# MICROSAR CAN Driver

## Technical Reference

Infineon™ Aurix Plus Family®
Version 4.01.00



| | |
|---|---|
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| Status | Released |

# 1 Document Information

## 1.1 History

| Author | Date | Version | Remarks |
|---|---|---|---|
| P. Herrmann | 2017-02-22 | 1.00.00 | Creation based on SPC58xx description |
| P. Herrmann<br>G.Pflügel | 2017-04-25 | 1.01.00 | Added latest MCAN Bosch Errata (#16, #17, #18)<br>Added MCAN independent Errata for Aurix Plus |
| G.Pflügel | 2017-07-26 | 2.00.00 | Restructure of history |
| P. Herrmann | 2017-08-03 | 2.01.00 | Updated SPC574Kxx derivative decription for new cut 2.4 hardware revision.<br>Enhanced description in chapter<br>- 4.8.3 “Hardware Loop Check / Timeout Monitoring”<br>- 4.10 “Hardware Specific” |
| G.Pflügel | 2017-08-21 | 2.02.00 | - Platform SAM V71 and Traveo merged together and renamed to platform Arm32Mcan<br>- Platform Telemaco and compiler ARM added to platform Arm32Mcan |
| P. Herrmann | 2017-09-18 | 2.03.00 | Enhanced ch. 4.8.1 “Dev. Error Reporting” |
| P. Herrmann | 2017-10-05 | 2.04.00 | Added Silent Mode |
| P. Herrmann | 2017-11-21 | 2.05.00 | Template update, enhanced Silent Mode description |
| P. Herrmann | 2018-01-15 | 2.06.00 | Dynamic MCAN Revision detection |
| M. Huse | 2018-02-27 | 2.07.00 | Extended Ram Check |
| P. Herrmann | 2018-03-02 | 2.08.00 | Telemaco3P STA1385 Cut2.1 |
| G.Pflügel | 2018-03-28 | 2.09.00 | Tricore TC38x and TC39x Step_B added |
| M. Huse | 2018-04-04 | 2.10.00 | BCM89103 added |
| M. Huse | 2018-04-11 | 2.11.00 | Updated API description |
| C. Huo | 2018-04-12 | 2.12.00 | TDA3x added |
| M. Huse | 2018-04-19 | 3.00.00 | Updated document for multi driver compatibility |
| M. Huse | 2018-05-07 | 3.00.01 | Updated ISR section for multi driver compatibility. |
| G.Pflügel | 2018-06-11 | 3.01.00 | HighTec GNU for Tricore |
| M. Huse | 2018-07-23 | 3.02.00 | Visconti5 added |
| G.Pflügel | 2018-09-21 | 3.03.00 | Support HighTec GNU for Spc58xx |
| M. Huse | 2018-10-23 | 3.04.00 | Support IAR compiler for ARM.<br>Traveo2 added |
| M. Huse | 2018-12-17 | 3.05.00 | Updated description for Generic PreTransmit.<br>Added areas for Protected Register Access |
| M. Huse | 2019-02-11 | 3.06.00 | ATSAME5X added. Updated Mcan Errata sheet reference |
| G.Pflügel | 2019-03-21 | 3.07.00 | Tricore TC35x added |

| | | | |
|---|---|---|---|
| P. Herrmann | 2019-03-28 | 4.00.00 | R22 update |
| M. Huse | 2019-04-18 | 4.01.00 | ATSAMC21 added. Support ARM6 compiler for ARM derivatives. BCM89107 added. TC37X added. Added TriCore specific hardware loop and errata description. |

Table 1-1 Document History

## 1.2 Reference Documents

| No. | Title | Version |
|---|---|---|
| [1] | AUTOSAR_SWS_CAN_DRIVER.pdf | 2.4.6 +<br>3.0.0 +<br>4.0.0 |
| [2] | AUTOSAR_BasicSoftwareModules.pdf | V1.0.0 |
| [3] | AUTOSAR_SWS BSW Scheduler | V1.1.0 |
| [4] | AUTOSAR_SWS_CAN_Interface.pdf | 3.2.7 +<br>4.0.0 +<br>5.0.0 |
| [5] | AN-ISC-8-1118 MICROSAR BSW Compatibility Check | V1.0.0 |
| [6] | M_CAN Controller Area Network Errata Sheet | REL2018 0720 |
| [7] | Appl. Note AN-ISC-8-1190 CAN Self Diag | 1.1.0 |
| [8] | ISO DIS 11898-1 | 2015 |

Table 1-2 Reference Documents

## 1.3 Scope of the Document

This document describes the functionality, API and configuration of the MICROSAR CAN Driver as specified in [1]. The CAN Driver is a hardware abstraction layer with a standardized interface to the CAN Interface layer.

**Caution**
We have configured the programs in accordance with your specifications in the questionnaire. Whereas the programs do support other configurations than the one specified in your questionnaire, Vector’s release of the programs delivered to your company is expressly restricted to the configuration you have specified in the questionnaire.

## Content

## Illustrations



## Tables

# 2 Hardware Overview

The following table summarizes information about the CAN Driver. It gives you detailed information about the derivatives and compilers. As very important information the documentations of the hardware manufacturers are listed. The CAN Driver is based upon these documents in the given version.

| Derivative | Compiler | Hardware Manufacturer Document | Version |
|---|---|---|---|
| TC357<br>TC375<br>TC377<br>TC387<br>TC389<br>TC397<br>TC399 | Tasking<br>HighTec GNU | AURIXTC3XX_ts__TargetSpec_part1.pdf<br>AURIXTC3XX_ts__TargetSpec_part2.pdf<br>TC35X_ts_appx_V2.5.1.pdf<br>TC37X_ts_appx_V2.5.1.pdf<br>TC39XB_ts_appx_V2.5.1.pdf<br>TC38X_ts_appx_V2.3.0.pdf | V2.1.0<br>V2.1.0<br>V2.5.1<br>V2.5.1<br>V2.5.1<br>V2.3.0 |
| A_Step derivatives of the TC39x are no more supported with this version of the CAN-driver | | | |

Table 2-1 Supported Hardware Overview

**Derivative:** This can be a single information or a list of derivatives, the CAN Driver can be used on.

**Compiler:** List of Compilers the CAN Driver is working with

**Hardware Manufacturer Document Name:** List of hardware documentation the CAN Driver is based on.

**Version:** To be able to reference to this hardware documentation its version is very important.

# 3 Introduction

This document describes the functionality, API and configuration of the AUTOSAR BSW module CAN as specified in [1].

Since each hardware platform has its own behavior based on the CAN specifications, the main goal of the CAN Driver is to give a standardized interface to support communication over the CAN bus for each platform in the same way. The CAN Driver works closely together with the higher layer CAN interface.

| | | |
|---|---|---|
| **Supported AUTOSAR Release*:** | 3 and 4 | |
| **Supported Configuration Variants:** | Pre-Compile,<br>Link-Time,<br>Post-Build Loadable,<br>Post-Build Selectable (MICROSAR Identity Manager) | |
| | | |
| **Vendor ID:** | CAN_VENDOR_ID | 30 decimal<br>(= Vector-Informatik, according to HIS) |
| **Module ID:** | CAN_MODULE_ID | 80 decimal<br>(according to ref. [2]) |
| **AR Version:** | CAN_AR_RELEASE_MAJOR_VERSION<br>CAN_AR_RELEASE_MINOR_VERSION<br>CAN_AR_RELEASE_REVISION_VERSION | AUTOSAR Release version BCD coded |
| **SW Version:** | CAN_SW_MAJOR_VERSION<br>CAN_SW_MINOR_VERSION<br>CAN_SW_PATCH_VERSION | MICROSAR CAN mudule version BCD coded |

* For the precise AUTOSAR Release 3.x (and 4.x) please see the release specific documentation.

## 3.1 Architecture Overview

The following figure shows where the CAN is located in the AUTOSAR architecture.

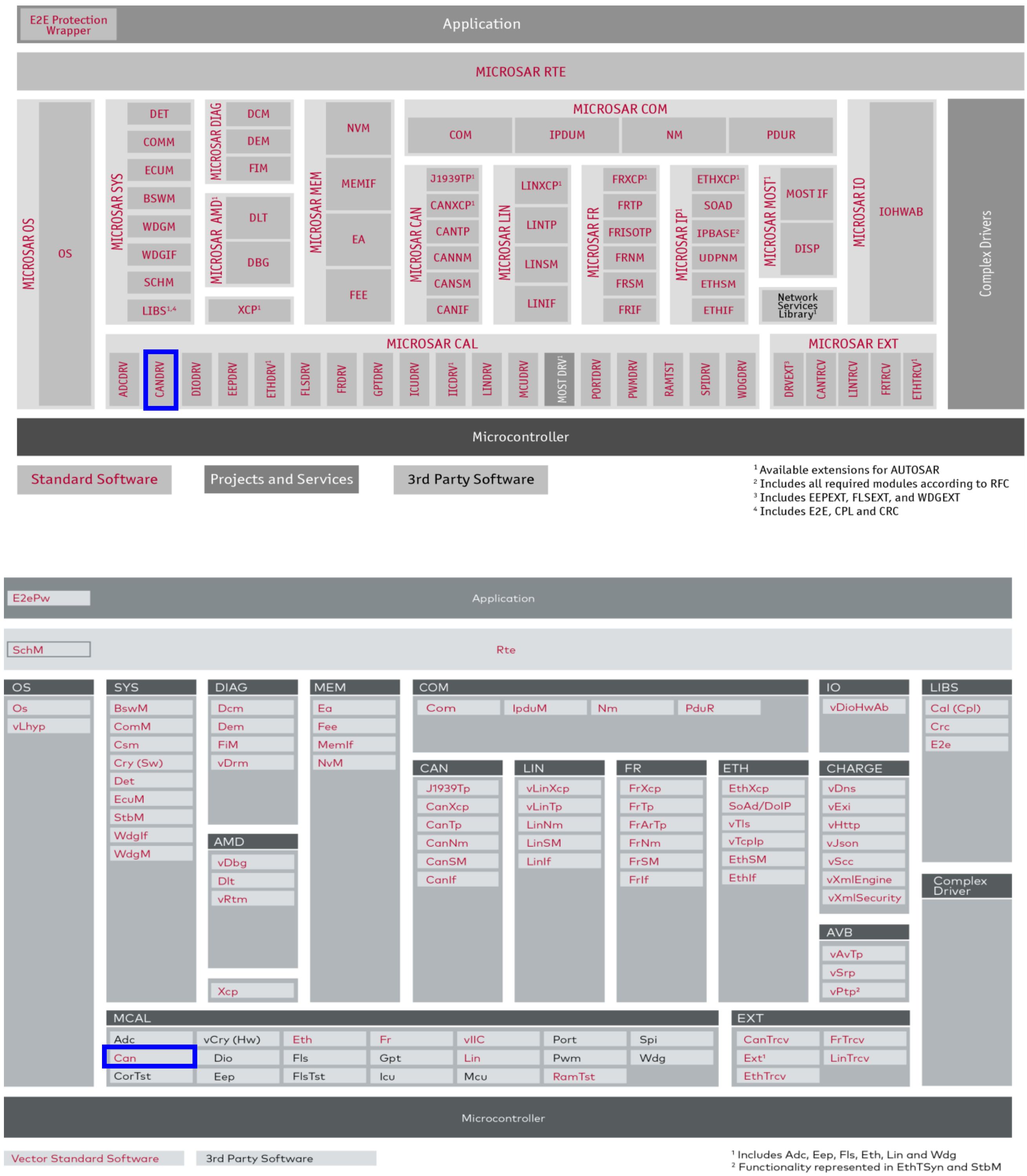



Figure 3-1 AUTOSAR architecture

The next figure shows the interfaces to adjacent modules of the CAN. These interfaces are described in chapter 7.

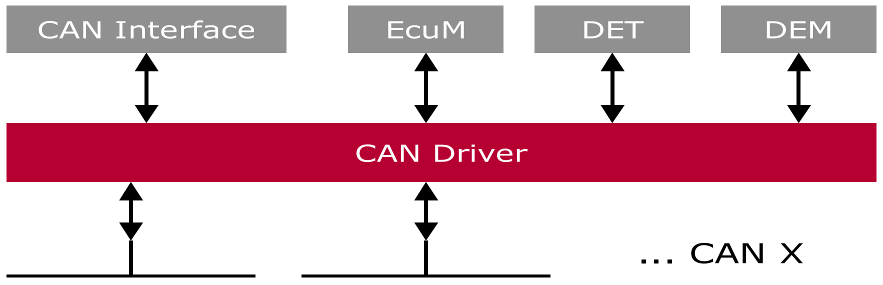



Figure 3-2 Interfaces to adjacent modules of the CAN

# 4 Functional Description

## 4.1 Features

The features listed in this chapter cover the complete functionality specified in [1].

The "supported" and "not supported" features are presented in the following table.

For further information of not supported features also see chapter 9.

| Feature Naming | Short Description | CFG5 |
|---|---|---|
| **Initialization** | | |
| Driver | General driver initialization function Can_Init() | ■ |
| Controller | Controller specific initialization function Can_InitController(). | ■ |
| **Communication** | | |
| Transmission | Transmitting CAN frames. | ■ |
| Transmit confirmation | Callback for successful Transmission. | ■ |
| Reception | Receiving CAN frames. | ■ |
| Receive indication | Callback for receiving Frame. | ■ |
| **Controller Modes** | | |
| Sleep Mode | Controller supports Sleep Mode (power saving). | □ |
| Wakeup over CAN | Controller supports wakeup over CAN. | □ |
| Stop Mode | Controller supports Stop Mode (passive to CAN bus). | ■ |
| Bus Off detection | Callback for Bus Off event. | ■ |
| Silent Mode | Support Silent Mode where the controller only listens passive. | ■ |
| MirrorMode / BusMirroring | Support message mirroring where the controller support generic confirmation function for mirroring and support an API to activate and deactivate this. | ■ |
| **Polling Modes** | | |
| Tx confirmation | Support Polling Mode for Transmit confirmation. | ■ |
| Reception | Support Polling Mode for Reception. | ■ |
| Wakeup | Support Polling Mode for Wakeup event. | □ |
| Bus Off | Support Polling Mode for Bus Off event. | ■ |
| Mode | Support Polling Mode for mode transition. | ■ |
| | | |

| **Mailbox objects** | | |
|---|---|---|
| Tx BasicCAN | Standard mailbox to send CAN frames (Used by CAN Interface data queue). | ■ |
| Tx Hardware FIFO | Using a FIFO mechanism for Tx BasicCAN mailboxes | □ |
| Multiplexed Tx | Using 3 mailboxes for Tx BasicCAN mailbox (external priority inversion avoided). | ■ |
| Tx FullCAN | Separate mailbox for special Tx message used. | ■ |
| Maximum amount | Available amount of mailboxes. | 32 |
| Rx FullCAN | Separate mailbox for special Rx message used. | ■ |
| Maximum amount | Available amount of mailboxes. | 64 |
| Rx BasicCAN | Standard mailbox to receive CAN frames (FIFO-0/1 supported). | ■ |
| Maximum amount | Available amount of BasicCAN objects.<br>By default there is one FIFO(0) supported with a max. amount of 64 entries. In case of “Multiple BasicCAN” (see below) support an additional second FIFO(1) with 64 entries is supported. | 1 (64)<br>2(128) |
| | | |
| **Others** | | |
| DEM | Support Diagnostic Event Manager (error notification). | ■ |
| DET | Support Development Error Detection (error notification). | ■ |
| Version API | API to read out component version. | ■ |
| Maximum supported Controllers | Maximum amount of supported Controllers (hardware channels). | 12 |
| Cancellation of Tx objects | Support of Tx Cancellation (out of hardware). Avoid internal priority inversion. | □ |
| Identical ID cancellation | Tx Cancellation also for identical IDs. | ■ |

