



MCAL ICU Module Software Design Document

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- Signal Measurements API Design flow
- Testing Guidelines
- Template Revision History



1 Revision History

Version	Date	Author	Document Status	Comments
0.1	21 Apr 2022	Achalla Surya Bharath	DONE	Page creation and format updates
0.2	22 Apr 2022	Achalla Surya Bharath	DONE	Document Updates with Introduction and overview
0.3	25 Apr 2022	Achalla Surya Bharath	DONE	Updated section "Development Errors" to include requirement mapping
0.4	26 Apr 2022	Achalla Surya Bharath	DONE	Updated section "Driver Api's and Decision Analysis Review"
0.5	27 Apr 2022	Achalla Surya Bharath	DONE	Updated Design Id with description
0.6	18 May 2022	Achalla Surya Bharath	DONE	Updated diagrams , Sec 5.5 and other review comments



Version	Date	Author	Document Status	Comments
0.7	25 May 2022	Achalla Surya Bharath	DONE	Updated Safety Diagnostic API's and other review comments
v.65	09 Jun 2022	Achalla Surya Bharath	DONE	Added Comala Workflow



2 Terms and Abbreviations

Abbreviation / Term	Meaning / Explanation
ICU	Input Capture Unit
AUTOSAR	AUTomotive Open System ARchitecture
RTE	Runtime Environment
BSW	Basic Software
MCAL	MicroController Abstraction Layer
SBL	Serial Bootloader
API	Application Programming Interface
DET	Default Error Tracer



Abbreviation / Term	Meaning / Explanation
DEM	Diagnostic Event Manager – module to handle diagnostic relevant events.
ECU	Electronic Control Unit
MCU	Micro Controller Unit
OS	Operating System
SoC	System on a Chip
DAR	Decision Analysis and Resolution

3 Introduction

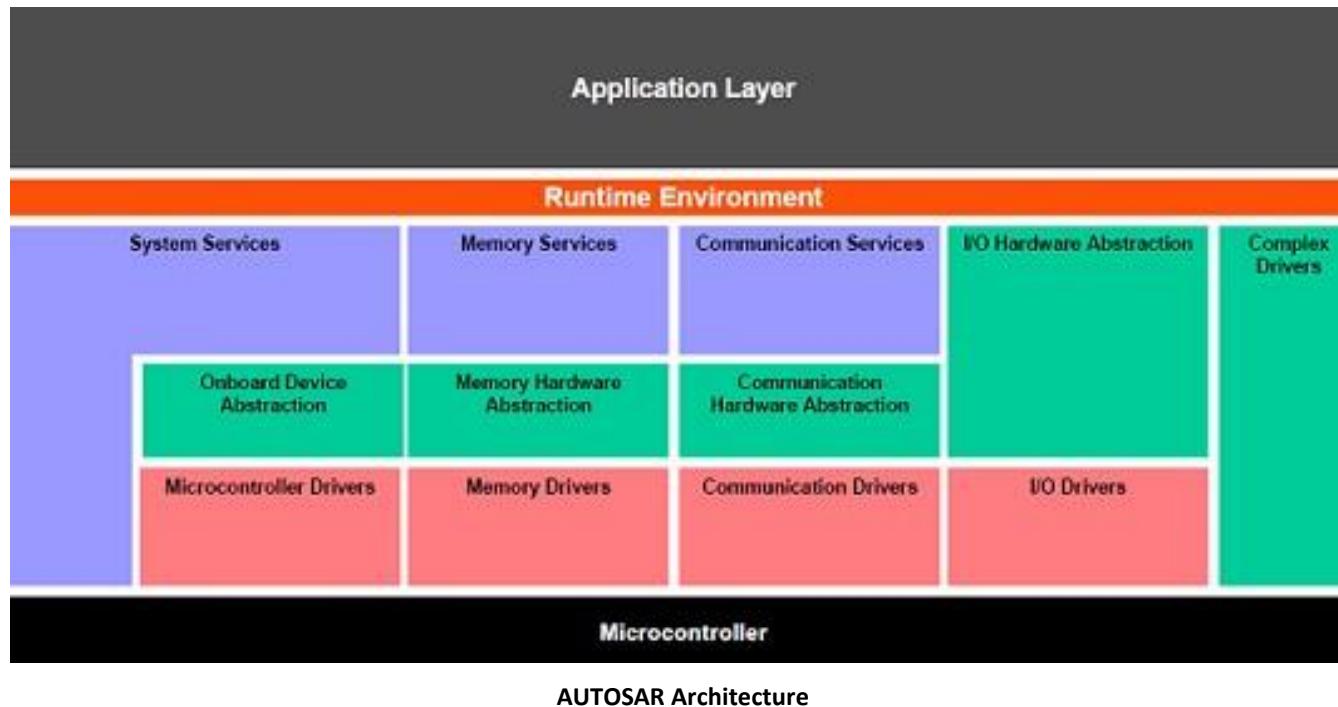
3.1 Overview

The figure below depicts the AUTOSAR layered architecture as 3 distinct layers,

- Application
- Runtime Environment (RTE) and
- Basic Software (BSW).

The BSW is further divided into 4 layers:

- Services
- Electronic Control Unit Abstraction • MicroController Abstraction (MCAL) and
- Complex Drivers.



MCAL is the lowest abstraction layer of the Basic Software. It contains internal drivers that are software modules that interact with the Microcontroller and its internal peripherals directly. ICU driver will use ECAP (Enhanced Capture) hardware IP for demodulation of a PWM signal, counting pulses, measuring of frequency and duty cycle and generating simple interrupts.

3.2 Purpose and Scope

The Detailed Design document provides the design details of ICU driver and aims to provide a guide to a design that could be implemented by a software developer. The scope of this document is to describe the software design procedure of ICU module.

3.3 Module Overview

The Icu driver uses ECAP module to capture events. There are three ECAP instances available to work with (ECAP0 - ECAP2) on J721E and J7200. The Icu driver provides the following features:

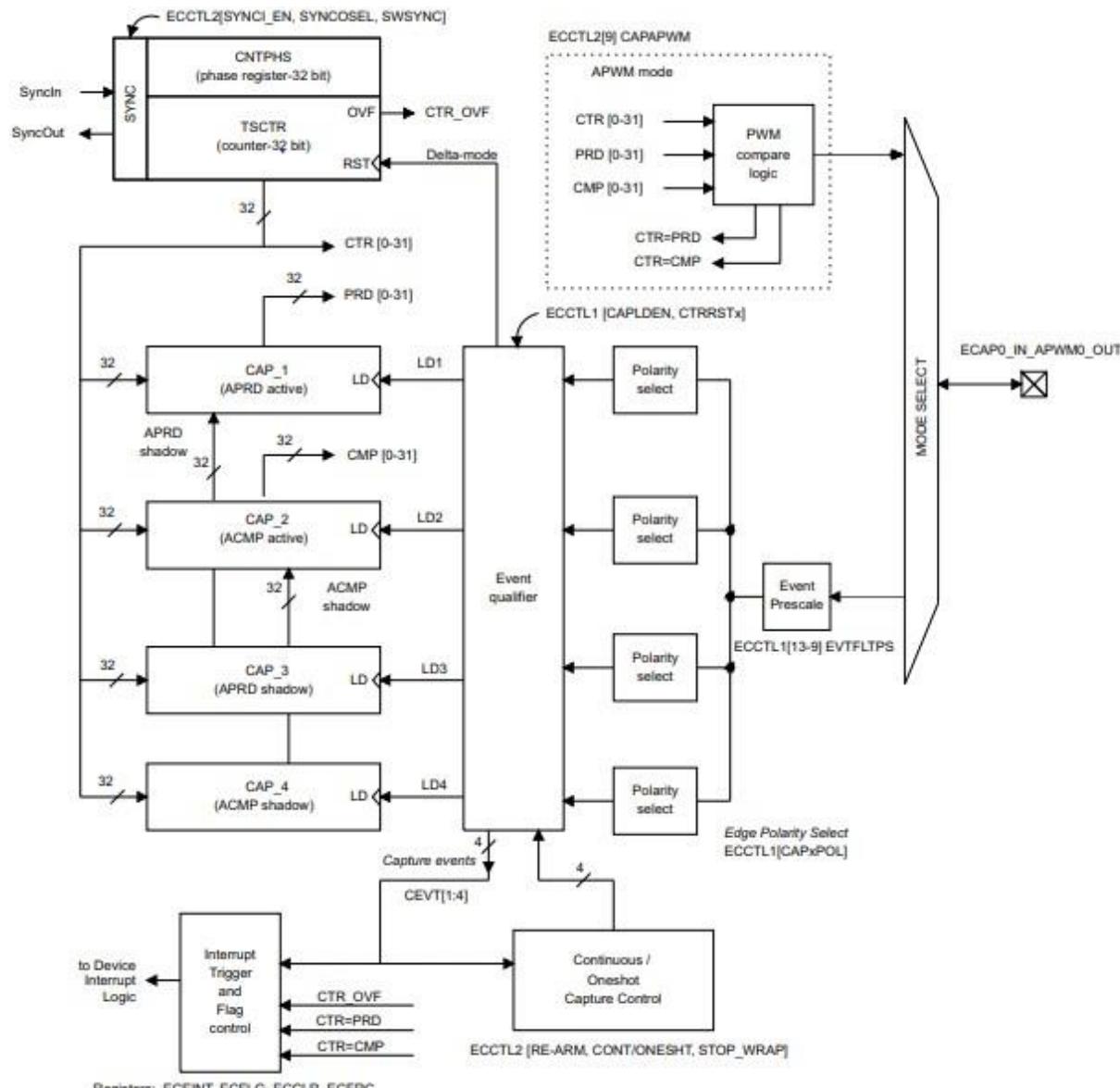
- Signal Measurements - High time, Low time, Period time, Duty cycle
 - Edge Detection - Provide notification for each edge detected
 - Edge Counting - Measure edge counts
 - Edge Timestamping - Measure the absolute time when edges occur
- The hardware ECAP module includes the following features:
- 32-bit time base Counter
 - 4x32 event time-stamp capture Registers
 - Interrupt capability for capture events
 - Absolute time-stamp capture
 - Difference (Delta) mode time-stamp capture
 - All above resources dedicated to a single input pin



Please note that this is just for reference purpose, for other details please refer to technical reference manual. Note that not all feature available in ECAP hardware IP are currently supported by ICU driver.

It uses hardware IP "ecap_10_rel.1.0.x" .Refer to SoC User Manual for specific details.





