# Introduction on ARM® Cortex®-M Kernel Based on Automotive MCUs
# Kinetis汽车微控制器和PowerPC汽车微控制器介绍

APF-ACC-T0983

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# A *Global Leader* in **Automotive MCU**
# 汽车微控制器供应商的领导者

**>50** Year Legacy

**>5,500** Engineers

**>6,000** Patent Families

**Five** Core Product Groups

- Microcontrollers
- Digital Networking
- Automotive MCU
- Analog & Sensors
- RF

**Four** Primary Markets

- Automotive
- Networking
- Industrial
- Consumer

Freescale shipped over **370M** automotive MCUs (>4 per car) in 2012
Freescale is in **approximately 50 million** new vehicles / year
飞思卡尔为市场提供超过3.7亿**片汽**车微控制器（平均每辆车超过**4片**），
**每年超**过五千万辆新车使用了飞思卡尔的汽车微控制器

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# The Freescale Global Presence 飞思卡尔在全球


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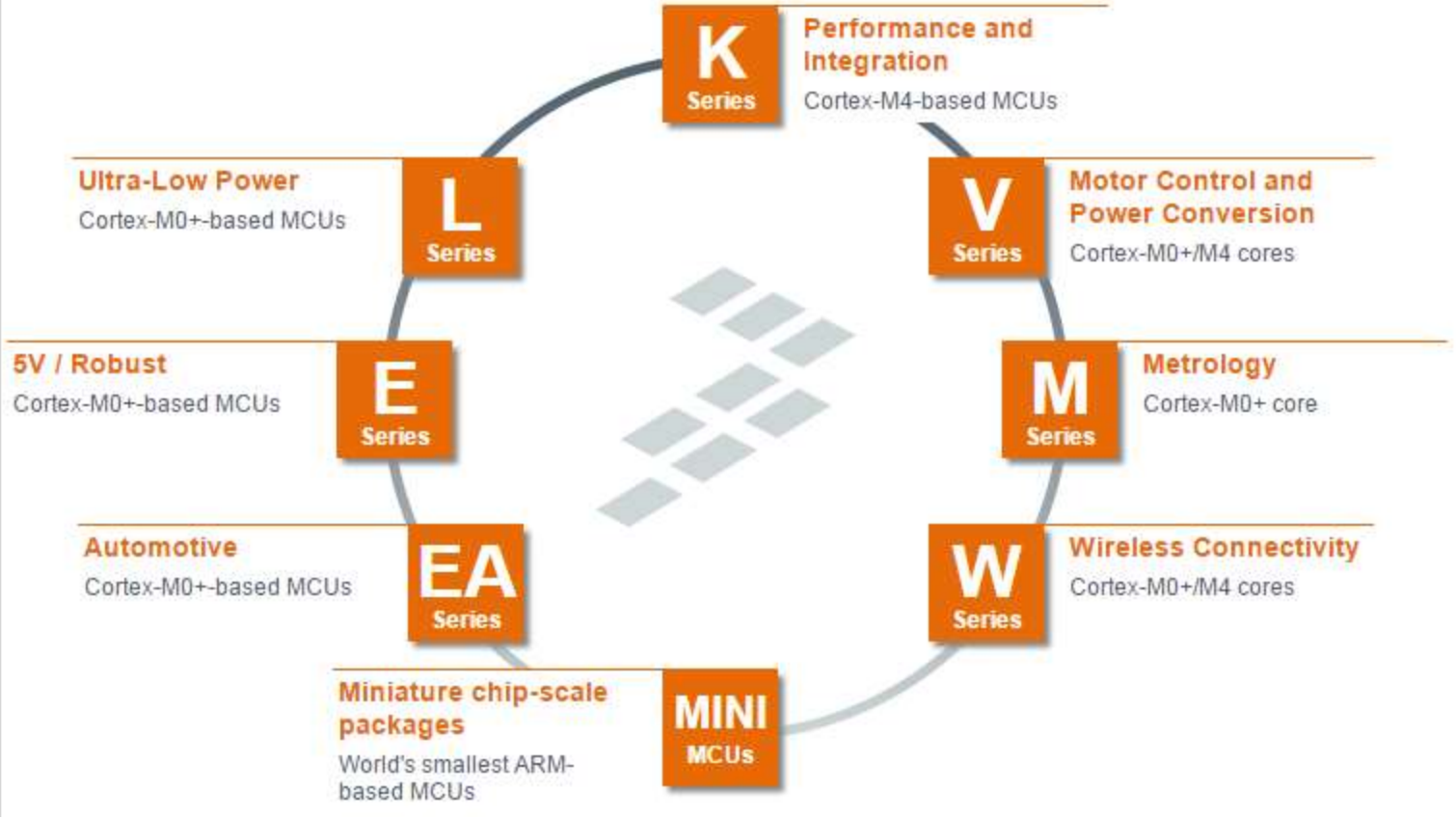
# 飞思卡尔半导体（中国）有限公司

- 飞思卡尔在中国的业务始于1992年
- 在中国拥有约4,000 名员工
- 拥有1 个天津装配和测试运营中心，该中心每周生产超过900万件半导体产品
- 北京、苏州、天津、上海和成都5个IC设计中心
- 北京、上海、深圳、香港、成都、青岛、西安、南京、武汉、重庆和长春11个销售办事处

# Kinetis Auto MCU: Automotive 32-bit ARM MCU
# 基于32位ARM内核的汽车微控制器

# Kinetis 32-bit MCU based on ARM Cortex-M Cores
# 基于ARM Cortex M内核的MCU产品

Kinetis Microcontrollers (MCUs) consist of multiple hardware- and software-compatible ARM® Cortex®-M0+ and -M4-based MCU series with an exciting new roadmap planned to include the new Cortex-M7 core. Kinetis MCUs offer exceptional low-power performance, scalability and feature integration.

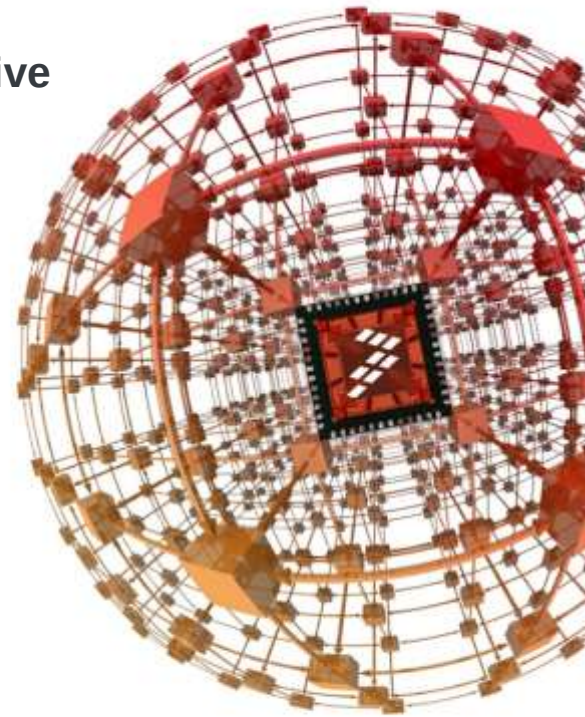


# Kinetis EA: Entry Level Automotive 32-bit ARM MCU

# Kinetis EA Series MCUs : ARM-Based 32-bit MCUs for Challenging Environments

# KEA是为严苛环境设计的汽车级ARM MCU

## Kinetis EA Series MCUs: 32-bit ARM-based MCUs for Automotive



- Based on a 32-bit ARM Cortex®-M0+ 48MHz core which equals high performance with ultra-low power
- 8K to 128K embedded flash, pin-to-pin compatible
- **AEC-Q100 qualified, -40°C to 125°C**
- **Enhanced ESD/EMC (6kV HBM)**
- **Automotive connectivity: CAN, LIN (UART), SPI and $I^2C$**
- **Automotive IPs: 12-bit ADC, ACMP, Timers (FTM, PWM, PIT, PWT, RTC)**
- $V_{DD}$ = 2.7 - 5.5 V, 3.3 V or 5 V convenience

**Start Your Design Easily Today!**

- **Most complete MCU + development environment**
- **24-hours to prototype, 2 months to production grade**
- Samples and Evaluation Boards (8K to 128KB)
- Qualification July 2014

ARM

# KEA128 Block Diagram 内部框图

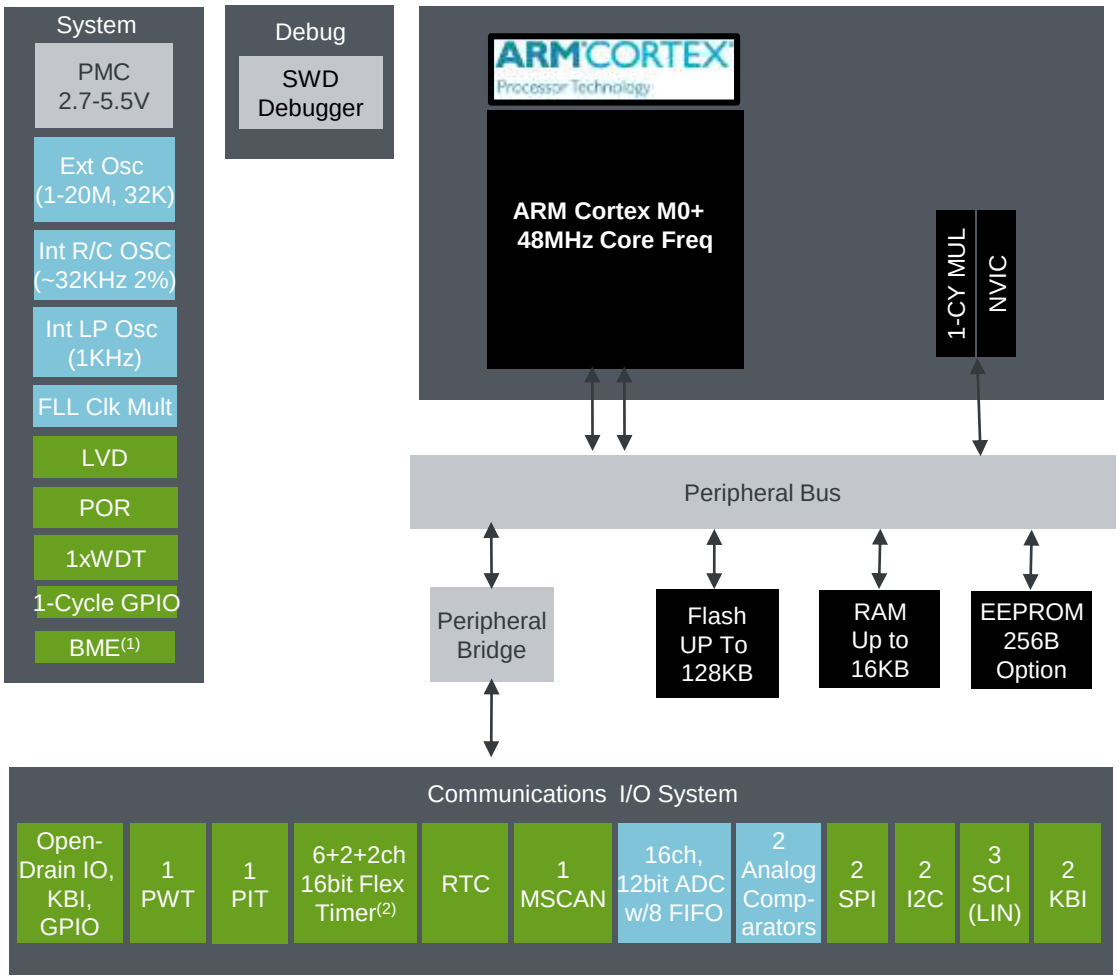
Digital Components | 5V Analogue Components | MCU Core and Memories

**Applications:**
- Automotive general purpose

**Operating Characteristics:**
- Voltage range: 2.7 to 5.5 V
- Temperature range: -40 to 125°C

**Key Features:**
- ARM Cortex M0+ core 48MHz
- Up to 128K embedded flash
- Up to 16K RAM
- External OSC + internal ICS for clock
- System functions: LVD, WDG, CRC, LP modes
- Communication: SPI, SCI, IIC, CAN
- Timers: FTM, PWM, PIT, PWT, RTC
- 12bit ADC and ACMP

**Packages:**
- 16TSSOP, 24QFN, 32/ 64/ 80LQFP
- Pin compatible within KEA family




(1) Support bit operation in RAM
(2) Faster timer running 2 x core clock

# Kinetis EA Series MCUs for Automotive

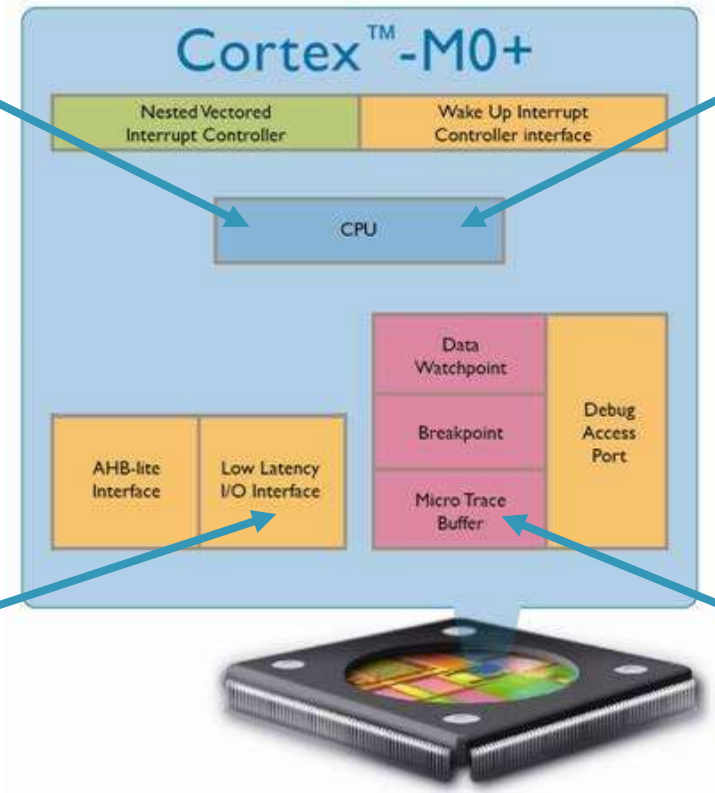
## Built on the ARM® Cortex® -M0+ Processor

