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Document Change History

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Table of Contents

1 Introduction and functional overview 7

2 Acronyms and abbreviations 8

3 Related documentation 9

3.1 Input documents 9
3.2 Related standards and norms 9

4 Constraints and assumptions 10

4.1 Limitations 10
4.2 Applicability to car domains 10

5 Dependencies to other modules 11

5.1 File structure 11
5.1.1 Code file structure 11
5.1.2 Header file structure 12
5.2 System clock 12
5.3 Onboard communication handlers 12

6 Requirements traceability 13

7 Functional specification 20

7.1 General design rules 20
7.2 Error classification 20
7.3 Error detection 21
7.4 Error notification 21
7.5 External watchdog driver 21

8 API specification 22

8.1 Imported types 22
8.2 Type definitions 22
8.2.1 Wdg_ConfigType 22
8.3 Function definitions 22
8.3.1 Wdg_Init 22
8.3.2 Wdg_SetMode 23
8.3.3 Wdg_Trigger 25
8.3.4 Wdg_GetVersionInfo 26
8.4 Call-back Notifications 27
8.5 Scheduled functions 27
8.6 Expected Interfaces 27
8.6.1 Mandatory Interfaces 27
8.6.2 Optional Interfaces 27
8.6.3 Configurable interfaces 28

9 Sequence diagrams 29

9.1 Watchdog initialization, triggering and mode switching 29
9.2 Data exchange between watchdog driver and hardware 30

10 Configuration specification 31
10.1 How to read this chapter 31
10.1.1 Configuration and configuration parameters 31
10.1.2 Containers 31
10.1.3 Specification template for configuration parameters 32
10.2 Containers and configuration parameters 33
10.2.1 Variants 33
10.2.2 Wdg 33
10.2.3 WdgGeneral 33
10.2.4 WdgModeConfig 35
10.2.5 WdgSettingsFast 35
10.2.6 WdgSettingsSlow 35
10.2.7 WdgSettingsOff 36
10.2.8 WdgTimeoutList 36
10.2.9 WdgExternalConfiguration 36
10.3 Published Information 37
10.3.1 WdgPublishedInformation 37
11 Changes to Release 1 39
11.1 Deleted SWS Items 39
11.2 Replaced SWS Items 39
11.3 Changed SWS Items 39
11.4 Added SWS Items 39
12 Changes during TO SWS Improvements 41
12.1 Deleted SWS Items 41
12.2 Replaced SWS Items 41
12.3 Changed SWS Items 41
12.4 Added SWS Items 41

1 Introduction and functional overview

This document specifies the functionality, API and the configuration of the AUTOSAR Basic Software module watchdog driver (Wdg).

This module provides services for initialization, changing the operation mode and triggering the watchdog.

The functional requirements and the functional scope are the same for both internal and external watchdog drivers. Hence the API is semantically identical.

2 Acronyms and abbreviations

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

Abbreviation / Acronym:	Description:
WDG	Watchdog (module specific prefix)
DET	Development Error Tracer – module to catch development errors.
DEM	Diagnostic Event Manager – module to handle diagnostic relevant events.

Definitions needed for understanding of the concepts

Definition:	Description:
Off-Mode	The watchdog hardware is disabled / shut down. This might be necessary in order to shut down the complete ECU and not get cyclic resets from a still running external watchdog. This mode might not be allowed for safety critical systems. In this case, the Wdg module has to be configured to prevent switching to this mode.
Slow-Mode	Triggering the watchdog hardware can be done with a long timeout period. This mode can e.g. be used during system startup / initialization phase. E.g. the watchdog hardware is configured for toggle mode (no constraints on the point in time at which the triggering is done) and a timeout period of 20 milliseconds.
Fast-Mode	Triggering the watchdog hardware has to be done with a short timeout period. This mode can e.g. be used during normal operations of the ECU. E.g. the watchdog hardware is configured for window mode (triggering the watchdog has to occur within certain minimum / maximum boundaries within the timeout period) and a timeout period of 5 milliseconds.

3 Related documentation

3.1 Input documents

[1] Layered Software Architecture
https:/svn2.autosar.org/repos2/22_Releases
AUTOSAR_LayeredSoftwareArchitecture.pdf

[2] General Requirements on Basic Software Modules
https:/svn2.autosar.org/repos2/22_Releases
AUTOSAR_SRS_General.pdf

[3] General Requirements on SPAL
https:/svn2.autosar.org/repos2/22_Releases
AUTOSAR_SRS_SPAL_General.pdf

[4] Requirements on watchdog driver
https:/svn2.autosar.org/repos2/22_Releases
AUTOSAR_SRS_WatchdogDriver.pdf

[5] Specification of Watchdog Interface
https:/svn2.autosar.org/repos2/22_Releases
AUTOSAR_SWS_WatchdogInterface.pdf

[6] AUTOSAR Basic Software Module Description Template
https:/svn2.autosar.org/repos2/22_Releases
AUTOSAR_BSW_Module_Description.pdf

3.2 Related standards and norms

None

4 Constraints and assumptions

4.1 Limitations

No limitations.

4.2 Applicability to car domains

No restrictions.

5 Dependencies to other modules

A Wdg module for an internal (on-chip) watchdog accesses the microcontroller hardware directly and is located in the Microcontroller Abstraction layer.

A Wdg module for an external watchdog uses other modules (e.g. SPI) to access the external watchdog device. Such a Wdg module is located in the ECU Abstraction Layer.

WDG055: The Wdg module for an external watchdog driver shall have source code that is independent of the microcontroller platform.

5.1 File structure

5.1.1 Code file structure

WDG079: The code file structure shall not be defined within this specification completely. At this point it shall be pointed out that the code-file structure shall include the following files named:

- Wdg_Lcfg.c – for link time configurable parameters and
- Wdg_PBcfg.c – for post build time configurable parameters.

These files shall contain all link time and post-build time configurable parameters.

5.1.2 Header file structure

WDG061: The Wdg module shall adhere to the following file structure:

