

## AUTOSAR Software Overview AMF-AUT-T0022

#### **Rebeca Delgado** Field Applications Engineer

September 2013

## Freescale in Automotive

#### Freescale Leadership in Driving Standards

- First semiconductor supplier to join the AUTOSAR partnership
- Active member of JASPAR
- Member of GENIVI
- Co-founded Open Alliance on Ethernet for Automotive

#### Broadest Automotive MCU Product Portfolio

 Auto-qualified products (8/16/32-bit MCUs & MPUs) span body electronics, powertrain, safety and chassis and driver information systems.

#### Customer Relationships

 Freescale has solid, long-standing customer relationships with nearly every automotive manufacturer and Tier 1 supplier in the world

#### Long-term Global Presence

 Freescale has what it takes to meet the stringent requirements of the global automotive market





Freescale provides software products where in-depth hardware knowledge is crucial – including AUTOSAR MCAL and OS, Core Self Test, and application-specific libraries to address unique hardware features.





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### Freescale Automotive Software - Global Support





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# NP\_-bit Automotive Software Product Overview by Segment

	Body	Chassis/Safety	Powertrain
	560xB/C/D, 564xB/C, 5668G	560xP, 560xE, 564xL, 567xK	563xM, 564xA, 567xF
AUTOSAR 3.x AUTOSAR 4.0	MCAL OS	MCAL OS	MCAL OS
Non-AUTOSAR (Prod Code)		Eth Streaming SW Camera Appl SW	
Non-AUTOSAR (Demo Code)	Flash / EE Drv	Flash / EE Drv Motor Control Lib	Flash / EE Drv eTPU Lib
Safety	Instruct	ion based Core Self Test (e20 Core Self Test 60%	0 cores)

#### Not all shown products are available for all MCUs





### **AUTOSAR – Global Automotive Software Standard**

AUTOSAR aims to improve complexity management of integrated E/E architectures through increased reuse and exchangeability of SW modules between OEMs and



- Hardware and software is widely independent of each other.
- Development can be de-coupled by horizontal layers. Reduces development time and costs.
- Reuse of software enabled at OEM and at suppliers. Enhances quality and efficiency.



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## AUTOSAR Architecture



![](_page_7_Picture_2.jpeg)

#### Source: AUTOSAR Development Partnership

## AUTOSAR – Global Automotive Software Standard

- Benefits for car manufacturer
  - Establish development distribution among suppliers
  - Compete on innovative functions with increased design flexibility
  - Simplify software and system integration
  - Reduce cost of overall software development
- Benefits for supplier
  - Reduce version proliferation
  - Reuse software modules across car manufacturers
  - Increase efficiency of application development

#### Volume of ECUs with AUTOSAR

![](_page_8_Figure_11.jpeg)

- Members represent about 80% of worldwide car production.
- In 2016 approx 25% of ECUs will be based on AUTOSAR.

Source: AUTOSAR

#### Source: AUTOSAR Development Partnership

![](_page_8_Picture_16.jpeg)

Presents, the Freeholds logs, AVNex, C.S., Codo/ESF, Cado/Marcin, OxeFine, OxeFine, OxeFine, OxeFine, Devergy Ethiert Soldions logs, Kiteta, incoludoT, PSD, Preve/GMCC, Processor Reserv, CortD, Sonna, EsthAnama, Inst SaleAnama, Inst SaleAnama, Sanger, Sanger, Sanger, SaleAnama, SaleAn **Reusability of BSW Modules and SW Components** 

![](_page_9_Figure_1.jpeg)

Antari, Beefin, BeeStack, CareNet, Flests, Layerscope, MignY, MRC, Pattorn in a Pacturge, GorG Gorwege, GUIDC Engine, Ready Play, SWUTMOS, Trever, TurboLink, Vytmit and Ethnic an Endertonia of Presson Remiconductor, No. All other product or solvice names are the property of their respective elements. C 2011 Presson Section ductor, Inc.