### Energy Efficiency

- 2-stage pipeline – reduced cycles per instruction (CPI) enabling faster branch instruction and ISR entry
- Program memory access on alternate cycles

### Processing

- Only 56 Instructions, mostly coded on 16-bit. Option for fast MUL 32x32 bit in 1 cycle
- Cortex-M0/3/4 compatible
- 1.77CM/MHz
- Best-in-class code density – reduced cost, power consumption and pin-count




### Single-Cycle I/O Port

- 50% higher GPIO toggling frequency than standard I/O
- Improves reaction time to external events allowing bit-banding and software protocol emulation
- Save precious cycles, e.g. set faster peripherals for low-power access
- Access GPIO/peripherals while processor fetches the next instruction

### Micro Trace Buffer

- Powerful, lightweight trace solution enabling fast debug
- Non-intrusive – trace information stored in small area of MCU SRAM (size defined by programmer)
- Trace read over Serial Wire /JTAG (CPU stopped)

# KEA products comparison table 产品列表

| Device | Features | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Flash | RAM | EE PROM | Freq | MS CAN | SCI | SPI | ATD | PWT | Flex-Tim | ACMP | IIC | GPIO | Packages |
| KEAZN8 | 8K | 1K | emulate | 48MHz | 0 | 1 | 1 | 12c12b | 1 | 6c+2c 16b | 2 | 1 | Up to 22 | 16 TSSOP/ 24 QFN |
| KEAZN16 | 16K | 2K | 256B | 40MHz | 0 | 3 | 2 | 16c12b | NA | 6c+2c+ 2c 16b | 2 | 2 | Up to 57 | 32/64 LQFP |
| KEAZN32 | 32K | 4K | 256B | 40MHz | 0 | 3 | 2 | 16c12b | NA | 6c+2c+ 2c 16b | 2 | 2 | Up to 57 | 32/64 LQFP |
| KEAZN64 | 64K | 4K | 256B | 40MHz | 0 | 3 | 2 | 16c12b | NA | 6c+2c+ 2c 16b | 2 | 2 | Up to 57 | 32/64 LQFP |
| KEAZ64 | 64K | 8K | emulate | 48MHz | 1 | 3 | 2 | 16c12b | 1 | 6c+2c+ 2c 16b | 2 | 2 | Up to 71 | 64/80 LQFP |
| KEAZ128 | 128K | 16K | emulate | 48MHz | 1 | 3 | 2 | 16c12b | 1 | 6c+2c+ 2c 16b | 2 | 2 | Up to 71 | 64/80 LQFP |

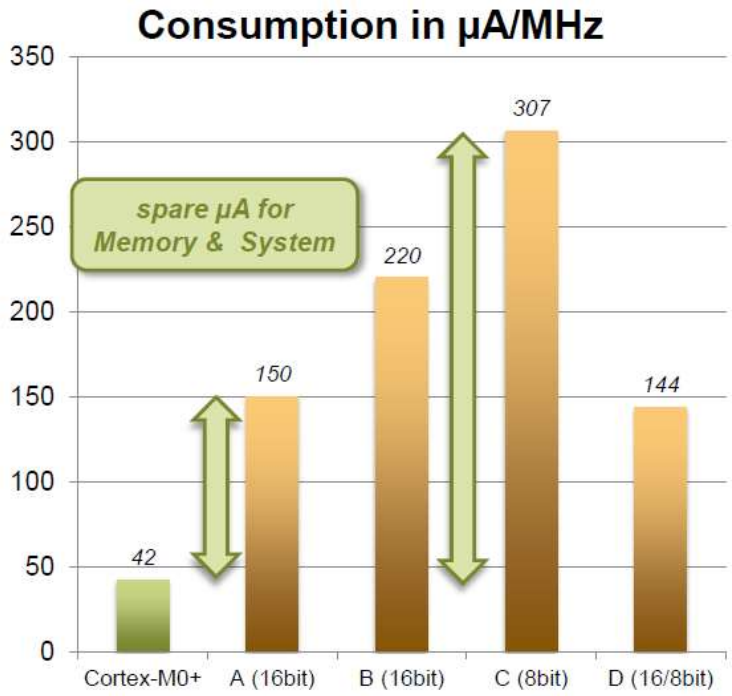
# KEA Key differentiators KEA的关键特性

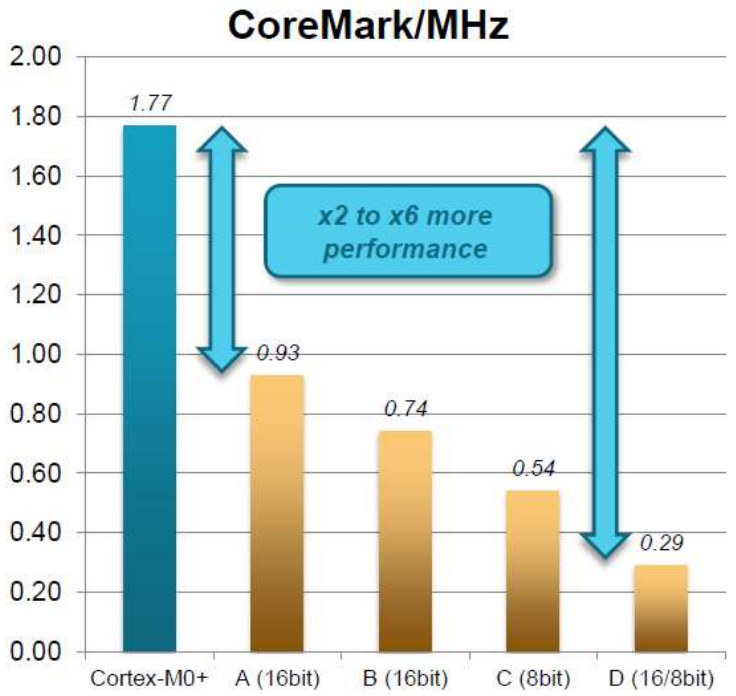
KEA MCU is cost-effective auto-grade scalable 32bit product family with complete ARM ecosystem for a wide range of automotive applications

-- Customers can start design easily today for fast prototyping!

- Super scalable product family
  - 8K to 2M embedded flash, pin to pin compatible
  - Save HW&SW porting effort
- Automotive grade Quality
  - AEC Q100 certificated, Proven automotive IP on board, Enhanced EMC/ESD performance
- High Performance
  - 32-bit ARM M0+ core, compared with 8/16bit core in similar flash size devices
- Low power consumption
  - M0+ core optimized for low power
  - Chip level low power design
- Advanced automotive connectivity
  - Plenty of automotive peripherals including CAN, LIN(SCI), SPI, IIC etc
- Wide operating range
  - Vdd = 2.7 - 5.5V, 3.3V or 5V convenience
  - Ta = -40C to 125C
- Ideal for automotive applications

# KEA Benchmark 功耗与处理能力的对比
## Performance & power consumption advantage



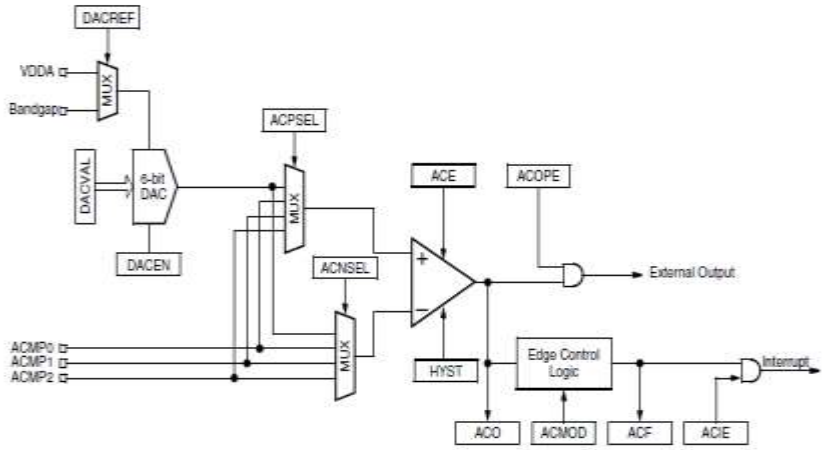




*Cortex-M0+: 1.8V, 25C, std configuration, TSMC180ULL, running CoreMark*

**Stop mode current 1uA**
**M0+ 0.95 DMIPS per MHz**

# Analog Comparator (ACMP) 模拟比较器

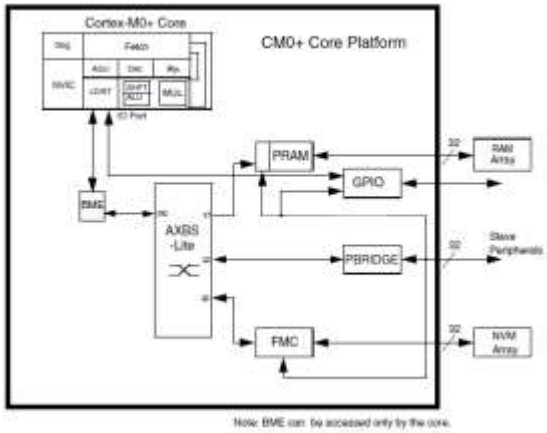
- The ACMP is composed of two parts: digital to analog (DAC) and comparator.
- DAC works as input of the CMP. DAC can select VDD or on chip bandgap as the input. DAC converts the data to a stepped analog output , which fed the ACMP as internal reference input.
- ACMP can achieve analog comparison between positive input and negative input
- The comparison result appear as a digital output.
- DAC must be configured before the ACMP is enabled.




ACMP block diagram

# Bit Manipulation Engine (BME) 位操作引擎

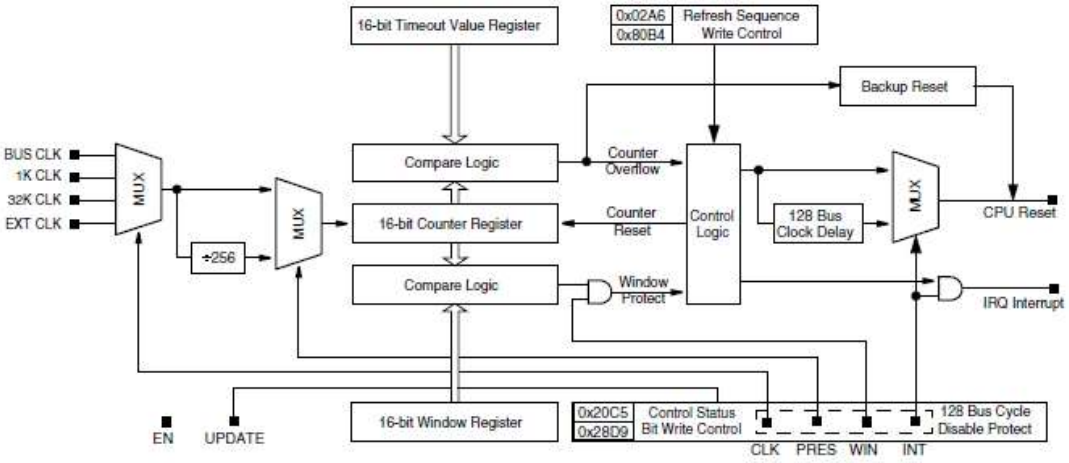
- The BME is a hardware block that resides between the platform and E-Series Core that allows read-modify-write operations to be performed on peripheral registers using data stored in the target address
- This architectural capability known as ,"decorated storage“, defines a mechanism for providing additional semantics for load and store operations to memory mapped peripherals beyond just the reading and writing of data values to the addressed memory locations.
- Decorated stores support bit field inserts, logical AND, OR, and XOR operations
- Decorated Loads supports load and clear one bit (LAC1), load and set one bit (LAS1), unsigned bit field extract (UBFX)




Cortex-M0+ core platform block diagram

# Watchdog Timer (WDOG) 看门狗

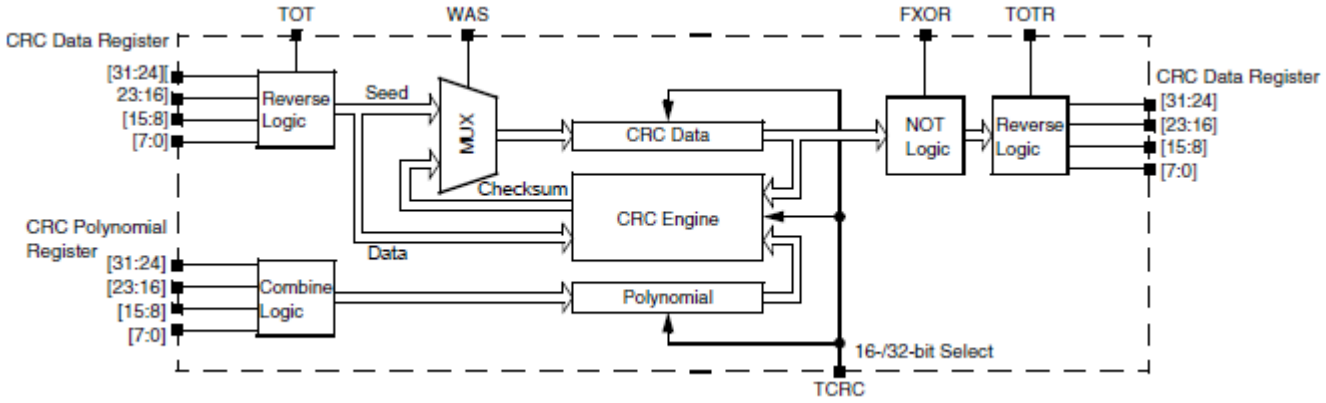
- Configurable clock source inputs independent from the bus clock: internal 32 kHz RC oscillator, Internal 1kHz RC oscillator, External clock source.
- The watchdog resets the MCU if the watchdog counter is not refreshed
- The timeout period, window mode, and clock source are all programmable but must be configured within 128 bus clocks after a reset.




