Freescale EV/HEV Products and solution

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Automotive Senior Marketing
Main Content

• Freescale Overview & EV/HEV Market

• Freescale EV/HEV MCU Product & Solution

• Freescale EV/HEV Analog Product & Solution
A Global Leader in Microcontrollers and Digital Networking Processors

Five Core Product Groups

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

Four Primary Markets

- Automotive
- Networking
- Industrial
- Consumer

>50 Year Legacy

>5,500 Engineers

>6,000 Patent Families
### 50+ Year Heritage of Innovation

More than **6,000** patent families granted and pending worldwide

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1952</td>
<td>3-amp power transistor</td>
</tr>
<tr>
<td>1960</td>
<td>Si-base transistor</td>
</tr>
<tr>
<td>1975</td>
<td>MC6800 1st microprocessor used in automotive application</td>
</tr>
<tr>
<td>1979</td>
<td>16-bit processor MC68000</td>
</tr>
<tr>
<td>1984</td>
<td>32-bit processor MC68020</td>
</tr>
<tr>
<td>1989</td>
<td>MC68302 comms processor</td>
</tr>
<tr>
<td>1991</td>
<td>PowerPC® (1) Alliance</td>
</tr>
<tr>
<td>1993</td>
<td>1st RF-LDMOS device for 1GHz cellular handset &amp; infrastructure markets</td>
</tr>
<tr>
<td>1994</td>
<td>1st PowerPC® processor</td>
</tr>
<tr>
<td>1995</td>
<td>MPC860 PowerQUICC</td>
</tr>
<tr>
<td>1996</td>
<td>500-700 MHz, 65 W RF plastic package</td>
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<tr>
<td>1998</td>
<td>1st PowerQUICC II comms processor</td>
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<tr>
<td>2001</td>
<td>MPC7455 SOI volume production</td>
</tr>
<tr>
<td>2003</td>
<td>MXC 1st single-core modem: “smartphone-on-a-postage stamp”</td>
</tr>
<tr>
<td>2003</td>
<td>Leading capacitive tire pressure MEMS</td>
</tr>
<tr>
<td>2004</td>
<td>1st 130 nm MCU with 2 MB eNVM</td>
</tr>
<tr>
<td>2005</td>
<td>i.MX31 apps processor for mobile multimedia</td>
</tr>
<tr>
<td>2006</td>
<td>MC9RS08KA2 ultra-low-power MCU with RS08 core</td>
</tr>
<tr>
<td>2006</td>
<td>Multicore DSP for wireless &amp; wireline infrastructure</td>
</tr>
<tr>
<td>2006</td>
<td>One of industry’s 1st commercial MRAM products</td>
</tr>
<tr>
<td>2007</td>
<td>Flexis QE128 family: migration from 8-bit to 32-bit MCUs</td>
</tr>
<tr>
<td>2008</td>
<td>Debuts world’s most powerful automotive MCU for ‘green’ engine design</td>
</tr>
<tr>
<td>2008</td>
<td>Industry’s most accurate Li-ion battery charging IC</td>
</tr>
<tr>
<td>2008</td>
<td>Samples LED backlighting IC</td>
</tr>
<tr>
<td>2009</td>
<td>Leader in 90 nm MCU with embedded flash</td>
</tr>
<tr>
<td>2009</td>
<td>Breakthrough in power conversion tech for solar</td>
</tr>
<tr>
<td>2010</td>
<td>Xtrinisc - smart sensor platform</td>
</tr>
<tr>
<td>2010</td>
<td>Industry’s most powerful auto MCU (MPC5674F)</td>
</tr>
<tr>
<td>2010</td>
<td>Industry’s 1st radar technology with integrated 77 GHz SiGe programmable transmitter &amp; PLL</td>
</tr>
<tr>
<td>2010</td>
<td>Founding member of Linaro software alliance</td>
</tr>
<tr>
<td>2010</td>
<td>Kinetics - most scalable MCU portfolio based on ARM® Cortex™ M4 processor</td>
</tr>
<tr>
<td>2011</td>
<td>QorIQ Converge: 1st scalable multimode MPU+DSP “base station on a chip”</td>
</tr>
<tr>
<td>2011</td>
<td>QorIQ T series 24+ core multi-thread MPUs</td>
</tr>
<tr>
<td>2011</td>
<td>Airfast #1 in RF power for more than 6 years</td>
</tr>
<tr>
<td>2011</td>
<td>S12 MagniV MCUs: digital &amp; high-voltage analog on a single die</td>
</tr>
<tr>
<td>2011</td>
<td>PX series built on Power Architecture: controls 3+ comms &amp; 6 motors simultaneously</td>
</tr>
<tr>
<td>2012</td>
<td>Layerscape software-aware, core-agnostic development platform</td>
</tr>
<tr>
<td>2012</td>
<td>Qorivva: 1st auto MCU with ISO 26262 functional safety certification</td>
</tr>
</tbody>
</table>