| | | |
|---|---|---|
| Standard ID types | Standard Identifier supported (Tx and Rx). | ■ |
| Extended ID types | Extended Identifier supported (Tx and Rx). | ■ |
| Mixed ID types | Standard and Extended Identifier supported (Tx and Rx). | ■ |
| CAN FD Mode1 | FD frames with baudrate switch supported (Tx and Rx). | ■ |
| CAN FD Mode2 | FD frames up to 64 data bytes supported (Tx and Rx). | ■ |
| Hardware Loop Check (Timeout monitoring) | To avoid possible endless loops (occur by hardware issue). | ■ |
| Multiple CAN driver | API infixed CAN driver support | ■ |
| Pretended Networking | Support pretended networking (since ASR 4.2.0) | □ |
| Individual Polling | Support individual polling mode (selectable for each mailbox separate).<br>Limitation: AutoSar feature multiple cyclic functions with different time periods are not supported. The polling takes part in the same main function calls (since ASR 4.2.0). | ■ |
| TriggerTransmit | Support trigger transmit (since ASR 4.2.0) | ■ |
| EcuC partition map | Support EcuC partition mapping (since ASR 4.4.0). | ■ |
| **AutoSar extensions** | | |
| Individual Polling | Support individual Polling Mode (selectable for each mailbox separate). | ■* |
| Multiple Rx Basic CAN | Support Multiple BasicCAN objects.<br>This gives the possibility to use additionally Fifo-1 with 64 additional elements. By optimizing the acceptance filtering overruns can be avoided . | ■* |
| Multiple Tx Basic CAN | Support Multiple Tx BasicCAN objects. Used to send different Tx groups over separate mailboxes with different buffering behavior (see Can Interface). | ■* |

| | | |
|---|---|---|
| Rx Queue | Support Rx Queue. This offers the possibility to buffer received data in interrupt context but handle it later asynchronous in the polling task. | ■* |
| Secure Rx Buffer used | Special hardware buffer used to save received data temporarily. | □ |
| Hardware Loop Check by Application | Hardware Loop Check can be defined to be done by application (special API available) | ■ |
| Configurable “Nested CAN Interrupts” | Nested CAN interrupts allowed and can be also switched to none-nested. | ■ |
| Report CAN_E_TIMEOUT DEM as DET | Report CAN_E_TIMEOUT (Hardware Loop Check / Timeout monitoring) to DET instead of DEM. | ■ |
| Support Mixed ID | Force CAN Driver to handle Mixed ID (standard and extended ID) at pre-compile-time to expand the ID type later on. | ■ |
| Optimize for one controller | Activate this for 1 controller systems when you never will expand to multi-controller. So that the CAN Driver works more efficient | ■ |
| Dynamic FullCAN Tx ID | Always write FullCAN Tx ID within Can_Write() API function. Deactivate this to optimize code when you do not use FullCAN Tx objects dynamically. | □ |
| Size of Hw HandleType | Support 8-bit or 16-bit Hardware Handles depending on the hardware usage. | ■ |
| Generic PreCopy | Support a callback function for receiving any CAN message (following callbacks could be suppressed) | ■ |
| Generic Confirmation | Support a callback function for successful transmission of any CAN message (following callbacks could be suppressed) | ■ |
| Get Hardware Status | Support a API to get hardware status Information (see CanGetStatus()) | ■ |
| Interrupt Category selection | Support Category 1 or Category 2 Interrupt Service Routines for OS | ■ |
| Common CAN | Support merge of 2 controllers in hardware to get more Rx FullCAN objects | □ |

| | | |
|---|---|---|
| Overrun Notification | Support DET or Application notification caused by overrun (overwrite) of an Rx message.<br>Please note that 'Overrun' is supported for BasicCAN objects but is not available for FullCAN objects.<br>While not processed a Message ID Filter Element referencing a specific FullCAN object will not match, causing the acceptance filtering to continue. Subsequent Message ID Filter Elements may cause the received message to be stored into<br>- another FullCAN object, or<br>- a BasicCAN object, or<br>- the message may be rejected, depending on the filter configuration. | ■ |
| RAM check | Support CAN mailbox RAM check | ■ |
| Extended RAM Check | Support extended RAM check. Handling of individual deactivated mailboxes and controllers. | ■ |
| Generic PreTransmit | Support a callback function with pointer to Data, right before this data will be written in Hardware mailbox buffer to send. (Use this to change data or cancel transmission) | ■ |

Table 4-1 Supported features

■ Feature is supported

☐ Feature is not supported

* HighEnd Licence only

** Project specific (may not be available)

## 4.2 Initialization

Can_Init() has to be called to initialize the CAN Driver at power on and sets controller independent init values. This function has to be called before Can_InitController().

MICROSAR401 only: baud rate settings given by Can_InitController parameter.

Can_InitController() initializes the controller, given as parameter, and can also be used to reinitialize. After this call the controller stays in Stop Mode until the CAN Interface changes to Start Mode.

Can_InitMemory() is an additional service function to reinitialize the memory to bring the driver back to a pre-power-on state (not initialized). Afterwards Can_Init() and Can_InitController() have to be called again. It is recommended to use this function before calling Can_Init() to secure that no startup-code specific pre-initialized variables affect the driver startup behavior.

## 4.3 Communication

Can_Write() is used to send a message over the mailbox object given as "Hth". The data, DLC and ID is copied into the hardware mailbox object and a send request is set. After sending the message the CAN Interface CanIf_TxConfirmation() function is called. Right before the data is copied into the mailbox buffer the ID, DLC and data may be changed by `Appl_GenericPreTransmit()` callback.

When "Generic Confirmation" is activated the callback Appl_GenericConfirmation() will be called before CanIf_TxConfirmation() and the call to this can be suppressed by Appl_GenericConfirmation() return value.

For Tx messages the ID will be copied. (Exception: feature "Dynamic FullCAN Tx ID" is deactivated, then the FullCAN Tx messages will be only set while initialization)

If the mailbox is currently sending the status busy will be returned. Then the message may be queued in the CAN interface (if feature is active).

If cancellation in hardware is supported the lowest priority ID inside currently sending object is canceled, and therefore re-queued in the CAN Interface.

Appl_GenericPreCopy() (if activated) is called and depend on return value also CanIf_RxIndication() as a CAN Interface callback, is called when a message is received. The receive information like ID, DLC and data are given as parameter.

When Rx Queue is activated the received messages (polling or interrupt context) will be queued (same queue over all channels). The Rx Queue will be read by calling Can_Mainfunction_Read () and the Rx Indication (like CanIf_RxIndication()) will be called out of this context. Rx Queue is used for Interrupt systems to keep Interrupt latency time short.

### 4.3.1 Mailbox Layout

The generation tool supports a flexible allocation of message buffers. In the following tables the possible mailbox layout is shown (the range for each mailbox type depends on the used mailboxes).

| Hardware object number | Hardware object type | Amount of hardware objects | Description |
|---|---|---|---|
| 0 … N | **Tx FullCAN** | 0 … 31 max. (0 … 29 in case of multiplexed transmission) | These objects are used to transmit specific message IDs. The user must define statically in the generation tool which CAN message IDs are located in Tx FullCAN objects. The generation tool assigns the message IDs to the FullCAN hardware objects. |
| (N+1) … M | **Tx BasicCAN** | 1 or 3 (3 in case of multiplexed transmission) | All other CAN message IDs are transmitted via the Tx Basic object. If the transmit message object is busy, the transmit requests are stored in the CAN Interface queue (if activated). |

| | | | |
|---|---|---|---|
| (M+1) … O | **Unused** | 0 … 95 | These objects are not used. It depends on the configuration of receive and transmit objects how many unused objects are available. |
| O…P | **Rx FullCAN** | 0 … 64 | These objects are used to receive specific CAN messages. The user defines statically (Generation Tool) that a CAN message should be received in a FullCAN message object. The Generation Tool distributes the messages to the FullCAN objects. |
| 96 | **Rx BasicCAN** | FIFO-0 with max. 64 entries | All CAN message IDs, depending on the acceptance filter match, are received via the Rx BasicCAN message object through Rx FIFO 0.<br>Each Rx Basic message object consists of 64 message buffers.<br>128 acceptance filters are available for standard IDs and 64 acceptance filters are available for extended IDs.<br>In case of mixed ID Mode 128+64 = 192 filters are available.<br>Please note that this maximum amount of filters is also used for FIFO-1 if available. |
| 97 | **Rx BasicCAN** | FIFO-1 with max. 64 entries | All CAN message IDs, depending on the acceptance filter match, are received via the Rx BasicCAN message objects through Rx FIFO 1.<br>Each Rx Basic message object consists of 64 message buffers.<br>128 acceptance filters are available for standard IDs and 64 acceptance filters are available for extended IDs.<br>In case of mixed ID Mode 128+64 = 192 filters are available.<br>Please note that this maximum amount of filters is also used for FIFO-0. |

The “CanObjectId” (ECUc parameter) numbering is done in following order: Tx FullCAN, Tx BasicCAN, Unused, Rx FullCAN, Rx BasicCAN (like shown above). “CanObjectId’s” for next controller begin at end of last controller. Gaps in “CanObjectId” for unused mailboxes may occur.

### 4.3.2 Mailbox Processing Order

The hardware mailbox will be processed in following order:

| Object Type | Order / priority to send or receive |
|---|---|
| Tx FullCAN | Object ID Low to High |
| Tx BasicCAN | Object ID Low to High |
| Rx FullCAN | Object ID Low to High |
| Rx BasicCAN | FIFO |

In Case of Interrupt, Rx FullCANs will be processed before Rx BasicCANs.

In Case of Polling, Rx FullCANs will be processed before Rx BasicCANs.

The order between Rx and Tx mailboxes depends on the call order of the polling tasks or the interrupt context and cannot be guaranteed.

The Rx Queue will work like a FIFO filled with the above mentioned method.

### 4.3.3 Acceptance Filter for BasicCAN

For each CAN channel a maximum amount of 128 filters for standard and 64 filters for extended ID configurations is available. Thus 192 filters are available for mixed ID configurations.

For acceptance filtering each list of filters is executed from element #0 until the first matching element. Acceptance filtering stops at the first matching element. Each filter element decides if the received message is stored within FIFO-0 (or FIFO-1 if available).

If no message should be received, select the “Multiple Basic CAN” feature and set the amount to 0. Otherwise the filter should be set to “close”. Use feature “Rx BasicCAN Support” to deactivate unused code (for optimization).

### 4.3.4 Remote Frames

The CAN Driver initializes the CAN controller not to receive remote frames. Therefore no additional action is required during runtime by the CAN Driver for remote frame filtering. Remote frames will not have any influence on communication because they are not received by the CAN hardware.

## 4.4 States / Modes

You can change the CAN cell mode via Can_SetControllerMode(). The last requested transition will be executed. The upper layer has to take care about valid transitions.

The following mode changes are supported:

**CAN_T_START**

**CAN_T_STOP**

Notification of mode change may occur asynchronous by notification `CanIf_ControllerModeIndication()`.

### 4.4.1 Start Mode (Normal Running Mode)

This is the mode where communication is possible. This mode has to be set after Initialization because Controller is first in Stop Mode.

The Bit Stream Processor synchronizes itself to the data transfer on the CAN bus by waiting for the occurrence of a sequence of 11 consecutive recessive bits (= Bus_Idle) before it can take part in bus activities and start the message transfer.

### 4.4.2 Stop Mode

If Stop Mode is requested, either by software or by going BusOff, then the CAN module is switched into INIT mode. In this mode message transfer from and to the CAN bus is stopped, the status of the CAN bus transmit output is recessive (HIGH).

Going to Stop Mode does not change any configuration register.

### 4.4.3 Power Down Mode

The CAN controller does not support a Sleep/Wakeup Mode, nevertheless power saving is possible with the "Power Down" Mode via a Clock Stop Request (CSR).

After requesting Clock Stop all pending transmissions have to be completed then the CAN Controller waits until bus idle state is detected. Then the CAN Controller sets Initialization to one to prevent any further CAN transfers. Now the CAN Controller acknowledges that it is ready for power down by setting Clock Stop Acknowledge. At this point of time the CAN Controller clock inputs may be switched off.

To leave Power Down Mode, the application has to turn on the CAN Controller clocks before resetting Clock Stop Request. The CAN Controller will acknowledge this by resetting Clock Stop Acknowledge. Afterwards the CAN communication can be restarted by resetting the initialization mode.

The application is, if configured, requested to turn off the clocks for CAN and Host controllers. When the Clock Stop Request returns, then it is assumed that the clocks are off.

In the same way the application is requested to turn on the CAN clocks during power up before the CAN starts communication. When the Clock Start Request returns, then it is assumed that the clocks are on.

Please note that the user callback function that will be called in case of a clock stop request acknowledge must be defined via a user-configuration file (see example below).

Example for a user – configuration file entry defining the Clock Start/Stop callback functions:

```
#define ApplCanClockStop(CanChannel)      ApplCanClockStopAcknowledged(CanChannel)
/* will be called when the application is allowed to turn off the clocks for CAN and Host */
#define ApplCanClockStart(CanChannel)     ApplCanClockStartRequested(CanChannel)
/* will be called when the application must turn on the clocks for CAN and Host before communication is started */
```

The parameter "`CanChannel`" is either of type "void" in case of a single channel configuration or it contains the number of the CAN channel in case of a multi channel configuration.

### 4.4.4 Bus Off

`CanIf_ControllerBusOff()` is called when the controller detects a Bus Off event. The mode is automatically changed to Stop Mode. The upper layers have to care about returning to normal running mode by calling Start Mode.

### 4.4.5 Silent Mode

Support API (`Can_SetSilentMode()`) to switch into 'SilentMode' where the controller does not take part on BUS communication (no ACK) but can listen for messages.

Please refer also to ISO 11898 bus monitoring.

The MCAN describes this mode as Bus Monitoring Mode:

In Bus Monitoring Mode (see ISO 11898-1:2015, 10.14 Bus monitoring), the M_CAN is able to receive valid data frames and valid remote frames, but cannot start a transmission. In this mode, it sends only recessive bits on the CAN bus. If the M_CAN is required to send a dominant bit (ACK bit, overload flag, active error flag), the bit is rerouted internally so that the M_CAN monitors this dominant bit, although the CAN bus may remain in recessive state. In Bus Monitoring Mode register TXBRP is held in reset state.

The Bus Monitoring Mode can be used to analyze the traffic on a CAN bus without affecting it by the transmission of dominant bits.

In case of an error condition or overload condition no dominant bits are sent, instead the MCAN waits for the occurrence of bus idle condition to resynchronize itself to the CAN communication. The error counters (ECR.REC, ECR.TEC) are frozen while Error Logging (ECR.CEL) is active. This can be used in applications that adapt themselves to different CAN bit rates.

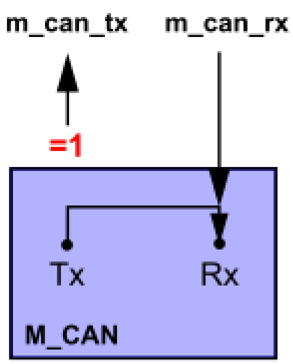



Figure 4-1 Bus Monitoring Mode.

**Caution**
With activated “Silent Mode” do not use any other API than
Can_SetSilentMode(“CAN_SILENT_INACTIVE”),
Can_SetControllerMode(“START” or “STOP”) or
Can_ChangeBaudrate() or Can_SetBaudrate().
Especially do NOT request any transmission.

### 4.4.6 Dynamic MCAN detection

In the case of several platform hardware versions with different MCAN Revisions are used, the integrated MCAN Revision can be detected during runtime by the CAN Driver. If so, the CAN Driver adapts itself to the underlying MCAN Revision.

To enable this mode the preprocessor switch "`C_ENABLE_DYNAMIC_MCAN_REVISION`" must be defined via a user configuration file.

Adaptations which do not need additional data are accomplished internally now. For adaptations which need additional data the user callback function "`ApplCanInitPostProcessing()`" has to be enabled in addition. This callback function is called during initialization time of the MCAN and thus allows to overwrite MCAN registers with values which are MCAN Revision dependent (see ch. 7.2.44).

**Caution**
Please note that the dynamic MCAN detection only works upwards.
This means that the configuration is always based on MCAN Revision 3.0.x.
The effective underlying MCAN Revision may be either 3.0.x or 3.2.x.

## 4.5 Re-Initialization

A call to `Can_InitController()` cause a re-initialization of a dedicated CAN controller. Pending messages may be processed before the transition will be finished. A re-initialization is only possible out of Stop Mode and does not change to another mode.

After re-initialization all CAN communication relevant registers are set to initial conditions.