WDOG block diagram

# Cyclic Redundancy Check (CRC) CRC校验单元

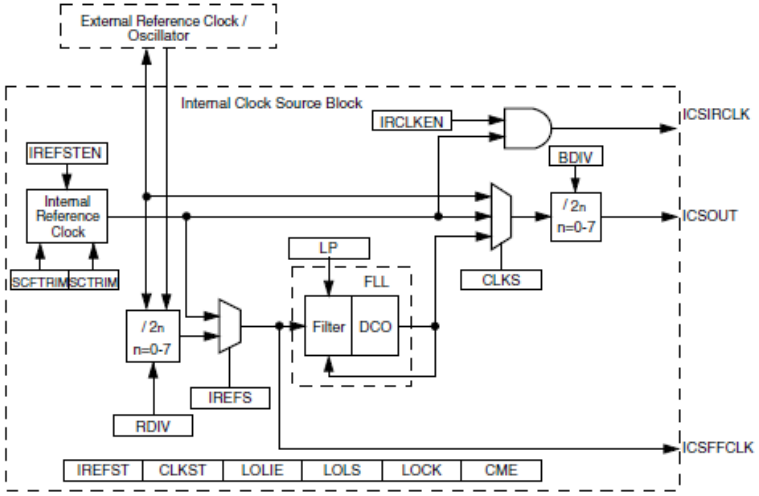
- 16/32-bit CRC code for error detection
- Programmable 16/32-bit initial seed value
- Programmable 16/32-bit polynomial
- Reverse input and output data by bit in a byte (no byte reverse)
- Final complement output of result




CRC block diagram

# Internal Clock Source (ICS) 内部时钟源

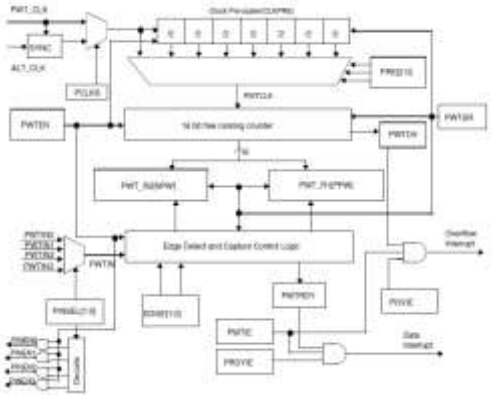
- Provide source clock choices for the MCU.
- FLL (Frequency-locked loop) as a clock source for the MCU, FLL is controllable by either internal or external clock reference clock.
- FLL is trimmable for accuracy.
- Seven modes of operation. FLL engaged internal mode is automatically selected out of reset.




ICS block diagram

# Pulse Width Timer (PWT) 脉宽测量定时器

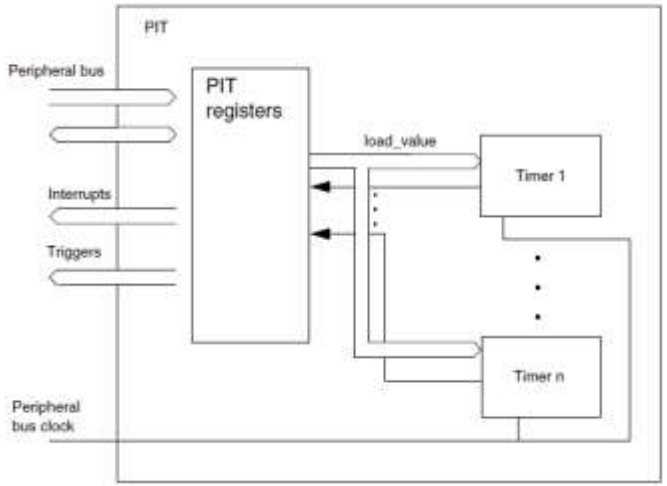
- Allows the user to find the  width of input pulse and its frequency immediately.
- Four selectable pulse inputs.
- Measures duration of a pulse or the period of a signal input to the pulse width input using a 16-bit free running counter.
- Can measure positive and negative pulse width.
- Measurement can be triggered at the first rising edge or falling edge.
- The counter is cleared without loading to the registers when the  first valid (trigger edge) is detected.



PWT block diagram

# Periodic Interrupt Timer (PIT) 周期定时器

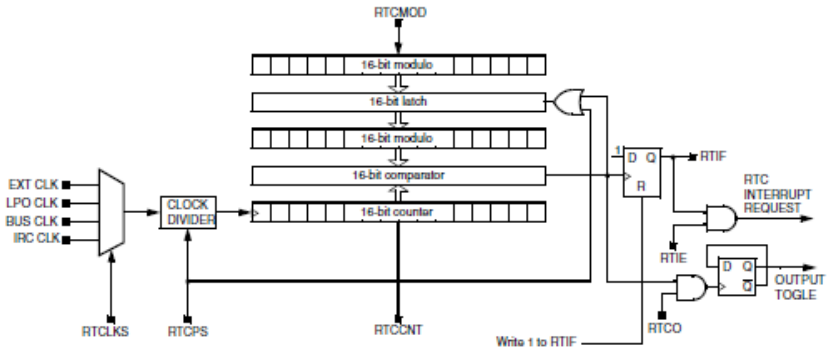
- The PIT module is an array of timers that can be used to raise interrupts and triggers.
- 2 timers available
- 32-bit timer.
- Capability to chain timers. When chain mode is enabled on a timer, timer will only counter after previous timer has expired.




PIT block diagram

# Real Timer Counter (RTC) 实时时钟定时器

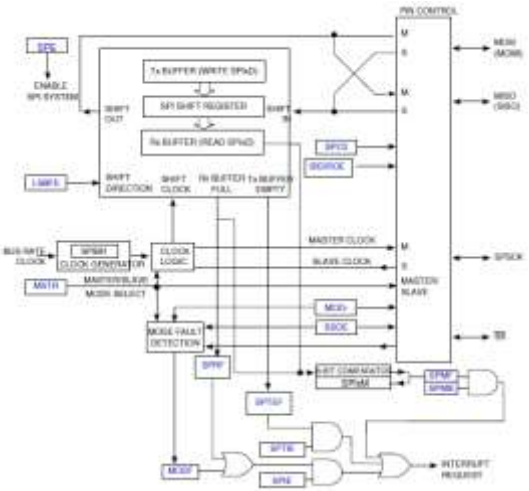
- Composed of 16-bit up counter with a 16-bit modulo register, and a clock source selector, and a prescaler block with binary – based and decimal-based selectable values.
- Selectable clock sources: External oscillator, LPO (~1 kHz), Bus clock, and Internal Reference clock (32 kHz)
- RTC allows interrupts every time the counter has reached the modulo value.
- RTC allows an output to external pinout by toggling the level, every time that counter reach the modulo value.



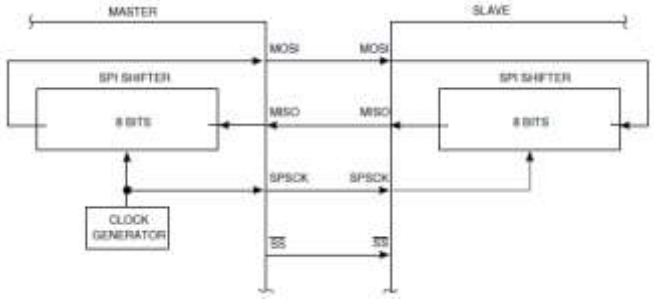

RTC block diagram

# Serial Peripheral Interface (SPI)

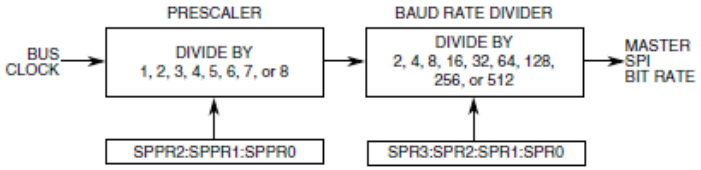
- The SPI provides for full/duplex, synchronous, serial communication between the MCU and peripheral devices.
- Baud rate up to the bus clock divided by two in master mode.
- Baud rate up to the bus clock divided by four in slave mode.
- The SS output feature automatically drives the SS pin low during transmission to select external devices and drives the SS pin high during idle to deselect external devices



SPI module block diagram w/o FIFO



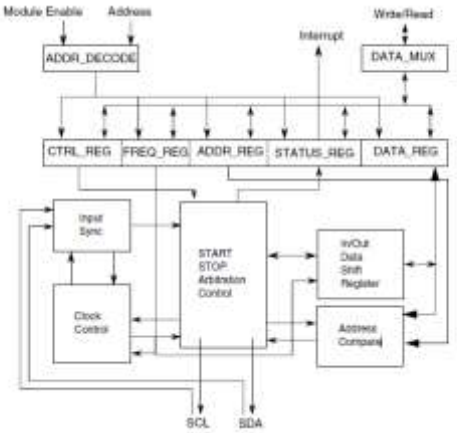

SPI system connections




SPI baud rate generation

# Inter-Integrated Circuit (IIC)

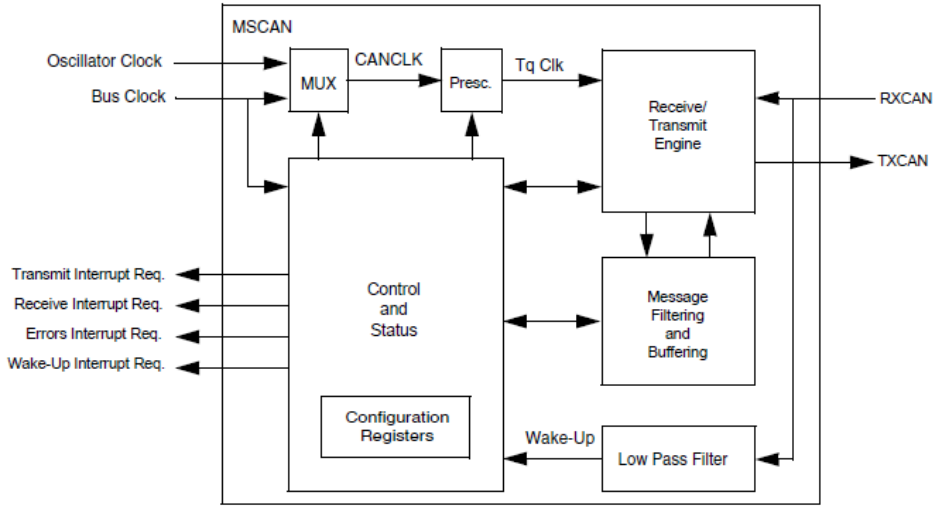
- The IIC module provides a method of communication between a number of devices.
- Interface designed to operate up to 100 kbit/sec with maximum bus loading and timing.
- The I2C device capable of operating at higher baud rates, up to a maximum of clock/20, with reduced bus loading.
- START and STOP signal generation and detection
- Bus busy detection




IIC block diagram

# Scalable Controller Area Network (MSCAN)

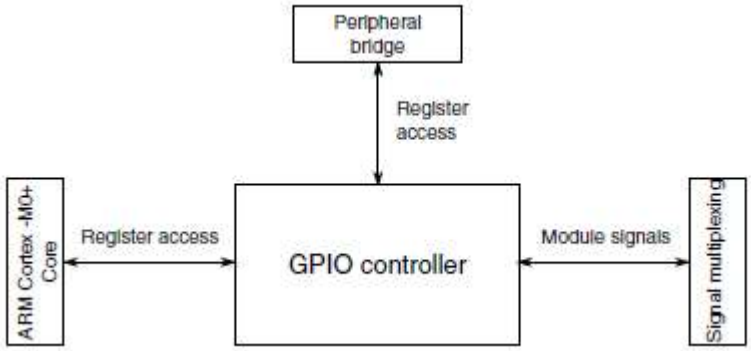
- Implementation of the CAN protocol- Version 2.0A/B
- Five receive buffers with FIFO storage scheme
- Three transmit buffers
- Programmable listen-only mode for monitoring of CAN bus
- Programmable bus-off recovery functionality




MSCAN block diagram

# General Purpose Input/Output (GPIO)

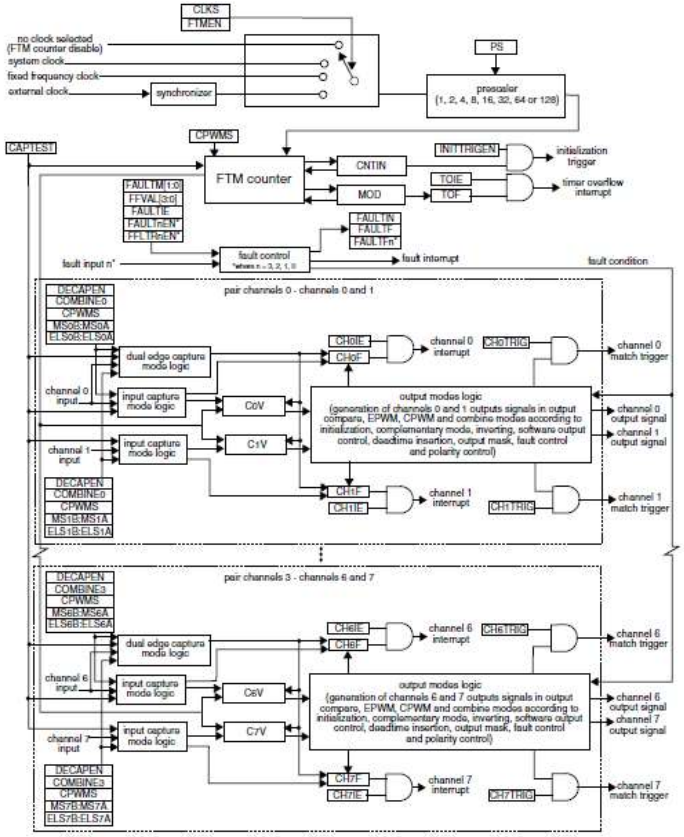
- Up to 71 general-purpose input/output (GPIO)
- Efficient bit manipulation of GPIO supported through the addition of set, clear, and toggle write-only register for each port output data register.
- Port Data Input register visible in all digital pin-multiplexing modes.
- Fast GPIO implemented, with 1-cycle load and stores.