3.4 Requirements

The ICU driver shall implement as per requirements detailed in [References 1 - AUTOSAR 4.3.1](#).

3.4.1 Features Supported

- Capture Functionality using the ECAP module.
- Edge polarity (activation) setting.
- Enabling of Development Error Detection and Runtime Error Detection.

3.4.2 Features Not Supported / NON Compliance

- [NON Compliance] Hardware does not support wakeup capability. Hence, the below features are not supported.
- Controlling Wakeup interrupts.
- Icu_SetMode()
- Icu_DisableWakeup()
- Icu_EnableWakeup()
- Icu_CheckWakeup()

3.5 Assumptions

Below listed points are assumed to be valid for this design/implementation, exceptions and other deviations are listed for each explicitly. Care should be taken to ensure these assumptions are addressed.



1. The functional clock to the Icu module is expected to be ON before calling any Icu service APIs. The Icu driver doesn't perform any programming to enable the module functional clock. The default functional clock is 125Mhz.
2. Interrupt configuration for Icu interrupt registration should be done by application. Refer to example application for reference.
3. The Icu module depends on the system clock, prescalers and PLL.

3.6 Hardware and SW platforms

Hardware Platforms

- Refer to specified SoC User Manual to check if ICU module is supported. **Software Platforms**
- Bare-Metal

3.7 Dependencies

DET

This implementation depends on the DET in order to report development errors and can be turned OFF. Refer section for detailed error codes.

SchM

This implementation requires 1 level of exclusive access to guard critical sections. Invokes SchM_Enter_Icu_ICU_EXCLUSIVE_AREA_0 (), SchM_Exit_Icu_ICU_EXCLUSIVE_AREA_0 () to enter critical section and exit.

In the example implementation (File Structure, SchM_Icu.c) , all the interrupts on CPU are disabled. However, disabling of the enabled ECAP interrupt should suffice.

Module MCU

The ICU driver depends on the system clock, prescaler(s) and PLL. Hence the length of an ICU timer tick depends on the clock settings made in the module MCU. The ICU driver will not take care of setting the registers which configure the global clock, global prescaler(s) and PLL in its Init function. This has to be done by the MCU module. The ICU driver only configures local (ICU peripheral specific) clocks, prescalers and so on.



OS (Operating System)

The ICU driver uses interrupts and therefore there is a dependency on the OS which configures the interrupt sources. It will provide the call-back functions only.

The ICU driver will not take care of setting the registers for interrupt association in its Init function. The overall assignment and activation of the interrupt system is done by the Operating System. **Module PORT**

The configuration of port pins used for the ICU as inputs is done by the PORT driver. Hence the PORT driver has to be initialized prior to the use of ICU functions. Otherwise ICU functions will exhibit undefined behaviour.

Module EcuM

The ICU driver will do the reporting of wakeup interrupts to the EcuM.

3.8 Stakeholders

- Developers
- Test Engineers
- Customer Integrator

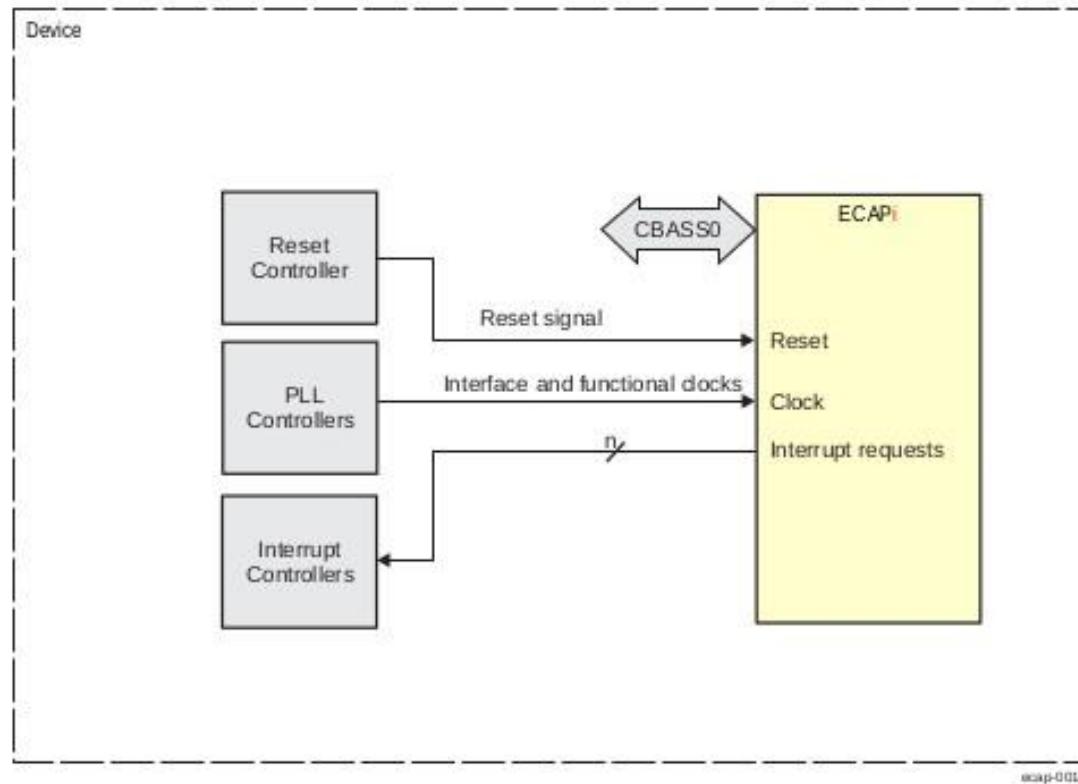
3.9 References

	Specification	Comment/Link
1	AUTOSAR 4.3.1	AUTOSAR_SWS_ICUDriver
2	Software Architecture	Mcal Software Architecture.
3	BSW General Requirements / Coding guidelines	Autosar and Coding guidelines for the Mcal drivers.
4	Software Product Specification (SPS)	Product Functional requirements.

4 Design Description

4.1 Fundamental Operation

- ECAP Edge Polarity Select and Qualifier Four Independent edge polarity selection multiplexers are used, one for each capture event. Each edge(capture event) will have the polarity set according to the activation edge selected.
- ECAP Interrupt Control An interrupt can be generated on capture events 1 through 4. In ICU driver module, interrupt will be generated for every single capture event - so all 4 capture events are triggered for edge counting, edge detection, timestamp calculation and signal measurements. •Please refer to TRM section 12.4.1.1



ECAP Overview



4.2 Sequence Diagrams

The Icu driver follows the code sequence outlined by the Autosar Spec for Icu Module. Please refer to [References 1 - AUTOSAR 4.3.1](#).

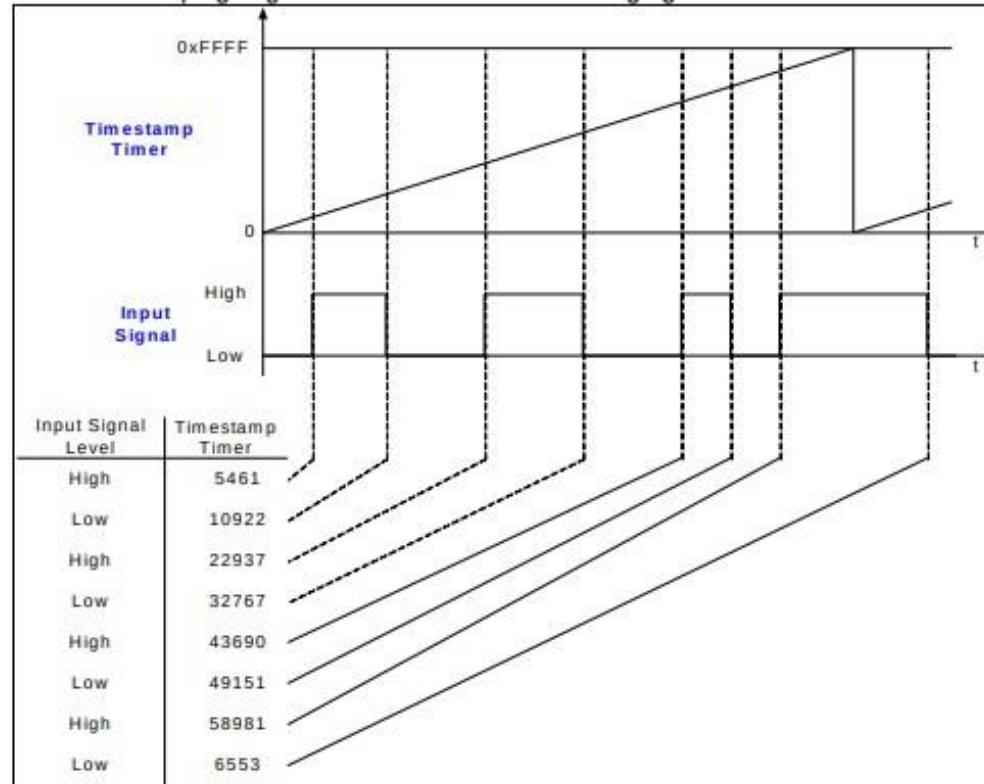
4.3 Resource Behavior

There are no hard requirements for resource allocation for Icu driver. Average Stack Size of ICU Driver is around 2 kilo bytes.

4.4 Interrupt Service Routines

An interrupt can be generated on capture events 1 through 4. In ICU driver module, interrupt will be generated for every single capture event - so all 4 capture events are triggered for edge counting, edge detection, timestamp calculation and signal measurements.

When a capture event occurs and capture register reads value, an interrupt flag will be raised for that event. The ISR in ICU module will recognize the the capture event and perform required steps based on the measurement mode (Please refer to [1](#)) selected in configurator. For example, if Timestamp measurement mode is selected, the timestamp specific ISR will be called, required values will be stored in module, and interrupts will be cleared from there.