## Freescale AUTOSAR Products

- Freescale offers cost effective production-ready MCAL and OS
- What the customer gets:
  - From Freescale (shaded blue below): MCAL (source code), OS (source code) and supporting Configuration Tool (executable).
  - From Partners (Elektrobit, Vector, KPIT, etc.) The rest of AUTOSAR basic software as needed. Partner does integration (Freescale IP + Partner IP + Customer IP)

![](_page_10_Figure_5.jpeg)

![](_page_10_Picture_6.jpeg)

## AUTOSAR MCAL Product

- MCAL drivers for each MCU peripheral, compliant to AUTOSAR 2.1 / 3.x / 4.0
- AUTOSAR 2.1/3.0 MCAL: excl. RamTst module
- AUTOSAR 4.0 MCAL: excl. RamTst, CoreTst, FlashTst modules
- All components configurable in any AUTOSAR-compliant configuration tool
- Configuration Tool EB tresos StudioTM and plug-ins are part of the product

![](_page_11_Figure_6.jpeg)

![](_page_11_Picture_7.jpeg)

## AUTOSAR Operating System

- Configurable in AUTOSAR configuration tool
- Available in Scalability Classes 1, 2, 3, 4 to fit the needs of different applications
  - SC1 deterministic RTOS baseline (tasks, events, counters, alarms, messages)
  - SC2 timing based task determinism (low-latency, precise timing for periodic tasks)
  - SC3 protected memory (MMU/MPU) for tasks avoids memory collisions for safety systems
  - SC4 timing and memory protected tasks, utilizes the full capabilities of the silicon for secure and protected RTOS designed specifically for the automobile.
- Availability of SC2,3,4 depends on MCU family / presence of MPU

![](_page_12_Figure_8.jpeg)

![](_page_12_Picture_9.jpeg)

Presents: The Freesewite logs: MONex, D.S. Code/EST, Code/Este, Oxf/Fire, Oxf/Fire, Oxf/Fire, Different Soldions legs: Monex, mode/s01, PEG, PreverQUCC, Processor Royer, CorD, Carros, Earlehauer, Na Salekauer Rog, StatCare, Strafferey and Vorlab are trailereade of Freezewite Reserved Samcconducts; to: Deg U.S. Fire, Thr. Oth. Antar, Bel/R, BedStack, Careker, Rest, Layrenage, Migry, MRC, Pathon et a Pantage, OxfO Gonverg, UXCC Teger, Robin Pay, StatCare, Tabolan, Vytral and Tamica as before a File-Reserved Reserved Astron. Science Samo are to anyone means are to anyone; if the respective areas as 2011 Freedak Samcconducts; to: Science.com

## AUTOSAR Documents

- Released AUTOSAR documents can be found at <u>www.autosar.org</u>
- 2 documents exist for each BSW module:
  - SRS: Software requirement specification
  - SWS: Software Specification
- The **SRS** describes requirements, that must be fulfilled by a Basic Software Module (BSW).
  - Chapters of SRS documents
    - Chapter 1 defines the area of application of the BSW
    - Chapter 2 defines the structure of the document
    - Chapter 3 defines the acronyms used in that document
    - Chapter 4 is the main chapter.
    - Contains a brief description of the BSW functional overview and continues with the requirements.

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![](_page_13_Picture_12.jpeg)

## AUTOSAR Documents

- The SWS(Software Specification) contains the most detailed information for each Basic Software Module
- Each SWS document is structured as follows:
  - Chapter 1 –introduction and brief overview of functional behavior of the BSW
  - Chapter 2 –used acronyms
  - Chapter 3 referenced documents
  - Chapter 4 restrictions and applicability for the automotive domain
  - Chapter 5 relation to other BSW modules and the file structure of the BSW
  - Chapter 6 –requirement matrix containing links to requirements from the related SRS document
  - Chapter 7 & 8 contain the description of the:
    - functional behavior of the BSW
    - applications programming interface (API)
  - Chapter 9 –Message sequence charts are used to describe the sequential behavior of a SWC in relation to other SWCs
  - Chapter 10 possibilities of configuration are defined
  - Chapter 11 Release changes are documented