GPIO configuration

# FlexTimer Module (FTM)

- Supports input capture, output compare, and the generation of PWM signals to control electric motor and power management applications.
- The FTM time reference is a 16-bit counter that can be used as an unsigned or signed counter.
- FlexTimer input triggers can be from comparators, ADC, or other submodules to initiate timer functions automatically.



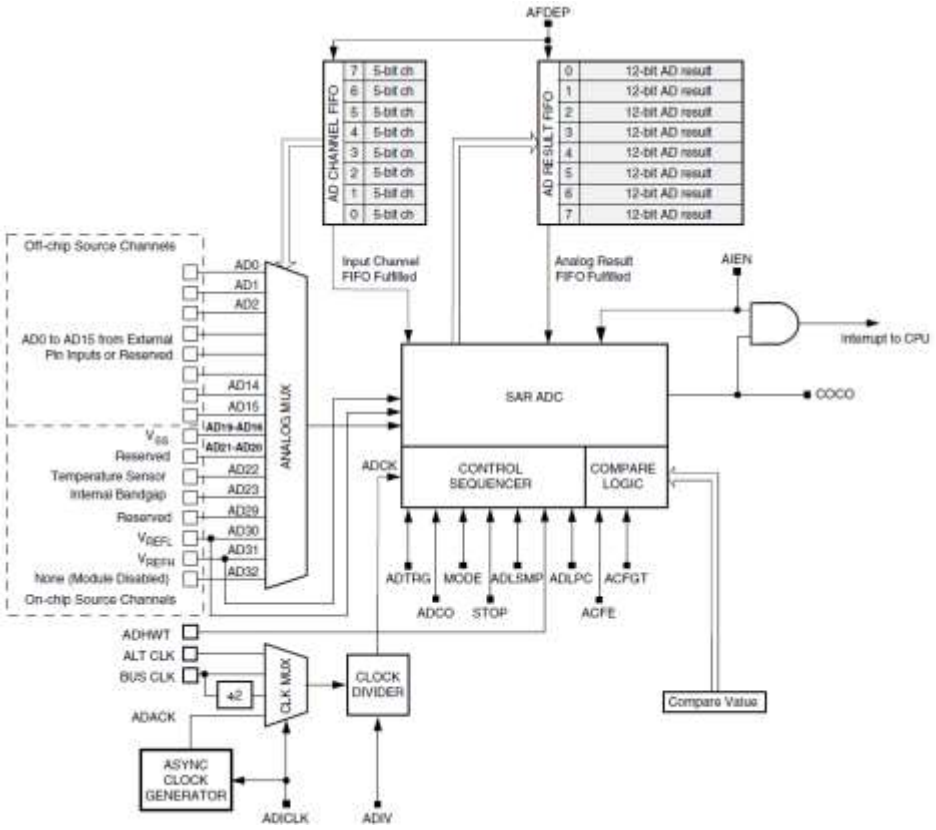

FTM block diagram

# Universal Asynchronous Receiver/ Transmitter (UART)

- Used to communicate with personal computes  or workstation and with other embedded controllers.
- Support LIN protocol
- Up to three UART modules.
- Interrupt-driven or polled operation for transmitter and receiver
- Programmable 13-bit baud rates. Supports a broad range of standard baud rates beyond 115.2 kbaud
- Transmitter and receiver within the same UART use a common baud rate, and each UART module has a separate baud rate generator.

# Analog to digital converter (ADC)

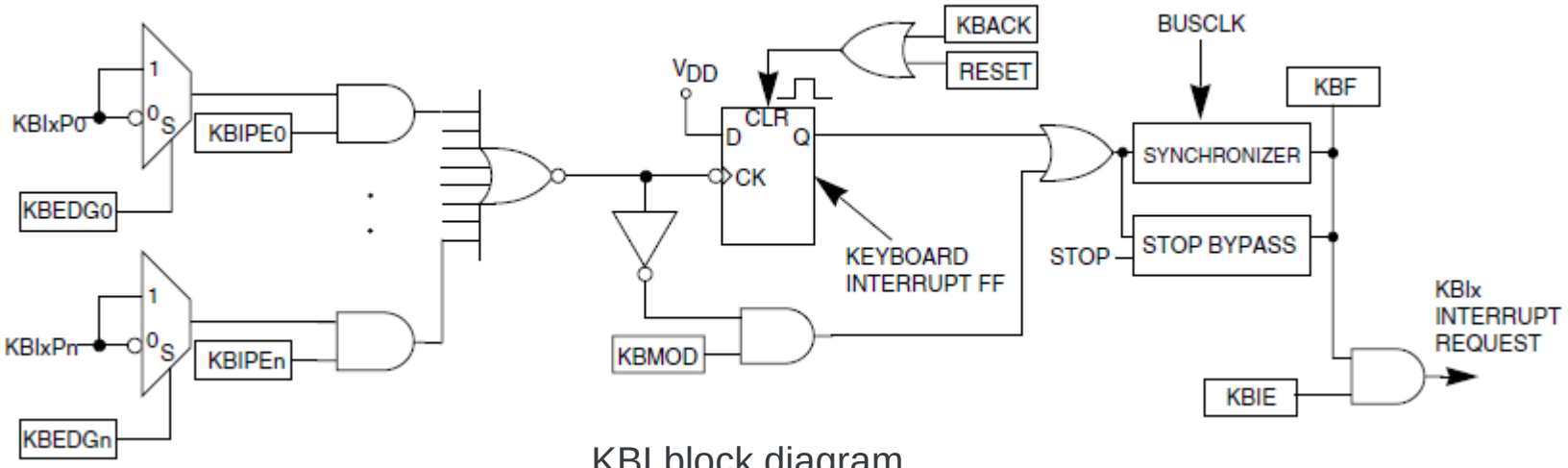
- Supports up to 24 separate analog inputs.
- Linear Successive Approximation algorithm with 8-, 10-, or 12-bit resolution
- Supports both software and hardware triggers.
- Support up to eight result FIFO with selectable FIFO depth
- Configurable sample time and conversion speed/power
- Input clock selectable from up to four sources
- Automatic compare with interrupt for less-than, or greater-than or equal-to, programmable value




ADC block diagram

# Keyboard Interrupt (KBI)

- Up to 32 KBI pins with individual pin enable bits.
- Each keyboard interrupt pin is programmable as:
  - falling-edge sensitivity only
  - rising-edge sensitivity only
  - both falling-edge and low-level sensitivity
  - both rising-edge and high-level sensitivity
- Capability to exit from low-power modes




KBI block diagram

# Software & enablement 软件和支持

# KEA Easy Enablement: 生态环境的支持

## Rapid Prototyping for Quality Software Development

- **Freescale library and tool:**
  - Automotive Math and Motor Control Library for Cortex M0+
  - Motor Control Application Tuning (MCAT) tool
  - FreeMASTER
- **IDE Debugger/Compiler**
  - CodeWarrior 10.6, KDS, Processor Expert integrated
  - IAR
  - Keil
  - Cosmic IDE for Kinetis ARM MCUs
- **Operating Systems:**
  - MQX Lite
- **Drivers**
  - Split Gate Flash Driver Software for Kinetis EA Series MCU
  - Flash driver for EEPROM emulation
  - LIN driver
  - CAN driver
  - Other peripherals and IO drivers
  - Optional Autosar MCAL and Vector Driver
- **Debugger Interface**
  - P&E Micro: Umultilink

# KEA Low Cost StarterTRAK Boards 低成本开发板

## TRK-KEA8

- KEA8 MCU in a 24 QFN package
- On-board openSDA debugging and programming circuit using K20 MCU
- LIN communications interface
- Analog interface with potentiometer
- High efficiency LEDs
- SCI serial communication interface

## TRK-KEA64

- KEA64 MCU in a 64 LQFP package
- On-board openSDA debugging and programming circuit using the K20 MCU
- LIN communications interface
- Analog interface with potentiometer
- High efficiency LEDs
- SCI serial communication interface

## TRK-KEA128

- KEA128 MCU in a 80 LQFP package
- On-board openSDA debugging and programming circuit using K20 MCU
- LIN communications interface
- Analog interface with potentiometer
- High efficiency LEDs
- SCI serial communication interface
- CAN communications interface

# Motor Control Reference Design Overview 电机控制参考设计

## Highlights

- Based on the Kinetis KEAZ128 32-bit ARM Cortex-M0+ automotive MCU
- Motor control solution for 12 V automotive systems 3-phase sensorless brushless DC (BLDC)
- Hardware solution consists of the KEAZ128 MCU, MC33903 SBC and MC33937A 3-phase FET pre-driver
- LIN & CAN connectivity support

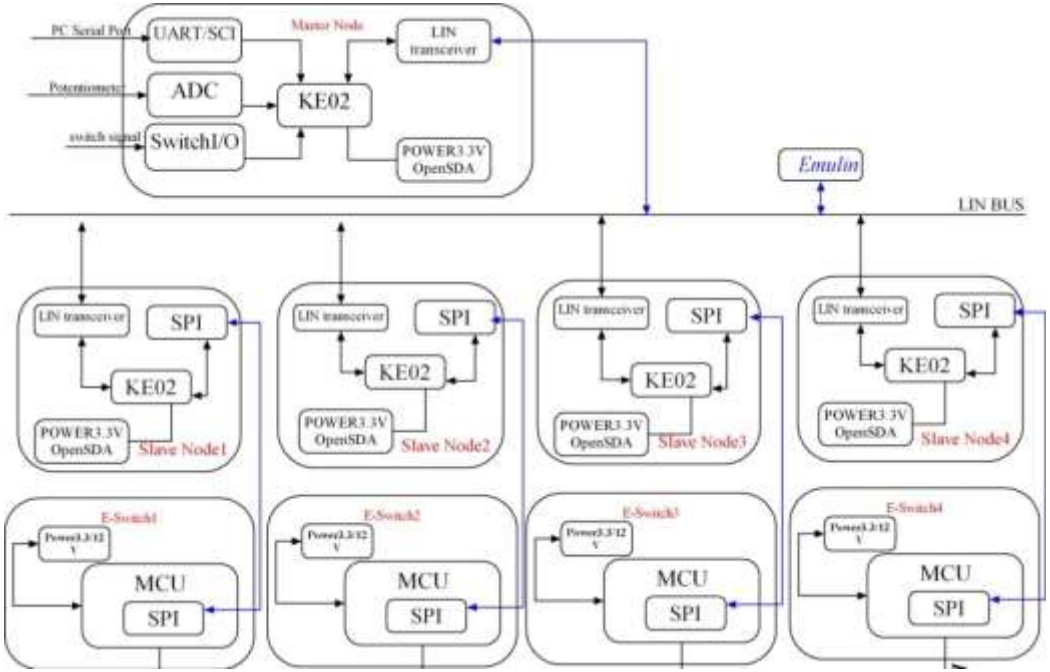
## Integrated Software

- Automotive Math and Motor Control Library set for ARM Cortex-M0+, Application Software
- Application data visualization and control with FreeMASTER run-time debugging tool included
- Motor Control Application Tuning (MCAT) tool allows run-time tuning of the application parameters included

# Lighting Control Module with KEA 车灯控制参考设计

**Features：**

- LIN based lighting control module
- Master module sending commands via LIN bus to control lamp on each slave node
- KEA64 MCU is used for both master and slave nodes
- High efficiency LIN message processing on KEA64 MCU
- Very low power consumption of the module in standby mode
- eSwitch to drive lights with over current/temperature protection




**Products:**

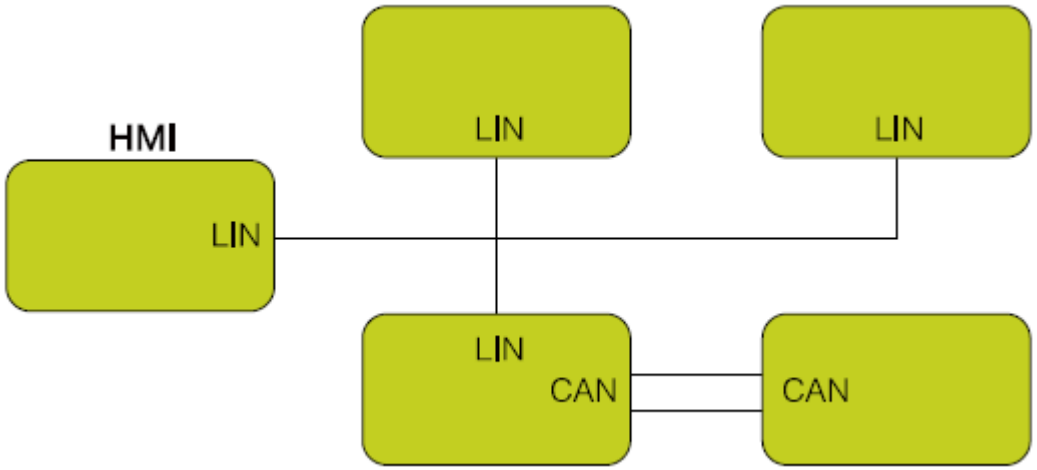
- KEA64
- eSwitch

**Reference design Available now**

# Green Auto Network with KEA 低功耗CAN/LIN 网关

**Features**：

- A CAN/LIN network demo on  vehicle
- Each node has KEAZ128 as main micro with CAN/LIN controller
- HS CAN phy MC33901 and LIN phy MC33662 for each node
- Extremely low power consumption on KEA MCU with multiple wakeup sources
- Fast development process based on CodeWarrior driver library