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Freescale patent total as of January 2013

(1) The “PowerPC®” name is a trademark of IBM Corp. and is used under license.
Major Trends Shaping Our Future

- **Going Green**
- **Health & Safety**
- **Connected Intelligence**

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Why EV/HEV

- Consumer motivation switching from ICE to HEV/EV powered car (US)

- Innovative pricing models or lower price overall ............. 71%
- Extended reach or range of the vehicles ....................... 64%
- Convenience of usage or services ................................ 63%
- Availability of charging infrastructure .......................... 62%
- SIGNIFICANTLY HIGHER OIL PRICES ....................... 51%
- Green image or sustainability concerns ....................... 48%
- GOVERNMENT INCENTIVES OR REGULATIONS .......... 41%
- Traffic congestion ................................................... 26%

Source IBM, 2011

BOTTOM LINE: Consumers must perceive benefits from electric car ownership. Decision to buy is a matter of price, function and network externalities.
## The Mileage Cost – Electric vs. Gas

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>EMEA</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kWh GM Volt</td>
<td>kWh Nissan Leaf</td>
</tr>
<tr>
<td>Battery capacity</td>
<td>16</td>
<td>40</td>
</tr>
<tr>
<td>Mileage capability</td>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td>Yearly mileage average</td>
<td>24</td>
<td>100</td>
</tr>
<tr>
<td>Gas consumption average</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas price (est. 1Q2012)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity cost</td>
<td>0,08 €</td>
<td>0,08 €</td>
</tr>
<tr>
<td>Annual Energy expense</td>
<td>800 €</td>
<td>480 €</td>
</tr>
</tbody>
</table>

### Notes:
- The electric cost may vary by country.
- Gas price depends on tax rate by country.
- High cost battery may be offset by subsidy and overall savings.
- Within one year the savings factor is up to 4x for electric charge vs. gas vehicles.

Cost estimates for the Li-ion batteries currently used in most vehicles, for instance, run in a range of $600 - $900 per kilowatt-hour; the U.S. Energy Department’s goal is to reduce battery prices to $250/kWh by 2020.
Why not Move to EV/HEV quickly - EV/HEV in Review

• Batteries continue to be the weak link
  - Too heavy
  - Too Costly
  - Too little power for the weight/cost
  - Un-known lifetime performance

• Progress is being made in batteries
  - Lithium-ion could provide improvement

• Current market driven by early adopters
  - Next stage driven by cost/benefit trade-off
  - Strongly enabled by higher prices for gasoline
Challenges and Freescale Solution

• Challenges (System level)
  – Motor Control / Real time processing
    ▪ Precise, Fast, and Deterministic control timing
    ▪ Execution performance and Code optimizations
  – Complex Distributed System
    ▪ Synchronization of Multiple controllers
    ▪ High communication availability (5ms response window)
  – System costs
    ▪ Multiple controllers and sensors
    ▪ Memory requirements for Flash and SRAM
    ▪ Development costs for controller software

► Freescale Solutions (MCU level)
  ► Motor Control / Real time processing
    • High Performance Power architecture
    • Sophisticated timer and triggering coprocessors
    • Optimized algorithms for Field Oriented Control
  ► Complex Distributed System
    • Flexray for Deterministic and fast communications
    • Flexray or accelerated CAN
  ► System costs
    • Sensorless control to eliminate expensive components
    • On-chip Resolver to digital decoding capability
    • Scalable roadmap of architecturally compatible devices
    • Optimized Software for Autosar and Motor Control Libraries
    • Extensive SW eco system
Freescale Uniquely Positioned To Address HEV/EV

Start Stop
- Drivers
- Re-Gen Braking
- Power Devices

Inverter
- Control & Safing MCU
- Isolation
- Drivers
- Power Devices
- FOC Software
- Modeling and Simulation Tools

