
Range:	MEMIF_MODE_SLOW	The underlying memory abstraction modules and drivers are working in slow mode.
	MEMIF_MODE_FAST	The underlying memory abstraction modules and drivers are working in fast mode.
Description:	Denotes the operation mode of the underlying abstraction modules and device drivers.	

⌋()

8.3 Function definitions

[SWS_MemIf_00017] ⌈The API specified in this chapter shall be mapped to the API of the underlying memory abstraction modules. For functional behavior refer to the specification of those modules respectively to that of the underlying memory drivers. ⌋ (SRS_MemHwAb_14019, SRS_MemHwAb_14022)

[SWS_MemIf_00018] ⌈The parameter DeviceIndex shall be used for selection of memory abstraction modules (and thus memory devices). If only one memory abstraction module is configured, the parameter DeviceIndex shall be ignored. ⌋ (SRS_MemHwAb_14020, SRS_MemHwAb_14021)

[SWS_MemIf_00019] ⌈If only one memory abstraction module is configured, the Memory Abstraction Interface shall be implemented as a set of macros mapping the Memory Abstraction Interface API to the API of the corresponding memory abstraction module. ⌋ (SRS_SPAL_12078, SRS_MemHwAb_14021, SRS_MemHwAb_14025)

Example:
```
#define MemIf_Write(DeviceIndex, BlockNumber, DataPtr) \
       Fee_Write(BlockNumber, DataPtr)
```

[SWS_MemIf_00020] ⌈If more than one memory abstraction module is configured, the Memory Abstraction Interface shall use efficient mechanisms to map the API calls to the appropriate memory abstraction module. ⌋ (SRS_SPAL_12078, SRS_MemHwAb_14021, SRS_MemHwAb_14025)

Note: One solution is to use tables of pointers to functions where the parameter `DeviceIndex` is used as array index.

Example:
```
#define MemIf_Write(DeviceIndex, BlockNumber, DataPtr) \
      MemIf_WriteFctPtr[DeviceIndex](BlockNumber,DataPtr)
```

Note: The service IDs given in this interface specification are related to the service IDs of the underlying memory abstraction module(s). For that reason, they may not start with 0.

[SWS_MemIf_00022] ⌈If more than one memory abstraction module is configured and development error detection is enabled for this module, the functions of the Memory Abstraction Interface API shall check the parameter `DeviceIndex` for being an existing device or the broadcast identifier within the module's services. ⌋ (SRS_BSW_00323, SRS_MemHwAb_14021, SRS_MemHwAb_14023)

[SWS_MemIf_00023] ⌈The functions of the Memory Abstraction Interface API shall report detected errors attributed to an illegal parameter `DeviceIndex` to the Development Error Tracer (DET) with the error code `MEMIF_E_PARAM_DEVICE` and the called service shall not be executed. ⌋(SRS_BSW_00386, SRS_SPAL_12448)

[SWS_MemIf_00024] ⌈If a called function of the Memory Abstraction Interface API has detected an error attributed to an illegal parameter `DeviceIndex` and has a return value, it shall be set as follows:

MemIf_GetStatus:	`MEMIF_UNINIT`
MemIf_GetJobResult:	`MEMIF_JOB_FAILED`
All other functions:	`E_NOT_OK`. ⌋()

8.3.1 MemIf_SetMode

[SWS_MemIf_00038] ⌈

Service name:	MemIf_SetMode

Syntax:	`void MemIf_SetMode(`
	`  MemIf_ModeType Mode`
	`)`

Service ID[hex]:	0x01
Sync/Async:	Synchronous
Reentrancy:	Non Reentrant
Parameters (in):	Mode | --
Parameters (inout):	None
Parameters (out):	None
Return value:	None
Description:	Invokes the "SetMode" functions of all underlying memory abstraction modules.

⌋()

Note: The device index was intentionally left out in the above function, that is the Memory Interface shall switch all underlying modules into the requested mode. An

extra “broadcast” parameter is not needed in this case since the devices shall not be switched to different modes individually.