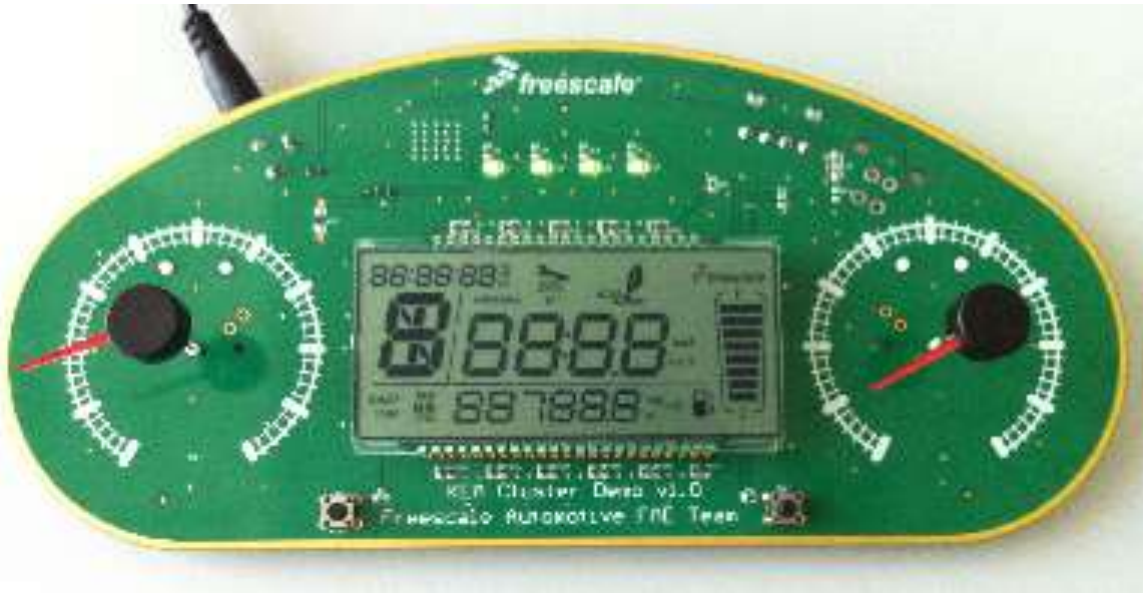

**Products:**

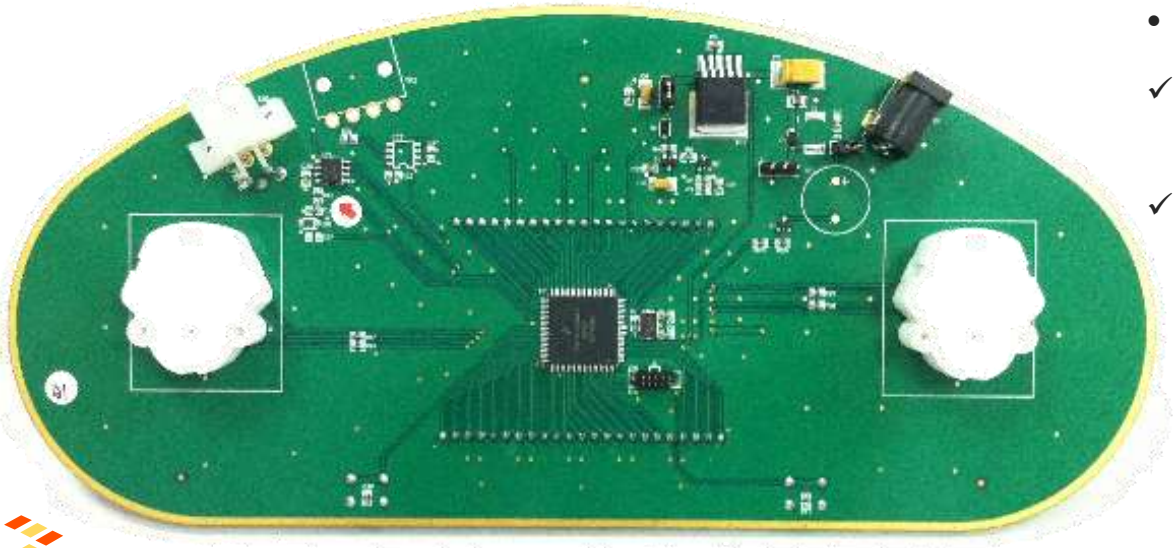
- KEAZ128
- MC33901
- MC33662

Reference design Available now

# Entry-Level Cluster Reference Design with KEAZ128
# 入门级仪表参考设计

- Single KEAZ128 to drive one Segment LCD plus two Stepper Motors.
- 48MHz bus clock
- GPIO are used to drive Segment LCD , CPU loading:  <+1%
  - External resistances added
- CAN/LIN supported
- Stepper control with FlexTimer



- Target Market:
  - ✓ HVAC panel with or without Segment LCD;
  - ✓ Entry-level Cluster.

# General Purpose 32-bit ARM MCU


## Applications:

- Pump/Fan controller
- BCM, HAVC, Seat, Windows
- Entry Level Gateway
- DC/BLDC Motor control
- Ambient /exterior lighting
- Park assist, Passive Entry, TPMS
- Infotainment companion MCU

## Reference Solutions:

- BLDC motor control
- Interior / Exterior LED Lighting
- Low Power LIN/CAN Node Networking

# Kinetis FA: Automotive 32-bit ARM MCU
# KFA汽车微控制器简介

# Market Requirements and Freescale KFA solution
# 市场对KFA产品的需求

- **Energy Efficiency** with **High Performance**
  - 512K device <25uA sleep mode with SRAM powered
- Standardized Architecture, **Reduced R&D Investment**
  - Standard architecture, scalable 8k - 2M
  - Reduce dev time & cost
  - Future-proofed investment with ARM
- **Safety and Security**
  - ASIL B for body electronics
  - HW security modules
- Broad Spectrum of **Communications Interface**
  - CAN incl FD, LPLIN, FlexIO comms module, Security

**Integrated Software Solutions**

1. Broad Range of Tools
2. Middleware & Reference Design
3. Software enhanced peripherals
4. Autosar MCAL & OS
5. Production grade driver packs

# KFA 512K Block Diagram

Preliminary and subject to change

Digital Components | 5V Analogue Components | MCU Core and Memories

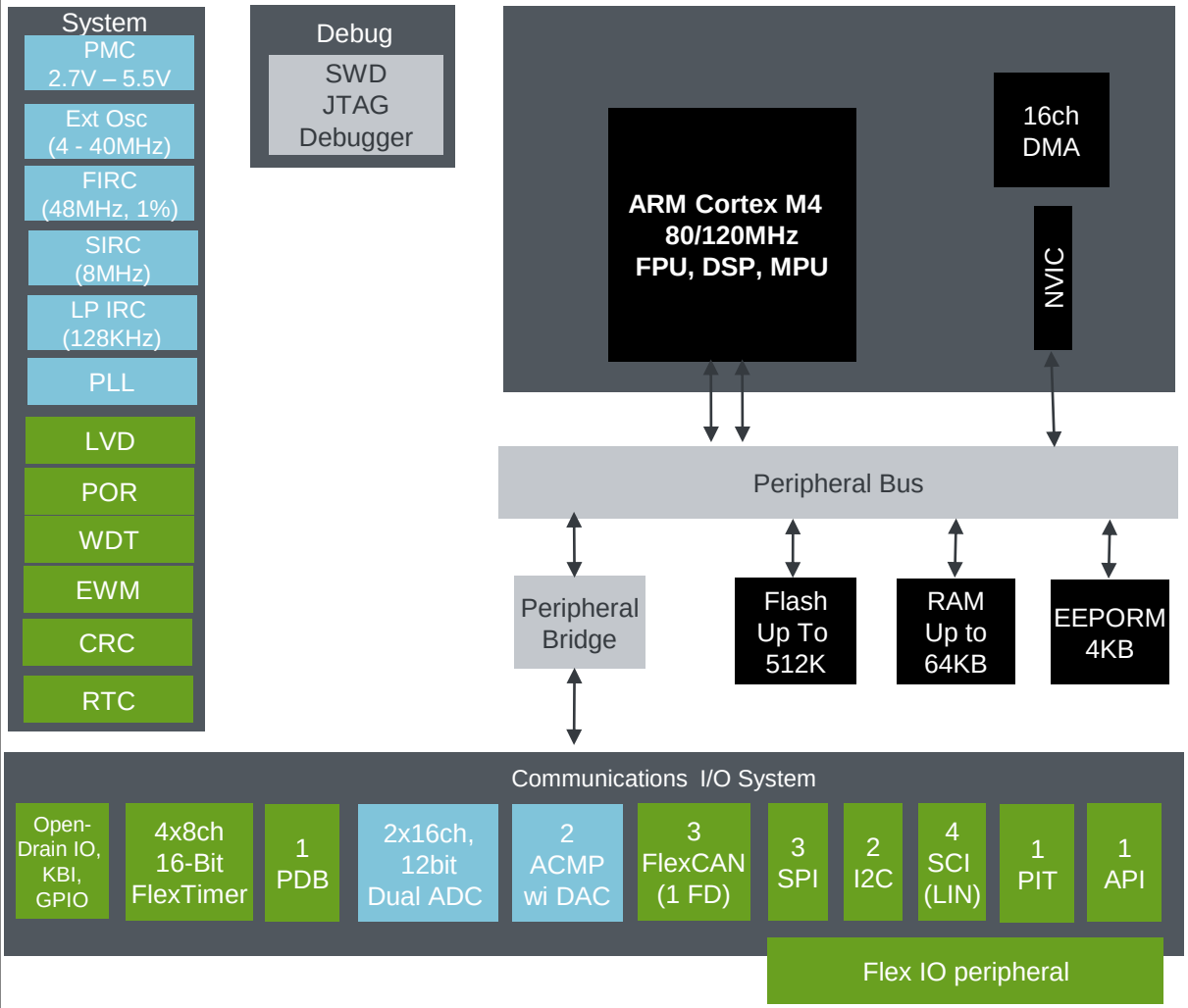
## Target application:
•Automotive body and general purpose

## High performance
- ARM Cortex M4 up to 120MHz w FPU
- eDMA from Qorivva family

## Low power
- Low leakage technology
- Multiple VLP modes and IRC combos
- Wake-up on analog thresholds

## Software Friendly Architecture
- High RAM to Flash ratio
- Independent CPU and peripheral clocking
- 48MHz 1% IRC – no PLL init required in LP
- Registers maintained in all modes
- Programmable triggers for ADC → no SW delay counters or extra interrupts

## Functional safety
- ISO26262 support for ASIL B or higher
- MPU
- ECC on Flash/Dataflash and RAM
- Independent internal OSC for Watchdog
- Diversity between ADC and ACMP
- Diversity between SPI/SCI and FlexIO
- Core self test libraries
- Scalable LVD protection
- CRC




## Operating Characteristics
- Voltage range: 2.7 to 5.5 V
- Temperature (ambient): -40 to 125° C

## Packages and IO
64/100pin compatible within product Family
Powered ESD protection, GPIO quantity optimization

# M4 512K - Initial targets @ 25C

| Power Mode | Description | Total Idd | Idd / MHz |
|---|---|---|---|
| High Speed Run mode | @ 100/50/25 MHz, all peripherals on, while1 | 30mA | 300uA / MHz |
| High Speed Run mode | @ 100/50/25 MHz, all peripherals off, while1 | 23mA | 230uA / MHz |
| Normal RUN mode | @ 72/36/24 MHz, all peripherals on, while1 | 19mA | 264uA / MHz |
| Normal RUN mode | @ 72/36/24 MHz, all peripherals off, while1 | 14mA | 194uA / MHz |
| Wait mode | @ 72/36/24 MHz, all peripherals off | 8mA | 112uA/MHz |
| Stop mode | | 250uA | - |
| VLPS mode | | 15uA | - |



ARM

# Software & enablement 软件和资源

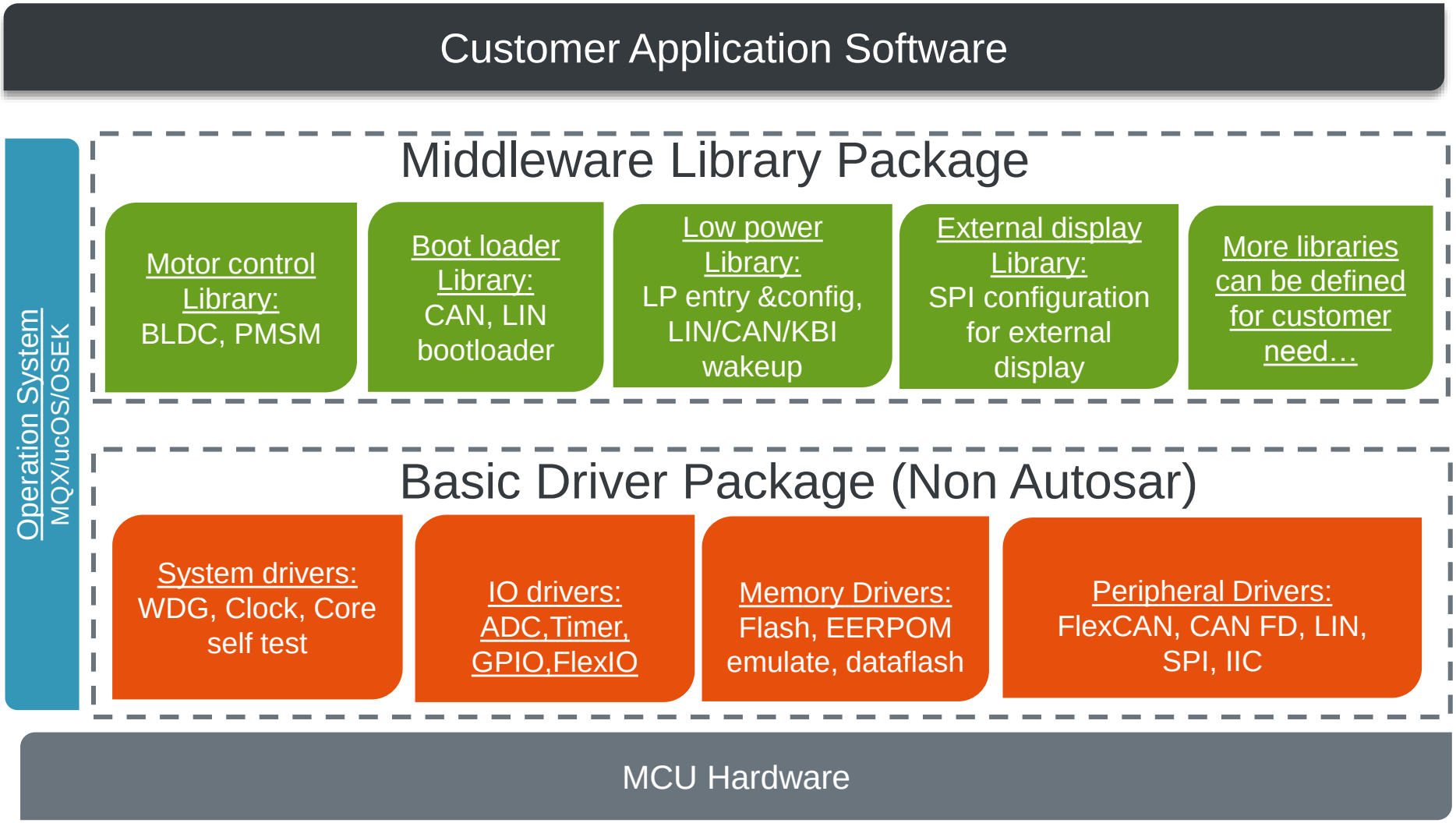
## Freescale tools 开发工具

- Automotive Design Studio IDE (ADS)
  - Same eclipse graphical interface as CW
  - PE integrated, reuse existing demo codes