LV Battery Monitoring
- MCU
- Voltage Monitoring
- Packaging

HV Battery Management
- MCU
- Charge Monitoring
- Charge Balancing
- Communications
- Isolation

Charge Point
- MCU
- Communications
High Voltage Motor Dynamometer LAB in Phoenix

EV team in Phoenix with the necessary skills to do:

• Competitive analysis / existing product evaluation
• Validating new ideas / inventions IP & patents
• Define new potential products. Provide requirements / prototypes
• Help with evaluation of potential partners / acquisitions

• Integrate products / leverage ideas from across the Corporation
• Provide an environment for rapid prototyping
• Testing / making business case on new concepts
Continuing To Build On Our Real World Experience

Freescale Designed

• Controller Board
• Gate Driver Board
• Common Mode Filter Board

• Motor Control Software
• Enclosure

65kW Prototype Inverter Developed for an Auto OEM
Resolver Interface

- Electro-magnetic induction type angle sensor
- Output voltage proportional to the rotational angle by alternating current excitation
- Develop hardware peripheral for reference generation, signal sampling, and sin/cos decoding
- Requirements shared with chassis & safety segment
Battery Management

- Use existing multicore solutions for high throughput processing power
- Significant A/D resources required

- Functional safety (ASIL-C/D system level assessment)
Microcontroller Solutions for EV/HEV – Overview

Aug. 2013
Addressing EV/HEV Needs: **Power, Performance, Support**

- **Automotive highest performance MCU**
  - Multi-core designs allow lower power per MHz
  - Targeting >1400 DMIPS on 55nm
  - Qorivva e200z4 / z7 cores enhanced to run at 200MHz / 300MHz
  - On-chip DSP, SIPI and faster debug capabilities

- **Optimize HEV/EV designs using;**
  - FlexPWM
  - eTPU/GTM
  - Resolver

- **Enablement to support emerging markets**
  - Software code examples, engine reference designs and motor control libraries to speed development
  - eTPU function selector to autocode difficult engine parameters
Addressing Powertrain Needs: Safety & Security

- ISO26262 (Functional Safety)
  - Qorivva supports ASIL-C and ASIL-D applications
    - Lockstep core and end to end ECC on all 55nm products

- Flash Reprogramming Detection and Prevention
  - Tamper detection and encryption options on all 55nm products
  - ECC, HSM, SB256 (secure boot 256bit encryption)
Advanced Architectures: Powertrain

- **Multicore Processing** (enhances throughput)
- **Lockstep Core** (safety)
- **I/O Processor** (offloads main cores)
- **Crossbar** (reduces delays in multicore memory access)
- **Embedded Flash / RAM**
- **DSP Functionality**
- **Local I-RAM / D-RAM** (instruction RAM, data RAM) to maximize throughput
- **Multicore Processing** (enhances throughput)
- **Lockstep Core** (safety)
- **I/O Processor** (offloads main cores)
- **Crossbar** (reduces delays in multicore memory access)
- **Embedded Flash / RAM**
- **DSP Functionality**
- **Local I-RAM / D-RAM** (instruction RAM, data RAM) to maximize throughput

### Computational Shell
- 300 MHz Cores
- 200 MHz Crossbar
- Power™ e200Z7
- FPU
- VLE
- 16k I-Cache
- 4k D-Cache
- MPU
- Memory Protection Unit
- Hi Bandwidth Cross Bar Switch with ECC – 200MHz
- Flash Ctrl
- SRAM Ctrl
- 8MB Flash
- 6x 64k EEPROM
- 16k Overlay RAM
- Calibration Bus
- 512k SRAM

### Peripherals Control Shell
- 200 MHz Core
- 100 MHz Crossbar - 50 MHz Periphery
- Power™ e200Z4
- MCM
- 2x FlexRay
- Ethernet
- SWTIIC
- STM
- INTC
- I-RAM 32k
- D-RAM 32k
- MPU
- Memory Protection Unit
- Bridge A
- Bridge B
- Periph
- Periph
- Periph
- Periph
- eTPU
- FlexPWM
- GTM
- High-Speed A/D Converters
- Reaction Channels
- Decimation Filters
eTPU / FlexPWM

**Key Market Characteristics**
- Maintained for legacy customers
- Large eTPU code base, mature toolset
- FlexPWM for efficient inverter control

**Key Technical Characteristics**
- Upgrading design process for ASIL C/D
- Lockstep and safety designs
- Improved reaction channels for current control
- Decimation filters