## 4.6 CAN Interrupt Locking

`Can_DisableControllerInterrupts()` and `Can_EnableControllerInterrupts()` are used to disable and enable the controller specific Interrupt, Rx, Tx, Wakeup and BusOff (/ Status) together. These functions can be called nested.

## 4.7 Main Functions

`Can_MainFunction_Write()`, `Can_MainFunction_Read()`, `Can_MainFunction_BusOff()` and `Can_MainFunction_Wakeup()` are called by upper layers to poll the events if the specific Polling Mode is activated. Otherwise these functions return without any action and the events will be handled in interrupt context.

When individual polling is activated only mailboxes that are configured as to be polled will be polled in the main functions "`Can_MainFunction_Write()`" and "`Can_MainFunction_Read()`", all others are handled in interrupt context.

If the Rx Queue feature is activated then the queue is filled in interrupt or polling context, like configured. But the processing (indications) will be done in "`Can_MainFunction_Read()`" context.

Can_MainFunction_Mode() can be called by upper layers to poll asynchronous mode transition notifications.

## 4.8 Error Handling

### 4.8.1 Development Error Reporting

Development errors are reported to DET using the service `Det_ReportError()`, if the pre-compile parameter CAN_DEV_ERROR_DETECT == STD_ON.

The tables below, shows the API ID and Error ID given as parameter for calling the DET.

Instance ID is always 0 because no multiple Instances are supported.

| Errors reported to DET: | |
|---|---|
| **Error ID** | **Short Description** |
| CAN_E_PARAM_POINTER | API gets an illegal pointer as parameter. |
| CAN_E_PARAM_HANDLE | API gets an illegal handle as parameter |
| CAN_E_PARAM_DLC | API gets an illegal DLC as parameter |
| CAN_E_PARAM_CONTROLLER | API gets an illegal controller as parameter |
| CAN_E_UNINIT | Driver API is used but not initialized |
| CAN_E_TRANSITION | Transition for mode change is illegal |
| CAN_E_DATALOST<br>(value: 0x07, AutoSar extension) | Rx overrun (overwrite) detected |
| CAN_E_PARAM_BAUDRATE<br>(value: 0x08, AutoSar extension) | Selected Baudrate is not valid |
| CAN_E_RXQUEUE<br>(value: 0x10, AutoSar extension) | Rx Queue overrun<br>(Last received message is lost and will not be received. Avoid this by increasing the queue size) |
| CAN_E_TIMEOUT_DET<br>(value: 0x11, AutoSar extension) | Same as CAN_E_TIMEOUT for DEM but this is notified to DET due to switch “CAN_DEV_TIMEOUT_DETECT” is set to STD_ON (see configuration options) |
| CAN_E_GENDATA<br>(value:0x12, AutoSar extension) | Standardized issue for inconsistent generated data |
| kCanErrorMcanRevision<br>(value:0xA2, AutoSar extension) | The configured Mcan Revision is not equal to the Mcan Revision read directly from the underlying hardware during startup. |
| kCanErrorMcanMessageRAMOverflow<br>(value:0xA3, AutoSar extension) | The address used for a Message RAM access is behind the end address of the available Message RAM. |
| kCanErrorChannelHdlTooLarge<br>(value:0xA4, AutoSar extension) | The handle used for the channel parameter is larger than the number of configured channels |

Table 4-2 Errors reported to DET

| API from which the errors are reported to DET: | |
|---|---|
| **API ID** | **Functions using that ID** |
| CAN_VERSION_ID | Can_GetVersionInfo() |
| CAN_INIT_ID | Can_Init() |
| CAN_INITCTR_ID | Can_InitController() |
| CAN_SETCTR_ID | Can_SetControllerMode() |
| CAN_DIINT_ID | Can_DisableControllerInterrupts() |
| CAN_ENINT_ID | Can_EnableControllerInterrupts() |
| CAN_WRITE_ID | Can_Write(), Can_CancelTx() |
| CAN_TXCNF_ID | CanHL_TxConfirmation() |
| CAN_RXINDI_ID | CanBasicCanMsgReceived(), CanFullCanMsgReceived() |
| CAN_CTRBUSOFF_ID | CanHL_ErrorHandling() |
| CAN_CKWAKEUP_ID | CanHL_WakeUpHandling(), Can_Cbk_CheckWakeup() |
| CAN_MAINFCT_WRITE_ID | Can_MainFunction_Write() |
| CAN_MAINFCT_READ_ID | Can_MainFunction_Read() |
| CAN_MAINFCT_BO_ID | Can_MainFunction_BusOff() |
| CAN_MAINFCT_WU_ID | Can_MainFunction_Wakeup() |
| CAN_MAINFCT_MODE_ID | Can_MainFunction_Mode() |
| CAN_CHANGE_BR_ID | Can_ChangeBaudrate() |
| CAN_CHECK_BR_ID | Can_CheckBaudrate() |
| CAN_SET_BR_ID | Can_SetBaudrate() |
| CAN_HW_ACCESS_ID (value: 0x20, AUTOSAR extension) | Used when hardware is accessed (call context may vary) |

Table 4-3 API from which the Errors are reported

#### 4.8.1.1 Parameter Checking

AUTOSAR requires that API functions check the validity of their parameters (Refer to [1]). These checks are for development error reporting and can be enabled and disabled separately. Refer to the configuration chapter where the enabling/disabling of the checks is described. Enabling/disabling of single checks is an addition to the AUTOSAR standard which requires enable/disable the complete parameter checking via the parameter `CAN_DEV_ERROR_DETECT`.

#### 4.8.1.2 Overrun/Overwrite Notification

As AUTOSAR extension the overrun detection may be activated by configuration tool. The notification can be configured to issue a DET call (MICROSAR 4.x) or an Application call (*Appl_CanOverrun*()).

Please note that 'Overrun' is supported for BasicCAN objects but is not available for FullCAN objects.

While the received message is still in the Rx buffer contained (New Data flag is set) for a specific FullCAN object a Message ID Filter Element referencing this specific object will not match, causing the acceptance filtering to continue. Following Message ID Filter Elements may cause the received message to be stored into another Rx Buffer, or into an Rx FIFO, or the message may be rejected, depending on filter configuration.

### 4.8.2 Production Code Error Reporting

Production code related errors are reported to DEM using the service `Dem_ReportErrorStatus()`, if the pre-compile parameter `CAN_PROD_ERROR_DETECT == STD_ON`.

The table below shows the Event ID and Event Status given as parameter for calling the DEM. This callout may occur in the context of different API calls (see Chapter "Hardware Loop Check / Timeout Monitoring").

| Event ID | Event Status | Short Description |
| --- | --- | --- |
| CAN_E_TIMEOUT | DEM_EVENT_STATUS_FAILED | Timeout in "Hardware Loop Check" occurred, hardware has to be checked or timeout is too short. |
| | | |

Table 4-4 Errors reported to DEM

### 4.8.3 Hardware Loop Check / Timeout Monitoring

The feature "Hardware Loop Check" is used to break endless loops caused by hardware issue. This feature is configurable see Chapter 7 and also Timeout Duration description.

Since AUTOSAR4 a synchronous part of mode transitions will be also limited by this timeout mechanism which is no issue but a timing limit. The following asynchronous part of mode transition is handled without Hardware Loop Check.

The Hardware Loop Check will be handled by CAN driver internal except when setting "Hardware Loop Check by Application" is activated.

Nevertheless, refer to "short description" below (there may be activities that should be initiated by the application like a reset of the CAN controller or some special mode transitions). If so, the "Hardware Loop Check by Application" is recommended to be used to handle the concerned loop explicitly.

#### 4.8.3.1 Critical Loops

A loop exception must be handled by application like described below.

| Loop Name / source | Short Description |
|---|---|
| kCanLoopInit | This channel dependent loop is called during channel initialization and mode transistion, and is processed as long as the CAN cell does not enter resp. leave the configuration mode.<br>While entering the configuration mode, message transfer from and to the CAN bus is stopped, the status of the CAN bus transmit output is recessive.<br>There is a delay from writing to a command register until the update of the related status register bits due to clock domain crossing (Host and CAN clock). Therefore the programmer has to assure that the previous value written to INIT has been accepted.<br>If the loop cancels, try to reinitialize the controller again or reset the hardware. |
| kCanLoopIrFlag | This is a channel dependent loop called from the function of the Can interrupt handling (Tx/Rx/Error). The loop is processed if the requested interrupt flag is not cleared in hardware immediately due to erroneous hardware behavior. The loop is implemented as a part of the workaround for MCMCAN_AI.H001_EPN TriCore Erratum.<br><br>The loop is expected to be expected no more than once.<br><br>The affected channel must be re-initialized if the loop is cancelled as the interrupt line from the MCMCAN module is no longer operating as expected. |

Table 4-5 Hardware Loop Check (critical)

#### 4.8.3.2 Uncritical Loops

No additional application handling needed after loop break.

| Loop Name / source | Short Description |
|---|---|
| kCanLoopSleep | When Clock Stop is requested then all pending transfer requests are completed first.<br>When the CAN bus reached idle then Clock Stop will be acknowledged.<br>(See also „kCanLoopClockStop" below, but only used for Bosch Erratum #7) |
| kCanLoopClockStop | When Clock Stop is requested then all pending transfer requests are completed first.<br>When the CAN bus reached idle then Clock Stop will be acknowledged.<br>(Please see also ch. 4.4.3 Power Down Mode) |
| kCanLoopRxFifo | This channel dependent loop is called in CanInterruptRx and is processed until the Rx FIFO becomes empty. The loop is delayed if the controller receives a burst of messages. The maximum expected duration is the time needed until all messages in the reception FIFO are confirmed.<br><br>If the loop cancels then, in case of an interrupt driven configuration, the remaining messages in the Fifo(s) will be read not till the next Rx interrupt appears.<br>In case of a polling configuration the polling will continue as usual with the next task cycle. |

Table 4-6 Hardware Loop Check (uncritical)

#### 4.8.3.3 Loops used for synchronous mode transitions

AUTOSAR4: Driver handle the mode transition in asynchronous way afterwards, so no additional handling is necessary.

AUTOSAR3: Higher layer has to handle this (see below).

| Loop Name / source | Short Description |
|---|---|
| kCanLoopStart | Used for short time mode transition blocking (short synchronous timeout). Same value for kCanLoopStart, kCanLoopStop, kCanLoopSleep and kCanLoopWakeup.<br>No Issue when timeout occurs. |
| kCanLoopStop | Used for short time mode transition blocking (short synchronous timeout). Same value for kCanLoopStart, kCanLoopStop, kCanLoopSleep and kCanLoopWakeup.<br>No Issue when timeout occurs. |

Table 4-7 Hardware Loop Check (synchronous mode transition)

### 4.8.4 CAN RAM Check

The CAN Driver supports a check of the CAN controller's mailboxes. The CAN controller RAM check is called internally every time a power on is executed within function Can_InitController(), or a Bus-Wakeup event happen. The CAN Driver verifies that no used mailboxes are corrupt. A mailbox is considered corrupt if a predefined pattern is written to the appropriate mailbox registers and the read operation does not return the expected pattern. If a corrupt mailbox is found the function Appl_CanCorruptMailbox() is called. This function tells the application which mailbox is corrupt.

After the check of all mailboxes the CAN Driver calls the call back function Appl_CanRamCheckFailed() if at least one corrupt mailbox was found. The application must decide if the CAN Driver disables communication or not by means of the call back function's return value. If the application has decided to disable the communication there is no possibility to enable the communication again until the next call to Can_Init().

The CAN RAM check functionality itself can be activated via Generation Tool.

### 4.8.5 Extended RAM Check

The CAN Driver supports a check for all accessible CAN Controller's control registers and mailbox registers. The extended RAM check will be executed during power on initialization and by direct call. Mailboxes will be deactivated when pattern check fails or configured values are corrupt. The CAN Controller will be deactivated when at least one mailbox is corrupt or one or more controller register failed the pattern check or configured values are corrupt.

Mailbox and controller stay deactivated until explicitly re-activated. The application is fully responsible to handle this (see Application Note [7] for further information).

API to execute extended RAM check:

```
Can_RamCheckExecute()
```

Callouts to notify corrupt mailboxes or controllers:

```
CanIf_RamCheckCorruptController(),CanIf_RamCheckCorruptMailbox()
```

API to re-activate the mailbox or controller again:

```
Can_RamCheckEnableMailbox(),Can_RamCheckEnableController()
```

Please note that only the registers that have both read and write functionality are checked.

## 4.9 Common CAN

Common CAN connect 2 hardware CAN channels to one logical controller. This allows configuring more FullCAN mailboxes. The second hardware channel is used for Rx FullCAN mailboxes.

The filter mask of the BasicCAN should exclude the message received by the FullCAN messages of the second CAN Controller. This means each message ID must be received on one CAN hardware channel only. The filter optimization takes care about this when common CAN is activated.

For configuration of Common CAN specific settings in generation tool see chapter 7.6.2.

**Caution**

Only one Transceiver (Driver) has to be used for this two Common CAN hardware channels (connect TX and RX lines).

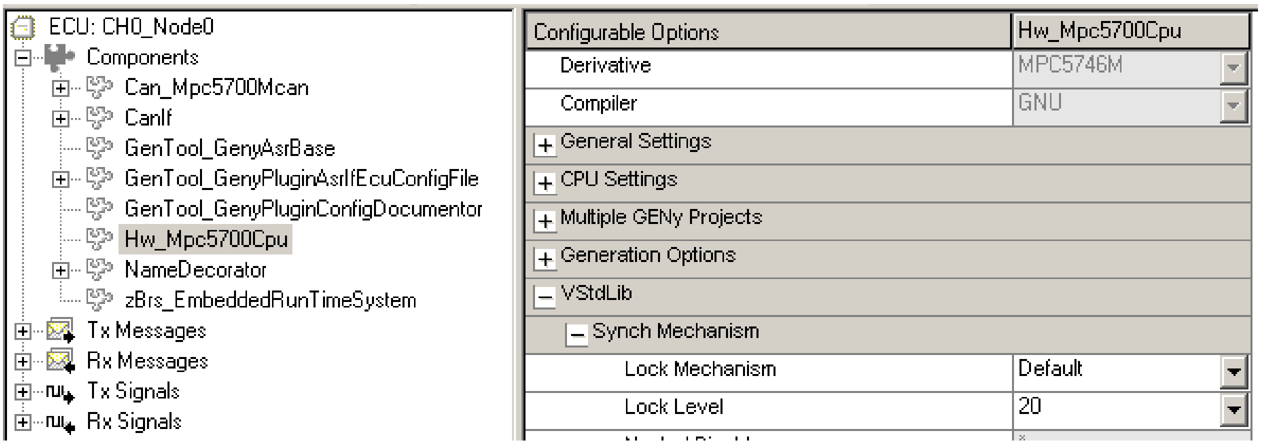
Reason: Upper layers only know one Controller for this 2 hardware channel Common CAN and therefore only one Transceiver can be handled.

## 4.10 Hardware Specific

For a correct operation the driver expects all of its registers and the MCAN Message RAM to be accessible in “User Mode”. Please check the Hardware Reference Manual (see chapter 2) for the appropriate measures to be taken like register and memory protection mechanisms.

For a correct operation the driver also expects the correct configuration of interrupt control registers and correct transceiver configuration.

If the application code applies the VStdlib delivered by Vector and it intends to enable/disable the global interrupt using different, then it has configure the “lock level” within GENy accordingly:




Please note that furthermore the dedicated processor core has to be selected accordingly.

By default core – 0 is used. If you decide to take another core, then you have to overwrite the pre-processor macro by using a user-configuration file.

Example (appropriate for SPC58xx derivatives):

```
#define PPC_INTC_CPR  (*(volatile uint32*)  0xFC040000  - with INTC_0 used,
```

```
#define PPC_INTC_CPR  (*(volatile uint32*)  0xF4044000  - with INTC_1 used,
```

Additionally the clock supply has to be provided and finally it is necessary to configure the port pins correctly to get CAN communication.

> **Please note**
> This configuration work is not part of the CAN Driver.

### 4.10.1 Error Interrupt

The MCAN error interrupt source is used only partially by the CAN Driver. Only BusOff events are handled and reported to the upper layers by the CAN Driver.

