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23.06.2008	2.2.2	AUTOSAR Administration	Legal disclaimer revised
23.01.2008	2.2.1	AUTOSAR Administration	Table formatting corrected

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26.01.2006	2.0.0	AUTOSAR Administration	Document structure adapted to common Release 2.0 SWS Template. • Major changes in chapter 10 • Structure of document changed partly • Other changes see chapter 11
23.06.2005	1.0.0	AUTOSAR Administration	Initial Release

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1 Introduction and functional overview

This specification describes the functionality and API for a MCU [**M**icro**c**ontroller **U**nit] driver. The MCU driver provides services for basic microcontroller initialization, power down functionality, reset and microcontroller specific functions required by other MCAL software modules. The initialization services allow a flexible and application related MCU initialization in addition to the start-up code (see figure below). The start-up code is very MCU specific. The provided start-up code description in this document is for guidance and implies functionality which has to be taken into account before standardized MCU initialization is able to start.

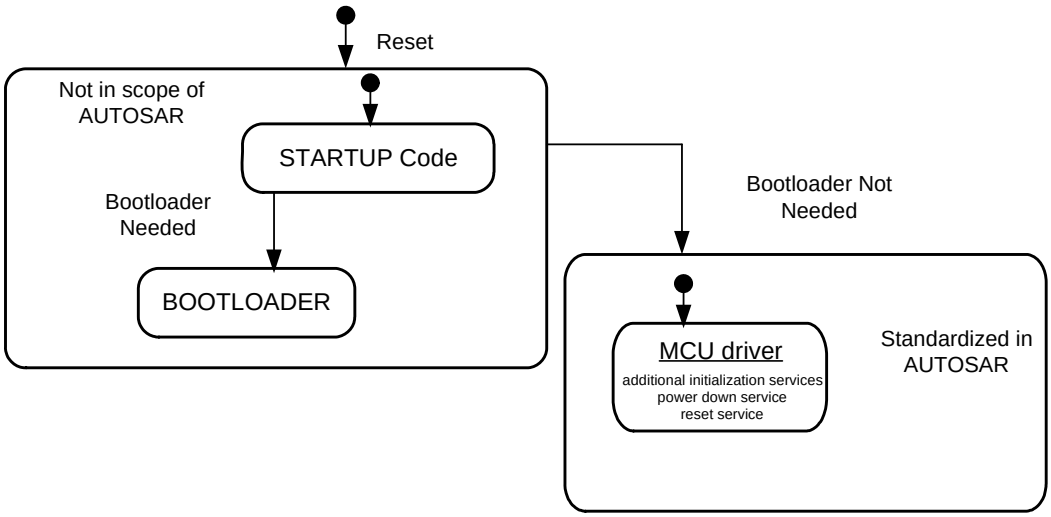

Figure 1: Scope of the MCU Driver Specification

The MCU driver accesses the microcontroller hardware directly and is located in the Microcontroller Abstraction Layer (MCAL).

MCU driver Features:

- Initialization of MCU clock, PLL, clock prescalers and MCU clock distribution
- Initialization of RAM sections
- Activation of µC reduced power modes
- Activation of a µC reset
- Provides a service to get the reset reason from hardware

2 Acronyms and abbreviations

Abbreviation / Acronym:	*Description:*
uC	Microcontroller
MCU	Micro Controller Unit
SFR	Special Function Register (MCU register)
DEM	Diagnostic Event Manager
DET	Development Error Tracer

Table 1: Acronyms and Abbreviations

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] Specification of Development Error Tracer,
AUTOSAR_SWS_DevelopmentErrorTracer.pdf

[5] Specification of ECU Configuration,
AUTOSAR_TPS_ECUConfiguration.pdf

[6] Specification of Diagnostic Event Manager,
AUTOSAR_SWS_ DiagnosticEventManager.pdf

[7] Specification of ECU State Manager,
AUTOSAR_SWS_ECUStateManager.pdf

[8] General Requirements on SPAL,
AUTOSAR_SRS_SPALGeneral.pdf

[9] Requirements on MCU driver,
AUTOSAR_SRS_MCUDriver.pdf

[10] Specification of Standard Types,
AUTOSAR_SWS_StandardTypes.pdf

[11] Basic Software Module Description Template,
AUTOSAR_TPS_BSWModuleDescriptionTemplate.pdf

4 Constraints and assumptions

4.1 Limitations

In general the activation and configuration of MCU reduced power mode is not mandatory within AUTOSAR standardization.

Enabling/disabling of the ECU or uC power supply is not the task of the MCU driver. This is to be handled by the upper layer.

4.2 Applicability to car domains

No restrictions

5 Dependencies to other modules

5.1 Start-up code

Before the MCU driver can be initialized, a basic initialization of the MCU has to be executed. This MCU specific initialization is typically executed in a start-up code.

The start-up code of the MCU shall be executed after power up and any kind of microcontroller reset. It shall perform very basic and microcontroller specific start-up initialization and shall be kept short because the MCU clock and PLL are not yet initialized. The start-up code shall cover MCU specific initialization which is not part of other MCU services or other MCAL drivers. The following description summarizes the basic functionality to be included in the start-up code. It is listed for guidance because some functionality might not be supported in all MCU's.

The start-up code shall initialize the base addresses for interrupt and trap vector tables. These base addresses are provided as configuration parameters or linker/locator setting.

The start-up code shall initialize the interrupt stack pointer if an interrupt stack is supported by the MCU. The interrupt stack pointer base address and the stack size are provided as configuration parameter or linker/locator setting

The start-up code shall initialize the user stack pointer. The user stack pointer base address and the stack size are provided as configuration parameter or linker/locator setting.

If the MCU supports context save operation, the start-up code shall initialize the memory which is used for context save operation. The maximum amount of consecutive context save operations is provided as configuration parameter or linker/locator setting.

The start-up code shall ensure that the MCU internal watchdog shall not be serviced until the watchdog is initialized from the MCAL watchdog driver. This can be done for example by increasing the watchdog service time.

If the MCU supports cache memory for data and/or code, it shall be initialized and enabled in the start-up code.

The start-up code shall initialize MCU specific features with respect to internal memory as, for example, memory protection.

If external memory is used, the memory shall be initialized in the start-up code. The start-up code shall be prepared to support different memory configurations depending on code location. Different configuration options shall be taken into account for code execution from external/internal memory.

The settings of the different memories shall be provided to the start-up code as configuration parameters.
In the start-up code a default initialization of the MCU clock system shall be performed including global clock prescalers.

The start-up code shall enable protection mechanisms for special function registers (SFR's) if supported by the MCU.

The start-up code shall initialize all necessary write once registers or registers common to several drivers where one write, rather than repeated writes, to the register is required or highly desirable.

The start-up code shall initialize a minimum amount of RAM in order to allow proper execution of the MCU driver services and the caller of these services.

Note: The start-up code is ECU and MCU dependant. Details of the specification shall be described in the design specification of the MCU.

5.2 File structure

5.2.1 Code file structure

Note: The code file structure shall not be defined within this specification.

5.2.2 Header file structure

The include file structure shall be as follows:

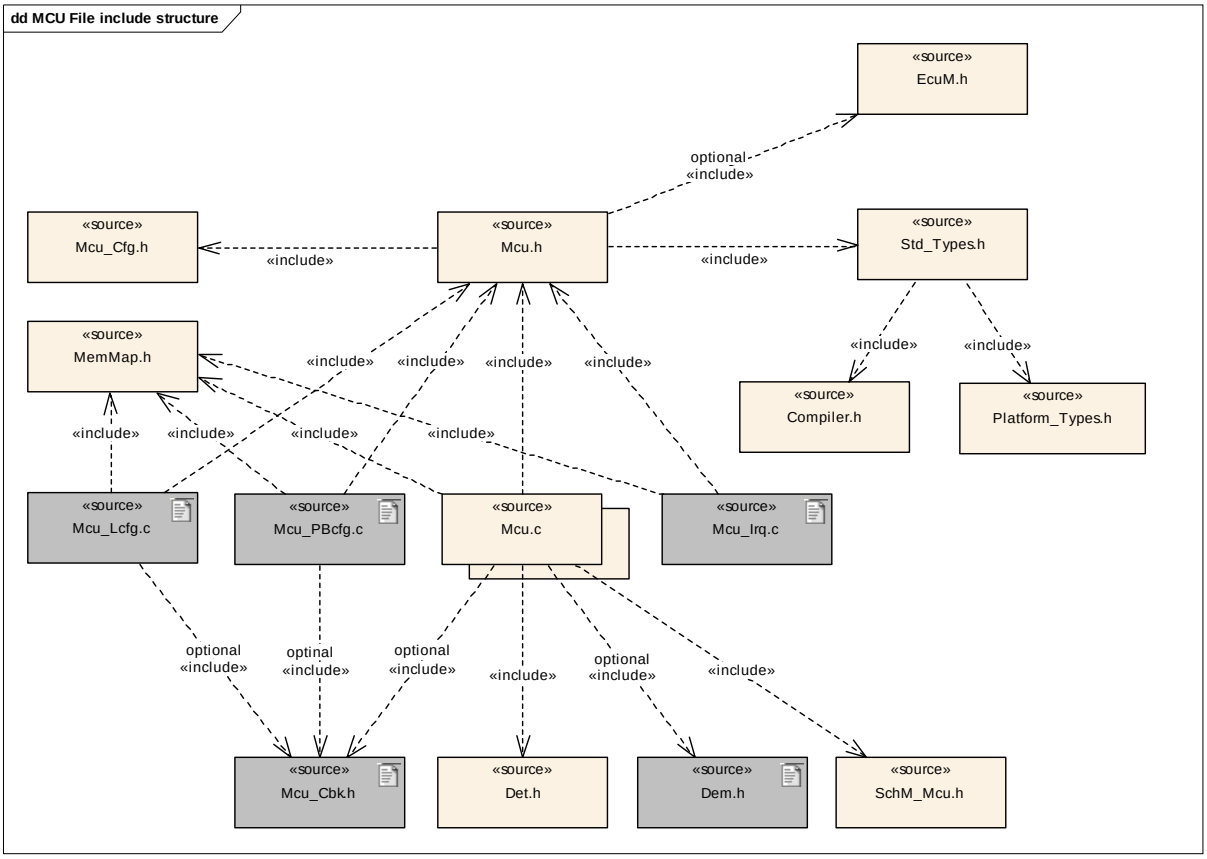

Figure 2: Header File Structure

MCU108: `Mcu.c` shall include `Mcu.h`.
MCU211: `Mcu.h` shall include `Mcu_Cfg.h` for the API pre-compiler switches.