8.3.2 MemIf_Read

[SWS_MemIf_00039]⌈

Service name:	MemIf_Read	
Syntax:	`Std_ReturnType MemIf_Read( uint8 DeviceIndex, uint16 BlockNumber, uint16 BlockOffset, uint8* DataBufferPtr, uint16 Length )`	
Service ID[hex]:	0x02	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	DeviceIndex	--
	BlockNumber	--
	BlockOffset	--
	Length	--
Parameters (inout):	None	
Parameters (out):	DataBufferPtr	--
Return value:	Std_ReturnType	In case development error detection is enabled for the Memory Abstraction Interface and a development error is detected according to MemIf022 the function shall return E_NOT_OK else it shall return the value of the called function of the underlying module.
Description:	Invokes the "Read" function of the underlying memory abstraction module selected by the parameter DeviceIndex.	

⌋()

8.3.2.1 MemIf_Write

[SWS_MemIf_00040]⌈

Service name:	MemIf_Write	
Syntax:	`Std_ReturnType MemIf_Write( uint8 DeviceIndex, uint16 BlockNumber, const uint8* DataBufferPtr )`	
Service ID[hex]:	0x03	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	DeviceIndex	--
	BlockNumber	--
	DataBufferPtr	--
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	In case development error detection is enabled for the Memory Abstraction Interface and a development error is detected according to MemIf022 the function shall return E_NOT_OK else it shall return the value of the called function of the underlying

		module.
Description:	Invokes the "Write" function of the underlying memory abstraction module selected by the parameter DeviceIndex.	

⌋()

8.3.3 MemIf_Cancel

[SWS_MemIf_00041]⌈

Service name:	MemIf_Cancel	

Syntax:	`void MemIf_Cancel(`
	`  uint8 DeviceIndex`
	`)`	

Service ID[hex]:	0x04	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	DeviceIndex	--
Parameters (inout):	None	
Parameters (out):	None	
Return value:	None	
Description:	Invokes the "Cancel" function of the underlying memory abstraction module selected by the parameter DeviceIndex.	

⌋()

8.3.4 MemIf_GetStatus

[SWS_MemIf_00042]⌈

Service name:	MemIf_GetStatus	

Syntax:	`MemIf_StatusType MemIf_GetStatus(`
	`  uint8 DeviceIndex`
	`)`	

Service ID[hex]:	0x05	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	DeviceIndex	--
Parameters (inout):	None	
Parameters (out):	None	
Return value:	MemIf_StatusType	--
Description:	Invokes the "GetStatus" function of the underlying memory abstraction module selected by the parameter DeviceIndex.	

⌋()

[SWS_MemIf_00035] ⌈If the function MemIf_GetStatus is called with the device index denoting a broadcast to all configured devices (`MEMIF_BROADCAST_ID`), the Memory Abstraction Interface module shall call the “GetStatus” functions of all underlying devices in turn. It shall return the value

- `MEMIF_IDLE` – if all underlying devices have returned this state
- `MEMIF_UNINIT` – if at least one device returned this state, all other returned states shall be ignored
- `MEMIF_BUSY` – if at least one configured device returned this state and no other device returned `MEMIF_UNINIT`

- MEMIF_BUSY_INTERNAL – if at least one configured device returned this state and no other device returned MEMIF_BUSY or MEMIF_UNINIT ⌋()

Note: *The special "broadcast" device ID in the call to MemIf_GetStatus is used to query whether all devices are idle in order to shut down the ECU.*

8.3.5 MemIf_GetJobResult

[SWS_MemIf_00043]⌈

Service name:	MemIf_GetJobResult	
Syntax:	`MemIf_JobResultType MemIf_GetJobResult( uint8 DeviceIndex )`	
Service ID[hex]:	0x06	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	DeviceIndex	--
Parameters (inout):	None	
Parameters (out):	None	
Return value:	MemIf_JobResultType	In case development error detection is enabled for the Memory Abstraction Interface and a development error is detected according to SWS_MemIf_00022 the function shall return MEMIF_JOB_FAILED else it shall return the value of the called function of the underlying module.
Description:	Invokes the "GetJobResult" function of the underlying memory abstraction module selected by the parameter DeviceIndex.	