> **Please note**
> The BusOff recovery sequence cannot be shortened (e.g. by initializing the CAN device). If the device goes BusOff, it will enter the INIT Mode by its own, stopping all bus activities.
> When leaving the INIT Mode the device will wait for 129 occurrences of Bus Idle (129 x 11 consecutive recessive bits) before resuming normal operation.

> **Please note**
> The Timeout Counter is used for CAN driver internal purposes (supervision of possible transmit confirmations arriving delayed after a cancellation was requested). Thus the “Timeout Occurred” interrupt may occur occasionally.

### 4.10.2 Not supported hardware features

All available 32 transmit message buffers per CAN channel are used as dedicated buffers and can be used either as BasicCAN or FullCAN objects (see 4.3.1).

- Tx Event FIFO is not used
- Tx Queue is not used
- The filtering of High Priority messages are not supported.
- Range Filters are not supported
- Transmit Cancellation is (no longer) supported

### 4.10.3 MCAN specific behavior

Please note that MCAN Revision 3.1.x is the very first one which supports CAN-FD functionality (bitrate switching and full 64 data bytes) on a "per message" basis.

MCAN Revision 3.0.x supports CAN-FD on a "per channel" basis, thus not allowing a change between Classic CAN and CAN-FD format during runtime.

# 5 Integration

This chapter gives necessary information for the integration of the MICROSAR CAN into an application environment of an ECU.

## 5.1 Scope of Delivery

The delivery of the CAN contains the files, which are described in the chapter's 5.1.1 and 5.1.2:

Dependent on library or source code delivery the marked (+) files may not be delivered.

### 5.1.1 Static Files

| File Name | Description |
|---|---|
| (+) Can_Local.h | This is an internal header file which should not be included outside this module |
| (+) Can.c | This is the source file of the CAN. It contains the implementation of CAN module functionality. |
| (+) Can.lib | This is the library build out of Can.c, Can.h and Can_Local.h |
| Can.h | This is the header file of the CAN module (include API declaration) |
| Can_Irq.c | This is the interrupt declaration and callout file (supports interrupt configuration as link time settings) |

Table 5-1 Static files

### 5.1.2 Dynamic Files

The dynamic files are generated by the configuration tool.

| File Name | Description |
|---|---|
| Can_Cfg.h | Generated header file, contains some type, prototype and pre-compile settings |
| Can_Lcfg.c | Generated file contains link time settings. |
| Can_PBcfg.c | Generated file contains post build settings. |
| Can_DrvGeneralTypes.h | Generated file contains CAN Driver part of Can_GeneralTypes.h (supported by Integrator) |

Table 5-2 Generated files

## 5.2 Include Structure

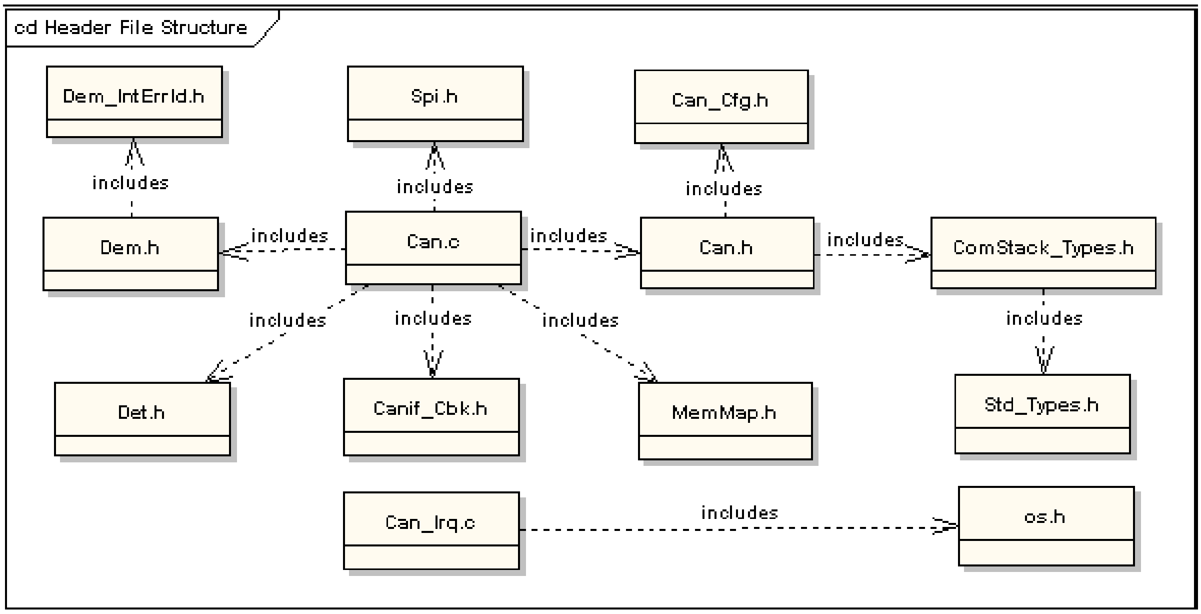



Figure 5-1 Include Structure (AUTOSAR)

Deviation from AUTOSAR specification:

- Additionally the EcuM_Cbk.h is included by Can_Cfg.h (needed for wakeup notification API).
- ComStack_Types.h included by Can_Cfg.h, because the specified types have to be known in generated data as well.
- Os.h will be included by Can_Cfg.h because of used data-types
- Spi.h is not yet used.
- MICROSAR403 only: Can_GeneralTypes.h will be included by Can_Cfg.h not by Can.h direct.

## 5.3 Critical Sections

The AUTOSAR standard provides with the BSW Scheduler a BSW module, which handles entering and leaving critical sections.

For more information about the BSW Scheduler please refer to [3]. When the BSW Scheduler is used the CAN Driver provides critical section codes that have to be mapped by the BSW Scheduler to following mechanism:

| Critical Section Define | Description |
|---|---|
| CAN_EXCLUSIVE_AREA_0 | CanNestedGlobalInterruptDisable/Restore() is used within Can_MainFunction_Write() and inside the transmit confirmation to assure that transmit confirmations do not conflict with further transmit requests.<br>> Duration is short.<br>> No API call of other BSW inside. |
| CAN_EXCLUSIVE_AREA_1 | Using inside Can_DisableControllerInterrupts() and Can_EnableControllerInterrupts() to secure Interrupt counters for nested calls.<br>> Duration is short.<br>> No API call of other BSW inside.<br>> Disable global interrupts – or – Empty in case Can_Disable/EnableControllerInterrupts() are called within context with lower or equal priority than CAN interrupt. |
| CAN_EXCLUSIVE_AREA_2 | Using inside Can_Write() to secure software states of transmit objects.<br>> Only when no Vector CAN Interface is used.<br>> Duration is medium.<br>> No API call of other BSW inside.<br>> Disable global interrupts - or - Disable CAN interrupts and does not call function reentrant. |
| CAN_EXCLUSIVE_AREA_3 | Using inside Tx confirmation to secure state of transmit object in case of cancellation. (Only used when Vector Interface Version smaller 4.10 used)<br>> Duration is medium.<br>> Call to CanIf_CancelTxConfirmation() inside (no more calls in CanIf).<br>> Disable global interrupts - or - Disable CAN interrupts and do not call function Can_Write() within. |
| CAN_EXCLUSIVE_AREA_4 | Using inside received data handling (Rx Queue treatment) to secure Rx Queue counter and data.<br>> Duration is short.<br>> No API call of other BSW inside.<br>> Disable Global Interrupts - or - Disable all CAN interrupts. |
| CAN_EXCLUSIVE_AREA_5 | Using inside wakeup handling to secure state transition. (Only in wakeup Polling Mode)<br>> Duration is short.<br>> Call to DET inside.<br>> Disable global interrupts (do not use CAN interrupt locks here) |

| | |
|---|---|
| CAN_EXCLUSIVE_AREA_6 | Using inside Can_SetControllerMode() and BusOff to secure state transition.<br>> Duration is medium.<br>> No API call of other BSW inside.<br>> Use CAN interrupt locks here, when the API for one controller is not called in a context higher than the CAN interrupt<br>or<br>Disable global interrupts |

Table 5-3 Critical Section Codes

## 5.4 Compiler Abstraction and Memory Mapping

The objects (e.g. variables, functions, constants) are declared by compiler independent definitions – the compiler abstraction definitions. Each compiler abstraction definition is assigned to a memory section.

The following table contains the memory section names and the compiler abstraction definitions defined for the CAN Interface and illustrates their assignment among each other.

| ***Compiler Abstraction Definitions*** <br> ***Memory Mapping Sections*** | *CAN_CODE* | *CAN_STATIC_CODE* | *CAN_CONST* | *CAN_CONST_PBCFG* | *CAN_VAR_NOINIT* | *CAN_VAR_INIT* | *CAN_VAR_PBCFG* | *CAN_INT_CTRL* | *CAN_REG_CANCELL* | *CAN_RX_TX_DATA* | *CAN_APPL_CODE* | *CAN_APPL_CONST* | *CAN_APPL_VAR* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAN_START_SEC_CODE<br>CAN_STOP_SEC_CODE | ■ | | | | | | | | | | | | |
| CAN_START_SEC_STATIC_CODE<br>CAN_STOP_SEC_STATIC_CODE | | ■ | | | | | | | | | | | |
| CAN_START_SEC_CONST_8BIT<br>CAN_STOP_SEC_CONST_8BIT | | | ■ | | | | | | | | | | |
| CAN_START_SEC_CONST_16BIT<br>CAN_STOP_SEC_CONST_16BIT | | | ■ | | | | | | | | | | |
| CAN_START_SEC_CONST_32BIT<br>CAN_STOP_SEC_CONST_32BIT | | | ■ | | | | | | | | | | |
| CAN_START_SEC_CONST_UNSPECIFIED<br>CAN_STOP_SEC_CONST_UNSPECIFIED | | | ■ | | | | | | | | | | |
| CAN_START_SEC_PBCFG<br>CAN_STOP_SEC_PBCFG | | | | ■ | | | | | | | | | |
| CAN_START_SEC_PBCFG_ROOT<br>CAN_STOP_SEC_PBCFG_ROOT | | | | ■ | | | | | | | | | |
| CAN_START_SEC_VAR_NOINIT_UNSPECIFIED<br>CAN_STOP_SEC_VAR_NOINIT_UNSPECIFIED | | | | | ■ | | | | | | | | |
| CAN_START_SEC_VAR_INIT_UNSPECIFIED<br>CAN_STOP_SEC_VAR_INIT_UNSPECIFIED | | | | | | ■ | | | | | | | |
| CAN_START_SEC_VAR_PBCFG<br>CAN_STOP_SEC_VAR_PBCFG | | | | | | | ■ | | | | | | |
| CAN_START_SEC_CODE_APPL<br>CAN_STOP_SEC_CODE_APPL | | | | | | | | | | | ■ | | |

Table 5-4 Compiler abstraction and memory mapping

The Compiler Abstraction Definitions CAN_APPL_CODE, CAN_APPL_VAR and CAN_APPL_CONST are used to address code, variables and constants which are declared by other modules and used by the CAN Driver.

These definitions are not mapped by the CAN Driver but by the memory mapping realized in the CAN Interface or direct by application.

CAN_CODE: used for CAN module code.

CAN_STATIC_CODE: used for CAN module local code.

CAN_CONST: used for CAN module constants.

CAN_CONST_PBCFG: used for CAN module constants in Post-Build section.

CAN_VAR_*: used for CAN module variables.

CAN_INT_CTRL: is used to access the CAN interrupt controls.

CAN_REG_CANCELL: is used to access the CAN cell itself.

CAN_RX_TX_DATA: access to CAN Data buffers.

CAN_APPL_*: access to higher layers.

## 5.5 Protected Register Access

If the protected register access is configured by the OS, you need to include the Os.h and configure the following areas:

### 5.5.1 CAN_PROTECTED_AREA_GLOBAL

CAN_PROTECTED_AREA_GLOBAL is used for accessing the global registers of the active subsystems.

### 5.5.2 CAN_PROTECTED_AREA_CHANNEL

CAN_PROTECTED_AREA_CHANNEL is used for accessing the channel specific registers of the active channels.

### 5.5.3 CAN_PROTECTED_AREA_SRN

CAN_PROTECTED_AREA_SRN is used for access to the Service Request Node used for the CAN interrupt handling. This is only used when OS interrupt control is not enabled.

The CAN driver will then not write directly to the protected register, the OS carries this.

# 6 Hardware Specific Hints

## 6.1 Usage of interrupt functions

According to the current implementation of MCAN generator there is a fix assignment of interrupt functions to the CAN Controller. The postfix of the interrupt function name equates the Service request Node (SRN) number according to your configuration.

The relationship of the different parts of interrupt depending names for the Tricore platform is described in the following table. The SRN's that's are used are not configurable (the CAN-driver use fix values for the GRINT registers).

| Node name used in datasheet | Name used in Cfg5 | Interrupt output line used in datasheet | SRN name used in datasheet | ISR name used in Can_Irq.c |
|---|---|---|---|---|
| CAN00 | M_CAN0 | INT_O0 MCMCAN | SRC_CAN0INT0 | CanIsr_0 |
| CAN01 | M_CAN1 | INT_O1 MCMCAN | SRC_CAN0INT1 | CanIsr_1 |
| CAN02 | M_CAN2 | INT_O2 MCMCAN | SRC_CAN0INT2 | CanIsr_2 |
| CAN03 | M_CAN3 | INT_O3 MCMCAN | SRC_CAN0INT3 | CanIsr_3 |
| CAN10 | M_CAN4 | INT_O4 MCMCAN | SRC_CAN1INT0 | CanIsr_4 |
| CAN11 | M_CAN5 | INT_O5 MCMCAN | SRC_CAN1INT1 | CanIsr_5 |
| CAN12 | M_CAN6 | INT_O6 MCMCAN | SRC_CAN1INT2 | CanIsr_6 |
| CAN13 | M_CAN7 | INT_O7 MCMCAN | SRC_CAN1INT3 | CanIsr_7 |

**Derivative TC35x**

| Node name used in datasheet | Name used in Cfg5 | Interrupt output line used in datasheet | SRN name used in datasheet | ISR name used in Can_Irq.c |
|---|---|---|---|---|
| CAN00 | M_CAN0 | INT_O0 MCMCAN | SRC_CAN0INT0 | CanIsr_0 |
| CAN01 | M_CAN1 | INT_O1 MCMCAN | SRC_CAN0INT1 | CanIsr_1 |
| CAN02 | M_CAN2 | INT_O2 MCMCAN | SRC_CAN0INT2 | CanIsr_2 |
| CAN03 | M_CAN3 | INT_O3 MCMCAN | SRC_CAN0INT3 | CanIsr_3 |
| CAN10 | M_CAN4 | INT_O4 MCMCAN | SRC_CAN1INT0 | CanIsr_4 |
| CAN11 | M_CAN5 | INT_O5 MCMCAN | SRC_CAN1INT1 | CanIsr_5 |
| CAN12 | M_CAN6 | INT_O6 MCMCAN | SRC_CAN1INT2 | CanIsr_6 |
| CAN13 | M_CAN7 | INT_O7 MCMCAN | SRC_CAN1INT3 | CanIsr_7 |
| CAN20 | M_CAN8 | INT_O8 MCMCAN | SRC_CAN2INT0 | CanIsr_8 |
| CAN21 | M_CAN9 | INT_O9 MCMCAN | SRC_CAN2INT1 | CanIsr_9 |
| CAN22 | M_CAN10 | INT_O10 MCMCAN | SRC_CAN2INT2 | CanIsr_10 |
| CAN23 | M_CAN11 | INT_O11 MCMCAN | SRC_CAN2INT3 | CanIsr_11 |

**Derivative TC38x and TC39x**

Table 6-1 Hardware Controller – Interrupt Functions

## 6.2 Interrupt Control

This section describes Interrupt Control.

### 6.2.1 Interrupt Control by Driver

Parameter ‘CAN_INTLOCK’ == CAN_DRIVER or

CAN_BOTH)

Parameter ‘CAN_USE_OS_INTERRUPT_CONTROL’== STD_OFF

With this configuration, the interrupt control registers are directly accessed by the driver. In case of the Tricore platform, the SRN registers for the CAN interrupts are accessed. Be aware that this requires access rights (that may be limited by restricted operation modes, memory protection or similar) and also exclusive write access by the driver (the registers must not be written by other modules after the call of Can_Init()).