TimeStamping Overview



4.5 Time Unit Ticks

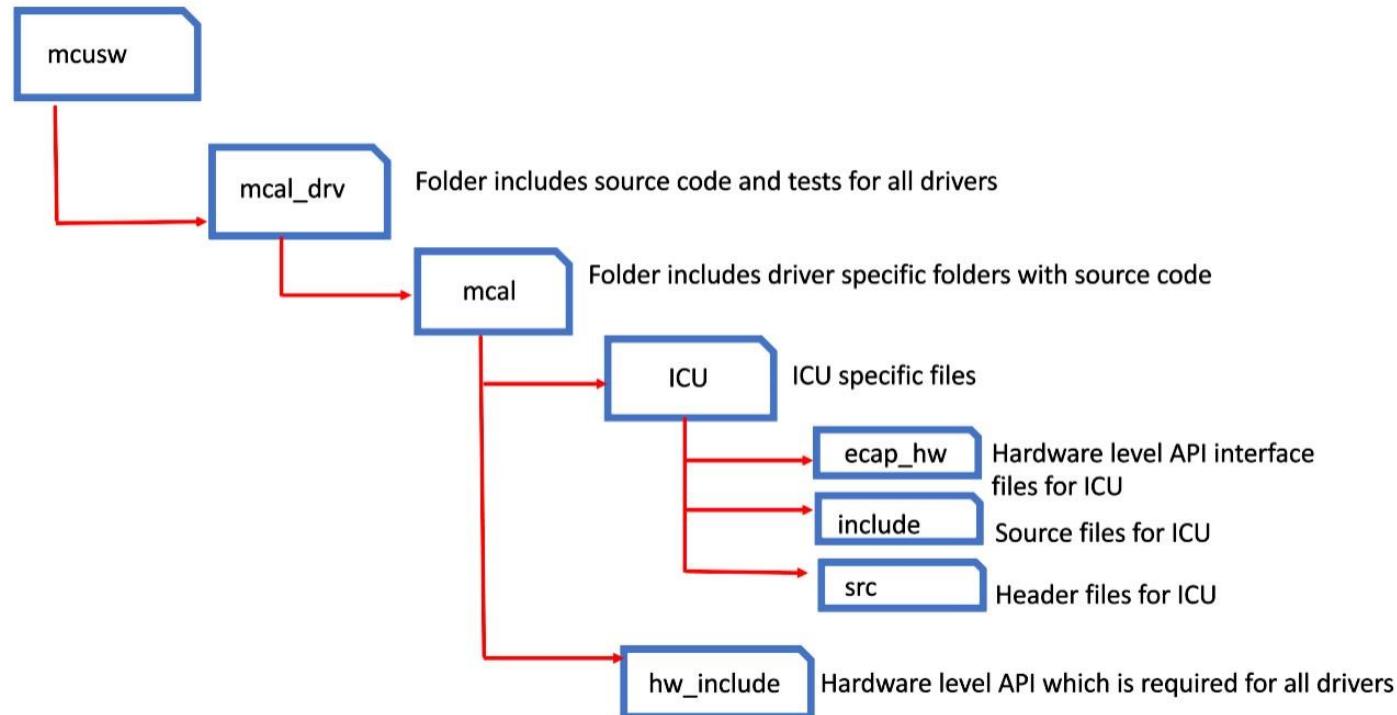
Refer [References 1 - AUTOSAR 4.3.1](#). specifically section 7.1.3 of the specification for more details All time units used within the API services of the ICU module shall be of the unit ticks.

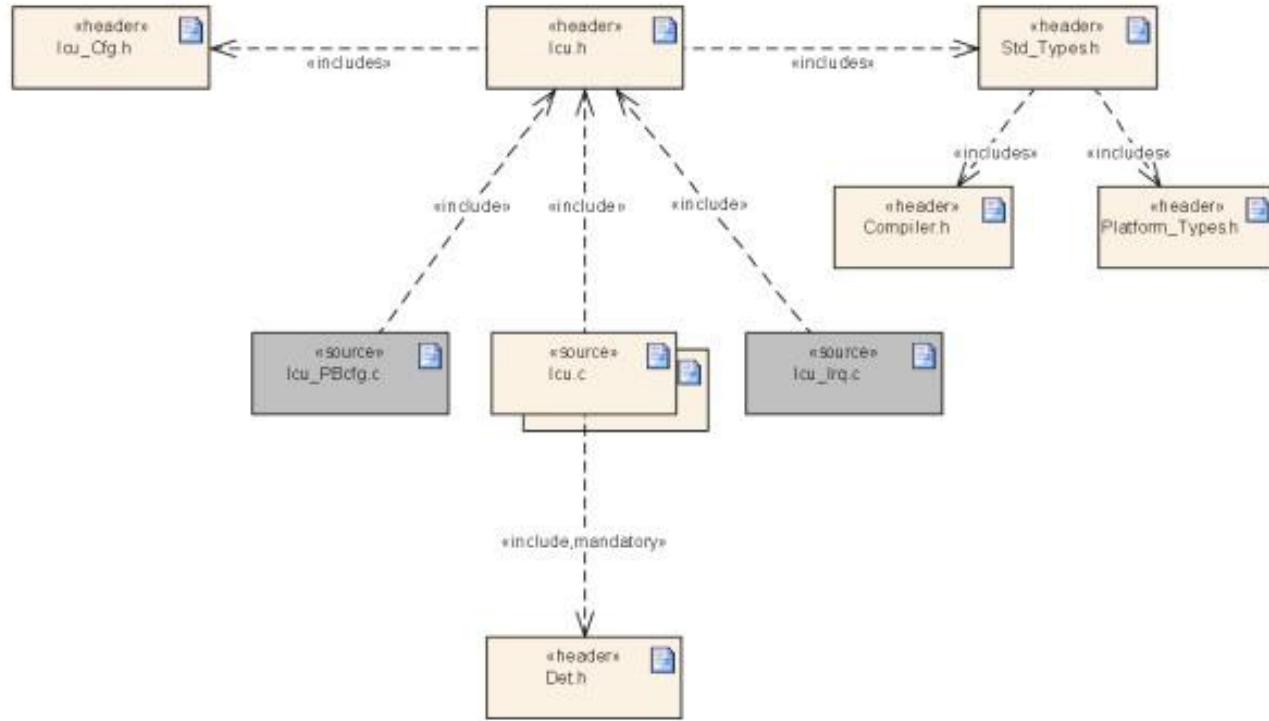
4.6 Directory Structure

The directory structure is as depicted in figures below, the source files can be categorised under “Driver Implementation” and “Example Application” **Driver**

Implemented by

- Icu.h, Icu_Priv.h : Shall implement the interface provided by the Icu driver.
- Icu_Irq.h : Contains ISR function declaration.
- Icu.c, Icu_Priv.c Icu_Irq.c : Shall implement the driver functionality.
- hw_include : Shall be used by example application.

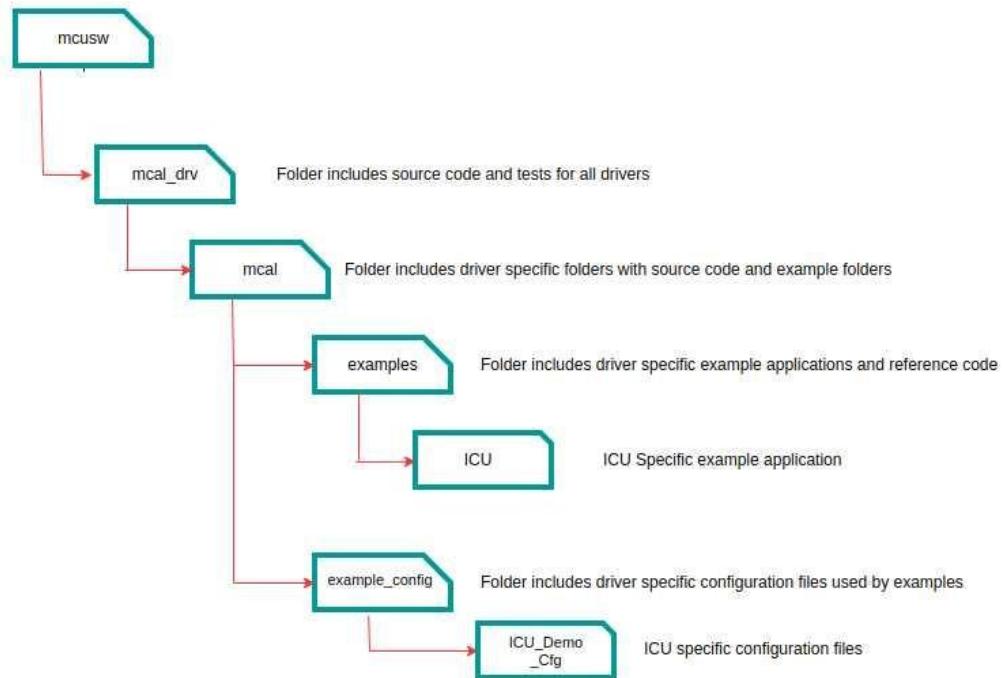






Example Application

- Icu_Cfg.h: Shall implement the generated configuration for Pre-Compile variant
- Icu_PBCfg.h: Shall be used for Post-Build variant
- IcuApp.c and IcuApp_Startup.c: Shall implement the example application that demonstrates the use of the driver.





Design Identifier	Description
 MCAL-6917 - SWS_Icu_00249 : Icu_PBcfg.c Source File Structure PUBLISHED	SWS_Icu_00249 : Icu_PBcfg.c Source File Structure
 MCAL-6931 - SWS_Icu_00253 : Icu_Lcfg.c sBsw_Stubs Header File Structure PUBLISHED	SWS_Icu_00253 : Icu_Lcfg.c sBsw_Stubs Header File Structure
 MCAL-6960 - SWS_Icu_00256 : Icu.h Bsw_Stubs Header File Structure PUBLISHED	SWS_Icu_00256 : Icu.h Bsw_Stubs Header File Structure
 MCAL-6972 - SWS_Icu_00250 : Icu.c Source File Structure PUBLISHED	SWS_Icu_00250 : Icu.c Source File Structure
 MCAL-7048 - SWS_Icu_00254 : Icu_PBcfg.c Bsw_Stubs Header File Structure PUBLISHED	SWS_Icu_00254 : Icu_PBcfg.c Bsw_Stubs Header File Structure
 MCAL-7064 - SWS_Icu_00246 : Icu_Irq.c Source File Structure PUBLISHED	SWS_Icu_00246 : Icu_Irq.c Source File Structure

Design Identifier	Description
 MCAL-7091 - SWS_Icu_00252 : Icu_Irq.c Bsw_Stubs Header File Structure PUBLISHED	SWS_Icu_00252 : Icu_Irq.c Bsw_Stubs Header File Structure
 MCAL-7113 - SWS_Icu_00251 : Icu.c Bsw_Stubs Header File Structure PUBLISHED	SWS_Icu_00251 : Icu.c Bsw_Stubs Header File Structure
 MCAL-7118 - SWS_Icu_00247 : Configuration Source File Structure PUBLISHED	SWS_Icu_00247 : Configuration Source File Structure
 MCAL-7128 - SWS_Icu_00245 : Icu_Cfg.h Header File Structure PUBLISHED	SWS_Icu_00245 : Icu_Cfg.h Header File Structure

4.7 Configurator

The AUTOSAR Icu Driver Specification details mandatory parameters that shall be configurable via the configurator. Please refer section 10 in [References 1 - AUTOSAR 4.3.1](#). Error Checks are common for variants of devices and we can do this in xdm or generator code.