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**Reaction Module**

**Timer Router**

**Timers**

**Modulation Control Bank**

**Threshold Bank**

**Holdoff Value bank**

**Core Legend**

CC = Computational Core
IO = I/O Processor
LS = Lockstep Core

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**MPC5777C Cobra 55**
- 8M Flash, 512k SRAM
- 2CC + 1LS, 264MHz
- FlexRay, 3xeTPU2+

**MPC5746R Rainier**
- 4M Flash, 320k SRAM
- 2CC + 1LS, 200MHz
- FlexRay, 2xeTPU2+

**MPC5742F Fuji**
- Up to 2M Flash, 160k SRAM
- 1CC + 1LS, Up to 200MHz
- 1xeTPU2+
GTM Introduction

**Key Market Characteristics**
- Defined and developed by Bosch
- Continental is close follower
- Developed for “standard” timer from multiple sources

**Key Technical Characteristics**
- Multicore architectures
- Data flow driven design concept
- Configurable dedicated hardware sub-modules
- Central routing unit managing all internal data movement between sub-modules.
- Internal programmable RISC-like cores
- Qual Q1 2014

**Drawbacks**
- Reliance on Bosch by Freescale and non-Bosch Tier 1s
- Weakness for motor control
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 (incl. 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 – 5 channels (2 supporting μSec channel)
- LINFlex - 5 channels (2 supporting μSec channel)
- FlexCAN – 4 channels
- 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 BGA
- 292 BGA eCal package (incl. RAM buddy chip) for emulation/debug

Enablement

- Software: AutoSAR drivers
- Tools: Debugger (Lauterbach), multicore compiler (Wind River and Green Hills)
Key Functional Characteristics
- Two independent 200 MHz Power Architecture z4 computational cores
  - Single 200 MHz Power Architecture z4 core in delayed lockstep for ASIL-D safety
  - Single I/O 200 MHz Power Architecture z4 core
- eDMA controller – 64 channels
- 4M Flash with ECC
- 320k total SRAM with ECC
  - 128k of system RAM (incl. 64k standby on 292 PBGA package)
  - 192k of tightly coupled data RAM
- 6 ΣΔ & 8 SAR converters – 60 channels on 292 MAPBGA, 48 channels on 176 LQFP
- Ethernet (MII/RMII)
- DSPI – 7 channels (2 supporting μSec ch.)
- LINFlex - 5 channels (2 supporting μSec ch.)
- MCAN-FD/TTCAN – 3x modules/1x module
- GTM – 120 timer channels

Key Electrical Characteristics
- -40 to +125 °C (ambient)
- 165 °C junction for KGD
- 1.26V Vdd, 5.0V I/O, 5V ADC

Package
- 176 LQFP / EP, 292 PBGA
- eCal emulation device for each package

Enablement
- Software: AutoSAR drivers
- Tools
  - Debugger: Green Hills, Lauterbach and PLS
  - Multicore compiler: HighTec, GCC, Wind River, GHS
  - Simulation tools
32 bit MCU Summary

- **Qorivva MCUs** cover the MPC55xx (130nm), MPC56xx (90nm) families, and **MPC57xx (55nm)** families.

- **90nm 32-bit MCU in Qorivva:**
  - MPC563xM, 564xA for Powertrain and VCU/HCU
  - MPC560xP and MPC564xL, for Safety and Motor control
  - MPC560xB/C, for VCU/HCU and gateway and high end body control.

- **55nm 32-bit MCU in Qorivva:**
  - MPC570xB, 574xG, 574xF for VCU/HCU and Battery Control
  - MPC574xR/M 577xC, for VCU/HCU and Motor control (MCU)
Analog Solutions for EV/HEV – Overview
Power Management & P/L Market Dynamics

**Energy Efficiency**
- Government regulations to reduce CO2 emissions (impact is 20% Power saving target on each ECU)
- New E/E architecture preparing transition to EV-HEV
- New CAN standard for energy saving

**Functional Safety**
- ISO26262 Standardization for Auto and IEC61508 for Industrial
- Functional Safety requiring system approach
- MCU Attach solutions offering Freescale leadership in growing markets and value

**Connectivity EveryWhere**
- 100M# vehicles at horizon 2020
- 1,7B# CAN and 1,0B# LIN
- Standardization of EMC and ESD certification requirements
- CAN partial networking and Flexible data new innovations
- Trends in Ethernet penetration for both Auto and Industrial markets