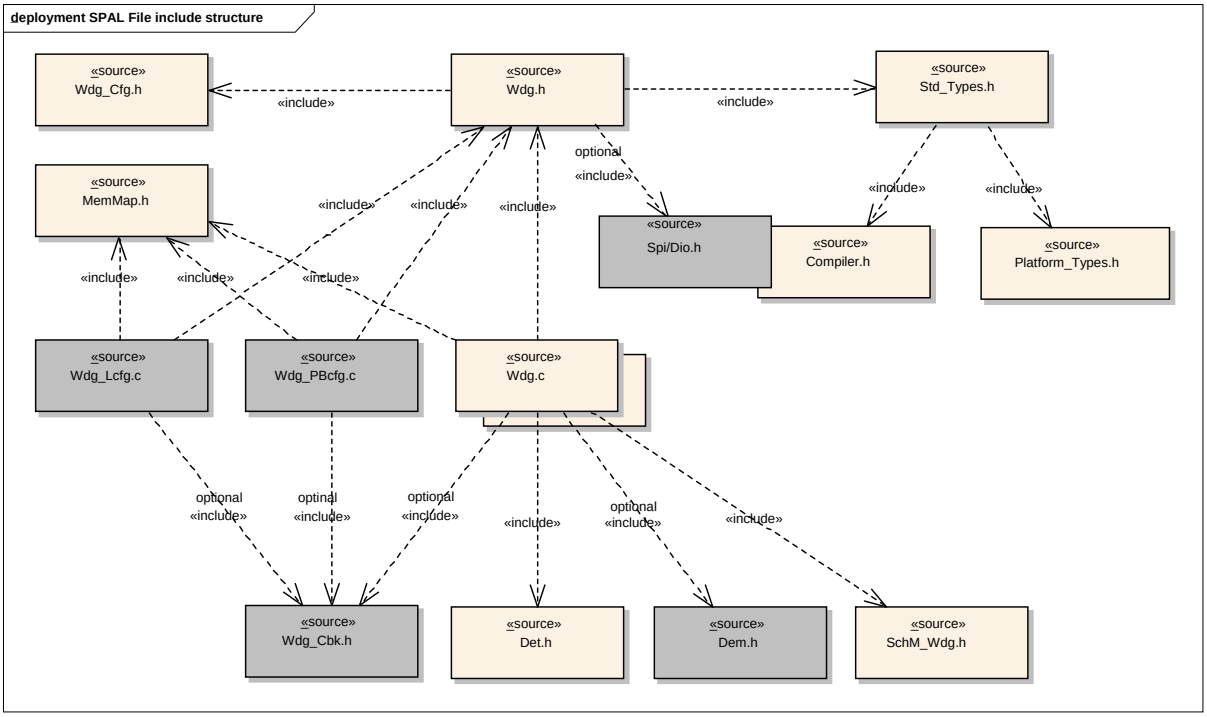

Figure 1: File include structure

WDG080: The Wdg module shall optionally include the `Dem.h` file for any production errors reported during implementation.

By this inclusion, the APIs to report errors as well as the required Event Id symbols are included. 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.

5.2 System clock

If the hardware of the internal watchdog depends on the system clock, changes to the system clock (e.g. PLL on → PLL off) may also affect the clock settings of the watchdog hardware.

5.3 Onboard communication handlers

A Wdg module for an external watchdog device depends on the API and capabilities of the used onboard communication handlers or drivers (e.g. SPI handler).

6 Requirements traceability

Document: General Requirements on Basic Software Modules

Requirement	*Satisfied by*
[BSW00344] Reference to link-time configuration	WDG082
[BSW00404] Reference to post build time configuration	WDG001, WDG082
[BSW00405] Reference to multiple configuration sets	WDG001, WDG004
[BSW00345] Pre-compile-time configuration	WDG045, WDG073, WDG082
[BSW159] Tool-based configuration	Chapter 10.2
[BSW167] Static configuration checking	WDG086, WDG087
[BSW171] Configurability of optional functionality	WDG069, WDG070, WDG071, WDG081
[BSW170] Data for reconfiguration of SW-components	Not applicable (this module does not depend on faults, signals, …)
[BSW00380] Separate C-File for configuration parameters	WDG079
[BSW00419] Separate C-Files for pre-compile time configuration parameters	Not applicable (only #define's as pre-compile time parameters)
BSW00381] Separate configuration header file for pre-compile time parameters	WDG061
[BSW00412] Separate H-File for configuration parameters	WDG061
[BSW00382] Not-used configuration elements need to be listed	Not applicable (there are no not-used configuration elements for this module)
[BSW00383] List dependencies of configuration files	Not applicable (this module does not use configuration files from other modules)
[BSW00384] List dependencies to other modules	Chapter 5
[BSW00387] Specify the configuration class of callback function	Not applicable (this module does not provide any callback functions)
[BSW00388] Introduce containers	Chapter 10.2
[BSW00389] Containers shall have names	Chapter 10.2.2
[BSW00390] Parameter content shall be unique within the module	Chapter 10.2.2
[BSW00391] Parameter shall have unique names	Chapter 10.2.2
[BSW00392] Parameters shall have a type	Chapter 10.2.2
[BSW00393] Parameters shall have a range	Chapter 10.2.2
[BSW00394] Specify the scope of the parameters	Chapter 10.2.2
[BSW00395] List the required parameters (per parameter)	Chapter 10.2.2
[BSW00396] Configuration classes	Chapter 10.2.2
[BSW00397] Pre-compile-time parameters	Chapter 10.2.2
[BSW00398] Link-time parameters	Chapter 10.2.1, WDG082
[BSW00399] Loadable Post-build time parameters	Chapter 10.2.1, WDG082, WDG083
[BSW00400] Selectable Post-build time parameters	WDG001, WDG082
[BSW00402] Published information	Chapter 10.3
[BSW00375] Notification of wake-up reason	Not applicable (this module does not provide any wake-up reason)
[BSW101] Initialization interface	WDG001
[BSW00416] Sequence of Initialization	Not applicable

	(requirement on system design, not on a single module)
[BSW00406] Check module initialization	WDG019
[BSW168] Diagnostic Interface of SW components	Not applicable (this module does not support a special diagnostic interface)
[BSW00407] Function to read out published parameters	Chapter 8.3.4
[BSW00423] Usage of SW-C template to describe BSW modules with AUTOSAR Interfaces	Not applicable (this module does not provide an AUTOSAR interface)
[BSW00424] BSW main processing function task allocation	Not applicable (this module does not provide a schedulable main function)
[BSW00425] Trigger conditions for schedulable objects	Not applicable (this module does not provide any schedulable objects)
[BSW00426] Exclusive areas in BSW modules	Not applicable (no exclusive areas specified for this module)
[BSW00427] ISR description for BSW modules	Not applicable (this module does not provide any ISRs)
[BSW00428] Execution order dependencies of main processing functions	Not applicable (this module does not provide a schedulable main function)
[BSW00429] Restricted BSW OS functionality access	Not applicable (this module doesn't use any OS objects or services)
[BSW00431] The BSW Scheduler module implements task bodies	Not applicable (requirement on the BSW scheduler module)
[BSW00432] Modules should have separate main processing functions for read/receive and write/transmit data path	Not applicable (this module does not provide a schedulable main function)
[BSW00433] Calling of main processing functions	Not applicable (requirement on system design, not a single module)
[BSW00434] The Schedule Module shall provide an API for exclusive areas	Not applicable (this is not the schedule module)
[BSW00336] Shutdown interface	WDG031
[BSW00337] Classification of errors	WDG010, WDG013
[BSW00338] Detection and Reporting of development errors	WDG089, WDG090, WDG017, WDG018, WDG019, WDG052, WDG025, WDG026, WDG035, WDG091, WDG092
[BSW00369] Do not return development error codes via API	WDG066, WDG012
[BSW00339] Reporting of production relevant error status	Not applicable (no production relevant error status, only error events)
[BSW00421] Reporting of production relevant error events	WDG012
[BSW00422] Debouncing of production relevant error status	Not applicable (requirement on the DEM, not a general requirement)
[BSW00420] Production relevant error event rate detection	Not applicable (requirement on the DEM, not a general requirement)
[BSW00417] Reporting of Error Events by Non-Basic Software	Not applicable (this is a basic software module)