Mcu.c has access to the Mcu_Cfg.h via the implicitly included Mcu.h file.

MCU213: `Mcu_Irq.c` shall include `Mcu.h` for the function prototype which shall be called in the interrupt function.

MCU215: The type definitions for `Mcu_Lcfg.c` and `Mcu_PBcfg.c` are located in the file `Mcu.h`.

Rather the implicit include of Mcu_Cfg.h via Mcu.h in the files Mcu_Lcfg.c and Mcu_PBcfg.c is necessary to solve the following construct:

```
Mcu.h
----------
#include "Mcu.h"

#ifdef xxx_VERSION_INFO_API
xxx_GetVersionInfo(...)
#endif

Mcu_Cfg.h
---------------
#define xxx_VERSION_INFO_API
```

MCU216: `Mcu_Lcfg.c` shall include `Mcu_Cbk.h` for a link time configuration if the call back function is linked to the module via the ROM structure.

MCU218: `Mcu_PBcfg.c` shall include `Mcu_Cbk.h` for post build time configuration if the call back function is linked to the module via the ROM structure.

MCU219: `Mcu.c` shall include `Mcu_Cbk.h` for pre-compile time configuration.

MCU109: The MCU module shall include the `Dem.h` file. By this inclusion, the APIs to report errors as well as the required Event Id symbols are included.

MCU220: This specification defines the name of the Event Id symbols which are provided by XML to the DEM configuration tool. The DEM configuration tool assigns ECU dependent values to the Event Id symbols and publishes the symbols in `Dem_IntErrId.h`.

6 Requirements traceability

Document: AUTOSAR requirements on Basic Software, general [3]

Requirement	***Satisfied by***
[BSW003] Version identification	MCU037
[BSW004] Version check	MCU110
[BSW005] No hard coded horizontal interfaces within MCAL	Not applicable (Because the architectural AUTOSAR concept is the basis for this concept).
[BSW006] Platform independency	Not applicable (Because the MCU module is not above the MCAL).
[BSW007] HIS MISRA C	Not applicable (Because this is a requirement for implementation).
[BSW009] Module User Documentation	See Section 3.1
[BSW010] Memory resource documentation	Not applicable (Because this is a requirement for implementation).
[BSW101] Initialization interface	MCU026
[BSW158] Separation of configuration from implementation	See Section 5.2
[BSW159] Tool-based configuration	See Section 5.2
[BSW160] Human-readable configuration data	Not applicable (Because this requirements only applies to the configuration. Requirement on implementation).
[BSW161] Microcontroller abstraction	Not applicable (Because the architectural AUTOSAR concept is the basis for this concept).
[BSW162] ECU layout abstraction	Not applicable (Because the architectural AUTOSAR concept is the basis for this concept).
[BSW164] Implementation of interrupt service routines	Not applicable (Because the MCU does not provide interrupt functionality).
[BSW167] Static configuration checking	Not Applicable (Because this is a requirement for the configuration tool).
[BSW168] Diagnostic Interface of SW components	Not applicable (Because this is a requirement on SW components).
[BSW170] Data for reconfiguration of AUTOSAR SW-Components	Not applicable (Because this is a requirement on SW components).
[BSW171] Configurability of optional functionality	MCU119_Conf, MCU120_Conf
[BSW172] Compatibility and documentation of scheduling strategy	Not applicable (Because the MCU does not have any special scheduling requirements).
[BSW00300] Module naming convention	See Section 5.2

[BSW00301] Limit imported information	See Section 5.2
[BSW00302] Limit exported information	See Section 5.2
[BSW00304] AUTOSAR integer data types	See Section 8.2
[BSW00305] Self-defined data types naming convention	See Section 8.2
[BSW00306] Avoid direct use of compiler and platform specific keywords	See Figure 5.2
[BSW00307] Global variables naming convention	Not applicable (Because this is a requirement on implementation).
[BSW00308] Definition of global data	Not applicable (Because this is a requirement for the implementer).
[BSW00309] Global data with read-only constraint	See Section 8.3.1
[BSW00310] API naming convention	See Section 8.3
[BSW00312] Shared code shall be reentrant	See Section 8.3
[BSW00314] Separation of interrupt frames and service routines	See Section 5.2
[BSW00318] Format of module version numbers	MCU037,
[BSW00321] Enumeration of module version numbers	Not Applicable (Because this is a requirement for the implementer).
[BSW00323] API parameter checking	MCU017
[BSW00325] Runtime of interrupt service routines	Not applicable (Because this is not a requirement of the MCU driver. Requirement for the implementer).
[BSW00326] Transition from ISRs to OS tasks	Not applicable (Because this is a requirement for the implementer).
[BSW00327] Error values naming convention	MCU012
[BSW00328] Avoid duplication of code	Not applicable (Because this is a requirement for the implementer).
[BSW00329] Avoidance of generic interfaces	Not applicable (Because there are no generic interfaces specified within this SWS).
[BSW00330] Usage of macros / inline functions instead of functions	Not applicable (Because this is a requirement for the implementer).
[BSW00331] Separation of error and status values	Not applicable (Because there are no status values specified within this SWS).
[BSW00333] Documentation of callback function context	Not applicable (Because there is no callback functionality in the MCU driver).
[BSW00334] Provision of XML file	Not applicable (Because this requirement is specified by another document).
[BSW00335] Status values naming convention	Not applicable (Because there are no status values specified within the SWS).

[BSW00336] Shutdown interface	Not applicable (Because for the MCU driver there is no need for this requirement).
[BSW00337] Classification of errors	MCU012, MCU015
[BSW00338] Detection and Reporting of development errors	MCU013
[BSW00339] Reporting of production relevant error status	MCU049
[BSW00341] Microcontroller compatibility documentation	Not applicable (Because this is a requirement for the implementer).
[BSW00342] Usage of source code and object code	Not applicable (Because this is a requirement for the implementer).
[BSW00343] Specification and configuration of time	Not applicable (Because time configuration is not a requirement of the MCU driver).
[BSW00344] Reference to Link-time configuration	MCU119_Conf
[BSW00345] Pre-compile-time configuration	See Section 5.2.2, MCU119_Conf
[BSW00346] Basic set of module files	See Section 5.2.2
[BSW00347] Naming separation of different instances of BSW drivers	Not applicable (Because this is a requirement on implementation).
[BSW00348] Standard type header	See Section 5.2.2
[BSW00350] Development error detection keyword	MCU118
[BSW00353] Platform specific type header	See Section 5.2.2
[BSW00355] Do not redefine AUTOSAR integer data types	Not applicable (Because there is no integer data types redefined in this specification).
[BSW00357] Standard API return type	Not applicable (Because this type is not used within the SWS).
[BSW00358] Return type of init() functions	See Section 8.3.1
[BSW00359] Return type of callback functions	Not applicable (Because the MCU driver does not provide a callback mechanism).
[BSW00360] Parameters of callback functions	Not applicable (Because the MCU driver does not provide a callback mechanism).
[BSW00361] Compiler specific language extension header	See Section 5.2.2
[BSW00369] Do not return development error codes via API	MCU013, MCU015
[BSW00370] Separation of callback interface from API	Not applicable (Because the MCU driver does not provide a callback mechanism).
[BSW00371] Do not pass function pointers via API	Not applicable (Because no function pointers are passed via API in this SWS).
[BSW00373] Main processing function naming convention	Not applicable (Because there is no main processing function is specified).
[BSW00374] Module vendor identification	MCU121MCU037