![](_page_14_Picture_15.jpeg)

## BSW Configuration Classes

- Pre-compile configuration
  - Configuration parameters can not be changed after compilation
  - Example: Mapping of microcontroller pins to signals
- Link-time configuration
  - Configuration is determined by linker scripts
  - Configuration parameters can not be changed after link process
  - Purpose: provides capability to deliver object code to the integrator
- Post-build configuration
  - Post-build time loadable
    - Configuration parameters can be changed after build process without complete re-flash of ECU
  - Post-build time selectable
    - Configuration parameter set is selected from multiple configuration sets during boot time
    - All possible configuration sets need to be included at compile time
  - Configuration parameters are stored at a known memory location
  - Post-build configuration class BSW modules might also contain pre-compile or link-time parameters (not all parameters have to be post-build)
  - Purpose: use one software package in different vehicles

![](_page_15_Picture_17.jpeg)

![](_page_16_Picture_0.jpeg)

### **AUTOSAR and ISO26262**

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![](_page_16_Picture_3.jpeg)

## ISO 26262 : Automotive Norm on Functional Safety

- ISO 26262 is a Functional Safety standard applicable to automotive systems. This norm is an adaptation of the Functional Safety standard IEC 61508.
- ISO 26262 is applied to ensure that electronic systems in automotive applications are completely safe. Thus it covers functional safety aspects of the entire development process, including requirements specification, design, implementation, integration, verification, validation, and configuration.

#### Figure 1: Functional Safety Standards Details

Standar	rds Defined		Level Con	nparison	Failure N	leasures	New Policy	
	Generic industry standard, applicable to electrical/electronic/programmable electronic safety-related systems		No direct correlation for SIL and ASIL levels		IEC 61508		<ul> <li>Information is more</li> </ul>	
					SIL Random HWFR target		structured in ISO 26262	
IEC	Integrity levels	SIL 1 SIL 2	SIL ASII (IEC) (ISC	ASIL	4	≥10 <sup>.9</sup> to <10 <sup>.8</sup>	<ul> <li>Concept of safety culture</li> </ul>	
61508	integrity levele	SIL 3, SIL 4		(ISO)	3	≥10 <sup>-8</sup> to <10 <sup>-7</sup>	exists in ISO 26262	
9:	Publication date	More than 10 years ago	4		2	≥10 <sup>.7</sup> to <10 <sup>.6</sup>	2.	
				D	1	≥10 <sup>-6</sup> to <10 <sup>-4</sup>	Terminology is well defined	
	Automotive industry standard,		3		ISO 26262		in ISO 26262 (safety plan, safety case, work products.	
	electronic systems	in road vehicles		C	ASIL	Random HWFR target	confirmation measure, etc.)	
ISO 26262	Integrity levels	ASILA, ASILB,	2	в	D	<10 <sup>-8</sup> h <sup>-1</sup>	Bolos and responsibilities	
20202	ASILC, ASILD				с	<10 <sup>-7</sup> h <sup>-1</sup>	are better defined in	
	Publication date	Dication date Target end 2011		A	в	<10 <sup>-7</sup> h <sup>-1</sup>	ISO 26262, (PM, safety manager)	

Source: Adressing the Challenges of Functional Safety in Industrial and Automotive Markets, White Paper, 2012, www.freescale.com

![](_page_17_Picture_6.jpeg)

![](_page_18_Picture_0.jpeg)

![](_page_18_Picture_1.jpeg)

#### **Functional Safety. Simplified.**

**Simplifies the process** of system compliance, with solutions designed to address the requirements of automotive and industrial functional safety standards

Reduces the time and complexity required to develop safety systems that comply with ISO 26262 and IEC 61508 standards Supports the most stringent Safety Integrity Levels (SILs), enabling designers to build with confidence

Zero defect methodology from design to manufacturing to help ensure our products meet the stringent demands of safety applications