[BSW00323] API parameter checking	WDG025, WDG026, WDG091, WDG092, WDG089, WDG090
[BSW004] Version check	WDG086, WDG087
[BSW00409] Header files for production code error IDs	WDG062
[BSW00385] List possible error notificatons	WDG010, WDG013
[BSW00386] Configuration for detecting an error	WDG045, WDG064, WDG065
[BSW161] Microcontroller abstraction	Not applicable (requirement on AUTOSAR architecture, not a single module)
[BSW162] 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)
[BSW005] No hard coded horizontal interfaces within MCAL	Not applicable (requirement on AUTOSAR architecture, not a single module)
[BSW00415] User dependent include files	Not applicable (only one user for this module)
[BSW164] Implementation of interrupt service routines	Not applicable (this module does not implement any ISRs)
[BSW00325] Runtime of interrupt service routines	Not applicable (this module does not implement any ISRs)
[BSW00326] Transition from ISRs to OS tasks	Not applicable (this module does not implement any ISRs)
[BSW00342] Usage of source code and object code	Not applicable (requirement on AUTOSAR architecture, not a single module)
[BSW00343] Specification and configuration of time	Not applicable (no configurable timings)
[BSW160] Human-readable configuration data	Not applicable (requirement on documentation, not on specification)
[BSW007] HIS MISRA C	Not applicable (requirement on implementation, not on specification)
[BSW00300] Module naming convention	Not applicable (requirement on implementation, not on specification)
[BSW00413] Accessing instances of BSW modules	Not implementable in R2.0 timeframe.
[BSW00347] Naming separation of different instances of BSW drivers	Not applicable (requirement on the implementation, not on the specification)
[BSW00305] Self-defined data types naming convention	Chapter 8.2.1
[BSW00307] Global variables naming convention	Not applicable (requirement on the implementation, not on the specification)
[BSW00310] API naming convention	Chapters 8.3.1, 8.3.2, 8.3.3
[BSW00373] Main processing function naming convention	Not applicable (no main processing function)
[BSW00327] Error values naming convention	WDG010, WDG013
[BSW00335] Status values naming convention	Not applicable

	(status value not seen outside of this module)
[BSW00350] Development error detection keyword	WDG045, WDG069
[BSW00408] Configuration parameter naming convention	Chapter 10.2.2, Chapter 10.2.3
[BSW00410] Compiler switches shall have defined values	Chapter 10.2.2
[BSW00411] Get version info keyword	Chapter 10.2.2
[BSW00346] Basic set of module files	WDG061
[BSW158] Separation of configuration from implementation	WDG061
[BSW00314] Separation of interrupt frames and service routines	Not applicable (this module does not implement any ISRs)
[BSW00370] Separation of callback interface from API	Not applicable (this module does not provide any callback routines)
[BSW00348] Standard type header	Not applicable (standard header files included via interface header file)
[BSW00353] Platform specific type header	Not applicable (standard header files included via interface header file)
[BSW00361] Compiler specific language extension header	Not applicable (standard header files included via interface header file)
[BSW00301] Limit imported information	WDG061
[BSW00302] Limit exported information	Not applicable (requirement on the implementation, not on the specification)
[BSW00328] Avoid duplication of code	Not applicable (requirement on the implementation, not on the specification)
[BSW00312] Shared code shall be reentrant	Not applicable (requirement on the implementation, not on the specification)
[BSW006] Platform independency	Not applicable (this is a module of the microcontroller abstraction layer)
[BSW00357] Standard API return type	Chapter 8.3.2
[BSW00377] Module specific API return types	Not applicable (no module specific return types)
[BSW00304] AUTOSAR integer data types	Not applicable (requirement on implementation, not for specification)
[BSW00355] Do not redefine AUTOSAR integer data types	Not applicable (requirement on implementation, not for specification)
[BSW00378] AUTOSAR boolean type	Not applicable (requirement on implementation, not for specification)
[BSW00306] Avoid direct use of compiler and platform specific keywords	Not applicable (requirement on implementation, not for specification)
[BSW00308] Definition of global data	Not applicable (requirement on implementation, not for specification)
[BSW00309] Global data with read-only constraint	Not applicable (requirement on implementation, not for specification)

[BSW00371] Do not pass function pointers via API	Not applicable (no function pointers in this specification)
[BSW00358] Return type of init() functions	Chapter 8.3.1
[BSW00376] Return type and parameters of main processing functions	Not applicable (this module does not provide a main processing function)
[BSW00359] Return type of callback functions	Not applicable (this module does not provide any callback routines)
[BSW00360] Parameters of callback functions	Not applicable (this module does not provide any callback routines)
[BSW00329] Avoidance of generic interfaces	Chapters 8.3.1, 8.3.2, 8.3.3 (explicit interfaces defined)
[BSW00330] Usage of macros / inline functions instead of functions	Not applicable (requirement on implementation, not for specification)
[BSW00331] Separation of error and status values	WDG010, WDG013
[BSW009] Module User Documentation	Not applicable (requirement on documentation, not on specification)
[BSW00401] Documentation of multiple instances of configuration parameters	Not applicable (all configuration parameters are single instance only)
[BSW172] Compatibility and documentation of scheduling strategy	Not applicable (no internal scheduling policy)
[BSW010] Memory resource documentation	Not applicable (requirement on documentation, not on specification)
[BSW00333] Documentation of callback function context	Not applicable (this module does not provide any callback routines)
[BSW00374] Module vendor identification	WDG074
[BSW00379] Module identification	WDG074
[BSW003] Version identification	WDG074
[BSW00318] Format of module version numbers	WDG074
[BSW00321] Enumeration of module version numbers	Not applicable (requirement on implementation, not for specification)
[BSW00341] Microcontroller compatibility documentation	Not applicable (requirement on documentation, not on specification)
[BSW00334] Provision of XML file	Not applicable (requirement on documentation, not on specification)
[BSW00435] Module Header File Structure for the Basic Software Scheduler	Chapter 5.1.2
[BSW00436] Module Header File Structure for the Basic Software Memory Mapping	Chapter 5.1.2

Document: General Requirements on SPAL

Requirement	***Satisfied by***
[BSW12263] Object code compatible configuration concept	WDG004, WDG073, WDG082
[BSW12056] Configuration of notification mechanisms	Not applicable (this module does not support any notification

	mechanism)
[BSW12267] Configuration of wake-up sources	Not applicable (this module does not wake up the ECU / MCU)
[BSW12057] Driver module initialization	WDG100, WDG101
[BSW12125] Initialization of hardware resources	WDG100, WDG101
[BSW12163] Driver module de-initialization	WDG025, WDG026, WDG031
[BSW12058] Individual initialization of overall registers	WDG100, WDG101
[BSW12059] General initialization of overall registers	WDG100, WDG101
[BSW12060] Responsibility for initialization of one-time writable registers	WDG100, WDG101
[BSW12461] Responsibility for register initialization	WDG100, WDG101
[BSW12462] Provide settings for register initialization	Not applicable (requirement on implementation, not on specification)
[BSW12463] Combine and forward settings for register initialization	Not applicable (requirement on configuration, not on specification)
[BSW12062] Selection of static configuration sets	WDG001
[BSW12068] MCAL initialization sequence	Not applicable (requirement for system integration, not for a single module)
[BSW12069] Wake-up notification of ECU State Manager	Not applicable (this module does not wake up the ECU / MCU)
[BSW157] Notification mechanisms of drivers and handlers	Not applicable (this module does not support any notification mechanism)
[BSW12155] Prototypes of callback functions	Not applicable (this module does not provide any callback functions)
[BSW12169] Control of operation mode	WDG102
[BSW12063] Raw value mode	Not applicable (this module does not provide any data to the user)
[BSW12075] Use of application buffers	Not applicable (this module does not operate on buffers)
[BSW12129] Resetting of interrupt flags	Not applicable (this module does not implement any ISRs)
[BSW12064] Change of operation mode during running operation	WDG016, WDG017, WDG102, WDG103
[BSW12448] Behavior after development error detection	WDG025, WDG017, WDG026, WDG091, WDG092, WDG089, WDG090
[BSW12067] Setting of wake-up conditions	Not applicable (this module does not wake up the ECU / MCU)
[BSW12077] Non-blocking implementation	Not applicable (no long term loops)
[BSW12078] Runtime and memory efficiency	Not applicable (requirement for implementation, not for specification)
[BSW12092] Access to drivers	WDG076
[BSW12265] Configuration data shall be kept constant	WDG001
[BSW12264] Specification of configuration items	WDG073