**Simplify Complexity**
- Acceleration of Computing capabilities (32bit market growth)
- Needs for Plug and Play and Attach compatible solutions
- Professional Eco system
- Demonstrators
Freescale SBC Segmentation
Different Standard Solutions for Different System Needs

**Physical Layer**

- **entrySBCs**
  - Simple Low Power Modes
  - Robustness
  - Design for Cost
  - CAN Partial Networking
  - Selective Wake up

- **SBCs**
  - Ultra Low Power Modes
  - Flexible Power Management
  - Medium Functional Safety

- **PowerSBCs**
  - Energy Efficient (>85%)
  - High Current (up to 2.0A)
  - High Functional Safety (fit for ASILD applications)

**KEY VALUES**
MC33907/8 Safe SBC with Buck/Boost Regulator

System Basis Chip (SBC) family providing energy efficient DC/DC power conversion and low voltage operation with advanced functional safety mechanisms

Differentiating Points

• **Availability**: Ultra low voltage operation **down to 2.7V**
• **Efficiency**: of a Dual DC/DC converter topology
• **Safety**: Innovative architecture allowing **independent** monitoring of safety critical parameters
• **Scalable**: family of products supporting a wide range of MCU and power segmentation architectures

Product Features

• Flexible DC/DC Buck pre regulator with optional Boost to fit with LV124
• Multiple supplies up to 1.5 A
• Low Power Modes (**25µA**) -50% versus competition
• Analog Multiplexer & Battery sensing
• **Independent fail safe state machine** supporting functional safety standards
• Secure SPI interface
• Robust physical layers with superior EMI/ESD performance

Typical Block Diagram

Typical Applications

• Power management
• Functional safety integration
• Safety Critical Motor Control
# MC33907/8 Safe SBC with Buck/Boost Regulator Features Table Overview

<table>
<thead>
<tr>
<th>Part Number</th>
<th>PC33907 PowerSBC10</th>
<th>PC33908 PowerSBC20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-regulator (6.5V) 5%</td>
<td>2A (B-B_440kHz)</td>
<td>2A (B-B_440kHz)</td>
</tr>
<tr>
<td>MCU core supply VCore / 2%</td>
<td>0.8A (B_2.4MHz)</td>
<td>1.5A (B_2.4MHz)</td>
</tr>
<tr>
<td>MCU A/D ref. voltage supply VCCA /1%</td>
<td>100 mA (int) +/-1% Or 300mA (ext. PNP) +/-3%</td>
<td>100 mA (int) +/-1% Or 300mA (ext. PNP) +/-3%</td>
</tr>
<tr>
<td>Auxiliary ECU supply Vaux / 3%</td>
<td>Up to 300 mA Tracker / Auxiliary</td>
<td>Up to 300 mA Tracker / Auxiliary</td>
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<tr>
<td>Can_5V Supply – VCAN (dedicated to internal CAN physical layer)</td>
<td>100mA</td>
<td>100mA</td>
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<tr>
<td>CAN Interface</td>
<td>1</td>
<td>1</td>
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<tr>
<td>IOs</td>
<td>6 (incl. F/S inputs)</td>
<td>6 (incl. F/S inputs)</td>
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<tr>
<td>Watchdog</td>
<td>Challenger</td>
<td>Challenger</td>
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<tr>
<td>Stdby mode - LPOFF</td>
<td>25µA</td>
<td>25µA</td>
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<tr>
<td>AMUX &amp; Battery Sense</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Fail Safe</td>
<td>Independant I&amp;O</td>
<td>Independant I&amp;O</td>
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<tr>
<td>Package</td>
<td>LQFP48eP</td>
<td>LQFP48eP</td>
</tr>
</tbody>
</table>
## MC33907/8 Safe SBC with Buck/Boost Regulator

**Product Differentiation**

New generation of System Basis Chip, ideal companion solution of Qorivva MCUs, offering scalable and energy efficient DC/DC solution, support lowest operating voltages standards and combine advanced functional safety mechanisms.

### Efficiency & Availability

- **Energy Efficient Solution™**
  - Combination of the efficiency of a standard DC/DC with unique low voltage operation down to 2.7V \( V_{sup} \).

### Fit for ISO26262 Functional Safety

- **SafeAssure Solution™**
  - Innovative IC architecture allowing independent monitoring of safety critical parameters, ideal for stringent safety needs.