### 6.2.2 Interrupt Control by OS

This feature is only implemented for TDA3x platform, not implemented on other platforms.

Parameter 'CAN_INTLOCK' == CAN_DRIVER or CAN_BOTH

Parameter 'CAN_USE_OS_INTERRUPT_CONTROL'== STD_ON

The driver implementation is used to modify all registers as required, but the actual accesses to the interrupt controller registers are performed by services provided by the operating system. This variant also requires that these registers are not written by other software modules after the call of Can_Init().

**Please note**
This configuration variant is only supported for MICROSAR4. The used services are provided by the MICROSAR Gen7 OS. If another operating system is used, the calls have to be mapped to corresponding functionalities during integration.

### 6.2.3 Interrupt Control by Application

Parameter 'CAN_INTLOCK' == CAN_APPL or CAN_BOTH )

Parameter 'CAN_USE_OS_INTERRUPT_CONTROL' is don't care

If an exclusive write access to the interrupt control registers is not possible, the driver can be configured for an external interrupt handling by means of callout functions. In this case the application must ensure proper disabling and restoring of the used CAN interrupt sources and handling of the wakeup interrupt.

## 6.3 Extra Registers

Some micro-controllers have extra registers other than the standard MCAN registers. These registers are initialized by calling Can_Init() API during the initialization phase.

## 6.4 MCAN Errata

The following Errata (please see ch. 6.2 for further details) are considered by the CAN Driver. By default all erratas which are appropriate for the configured MCAN Revision are enabled. If a specific erratum shall be disabled or enabled beyond that it can be configured via a user configuration file.

| Errata No. | Title | MCAN Rev. affected |
|---|---|---|
| 6 | Change of CAN operation mode during start of transmission.<br>Only activated if "`CAN_BOSCH_ERRATUM_006" is defined as STD_ON`. | 2.9.5, 2.9.6, 3.0.0, 3.0.1 |
| 7 | Problem with frame transmission after recovery from Restricted Operation Mode.<br>Only activated if "`CAN_BOSCH_ERRATUM_007" is defined as STD_ON`. | 2.9.5, 2.9.6, 3.0.0, 3.0.1 |

| | | |
|---|---|---|
| 8 | Setting / resetting CCCR.INIT during frame reception.<br>Only activated if “`CAN_BOSCH_ERRATUM_008‟ is defined as STD_ON.` | 2.9.5, 2.9.6, 3.0.0, 3.0.1 |
| 10 | Setting CCCR.CCE while a Tx scan is ongoing.<br>Only activated if “`CAN_BOSCH_ERRATUM_010‟ is defined as STD_ON.` | 2.9.5, 2.9.6, 3.0.0, 3.0.1 |
| 11 | Needless activation of interrupt IR.MRAF.<br>Only activated if “`CAN_BOSCH_ERRATUM_011‟ is defined as STD_ON.` | 2.9.5, 2.9.6, 3.0.0, 3.0.1, 3.1.0 |
| 12 | Return of receiver from Bus Integration state after Protocol Exception Event.<br>Only activated if “`CAN_BOSCH_ERRATUM_012‟ is defined as STD_ON.` | 2.9.6, 3.0.0, 3.0.1, 3.1.0 |
| 13 | Message RAM / RAM Arbiter not responding in time.<br>When the M_CAN wants to store a received frame and the Message RAM / RAM Arbiter does not respond in time, this message cannot be stored completely and it is discarded with the reception of the next message. Interrupt flag IR.MRAF is set. It may happen that the next received message is stored incomplete.<br>In this case, the respective Rx Buffer or Rx FIFO element holds inconsistent data.<br>**!** When the M_CAN has been integrated correctly (the Host and the CAN clock must be fast enough to handle a worst case configuration containing the maximum of MCAN Message RAM elements), this behaviour can only occur in case of a problem with the Message RAM itself or the RAM Arbiter.<br>The application must assure that the clocking of Host and CAN is appropriate. The CAN Driver does not care about these configuration aspects. | 2.9.6, 3.0.0, 3.0.1, 3.1.0, 3.2.0 |

| | | |
|---|---|---|
| 14 | Data loss (payload) in case storage of a received frame has not completed until end of EOF field is reached.<br>The time needed for acceptance filtering and storage of a received message depends on the<br>- Host clock frequency,<br>- the number of M_CANs connected to a single Message RAM,<br>- the Message RAM arbitration scheme, and<br>- the number of configured filter elements.<br>In case storage of a received message has not completed until end of the received frame then corrupted data can be contained in the Message RAM.<br><br>Interrupt flag IR.MRAF is not set.<br><br>! If storage of messages cannot be completed the application is responsible for reducing the maximum number of configured filter elements for the M_CANs attached to the Message RAM until the calculated clock frequency is below the Host clock frequency used with the actual device. | 2.9.6, 3.0.0, 3.0.1, 3.1.0, 3.2.0 |
| 1-5 | These errata are in the responsibility of the application and are not considered by the CAN Driver. | 2.0.0, 2.9.5, 2.9.6, 3.0.0, 3.0.1 |
| 9 | Frame transmission in DAR mode.<br>Not considered by the CAN Driver, frame transmission in DAR mode is not supported. | 2.9.5, 2.9.6, 3.0.0, 3.0.1 |
| 15 | Edge filtering causes miss-synchronization when falling edge at Rx input pin coincides with end of integration phase.<br>Not considered by the CAN Driver, Edge Filtering is not supported. | 3.1.0, 3.2.0, 3.2.1 |
| 16 | Configuration of NBTP.NTSEG2 = ‘0’ is not allowed.<br>This erratum is in the responsibility of the application during configuration time and is not considered by the CAN Driver during compile or runtime. | |
| 17 | Retransmission in DAR mode due to lost arbitration at the first two identifier bits.<br>Not considered by the CAN Driver, DAR Mode is not supported. | 2.9.6, 3.0.0, 3.0.1, |

| | | |
|---|---|---|
| 18 | Tx FIFO message sequence inversion.<br>Not considered by the CAN Driver, Tx Fifo is not supported. | 3.1.0, 3.2.0, 3.2.1 |

Table 6-2 MCAN Errata

## 6.5 Platform Errata

The following Errata must be considered depending on the underlying hardware platform:

### 6.5.1 Infineon

Information is available in the following Infineon erratum: MCMCAN_AI_H001_EPN_v1_0.pdf

All TriCore TC3X derivatives are affected.

| Erratum |
|---|
| Interrupt requests are not generated under certain conditions.<br>**Errata reference: MCMCAN_AI.H001_EPN**<br><br>Fix/Workaround:<br>Make sure that the CAN_TRICORE_ERRATUM_AI_H001 define is generated as STD_ON |

Table 6-3 TriCore Erratum MCMCAN_AI.H001_EPN

# 7 API Description

## 7.1 Interrupt Service Routines provided by CAN

### 7.1.1 Type of Interrupt Function

- Category 2 (only for OSEK OS or AUTOSAR OS):
  A macro “ISR(CanIsr_x)” will be used to declare ISR function call. The name given as parameter for interrupt naming (x = Physical CAN Channel number). For macro definition see OS specification. The OS has full control of the ISR.
  switch: C_ENABLE_OSEK_OS_INTCAT2
- Category 1:
  Using OS with category 1 interrupts need an Interface layer handling these interrupts in task context like defined in BSW00326 (AUTOSAR_SRS_General).
  switch: C_DISABLE_OSEK_OS_INTCAT2
- Void-Void Interrupt Function:
  Like in Category 1 the Interrupt is not handled by OS and the ISR is declared as void ISR(void) and has to be called by interrupt controller in case of an CAN interrupt.
  switch: C_ENABLE_ISRVOID

### 7.1.2 CAN ISR API

| **Prototype** | |
|---|---|
| `void CanIsr_<x>(void);` | |
| **Parameter** | |
| --- | --- |
| **Return code** | |
| --- | --- |
| **Functional Description** | |
| Handles interrupts of hardware channel <x> for Rx, Tx, BusOff events. | |
| **Particularities and Limitations** | |
| > Number of available functions depends on used MCU derivative.<br>> The functions are not designated as interrupt functions. If it is necessary to save/restore all general purpose registers and to use a different “return from interrupt” instruction the application code has to implement the compiler specific pragma (e.g. for Wind River™ DIAB™: #pragma interrupt CanIsr_x). | |

Table 7-1 MCAN CanIsr_<x>

## 7.2 Services provided by CAN

The CAN API consists of services, which are realized by function calls.

### 7.2.1 Can_InitMemory

| **Prototype** | |
|---|---|
| `void Can_InitMemory (void)` | |
| **Parameter** | |
| - | |
| **Return code** | |
| void | - |
| **Functional Description** | |
| Service initializes module global variables, which cannot be initialized in the startup code.<br>Use this to re-run the system without performing a new start from power on.<br>(E.g.: used to support an ongoing debug session without a complete re-initialization.)<br>Must be followed by a call to "Can_Init()". | |
| **Particularities and Limitations** | |
| Called by Application. | |
| ⚠ | **Caution**<br>None AUTOSAR API |
| Call context | |
| > Should be called while power on initialization before "Can_Init()" on task level.<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: Always | |

Table 7-2 Can_InitMemory

### 7.2.2 Can_Init

| **Prototype** | |
|---|---|
| `void Can_Init (Can_ConfigPtrType ConfigPtr)` | |
| **Parameter** | |
| ConfigPtr [in] | Pointer to the configuration data structure.<br>When using the "Multiple ECU" configuration feature, then for each Identity the appropriate<br>"CanConfig_<Identity>"-structure exists and has to be chosen here. |
| **Return code** | |
| void | - |
| **Functional Description** | |
| This function initializes global CAN Driver variables during ECU start-up. | |
| **Particularities and Limitations** | |
| Called by Can Interface.<br>Parameter "ConfigPtr" will be taken into account only for "Multiple ECU Configrutaion" and in Post-Build variant.<br>Disabled Interrupts. | |
| Call context | |
| > Has to be called during start-up before CAN communication.<br>> Must be called before calling "Can_InitController()" but after call of "Can_InitMemory()".<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: Always | |

Table 7-3 Can_Init

### 7.2.3 Can_InitController

| Prototype | |
|---|---|
| `void Can_InitController (uint8 Controller, Can_ControllerBaudrateConfigPtrType Config)` | |
| **Parameter** | |
| Controller [in] | Number of controller |
| Config [in] | Pointer to baud rate configuration structure |
| **Return code** | |
| void | - |
| **Functional Description** | |
| Initialization of controller specific CAN hardware.<br>The CAN Driver registers and variables are initialized.<br>The CAN controller is fully initialized and left back within the state "Stop Mode", ready to change to "Running Mode". | |
| **Particularities and Limitations** | |
| Called by CanInterface.<br>Disabled Interrupts. | |
| Call context | |
| > Has to be called during the startup sequence before CAN communication takes place but after calling "Can_Init()".<br>> Must not be called while in "Sleep Mode".<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: MICROSAR401 only | |

Table 7-4 Can_InitController

### 7.2.4 Can_ChangeBaudrate

| Prototype | |
|---|---|
| `Std_ReturnType` **`Can_ChangeBaudrate`** `(uint8 Controller, const uint16 Baudrate)` | |
| **Parameter** | |
| Controller [in] | Number of controller to be changed |
| Baudrate [in] | Baud rate to be set |
| **Return code** | |
| Std_ReturnType | > E_NOT_OK Baud rate is not set<br>> E_OK Baud rate is set |
| **Functional Description** | |
| This service shall change the baud rate and reinitialize the CAN controller. | |
| **Particularities and Limitations** | |
| Called by Application.<br>The CAN controller must be in "Stop Mode". | |
| Call context | |
| > Has to be called during the startup sequence before CAN communication takes place but after calling "Can_Init()".<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: MICROSAR403 only & if "CanChangeBaudrateApi" is activated or "CanSetBaudrateApi" is de-activated. | |

Table 7-5 Can_ChangeBaudrate

### 7.2.5 Can_CheckBaudrate

| **Prototype** | |
|---|---|
| `Std_ReturnType` **`Can_CheckBaudrate`** `(uint8 Controller, const uint16 Baudrate)` | |
| **Parameter** | |
| Controller [in] | Number of controller to be checked |
| Baudrate [in] | Baud rate to be checked |
| **Return code** | |
| Std_ReturnType | > E_NOT_OK Baud rate is not available<br>> E_OK Baud rate is available |
| **Functional Description** | |
| This service shall check if the given baud rate is supported of the CAN controller. | |
| **Particularities and Limitations** | |
| Called by Application.<br>The CAN controller must be initialized. | |
| Call context | |
| > Must not be called nested.<br>> Only available if "CanChangeBaudrateApi" is activated.<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: MICROSAR403 only & "CanChangeBaudrateApi" is activated ("CAN_CHANGE_BAUDRATE_API == STD_ON") | |

Table 7-6 Can_CheckBaudrate

### 7.2.6 Can_SetBaudrate

| Prototype | |
|---|---|
| `Std_ReturnType **Can_SetBaudrate** (uint8 Controller, uint16 BaudRateConfigID)` | |
| **Parameter** | |
| Controller [in] | Number of controller to be set |
| BaudRateConfigID [in] | Identity of the configured baud rate (available as Symbolic Name) |
| **Return code** | |
| Std_ReturnType | > E_NOT_OK Baud rate is not set<br>> E_OK Baud rate is set |
| **Functional Description** | |
| This service shall change the baud rate and reinitialize the CAN controller.<br>(Similar to "Can_ChangeBaudrate()" but used when identical baud rates are used for different CAN FD settings). | |
| **Particularities and Limitations** | |
| Called by Application. | |
| Call context | |
| > Must not be called nested.<br>> Only available if "CanSetBaudrateApi" is activated.<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: MICROSAR403 only & "CanSetBaudrateApi" is activated ("CAN_SET_BAUDRATE_API == STD_ON") | |

Table 7-7 Can_SetBaudrate

_InitStruct

### 7.2.7 Can_GetVersionInfo

| Prototype | |
|---|---|
| `void Can_GetVersionInfo (Can_VersionInfoPtrType VersionInfo)` | |
| **Parameter** | |
| VersionInfo [out] | Pointer to where to store the version information of the CAN Driver.<br>typedef struct {<br>uint16 vendorID;<br>uint16 moduleID;<br>} Std_VersionInfoType; |
| **Return code** | |
| void | - |
| **Functional Description** | |
| Get the version information of the CAN Driver. | |
| **Particularities and Limitations** | |
| Called by Application. | |
| Call context | |
| > Only available if "CanVersionInfoApi" is activated.<br>> This function is Synchronous<br>> This function is Reentrant<br>> Availability: "CanVersionInfoApi" is activated ("CAN_VERSION_INFO_API == STD_ON") | |

Table 7-8 Can_GetVersionInfo

### 7.2.8 CanGetStatus

| Prototype | |
|---|---|
| `uint8 Can_GetStatus (uint8 Controller)` | |
| **Parameter** | |
| Controller [in] | Number of the controller requested for status information |
| **Return code** | |
| uint8 | > CAN_STATUS_START<br>> CAN_STATUS_STOP (Bit coded status information)<br>> CAN_STATUS_INIT<br>> CAN_STATUS_INCONSISTENT,<br>> CAN_DEACTIVATE_CONTROLLER (only with "CanRamCheck" active)<br>> CAN_STATUS_WARNING<br>> CAN_STATUS_PASSIVE<br>> CAN_STATUS_BUSOFF<br>> CAN_STATUS_SLEEP |
| **Functional Description** | |
| Delivers the status of the hardware.<br>Only one of the status bits CAN_STATUS_SLEEP/ STOP/ START/ BUSOFF/ PASSIVE/ WARNING is set.<br>The CAN_STATUS_INIT bit is always set if a controller is initialized.<br>CAN_STATUS_SLEEP has the highest and CAN_STATUS_WARNING the lowest priority.<br>CAN_STATUS_INCONSISTENT will be set if one Common CAN channel. is not "Stop" or "Sleep".<br>CAN_DEACTIVATE_CONTROLLER is set in case the "CanRamCheck" detected an Issue.<br>"status" can be analyzed using the provided API macros:<br>CAN_HW_IS_OK(status): return "true" in case no warning, passive or bus off occurred.<br>CAN_HW_IS_WARNING(status): return "true" in case of waning status.<br>CAN_HW_IS_PASSIVE(status): return "true" in case of passive status.<br>CAN_HW_IS_BUSOFF(status): return "true" in case of bus off status (may be already false in Notification).<br>CAN_HW_IS_WAKEUP(status): return "true" in case of not in Sleep Mode.<br>CAN_HW_IS_SLEEP(status): return "true" in case of Sleep Mode.<br>CAN_HW_IS_STOP(status): return "true" in case of Stop Mode.<br>CAN_HW_IS_START(status): return "true" in case of not in Stop Mode.<br>CAN_HW_IS_INCONSISTENT(status): return "true" in case of an inconsistency between two common CAN channels. | |
| **Particularities and Limitations** | |
| Called by network management or Application. | |
| **Caution**<br>None AUTOSAR API | |
| Call context | |

| |
|---|
| > This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: ""CanGetStatus" is activated ("CAN_GET_STATUS == STD_ON") |