Document: Requirements on watchdog driver

Requirement	***Satisfied by***
[BSW12015] Configuration of watchdog modes	WDG051
[BSW12105] Watchdog initialization	WDG001, WDG100, WDG101
[BSW12106] Prohibit disabling of watchdog	WDG025, WDG026
[BSW12018] Watchdog mode selection service	WDG032, WDG102, WDG103
[BSW12019] Watchdog trigger service	WDG036, WDG093, WDG094
[BSW12165] Functional scope	WDG077
[BSW12166] SPI channel configuration	WDG078
[BSW12167] Common Watchdog API	Not applicable (only interface to watchdog drivers)
[BSW12168] Microcontroller independency	Not applicable (requirement for implementation, not for specification)

7 Functional specification

7.1 General design rules

WDG086: The Wdg module shall statically check the configuration parameters (at the latest during compile time) for correctness.

WDG087: The Wdg module shall validate the consistency of the version information in the module header and source files (e.g. by comparing the version information in the module header and source files with a pre-processor macro).

WDG031: The Wdg module shall not implement an interface for de-initialization/shutdown. If the watchdog supports a de-initialization/shutdown and the environment allows the usage of this feature, the de-initialization/shutdown shall be achieved by calling the `Wdg_SetMode` routine with OFF mode parameter.

Rationale: Some watchdogs do not support the de-initialization/shutdown functionality and in some environments this feature must not be used (e.g. in safety critical systems).

WDG034: The start address of the watchdog trigger routine shall be statically configurable to a fixed memory location by the user. The user needs to take care that Configured memory location is valid for the platform on which driver is being implemented on.This configuration parameter shall only be given if supported/needed by the hardware.

Rationale: This allows the watchdog device to identify the correct trigger input if supported by the hardware.

WDG040: If interrupts have to be disabled in order to ensure data consistency or correct functionality of this module (e.g. while switching the watchdog mode or during the watchdog trigger routine), this shall be done by using the corresponding BSW Schedler functionality if possible.

7.2 Error classification

WDG062: The Wdg module shall take the values for production code Event Ids from the file Dem_IntErrId.h which is included via Dem.h.

WDG063: Development error values are of type uint8.

WDG010: The Wdg module shall detect the following errors and exceptions depending on its configuration (development/production mode):

Type or error	***Relevance***	***Related error code***	***Value [hex]***
API service used in wrong context (e.g. module not initialized).	Development	`WDG_E_DRIVER_STATE`	0x10

API service called with wrong / inconsistent parameter(s)	Development	WDG_E_PARAM_MODE WDG_E_PARAM_CONFIG	0x11 0x12
Switching between watchdog modes failed.	Production	WDG_E_MODE_SWITCH_FAILED	Assigned by DEM
Disabling of watchdog not allowed (e.g. in safety relevant systems)	Production	WDG_E_DISABLE_REJECTED	Assigned by DEM

7.3 Error detection

WDG045: The detection of development errors is configurable (*ON* / *OFF*) at pre-compile time. The switch `WdgDevErrorDetect` (see chapter 10) shall activate or deactivate the detection of all development errors.

WDG064: If the `WdgDevErrorDetect` 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.

WDG065: The detection of production code errors cannot be switched off.

7.4 Error notification

WDG066: Detected evelopment errors shall be reported to the Development Error Tracer (DET) if the pre-processor switch `WdgDevErrorDetect` is set. The error codes shall not be used as return values of the called function.

WDG012: Detected production relevant error events shall be reported to the Diagnostic Event Manager (DEM). The error codes shall not be used as return values of the called function.

WDG013: Additional errors that are detected because of specific implementation and/or specific hardware properties shall be added in the module's implementation documentation. The classification and enumeration shall be compatible to the errors listed above [WDG010]

7.5 External watchdog driver

WDG076: To access the external watchdog hardware, the Wdg module shall use the functionality and API of the corresponding handler or driver, e.g. the SPI handler or DIO driver.

WDG077: A Wdg module for an external watchdog shall satisfy the same functional requirements and offer the same functional scope as a Wdg module for an internal watchdog. Hence their respective APIs are semantically identical.

WDG078: The Wdg module shall add all parameters required for accessing the external watchdog hardware, e.g. the used SPI channel or DIO port, to the module's published parameters and to the module's configuration parameters.

8 API specification

8.1 Imported types

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

WDG105:

Header file	*Imported Type*
Dem_Types.h	Dem_EventIdType
Std_Types.h	Std_VersionInfoType
	Std_ReturnType
WdgIf_Types.h	WdgIf_ModeType

8.2 Type definitions

8.2.1 Wdg_ConfigType

Name:	`Wdg_ConfigType`	
Type:	`Structure`	
Range:	`Hardware dependent structure`	Structure to hold the watchdog driver configuration set.
Description:	Used for pointers to structures holding configuration data provided to the Wdg module initialization routine for configuration of the module and watchdog hardware.	

8.3 Function definitions

8.3.1 Wdg_Init

WDG106:

Service name:	Wdg_Init	
Syntax:	`void Wdg_Init( const Wdg_ConfigType* ConfigPtr )`	
Service ID[hex]:	0x00	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	ConfigPtr	Pointer to configuration set.
Parameters (inout):	None	
Parameters (out):	None	
Return value:	None	
Description:	Initializes the module.	

WDG001: The `Wdg_Init` function shall initialize the Wdg module and the watchdog hardware, i.e. it shall set the default watchdog mode and timeout period as provided in the configuration set.

The user can choose the configuration set to be used with the `Wdg_Init` function from a limited number of statically configured sets

WDG100: The `Wdg_Init` function shall initialize all global variables of the Wdg module.

WDG101: The `Wdg_Init` function shall initialize those controller registers that are needed for controlling the watchdog hardware and that do not influence/depend on other (hardware) modules.

Registers that can influence or depend on other modules are initialized by a common system module.

WDG025: If disabling the watchdog is not allowed (because pre-compile configuration parameter WdgDisableAllowed==OFF) and if the default mode given in the provided configuration set disables the watchdog, the `Wdg_Init` function shall not execute the initialization but raise the production error `WDG_E_DISABLE_REJECTED`.