⌋()

8.3.6 MemIf_InvalidateBlock

[SWS_MemIf_00044]⌈

Service name:	MemIf_InvalidateBlock	
Syntax:	`Std_ReturnType MemIf_InvalidateBlock( uint8 DeviceIndex, uint16 BlockNumber )`	
Service ID[hex]:	0x07	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	DeviceIndex	--
	BlockNumber	--
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	In case development error detection is enabled for the Memory Abstraction Interface and a development error is detected according to MemIf022 the function shall return E_NOT_OK else it shall return the value of the called function of the underlying module.
Description:	Invokes the "InvalidateBlock" function of the underlying memory abstraction module selected by the parameter DeviceIndex.	

⌋()

8.3.7 MemIf_GetVersionInfo

[SWS_MemIf_00045]⌈

Service name:	MemIf_GetVersionInfo	
Syntax:	`void MemIf_GetVersionInfo( Std_VersionInfoType* VersionInfoPtr )`	
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:	Returns version information.	

⌋(SRS_BSW_00407)

[SWS_MemIf_00063] ⌈If development error detection for the module `MemIf` is enabled: the function `MemIf_GetVersionInfo` shall raise the development error `MemIf_E_PARAM_POINTER` if the argument is a NULL pointer and return without any action. ⌋()

8.3.8 MemIf_EraseImmediateBlock

[SWS_MemIf_00046]⌈

Service name:	MemIf_EraseImmediateBlock	
Syntax:	`Std_ReturnType MemIf_EraseImmediateBlock( uint8 DeviceIndex, uint16 BlockNumber )`	
Service ID[hex]:	0x09	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	DeviceIndex	--
	BlockNumber	--
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	In case devlopment error detection is enabled for the Memory Abstraction Interface and a development error is detected according to MemIf022 the function shall return E_NOT_OK else it shall return the value of the called function of the underlying module.
Description:	Invokes the "EraseImmediateBlock" function of the underlying memory abstraction module selected by the parameter DeviceIndex.	

⌋()

8.4 Call-back notifications

None, the NVRAM manager shall provide the callback routines for the underlying memory abstraction modules.

8.5 Scheduled functions

None, there are no asynchronous functions in this module.

8.6 Expected Interfaces

8.6.1 Mandatory Interfaces

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

[SWS_MemIf_00047]⌈

API function	***Description***
Ea_Cancel	Cancels the ongoing asynchronous operation.
Ea_EraseImmediateBlock	Erases the block BlockNumber.
Ea_GetJobResult	Service to return the JobResult.
Ea_GetStatus	Service to return the Status.
Ea_InvalidateBlock	Invalidates the block BlockNumber.
Ea_Read	Reads Length bytes of block Blocknumber at offset BlockOffset into the buffer DataBufferPtr.
Ea_SetMode	Sets the mode.
Ea_Write	Writes the contents of the DataBufferPtr to the block BlockNumber.
Fee_Cancel	Service to call the cancel function of the underlying flash driver.
Fee_EraseImmediateBlock	Service to erase a logical block.
Fee_GetJobResult	Service to query the result of the last accepted job issued by the upper layer software.
Fee_GetStatus	Service to return the status.
Fee_InvalidateBlock	Service to invalidate a logical block.
Fee_Read	Service to initiate a read job.
Fee_SetMode	Service to call the Fls_SetMode function of the underlying flash driver.
Fee_Write	Service to initiate a write job.

⌋()

8.6.2 Optional Interfaces

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

[SWS_MemIf_00048]⌈

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

⌋(SRS_BSW_00387, SRS_BSW_00385)

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 call-back function. The names of these kind of interfaces is not fixed because they are configurable.