[BSW00375] Notification of wake-up reason	Not Applicable (Because the MCU driver does not provide notification of wake-up).
BSW00376] Return type and parameters of main processing functions	Not applicable (Because there is no main processing function specified).
[BSW00377] Module specific API return types	Not applicable (Because this type is not used within the SWS).
[BSW00378] AUTOSAR boolean type	See Section 10.2.2
[BSW00379] Module identification	MCU037
[BSW00380] Separate C-File for configuration parameters	See Section 5.2.2
[BSW00381] Separate configuration header file for pre-compile time parameters	See Section 5.2.2
[BSW00382] Not-used configuration elements need to be listed	Not applicable (Because this is an implementation requirement).
[BSW00383] List dependencies of configuration files	See Section 5.2.2
[BSW00384] List dependencies to other modules	See Section 5.2.2
[BSW00385] List possible error notifications	See Section 7.4
[BSW00386] Configuration for detecting an error	See Section 7.2.2
[BSW00387] Specify the configuration class of callback function	Not applicable (Because the MCU driver does not have any callback capability).
[BSW00388] Introduce containers	See Section 10.2.2
[BSW00389] Containers shall have names	See Section 10.2.2
[BSW00390] Parameter content shall be unique within the module	See Chapter 8.3
[BSW00391] Parameter shall have unique names	See Chapter 8.3
[BSW00392] Parameters shall have a type	See Chapter 8.3
[BSW00393] Parameters shall have a range	See Chapter 8.3
[BSW00394] Specify the scope of the parameters	See Chapter 8.3
[BSW00395] List the required parameters (per parameter)	Not applicable (Because none of the parameters of the MCU driver are dependent on other modules).
[BSW00396] Configuration classes	See Chapter 10.2.2
[BSW00397] Pre-compile-time parameters	See Chapter 10.2.2
[BSW00398] Link-time parameters	See Chapter 10.2.2
[BSW00399] Loadable Post-build time parameters	See Chapter 10.2.2
[BSW00400] Selectable Post-build time parameters	See Chapter 10.2.2
[BSW00401] Documentation of multiple instances of configuration parameters	See Chapter 10.2.2
[BSW00402] Published information	See Chapter 10.3
[BSW00404] Reference to post build time configuration	See Chapter 10.2.2
[BSW00405] Reference to multiple configuration sets	See Chapter 10.2.2
[BSW00406] Check module initialization	MCU026
[BSW00407] Function to read out published parameters	MCU103
[BSW00408] Configuration parameter naming convention	See Chapter 10.2.2
[BSW00409] Header files for production code error IDs	See Section 5.2.2
[BSW00410] Compiler switches shall have defined values	See Chapter 10.2.2
[BSW00411] Get version info keyword	MCU103, MCU104
[BSW00412] Separate H-File for configuration parameters	See Section 5.2.2
[BSW00413] Accessing instances of BSW modules	Not applicable (Because this is a requirement on implementation).
[BSW00414] Parameter of init function	MCU126

[BSW00415] User dependent include files	See Section 5.2.2
[BSW00416] Sequence of Initialization	Not applicable (Because this requirement describes the initialization of the whole SPAL layer).
[BSW00417] Reporting of Error Events by Non-Basic Software	Not applicable (Because this driver is part of the basic software layer, applies only for non-BSW modules).
[BSW00419] Separate C-Files for pre-compile time configuration parameters	See Section 5.2.2
[BSW00420] Production relevant error event rate detection	Not applicable (Because this requirement applies only to DEM).
[BSW00421] Reporting of production relevant error events	MCU049
[BSW00422] Debouncing of production relevant error status	MCU049
[BSW00423] Usage of SW-C template to describe BSW modules with AUTOSAR Interfaces	Not applicable (Because it is a non functional requirement. The MCU driver has no AUTOSAR interface).
[BSW00424] BSW main processing function task allocation	Not applicable (Because the MCU driver does not contain any main processing functions).
[BSW00425] Trigger conditions for schedulable objects	Not applicable (Because the MCU driver does not contain any schedulable objects/services. This is a requirement for the implementer).
[BSW00426] Exclusive areas in BSW modules	Not applicable (Because this requirement applies only for the module descriptions template).
[BSW00427] ISR description for BSW modules	Not applicable (Because this is a requirement for the implementer).
[BSW00428] Execution order dependencies of main processing functions	Not applicable (Because the MCU driver does not contain any main processing functions).
[BSW00429] Restricted BSW OS functionality access	Not applicable (Because the MCU driver is not dependent on the OS driver).
[BSW00431] The BSW Scheduler module implements task bodies	Not applicable (Because this requirement is for an upper layer. There is no scheduling functionality in the MCU driver).
[BSW00432] Modules should have separate main processing functions for read/receive and write/transmit data path	Not applicable (Because the MCU driver does not contain any main processing functions).
[BSW00433] Calling of main processing functions	Not applicable (Because the MCU driver does not contain any main processing functions).
[BSW00434] The Schedule Module shall provide an API for exclusive areas	Not applicable (Because it is a non-functional requirement. There is no scheduling functionality in the MCU driver)
[BSW00435] Header file Structure for the Basic Software Scheduler	See Figure 2
[BSW00436] Module Header File Structure for the Basic Software Memory Mapping	See Figure 2
[BSW00442] Debugging Support	MCU200 MCU201 MCU202 MCU203

Document: AUTOSAR requirements on Basic Software, cluster SPAL [8] e [9]

Requirement	***Satisfied by***
[BSW12263] Object code compatible configuration concept	SeeSection 10.2.2
[BSW12056] Configuration of notification mechanisms	SeeSection 10.2.2
[BSW12267] Configuration of wake-up sources.	Not Applicable (Because the MCU driver does not provide configuration information for wake-up sources).
[BSW12057] Driver module initialization	MCU026
[BSW12125] Initialization of hardware resources	MCU116, MCU244, MCU245, MCU246, MCU247
[BSW12163] Driver module deinitialization	Not applicable (Because the MCU driver cannot be de-initialized).
BSW12068] MCAL initialization sequence	Not applicable (Because this is a general software integration requirement).
[BSW12069] Wake-up notification of ECU State Manager	Not Applicable (Because the MCU driver does not provide notification of wake-up).
[BSW157] Notification mechanisms of drivers and handlers	MCU008, MCU005, MCU006, MCU012
[BSW12155] Prototypes of callback functions	Not applicable (Because there is no callback functionality in the MCU driver).
[BSW12169] Control of operation mode	Not applicable (Because there are no special operation modes defined for the MCU driver. The specified MCU mode interface (see MCU164, MCU165) is able to change operation modes of the whole MCU, which is not meant with this requirement).
[BSW12063] Raw value mode	MCU006
[BSW12075] Use of application buffers	Not applicable (Because there is no random streaming capability).
[BSW12129] Resetting of interrupt flags	Not applicable (Because the interrupt functionality not part of the MCU driver)
[BSW12064] Change of operation mode during running operation	Not applicable (Because this is a non-functional requirement concerning system design).
[BSW12067] Setting of wake-up conditions	Not Applicable (Because the MCU driver does not provide notification of wake-up).
[BSW12448] Behaviour after development error detection	MCU013
[BSW12077] Non-blocking implementation	Not Applicable (Because this is a requirement for the implementer).
[BSW12078] Runtime and memory efficiency	Not Applicable (Because this is a requirement for the implementer).
[BSW12092] Access to drivers	Not Applicable (Because this is a requirement concerning

	system design).
[BSW12265] Configuration data shall be kept constant	Not Applicable (Because this is a requirement for the implementer).
[BSW12264] Specification of configuration items	See Section 10.2.2
[BSW12350] Configuration of RAM segments	MCU030
[BSW12331] RAM Initialization	MCU011
[BSW12392] Provide lock status of PLL	MCU008
[BSW12336] Activate PLL Clock distribution	MCU140, MCU141, MCU056
[BSW12207] Configuration of clock safety features	MCU031, MCU054
[BSW12208] Initialization of MCU Clock	MCU248 MCU137, MCU138
[BSW12394] Fault condition handling of clock safety features	MCU012, MCU053;
[BSW12000] Provide standardized reset reason	MCU005, MCU052
[BSW12215] Provide raw reset status	MCU006
[BSW12277] Reset trigger function	MCU143, MCU144, MCU055
[BSW12268] MCU Power Management Control	MCU164, MCU165
[BSW12421] Low Power Mode Configuration	MCU035
[BSW12461] Responsibility for register initialisation	MCU116, MCU244, MCU245, MCU246, MCU247
[BSW12462] Provide settings for register initialisation.	See Section 10.3
[BSW12463] Combine and forward settings for register initialisation.	Not applicable (Because this is a requirement for a configuration tool).
[BSW13701] Providing Ram Status	MCU207,MCU208, MCU209, MCU181_Conf

7 Functional specification

7.1 General Behavior

7.1.1 Background and Rationale

The MCU driver provides MCU services for Clock and RAM initialization. In the MCU configuration set, the MCU specific settings for the Clock (i.e. PLL setting) and RAM (i.e. section base address and size) shall be configured.

7.1.2 Requirements

7.1.2.1 Reset

MCU055: The MCU module shall provide a service to provide software triggering of a hardware reset.

Note: Only an authorized user shall be able to call this reset service function.

MCU052: The MCU module shall provide services to get the reset reason of the last reset if the hardware supports such a feature.

Note: In an ECU, there are several sources which can cause a reset. Depending on the reset reason, several application scenarios might be necessary after re-initialization of the MCU.

7.1.2.2 Clock

MCU248 Mcu shall provide a service to enable and set the MCU clock.
(i.e. Cpu clock, Peripheral Clock, Prescalers, Multipliers have to be configured in the MCU)

Note: All the available peripheral clocks have to be made available to the other BSW modules via the McuClockReferencePoint container.