WDG089: When development error detection is enabled for the Wdg module: The function `Wdg_Init` shall check that the parameter ConfigPtr is not NULL (except for the Pre-Compiled variant). If this error is detected, the function Wdg_Init shall not execute the initialization but raise the development error `WDG_E_PARAM_CONFIG.`

WDG090: When development error detection is enabled for the Wdg module: The `Wdg_Init` function shall check that the (hardware specific) contents of the given configuration set is within the allowed boundaries. If this error is detected, the function Wdg_Init shall not execute the initialization but raise the development error `WDG_E_PARAM_CONFIG`.

WDG019: When development error detection is enabled for the Wdg module: The `Wdg_Init` function shall set the Wdg module's internal state from `WDG_UNINIT` (the default state) to `WDG_IDLE` if the initialization was successful.

8.3.2 Wdg_SetMode

WDG107:

Service name:	Wdg_SetMode

Syntax:	`Std_ReturnType Wdg_SetMode(`
	`  WdgIf_ModeType Mode`
	`)`

Service ID[hex]:	0x01
Sync/Async:	Synchronous

Reentrancy:	Non Reentrant	
Parameters (in):	Mode	One of the following statically configured modes: 1. WDGIF_OFF_MODE 2. WDGIF_SLOW_MODE 3. WDGIF_FAST_MODE
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	Std_ReturnType.
Description:	Switches the watchdog into the mode Mode.	

By choosing one of a limited number of statically configured settings (e.g. toggle or window watchdog, different timeout periods) the Wdg module and the watchdog hardware can be switched between the following three different watchdog modes using the `Wdg_SetMode` function:

- WDGIF_OFF_MODE
- WDGIF_SLOW_MODE
- WDGIF_FAST_MODE

WDG051: The configuration set provided to the Wdg module's initialization routine shall contain the hardware / driver specific parameters to be used in the different watchdog modes.

WDG102: The `Wdg_SetMode` function shall switch the Wdg module and the watchdog hardware from the current watchdog mode to the watchdog mode defined by the parameter Mode. This means that the function shall attempt to set all parameters of the Wdg module and the watchdog hardware to the values defined in the configuration for that new mode.

WDG103: The `Wdg_SetMode` function shall return `E_OK` if the mode switch has been executed completely and successfully, i.e. all parameters of the Wdg module and the watchdog hardware have been set to the new values

WDG016: If switching the Wdg module and the watchdog hardware into the requested mode is not possible, e.g. because of inconsistent mode settings or because some timing constraints have not been met, the `Wdg_SetMode` function shall return the value `E_NOT_OK` and raise production error `WDG_E_MODE_SWITCH_FAILED`.

WDG026: If disabling the watchdog is not allowed (e.g. in safety relevant systems, see (WDG070) the `Wdg_SetMode` function shall check whether the settings for the requested mode would disable the watchdog. In this case, the function shall not execute the mode switch but raise the production error `WDG_E_DISABLE_REJECTED` and return with the value `E_NOT_OK`.

WDG091: When development error detection is enabled for the Wdg module: The `Wdg_SetMode` function shall check that the parameter Mode is within the allowed

range. If this is not the case, the function shall not execute the mode switch but raise development error WDG_E_PARAM_MODE and return with the value E_NOT_OK

WDG092: When development error detection is enabled for the Wdg module: The Wdg_SetMode function shall check that the (hardware specific) settings for the requested mode are within the allowed boundaries. If this is not the case, the function shall not execute the mode switch but raise the development error WDG_E_PARAM_MODE and return with the value E_NOT_OK.

WDG017: When development error detection is enabled for the Wdg module: The Wdg_SetMode function shall check that the Wdg module's state is WDG_IDLE (meaning the Wdg module and the watchdog hardware are initialized and the watchdog is currently not being triggered or switched). If this is not the case, the function shall not execute the mode switch but raise the development error WDG_E_DRIVER_STATE and return with the value E_NOT_OK.

WDG018: When development error detection is enabled for the Wdg module: The function Wdg_SetMode shall set the Wdg module's state to WDG_BUSY during its execution and shall reset the Wdg module's state to WDG_IDLE as last operation before it returns to the caller.

8.3.3 Wdg_Trigger

WDG108:

Service name:	Wdg_Trigger

Syntax:	`void Wdg_Trigger(`
	
	`)`

Service ID[hex]:	0x02
Sync/Async:	Synchronous
Reentrancy:	Non Reentrant
Parameters (in):	None
Parameters (inout):	None
Parameters (out):	None
Return value:	None
Description:	Triggers the watchdog hardware. It has to be called cyclically by some upper layer function (usually the watchdog manager) in order to prevent the watchdog hardware from expiring.

WDG036: The Wdg_Trigger function shall trigger the watchdog hardware.

WDG093: If the watchdog hardware requires an activation code which can be configured or changed, the Wdg module shall handle the activation code internally. In this case, the Wdg module shall pass the correct activation code to the watchdog hardware and the watchdog hardware in turn shall update the Wdg module's internal variable where the next expected access code is stored.

WDG094: If the watchdog hardware requires an activation code which can be configured or changed, the trigger cycle of the Wdg module shall be defined with a value so that updating the activation code by the watchdog hardware can be guaranteed (see Figure 3).

WDG095: If the watchdog hardware requires an activation code which can be configured or changed and the initial activation code can be configured, the activation code shall be provided in the Wdg module's configuration set. If the activation code is fixed for a particular hardware the above requirement can be ignored.

WDG035: When development error detection is enabled for the Wdg module: the `Wdg_Trigger` function shall check whether the Wdg module's state is `WDG_IDLE` (meaning the watchdog driver and hardware are initialized and the watchdog is currently not being triggered or switched). If this is not the case, the function shall not trigger the watchdog hardware but raise the development error `WDG_E_DRIVER_STATE`.

WDG052: When development error detection is enabled for the Wdg module: the `Wdg_Trigger` shall set the Wdg module's state to `WDG_BUSY` during its execution and shall reset the module's state to `WDG_IDLE` as last operation before it returns to the caller.

WDG041: The the `Wdg_Trigger` function shall be calleable at interrupt level.

WDG104: The Wdg module's environment shall make sure that the Wdg module has been initialized before the `Wdg_Trigger` routine is called

8.3.4 Wdg_GetVersionInfo

WDG109:

Service name:	Wdg_GetVersionInfo	

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

Service ID[hex]:	0x04	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	None	
Parameters (inout):	None	
Parameters (out):	versioninfo	Pointer to where to store the version information of this module.
Return value:	None	
Description:	Returns the version information of the module.	

WDG067: The `Wdg_GetVersionInfo` function shall return the version information of this module. The version information includes:

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

WDG068: The `Wdg_GetVersionInfo` function shall be pre-compile time configurable On/Off by the configuration parameter `WdgVersionInfoApi`.

WDG099: If source code for caller and callee of the `Wdg_GetVersionInfo` function is available, the module Wdg should realize this function as a macro, defined in the module's header file.

8.4 Call-back Notifications

This chaper lists all functions provided by the Wdg module to lower layer modules.

There are no callback notifications provided by this module since it is at the lowest layer of the software architecture.

8.5 Scheduled functions

This chaper lists all functions provided by the Wdg module and called directly by the Basic Software Module Scheduler.