Design Identifier	Description
 MCAL-7014 - ECUC_Icu_00026 : IcuGeneral Container PUBLISHED	ECUC_Icu_00026 : IcuGeneral Container
 MCAL-7101 - ECUC_Icu_00232 : IcuDevErrorDetect PUBLISHED	ECUC_Icu_00232 : IcuDevErrorDetect
 MCAL-6968 - ECUC_Icu_00114 : IcuOptionalApis PUBLISHED	ECUC_Icu_00114 : IcuOptionalApis
 MCAL-7134 - ECUC_Icu_00234 : IcuDeInitApi PUBLISHED	ECUC_Icu_00234 : IcuDeInitApi
 MCAL-7082 - ECUC_Icu_00124 : IcuEdgeCountApi PUBLISHED	ECUC_Icu_00124 : IcuEdgeCountApi
 MCAL-7142 - ECUC_Icu_00356 : IcuEdgeDetectApi PUBLISHED	ECUC_Icu_00356 : IcuEdgeDetectApi
 MCAL-7004 - ECUC_Icu_00238 : IcuGetInputStateApi PUBLISHED	ECUC_Icu_00238 : IcuGetInputStateApi
 MCAL-7015 - ECUC_Icu_00239 : IcuGetTimeElapsedApi PUBLISHED	ECUC_Icu_00239 : IcuGetTimeElapsedApi

Design Identifier	Description
 MCAL-7007 - ECUC_Icu_00240 : IcuGetVersionInfoApi PUBLISHED	ECUC_Icu_00240 : IcuGetVersionInfoApi
 MCAL-7046 - ECUC_Icu_00123 : IcuTimestampApi PUBLISHED	ECUC_Icu_00242 : IcuSignalMeasurementApi
 MCAL-6933 - ECUC_Icu_00242 : IcuSignalMeasurementApi PUBLISHED	ECUC_Icu_00123 : IcuTimestampApi
 MCAL-7046 - ECUC_Icu_00123 : IcuTimestampApi PUBLISHED	ECUC_Icu_00123 : IcuTimestampApi
 MCAL-6982 - ECUC_Icu_00027 : IcuChannel PUBLISHED	ECUC_Icu_00027 : IcuChannel
 MCAL-7001 - ECUC_Icu_00354 : IcuChannelId PUBLISHED	ECUC_Icu_00354 : IcuChannelId
 MCAL-7146 - ECUC_Icu_00222 : IcuDefaultStartEdge PUBLISHED	ECUC_Icu_00222 : IcuDefaultStartEdge
 MCAL-6896 - ECUC_Icu_00223 : IcuMeasurementMode PUBLISHED	ECUC_Icu_00223 : IcuMeasurementMode



Design Identifier	Description
 MCAL-7055 - ECUC_Icu_00021 : IcuSignalEdgeDetection PUBLISHED	ECUC_Icu_00021 : IcuSignalEdgeDetection
 MCAL-7109 - ECUC_Icu_00225 : IcuSignalNotification PUBLISHED	ECUC_Icu_00225 : IcuSignalNotification
 MCAL-7061 - ECUC_Icu_00226 : IcuSignalMeasurement PUBLISHED	ECUC_Icu_00226 : IcuSignalMeasurement
 MCAL-6993 - ECUC_Icu_00227 : IcuSignalMeasurementProperty PUBLISHED	ECUC_Icu_00227 : IcuSignalMeasurementProperty
 MCAL-7108 - ECUC_Icu_00228 : IcuTimestampMeasurement PUBLISHED	ECUC_Icu_00228 : IcuTimestampMeasurement
 MCAL-7119 - ECUC_Icu_00229 : IcuTimestampMeasurementProperty PUBLISHED	ECUC_Icu_00229 : IcuTimestampMeasurementProperty
 MCAL-6997 - ECUC_Icu_00230 : IcuTimestampNotification PUBLISHED	ECUC_Icu_00230 : IcuTimestampNotification

Design Identifier	Description
 MCAL-7051 - ECUC_Icu_00219 : IcuConfigSet PUBLISHED	ECUC_Icu_00219 : IcuConfigSet
 MCAL-6955 - ECUC_Icu_00220 : IcuMaxChannel PUBLISHED	ECUC_Icu_00220 : IcuMaxChannel

4.7.1 NON Standard configurable parameters

The design's specific configurable parameters are as follows:

Parameter	Usage comment
IcuFunctionalClock	This is the value of the System Clock freq
IcuDeviceVariant	This shall allow integrators to select the device variant for which integration is being performed. This parameter shall be used by driver to impose device specific constraints. The user guide shall detail the device specific constraints

Parameter	Usage comment
IcuClkPrescaler	This parameter allows the selection of pre-scalar value. The prescaler stage is clocked with the ICU clock and acts as a clock divider for the time-base clock.
Design Identifier	Description
 MCAL-7120 - ECUC_Icu_Custom: Icu_FunctionalClock PUBLISHED	ECUC_Icu_Custom: Icu_FunctionalClock
 MCAL-6952 - ECUC_Icu_Custom: Icu_DeviceVariant PUBLISHED	ECUC_Icu_Custom: Icu_DeviceVariant
 MCAL-7079 - ECUC_Icu_Custom: Icu_ClkPrescalar PUBLISHED	ECUC_Icu_Custom: Icu_ClkPrescalar

4.7.2 Implementation specific parameters (computed)

The configurator shall determine the maximum number of channels that are configured and generate a macro to define the same. This shall be used to perform range checks on channel configurations and channel ID provided at driver initialization time. Refer section [5.1 - MACROS, Data Types & Structures](#)

4.7.3 Variant Support

The driver shall support both VARIANT-POST-BUILD & VARIANT-PRE-COMPIL

4.8 Error Classification

Errors are classified in two categories, development error and runtime / production error.

4.8.1 Development Errors

AUTOSAR requires that API functions check the validity of their parameters and module status. The checks in table are internal parameter checks of the API functions. These checks are for development error reporting and can be enabled or disabled.

The detection of development errors is configurable (ON / OFF) at pre-compile time. The switch ICU_DEV_ERROR_DETECT will activate or deactivate the detection of all development errors.

	Description
 MCAL-7045 - SWS_Icu_00382 : Development Error Types PUBLISHED	SWS_Icu_00382 : Development Error Types

Design Identifier

Design Identifier	Description
 MCAL-6953 - SWS_Icu_00022 : Development error ICU_E_UNINIT PUBLISHED	SWS_Icu_00022 : Development error ICU_E_UNINIT



4.8.2 Development Error Reporting

By default, development errors are reported to the DET using the service Det_ReportError(), if development error detection and reporting are enabled (i.e. checkboxes Development Mode and Development Error Reporting are checked).

Type of Error	Related Error code	Value (Hex)
API is called with invalid pointer	ICU_E_PARAM_POINTER	0x0A
API service used with an invalid channel identifier or channel was not configured for the functionality of the called API	ICU_E_PARAM_CHANNEL	0x0B
API service used with an invalid or not feasible activation	ICU_E_PARAM_ACTIVATION	0x0C
Init Function Failed	ICU_E_INIT_FAILED	0x0D

API service used with an invalid buffer size	ICU_E_PARAM_BUFFER_SIZE	0x0E
API service Icu_SetMode used with an invalid mode	ICU_E_PARAM_MODE	0x0F
API service used without module initialization	ICU_E_UNINIT	0x14
API service Icu_SetMode is called while in running operation	ICU_E_BUSY_OPERATION	0x16
API Icu_Init service is called and when the ICU driver and the Hardware are already initialized	ICU_E_ALREADY_INITIALIZED	0x17
API Icu_StartTimeStamp is called and the parameter NotifyInterval is Invalid	ICU_E_PARAM_NOTIFY_INTERVAL	0x18
API Icu_GetVersionInfo is called and the parameter versioninfo is invalid	ICU_E_PARAM_VINFO	0x19

4.8.3 Runtime Errors

Type of Error	Related Error code	Value (Hex)



API service Icu_StopTimestamp called on a channel which was not started or already stopped	ICU_E_NOT_STARTED	0x15
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4.8.4 Debugging support

Icu driver makes driver status available for debugging. The input channel status can be probed using the Icu_GetInputState() API.

4.8.5 Error notification (DEM)

All detected run time errors shall be reported to Det_ReportRuntimeError () service.

5 Implementation Details

5.1 Data structures and resources

MACROS, Data Types & Structures

The sections below lists some of key data structures that shall be implemented and used in driver implementation.

Max Number Channels

Identifier	Comments
ICU_MAX_NUM_CHANNELS	Defines the maximum number of instances available in ICU module. This is specific to SoC being used (3 for J721E and J7200).
Icu_ChannelPrescalerType	Defines Prescaler type
Icu_NotifyFuncType	Notification callback function pointer
Icu_ChannelConfigType	ICU Channel Configuration
Icu_ChannelConfigType_PC	ICU Channel Config Structure of Pre-Compile only

Identifier	Comments
Icu_ConfigType_PC	ICU Config Structure of Pre-Compile only

Icu_ModeType

Used to allow enabling/disabling of all interrupts which are not required for the ECU wakeup. This will only be set to ICU_MODE_NORMAL as wakeup capability is not supported by hardware. Please refer section 8.2.1 of [References 1 - AUTOSAR 4.3.1](#). **Icu_ChannelType**

Numeric identifier of an ICU Channel. Please refer section 8.2.2 of [References 1 - AUTOSAR 4.3.1](#).

Icu_InputStateType

Input state of an ICU channel. Please refer section 8.2.3 of [References 1 - AUTOSAR 4.3.1](#). **Icu_ConfigType**

This type contains initialization data. Please refer section 8.2.4 of [References 1 - AUTOSAR 4.3.1](#).

Icu_ActivationType

Definition of the type of activation of an ICU channel. Please refer section 8.2.5 of [References 1 - AUTOSAR 4.3.1](#).

Icu_ValueType

Width of the buffer for timestamp ticks and measured elapsed timeticks. This will be 32-bit to match the hardware timer. Please refer section 8.2.6 of [References 1 - AUTOSAR 4.3.1](#).

Icu_DutyCycleType

Type which shall contain the values, needed for calculating duty cycle. Please refer section 8.2.7 of [References 1 - AUTOSAR 4.3.1](#).