![](_page_18_Picture_7.jpeg)

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![](_page_19_Figure_1.jpeg)

![](_page_19_Picture_2.jpeg)

### NPPICE Capability Level 3 in all Process Areas (HIS-Scope) – since 2010

		Assessment					
ID	Process Name	PA 1.1	PA 2.1	PA 2.2	PA 3.1	PA 3.2	Cap. Level
MAN.3	Project Managment	F	F	F	L	F	3
ENG.4	Analysis	F	F	F	F	F	3
ENG.5	Software Design	F	F	F	F	F	3
ENG.6	Software Construction	F	F	F	F	F	3
ENG.7	Software Integration Test	F	F	F	L	L	3
SUP.1	Quality Assurance	F	F	F	F	F	3
SUP.8	Configuration Management	F	F	F	F	F	3
SUP.9	Management	F	F	F	F	F	3
SUP.10	Change Request Management	F	F	F	F	F	3

F: Fully achieved L: Largely achieved

![](_page_20_Picture_3.jpeg)

Presents, the Freetook log, AVNo, C.S., Cob/EST, CadiMarcin, OxfFre, OxfFre, OxfFre, Oxfer, Structure, Statistics and Structure, Statistics and Structure, Structure, Statistics, Statisti

## Automotive Software for ISO 26262

- Support efficient achievement of systemlevel safety goals up to ASIL-D
  - Safety with minimized performance degradation
  - Safety simplified for integrators
  - Cross-platform consistent architecture
- Support achievement of hardware architectural metrics up to ASIL-D

![](_page_21_Figure_6.jpeg)

![](_page_21_Picture_7.jpeg)

## Summary

- Freescale's mission is to be the benchmark provider for silicon and software that enables our customers to build scalable platforms for automotive body, powertrain, safety and chassis, and driver information systems.
- Since several years Freescale successfully delivers production ready AUTOSAR MCAL and OS software. Freescale now expands its software roadmap to support our SafeAssure program, as well as Automotive Ethernet, Motor Control, and Radio solutions.

![](_page_22_Figure_3.jpeg)

### Silicon + Software + Services + Support

![](_page_22_Picture_5.jpeg)

![](_page_23_Picture_0.jpeg)

## AUTOSAR Configuration Methodology / Tool

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![](_page_23_Picture_3.jpeg)

## Basic Software Configuration Process

![](_page_24_Figure_1.jpeg)

![](_page_24_Picture_2.jpeg)

## Static configuration

![](_page_25_Figure_1.jpeg)

- Static configuration allowes to change code behaviour dependent on configuration parameters
- Functionality can be designed to be statically defined instead of definition during runtime, e.g. Creating tasks in configuration instead of during runtime with a function
- ⇒lower memory footprint, faster execution, scalable/tailored to the application needs

![](_page_25_Picture_5.jpeg)

## EB tresos Studio

- EB tresos Studio is an easy-to-use tool for ECU standard software configuration, validation and code generation
- Full support for the AUTOSAR standard
- Full support for the Freescale AUTOSAR software and the EB tresos AutoCore

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Source: Elektrobit

![](_page_26_Picture_6.jpeg)

- Integrated, graphical user interface
- Based upon Eclipse and open standards
- Online-help and parameter-specific help

![](_page_26_Figure_10.jpeg)

![](_page_26_Picture_11.jpeg)