## Third party tool

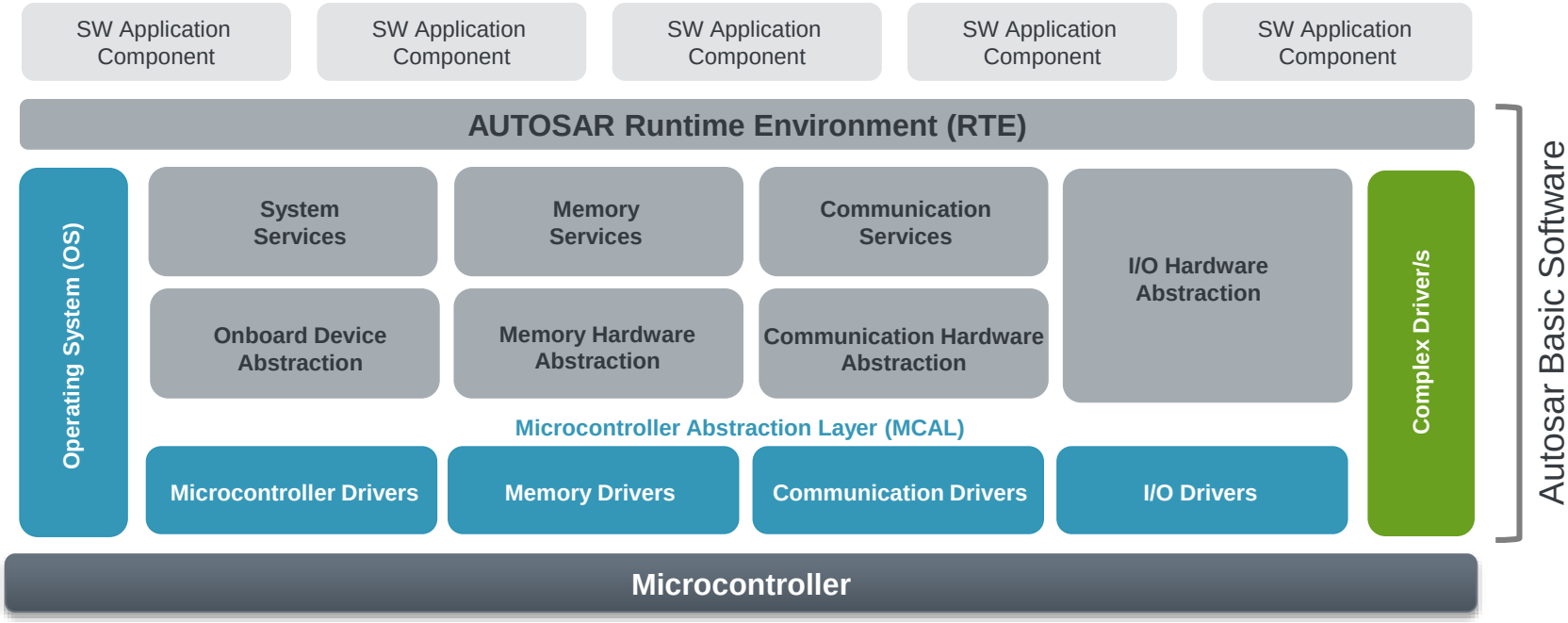
- Green Hills
- IAR
- Keil

# KFA SW architecture overview - Non AUTOSAR
# 所有模块的底层驱动



# KFA SW architecture – Autosar
# 支持AutoSAR的MCAL和OS

- **Freescale Standard Products** (shaded blue below) - MCAL (source code), OS (source code) and Config Tool (executable) for MCAL and OS.
- **Partner Products** (Elektrobit, Vector, KPIT, etc.) – The rest of AUTOSAR basic software as needed & Integration Services (FSL IP + Partner IP + Customer IP)
- **Complex Drivers** (shaded green below) – custom software offered by Freescale Consulting & Professional Engineering Services




Developed in respect to **AutoSAR4.x**, **SPICE Level 3** and **ISO26262** standards.

## High performance platform: safety and security

CPU bandwidth/ DMA / FPU / Low power / CAN-FD/ ISO26262 /Security/…

- SW friendly flexible architecture for broad market appeal

## Reduce R&D effort/Time-to-Market

- Complete enablement with tools and software ecosystem
- Expand software offering into higher levels of abstraction / model-based design

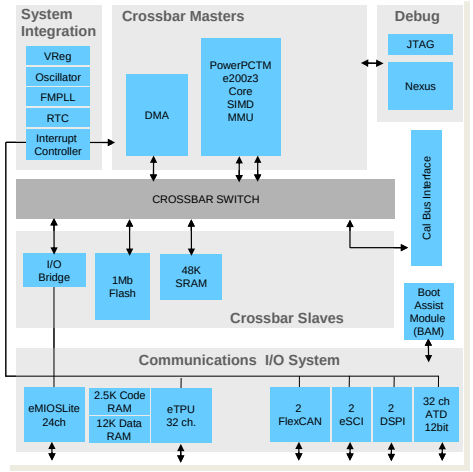
## Future-proof your design

- See software as an investment, not a cost
- Scalability / ARM portfolio

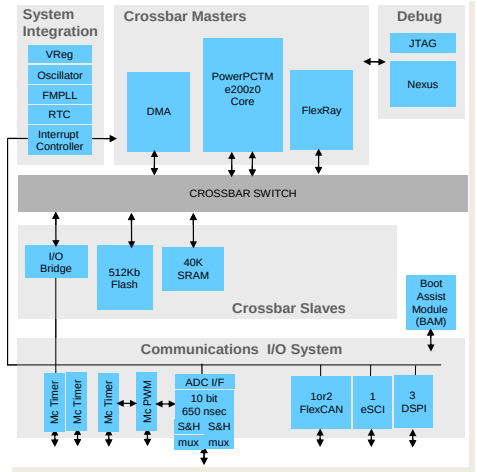
# PowerPC Automotive MCU
# PowerPC汽车微控制器

# Cross Family Compatibility 面向不同应用的PowerPC产品

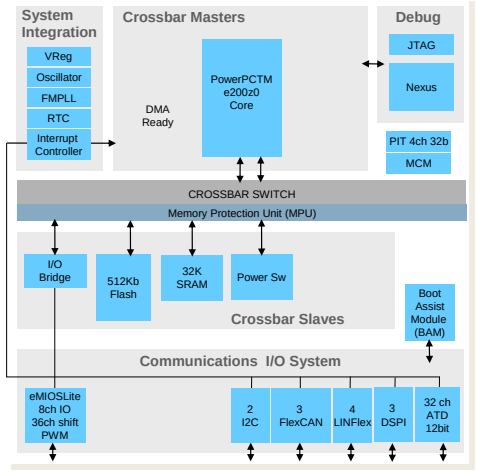
**“Monaco” MPC563xM**
(Powertrain)



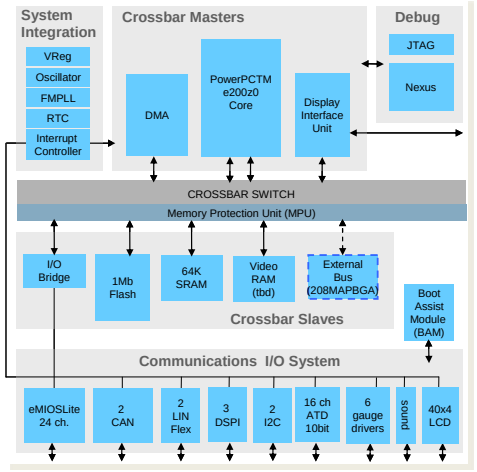

**“Pictus” MPC560xP**
(Steering/Airbag)




**“Bolero” MPC560xB**
(Body/Gateway)



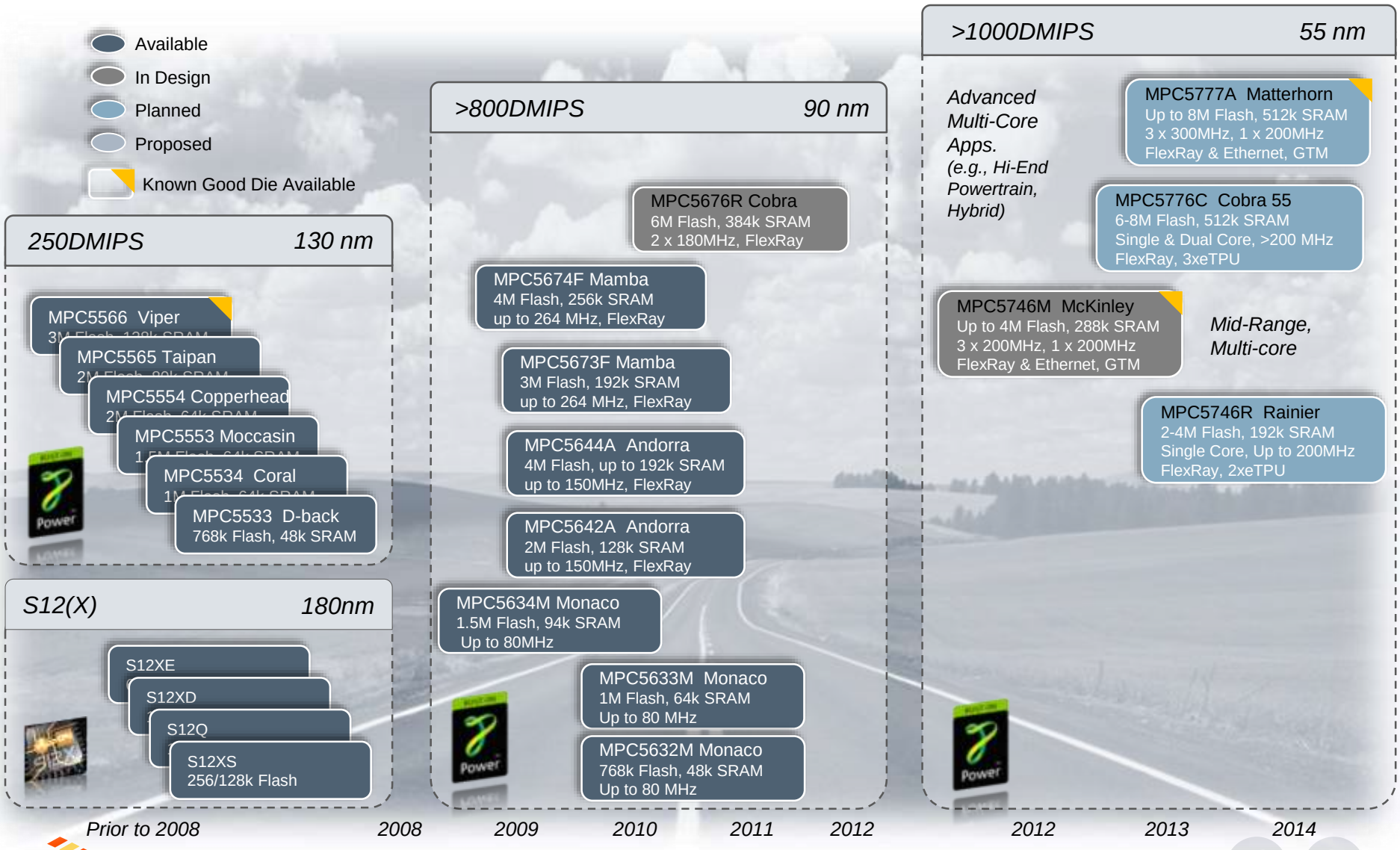

**“Spectrum” MPC5606S**
(Inst Cluster)




***32-bit standard architecture adopted across all product families***

- Maximum IP reuse
- Optimized design and test flow
- Consolidated tool chain
- Strong Marketing message in compatibility