Table 7-9 CanGetStatus

### 7.2.9 Can_GetControllerErrorState

| Prototype | |
|---|---|
| `Std_ReturnType **Can_GetControllerErrorState** (uint8 Controller, Can_ErrorStatePtrType ErrorStatePtr)` | |
| **Parameter** | |
| Controller [in] | Number of the controller requested for status information |
| ControllerModePtr [out] | Pointer to variable to store CAN controller's error state. Must not be NULL. |
| **Return code** | |
| Std_ReturnType | E_NOT_OK Controller mode is not available |
| Std_ReturnType | E_OK Controller mode is available |
| **Functional Description** | |
| Gets the error state of the given controller. | |
| **Particularities and Limitations** | |
| Configuration Variant(s): CAN_GET_STATUS == STD_ON<br>(CREQ-178459) | |
| Call context | |
| > ANY<br>> This function is Synchronous<br>> This function is Reentrant<br>> Availability: "CanGetStatus" is activated ("CAN_GET_STATUS == STD_ON") | |

Table 7-10 Can_GetControllerErrorState

### 7.2.10 Can_GetControllerTxErrorCounter

| **Prototype** | |
|---|---|
| `Std_ReturnType` **`Can_GetControllerErrorState`** `(uint8 Controller, Can_ErrorStatePtrType TxErrorStatePtr)` | |
| **Parameter** | |
| Controller [in] | Number of the controller requested for status information |
| ControllerModePtr [out] | Pointer to variable to store CAN controller's error state. Must not be NULL. |
| **Return code** | |
| Std_ReturnType | E_NOT_OK Controller mode is not available |
| Std_ReturnType | E_OK Controller mode is available |
| **Functional Description** | |
| Gets the TX error counter of the given controller. | |
| **Particularities and Limitations** | |
| Configuration Variant(s): CAN_GET_STATUS == STD_ON<br>(CREQ-178459) | |
| Call context | |
| > ANY<br>> This function is Synchronous<br>> This function is Reentrant<br>> Availability: "CanGetStatus" is activated ("CAN_GET_STATUS == STD_ON") | |

Table 7-11 Can_GetControllerTxErrorCounter

### 7.2.11 Can_GetControllerRxErrorCounter

| Prototype | |
|---|---|
| `Std_ReturnType` **`Can_GetControllerErrorState`** `(uint8 Controller, Can_ErrorStatePtrType RxErrorStatePtr)` | |
| **Parameter** | |
| Controller [in] | Number of the controller requested for status information |
| ControllerModePtr [out] | Pointer to variable to store CAN controller’s error state. Must not be NULL. |
| **Return code** | |
| Std_ReturnType | E_NOT_OK Controller mode is not available |
| Std_ReturnType | E_OK Controller mode is available |
| **Functional Description** | |
| Gets the RX error counter of the given controller. | |
| **Particularities and Limitations** | |
| Configuration Variant(s): CAN_GET_STATUS == STD_ON<br>(CREQ-178459) | |
| Call context | |
| > ANY<br>> This function is Synchronous<br>> This function is Reentrant<br>> Availability: "CanGetStatus" is activated ("CAN_GET_STATUS == STD_ON") | |

Table 7-12 Can_GetControllerTxErrorCounter

### 7.2.12 Can_GetControllerMode

| Prototype | |
|---|---|
| `Std_ReturnType` **`Can_GetControllerMode`** `(uint8 Controller, Can_ControllerStatePtrType ControllerModePtr)` | |
| **Parameter** | |
| Controller [in] | Number of the controller requested for status information |
| ControllerModePtr [out] | Pointer to variable to store CAN controller's mode. Must not be NULL. |
| **Return code** | |
| Std_ReturnType | E_NOT_OK Controller mode is not available |
| Std_ReturnType | E_OK Controller mode is available |
| **Functional Description** | |
| Gets the mode of the given controller. | |
| **Particularities and Limitations** | |
| Configuration Variant(s): CAN_GET_STATUS == STD_ON<br>(CREQ-178460) | |
| Call context | |
| > ANY<br>> This function is Synchronous<br>> This function is Reentrant<br>> Availability: "CanGetStatus" is activated ("CAN_GET_STATUS == STD_ON") | |

Table 7-13 Can_GetControllerMode

### 7.2.13 Can_SetControllerMode

| **Prototype** | |
|---|---|
| `Can_ReturnType` **`Can_SetControllerMode`** `(uint8 Controller, Can_StateTransitionType Transition)` | |
| **Parameter** | |
| Controller [in] | Number of the controller to be set |
| Transition [in] | Requested transition to destination mode |
| **Return code** | |
| Can_ReturnType | > CAN_NOT_OK mode change unsuccessful<br>> CAN_OK mode change successful |
| **Functional Description** | |
| Change the controller mode to the following possible destination values:<br>CAN_T_START,<br>CAN_T_STOP,<br>CAN_T_SLEEP,<br>CAN_T_WAKEUP. | |
| **Particularities and Limitations** | |
| Called by CanInterface.<br>Interrupts locked by CanInterface | |
| Call context | |
| > Must not be called within CAN Driver context like RX, TX or Bus Off callouts.<br>> This function is Non-Reentrant<br>> Availability: Always | |

Table 7-14 Can_SetControllerMode

### 7.2.14 Can_ResetBusOffStart

| **Prototype** | |
|---|---|
| `void` **`Can_ResetBusOffStart`** `(uint8 Controller)` | |
| **Parameter** | |
| Controller [in] | Number of the controller |
| **Return code** | |
| void | - |
| **Functional Description** | |
| This is a compatibility function (for a CANbedded protocol stack) used during the start of the Bus Off handling to remove the Bus Off state. | |
| **Particularities and Limitations** | |
| Called by CAN Driver. | |

| | |
|---|---|
| | **Caution**<br>None AUTOSAR API |
| **Call context** | |
| > Called while BusOff event handling (Polling or Interrupt context).<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: Always | |

Table 7-15 Can_ResetBusOffStart

### 7.2.15 Can_ResetBusOffEnd

| **Prototype** | |
|---|---|
| `void Can_ResetBusOffEnd (uint8 Controller)` | |
| **Parameter** | |
| Controller [in] | Number of the controller |
| **Return code** | |
| void | - |
| **Functional Description** | |
| This is a compatibility function (for a CANbedded protocol stack) used during the end of the Bus Off handling to remove the Bus Off state. | |
| **Particularities and Limitations** | |
| Called by CAN Driver. | |
| | **Caution**<br>None AUTOSAR API |
| **Call context** | |
| > Called inside "Can_SetControllerMode()" while Start transition.<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: Always | |

Table 7-16 Can_ResetBusOffEnd

### 7.2.16 Can_Write

| **Prototype** | |
|---|---|
| `Can_ReturnType Can_Write (Can_HwHandleType Hth, Can_PduInfoPtrType PduInfo)` | |
| **Parameter** | |
| Hth [in] | Handle of the mailbox intended to send the message |

| | |
|---|---|
| PduInfo [in] | Information about the outgoing message (ID, dataLength, data) |
| **Return code** | |
| Can_ReturnType | > CAN_NOT_OK transmit unsuccessful<br>> CAN_OK transmit successful<br>> CAN_BUSY transmit could not be accomplished due to the controller is busy. |
| **Functional Description** | |
| Send a CAN message over CAN. | |
| **Particularities and Limitations** | |
| Called by CanInterface.<br>CAN Interrupt locked. | |
| Call context | |
| > Called by the CanInterface with at least disabled CAN interrupts.<br>> (Due to data security reasons the CanInterface has to accomplish this and thus it is not needed a further more in the CAN Driver.)<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: Always | |

Table 7-17 Can_Write

### 7.2.17 Can_CancelTx

| | |
|---|---|
| **Prototype** | |
| `void Can_CancelTx (Can_HwHandleType Hth, PduIdType PduId)` | |
| **Parameter** | |
| Hth [in] | Handle of the mailbox intended to be cancelled. |
| PduId [in] | Pdu identifier |
| **Return code** | |
| void | - |
| **Functional Description** | |
| Cancel the TX message in the hardware buffer (if possible) or mark the message as not to be confirmed in case of the cancellation is unsuccessful. | |
| **Particularities and Limitations** | |
| Called by CanTp or Application. | |
| | **Caution**<br>None AUTOSAR API |
| Call context | |
| > Called by CanTp or Application.<br>> This function is Synchronous | |

| |
|---|
| > This function is Non-Reentrant<br>> Availability: Always |

Table 7-18 Can_CancelTx

### 7.2.18 Can_SetMirrorMode

| Prototype | |
|---|---|
| `void **Can_SetMirrorMode** (uint8 Controller, CddMirror_MirrorModeType mirrorMode)` | |
| **Parameter** | |
| Controller [in] | CAN controller |
| mirrorMode [in] | Activate or deactivate the mirror mode. |
| **Return code** | |
| void | none |
| **Functional Description** | |
| Activate mirror mode.<br>Switch the Appl_GenericPreCopy/Confirmation function ON or OFF. | |
| **Particularities and Limitations** | |
| Configuration Variant(s): C_ENABLE_MIRROR_MODE (user configuration file) Called by "Mirror Mode" CDD.<br>None AUTOSAR API | |
| Call context | |
| > ANY<br>> This function is Synchronous<br>> This function is Non-Reentrant | |

Table 7-19 Can_SetMirrorMode

### 7.2.19 Can_SetSilentMode

| Prototype | |
|---|---|
| `Std_ReturnType **Can_SetSilentMode** (uint8 Controller, Can_SilentModeType silentMode)` | |
| **Parameter** | |
| Controller [in] | CAN controller |
| silentMode [in] | Activate or deactivate the silent mode with CAN_SILENT_ACTIVE, CAN_SILENT_INACTIVE (Enumeration) |
| **Return code** | |
| Std_ReturnType | E_OK mode change successful. |
| Std_ReturnType | E_NOT_OK mode change failed. |

| Functional Description |
|---|
| Activate or deactivate the Silent Mode.<br>Switch to Silent Mode, as a listen only mode without ACK, and deactivate this mode again for regular communication. |
| **Particularities and Limitations** |
| The CAN controller must be in Stop Mode.<br>Configuration Variant(s): CAN_SILENT_MODE == STD_ON |
| **Call context** |
| > TASK<br>> This function is Synchronous<br>> This function is Non-Reentrant |

Table 7-20 Can_SetSilentMode

### 7.2.20 Can_CheckWakeup

| Prototype | |
|---|---|
| `Std_ReturnType` **`Can_CheckWakeup`** `(uint8 Controller)` | |
| **Parameter** | |
| Controller [in] | Number of the controller to be checked for Wake Up events. |
| **Return code** | |
| Std_ReturnType | > E_OK the given controller caused a Wake Up before.<br>> E_NOT_OK the given controller caused no Wake Up before. |
| **Functional Description** | |
| Service function to check the occurrence of Wake Up events for the given controller<br>(used as Wake Up callback for higher layers). | |
| **Particularities and Limitations** | |
| Called by CanInterface. | |
| **Call context** | |
| > Called while Wakeup validation phase.<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: In AR4.x named "Can_CheckWakeup", in AR3.x named "Can_Cbk_CheckWakeup" (Name mapped by define) | |

Table 7-21 Can_CheckWakeup

### 7.2.21 Can_DisableControllerInterrupts

| Prototype |
|---|
| `void` **`Can_DisableControllerInterrupts`** `(uint8 Controller)` |

| Parameter | |
|---|---|
| Controller [in] | Number of the CAN controller to disable interrupts for. |
| **Return code** | |
| void | - |
| **Functional Description** | |
| Service function to disable the CAN interrupt for the given controller (e.g. due to data security reasons). | |
| **Particularities and Limitations** | |
| Called by SchM.<br>Must not be called while CAN controller is in Sleep Mode. | |
| Call context | |
| > Called within Critical Area handling or out of Application code.<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: Always | |

Table 7-22 Can_DisableControllerInterrupts

### 7.2.22 Can_EnableControllerInterrupts

| Prototype | |
|---|---|
| `void Can_EnableControllerInterrupts (uint8 Controller)` | |
| **Parameter** | |
| Controller [in] | Number of the CAN controller to disable interrupts for. |
| **Return code** | |
| void | - |
| **Functional Description** | |
| Service function to (re-)enable the CAN interrupt for the given controller (e.g. due to data security reasons). | |
| **Particularities and Limitations** | |
| Called by SchM.<br>Must not be called while CAN controller is in Sleep Mode. | |
| Call context | |
| > Called within Critical Area handling or out of Application code.<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: Always | |

Table 7-23 Can_EnableControllerInterrupts

### 7.2.23 Can_MainFunction_Write

| Prototype | |
|---|---|
| `void Can_MainFunction_Write (void)` | |
| **Parameter** | |
| - | |
| **Return code** | |
| void | - |
| **Functional Description** | |
| Service function to poll TX events (confirmation, cancellation) for all controllers and all TX mailboxes to accomplish the TX confirmation handling (like CanInterface notification). | |
| **Particularities and Limitations** | |
| Called by SchM.<br>Must not interrupt the call of "Can_Write()". | |
| Call context | |
| > Called within cyclic TX task.<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: Always | |

Table 7-24 Can_MainFunction_Write

### 7.2.24 Can_MainFunction_Read

| Prototype | |
|---|---|
| `void Can_MainFunction_Read (void)` | |
| **Parameter** | |
| - | |
| **Return code** | |
| void | - |
| **Functional Description** | |
| Service function to poll RX events for all controllers and all RX mailboxes to accomplish the RX indication handling (like CanInterface notification).<br>Also used for a delayed read (from task level) of the RX Queue messages which were queued from interrupt context. | |
| **Particularities and Limitations** | |
| Called by SchM. | |
| Call context | |
| > Called within cyclic RX task.<br>> This function is Synchronous | |

| |
|---|
| > This function is Non-Reentrant<br>> Availability: Always |

Table 7-25 Can_MainFunction_Read

### 7.2.25 Can_MainFunction_BusOff

| **Prototype** | |
|---|---|
| `void Can_MainFunction_BusOff (void)` | |
| **Parameter** | |
| - | |
| **Return code** | |
| void | - |
| **Functional Description** | |
| Polling of Bus Off events to accomplish the Bus Off handling. Service function to poll Bus Off events for all controllers to accomplish the Bus Off handling<br>(like calling of "CanIf_ControllerBusOff()" in case of Bus Off occurrence). | |
| **Particularities and Limitations** | |
| Called by SchM. | |
| Call context | |
| > Called within cyclic BusOff task.<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: Always | |

Table 7-26 Can_MainFunction_BusOff

### 7.2.26 Can_MainFunction_Wakeup

| **Prototype** | |
|---|---|
| `void Can_MainFunction_Wakeup (void)` | |
| **Parameter** | |
| - | |
| **Return code** | |
| void | - |
| **Functional Description** | |
| Service function to poll Wake Up events for all controllers to accomplish the Wake Up handling<br>(like calling of "CanIf_SetWakeupEvent()" in case of Wake Up occurrence). | |
| **Particularities and Limitations** | |
| Called by SchM. | |

| Call context |
|---|
| > Called within cyclic Wakeup task.<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: Always |