Presents, the Freesewite login. Motivo, D.S., Code/EEF, Oxde/Warrish, Oxde/Fire, Oxde/Fire, Oxde/Ware, Televisty Efficient Solutions legin, Minuta, mediated). (PEG, ReverGUCC). Processor Gaper, Caroli, Garnan, Earlandauan, Rei Salekauar logi, Staticine, Bandraray and Vortilla var statienation of Freesewite Wareconducter, too, Eng. U.S. Ryt. 87 no. 08 Antary, Bankit, BeeStack, Carolive, Reas, Lagrenages, Magny, MRC, Parther et al. Pertuga, OxfC Genergia, UKCC Engine, Ready Fey, Statiffication, Traver, Tubolanik, Vyhral and Timola and Nationals of Freesona Bantaconducter, for XX Ontor protein or evolve names for the antary of the Independent evolution and the Statification of Colling Reads (SUI) Freevel Scholandauro, Intel and Timola and Nationals of Freesona Bantaconducter, for XX Ontor protein or evolve names for the antary of the Independent evolution and the Statification of Collin Televeloc Bantaconducter, Intel Antary, Statification of Freesona Bantaconducter, for XX Ontor protein or evolve names for the antary of the Independent evolution and the Statification of the Independent evolution of the Independent evolution and th

![](_page_27_Picture_0.jpeg)

Freescale AUTOSAR Integration Partners receive Freescale MCAL and OS releases for pre-integration into their proprietary AUTOSAR BSW products

![](_page_27_Picture_2.jpeg)

![](_page_27_Picture_3.jpeg)

## LITOSAR BSW Configuration Tool Example: tresos® ECU

- Graphical
- representation of ECU configuration description (ECD)
- Import/export of ECD
- Easy configuration of AUTOSAR BSW using precompile methodology

![](_page_28_Picture_5.jpeg)

![](_page_28_Picture_6.jpeg)

## **Parameter Description Files – XDM**

![](_page_29_Figure_1.jpeg)

Source: Elektrobit

![](_page_29_Picture_3.jpeg)

## Parameter Description Files – EPD/EPC

![](_page_30_Figure_1.jpeg)

![](_page_30_Picture_2.jpeg)

![](_page_31_Picture_0.jpeg)

### **Parameter Description Files – Beyond MCAL**

![](_page_31_Figure_2.jpeg)

Source: Elektrobit

![](_page_31_Picture_4.jpeg)

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![](_page_32_Picture_0.jpeg)

![](_page_32_Picture_1.jpeg)

Source: Elektrobit

![](_page_32_Picture_3.jpeg)

Errors & Warnings

![](_page_33_Picture_1.jpeg)

Source: Elektrobit

![](_page_33_Picture_3.jpeg)

Presents, the Freezete Logs, MNIvo, D.S., Code/EST, OndeWarris, OndFire, ColdFire, Col

Parameter Definition

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<pre><short-name>Hardware</short-name> and its corresponding</pre>	
<short-name>SOFTWARE</short-name>	
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Source: Elektrobit

![](_page_34_Picture_3.jpeg)

Pressure, the Freesede logs, AMNo, C.S., Color/ESF, CadelMarrico, DirPire, Dollaries, D. Main, Into Energy Ethinet: Solutions regis Xinese, model/CE, PEG, Preve/CACC, Processor Reper, CacHJ, Carnas, Earthouse, Into Catherane logs, RacCare, Springery and Voralla and stratements of Freezed Interconductor, the Solution of the Catherane logs, RacCare, Springery, and Voralla, and stratements of Freezed Interconductor, the Solution of the Solution of the Catherane logs, RacCare, Springer, Solution of the Solution of the Solution, Catherane logs, RacCare, Springer, Solution, Catherane, Solution, Solution,

![](_page_35_Picture_0.jpeg)

### Software Release Framework

Energianis, the Prospective Logis, ARMin, C.S., CookeTST, Dodolforma, Califfrin, Collithers, C.Waru, the Energy Efficient/Solutions logis, Netesta, incluines 7405, Rever(2ACC, Provision Depent 2000), Quiving SafeWorker, Nether Jada/Sacon Egg, Safetzen, Synaphing and Yarob, and Indexed Dependent Dependence, Inc., Reg. U.S. Pat, & Thr, Off, Nichot, Berella, Restinak, Coanner, Reva, Lagencase, Magnik, Moz, Rostom in a Package, Dario Daviergia, GUICC English, Baady Plan, SAAR/WINS, Towan, Tachstlank, Veferil and Xinnai and Indexeduations (Inc. Congress, Baady Plan, SAAR/WINS, Towan, Tachstlank, Veferil and Xinnai and Indexeduations). Comparison of the package of service names are the property of their respective owners, in 2013 Triescale Serviceduator, Inc.