7.1.2.3 MCU Mode service

MCU164: The MCU module shall provide a service to activate MCU reduced power modes.

The service, which activates the reduced power mode, shall allow access to power modes available in the uC hardware.

MCU165: The number of modes and the configuration is MCU dependent and shall be configured in the configuration set of the MCU module.

Note: The activation of MCU reduced power modes might influence the PLL, the internal oscillator, the CPU clock, uC peripheral clock and the power supply for core and peripherals.

In typical operation, MCU reduced power mode will be entered and exited frequently during ECU runtime. In this case, wake-up is performed when it is activated in one of the MCAL modules.

The upper layer is responsible for activating MCU normal operation (condition before execution of MCU power mode) or to switch off uC power supply.

For some MCU mode configuration, the MCU is able to wake up only via hardware reset.

7.1.3 Version Check

7.1.3.1 Background and Rationale

The integration of incompatible files shall be avoided. Minimum implementation is the version check of the header file inside the C file (version numbers of C and H files shall be identical).

7.1.3.2 Requirements

The Mcu module shall avoid the integration of incompatible files by the following pre-processor checks:

MCU110:
For included (external) header files:

- `<MODULENAME>_AR_ RELEASE_MAJOR_VERSION`
- `<MODULENAME>_AR_ RELEASE_MINOR_VERSION`

shall be verified.

7.2 Error classification

7.2.1 Background and Rationale

The error classification depends on the time of error occurrence according to the product life cycle:

- Development Errors:
  These errors shall be detected and fixed during the development phase. In most cases, these errors are software errors. The detection of errors that shall only occur during development can be switched off for production code (by static configuration, i.e. pre-processor switches).

- Production:
  These errors are hardware errors and software exceptions that cannot be avoided and are also expected to occur in production code.

7.2.2 Requirements

MCU111: Values for production code Event Ids are assigned externally by the configuration of the DEM. They are published in the file `Dem_IntErrId.h` and included via `Dem.h`.

MCU112: Development error values are of type uint8.

MCU012: The following errors and exceptions shall be detectable by the MCU module depending on its build version (development/production mode):

Type or error	Relevance	Related error code	Value

API service called with wrong parameter	Development	`MCU_E_PARAM_CONFIG`
		`MCU_E_PARAM_CLOCK`
		`MCU_E_PARAM_MODE`
		`MCU_E_PARAM_RAMSECTION`
		`MCU_E_PLL_NOT_LOCKED`
		`MCU_E_UNINIT`
		`MCU_E_PARAM_POINTER`
			`0x0A`
			`0x0B`
			`0x0C`
			`0x0D`
			`0x0E`
			`0x0F`
			`0x10`

Clock source failure	Production	`MCU_E_CLOCK_FAILURE`	Assigned by DEM

Table 2: Error Classification

MCU053: If clock failure notification is enabled in the configuration set and a clock source failure error occurs, the error code `MCU_E_CLOCK_FAILURE` shall be reported. (See also MCU051).

7.3 Error detection

MCU100: The detection of development errors is configurable (*ON* / *OFF*) at pre-compile time. The switch `McuDevErrorDetect` (see chapter 10) shall activate or deactivate the detection of all development errors.

MCU101: `If the McuDevErrorDetect` switch is enabled, API parameter checking is enabled. The detailed description of the detected errors can be found in chapter 7.2 and chapter 8.

MCU102: The detection of production code errors cannot be switched off.

7.4 Error notification

MCU016: The MCU driver follows the standardized AUTOSAR concept to report development errors. The provided routines are specified in the Development Error Tracer (DET) specification.

MCU013: Detected development errors shall be reported to the `Det_ReportError` service of the Development Error Tracer (DET) if the pre-processor switch `McuDevErrorDetect` is set (see chapter 10).

MCU051: The MCU driver follows the standardized AUTOSAR concept to report production errors. The provided callback routines are specified in the Diagnostic Event Manager (DEM) specification (see 6).

MCU049: Production errors shall be reported to the Diagnostic Event Manager (DEM).

MCU226: Production Errors shall not be used as the return value of the called function.

MCU015: Additional errors that are detected because of specific implementation and/or specific hardware properties shall be added to the MCU implementation specification. The classification and enumeration shall be compatible to the errors listed above (see MCU012).

7.5 Debugging Support

The following requirements deal with the definition of variables and the description of debug information.

MCU200: Each variable that shall be accessible by AUTOSAR Debugging, shall be defined as global variable.

MCU201: All type definitions of variables which shall be debugged, shall be accessible by the header file Mcu.h.

MCU202: The declaration of variables in the header file shall allow to calculate the size of the variables by C-"sizeof".

MCU203: Variables available for debugging shall be described in the respective Basic Software Module Description.

8 API specification

8.1 Imported types

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

MCU152:

Module	*Imported Type*
Dem	Dem_EventIdType
	Dem_EventStatusType
Std_Types	Std_ReturnType
	Std_VersionInfoType

8.2 Type definitions

8.2.1 Mcu_ConfigType

Name:	`Mcu_ConfigType`	
Type:	`Structure`	
Range:	`Hardware dependent structure`	A structure to hold the MCU driver configuration.
Description:	A pointer to such a structure is provided to the MCU initialization routines for configuration.	

MCU131: The structure `Mcu_ConfigType` is an external data structure (i.e. implementation specific) and shall contain the initialization data for the MCU module. It shall contain:

- MCU dependent properties
- Reset Configuration
- Definition of MCU modes
- Definition of Clock settings
- Definition of RAM sections

MCU054: The structure `Mcu_ConfigType` shall provide a configurable (enable/disable) clock failure notification if the MCU provides an interrupt for such detection.

If the clock failure is detected with other HW mechanisms e.g., the generation of a trap, this notification shall be disabled and the failure reporting shall be done outside the MCU driver.

MCU035: The definitions for each MCU mode within the structure `Mcu_ConfigType` shall contain: (depending on MCU)

- MCU specific properties
- Change of CPU clock
- Change of Peripheral clock
- Change of PLL settings
- Change of MCU power supply

MCU031: The definitions for each Clock setting within the structure `Mcu_ConfigType` shall contain:

- MCU specific properties as, e.g., clock safety features and special clock distribution settings
- PLL settings /start lock options
- Internal oscillator setting

MCU030: The definitions for each RAM section within the structure `Mcu_ConfigType` shall contain:

- RAM section base address
- Section size
- Data pre-setting to be initialized

Usage of linker symbols instead of scalar values is allowed.

8.2.2 Mcu_PllStatusType

Name:	`Mcu_PllStatusType`	
Type:	`Enumeration`	
Range:	`MCU_PLL_LOCKED`	PLL is locked
	`MCU_PLL_UNLOCKED`	PLL is unlocked
	`MCU_PLL_STATUS_UNDEFINED`	PLL Status is unknown
Description:	This is a status value returned by the function Mcu_GetPllStatus of the MCU module.	

MCU230: The type `Mcu_PllStatusType` is the type of the return value of the function `Mcu_GetPllStatus`.

MCU231: The type of `Mcu_PllStatusType` is an enumeration with the following values: `MCU_PLL_LOCKED`, `MCU_PLL_UNLOCKED`, `MCU_PLL_STATUS_UNDEFINED`.

8.2.3 Mcu_ClockType

Name:	`Mcu_ClockType`		
Type:	`uint`		
Range:	`0..<number of clock settings>- 1`	- -	The range is dependent on the number of different clock settings provided in the configuration structure. The type shall be chosen depending on MCU platform for best performance.
Description:	Specifies the identification (ID) for a clock setting, which is configured in the configuration structure		

MCU232: The type Mcu_ClockType defines the identification (ID) for clock setting configured via the configuration structure.

MCU233: The type shall be uint8, uint16 or uint32, depending on uC platform.

8.2.4 Mcu_ResetType

Name:	`Mcu_ResetType`	
Type:	`Enumeration`	
Range:	`MCU_POWER_ON_RESET`	Power On Reset (default)
	`MCU_WATCHDOG_RESET`	Internal Watchdog Timer Reset
	`MCU_SW_RESET`	Software Reset
	`MCU_RESET_UNDEFINED`	Reset is undefined
Description:	This is the type of the reset enumerator containing the subset of reset types. It is not required that all reset types are supported by hardware.	

MCU234: The type `Mcu_ResetType`, represents the different reset that a specified MCU can have.

MCU134: The MCU module shall provide at least the values `MCU_POWER_ON_RESET` and `MCU_RESET_UNDEFINED` for the enumeration `Mcu_ResetType`.

Note: Additional reset types of Mcu_ResetType may be added depending on MCU.

8.2.5 Mcu_RawResetType

Name:	`Mcu_RawResetType`		
Type:	`uint`		
Range:	`MCU dependent register value`	- -	The type shall be chosen depending on MCU platform for best performance.
Description:	This type specifies the reset reason in raw register format read from a reset status register.		

MCU235: The type `Mcu_RawResetType` specifies the reset reason in raw register format, read from a reset status register.

MCU236: The type shall be uint8, uint16 or uint32 based on best performance.

8.2.6 Mcu_ModeType

Name:	`Mcu_ModeType`		
Type:	`uint`		
Range:	`0..<number of MCU modes>-1`	- -	The range is dependent on the number of MCU modes provided in the configuration structure. The type shall be chosen depending on MCU platform for best performance.
Description:	This type specifies the identification (ID) for a MCU mode, which is configured in the configuration structure.		