The Wdg module has no scheduled functions.

8.6 Expected Interfaces

This chapter lists all functions that the Wdg module requires from other modules.

In addition to the functions listed below, additional functions might be used to access the external watchdog over Dio or Spi.

8.6.1 Mandatory Interfaces

WDG110:

API function	*Description*
Dem_ReportErrorStatus	Reports errors to the DEM.

8.6.2 Optional Interfaces

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

WDG111:

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

8.6.3 Configurable interfaces

This module does not require any configurable interfaces.

9 Sequence diagrams

9.1 Watchdog initialization, triggering and mode switching

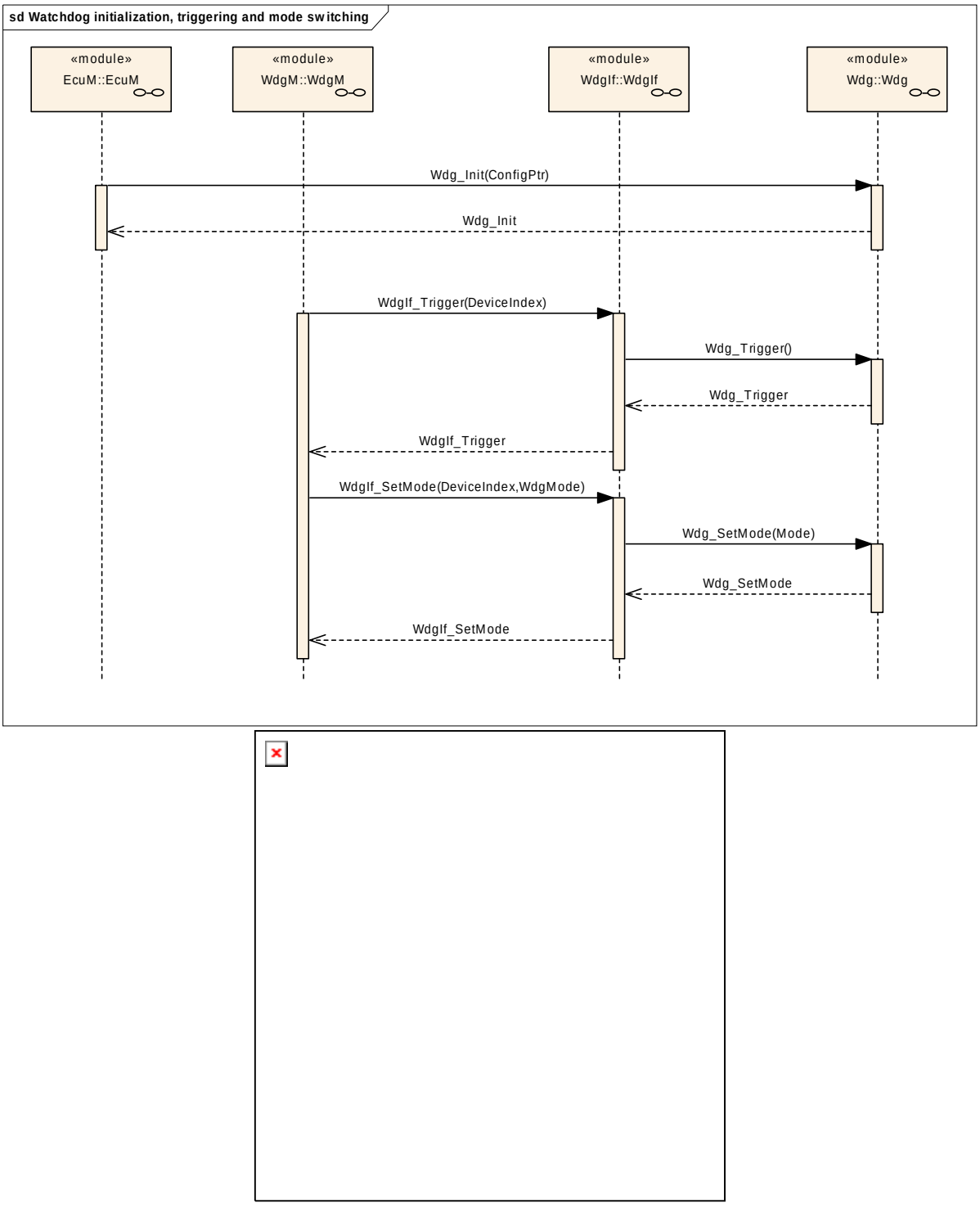

Figure 2: Sequence of watchdog initialization, triggering and mode switching

9.2 Data exchange between watchdog driver and hardware

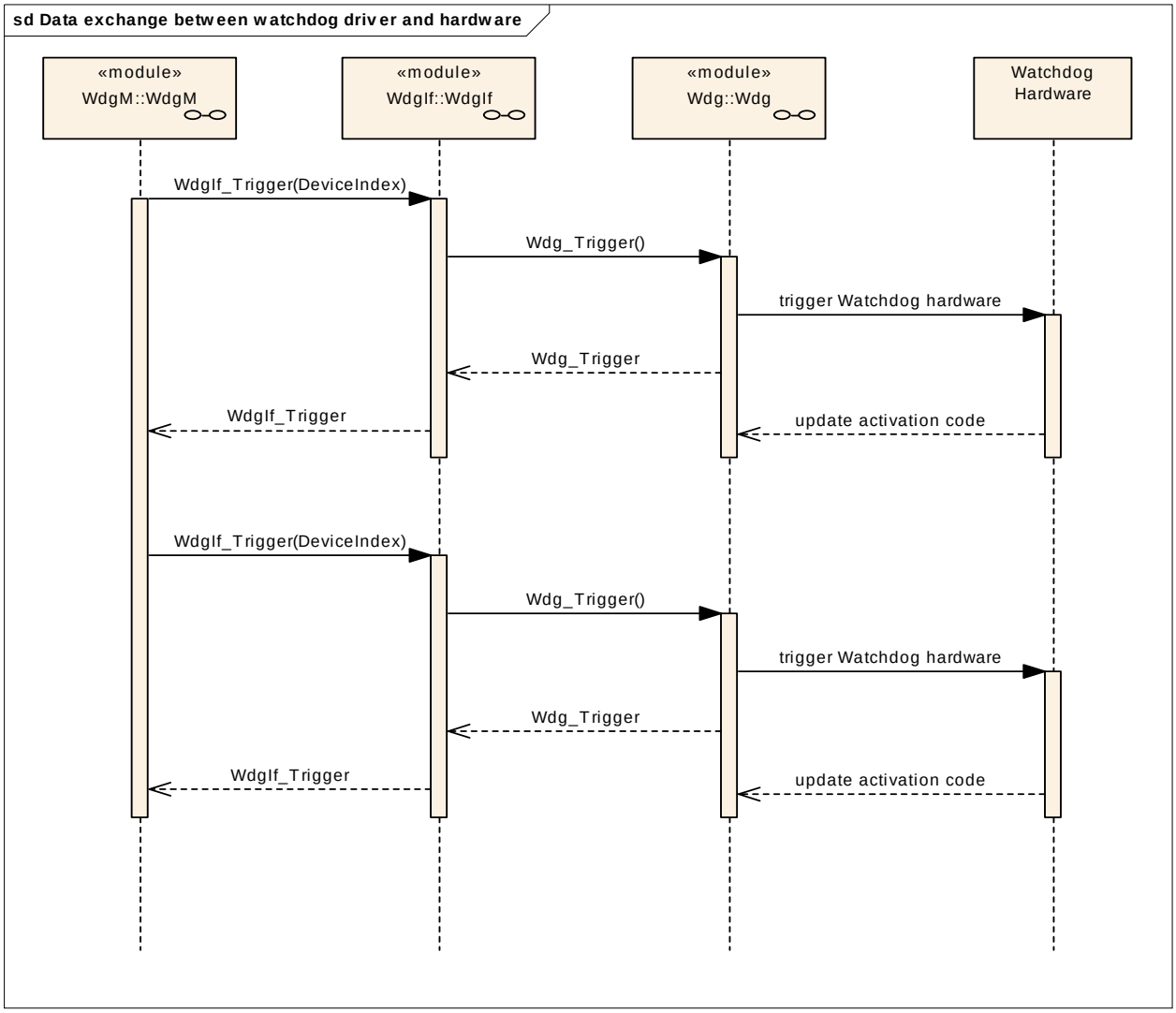

Figure 3: Data exchange between watchdog driver and hardware

10 Configuration specification

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

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

Chapter 10.3 specifies published information of the module Wdg.

10.1 How to read this chapter

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

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

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

10.1.1 Configuration and configuration parameters

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

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

10.1.2 Containers

Containers structure the set of configuration parameters. This means:

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

10.1.3 Specification template for configuration parameters

The following tables consist of three sections:
- the general section
- the configuration parameter section
- the section of included/referenced containers

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

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

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

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

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

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

10.2 Containers and configuration parameters

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

10.2.1 Variants

Variant PC: Settings for the different watchdog modes (see WDG082) provided as pre-compile time configuration parameters.

Variant LT: Settings for the different watchdog modes (see WDG082) provided as link-time configuration parameters.

Variant PB: Settings for the different watchdog modes (see WDG082) provided as post build time configuration parameters.

10.2.2 Wdg

Module Name	**Wdg**
Module Description	Configuration of the Wdg (Watchdog driver) module.

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
WdgExternalConfiguration	1	Configuration items for an external watchdog hardware
WdgGeneral	1	All general parameters of the watchdog driver are collected here.
WdgModeConfig	1	Configuration items for the different watchdog modes
WdgPublishedInformation	1	Container holding all Wdg specific published information parameters

10.2.3 WdgGeneral

SWS Item	**WDG114 :**
Container Name	WdgGeneral
Description	All general parameters of the watchdog driver are collected here.
Configuration Parameters	

SWS Item	**WDG115 :**		
Name	WdgDevErrorDetect {WDG_DEV_ERROR_DETECT}		
Description	Compile switch to enable / disable development error detection for this module. True: Development error detection enabled False: Development error detection disabled		
Multiplicity	1		
Type	BooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency			

SWS Item	**WDG116 :**		
Name	WdgDisableAllowed {WDG_DISABLE_ALLOWED}		
Description	Compile switch to allow / forbid disabling the watchdog driver during runtime. True: Disabling the watchdog driver at runtime is allowed. False: Disabling the watchdog driver at runtime is not allowed.		
Multiplicity	1		
Type	BooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module dependency: Safety relevant compile switch, this has to be in accordance with the corresponding settings for the watchdog manager.		