![](_page_35_Picture_3.jpeg)

### AUTOSAR Software Release Framework - Overview

- Early Access Release EAR (Lead customers only)
  - Includes a subset of MCAL Drivers with limited testing coverage
  - No Quality Documentation
- BETA Release (all customers)
  - Includes all MCAL Drivers (Feature Complete) fully verified and documented
  - Includes Integration Testing
  - Complete Quality Package
- Release to Market Candidate RTMC (all customers)
  - Beta criteria +
  - 100% Decision Coverage for one configuration
  - No open S1 and S2 defects
- Customer Compiler Tests (no new release)
  - Specific for the provided customer compiler version and settings
  - Production Approval and starting point for frozen branch support if required by customer

![](_page_36_Picture_15.jpeg)

![](_page_37_Picture_0.jpeg)

### **Auto SW Release Framework - Details**

		EAR	Beta	RTM-C
Content	Product scope	subset of MCAL drivers	full set of MCAL drivers	full set of MCAL drivers
Documentation	Technical	subset of user documentation	full user documentation	full user documentation
	Quality docs	no	Complete quality package	Complete quality package
Testing	Used HW	first samples	unqualified samples	qual-intent samples
	Test coverage	limited test coverage	all drivers fully verified, 100% of tests successfully executed	all drivers fully verified, 100% of tests successfully executed <sup>1)</sup>
	Decision coverage	no	90% DC for one configuration	100% DC for one configuration
	Extended testing	no	includes integration testing	includes integration testing & EPD testing
Feature coverage		partial feature coverage	100% coverage of defined features	100% coverage of defined features
Release criteria	Error Status		No open S1 defects	No open S1 & S2 defects

<sup>1)</sup> During Beta and RTMC release work, tests are added:

- To cover additional features / functionality requested after BETA release
- · As test suite is continously extended and improved over time

![](_page_37_Picture_6.jpeg)

![](_page_38_Picture_0.jpeg)

## Microcontroller Abstraction Layer

Energianis the Prospeck logs, AENNE, C-3, ContREST, DokAMartin, ColdPin, Collines J, CWan, the Tempp Ethiclentical analysis logs, Netersia, modulini T-NG, RowerGARC, Prantisson Daper, Dardo, Quiviou, Sakhwane, Him, Sakhwane, Baro, Sakhon, Saynehmy end Yano, and mathematical Sectorization. Commun. Exercision, Symposium Big, U.S. Pat, & Thr, Off, Nichol, Berella, Berstrack, Caarinet, Flexik, Lypercuses: Magnik, Mot, Rodomin in a Package, Dario Darverga, GUICC Englisis, Baady Flox, SAAR/MINS, Towan, Tachalank, Veferint and Ximma and indexidance. Commun. Commun. Sakking Commun. Tachalank, Veferint and Ximma and indexidance. Commun. Commun. Commun. Commun. Commun. Commun. Commun. Commun. Commun. 2015; Heiner Langeston conversion, II 2013 Energian. Sakking Commun. Sakking Commun. Commun. 2015; Heiner Langeston: Conversion, III 2013 Energian. Sakking Commun. 2015; Heiner Langeston: Conversion, III 2013 Energian. Sakking Commun. 2015; Heiner Langeston: Conversion. 2013 Energian. Bartestandoutter, Inc.