MCU237: The `Mcu_ModeType` specifies the identification (ID) for a MCU mode, configured via configuration structure.

MCU238: The type shall be uint8, uint16 or uint32.

8.2.7 Mcu_RamSectionType

Name:	`Mcu_RamSectionType`		
Type:	`uint`		
Range:	`0..< number of RAM sections>-1`	- -	The range is dependent on the number of RAM sections provided in the configuration structure. The type shall be chosen depending on MCU platform for best performance.
Description:	This type specifies the identification (ID) for a RAM section, which is configured in the configuration structure.		

MCU239: The `Mcu_RamSectionType` specifies the identification (ID) for a RAM section, configured via the configuration structure.

MCU240: The type shall be uint8, uint16 or uint32, based on best performance.

8.3 Mcu_RamStateType

Name:	`Mcu_RamStateType`	
Type:	`Enumeration`	
Range:	`MCU_RAMSTATE_INVALID`	Ram content is not valid or unknown (default).
	`MCU_RAMSTATE_VALID`	Ram content is valid:
Description:	This is the Ram State data type returned by the function Mcu_GetRamState of the Mcu module. It is not required that all RAM state types are supported by the hardware.	

8.4 Function definitions

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

8.4.1 Mcu_Init

MCU153:

Service name:	Mcu_Init	
Syntax:	`void Mcu_Init( const Mcu_ConfigType* ConfigPtr )`	
Service ID[hex]:	0x00	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	ConfigPtr	Pointer to MCU driver configuration set.
Parameters (inout):	None	
Parameters (out):	None	

Return value:	None
Description:	This service initializes the MCU driver.

MCU026: The function `Mcu_Init` shall initialize the MCU module, i.e. make the configuration settings for power down, clock and RAM sections visible within the MCU module.

Note: After the execution of the function `Mcu_Init`, the configuration data are accessible and can be used by the MCU module functions as, e.g., `Mcu_InitRamSection`.

The MCU module's implementer shall apply the following rules regarding initialization of controller registers within the function `Mcu_Init`:

1. **MCU116:** If the hardware allows for only one usage of the register, the driver module implementing that functionality is responsible for initializing the register.
2. **MCU244**: If the register can affect several hardware modules and if it is an I/O register, it shall be initialised by the PORT driver.
3. **MCU245**: If the register can affect several hardware modules and if it is not an I/O register, it shall be initialised by this MCU driver.
4. **MCU246:** One-time writable registers that require initialisation directly after reset shall be initialised by the startup code.
5. **MCU247**: All other registers not mentioned before shall be initialised by the start-up code.

MCU127: If not applicable, the MCU module's environment shall pass a NULL pointer to the function `Mcu_Init`. In this case the check for this NULL pointer has to be omitted.

Note: The term 'Hardware Module' refers to internal modules of the MCU and not to a BSW module.

8.4.2 Mcu_InitRamSection

MCU154:

Service name:	Mcu_InitRamSection	
Syntax:	`Std_ReturnType Mcu_InitRamSection( Mcu_RamSectionType RamSection )`	
Service ID[hex]:	0x01	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	RamSection	Selects RAM memory section provided in configuration set
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: command has been accepted E_NOT_OK: command has not been accepted e.g. due to parameter error

Description:	This service initializes the RAM section wise.

MCU011: The function `Mcu_InitRamSection` shall fill the memory from address `McuRamSectionBaseAddress` up to address `McuRamSectionBaseAddress + McuRamSectionSize-1` with the byte-value contained in `McuRamDefaultValue`, where `McuRamSectionBaseAddress`, `McuRamSectionSize` and `McuRamDefaultValue` are the values of the configuration parameters for each RamSection (see MCU030).

MCU136: The MCU module's environment shall call the function `Mcu_InitRamSection` only after the MCU module has been initialized using the function `Mcu_Init`.

8.4.3 Mcu_InitClock

MCU155:

Service name:	Mcu_InitClock	
Syntax:	`Std_ReturnType Mcu_InitClock( Mcu_ClockType ClockSetting )`	
Service ID[hex]:	0x02	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	ClockSetting	Clock setting
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: Command has been accepted E_NOT_OK: Command has not been accepted
Description:	This service initializes the PLL and other MCU specific clock options.	

MCU137: The function `Mcu_InitClock` shall initialize the PLL and other MCU specific clock options. The clock configuration parameters are provided via the configuration structure.

MCU138: The function `Mcu_InitClock` shall start the PLL lock procedure (if PLL shall be initialized) and shall return without waiting until the PLL is locked.

MCU139: The MCU module's environment shall only call the function `Mcu_InitClock` after the MCU module has been initialized using the function `Mcu_Init`.

MCU210: The function `Mcu_InitClock` shall be disabled if the parameter `McuInitClock` is set to FALSE. Instead this function is available if the former parameter is set to TRUE (see also **MCU182_Conf :**).

8.4.4 Mcu_DistributePllClock

MCU156:

Service name:	Mcu_DistributePllClock
Syntax:	`void Mcu_DistributePllClock( void )`
Service ID[hex]:	0x03
Sync/Async:	Synchronous
Reentrancy:	Non Reentrant
Parameters (in):	None
Parameters (inout):	None
Parameters (out):	None
Return value:	None
Description:	This service activates the PLL clock to the MCU clock distribution.

MCU140: The function `Mcu_DistributePllClock` shall activate the PLL clock to the MCU clock distribution.

MCU141: The MCU module's environment shall execute the function `Mcu_DistributePllClock` if the MCU module needs a separate request to activate the PLL clock after the PLL is locked. In this case, the function shall remove the current clock source (for example internal oscillator clock) from MCU clock distribution.

MCU056: The function `Mcu_DistributePllClock` shall return without affecting the MCU hardware if the PLL clock has been automatically activated by the MCU hardware.

MCU142: The MCU module's environment shall only call the function `Mcu_DistributePllClock` after the status of the PLL has been detected as locked by the function `Mcu_GetPllStatus`.

MCU205: The function `Mcu_DistributePllClock shall be available if the pre-compile parameter McuNoPll` is set to FALSE. Otherwise, this Api has to be disabled (`see also` **MCU180_Conf :**).

8.4.5 Mcu_GetPllStatus

MCU157:

Service name:	Mcu_GetPllStatus	
Syntax:	`Mcu_PllStatusType Mcu_GetPllStatus( void )`	
Service ID[hex]:	0x04	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	None	
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Mcu_PllStatusType	PLL Status

Description:	This service provides the lock status of the PLL.

MCU008: The function `Mcu_GetPllStatus` shall return the lock status of the PLL.

MCU132: The function `Mcu_GetPllStatus shall return MCU_PLL_STATUS_UNDEFINED` if this function is called prior to calling of the function `Mcu_Init`.

MCU206: The function `Mcu_GetPllStatus shall also return MCU_PLL_STATUS_UNDEFINED` if the pre-compile parameter `McuNoPll` is set to TRUE (see also **MCU180_Conf :**).

8.4.6 Mcu_GetResetReason

MCU158:

Service name:	Mcu_GetResetReason
Syntax:	`Mcu_ResetType Mcu_GetResetReason( void )`
Service ID[hex]:	0x05
Sync/Async:	Synchronous
Reentrancy:	Reentrant
Parameters (in):	None
Parameters (inout):	None
Parameters (out):	None
Return value:	Mcu_ResetType --
Description:	The service reads the reset type from the hardware, if supported.

MCU005: The function `Mcu_GetResetReason` shall read the reset reason from the hardware and return this reason if supported by the hardware. If the hardware does not support the hardware detection of the reset reason, the return value from the function `Mcu_GetResetReason` shall always be `MCU_POWER_ON_RESET`.

MCU133: The function `Mcu_GetResetReason shall return MCU_RESET_UNDEFINED` if this function is called prior to calling of the function `Mcu_Init,` and if supported by the hardware.

The User should ensure that the reset reason is cleared once it has been read out to avoid multiple reset reasons.

8.4.7 Mcu_GetResetRawValue

MCU159:

Service name:	Mcu_GetResetRawValue
Syntax:	`Mcu_RawResetType Mcu_GetResetRawValue( void`

	)	
Service ID[hex]:	0x06	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	None	
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Mcu_RawResetType	Reset raw value
Description:	The service reads the reset type from the hardware register, if supported.	

MCU135: The function `Mcu_GetResetRawValue shall return an` implementation specific value which does not correspond to a valid value of the reset status register and is not equal to 0 if this function is called prior to calling of the function `Mcu_Init,` and if supported by the hardware.

MCU006: The function `Mcu_GetResetRawValue shall` read the reset raw value from the hardware register if the hardware supports this. If the hardware does not have a reset status register, the return value shall be 0x0.

The User should ensure that the reset reason is cleared once it has been read out to avoid multiple reset reasons.

8.4.8 Mcu_PerformReset

MCU160:

Service name:	Mcu_PerformReset

Syntax:	`void Mcu_PerformReset(`
	`  void`
	`)`

Service ID[hex]:	0x07
Sync/Async:	Synchronous
Reentrancy:	Non Reentrant
Parameters (in):	None
Parameters (inout):	None
Parameters (out):	None
Return value:	None
Description:	The service performs a microcontroller reset.

MCU143: The function `Mcu_PerformReset` shall perform a microcontroller reset by using the hardware feature of the microcontroller.