Table 7-27 Can_MainFunction_Wakeup

### 7.2.27 Can_MainFunction_Mode

| Prototype | |
|---|---|
| `void Can_MainFunction_Mode (void)` | |
| **Parameter** | |
| - | |
| **Return code** | |
| void | - |
| **Functional Description** | |
| Service function to poll Mode changes over all controllers.<br>(This is handled asynchronous if not accomplished in "Can_SetControllerMode()"). | |
| **Particularities and Limitations** | |
| Called by SchM. | |
| Call context | |
| > Called within cyclic mode change task.<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: MICROSAR4x only | |

Table 7-28 Can_MainFunction_Mode

### 7.2.28 Can_RamCheckExecute

| Prototype | |
|---|---|
| `void Can_RamCheckExecute (uint8 Controller)` | |
| **Parameter** | |
| Controller [in] | CAN controller to be checked. |
| **Return code** | |
| void | none |
| **Functional Description** | |
| Check the MCAN Message RAM. | |

| |
|---|
| Check all controller specific and mailbox specific registers by write patterns and read back. Issue notification will appear in this context. |
| **Particularities and Limitations** |
| Has to be called within STOP Mode.<br>Configuration Variant(s): CAN_RAM_CHECK == CAN_EXTENDED CREQ-106641 |
| Call context |
| > TASK<br>> This function is Synchronous<br>> This function is Non-Reentrant |

Table 7-29 Can_RamCheckExecute

### 7.2.29 Can_RamCheckEnableMailbox

| **Prototype** | |
|---|---|
| `void Can_RamCheckEnableMailbox (Can_HwHandleType htrh)` | |
| **Parameter** | |
| htrh [in] | CAN mailbox to be reactivated. |
| **Return code** | |
| void | none |
| **Functional Description** | |
| Reactivate a mailbox after RamCheck failed.<br>Mailbox will be reactivated by clearing the deactivation flag (see also [7]). | |
| **Particularities and Limitations** | |
| Has to be called within STOP Mode after RamCheck failed (controller is deactivated).<br>Must be followed by Can_RamCheckEnableController() to activate mailbox and controller.<br>Configuration Variant(s): CAN_RAM_CHECK == CAN_EXTENDED<br>CREQ-106641 | |
| Call context | |
| > TASK<br>> This function is Synchronous<br>> This function is Non-Reentrant | |

Table 7-30 Can_RamCheckEnableMailbox

### 7.2.30 Can_RamCheckEnableController

| **Prototype** | |
|---|---|
| `void Can_RamCheckEnableController (uint8 Controller)` | |
| **Parameter** | |
| Controller [in] | CAN controller to be reactivated. |

| Return code | |
|---|---|
| void | none |
| **Functional Description** | |
| Reactivate CAN cells after RamCheck failed.<br>CAN cell will be reactivated by execute reinitialization. | |
| **Particularities and Limitations** | |
| Has to be called within STOP Mode after RamCheck failed (controller is deactivated).<br>Configuration Variant(s): CAN_RAM_CHECK == CAN_EXTENDED<br>CREQ-106641 | |
| Call context | |
| > TASK<br>> This function is Synchronous<br>> This function is Non-Reentrant | |

Table 7-31 Can_RamCheckEnableController

### 7.2.31 Appl_GenericPrecopy

| Prototype | |
|---|---|
| `Can_ReturnType` **`Appl_GenericPrecopy`** `(uint8 Controller, Can_IdType ID, uint8 DataLength, Can_DataPtrType DataPtr)` | |
| **Parameter** | |
| Controller [in] | Controller which received the message |
| ID [in] | ID of the received message (include IDE,FD).<br>In case of extended or mixed ID systems the highest bit (bit 31) is set to mark an extended ID.<br>FD-bit (bit 30) can be masked out with user define CAN_ID_MASK_IN_GENERIC_CALLOUT. |
| DataLength [in] | Data length of the received message (read only). |
| pData [in] | Pointer to the data of the received message. |
| **Return code** | |
| Can_ReturnType | > CAN_OK Higher layer indication will be called afterwards (CanIf_RxIndication()).<br>> CAN_NOT_OK Higher layer indication will not be called afterwards. |
| **Functional Description** | |
| Application callback function which informs about all incoming RX messages including the contained data.<br>It can be used to block notification to upper layer. E.g. to filter incoming messages or route it for special handling. | |
| **Particularities and Limitations** | |
| Called by CAN Driver.<br>"pData" is read only and must not be accessed for further write operations. | |

| |
|---|
| The parameter DataLength refers to the received data length by the CAN controller hardware.<br>Note, that the CAN protocol allows the usage of data length values greater than eight (CAN-FD).<br>Depending on the implementation of this callback it may be necessary to consider this special case (e.g. if the data length is used as index value in a buffer write access). |
| **Caution**<br>None AUTOSAR API |
| **Call context** |
| > Called within CAN message reception context (Polling or Interrupt).<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: "CanGenericPrecopy" is activated ("CAN_GENERIC_PRECOPY == STD_ON"). |

Table 7-32 Appl_GenericPrecopy

### 7.2.32 Appl_GenericConfirmation

| **Prototype** | |
|---|---|
| `Can_ReturnType Appl_GenericConfirmation (PduIdType PduId)` | |
| **Parameter** | |
| PduId [in] | Handle of the PDU specifying the message. |
| **Return code** | |
| Can_ReturnType | > CAN_OK Higher layer confirmation will be called afterwards (CanIf_TxConfirmation()).<br>> CAN_NOT_OK Higher layer confirmation will not be called afterwards. |
| **Functional Description** | |
| Application callback function which informs about TX messages being sent to the CAN bus. | |
| **Particularities and Limitations** | |
| Called by CAN Driver.<br>"PduId" is read only and must not be accessed for further write operations. | |
| **Caution**<br>None AUTOSAR API | |
| **Call context** | |
| > Called within CAN message transmission finished context (Polling or Interrupt).<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: "CanGenericConfirmation" is activated ("CAN_GENERIC_CONFIRMATION == STD_ON") & "CanIfTransmitBuffer" activated (in CanInterface). | |

Table 7-33 Appl_GenericConfirmation

### 7.2.33 Appl_GenericConfirmation

| **Prototype** | |
|---|---|
| `Can_ReturnType` **`Appl_GenericConfirmation`** `(uint8 Controller, Can_PduInfoPtrType DataPtr)` | |
| **Parameter** | |
| Controller [in] | CAN controller which send the message. |
| DataPtr [in] | Pointer to a Can_PduType structure including ID (include IDE,FD), DataLength, PDU and data pointer. |
| **Return code** | |
| Can_ReturnType | CAN_OK Higher layer (CanInterface) confirmation will be called.<br>CAN_NOT_OK No further higher layer (CanInterface) confirmation will be called. |
| **Functional Description** | |
| Application callback function which informs about TX messages being sent to the CAN bus.<br>It can be used to block confirmation or route the information to other layers as well. | |
| **Particularities and Limitations** | |
| Called by CAN Driver.<br>A new transmission within this call out will corrupt the DataPtr context.<br>If "Generic Confirmation" and "Transmit Buffer" (both set in CanInterface) are active, then the switch "Cancel Support Api" is also needed (also set in CanIf), otherwise a compiler error occurs. | |
| **Caution**<br>None AUTOSAR API | |
| Call context | |
| > Called within CAN message transmission finished context (Polling or Interrupt).<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: "CanGenericConfirmation" is set to API2 ("CAN_GENERIC_CONFIRMATION == CAN_API2"). | |

Table 7-34 Appl_GenericConfirmation

### 7.2.34 Appl_GenericPreTransmit

| **Prototype** | |
|---|---|
| `void` **`Appl_GenericPreTransmit`** `(uint8 Controller, Can_PduInfoPtrType_var DataPtr)` | |
| **Parameter** | |
| Controller [in] | CAN controller on which the message will be send. |
| DataPtr [in] | Pointer to a Can_PduType structure including ID (include IDE,FD), DataLength, PDU and data pointer. |
| **Return code** | |
| void | - |

| Functional Description |
|---|
| Application callback function allowing the modification of the data to be transmitted (e.g.: add CRC). |
| **Particularities and Limitations** |
| Called by CAN Driver. |
| **Caution**<br>None AUTOSAR API |
| Call context |
| > Called within "Can_Write()".<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: "CanGenericPretransmit" is activated ("CAN_GENERIC_PRETRANSMIT == STD_ON"). |

Table 7-35 Appl_GenericPreTransmit

### 7.2.35 ApplCanTimerStart

| Prototype | |
|---|---|
| `void ApplCanTimerStart (CanChannelHandle Controller, uint8 source)` | |
| **Parameter** | |
| Controller [in] | Number of the controller on which the hardware observation takes place.<br>(only if not using "Optimize for one controller") |
| source [in] | Source for the hardware observation (see chapter Hardware Loop Check / Timeout Monitoring). |
| **Return code** | |
| void | - |
| **Functional Description** | |
| Service function to start an observation timer (see chapter Hardware Loop Check / Timeout Monitoring). | |
| **Particularities and Limitations** | |
| Called by CAN Driver. | |
| **Caution**<br>None AUTOSAR API | |
| Call context | |
| > For context information please refer to chapter "Hardware Loop Check".<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: "CanHardwareCancelByAppl" is activated ("CAN_HW_LOOP_SUPPORT_API == STD_ON"). | |

Table 7-36 ApplCanTimerStart

### 7.2.36 ApplCanTimerLoop

| Prototype | |
|---|---|
| `Can_ReturnType **ApplCanTimerLoop** (CanChannelHandle Controller, uint8 source)` | |
| **Parameter** | |
| Controller [in] | Number of the controller on which the hardware observation takes place.<br>(only if not using "Optimize for one controller") |
| source [in] | Source for the hardware observation (see chapter Hardware Loop Check / Timeout Monitoring). |
| **Return code** | |
| Can_ReturnType | > CAN_NOT_OK when loop shall be broken (observation stops)<br>> CAN_NOT_OK should only be used in case of a timeout occurs due to a hardware issue.<br>> After this an appropriate error handling is needed (see chapter Hardware Loop Check / Timeout Monitoring).<br>> CAN_OK when loop shall be continued (observation continues) |
| **Functional Description** | |
| Service function to check (against generated max loop value) whether a hardware loop shall be continued or broken. | |
| **Particularities and Limitations** | |
| Called by CAN Driver. | |
| ⚠ | **Caution**<br>None AUTOSAR API |
| Call context | |
| > For context information please refer to chapter "Hardware Loop Check".<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: "CanHardwareCancelByAppl" is activated ("CAN_HW_LOOP_SUPPORT_API == STD_ON"). | |

Table 7-37 ApplCanTimerLoop

### 7.2.37 ApplCanTimerEnd

| Prototype | |
|---|---|
| `void **ApplCanTimerEnd** (CanChannelHandle Controller, uint8 source)` | |
| **Parameter** | |
| Controller [in] | Number of the controller on which the hardware observation takes place.<br>(only if not using "Optimize for one controller") |
| source [in] | Source for the hardware observation (see chapter Hardware Loop Check / Timeout Monitoring). |

| Return code | |
|---|---|
| void | - |
| **Functional Description** | |
| Service function to to end an observation timer (see chapter Hardware Loop Check / Timeout Monitoring). | |
| **Particularities and Limitations** | |
| Called by CAN Driver. | |
| **Caution**<br>None AUTOSAR API | |
| Call context | |
| > For context information please refer to chapter "Hardware Loop Check".<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: "CanHardwareCancelByAppl" is activated ("CAN_HW_LOOP_SUPPORT_API == STD_ON"). | |

Table 7-38 ApplCanTimerEnd

### 7.2.38 ApplCanInterruptDisable

| Prototype | |
|---|---|
| `void ApplCanInterruptDisable (uint8 Controller)` | |
| **Parameter** | |
| Controller [in] | Number of the controller for the CAN interrupt lock. |
| **Return code** | |
| void | - |
| **Functional Description** | |
| Service function to support the disabling of CAN Interrupts by the application.<br>E.g.: the CAN Driver itself should not access the common Interrupt Controller due to application specific restrictions (like security level etc.). Or the application like to be informed because of an CAN interrupt lock. | |
| **Particularities and Limitations** | |
| Called by CAN Driver. | |
| **Caution**<br>None AUTOSAR API | |
| Call context | |
| > Called by the CAN Driver within "Can_DisableControllerInterrupts()".<br>> This function is Synchronous<br>> This function is Non-Reentrant | |

| | |
|---|---|
| > Availability: "CanInterruptLock" is set to APPL or BOTH ("CAN_INTLOCK == CAN_APPL" or "CAN_INTLOCK == CAN_BOTH"). | |

Table 7-39 ApplCanInterruptDisable

### 7.2.39 ApplCanInterruptRestore

| **Prototype** | |
|---|---|
| `void ApplCanInterruptRestore (uint8 Controller)` | |
| **Parameter** | |
| Controller [in] | Number of the controller for the CAN interrupt unlock. |
| **Return code** | |
| void | - |
| **Functional Description** | |
| Service function to support the enabling of CAN Interrupts by the application.<br>E.g.: the CAN Driver itself should not access the common Interrupt Controller due to application specific restrictions (like security level etc.). Or the application like to be informed because of an CAN interrupt lock. | |
| **Particularities and Limitations** | |
| Called by CAN Driver. | |
| | **Caution**<br>None AUTOSAR API |
| Call context | |
| > Called by the CAN Driver within "Can_EnableControllerInterrupts()".<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: "CanInterruptLock" is set to APPL or BOTH ("CAN_INTLOCK == CAN_APPL" or "CAN_INTLOCK == CAN_BOTH"). | |

Table 7-40 ApplCanInterruptRestore

### 7.2.40 Appl_CanOverrun

| **Prototype** | |
|---|---|
| `void Appl_CanOverrun (uint8 Controller)` | |
| **Parameter** | |
| Controller [in] | Number of the controller for which the overrun was detected. |
| **Return code** | |
| void | - |

| Functional Description | |
|---|---|
| This function will be called when an overrun is detected for a BasicCAN mailbox.<br>Alternatively, a DET call can be selected instead of ("CanOverrunNotification" is set to "DET"). | |
| **Particularities and Limitations** | |
| Called by CAN Driver. | |
| | **Caution**<br>None AUTOSAR API |
| **Call context** | |
| > Called within CAN message reception or error detection context (Polling or Interrupt).<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: "CanOverrunNotification" set to APPL ("CAN_OVERRUN_NOTIFICATION == CAN_APPL"). | |

Table 7-41 Appl_CanOverrun

### 7.2.41 Appl_CanFullCanOverrun

| Prototype | |
|---|---|
| `void Appl_CanFullCanOverrun (uint8 Controller)` | |
| **Parameter** | |
| Controller [in] | Number of the controller for which the overrun was detected. |
| **Return code** | |
| void | - |
| **Functional Description** | |
| This function will be called when an overrun is detected for a FullCAN mailbox.<br>Alternatively a DET call can be selected instead of ("CanOverrunNotification" is set to "DET"). | |
| **Particularities and Limitations** | |
| Called by CAN Driver. | |
| | **Caution**<br>None AUTOSAR API |
| **Call context** | |
| > Called within CAN message reception or error detection context (Polling or Interrupt).<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: "CanOverrunNotification" set to APPL ("CAN_OVERRUN_NOTIFICATION == CAN_APPL"). | |

Table 7-42 Appl_CanFullCanOverrun

### 7.2.42 Appl_CanCorruptMailbox

| Prototype | |
|---|---|
| `void Appl_CanCorruptMailbox (uint8 Controller, Can_HwHandleType hwObjHandle)` | |
| **Parameter** | |
| Controller [in] | Number of the controller for which the check failed. |
| hwObjHandle [in] | Hardware handle of the defect mailbox. |
| **Return code** | |
| void | - |
| **Functional Description** | |
| This function will notify the application (during "Can_InitController()") about a defect mailbox within the CAN cell. | |
| **Particularities and Limitations** | |
| Called by CAN Driver. | |
| **Caution**<br>None AUTOSAR API | |
| **Call context** | |
| > Call within controller initialization.<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: "CanRamCheck" set to "MailboxNotifiation" ("CAN_RAM_CHECK == CAN_NOTIFY_MAILBOX"). | |