Icu_IndexType

Icu Index time to abstract the reutn value of service Icu_GetTimestampIndex(). Please refer section 8.2.8 of [References 1 - AUTOSAR 4.3.1](#).

Icu_EdgeNumberType

Type to abstract the return value of the service Icu_GetEdgeNumbers(). Please refer section 8.2.9 of [References 1 - AUTOSAR 4.3.1](#).

Icu_MeasurementModeType

Definition of the measurement mode type. Please refer section 8.2.10 of [References 1 - AUTOSAR 4.3.1](#). **Icu_SignalMeasurementPropertyType**

Definition of the measurement property type. Please refer section 8.2.11 of [References 1 - AUTOSAR 4.3.1](#).

Icu_TimestampBufferType

Definition of the timestamp measurement property type. Please refer section 8.2.12 of [References 1 - AUTOSAR 4.3.1](#).

5.2 Dynamic Behavior - Control Flow Diagram

The ICU Module can have two states: ICU_STATUS_UINIT (before the module had been initialized with Icu_Init) and ICU_STATUS_INIT (after module has been initialized).

The ICU State (logical input state of ICU Channel) can be ICU_ACTIVE or ICU_IDLE. ICU_ACTIVE - Input state of an ICU Channel, and activation edge has been detected. ICU_IDLE - Input state of an ICU Channel, no activation edge had been detected since last call of Icu_GetInputState() or Icu_Init().

Design Identifier	Description
 MCAL-7077 - SWS_Icu_00279 : Icu_InputStateType PUBLISHED	SWS_Icu_00279 : Icu_InputStateType

5.3 Dynamic Behavior - Data Flow Diagram

Not Applicable

5.4 Application Parameters

5.4.1 lcu_Init

	Description	Possible Value ranges	Unit of Value	Default Value	Variant
ConfigPtr	Pointer to a selected configuration structure	0xFFFFFFFF	-	-	NA

Parameter

5.4.2 lcu_Deinit

	Description	Possible Value ranges	Unit of Value	Default Value	Variant
NA	NA	NA	NA	NA	NA

Parameter



5.4.3 Icu_SetActivationCondition

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA
Activation	This service sets the Type of activation (if supported by hardware) ICU_RISING_EDGE, ICU_FALLING_EDGE, ICU_BOTH_EDGES	-	-	-	NA

5.4.4 Icu_DisableNotification

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA

5.4.5 Icu_EnableNotification

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA



5.4.6 lcu_GetInputState

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA

5.4.7 lcu_StartTimestamp

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA
BufferSize	Size of the external buffer (number of entries)	-	-	6	NA
NotifyInterval	Notification interval (number of events).	-	-	-	NA



5.4.8 Icu_StopTimestamp

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA

5.4.9 Icu_GetTimestampIndex

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA

5.4.10 Icu_ResetEdgeCount

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA



5.4.11 Icu_EnableEdgeCount

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA

5.4.12 Icu_EnableEdgeDetection

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA

5.4.13 Icu_DisableEdgeDetection

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA

5.4.14 Icu_DisableEdgeCount

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA

5.4.15 Icu_GetEdgeNumbers

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA

5.4.16 Icu_StartSignalMeasurement

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA



5.4.17 Icu_StopSignalMeasurement

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA

5.4.18 Icu_GetTimeElapsed

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA



5.4.19 Icu_GetDutyCycleValues

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
Channel	Numeric identifier of the ICU channel	0-3	-	-	NA
DutyCycleValues	Pointer to a buffer where the results (high time and period time) shall be placed.	-	-	60%	PreCompile

5.4.20 Icu_GetVersionInfo

Parameter	Description	Possible Value ranges	Unit of Value	Default Value	Variant
VersionInfoPtr	Returns the version information of this module. The function can be called on task level	-	-	-	NA



5.5 Safety Diagnostic Features

CAP3 - Periodic Software Readback of Static Configuration Registers / CAP4 - Software Readback of Written Configuration eCAP driver provides the API to read the static configuration registers of eCAP. The system integrator shall use the API to periodically read the static config registers. A snapshot of the values shall be taken after initializing the config registers and stored by the application. Periodically, the application can use the API to get the config values at runtime and compare. A new snapshot should be taken anytime the config value is changed by the application.

eCAP driver provides the APIs to set the config and to read back the written configuration for eCAP. The system integrator can use the APIs to read back the configuration after setting to confirm proper write.

The ICU MCAL driver provides the API - **Icu_RegisterReadback** to readback static and written configuration registers to implement this diagnostic feature.

6 Low Level Definitions

The detailed API and interface description is available as part of [References 1 - AUTOSAR 4.3.1](#). This section describes the API supported by the MCAL driver and the requirements covered by each of the API.

6.1 Driver API's

For the standard APIs please refer section 8.3 of [References 1 - AUTOSAR 4.3.1](#). Sections below highlight other design considerations for the implementation.

6.1.1 lcu_Init

Refer section 8.3.1 of [References 1 - AUTOSAR 4.3.1](#).

Design Identifier	Description
 MCAL-6967 - SWS_lcu_00040 : lcu_Init Status ICU_IDLE PUBLISHED	SWS_lcu_00040 : lcu_Init Status ICU_IDLE
 MCAL-6999 - SWS_lcu_00298 : lcu_Init Driver Initialization Initialization PUBLISHED	SWS_lcu_00298 : lcu_Init Driver Initialization



Design Identifier	Description
MCAL-7039 - SWS_Icu_00061 : Icu_Init Disable notifications PUBLISHED	SWS_Icu_00061 : Icu_Init Disable notifications
MCAL-7071 - SWS_Icu_00297 : Icu_Init Re-entrancy PUBLISHED	SWS_Icu_00297 : Icu_Init Re-entrancy
MCAL-7089 - SWS_Icu_00138 : Icu_Init Variant PC NULL PUBLISHED	SWS_Icu_00138 : Icu_Init Variant PC NULL
MCAL-7107 - SWS_Icu_00006 : Icu_Init Hardware Register Initialization PUBLISHED	SWS_Icu_00006 : Icu_Init Hardware Register Initialization
MCAL-7122 - SWS_Icu_00054 : Icu_Init Resources Configuration PUBLISHED	SWS_Icu_00054 : Icu_Init Resources Configuration

Design Identifier	Description
 MCAL-7112 - SWS_Icu_00220 : Icu_Init DET ICU_E_ALREADY_INITIALIZED PUBLISHED	SWS_Icu_00220 : Icu_Init DET ICU_E_ALREADY_INITIALIZED

6.1.2 Icu_Deinit

Refer section 8.3.2 of [References 1 - AUTOSAR 4.3.1](#).

Design Identifier	Description
 MCAL-6948 - SWS_Icu_00152 : Icu_Deinit RunTime PUBLISHED	SWS_Icu_00152 : Icu_Deinit RunTime
 MCAL-6954 - SWS_Icu_00036 : Icu_Deinit configuration PUBLISHED	SWS_Icu_00036 : Icu_Deinit configuration



Design Identifier	Description
 MCAL-6995 - SWS_Icu_00091 : Icu_Delnit Static Configuration DeInitialization PUBLISHED	SWS_Icu_00091 : Icu_Delnit Static Configuration DeInitialization
 MCAL-7022 - SWS_Icu_00299 : Icu_Delnit Non re-entrancy PUBLISHED	SWS_Icu_00299 : Icu_Delnit Non re-entrancy
 MCAL-7023 - SWS_Icu_00300 : Icu_Delnit Hardware Register DeInitialization PUBLISHED	SWS_Icu_00300 : Icu_Delnit Hardware Register DeInitialization
 MCAL-7025 - SWS_Icu_00221 : Icu_Delnit re-initialization PUBLISHED	SWS_Icu_00221 : Icu_Delnit re-initialization
 MCAL-7081 - SWS_Icu_00037 : Icu_Delnit Disable all used interrupts and notifications PUBLISHED	SWS_Icu_00037 : Icu_Delnit Disable all used interrupts and notifications

Design Identifier	Description
 MCAL-7127 - SWS_Icu_00301 : Icu_Delnit configuration parameter IcuDelnitApi PUBLISHED	SWS_Icu_00301 : Icu_Delnit configuration parameter IcuDelnitApi
 MCAL-6909 - SWS_Icu_00092 : Icu_Delnit Pre compile parameter IcuDelnitApi PUBLISHED	SWS_Icu_00092 : Icu_Delnit Pre compile parameter IcuDelnitApi

6.1.3 Icu_SetActivationCondition

Refer 8.3.7 of [References 1 - AUTOSAR 4.3.1](#).

Design Identifier	Description
 MCAL-6941 - SWS_Icu_00139 : Icu_SetActivationCondition ICU_IDLE PUBLISHED	SWS_Icu_00139 : Icu_SetActivationCondition ICU_IDLE

Design Identifier	Description
 MCAL-7002 - SWS_Icu_00090 : Icu_SetActivationCondition Activation Parameter PUBLISHED	SWS_Icu_00090 : Icu_SetActivationCondition Activation Parameter
 MCAL-7076 - SWS_Icu_00309 : Icu_SetActivationCondition Re-entrancy PUBLISHED	SWS_Icu_00309 : Icu_SetActivationCondition Re-entrancy
 MCAL-6947 - SWS_Icu_00159 : Icu_SetActivationCondition DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00159 : Icu_SetActivationCondition DET ICU_E_PARAM_CHANNEL
 MCAL-6973 - SWS_Icu_00043 : Icu_SetActivationCondition DET ICU_E_PARAM_ACTIVATION PUBLISHED	SWS_Icu_00043 : Icu_SetActivationCondition DET ICU_E_PARAM_ACTIVATION

6.1.4 Icu_DisableNotification



Refer section 8.3.8 of [References 1 - AUTOSAR 4.3.1](#).

Design Identifier	Description
 MCAL-6938 - SWS_Icu_00009 : Icu_DisableNotification Disable Notification PUBLISHED	SWS_Icu_00009 : Icu_DisableNotification Disable Notification
 MCAL-7042 - SWS_Icu_00310 : Icu_DisableNotification Re-entrancy PUBLISHED	SWS_Icu_00310 : Icu_DisableNotification Re-entrancy
 MCAL-7065 - SWS_Icu_00160 : Icu_DisableNotification DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00160 : Icu_DisableNotification DET ICU_E_PARAM_CHANNEL

6.1.5 Icu_EnableNotification

Refer section 8.3.9 of [References 1 - AUTOSAR 4.3.1](#).