MCU144: The function `Mcu_PerformReset` shall perform the reset type which is configured in the configuration set.

MCU145: The MCU module's environment shall only call the function `Mcu_PerformReset` after the MCU module has been initialized by the function `Mcu_Init`.

MCU146: MCU146: The function Mcu_PerformReset is only available if the pre-compile parameter McuPerformResetApi is set to TRUE. If set to FALSE, the function Mcu_PerformReset is not applicable. (see Section 10.2.2).

8.4.9 Mcu_SetMode

MCU161:

Service name:	Mcu_SetMode

Syntax:	`void Mcu_SetMode(`
	`  Mcu_ModeType McuMode`
	`)`

Service ID[hex]:	0x08
Sync/Async:	Synchronous
Reentrancy:	Non Reentrant
Parameters (in):	McuMode Set different MCU power modes configured in the configuration set
Parameters (inout):	None
Parameters (out):	None
Return value:	None
Description:	This service activates the MCU power modes.

MCU147: The function `Mcu_SetMode` shall set the MCU power mode. In case of CPU power down mode, the function `Mcu_SetMode` returns after it has performed a wake-up.

MCU148: The MCU module's environment shall only call the function `Mcu_SetMode` after the MCU module has been initialized by the function `Mcu_Init`.

Note: The environment of the function `Mcu_SetMode` has to ensure that the ECU is ready for reduced power mode activation.

Note: The API `Mcu_SetMode` assumes that all interrupts are disabled prior the call of the API by the calling instance. The implementation has to take care that no wakeup interrupt event is lost. This could be achieved by a check whether pending wakeup interrupts already have occurred even if `Mcu_SetMode` has not set the controller to power down mode yet.

8.4.10 Mcu_GetVersionInfo

MCU162:

Service name:	Mcu_GetVersionInfo

Syntax:	`void Mcu_GetVersionInfo(`
	`  Std_VersionInfoType* versioninfo`
	`)`

Service ID[hex]:	0x09
Sync/Async:	Synchronous
Reentrancy:	Reentrant
Parameters (in):	None

Parameters (inout):	None	
Parameters (out):	versioninfo	Pointer to where to store the version information of this module.
Return value:	None	
Description:	This service returns the version information of this module.	

MCU103: The function `Mcu_GetVersionInfo` shall return the version information of the MCU module. The version information includes:

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

MCU104: The function `Mcu_GetVersionInfo` shall be pre-compile time configurable On/Off by the configuration parameter `McuVersionInfoApi`.

MCU149: If source code for caller and callee of the function `Mcu_GetVersionInfo` is available, the MCU module should realize this function as a macro. The MCU module should define this macro in the module's header file.

MCU204: if development error detection is enabled, the parameter `versioninfo` shall be checked for being NULL. The error `MCU_E_PARAM_POINTER` shall be reported in case the value is a NULL pointer.

8.4.11 Mcu_GetRamState

MCU207:

Service name:	Mcu_GetRamState	
Syntax:	`Mcu_RamStateType Mcu_GetRamState( void )`	
Service ID[hex]:	0x04	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	None	
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Mcu_RamStateType	Status of the Ram Content
Description:	This service provides the actual status of the microcontroller Ram. (if supported)	

Note: Some microcontrollers offer the functionality to check if the Ram Status is valid after a reset. The function `Mcu_GetRamState` can be used for this reason.

MCU208: The MCU module's environment shall call this function only if the MCU module has been already initialized using the function `MCU_Init`.

MCU209: The function `Mcu_GetRamState` shall be available to the user if the pre-compile parameter `McuGetRamStateApi` is set to TRUE. Instead, if the former parameter is set to FALSE, this function shall be disabled

(e.g. the hardware does not support this functionality).

8.5 Call-back Notifications

There are no callback notifications for the MCU driver. The callback notifications are implemented in another module (ICU driver and/or complex drivers).

8.6 Scheduled Functions

There are no scheduled functions within the MCU driver.

8.7 Expected Interfaces

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

8.7.1 Mandatory Interfaces

MCU166:

API function	*Description*
Dem_ReportErrorStatus	Queues the reported events from the BSW modules (API is only used by BSW modules). The interface has an asynchronous behavior, because the processing of the event is done within the Dem main function.

8.7.2 Optional Interfaces

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

MCU163:

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

8.8 API parameter checking

MCU017: If the development error detection is enabled for the MCU module, the MCU functions shall check the following API parameters, report detected errors to the Development Error Tracer and reject with return value `E_NOT_OK` in case the function has a standard return type.

MCU018: If development error detection is enabled, the parameter ConfigPtr shall be checked for being NULL. Related error value: `MCU_E_PARAM_CONFIG.`

MCU019: `ClockSetting` shall be within the settings defined in the configuration data structure. Related error value: `MCU_E_PARAM_CLOCK`

MCU020: `McuMode` shall be within the modes defined in the configuration data structure. Related error value: `MCU_E_PARAM_MODE`

MCU021: `RamSection` shall be within the sections defined in the configuration data structure. Related error value: `MCU_E_PARAM_RAMSECTION`

MCU122: A error shall be reported if the status of the PLL is detected as not locked with the function `Mcu_DistributePllClock()`. The DET error reporting shall be used. Related error value: `MCU_E_PLL_NOT_LOCKED.`

MCU125: If development error detection is enabled and if any other function (except `Mcu_GetVersionInfo`) of the MCU module is called before `Mcu_Init` function, the error code `MCU_E_UNINIT` shall be reported to the DET.
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9 Sequence diagrams

9.1 Example Sequence for MCU initialization services

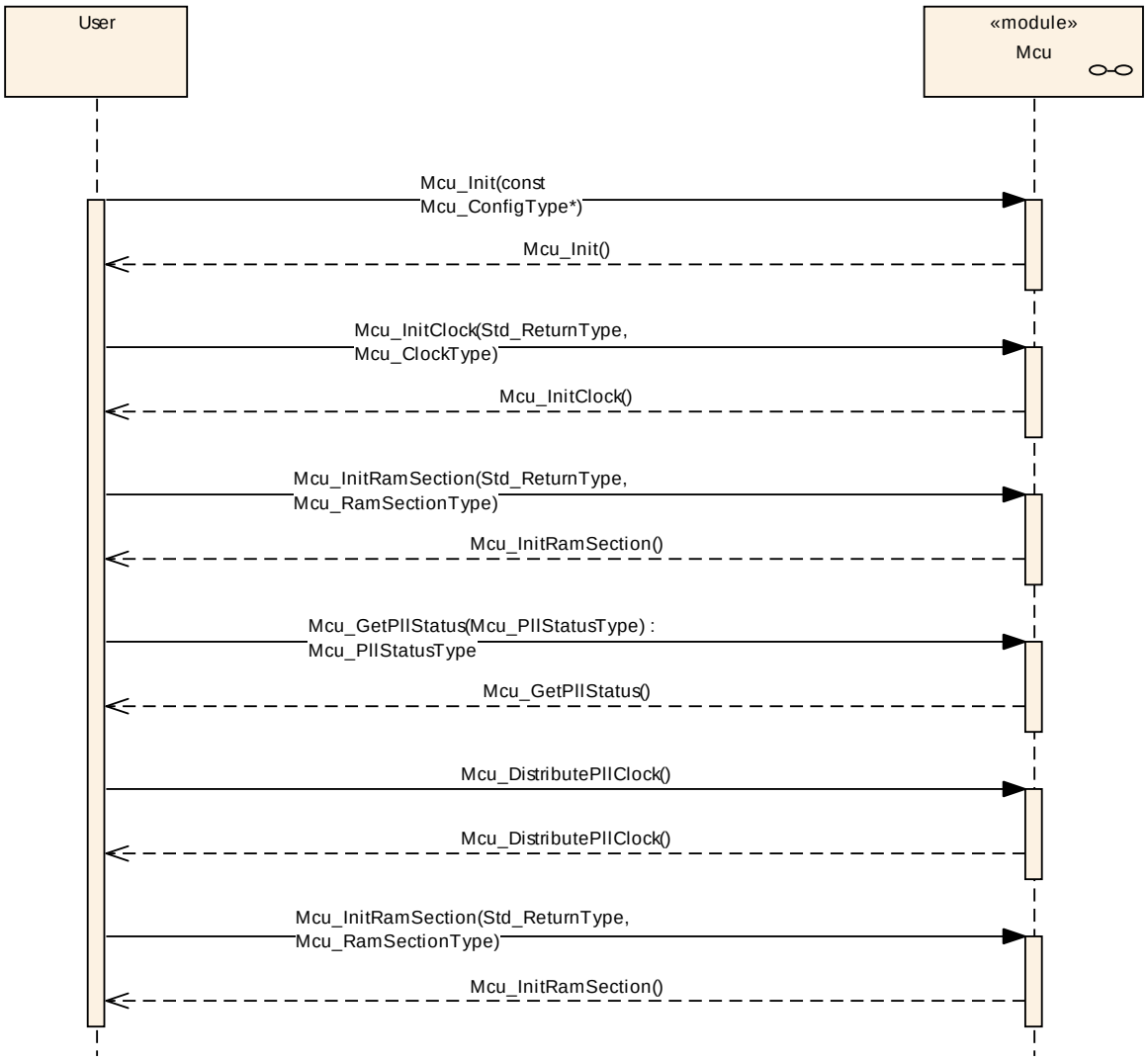

Figure 3: Sequence Diagram – MCU Initialisation

The order of services is just an example and might differ depending on the user. `Mcu_Init` shall be executed first after power-up. The user takes care that the PLL is locked by executing `Mcu_GetPllStatus`.