# Powertrain MCU Roadmap 动力总成路线图



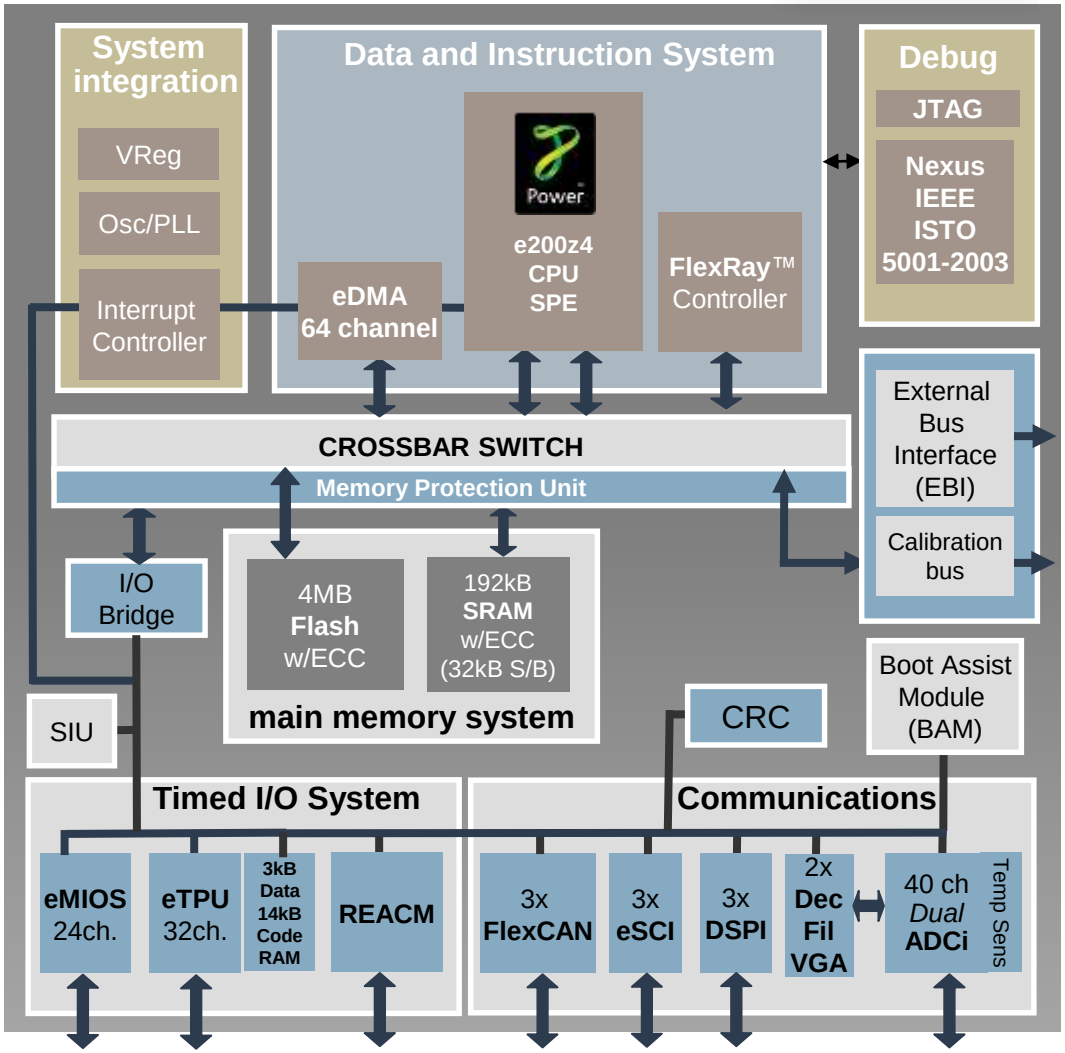
# MPC5644A Andorra 4M Block Diagram

## Core
- **150 MHz Power Architecture™ e200z4d Core + VLE**
  - Dual Issue Core with SPE Module for Floating Point & DSP
  - 8kB Instruction Cache - 2 or 4 way - with error detection
  - 24 Entry MMU, NMI, Power Saving mode

## Memory
- **4MB Byte RWW Flash with ECC**
- **217kB Total SRAM**
  - 192kB on chip static RAM (including 32kB standby) with ECC
  - 8kB unified-cache (with line locking)
  - 17kB for eTPU (14kB code & 3kB data)

## I/O
- **Timed I/O Channels**
  - 32 channel eTPU2
  - 24 channel eMIOS
- **FlexRay**
  - Dual Channel (10MB/s)
- **Reaction Module** – 6 channel support
- **3 x FlexCAN** - Compatible with TouCAN, 64 Message Buffers Each
- **3 x eSCI**
- **3 x DSPI** 16 bits wide up to 6 chip selects each
  - SPI with continuous mode and DMA support
  - Supporting Micro Second Bus, optionally using LVDS
- **1 x CRC unit**
- **40 channel Dual ADC** - up to 12 bit and up to 670ns conversions
  - 6 Queues with triggering and DMA support
  - Variable Gain Amplifier (X1, X2, X4)
  - Dual Decimation Filters
  - Temperature sensor and Absolute voltage reference

## System
- **FM-PLL**
- **64 Channel enhanced DMA Controller**
- **Peripheral Interrupt Timer (PIT) (**capable of queue triggering)
- **System Timer Module (STiM)** (for AutoSAR task monitor function)
- **Software Watchdog (SWaT)** (windowing watchdog)
- **378 source Interrupt Controller (plus NMI)**
- **Nexus IEEE-ISTO 5001-2003 Class 3+ (ETPU Class 1)**
- **Single 5V Power supply is optional for 208 and 176 QFP packages only**
- EBI and calibration busses (16/32bit)
- 176 LQFP / 208MapBGA / 324PBGA (bus, 40ADC)



# MPC563xM-based 4-cylinder Engine Reference Design
# 基于MPC5634M的汽油机参考设计

- Basic but fully functional Engine Control Unit
- Capable of running a four-cylinder gasoline engine
- Robust enclosure: Permits customer evaluation on dynamometer and in vehicle
- Low-level software provided
- Calibration using XCP
- Basic on board diagnostics using Freescale analog devices
- Documentation package

# MPC5746R Rainier 4M Block Diagram

**Key Functional Characteristics**

- Two independent 200 MHz Power Architecture z4 computational cores
  - Single 200 MHz Power Architecture z4 in lockstep
- eDMA – *64 channels (w/ lockstep DMA)*
- 4M Flash with ECC
- 320k total SRAM with ECC
  - 256k of system RAM (incls. 32k of standby RAM)
  - 64k of tightly coupled data RAM
- 3 ΣΔ ADC converters – *12 channels*
- 4 SAR converters – *52 channels*
- Cross Triggering Unit
- Ethernet (MII-lite/RMII)
- DSPI – *7 channels (2 supporting µSec channel)*
- LINFlex - *6 channels (2 supporting µSec channel)*
- FlexCAN – *4 chls, 2 w/* ***flexible data rate*** *capability*
- SENT – *6 channels*
- 2 eTPU2+ timers – *64 channels*
- 1 eMIOS – *32 channels*
- Reaction module – *10 channels*

**Key Electrical Characteristics**

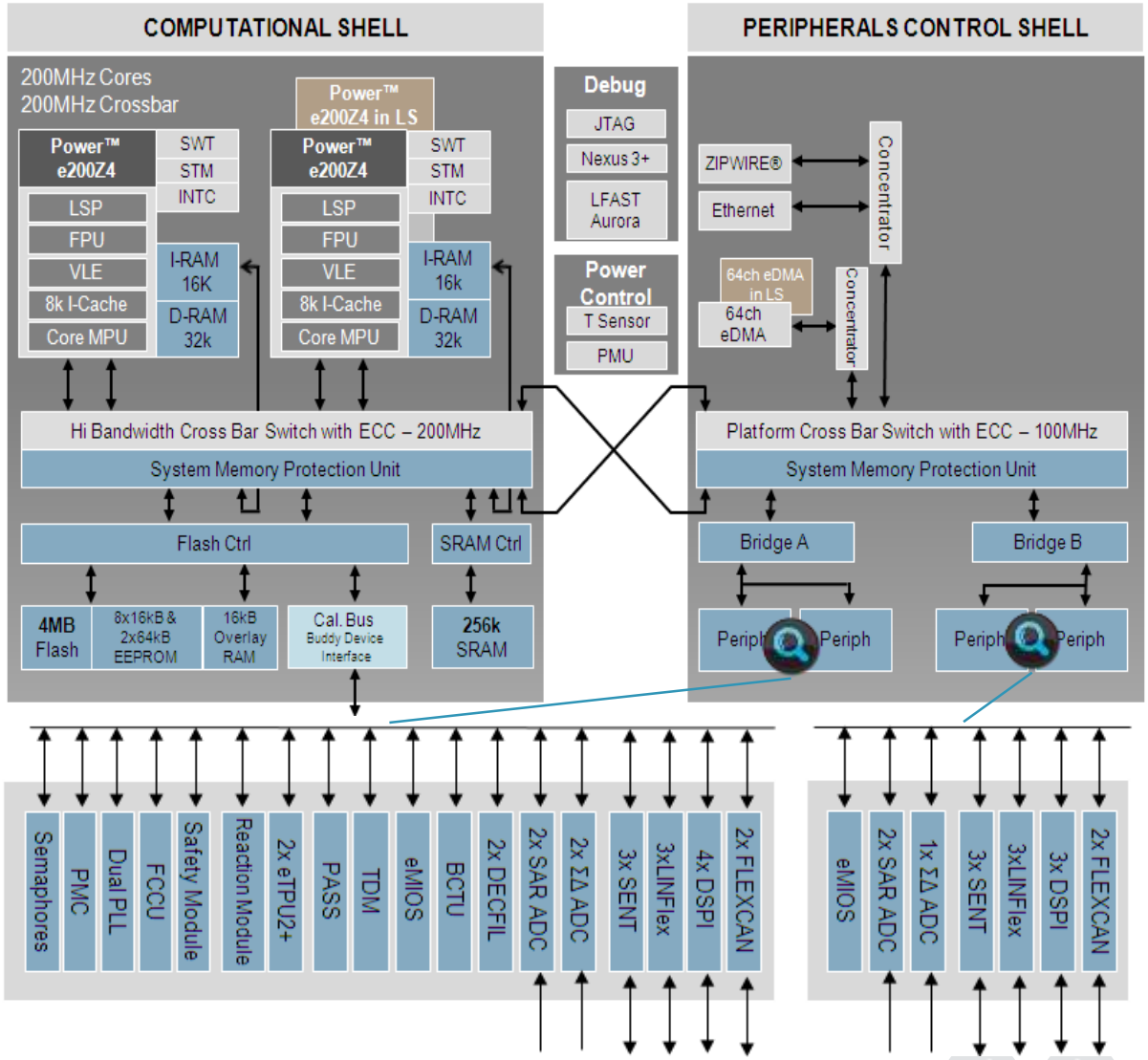
- -40 to +125 ° C (ambient)
- Single 5v power supply

**Package**

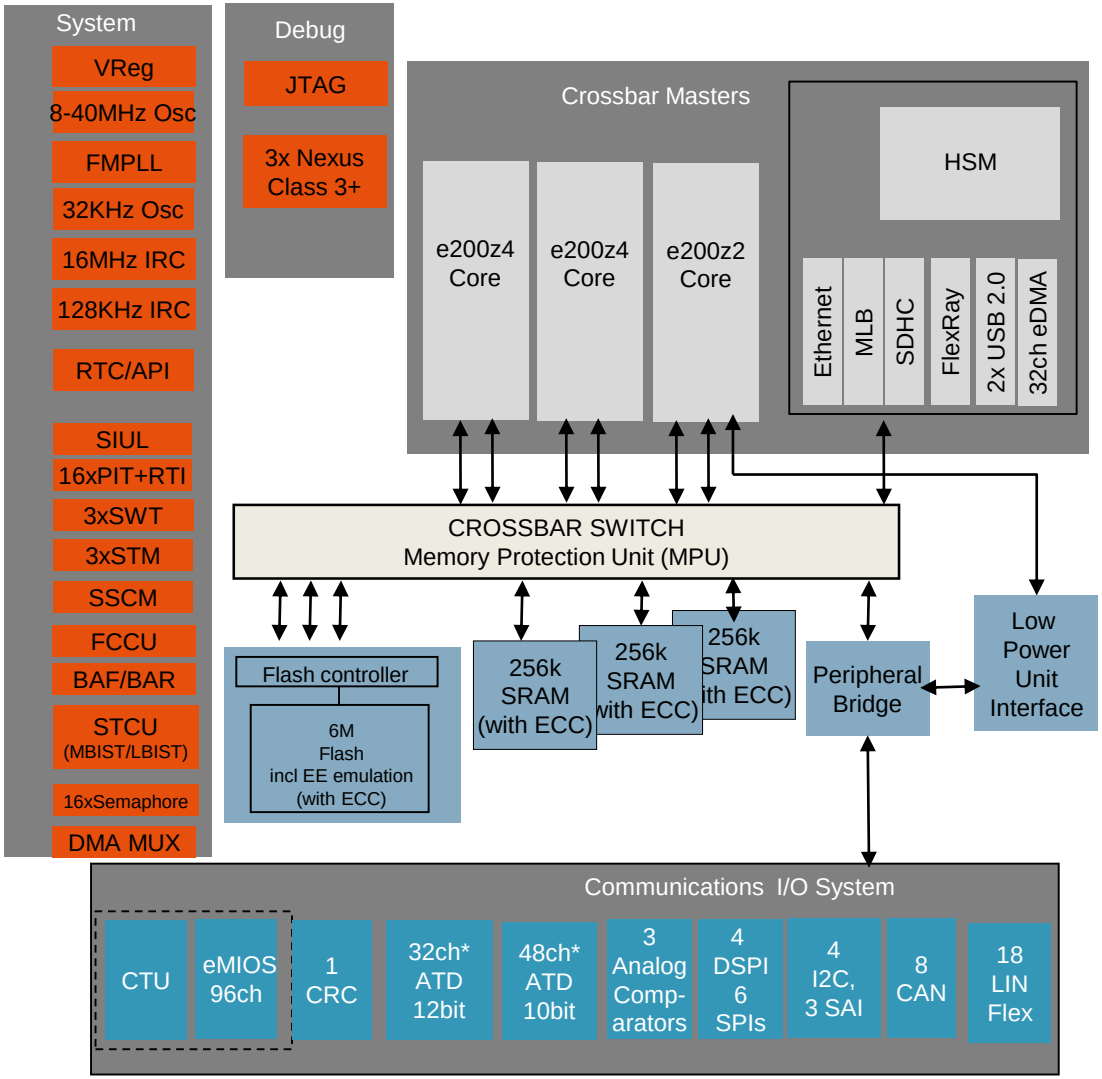
- 176 LQFP, 252 MAPBGA
- 292 MAPBGA eCal package (incls. RAM buddy chip) for emulation/debug

**Enablement**

- Software : AutoSAR drivers
- Tools : Debugger (Lauterbach), multicore compiler (Wind River and Green Hills)



# MPC5748C/G - Development Device and High End Gateway/BCM Solution




*Mixture of internal and external channels
Features available depend on package and device version