Design Identifier	Description
MCAL-7013 - SWS_Icu_00311 : Icu_EnableNotification Re-entrancy PUBLISHED	SWS_Icu_00311 : Icu_EnableNotification Re-entrancy
MCAL-7096 - SWS_Icu_00010 : Icu_EnableNotification Enable Notification PUBLISHED	SWS_Icu_00010 : Icu_EnableNotification Enable Notification
MCAL-6950 - SWS_Icu_00161 : Icu_EnableNotification DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00161 : Icu_EnableNotification DET ICU_E_PARAM_CHANNEL

6.1.6 Icu_GetInputState

Refer section 8.3.10 of [References 1 - AUTOSAR 4.3.1](#).

Design Identifier	Description
 MCAL-6920 - SWS_Icu_00315 : Icu_GetInputState configuration parameter IcuGetInputStateApi PUBLISHED	SWS_Icu_00315 : Icu_GetInputState configuration parameter IcuGetInputStateApi
 MCAL-6977 - SWS_Icu_00312 : Icu_GetInputState Re-entrancy PUBLISHED	SWS_Icu_00312 : Icu_GetInputState Re-entrancy
 MCAL-7037 - SWS_Icu_00031 : Icu_GetInputState Edge Detection Status PUBLISHED	SWS_Icu_00031 : Icu_GetInputState Edge Detection Status
 MCAL-7059 - SWS_Icu_00313 : Icu_GetInputState ICU_IDLE PUBLISHED	SWS_Icu_00313 : Icu_GetInputState ICU_IDLE

Design Identifier	Description
 MCAL-7068 - SWS_Icu_00030 : Icu_GetInputState IcuMeasurementMode Status PUBLISHED	SWS_Icu_00030 : Icu_GetInputState IcuMeasurementMode Status
 MCAL-7099 - SWS_Icu_00314 : Icu_GetInputState Signal Measurement Mode PUBLISHED	SWS_Icu_00314 : Icu_GetInputState Signal Measurement Mode
 MCAL-7138 - SWS_Icu_00122 : Icu_GetInputState Pre compile parameter IcuGetInputStateApi IcuGetInputStateApi PUBLISHED	SWS_Icu_00122 : Icu_GetInputState Pre compile parameter IcuGetInputStateApi
 MCAL-7140 - SWS_Icu_00032 : Icu_GetInputState ICU_ACTIVE->ICU_IDLE IcuGetInputState ICU_ACTIVE->ICU_IDLE PUBLISHED	SWS_Icu_00032 : Icu_GetInputState ICU_ACTIVE->ICU_IDLE

Design Identifier	Description
 MCAL-7075 - SWS_Icu_00162 : Icu_GetInputState DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00162 : Icu_GetInputState DET ICU_E_PARAM_CHANNEL
 MCAL-6983 - SWS_Icu_00049 : Icu_GetInputState DET Status ICU_IDLE PUBLISHED	SWS_Icu_00049 : Icu_GetInputState DET Status ICU_IDLE

6.1.7 Icu_StartTimestamp

Refer section 8.3.11 of [References 1 - AUTOSAR 4.3.1](#).

Design Identifier	Description
 MCAL-6974 - SWS_Icu_00064 : Icu_StartTimestamp Circular Buffer PUBLISHED	SWS_Icu_00064 : Icu_StartTimestamp Circular Buffer

Design Identifier	Description
 MCAL-7003 - SWS_Icu_00317 : Icu_StartTimestamp Capture TimerValues PUBLISHED	SWS_Icu_00317 : Icu_StartTimestamp Capture TimerValues
 MCAL-6930 - SWS_Icu_00063 : Icu_StartTimestamp Capture TimerValues Icu_SetActivationCondition PUBLISHED	SWS_Icu_00063 : Icu_StartTimestamp Capture TimerValues Icu_SetActivationCondition
 MCAL-7028 - SWS_Icu_00134 : Icu_StartTimestamp Notification PUBLISHED	SWS_Icu_00134 : Icu_StartTimestamp Notification
 MCAL-7057 - SWS_Icu_00321 : Icu_StartTimestamp configuration parameter IcuTimestampApi PUBLISHED	SWS_Icu_00321 : Icu_StartTimestamp configuration parameter IcuTimestampApi

Design Identifier	Description
 MCAL-7137 - SWS_Icu_00066 : Icu_StartTimestamp ICU_MODE_TIMESTAMP PUBLISHED	SWS_Icu_00066 : Icu_StartTimestamp ICU_MODE_TIMESTAMP
 MCAL-7148 - SWS_Icu_00318 : Icu_StartTimestamp Icu_EnableNotification PUBLISHED	SWS_Icu_00318 : Icu_StartTimestamp Icu_EnableNotification
 MCAL-6926 - SWS_Icu_00319 : Icu_StartTimestamp NotifyInterval Zero PUBLISHED	SWS_Icu_00319 : Icu_StartTimestamp NotifyInterval Zero
 MCAL-6921 - SWS_Icu_00320 : Icu_StartTimestamp NotifyInterval Number Of Events PUBLISHED	SWS_Icu_00320 : Icu_StartTimestamp NotifyInterval Number Of Events

Design Identifier	Description
 MCAL-6961 - SWS_Icu_00098 : Icu_StartTimestamp Pre compile parameter IcuTimestampApi PUBLISHED	SWS_Icu_00098 : Icu_StartTimestamp Pre compile parameter IcuTimestampApi
 MCAL-6996 - SWS_Icu_00163 : Icu_StartTimestamp DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00163 : Icu_StartTimestamp DET ICU_E_PARAM_CHANNEL
 MCAL-7129 - SWS_Icu_00354 : Icu_StartTimestamp DET ICU_E_PARAM_NOTIFY_INTERVAL PUBLISHED	SWS_Icu_00354 : Icu_StartTimestamp DET ICU_E_PARAM_NOTIFY_INTERVAL
 MCAL-7135 - SWS_Icu_00108 : Icu_StartTimestamp DET ICU_E_PARAM_BUFFER_SIZE PUBLISHED	SWS_Icu_00108 : Icu_StartTimestamp DET ICU_E_PARAM_BUFFER_SIZE

6.1.8 Icu_StopTimestamp

Refer section 8.3.12 of [References 1 - AUTOSAR 4.3.1](#)

Design Identifier	Description
 MCAL-7132 - SWS_Icu_00322 : Icu_StopTimestamp Re-entrancy PUBLISHED	SWS_Icu_00322 : Icu_StopTimestamp Re-entrancy
 MCAL-7040 - SWS_Icu_00166 : Icu_StopTimestamp DET ICU_E_NOT_STARTED PUBLISHED	SWS_Icu_00166 : Icu_StopTimestamp DET ICU_E_NOT_STARTED
 MCAL-6901 - SWS_Icu_00067 : Icu_StopTimestamp Stop Time Stamp Measurement PUBLISHED	SWS_Icu_00067 : Icu_StopTimestamp Stop Time Stamp Measurement
 MCAL-6906 - SWS_Icu_00165 : Icu_StopTimestamp ICU_MODE_TIMESTAMP PUBLISHED	SWS_Icu_00165 : Icu_StopTimestamp ICU_MODE_TIMESTAMP

Design Identifier	Description
 MCAL-6988 - SWS_Icu_00099 : Icu_StopTimestamp Pre compile parameter IcuTimestampApi PUBLISHED	SWS_Icu_00099 : Icu_StopTimestamp Pre compile parameter IcuTimestampApi
 MCAL-6929 - SWS_Icu_00164 : Icu_StopTimestamp DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00164 : Icu_StopTimestamp DET ICU_E_PARAM_CHANNEL
 MCAL-7035 - SWS_Icu_00323 : Icu_StopTimestamp configuration parameter IcuTimestampApi PUBLISHED	SWS_Icu_00323 : Icu_StopTimestamp configuration parameter IcuTimestampApi

6.1.9 Icu_GetTimestampIndex

Refer section 8.3.13 of [References 1 - AUTOSAR 4.3.1](#).



Design Identifier	Description
MCAL-6934 - SWS_Icu_00170 : Icu_GetTimestampIndex ICU_MODE_TIMESTAMP PUBLISHED	SWS_Icu_00170 : Icu_GetTimestampIndex ICU_MODE_TIMESTAMP
MCAL-7009 - SWS_Icu_00100 : Icu_GetTimestampIndex Pre compile parameter IcuTimestampApi PUBLISHED	SWS_Icu_00100 : Icu_GetTimestampIndex Pre compile parameter IcuTimestampApi
MCAL-7110 - SWS_Icu_00071 : Icu_GetTimestampIndex Timestamp Index PUBLISHED	SWS_Icu_00071 : Icu_GetTimestampIndex Timestamp Index
MCAL-7018 - SWS_Icu_00324 : Icu_GetTimestampIndex Re-entrancy PUBLISHED	SWS_Icu_00324 : Icu_GetTimestampIndex Re-entrancy

Design Identifier	Description
 MCAL-6987 - SWS_Icu_00135 : Icu_GetTimestampIndex Return Zero PUBLISHED	SWS_Icu_00135 : Icu_GetTimestampIndex Return Zero
 MCAL-6900 - SWS_Icu_00325 : Icu_GetTimestampIndex configuration parameter IcuTimestampApi PUBLISHED	SWS_Icu_00325 : Icu_GetTimestampIndex configuration parameter IcuTimestampApi
 MCAL-7072 - SWS_Icu_00169 : Icu_GetTimestampIndex DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00169 : Icu_GetTimestampIndex DET ICU_E_PARAM_CHANNEL
 MCAL-6967 - SWS_Icu_00040 : Icu_Init Status ICU_IDLE PUBLISHED	SWS_Icu_00040 : Icu_Init Status ICU_IDLE

6.1.10 Icu_ResetEdgeCount

Refer section 8.3.14 of [References 1 - AUTOSAR 4.3.1](#).