9.2 Mcu_GetResetReason

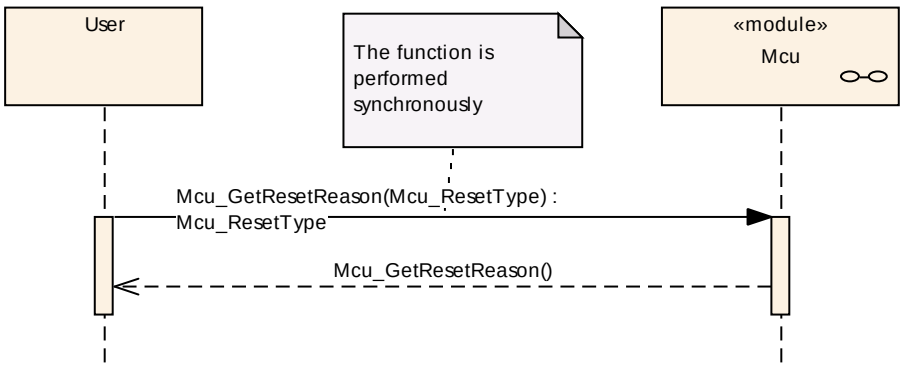

Figure 7: Sequence Diagram – MCU_GetResetReason

9.3 Mcu_GetResetRawValue

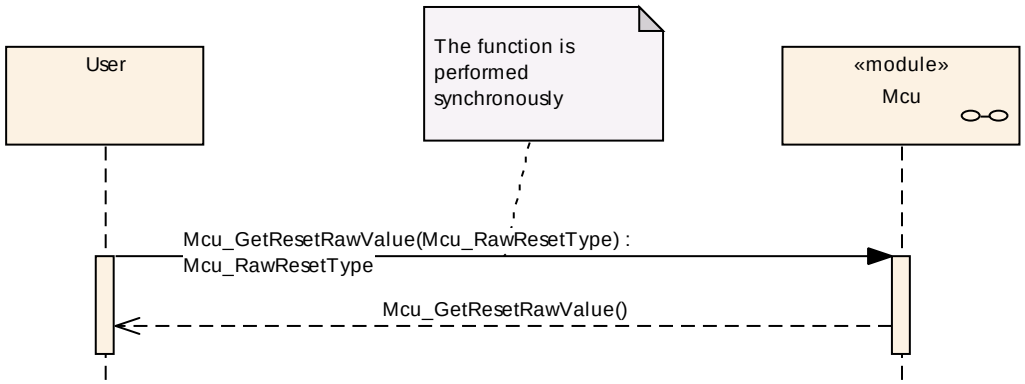

Figure 8: Sequence Diagram – Mcu_GetResetRawValue

9.4 Mcu_PerformReset

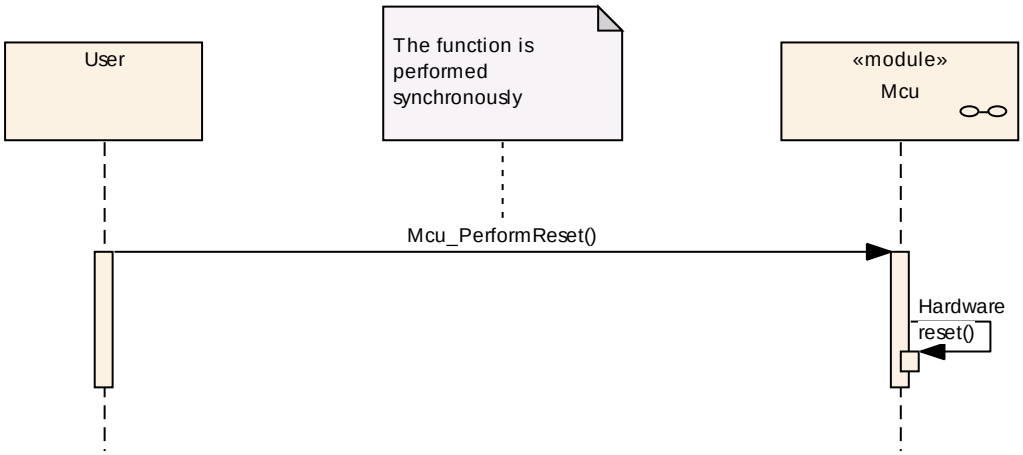

Figure 9: Sequence Diagram – Mcu_PerformReset

10 Configuration specification

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

Chapter 10.2 specifies the structure (containers) and the parameters of the module MCU.

Chapter 10.3 specifies published information of the module MCU.

10.1 How to read this chapter

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

- AUTOSAR Layered Software Architecture [2].
- AUTOSAR ECU Configuration Specification [5].
  This document describes the AUTOSAR configuration methodology and the AUTOSAR configuration metamodel in detail.

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

10.1.1 Configuration and configuration parameters

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

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

10.1.2 Containers

Containers structure the set of configuration parameters. This means:

- *all* configuration parameters are kept in containers.

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

10.2 Containers and configuration parameters

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

10.2.1 Variants

MCU129: VARIANT-PRE-COMPILE.
Only parameters with "Pre-compile time" configuration are allowed in this variant.
The intention of this variant is to optimize the parameters configuration for a source code delivery.

MCU130: VARIANT-POST-BUILD.
Parameters with "Pre-compile time", "Link time" and "Post-build time" are allowed in this variant.
The intention of this variant is to optimize the parameters configuration for a re-loadable binary.

MCU126: The initialization function of this module shall always have a pointer as a parameter, even though for VARIANT-PRE-COMPILE no configuration set shall be given. Instead a NULL pointer shall be passed to the initialization function.

10.2.2 Mcu

Module Name	*Mcu*
Module Description	Configuration of the Mcu (Microcontroler Unit) module.

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
McuGeneralConfiguration	1	This container contains the configuration (parameters) of the MCU driver.
McuModuleConfiguration	1	This container contains the configuration (parameters) of the MCU driver
McuPublishedInformation	1	Container holding all MCU specific published information parameters

10.2.3 McuGeneralConfiguration

SWS Item	**MCU118_Conf :**
Container Name	McuGeneralConfiguration{MCU General Configuration}
Description	This container contains the configuration (parameters) of the MCU driver.
Configuration Parameters	

SWS Item	**MCU166_Conf :**		
Name	McuDevErrorDetect {MCU_DEV_ERROR_DETECT}		
Description	Pre-processor switch for enabling the development error detection and reporting.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	MCU181_Conf :		
Name	McuGetRamStateApi {MCU_ GET_RAM_STATE_API}		
Description	Pre-processor switch to enable/disable the API Mcu_GetRamState. (e.g. If the H/W does not support the functionality, this parameter can be used to disable the Api).		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	Pre-compile time	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	MCU182_Conf :		
Name	McuInitClock {MCU_INIT_CLOCK}		
Description	If this parameter is set to FALSE, the clock initialization has to be disabled from the MCU driver. This concept applies when there are some write once clock registers and a bootloader is present. If this parameter is set to TRUE, the MCU driver is responsible of the clock initialization.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	true		
ConfigurationClass	Pre-compile time	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	MCU180_Conf :		
Name	McuNoPll {MCU_NO_PLL}		
Description	This parameter shall be set True, if the H/W does not have a PLL or the PLL circuitry is enabled after the power on without S/W intervention. In this case MCU_DistributePllClock has to be disabled and MCU_GetPllStatus has to return MCU_PLL_STATUS_UNDEFINED. Otherwise this parameters has to be set False		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	true		
ConfigurationClass	Pre-compile time	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	MCU167_Conf :		
Name	McuPerformResetApi {MCU_PERFORM_RESET_API}		
Description	Pre-processor switch to enable / disable the use of the function Mcu_PerformReset()		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	Pre-compile time	X	All Variants
	Link time	--	
	Post-build time	--	

Scope / Dependency	

SWS Item	**MCU168_Conf :**		
Name	McuVersionInfoApi {MCU_VERSION_INFO_API}		
Description	Pre-processor switch to enable / disable the API to read out the modules version information.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

No Included Containers

10.2.4 McuModuleConfiguration

SWS Item	**MCU119_Conf :**
Container Name	McuModuleConfiguration{MCU Module Configuration} [Multi Config Container]
Description	This container contains the configuration (parameters) of the MCU driver
Configuration Parameters	

SWS Item	**MCU170_Conf :**		
Name	McuClockSrcFailureNotification {MCU_CLOCK_SOURCE_FAILURE_NOTIFICATION}		
Description	Enables/Disables clock failure notification. In case this feature is not supported by HW the setting should be disabled.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	DISABLED	--	
	ENABLED	--	
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**MCU171_Conf :**		
Name	McuNumberOfMcuModes {Mcu_Number_Of_Modes}		
Description	This parameter shall represent the number of Modes available for the MCU. calculationFormula = Number of configured McuModeSettingConf		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	1 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**MCU172_Conf :**
Name	McuRamSectors {MCU_RAM_SECTORS}

Description	This parameter shall represent the number of RAM sectors available for the MCU. calculationFormula = Number of configured McuRamSectorSettingConf		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	1 .. 4294967295		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**MCU173_Conf :**		
Name	McuResetSetting {MCU_RESET_SETTING}		
Description	This parameter relates to the MCU specific reset configuration. This applies to the function Mcu_PerformReset, which performs a microcontroller reset using the hardware feature of the microcontroller.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	1 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
McuClockSettingConfig	1..*	This container contains the configuration (parameters) for the Clock settings of the MCU. Please see MCU031 for more information on the MCU clock settings.
McuDemEventParameterRefs	0..1	Container for the references to DemEventParameter elements which shall be invoked using the API Dem_ReportErrorStatus API in case the corresponding error occurs. The EventId is taken from the referenced DemEventParameter's DemEventId value. The standardized errors are provided in the container and can be extended by vendor specific error references.
McuModeSettingConf	1..*	This container contains the configuration (parameters) for the Mode setting of the MCU. Please see MCU035 for more information on the MCU mode settings.
McuRamSectorSettingConf	0..*	This container contains the configuration (parameters) for the RAM Sector setting. Please see MCU030 for more information on RAM sec-tor settings.