Table 7-43 Appl_CanCorruptMailbox

### 7.2.43 Appl_CanRamCheckFailed

| Prototype | |
|---|---|
| `uint8 Appl_CanRamCheckFailed (uint8 Controller)` | |
| **Parameter** | |
| Controller [in] | Number of the controller for which the check failed |
| **Return code** | |
| uint8 | > action With this "action" the application can decide how to proceed with the initialization.<br>> CAN_DEACTIVATE_CONTROLLER - deactivate the controller<br>> CAN_ACTIVATE_CONTROLLER - activate the controller |
| **Functional Description** | |
| This function will notify the application (during "Can_InitController()") about a defect CAN controller due to a previous failed mailbox check. | |

| Particularities and Limitations | |
|---|---|
| Called by CAN Driver. | |
| | **Caution**<br>None AUTOSAR API |
| Call context | |
| > Call within controller initialization.<br>> This function is Synchronous<br>> This function is Non-Reentrant<br>> Availability: "CanRamCheck" set to "Active" or "MailboxNotification" ("CAN_RAM_CHECK != CAN_NONE"). | |

Table 7-44 Appl_CanRamCheckFailed

### 7.2.44 ApplCanInitPostProcessing

| Prototype | |
|---|---|
| void **ApplCanInitPostProcessing** (CAN_HW_CHANNEL_CANTYPE_ONLY) | |
| **Parameter** | |
| Controller [in] | Number of the controller for which the check failed |
| **Return code** | |
| void | none |
| **Functional Description** | |
| Service function to<br>a) overwrite the previously set initialization values for the bit timing, taken from the generated data, with customer specific values:<br>For your convenience, the following access macros are supported:<br>- **CanBtpReg**(controller): the (N)BTP register of the specified CAN channel can be set according to the register definition (see Hardware Manufacturer Document in ch. 2).<br>Example: CanBtpReg(Controller) = 0x00070F70u;<br>or CanBtpReg(0) = 0x00070F70u; (when using 'Optimize for one controller').<br>- **CanCRelReg**(controller): the CREL register of the specified CAN channel can be read according to the register definition (see Hardware Manufacturer Document in ch. 2).<br>- **CanGetMcanRevision**(controller): the CREL register of the specified CAN channel is read and the release information (Version, Step and Sub Step) is returned as a vuint16 type.<br><br>b) bypass or configure the CAN Calibration Unit (CCCU) where available:<br>The CCCU is only available when using SPC58xx derivatives. Within this callback you are requested toeither configure or bypass the CCCU. If so, you must assure by your configuration that the first CAN channel being initialized is „MCAN_2“(Base Address 0xF7EE8000).<br>Example (for SPC58EC80):<br>`// CCCR INIT and CCE bits aleady set by CAN Driver during` | |

```
      initialization
    CCCU.CCFG |= 0x00000040ul;    // CCFG.BCC = „1“ Bypass CCCU
    MCAN.CCCR &= 0xFFFFFFFBul;    // CCCR.ASM = „0“ Reset Restricted Mode
```

**Particularities and Limitations**

Called by CAN Driver at the end of the CAN Driver initialization.

none

**Caution**

None AUTOSAR API

It is the responsibility of the application to assure that the register values are consistent with the release of the underlying derivative.

Call context

> Called within controller initialization.
> This function is Synchronous
> This function is Non-Reentrant
> Availability: Only available if 'C_ENABLE_INIT_POST_PROCESS' is defined via a user-config file.

Table 7-45 ApplCanInitPostProcessing

## 7.3 Services used by CAN

In the following table services provided by other components, which are used by the CAN are listed. For details about prototype and functionality refer to the documentation of the providing component.

| Component | API |
|---|---|
| DET | **Det_ReportError**<br>(see “Development Error Reporting”) |
| DEM | **Dem_ReportErrorStatus**<br>(see “Production Code Error Reporting”) |
| EcuM | **EcuM_CheckWakeup**<br>This function is called when Wakeup over CAN bus occur.<br>**EcuM_GeneratorCompatibilityError**<br>This function is called during the initialization, of the CAN Driver if the Generator Version Check or the CRC Check fails. (see [5]) |
| Application (optional non AUTOSAR) | **Appl_GenericPrecopy**<br>**Appl_GenericConfirmation**<br>**Appl_GenericPreTransmit**<br>**ApplCanTimerStart/Loop/End**<br>**Appl_CanRamCheckFailed, Appl_CanCorruptMailbox**<br>**ApplCanInterruptDisable/Restore**<br>**Appl_CanOverrun**<br>For detailed description see Chapter 7.2 |

| | |
|---|---|
| CANIF | **CanIf_CancelTxNotification** (non AUTOSAR)<br>A special Software cancellation callback only used within Vector CAN Driver CAN Interface bundle.<br>**CanIf_TxConfirmation**<br>Notification for a successful transmission. (see [4])<br>**CanIf_CancelTxConfirmation**<br>Notification for a successful Tx cancellation. (see [4])<br>**CanIf_RxIndication**<br>Notification for a message reception. (see [4])<br>**CanIf_ControllerBusOff**<br>Bus Off notification function. (see [4])<br>**CanIf_ControllerModeIndication**<br>MICROSAR4x only: Notification for mode sucessfully changed.<br>**CanIf_RamCheckCorruptMailbox**<br>Notification if RAM check detects a corrupt mailbox.<br>**CanIf_RamCheckCorruptController**<br>Notification if RAM check detects a corrupt CAN channel. |
| Os (MICROSAR4x) | **OS_TICKS2MS_<counterShortName>()**<br>Os macro to get timebased ticks from counter.<br>**GetElapsedValue**<br>Get elapsed tick count.<br>**GetCounterValue**<br>Get tick count start. |

Table 7-46 Services used by the CAN

# 8 Configuration

For CAN driver the attributes can be configured with configuration tool “CFG5”. The CAN Driver supports pre-compile, link-time and post-build configuration. For post-build systems, re-flashing the generated data can change some configuration settings. For post-build and link-time configurations pre-compile settings are configured at compile time and therefore unchangeable at link or post-build time.

The following parameters are set by CFG5 configuration.

## 8.1 Pre-Compile Parameters

Settings have to be available before compilation:

> Version API (Can_GetVersionInfo() activation)
```
#define CAN_VERSION_INFO_API          STD_ON/STD_OFF
```
> DET (development error detection)
```
#define CAN_DEV_ERROR_DETECT          STD_ON/STD_OFF
```
> Hardware Loop Check (timeout monitoring)
```
#define CAN_HARDWARE_CANCELLATION     STD_ON/STD_OFF
```
> Polling modes: Tx confirmation, Reception, Wakeup, BusOff
```
#define CAN_TX_PROCESSING   CAN_INTERRUPT/CAN_POLLING
#define CAN_RX_PROCESSING CAN_INTERRUPT/CAN_POLLING
#define CAN_BUSOFF_PROCESSINGCAN_INTERRUPT/CAN_POLLING
#define CAN_WAKEUP_PROCESSINGCAN_INTERRUPT/CAN_POLLING
#define CAN_INDIVIDUAL_PROCESSING     STD_ON/STD_OFF
```
> Multiplexed Tx (external PIA – by usage of multiple Tx mailboxes)
```
#define CAN_MULTIPLEXED_TRANSMISSION   STD_ON/STD_OFF
```
> Configuration Variant (define the configuration type when using post build variant)
```
#define CAN_ENABLE_SELECTABLE_PB
```
> Use Generic Precopy Function (None AUTOSAR feature)
```
#define CAN_GENERIC_PRECOPY           STD_ON/STD_OFF
```
> Use Generic Confirmation Function (None AUTOSAR feature)
```
#define CAN_GENERIC_CONFIRMATION       STD_ON/STD_OFF
```
> Use Rx Queue Function (None AUTOSAR feature)
```
#define CAN_RX_QUEUE              STD_ON/  (not supported)
                                  STD_OFF
```
> Used ID type (standard/extended or mixed ID format)
```
#define CAN_EXTENDED_ID              STD_ON/STD_OFF
#define CAN_MIXED_ID                 STD_ON/STD_OFF
```
> Usage of Rx and Tx Full and BasicCAN objects (deactivate only when not using and to save ROM and runtime consumption)
```
#define CAN_RX_FULLCAN_OBJECTS           STD_ON/STD_OFF
#define CAN_TX_FULLCAN_OBJECTS           STD_ON/STD_OFF
#define CAN_RX_BASICCAN_OBJECTS          STD_ON/STD_OFF
```
> Use Multiple BasicCAN objects
```
#define CAN_MULTIPLE_BASICCAN              STD_ON/STD_OFF
```
> Optimizations

```
#define CAN_ONE_CONTROLLER_OPTIMIZATION STD_ON/STD_OFF
#define CAN_DYNAMIC_FULLCAN_ID          STD_ON/STD_OFF
```

> Usage of nested CAN interrupts

```
#define CAN_NESTED_INTERRUPTS           STD_ON/STD_OFF
```

> Use Multiple ECU configurations

```
#define CAN_MULTI_ECU_CONFIG             STD_ON/STD_OFF
```

> Use RAM Check (verify mailbox buffers)

```
#define CAN_RAM_CHECK          CAN_NONE/
                                        CAN_NOTIFY_ISSUE/
                                        CAN_NOTIFY_MAILBOX
```

> Use Overrun detection

```
#define CAN_OVERRUN_NOTIFICATION      CAN_NONE/
                                                CAN_DET/
                                                CAN_APPL
```

> Tx Cancellation of Identical IDs

```
#define CAN_IDENTICAL_ID_CANCELLATION     STD_ON/STD_OFF
```

## 8.2 Link-Time Parameters

The library version of the CAN Driver uses the following generated settings:

- Maximum amount of used controllers and Tx mailboxes (has to be set for post-build variants at link-time)
- Rx Queue size
- Controller mapping (mapping of logical channel to hardware node).
- CAN hardware base address.

## 8.3 Post-Build Parameters

Following settings are post-build data that can be changed for re-flashing:

- Amount and usage of FullCAN Rx and Tx mailboxes
- Used database (message information like ID, DLC)
- Filters for BasicCAN Rx mailbox
- Baud-rate settings
- Module Start Address (only for post-build systems: The memory location for re-flashed data has to be defined)
- Configuration ID (only for post-build systems: This number is used to identify the post-build data
- CAN hardware Fifo depth

> CAN hardware clock and bit timing settings

## 8.4 Configuration with da DaVinci Configurator

See Online help within DaVinci Configurator and BSWMD file for parameter settings.

**Caution**
Since the Generation Tool does not know which MCAN Hardware Revision for the selected derivative you are actually using, this has to be specified in addition.

Please see below the supported values for the different hardware revisions:

MCAN_REV_10: MCAN Release 1, no CAN-FD support, no Rx FullCAN support
MCAN_REV_20: MCAN Release 2, CAN-FD support with higher bitrates
MCAN_REV_30: MCAN Release 3, CAN-FD support with higher bitrates and extended data length
MCAN_REV_310: MCAN Release 3, Step 1, SubStep 0, non-compatibility change to previous revisions
MCAN_REV_315: MCAN Release 3, Step 1, SubStep 5, CAN-FD support with ISO-11898-1 compatibility

The MCAN Revisions 3.2.x are compatible with MCAN_REV_315 and thus not mentioned separately.

# 9 AUTOSAR Standard Compliance

## 9.1 Limitations / Restrictions

| Category | Description | Version |
|---|---|---|
| Functional | No multiple AUTOSAR CAN driver allowed in the system | 3.0.6 |
| Functional | No support for L-PDU callout (AUTOSAR 3.2.1), but support 'Generic Precopy' instead | 3.2.1 |
| Functional | No support for multiple read and write period configuration | 3.2.1 |
| API | "Symbolic Name Values" may change their values after precompile phase so do not use it for Link Time or Post Build variants.<br>It's recommended that higher layer generator use Values (ObjectIDs) from EcuC file. Vector CAN Interface does so. | 3.0.6 |
| | For the acceptance filtering a maximum of 64 filters per CAN channel is supported in case of GENy is used as Generation Tool. | |

## 9.2 Hardware Limitations

### 9.2.1 Tx side

MCAN Tx Event FIFO is not supported.

MCAN Tx Queue is not supported.

All available buffers per CAN (32) are configured as dedicated Tx buffers.

### 9.2.2 Rx side

SREQ00014271 "message reception shall use overwrite mode" is not fulfilled for FullCAN messages due to hardware behaviour.

### 9.2.3 Used resources

Please note that the theoretical possible maximum configuration for the derivatives often requires more RAM space in the Shared Message RAM than there is actual available.

For each CAN channel the following elements can be configured. If the required size for a distinct configuration exceeds the maximum available RAM space in hardware then the configuration tool issues an error during generation time and you are requested to tailor down your configuration until it fits into the available Shared Message RAM.

Resource usage for one CAN channel:

| Area | Address range | Max size (byte) | Max. number of elements |
|---|---|---|---|
| Std Filter | 0x0000 – 0x01FF | 512 | 128 |
| Ext Filter | 0x0200 – 0x03FF | 512 | 64 |
| Rx FIFO 0 | 0x0400 – 0x07FF | 1024 | 64 |
| Rx FIFO 1 | 0x0800 – 0x0BFF | 1024 | 64 |
| Rx Buffer | 0x0C00 – 0x0FFF | 1024 | 64 |
| TxEvt FIFO | 0x1000 – 0x10FF | 256 | 32 |

| | | | |
|---|---|---|---|
| Tx buffer | 0x1100 – 0x12FF | 512 | 32 |
| | 0x1300 | **4864** bytes total | |

Thus a maximum of 24320 bytes (4864 * 5) can theoretically be configured but less RAM is physically available (e.g.: 16 KByte per CAN channel). You are requested to reduce the areas according to your needs.

Please note that in case of CAN-FD with data lengths greater than 8 data bytes corresponding Message RAM sizes have to be taken into consideration.

Please note that the “Tx Buffer region” and the “TTCAN region” (for channels with TTCAN support) for each channel is restricted to a dedicated address.

This is not consistent for all hardware releases, please refer to your hardware manufacturer documentation (see ch. 2 “Hardware Overview”).

### 9.2.4 Initialization of the CAN Message RAM

The internal SRAM features Error Correcting Code (ECC). Because these ECC bits can contain random data after the device is turned on, all SRAM locations must be initialized before being read by application code. Initialization is done by executing 64-bit writes to the entire SRAM block. The value written does not matter at this point, so the Store Multiple Word instruction will be used to write 16 general-purpose registers with each loop iteration.

By default the CAN Driver tries to accomplish this initialization. Due to the need of using assembler code notation it might happen that specific options for a distinct compiler (assembler) are not appropriate. If so, you can feel free to disable the CAN Driver internal initialization (see below on how to) and use your own initialization instead of.

To disable the CAN Driver internal initialization use a “User Config File” containing the following preprocessor definition:

```
#define CAN_ECC_INIT      STD_OFF
```

Put your initialization into execution just before calling Can_Init(). The MCAN clock must be available at this point of time.

Please refer to your hardware manufacturer documentation (see ch. 2 “Hardware Overview”) for the address layout.

## 9.3 Vector Extensions

Refer to Chapter “Features ” listed under “**AUTOSAR extensions**”

# 10 Glossary and Abbreviations

## 10.1 Glossary

| Term | Description |
|---|---|
| GENy | Generation tool for CANbedded and MICROSAR components |
| High End (license) | Product license to support an extended feature set (see Feature table) |

Table 10-1 Glossary

## 10.2 Abbreviations

| Abbreviation | Description |
|---|---|
| API | Application Programming Interface |
| AUTOSAR | Automotive Open System Architecture |
| BSW | Basis Software |
| DEM | Diagnostic Event Manager |
| DET | Development Error Tracer |
| ECU | Electronic Control Unit |
| HIS | Hersteller Initiative Software |
| ISR | Interrupt Service Routine |
| MICROSAR | Microcontroller Open System Architecture (the Vector AUTOSAR solution)<br>3.3x = AUTOSAR version 3<br>401 = AUTOSAR version 4.0.1<br>403 = AUTOSAR version 4.0.3<br>4x = AUTOSAR version 4.x.x |
| SWS | Software Specification |
| Common CAN | Connect two physical peripheral channels to one CAN bus (to increase the amount of FullCAN objects) |
| Hardware Loop Check | Timeout monitoring for possible endless loops. |

Table 10-2 Abbreviations

# 11 Contact

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