Design Identifier	Description
 MCAL-6949 - SWS_Icu_00326 : Icu_ResetEdgeCount Re- entrancy PUBLISHED	SWS_Icu_00326 : Icu_ResetEdgeCount Re-entrancy
 MCAL-7085 - SWS_Icu_00072 : Icu_ResetEdgeCount Reset PUBLISHED	SWS_Icu_00072 : Icu_ResetEdgeCount Reset
 MCAL-7116 - SWS_Icu_00327 : Icu_ResetEdgeCount configuration parameter ICU_EDGE_COUNT_API PUBLISHED	SWS_Icu_00327 : Icu_ResetEdgeCount configuration parameter ICU_EDGE_COUNT_API



Design Identifier	Description
MCAL-6915 - SWS_Icu_00171 : Icu_ResetEdgeCount DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00171 : Icu_ResetEdgeCount DET ICU_E_PARAM_CHANNEL

6.1.11 Icu_EnableEdgeCount

Refer section 8.3.15 of [References 1 - AUTOSAR 4.3.1](#)

Design Identifier	Description
MCAL-6898 - SWS_Icu_00328 : Icu_EnableEdgeCount Re-entrancy PUBLISHED	SWS_Icu_00328 : Icu_EnableEdgeCount Re-entrancy

Design Identifier	Description
 MCAL-6986 - SWS_Icu_00329 : Icu_EnableEdgeCount configuration parameter ICU_EDGE_COUNT_API PUBLISHED	SWS_Icu_00329 : Icu_EnableEdgeCount configuration parameter ICU_EDGE_COUNT_API
 MCAL-7067 - SWS_Icu_00073 : Icu_EnableEdgeCount Edge Configuration PUBLISHED	SWS_Icu_00073 : Icu_EnableEdgeCount Edge Configuration
 MCAL-7098 - SWS_Icu_00078 : Icu_EnableEdgeCount Enable Counting PUBLISHED	SWS_Icu_00078 : Icu_EnableEdgeCount Enable Counting
 MCAL-7149 - SWS_Icu_00074 : Icu_EnableEdgeCount MeasurementMode PUBLISHED	SWS_Icu_00074 : Icu_EnableEdgeCount MeasurementMode

Design Identifier	Description
 MCAL-7084 - SWS_Icu_00172 : Icu_EnableEdgeCount DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00172 : Icu_EnableEdgeCount DET ICU_E_PARAM_CHANNEL

6.1.12 Icu_EnableEdgeDetection

Refer section 8.3.16 of [References 1 - AUTOSAR 4.3.1](#)

Design Identifier	Description
 MCAL-6919 - SWS_Icu_00370 : Icu_EnableEdgeDetection configuration parameter IcuEdgeDetectApi PUBLISHED	SWS_Icu_00370 : Icu_EnableEdgeDetection configuration parameter IcuEdgeDetectApi
 MCAL-6959 - SWS_Icu_00371 : Icu_EnableEdgeDetection DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00371 : Icu_EnableEdgeDetection DET ICU_E_PARAM_CHANNEL



Design Identifier	Description
MCAL-6928 - SWS_Icu_00366 : Icu_EnableEdgeDetection Edge Configuration PUBLISHED	SWS_Icu_00366 : Icu_EnableEdgeDetection Edge Configuration
MCAL-7012 - SWS_Icu_00369 : Icu_EnableEdgeDetection Pre compile parameter IcuEdgeDetectApi PUBLISHED	SWS_Icu_00369 : Icu_EnableEdgeDetection Pre compile parameter IcuEdgeDetectApi
MCAL-7083 - SWS_Icu_00367 : Icu_EnableEdgeDetection MeasurementMode PUBLISHED	SWS_Icu_00367 : Icu_EnableEdgeDetection MeasurementMode
MCAL-7097 - SWS_Icu_00368 : Icu_EnableEdgeDetection Re-entrancy PUBLISHED	SWS_Icu_00368 : Icu_EnableEdgeDetection Re-entrancy

Design Identifier	Description
 MCAL-6964 - SWS_Icu_00365 : Icu_EnableEdgeDetection Edge Detection PUBLISHED	SWS_Icu_00365 : Icu_EnableEdgeDetection Edge Detection

6.1.13 Icu_DisableEdgeDetection

Refer section 8.3.17 of [References 1 - AUTOSAR 4.3.1](#)

Design Identifier	Description
 MCAL-6894 - SWS_Icu_00372 : Icu_DisableEdgeDetection Disable Edge Detection PUBLISHED	SWS_Icu_00372 : Icu_DisableEdgeDetection Disable Edge Detection
 MCAL-6916 - SWS_Icu_00375 : Icu_DisableEdgeDetection configuration parameter IcuEdgeDetectApi IcuEdgeDetectApi PUBLISHED	SWS_Icu_00375 : Icu_DisableEdgeDetection configuration parameter IcuEdgeDetectApi

Design Identifier	Description
 MCAL-6935 - SWS_Icu_00373 : Icu_DisableEdgeDetection Re-entrancy PUBLISHED	SWS_Icu_00373 : Icu_DisableEdgeDetection Re-entrancy
 MCAL-6897 - SWS_Icu_00376 : Icu_DisableEdgeDetection DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00376 : Icu_DisableEdgeDetection DET ICU_E_PARAM_CHANNEL

6.1.14 Icu_DisableEdgeCount

Refer section 8.3.18 of [References 1 - AUTOSAR 4.3.1](#)

Design Identifier	Description
 MCAL-7095 - SWS_Icu_00079 : Icu_DisableEdgeCount Disable Edge Count PUBLISHED	SWS_Icu_00079 : Icu_DisableEdgeCount Disable Edge Count

Design Identifier	Description
 MCAL-7056 - SWS_Icu_00330 : Icu_DisableEdgeCount Re-entrancy PUBLISHED	SWS_Icu_00330 : Icu_DisableEdgeCount Re-entrancy
 MCAL-6981 - SWS_Icu_00103 : Icu_DisableEdgeCount Pre compile parameter IcuEdgeCountApi PUBLISHED	SWS_Icu_00103 : Icu_DisableEdgeCount Pre compile parameter IcuEdgeCountApi
 MCAL-7070 - SWS_Icu_00331 : Icu_DisableEdgeCount configuration parameter IcuEdgeCountApi PUBLISHED	SWS_Icu_00331 : Icu_DisableEdgeCount configuration parameter IcuEdgeCountApi
 MCAL-6962 - SWS_Icu_00173 : Icu_DisableEdgeCount DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00173 : Icu_DisableEdgeCount DET ICU_E_PARAM_CHANNEL

6.1.15 Icu_GetEdgeNumbers

Refer section 8.3.19 of [References 1 - AUTOSAR 4.3.1](#)

Design Identifier	Description
 MCAL-7020 - SWS_Icu_00080 : Icu_GetEdgeNumbers Read Edge Count PUBLISHED	SWS_Icu_00080 : Icu_GetEdgeNumbers Read Edge Count
 MCAL-7044 - SWS_Icu_00332 : Icu_GetEdgeNumbers Re-entrancy PUBLISHED	SWS_Icu_00332 : Icu_GetEdgeNumbers Re-entrancy
 MCAL-6905 - SWS_Icu_00333 : Icu_GetEdgeNumbers configuration parameter ICU_EDGE_COUNT_API PUBLISHED	SWS_Icu_00333 : Icu_GetEdgeNumbers configuration parameter ICU_EDGE_COUNT_API
 MCAL-7143 - SWS_Icu_00174 : Icu_GetEdgeNumbers DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00174 : Icu_GetEdgeNumbers DET ICU_E_PARAM_CHANNEL

6.1.16 Icu_StartSignalMeasurement

Refer section 8.3.20 of [References 1 - AUTOSAR 4.3.1](#)

Design Identifier	Description
 MCAL-6937 - SWS_Icu_00140 : Icu_StartSignalMeasurement Default Edge Measurement PUBLISHED	SWS_Icu_00140 : Icu_StartSignalMeasurement Default Edge Measurement
 MCAL-7006 - SWS_Icu_00146 : Icu_StartSignalMeasurement Reset ICU_IDLE PUBLISHED	SWS_Icu_00146 : Icu_StartSignalMeasurement Reset ICU_IDLE
 MCAL-7017 - SWS_Icu_00142 : Icu_StartSignalMeasurement Pre compile parameter IcuSignalMeasurementApi PUBLISHED	SWS_Icu_00142 : Icu_StartSignalMeasurement Pre compile parameter IcuSignalMeasurementApi

Design Identifier	Description
 MCAL-7027 - SWS_Icu_00334 : Icu_StartSignalMeasurement Re-entrancy PUBLISHED	SWS_Icu_00334 : Icu_StartSignalMeasurement Re-entrancy
 MCAL-7106 - SWS_Icu_00335 : Icu_StartSignalMeasurement configuration parameter IcuSignalMeasurementApi PUBLISHED	SWS_Icu_00206 : Service name: Icu_DisableEdgeCount
 MCAL-7115 - SWS_Icu_00141 : Icu_StartSignalMeasurement ICU_MODE_SIGNAL_MEASUREMENT PUBLISHED	SWS_Icu_00141 : Icu_StartSignalMeasurement ICU_MODE_SIGNAL_MEASUREMENT
 MCAL-6918 - SWS_Icu_00176 : Icu_StartSignalMeasurement DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00176 : Icu_StartSignalMeasurement DET ICU_E_PARAM_CHANNEL



6.1.17 Icu_StopSignalMeasurement

Refer section 8.3.21 of [References 1 - AUTOSAR 4.3.1](#)

Design Identifier	Description
 MCAL-6939 - SWS_Icu_00143 : Icu_StopSignalMeasurement Stop Measurement PUBLISHED	SWS_Icu_00143 : Icu_StopSignalMeasurement Stop Measurement
 MCAL-6970 - SWS_Icu_00337 : Icu_StopSignalMeasurement configuration parameter IcuSignalMeasurementApi PUBLISHED	SWS_Icu_00337 : Icu_StopSignalMeasurement configuration parameter IcuSignalMeasurementApi
 MCAL-7063 - SWS_Icu_00336 : Icu_StopSignalMeasurement Re-entrancy PUBLISHED	SWS_Icu_00336 : Icu_StopSignalMeasurement Re-entrancy

Design Identifier	Description
 MCAL-7147 - SWS_Icu_00144 : Icu_StopSignalMeasurement ICU_MODE_SIGNAL_MEASUREMENT PUBLISHED	SWS_Icu_00144 : Icu_StopSignalMeasurement ICU_MODE_SIGNAL_MEASUREMENT
 MCAL-6908 - SWS_Icu_00145 : Icu_StopSignalMeasurement Pre compile parameter IcuSignalMeasurementApi PUBLISHED	SWS_Icu_00145 : Icu_StopSignalMeasurement Pre compile parameter IcuSignalMeasurementApi
 MCAL-7036 - SWS_Icu_00177 : Icu_StopSignalMeasurement DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00177 : Icu_StopSignalMeasurement DET ICU_E_PARAM_CHANNEL

6.1.18 Icu_GetTimeElapsed

Refer section 8.3.22 of [References 1 - AUTOSAR 4.3.1](#).