10.2.5 McuClockSettingConfig

SWS Item	**MCU124_Conf :**
Container Name	McuClockSettingConfig{MCU Clock Setting Configuration}
Description	This container contains the configuration (parameters) for the Clock settings of the MCU. Please see MCU031 for more information on the MCU clock settings.
Configuration Parameters	

SWS Item	**MCU183_Conf :**		
Name	McuClockSettingId {MCU_MODE_NORMAL}		
Description	The Id of this McuClockSettingConfig to be used as argument for the API call "Mcu_InitClock".		
Multiplicity	1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	1 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
McuClockReferencePoint	1..*	This container defines a reference point in the Mcu Clock tree. It defines the frequency which then can be used by other modules as an input value. Lower multiplictiy is 1, as even in the simpliest case (only one frequency is used), there is one frequency to be defined.

10.2.6 McuDemEventParameterRefs

SWS Item	**MCU187_Conf :**
Container Name	McuDemEventParameterRefs
Description	Container for the references to DemEventParameter elements which shall be invoked using the API Dem_ReportErrorStatus API in case the corresponding error occurs. The EventId is taken from the referenced DemEventParameter's DemEventId value. The standardized errors are provided in the container and can be extended by vendor specific error references.
Configuration Parameters	

SWS Item	**MCU188_Conf :**		
Name	MCU_E_CLOCK_FAILURE {MCU_E_CLOCK_FAILURE}		
Description	Reference to configured DEM event to report "Clock source failure".		
Multiplicity	0..1		
Type	Reference to [DemEventParameter]		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: ECU dependency: Dem		

No Included Containers

10.2.7 McuModeSettingConf

SWS Item	**MCU123_Conf :**
Container Name	McuModeSettingConf{MCU Mode Setting Configuration}
Description	This container contains the configuration (parameters) for the Mode

	setting of the MCU. Please see MCU035 for more information on the MCU mode settings.
Configuration Parameters	

SWS Item	**MCU176_Conf :**		
Name	McuMode {MCU_MODE_NORMAL}		
Description	The parameter represents the MCU Mode settings.		
Multiplicity	1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	1 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

No Included Containers

10.2.8 McuRamSectorSettingConf

SWS Item	**MCU120_Conf :**
Container Name	McuRamSectorSettingConf{MCU RAM Sector Setting Configuration}
Description	This container contains the configuration (parameters) for the RAM Sector setting. Please see MCU030 for more information on RAM sec-tor settings.
Configuration Parameters	

SWS Item	**MCU177_Conf :**		
Name	McuRamDefaultValue {MCU_RAM_DEFAULT_VALUE}		
Description	This parameter shall represent the Data pre-setting to be initialized		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**MCU178_Conf :**		
Name	McuRamSectionBaseAddress {MCU_RAM_SECTION_BASE_ADDRESS}		
Description	This parameter shall represent the MCU RAM section base address		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

SWS Item	**MCU179_Conf :**

Name	McuRamSectionSize {MCU_RAM_SECTION_SIZE}		
Description	This parameter represents the MCU RAM Section size in bytes.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

No Included Containers

10.2.9 McuClockReferencePoint

SWS Item	**MCU174_Conf :**
Container Name	McuClockReferencePoint
Description	This container defines a reference point in the Mcu Clock tree. It defines the frequency which then can be used by other modules as an input value. Lower multiplictiy is 1, as even in the simpliest case (only one frequency is used), there is one frequency to be defined.
Configuration Parameters	

SWS Item	**MCU175_Conf :**		
Name	McuClockReferencePointFrequency		
Description	This is the frequency for the specific instance of the McuClockReferencePoint container. It shall be given in Hz.		
Multiplicity	1		
Type	EcucFloatParamDef		
Range	`0 .. INF`		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module		

No Included Containers

10.2.10 McuPublishedInformation

SWS Item	**MCU184_Conf :**
Container Name	McuPublishedInformation
Description	Container holding all MCU specific published information parameters
Configuration Parameters	

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
McuResetReasonConf	1..*	This container contains the configuration for the different type of reset reason that can be retrieved from Mcu_GetResetReason Api.

10.2.11 McuResetReasonConf

SWS Item	**MCU185_Conf :**
Container Name	McuResetReasonConf
Description	This container contains the configuration for the different type of reset reason that can be retrieved from Mcu_GetResetReason Api.
Configuration Parameters	

SWS Item	**MCU186_Conf :**		
Name	McuResetReason {MCU_POWER_ON_RESET}		
Description	The parameter represents the different type of reset that a Micro supports. This parameter is referenced by the parameter EcuMResetReason in the ECU State manager module.		
Multiplicity	1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	0 .. 255		
Default value	--		
ConfigurationClass	***Published Information***	X	All Variants
Scope / Dependency	scope: Module		

No Included Containers

10.3 Published Information

[MCU001_PI] The standardized common published parameters as required by BSW00402 in the General Requirements on Basic Software Modules[3] shall be published within the header file of this module and need to be provided in the BSW Module Description. The according module abbreviation can be found in the List of Basic Software Modules [1].

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

11 Changes to Release 3.0

11.1 Deleted SWS Items

SWS Item	*Rationale*
MCU105	No Requirement of Mcu

11.2 Replaced SWS Items

SWS Item	*replaced by SWS Item*	*Rationale*
MCU0149	MCU049	Wrong Id number
MCU166	MCU166_Conf	Corrected the duplication.
MCU108	MCU108, 211, 213, 215, 216, 218, 219	Made Req atomic
MCU109	MCU109, 220	//
MCU110	MCU110, 225	//
MCU049	MCU049, 226	//
MCU116	MCU116,244,245,246,247	//

All the SWS IDs in chapter10 have been modified by TO. It was added the suffix _Conf to avoid names duplicated.

11.3 Changed SWS Items

SWS Item	*Rationale*
MCU147	Rephrased
MCU053	Rephrased
MCU055	Made Atomic
MCU134	Reformulated
MCU011	//
MCU110	//
MCU129	//
MCU130	//
MCU171_Conf	Changes in the configuration class
MCU179_Conf	Rephrased to increase the understandability-
MCU164	Made Atomic
MCU054	//
MCU171_Conf, MCU172_Conf, MCU173_Conf, MCU176_Conf, MCU177_Conf, MCU178_Conf, MCU179_Conf	Min and Max values in the Range field changed.

11.4 Added SWS Items

SWS Item	*Rationale*
MCU200,201,202,203	Inserted to cover the debugging concept
MCU204	Null Pointer checking in GetVersionInfo
MCU205,206,180_Conf	Inserted to disable the PLL related APIs
MCU207,208,209,181_Conf	Inserted to read the Ram Status
MCU182_Conf,MCU210	Switch to enable/disable the Mcu_InitClock Api
MCU230,231	Added atomic IDs in the datatype section
MCU232,233	//
MCU234	//
MCU235,236	//
MCU237,238	//
MCU239,240	//
MCU242,243	//
MCU248	Inserted a new section for the clock in chapter 7. A new note for the ClockReference concept was inserted as well
MCU183_Conf	Inserted new ID for the clock to be passed to Mcu_InitClock
MCU187_Conf, MCU188_Conf	Inserted reference to DemEventParameter container in the Dem module
MCU184_Conf	Inserted container McuPublishedInformation to group all the MCU specific published information
MCU185_Conf,186_Conf	Inserted a new container and a new configuration parameter to specify all the different type of reset that a specified Micro supports
MCU001_PI	Rework of Published Information

12 Changes to Release 4.0 Rev 1

12.1 Deleted SWS Items

SWS Item	*Rationale*
MCU225	Removed version check for the internal files in order to align this Spec ID with the general requirement BSW004.

12.2 Replaced SWS Items

SWS Item	*replaced by SWS Item*	*Rationale*

12.3 Changed SWS Items

SWS Item	*Rationale*
MCU125	Api checking initialization made more clear in accord to bugzilla 40048
MCU011	Renamed wrong configuration parameter RamSectionBase with the correct one RamSectionSize. In accord to bugzilla 40046
MCU210	Renamed configuration parameter Mcu_InitClock in McuInitClock

12.4 Added SWS Items

SWS Item	*Rationale*