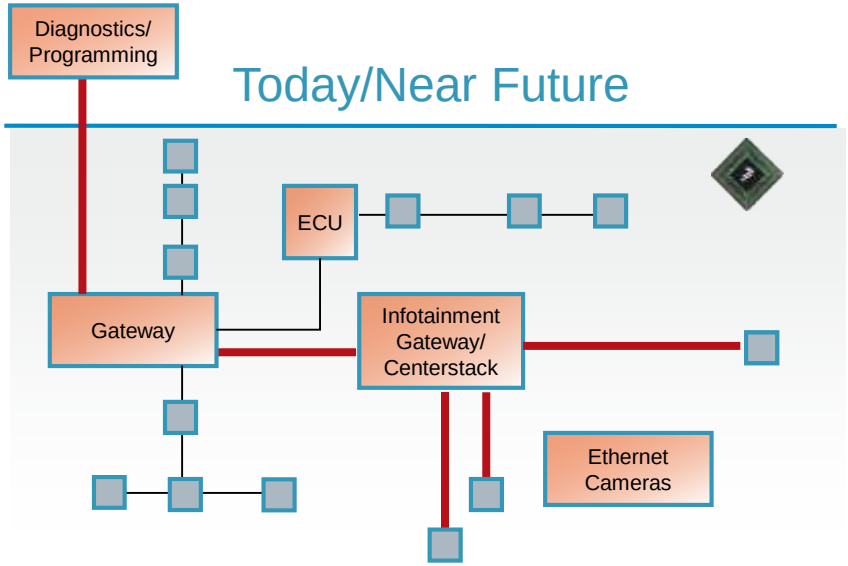
Applications:
- High end Gateway and Body Modules

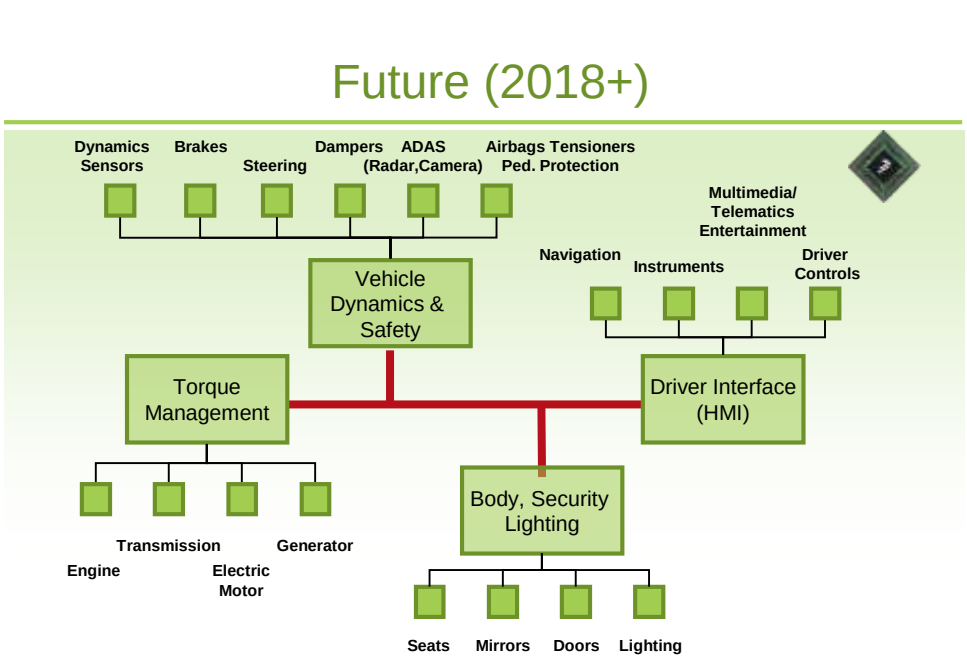
Key Characteristics:
- 2x e200z4 + 1x z2 cores, FPU on z4 cores
- 160 MHz max for z4s and 80 MHz on z2
- HSM Security Module option supports both SHE and EVITA low/medium standard
- Media Local Bus supports MOST communication
- 2 x USB 2.0 (1 OTG and 1 Host module) support interfacing to 3G modem and infotainment domain
- Ethernet 10/100 Mbps RMII, MII, +1588, AVB
- CAN module optionally supports CAN FD
- SDHC provides standard SDIO interface
- Low Power Unit provides reduced CAN, LIN, SPI, ADC functionality in low power mode
- Designed to ISO26262 process for use in ASIL B
- -40 to +125C (ambient)
- 3.0V to 5.5V

Packages:
•176 LQFP, 256 BGA, 324 BGA

| | 5747C | 5748C | 5747G | 5748G |
|---|---|---|---|---|
| Cores | 2 | 2 | 3 | 3 |
| Flash | 4M | 6M | 4M | 6M |
| RAM | 512k | 768k | 768k | 768k |
| MLB | N | N | Y | Y |
| USB | N | N | Y | Y |

# Automotive Electronics Architectural Trends
# 汽车电子网络结构的进化




**Distributed Electronic Control Units**

*One ECU per mechanical function - connected by multiple CAN and LIN interfaces*

**Distributed Computing**

*Major computing nodes on a high-performance network organized by "domains" that control distributed nodes.*

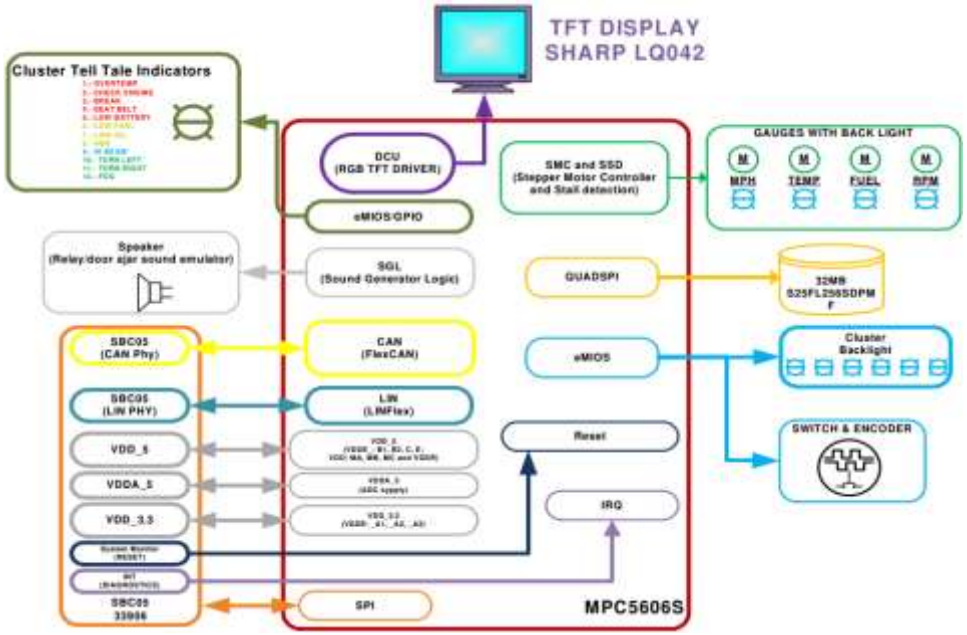
**Auto MCU: More** performance, **more** embedded memory, **more** safety for **less** cost, **less** power and **less** development effort

**市场对汽车微控制器的要求：更高性能，更大内存，更加安全，更低价格，更低功耗，更低开**发成本。

# MPC5606s Graphic Cluster reference design

Features：

- 4 illuminated analog gages
- WQVGA TFT display with four sets of animation
- Two-color LED rail around each gauge
- PowerSBC to provide CAN and LDO
- Real Time Clock unit
- Sound Generation for alarms




**Reference design Available now**

**Products:**

- MPC5606S
- MC33906

# MAC57Dxx Graphic Cluster reference design

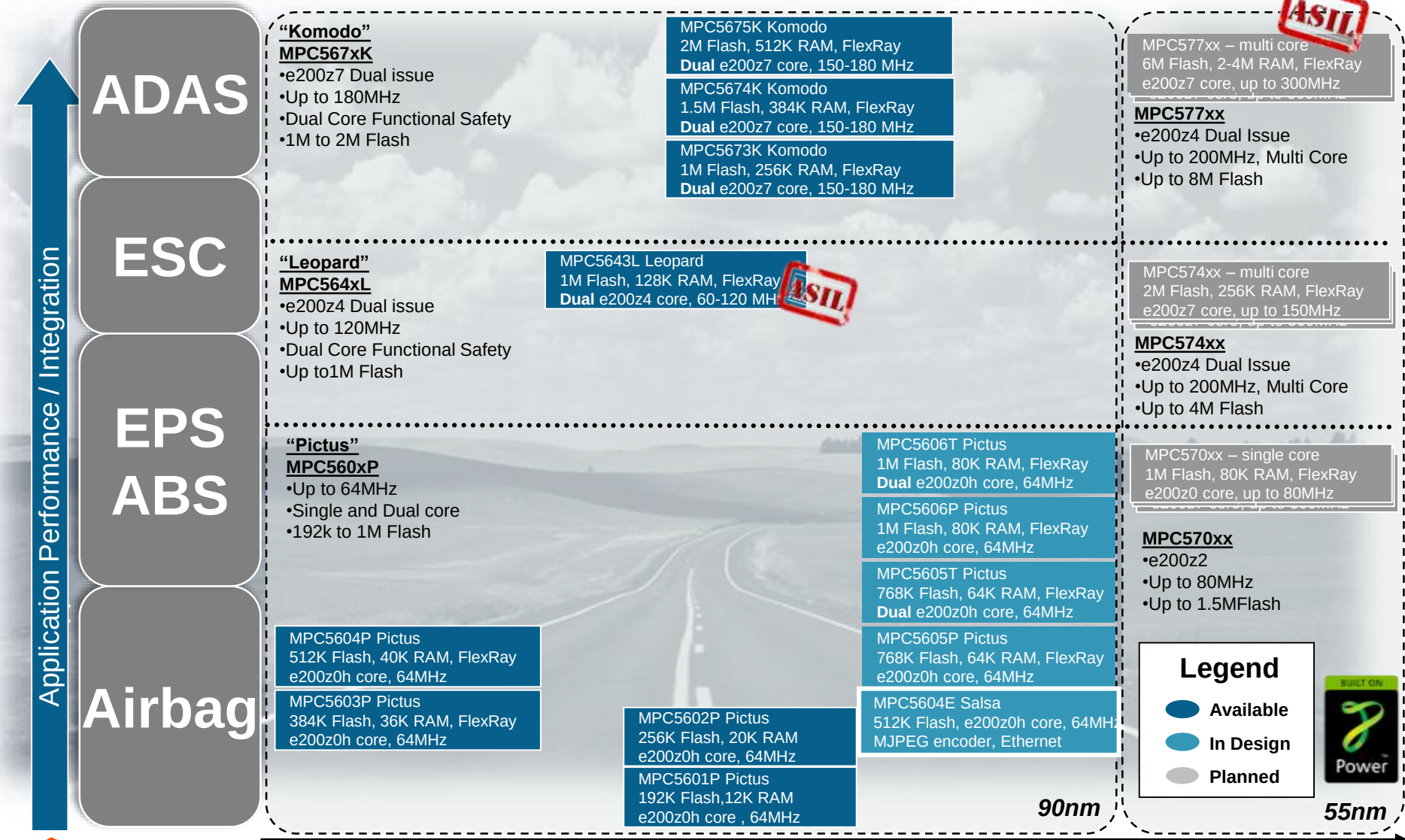
Features :

- One chip solution for TFT LCD and stepper motor driver
- Multi-Core ARM based solution:
  - Cortex A5 + Cortex M4 + Cortex M0+
  - flexible OS strategy
- High Resolution Graphics with 3D like animations
- Addressing Functional Safety and Security

**Products:**

- Halo

# MSG Safety and Chassis Roadmap
# 用于底盘和安全的解决方案

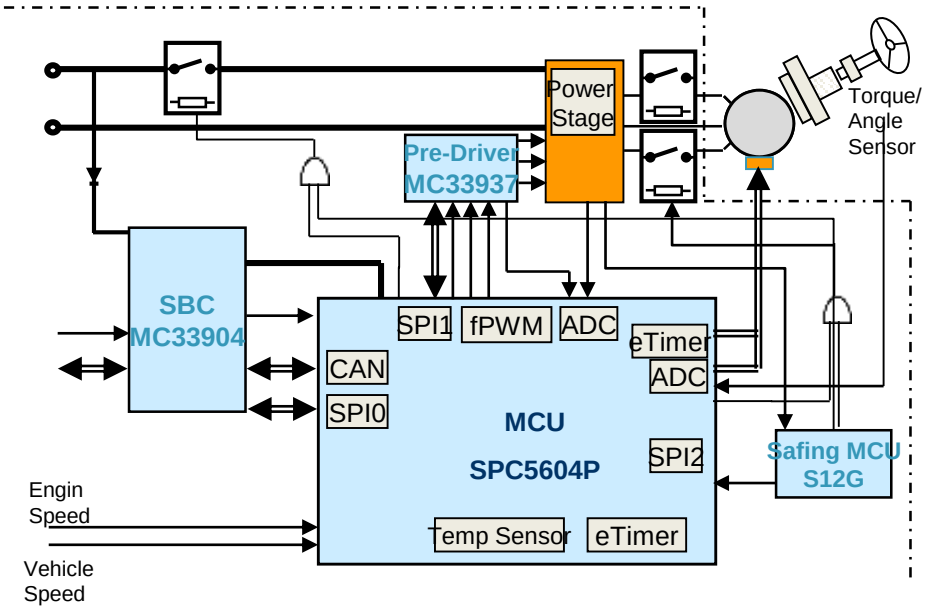



ASIL ISO 26262 compliant

# PMSM EPS Reference Design 永磁同步EPS参考设计

Features：

- Interfaces for rotor position transducers including: Incremental encoders, Digital Hall sensors, Sin/Cos sensors, Resolvers
- Vector control with position sensor
- Closed-loop current control
- Field weakening when the speed of the motor is to be increased above its base speed
- Decoding of the resolver output signals via an angle tracking observer method




**Products:**

- SPC5604P
- MC33937
- MC33904
- S12G

**Reference design Available now**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