Design Identifier	Description
 MCAL-6924 - SWS_Icu_00340 : Icu_GetTimeElapsed Captured Time Expiry PUBLISHED	SWS_Icu_00340 : Icu_GetTimeElapsed Captured Time Expiry
 MCAL-6944 - SWS_Icu_00081 : Icu_GetTimeElapsed Elapsed Signal Low Time PUBLISHED	SWS_Icu_00081 : Icu_GetTimeElapsed Elapsed Signal Low Time
 MCAL-6990 - SWS_Icu_00083 : Icu_GetTimeElapsed Elapsed Signal Period Time PUBLISHED	SWS_Icu_00083 : Icu_GetTimeElapsed Elapsed Signal Period Time
 MCAL-6975 - SWS_Icu_00105 : Icu_GetTimeElapsed Pre compile parameter IcuGetTimeElapsedApi IcuGetTimeElapsedApi PUBLISHED	SWS_Icu_00105 : Icu_GetTimeElapsed Pre compile parameter IcuGetTimeElapsedApi

Design Identifier	Description
 MCAL-6966 - SWS_Icu_00136 : Icu_GetTimeElapsed Captured Time PUBLISHED	SWS_Icu_00136 : Icu_GetTimeElapsed Captured Time
 MCAL-6951 - SWS_Icu_00082 : Icu_GetTimeElapsed Elapsed Signal High Time PUBLISHED	SWS_Icu_00082 : Icu_GetTimeElapsed Elapsed Signal High Time
 MCAL-7000 - SWS_Icu_00341 : Icu_GetTimeElapsed configuration parameter IcuGetTimeElapsedApi PUBLISHED	SWS_Icu_00341 : Icu_GetTimeElapsed configuration parameter IcuGetTimeElapsedApi
 MCAL-7051 - ECUC_Icu_00219 : IcuConfigSet PUBLISHED	ECUC_Icu_00219 : IcuConfigSet

Design Identifier	Description
 MCAL-7052 - SWS_Icu_00339 : Icu_GetTimeElapsed Requested Time Ongoing PUBLISHED	SWS_Icu_00339 : Icu_GetTimeElapsed Requested Time Ongoing
 MCAL-7092 - SWS_Icu_00338 : Icu_GetTimeElapsed Re-entrancy PUBLISHED	SWS_Icu_00338 : Icu_GetTimeElapsed Re-entrancy
 MCAL-7124 - SWS_Icu_00179 : Icu_GetTimeElapsed DET Return Zero PUBLISHED	SWS_Icu_00179 : Icu_GetTimeElapsed DET Return Zero
 MCAL-7066 - SWS_Icu_00178 : Icu_GetTimeElapsed DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00178 : Icu_GetTimeElapsed DET ICU_E_PARAM_CHANNEL

6.1.19 Icu_GetDutyCycleValues

Refer section 8.3.23 of [References 1 - AUTOSAR 4.3.1](#).

Design Identifier	Description
 MCAL-6902 - SWS_Icu_00345 : Icu_GetDutyCycleValues configuration parameter IcuGetDutyCycleValuesApi PUBLISHED	SWS_Icu_00345 : Icu_GetDutyCycleValues configuration parameter IcuGetDutyCycleValuesApi
 MCAL-6914 - SWS_Icu_00084 : Icu_GetDutyCycleValues Read Coherent Active Time PUBLISHED	SWS_Icu_00084 : Icu_GetDutyCycleValues Read Coherent Active Time
 MCAL-6969 - SWS_Icu_00342 : Icu_GetDutyCycleValues Re-entrancy PUBLISHED	SWS_Icu_00342 : Icu_GetDutyCycleValues Re-entrancy
 MCAL-6979 - SWS_Icu_00181 : Icu_GetDutyCycleValues DET Return Zero PUBLISHED	SWS_Icu_00181 : Icu_GetDutyCycleValues DET Return Zero



Design Identifier	Description
MCAL-7019 - SWS_Icu_00343 : Icu_GetDutyCycleValues Requested Time Ongoing PUBLISHED	SWS_Icu_00343 : Icu_GetDutyCycleValues Requested Time Ongoing
MCAL-6904 - SWS_Icu_00106 : Icu_GetDutyCycleValues Pre compile parameter IcuGetDutyCycleValuesApi PUBLISHED	SWS_Icu_00106 : Icu_GetDutyCycleValues Pre compile parameter IcuGetDutyCycleValuesApi
MCAL-7103 - SWS_Icu_00137 : Icu_GetDutyCycleValues Captured Time PUBLISHED	SWS_Icu_00137 : Icu_GetDutyCycleValues Captured Time
MCAL-7130 - SWS_Icu_00344 : Icu_GetDutyCycleValues Captured Time Expiry PUBLISHED	SWS_Icu_00344 : Icu_GetDutyCycleValues Captured Time Expiry

Design Identifier	Description
 MCAL-7073 - SWS_Icu_00180 : Icu_GetDutyCycleValues DET ICU_E_PARAM_CHANNEL PUBLISHED	SWS_Icu_00180 : Icu_GetDutyCycleValues DET ICU_E_PARAM_CHANNEL

6.1.20 Icu_GetVersionInfo

Refer section 8.3.24 of [References 1 - AUTOSAR 4.3.1](#)

Design Identifier	Description
 MCAL-7043 - SWS_Icu_00356 : Icu_GetVersionInfo DET ICU_E_PARAM_VINFO PUBLISHED	SWS_Icu_00356 : Icu_GetVersionInfo DET ICU_E_PARAM_VINFO



6.1.21 Icu_RegisterReadback

	Description	Comments
Service Name	Icu_RegisterReadback	Can be potentially turned OFF
Syntax	Std_ReturnType Icu_RegisterReadback(Icu_ChannelType Channel, P2VAR(Icu_RegisterReadbackType, AUTOMATIC, ICU_APPL_DATA) RegRbPtr)	Icu_RegisterReadbackType defines the type, that holds critical values, refer below
Sync / Async	Sync	
Reentrancy	Non Reentrant	
Parameter in	Icu_ChannelType Channel	Numeric identifier of the ICU channel

Parameters out	RegRbPtr	A pointer of type Icu_RegisterReadbackType which holds the read back values
Return Value	Standard return type	E_OK or E_NOT_OK in case of Icu not initialized or NULL buffer pointer
Design Identifier	Description	
 MCAL-6903 - ICU Safety Diagnostics: CAP3: Periodic Software Readback of Static Configuration Registers PUBLISHED	ICU Safety Diagnostics: CAP3: Periodic Software Readback of Static Configuration Registers	



Design Identifier	Description
MCAL-6980 - ICU Safety Diagnostics: CAP4: Software Readback of Written Configuration PUBLISHED	ICU Safety Diagnostics: CAP4: Software Readback of Written Configuration

6.2 Global Variables

This design expects that implementation will require to use following global variables.

Variable	Type	Description	Default Value
Icu_DrvObj	Icu_DriverObjType	Icu driver object	-
Icu_DrvStatus	uint8	Driver Status	ICU_STATUS_UNINIT



7 Performance Objectives

7.1 Resource Consumption Objectives

	ROM - Data(KB)	RAM - Program(KB)	RAM - Data(KB)	Stack Size (KB)	EEPROM (KB)	% CPU Utilization
5	NA	NA	1	2	NA	NA

ROM - Program(KB)

7.2 Critical timing and Performance

Not Applicable

8 Decision Analysis & Resolution (DAR)

8.1 Signal Measurements API Design flow

Sections below list some of the important design decisions and rational behind those decision.

No.	Decision Criteria	Alternatives	Selected alternative	Rationale	Trade-offs
1	Signal Measurements API could be implemented using either interrupt based or non-interrupt based functionality.	<p>The most efficient(least time delay) method shall be chosen. Also, the method which complies best with AUTOSAR specification will be analyzed.</p> <p>1. Use Interrupt based functionality</p> <p>Advantages:</p> <ul style="list-style-type: none"> • A notification can be generated when the signal measurement information has been successfully captured. • Application need not take care to ensure that information has been captured before calling the data gathering API. <p>Disadvantages:</p>	Use of non-Interrupt based functionality .	Use of non-Interrupt based functionality is chosen as it will ensure that there are no deviation from AUTOSAR specification.	

No.	Decision Criteria	Alternatives	Selected alternative	Rationale	Trade-offs
		<ul style="list-style-type: none"> • Some subsequent edges can be lost while processing the ISR. • The AUTOSAR specification does not mention ISR/notification handling for Signal Measurements functionality. If implemented through Interrupt functionality, it would be a deviation from AUTOSAR specification. <p>2. Use non-Interrupt based functionality.</p> <p>Advantages:</p> <ul style="list-style-type: none"> • Easier implementation and simpler integration. • Runtime will be more efficient as ISR processing will be eliminated. 			

No.	Decision Criteria	Alternatives	Selected alternative	Rationale	Trade-offs
		<ul style="list-style-type: none"> • Code size will be reduced as the application will take care of the timing assumptions. • User given the flexibility to handle the delay as they wish in the application. This can be done using several means, one being added time delay. • This implementation complies best with AUTOSAR provided requirements. <p>Disadvantages:</p> <ul style="list-style-type: none"> • Application needs to take care to add some delay after call of Icu_StartSignalMeasurement() API to ensure that there is sufficient time for the module to capture all required data. 			

9 Testing Guidelines

The sections below identify some of the aspects of design that would require emphasis during testing of this design implementation



- **Validating ECUC parameters**

- Validating ECUC Parameter: Configuration for each test case shall be generated by EB Tresos command line.

The sections below identify some of the aspects of design that would require emphasis during testing of this design implementation

- **ICU Signal Measurements : Duty Cycle, High Time, Low Time, Period Time**

- Test cases shall check the input signal wave and the signal measurements calculated by the ICU module match. The input signals can be tested using the MCAL EPWM module input.



10 Template Revision History

Author Name	Description	Version	Date
Krishna	Updated based on ASPICE requirements	0.8	20 Aug 2020
Krishna	Updated based on the feedback from Jon N	0.9	09 Oct 2020
Krishna	Updated the traceability scheme	1.0	17 Dec 2020
Yaniv Machani	Initial version	0.1	03 Oct 2018
Yaniv Machani	Updated to include EP views	0.4	02 Nov 2018



Author Name	Description	Version	Date
Yaniv Weizman	Restructuring and editing to further meet the A-SPICE and EP requirements	0.5	27 Dec 2018
Yaniv Weizman	Adding link to Architecture review template	0.6	22 Oct 2019
Yaniv Weizman	Adding requirement type column for requirements table (Functional/Non-Functional). Adding DAR table	0.65	13 Nov 2019
Yaniv Weizman	Adding tables for Testing guidelines	0.7	18 Nov 2019



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