There are no configurable interfaces for this module.

9 Sequence diagrams

Refer to the specifications of the memory abstraction modules.

10 Configuration specification

10.1 Containers and configuration parameters

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

10.1.1 Variants

[SWS_MemIf_00060] ⌈VARIANT-PRE-COMPILE
Only parameters with “Pre-compile time” configuration are allowed in this variant. ⌋()

10.1.2 MemIf

SWS Item	**ECUC_MemIf_00025 :**
Module Name	*MemIf*
Module Description	Configuration of the MemIf (Memory Abstraction Interface) module.

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
MemIfGeneral	1	Configuration of the memory abstraction interface (Memif) module.

10.1.3 MemIfGeneral

SWS Item	**ECUC_MemIf_00034 :**
Container Name	MemIfGeneral{MemIf_Configuration}
Description	Configuration of the memory abstraction interface (Memif) module.
Configuration Parameters	

SWS Item	**ECUC_MemIf_00035 :**		
Name	MemIfDevErrorDetect {MEMIF_DEV_ERROR_DETECT}		
Description	Pre-processor switch to enable and disable development error detection. true: Development error detection enabled. false: Development error detection disabled.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_MemIf_00033 :**
Name	MemIfNumberOfDevices {MEMIF_NUMBER_OF_DEVICES}
Description	Concrete number of underlying memory abstraction modules. Calculation Formula: Count number of configured EA and FEE modules.

Multiplicity	1		
Type	EcucIntegerParamDef		
Range	1 .. 2		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_MemIf_00032 :**		
Name	MemIfVersionInfoApi {MEMIF_VERSION_INFO_API}		
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	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

No Included Containers

11 Not applicable requirements

[SWS_MemIf_00999] ⌈These requirements are not applicable to this specification. ⌋ (BSW0034, SRS_BSW_00404, SRS_BSW_00405, SRS_BSW_00159, SRS_BSW_00170, SRS_BSW_00380, SRS_BSW_00412, SRS_BSW_00398, SRS_BSW_00399, SRS_BSW_00400, SRS_BSW_00375, SRS_BSW_00101, SRS_BSW_00416, SRS_BSW_00406, SRS_BSW_00168, SRS_BSW_00423, SRS_BSW_00424, SRS_BSW_00425, SRS_BSW_00426, SRS_BSW_00427, SRS_BSW_00428, SRS_BSW_00429, BSW00431, SRS_BSW_00432, SRS_BSW_00433, BSW00434, SRS_BSW_00336, SRS_BSW_00339, BSW00421, SRS_BSW_00422, BSW00420, SRS_BSW_00417, SRS_BSW_00161, SRS_BSW_00162, BSW00324, SRS_BSW_00005, SRS_BSW_00415, SRS_BSW_00164, SRS_BSW_00325, SRS_BSW_00326, SRS_BSW_00342, SRS_BSW_00343, SRS_BSW_00160, SRS_BSW_00007, SRS_BSW_00300, SRS_BSW_00413, SRS_BSW_00347, SRS_BSW_00307, SRS_BSW_00373, SRS_BSW_00314, SRS_BSW_00370, 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_00355, SRS_BSW_00378, SRS_BSW_00306, SRS_BSW_00308, SRS_BSW_00309, SRS_BSW_00371, SRS_BSW_00358, SRS_BSW_00414, SRS_BSW_00376, 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_12057, SRS_SPAL_12125, SRS_SPAL_12163, BSW12058, BSW12059, BSW12060, SRS_SPAL_12461, SRS_SPAL_12462, SRS_SPAL_12463, BSW12062, SRS_SPAL_12068, SRS_SPAL_12069, SRS_SPAL_00157, BSW12155, SRS_SPAL_12063, SRS_SPAL_12075, SRS_SPAL_12129, SRS_SPAL_12064, SRS_SPAL_12067, SRS_SPAL_12077, SRS_SPAL_12092, SRS_SPAL_12265, BSW12081)