SWS Item	**WDG117 :**		
Name	WdgIndex		
Description	Represents the watchdog driver's ID so that it can be referenced by the watchdog interface.		
Multiplicity	1		
Type	IntegerParamDef (Symbolic Name generated for this parameter)		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency			

SWS Item	**WDG118 :**		
Name	WdgTriggerLocation {WDG_TRIGGER_LOCATION}		
Description	Location (memory address) of the watchdog trigger routine.		
Multiplicity	1		
Type	FunctionNameDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module dependency: Only relevant if provided by hardware and needed by the system.		

SWS Item	**WDG119 :**		
Name	WdgVersionInfoApi		
Description	Compile switch to enable / disable the version information API True: API enabled False: API disables		
Multiplicity	1		
Type	BooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

No Included Containers

10.2.4 WdgModeConfig

SWS Item	**WDG082 :**
Container Name	WdgModeConfig{Wdg_ModeConfiguration} [Multi Config Container]
Description	Configuration items for the different watchdog modes
Configuration Parameters	

SWS Item	**WDG120 :**		
Name	WdgDefaultMode {WDG_DEFAULT_MODE}		
Description	Default mode for watchdog driver initialization. ImplementationType: WdgIf_ModeType		
Multiplicity	1		
Type	EnumerationParamDef		
Range	WDGIF_FAST_MODE		Default watchdog mode is "fast"
	WDGIF_OFF_MODE		Default watchdog mode is "off"
	WDGIF_SLOW_MODE		Default watchdog mode is "slow"
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	--	
	Post-build time	X	VARIANT-LINK-TIME, VARIANT-POST-BUILD
Scope / Dependency	scope: Module dependency: "Off" mode only possible if disabling the watchdog driver is allowed.		

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
WdgSettingsFast	1	Hardware dependent settings for the watchdog driver's "fast" mode.
WdgSettingsOff	1	Hardware dependent settings for the watchdog driver's "off" mode.
WdgSettingsSlow	1	Hardware dependent settings for the watchdog driver's "slow" mode.

10.2.5 WdgSettingsFast

SWS Item	**WDG121 :**
Container Name	WdgSettingsFast{WDG_SETTINGS_FAST}
Description	Hardware dependent settings for the watchdog driver's "fast" mode.
Configuration Parameters	

No Included Containers

10.2.6 WdgSettingsSlow

SWS Item	**WDG123 :**
Container Name	WdgSettingsSlow{WDG_SETTINGS_SLOW}
Description	Hardware dependent settings for the watchdog driver's "slow" mode.
Configuration Parameters	

No Included Containers

10.2.7 WdgSettingsOff

SWS Item	**WDG122 :**		
Container Name	WdgSettingsOff{WDG_SETTINGS_OFF}		
Description	Hardware dependent settings for the watchdog driver's "off" mode.		
Configuration Parameters			

No Included Containers

10.2.8 WdgTimeoutList

SWS Item	**WDG128 :**		
Container Name	WdgTimeoutList{WDG_TIMEOUT_LIST}		
Description	List of selectable timeout periods in [s].		
Configuration Parameters			

SWS Item	**WDG129 :**		
Name	WdgTimeoutPeriod		
Description	A single timeout period onto the Wdg can be configured.		
Multiplicity	1..*		
Type	FloatParamDef		
Default value	--		
ConfigurationClass	***Published Information***	X	All Variants
Scope / Dependency			

No Included Containers

10.2.9 WdgExternalConfiguration

SWS Item	**WDG112 :**		
Container Name	WdgExternalConfiguration{Wdg_ExternalConfiguration}		
Description	Configuration items for an external watchdog hardware		
Configuration Parameters			

SWS Item	**WDG113 :**		
Name	WdgExternalContainerRef {WDG_EXTERNAL_CONTAINER_REF}		
Description	Reference to either - a DioChannelGroup container in case the hardware watchdog is connected via DIO pins - a SpiSequenceConfiguration container in case the watchdog hardware is accessed via SPI		
Multiplicity	1		
Type	Choice Reference to DioChannelGroup,SpiSequence		
ConfigurationClass	***Pre-compile time***	X	VARIANT-PRE-COMPILE
	Link time	X	VARIANT-LINK-TIME
	Post-build time	X	VARIANT-POST-BUILD
Scope / Dependency	scope: Module dependency: See DIO resp. SPI SWS		

No Included Containers

10.3 Published Information

Published information contains data defined by the implementer of the SW module that does not change when the module is adapted (i.e. configured) to the actual HW/SW environment. It thus contains version and manufacturer information.