## NP eescale Implementation MCAL Delivery File Structure

![](_page_39_Figure_1.jpeg)

![](_page_39_Picture_2.jpeg)

![](_page_39_Figure_3.jpeg)

Presents, the Presente Logic AWWs, 0-5, Cost/EST, CadeMarco, Gathrie, CottFree, Cottars, No Energy Ethient Solations logic Kester, included C. PEG, PreveCUCC, Processor Raser, Catrill, Darna, Esthéhaue, Ins. Statisture Sign StatCare, Sprintery and Vorsilla and unalisated or Energical Barcodutter, too, Reg. U.S. Pet. 370, 000 Antar; Seefit, SedStat, Carvier, Feas, Layerson, Mayrill, MCC, Pathren e a Pathog, Card Gonvey, CutoC Engine, Rady Pay, Statistive Vision, Cardina, Santar, Seefit, SedStat, Carvier, Feas, Layerson, Mayrill, Statistical Science Science, Cardina, Statistical Science Science, Cardina, Santar, Sa

## Peescale Implementation Topics

### **3 Layer Architecture**

- 3 Layer Architecture
  - AUTOSAR API
  - LLD: low level, IP independent
  - IP dependent

Gpt\_StartTimer(...)
/\* error reporting and detection \*/

![](_page_40_Picture_7.jpeg)

![](_page_40_Picture_8.jpeg)

![](_page_41_Picture_0.jpeg)

### MCAL Port and Dio Modules

Pressols, the Pressols logs, ARNis, C.S. ColumPST, DokeMarne, Exiditive, Collition, C.Wan, the Immyp Ethiciter Ecolumna logs, Natesia, incluine). TRG: Rever(2ACC, Pression: Repert, 2010), Opinion, SafeWaren, Hun, Markanan Bay, Sharton, Synaphing and Markana are instruments of Pressults Teacherinations. Inclution, 2010, 2011. Science, Synaphing and Markana are instruments of Pressults Teacherinations: Inclution, 2010, 2011, Clavinga, Calific English, Basel Nature, Steval, Layencage, Magnik, Mor, Partherin, and Package, Darily Clavinga, Calific English, Basel Nature, Steval, Layencage, Magnik, Mor, Partherin et visionasia. Comp Clavinga, Calific English, Basel Nature, Steval, Layencage, Magnik, Mor, Partherina et visionasia. Comp Clavinga, Calific English, Basel Nature, Steval, Calific Artherin, Steval and visionasia. Comp Clavinga, Calific English, Basel Nature, Steval, Calific Artherin, Steval et visionasia. Comp Clavinga, Calific English, Basel Nature, Steval, Calific Arthering, Steval Human, Calific Arthering, Calific English, Basel Nature, Steval, Calific Arthering, Steval Human, Calific Arthering, Calific English, Basel Nature, Steval, Calific Arthory, Steval Human, Steval, Steval, Steval, Steval, Steval, Steval, Calific Arthory, Steval Human, Steval, Steval, Steval, Steval, Steval, Steval, Steval, Steval, Calific Arthory, Steval, Steval, Human, Steval, Steval

![](_page_42_Picture_0.jpeg)

- Initialization of all pins and ports of the Mcu
- Reinitialization with alternate configurations at runtime possible
- Reconfiguration of pins at runtime
- Port Port Pin Function Assignment (GPIO, Adc, SPI, PWM, ...)
   Dio

Name for

Subset of

Adjacent pins

Channel Group

on one port

- PadSelection implicitly via HW assignment

Name for

Channel

Port pin

a Port Pin:

PortPin is the only structural element

•	No	initialization	(done	be	Port)
---	----	----------------	-------	----	-------

- Provides APIs to read and write GPIO ports/pins
- Requires an initialized Port module
  - pins/ports need to be initialized via Port module
  - no formal connection between Port and Dio Ecu Configurations
- API synchronous and unbuffered
- Consistent read and write services (interruptible read-modify-write not allowed)
- Structural Elements:
  - Channel (single pin)
  - ChannelGroup (adjacent pins in the same port)
  - Port (aggregates Channels and ChannelGroups)

![](_page_42_Picture_18.jpeg)

Driver:

DIO Driver

PORT Driver:

Name for

a whole

port

Port

Port

### Sort/Dio Module Functional Overview

Port
------

- Initialization of all pins and ports of the Mcu
- Reinitialization with alternate configurations at runtime possible
- Reconfiguration of pins at runtime
- Port Pin Function Assignment (GPIO, Adc, SPI, PWM, ...)
  - PadSelection implicitly via HW assignment
- PortPin is the only structural element