The standard common published information like

- vendorId (WDG_VENDOR_ID),
- moduleId (WDG_MODULE_ID),
- arMajorVersion (WDG_AR_MAJOR_VERSION),
- arMinorVersion (WDG_ AR_MINOR_VERSION),
- arPatchVersion (WDG_ AR_PATCH_VERSION),
- swMajorVersion (WDG_SW_MAJOR_VERSION),
- swMinorVersion (WDG_ SW_MINOR_VERSION),
- swPatchVersion (WDG_ SW_PATCH_VERSION),
- vendorApiInfix (WDG_VENDOR_API_INFIX)

is provided in the BSW Module Description Template (see [6], Figure 4.1 and Figure 7.1). Additional published parameters are listed below if applicable for this module.

WDG075: If the watchdog hardware provides a uniform timeout resolution over the complete range, this resolution and the minimum and maximum timeout periods that can be selected shall be given. If the timeout resolution is not uniform a list of all possible timeout periods has to be provided.

10.3.1 WdgPublishedInformation

SWS Item	**WDG074 :**
Container Name	WdgPublishedInformation
Description	Container holding all Wdg specific published information parameters
Configuration Parameters	

SWS Item	**WDG124 :**		
Name	WdgMaxTimeout {WDG_MAX_TIMEOUT}		
Description	Maximum timeout period in [s].		
Multiplicity	0..1		
Type	FloatParamDef		
Default value	--		
ConfigurationClass	***Published Information***	X	All Variants
Scope / Dependency			

SWS Item	**WDG125 :**		
Name	WdgMinTimeout {WDG_MIN_TIMEOUT}		
Description	Minimum timeout period in [s].		
Multiplicity	0..1		
Type	FloatParamDef		
Default value	--		
ConfigurationClass	***Published Information***	X	All Variants
Scope / Dependency			

SWS Item	**WDG126 :**

Name	WdgResolution {WDG_RESOLUTION}		
Description	Resolution of watchdog timeout period in [s].		
Multiplicity	0..1		
Type	FloatParamDef		
Default value	--		
ConfigurationClass	***Published Information***	X	All Variants
Scope / Dependency			

SWS Item	**WDG127 :**		
Name	WdgTriggerMode {WDG_TRIGGER_MODE}		
Description	Watchdog trigger mode (toggle/window/both)		
Multiplicity	1		
Type	EnumerationParamDef		
Range	WDG_BOTH	--	
	WDG_TOGGLE	--	
	WDG_WINDOW	--	
ConfigurationClass	***Published Information***	X	All Variants
Scope / Dependency			

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
WdgTimeoutList	0..1	List of selectable timeout periods in [s].

11 Changes to Release 1

11.1 Deleted SWS Items

SWS Item	*Rationale*
WDG039	New SWS template for release 2.0
WDG002	Bugzilla Entry #4533

11.2 Replaced SWS Items

SWS Item of Release 1	*replaced by SWS Item*	*Rationale*
WGD030	WDG069	New SWS template for release 2.0 (copy-paste didn't work on the tags)
WDG058	WDG070	New SWS template for release 2.0 (copy-paste didn't work on the tags)
WDG053	WDG073	New SWS template for release 2.0 (copy-paste didn't work on the tags)
WDG024	WDG074	New SWS template for release 2.0 (copy-paste didn't work on the tags)
WDG054	WDG074	New SWS template for release 2.0 (copy-paste didn't work on the tags)
WDG059	WDG075	New SWS template for release 2.0 (copy-paste didn't work on the tags)
WDG060	WDG076	New SWS template for release 2.0 (copy-paste didn't work on the tags)
WDG049	WDG077	New SWS template for release 2.0 (copy-paste didn't work on the tags)
WDG050	WDG078	New SWS template for release 2.0 (copy-paste didn't work on the tags)

11.3 Changed SWS Items

SWS Item	*Rationale*
WDG045	New SWS template for release 2.0
WDG003	Bugzilla Entry #4077 (4577)
WDG017	Bugzilla Entry #4081 (4580)
WDG004	Bugzilla Entry #4582
WDG035	Bugzilla Entry #4080 (4579)
WDG037	Wrong figure referenced
WDG018, WDG052	Bugzilla Entry #4079 (4578)
WDG012	BSW00421
WDG083	Bugzilla Entry # 12138 (13066)
WDG037	Bugzilla Entry # 12136 (13068)

11.4 Added SWS Items

SWS Item	*Rationale*
WDG062	New SWS template for release 2.0
WDG063	New SWS template for release 2.0

WDG064	New SWS template for release 2.0
WDG065	New SWS template for release 2.0
WDG066	New SWS template for release 2.0
WDG067	New SWS template for release 2.0
WDG068	New SWS template for release 2.0
WDG079	New SWS template for release 2.0
WDG080	New SWS template for release 2.0
WDG081	New SWS template for release 2.0
WDG082	Added some Variants
WDG083	BSW00399

12 Changes during TO SWS Improvements

12.1 Deleted SWS Items

SWS Item	*Rationale*
WDG004	The text is left in, but the ID is removed as this is not a requirement. It is well covered by for example WDG102, WDG103,...
WDG009	Since the requirement is not applicable.

12.2 Replaced SWS Items

SWS Item of Release 1	*replaced by SWS Item*	*Rationale*
WDG027	WDG086, WDG087	Split because original requirement was on different issues
WDG003	WDG089, WDG090	Split because original requirement was on different issues
WDG008	WDG091, WDG092	Split because original requirement was on different issues
WDG037	WDG093, WDG094, WDG095	Split because original requirement was on different issues
WDG028	WDG100, WDG101	Split to make to make the requirement atomic
WDG032	WDG102, WDG103	Split to make to make the requirement atomic

12.3 Changed SWS Items

Many requirements have been changed to improve understandability without changing the technical contents.

SWS Item	*Rationale*
WDG031	Rephrased the requirement.
WDG034	Rephrased the requirement.
WDG019	Rephrased the requirement.

12.4 Added SWS Items

SWS Item	*Rationale*
WDG099	Gave id to hint out of Wdg_GetVersionInfo
WDG104	Gave id to a note out of the Wdg_Trigger table
WDG105	UML Model linking of imported types
WDG106	UML Model linking of Wdg_Init
WDG107	UML Model linking of Wdg_SetMode
WDG108	UML Model linking of Wdg_Trigger
WDG109	UML Model linking of Wdg_GetVersionInfo
WDG110	UML Model linking of mandatory interfaces
WDG111	UML Model linking of optional interfaces