Driver:	Name for a Port Pin:	Name for Subset of Adjacent pins on one port	Name for a whole port
DIO Driver	Channel	Channel Group	Port
PORT Driver:	Port pin		Port

#### Dio

- No initialization (done be Port)
- Provides APIs to read and write GPIO ports/pins
- Requires an initialized Port module
  - pins/ports need to be initialized via Port module
  - no formal connection between Port and Dio Ecu Configurations
- API synchronous and unbuffered
- Consistent read and write services (interruptible read-modify-write not allowed)
- Structural Elements:
  - Channel (single pin)
  - ChannelGroup (adjacent pins in the same port)
  - Port (aggregates Channels and ChannelGroups)

![](_page_43_Picture_21.jpeg)

herecare, the Freenole logs. AVMex, C.S., Color/EST, Cadultanice, Cadifine, CVAFine, C.Maxe, Inv Energy Ethiant Soldions legs. Konto, mobileD, PSD, PreveGUCC, Processor Ecsew, CoVD, Samue, Esthehaum Kaya, Sanchara, Samphray and Vortilla and statements of Freezok Terroconductor, the U.S. File. Str., ORlenter, SeviR, BeetSack, ConVex, Frees, Layersona, MayW, MIC, Parther et a Pentage, Card Generage, Calcol Chipme, Radof Pay, SWATMOS, Tree, Turbolumi, Vynrill and Trease, and an antimication of Precision Benconductor, Neurophility, Activity and Antiana Terrora, and trease and an antimication of the Control Control of the Second Sec

### Strt/Dio Modules Freescale Implementation

![](_page_44_Figure_1.jpeg)

![](_page_44_Picture_2.jpeg)

Presents, the Freestativ logs, MWex, D.S. Code/EEF, CodeWarris, Old/Fire, CodeWarr, D.Ware, No Energy Ethinet Solidions legs, Kitela, includeD, PED, PreverQUCC, Processor Rayer, CodU, Carina, EarthAssan, the SateMazare logs StarCare, Symptrey and VorDia versitematics of Freestate Rayer, CodU, Antar, SeeRe, BeeStack, ConvAre, Ress, Layweap, Maryl, MRC, Partiere et a Package, Carin Converga, OLOC Engen, Rayer Nat, Park, SateMarol, Net, Natore, Net, Vanit, and Trans. an ethicities of Research Rayer, Vanit, Nat, Convergendant or Network and the Internative Tele Angeotae Sectional Sectional

# rt Module Origuration Pin Configuration

![](_page_45_Figure_1.jpeg)

![](_page_45_Picture_2.jpeg)

![](_page_46_Picture_0.jpeg)

defined by AUTOSAR

```
void Port_Init(
    const Port_ConfigType *ConfigPtr
)
```

- Initializes all Pins and Padselection Registers
- Reconfiguration at runtime possible
- Should be called also after reset

![](_page_46_Picture_6.jpeg)

Presents, the Freenance logs, AVWs, D.S. Code/EBT, Code/Marcin, Old/Fris, Collings, No:Evergy Ethiant Solutions logs, Kanta, endedolf, PSD, Preve/GMCC, Processing Rayer, Qurit, Damas, Edhekawa, Kai Salekawa, Kai Salekawa, Sarray, and Vordia and taskewa katego and the conduct and the Antari, Saleka, Backlas, Careka, Rass, Layeraga, Mayri, VRC, Pathere is a Pathoga, OxfG Gonvega, OxfCC Enges, Rady Rey, SMUTMOS, Tree, Tubolok, Vysnit and Tarrisa are tadentiss of Prevent Retrocoduum. In: All other product or anterior and and the strateging their Angelian and Strateging Careford Sectorations (et al. 2014).

![](_page_47_Picture_0.jpeg)

![](_page_47_Picture_1.jpeg)