### Power Scalability Qorivva Attach strategy

- Scalable set of products that help customer to design a platform solutions with various MCU and Power segmentation.

### Characteristics

- **Innovative DC/DC PMICs solutions to improve energy utilization**
- **Low Current consumption during low power mode. combined wake-up strategy**
- **Sustain Class A during 3.5V battery voltage during cranking pulse, (2.7V \( V_{sup} \), called LV124 specification)**
- **Fit for purpose of ASILD application, combined with MCUs like MPC5643L**
- **Advanced HW Safety to allow external MCU verification through independent fail safe state machine.**
- **Safe Documentation to support ISO26262 system certification**
- **Ideal Power Supply for large range of Freescale 32bit Qorivva MCUs**
- **Combined ecosystem to simplify MCU and PowerSBC interaction**
- **Pin-to-pin compatible products allowing OEMs to design one board platform for multiple vehicle**
Enhanced EVB: eEVB
MC33907 (PowerSBC10) + MPC5643L (Leopard)

• Complete solution using FSL Power supply unit and MCU
• Easy to use (using GUI)
• Low Level Drivers available and delivered with kit
• Fit with ASILD application requirements
• Fault injection validation
• Speed-up customer development
Intelligent Precision Battery Sensors
Freescale’s Intelligent Precision Battery Sensors - Overview

**MM912J637 – 12V Pb (LIN)**

**MCU** S12 (16-bit)
- Flash 96k/128k
- Data Flash 4k
- RAM 6k

**Mixed-Signal Chip**
- LIN Physical Layer (ESD 15kV)
- Watchdog
- Standby Current <100μA (1sec Isense)
- Vreg capability 50mA
- Operating Voltage 3.5..28V
- RAM Contents Guaranteed :2.5...3.5V
- 3x ADC (2nd Order Sigma Delta) 16bit
- Current Measurement
  - Relative Accuracy <0.5%
  - Voltage Measurement
  - Relative Accuracy <0.2%
  - Temperature Measurement
  - Relative Accuracy <2K
- Operating Temperature  -40°C<Ta<125°C

**MM9Z1J638 – Multi Applications (LIN, msCAN)**

**MCU S12Z (32-bit ALU)**
- Flash 96k/128k
- EEPROM 4k
- RAM 8k
- msCAN

**Mixed-Signal Chip**
- LIN Physical Layer
- Watchdog
- Standby Current <100μA (1sec Isense)
- Vreg capability 150mA
- Operating Voltage 3.5..28V (Vs3:52V)
- RAM Contents Guaranteed :2.5...3.5V
- 3x ADC (2nd Order Sigma Delta) 16bit
- Current Measurement
  - Relative Accuracy <0.5%
  - Voltage Measurement
  - Relative Accuracy <0.2%
  - Temperature Measurement
  - Relative Accuracy <2K
- Operating Temperature  -40°C<Ta<125°C
## Freescale Intelligent Battery Sensors - Feature Comparison

<table>
<thead>
<tr>
<th>MM912J637AM2</th>
<th>MM9Z1J638AM2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Application</strong></td>
<td><strong>Applications</strong></td>
</tr>
<tr>
<td>- 12V PB Battery (LIN)</td>
<td>- 12V Pb Battery (Lin, CAN), 14V Li-ion Battery, Multi-battery apps, HV Battery Junction Box</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td><strong>Communication</strong></td>
</tr>
<tr>
<td>- LIN, SCI, SPI</td>
<td>- msCAN, LIN, SCI, SPI</td>
</tr>
<tr>
<td><strong>Just Enough MCU Performance</strong></td>
<td><strong>Higher MCU Performance</strong></td>
</tr>
<tr>
<td><strong>Features</strong></td>
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<tr>
<td>- Cranking mode</td>
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<tr>
<td>- 2\textsuperscript{nd} Vsense</td>
<td>- 4 attenuated Vsense and 4 direct Voltage Pins</td>
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<tr>
<td>- External Temp sense</td>
<td>- 4 External Temp sense</td>
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<tr>
<td><strong>Full Temp Range</strong></td>
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<tr>
<td>- -40C..125C</td>
<td>- -40C..125C</td>
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<tr>
<td><strong>PPAP completed</strong></td>
<td><strong>Final Silicon, PPAP: 4Q13, SOP: 3Q14</strong></td>
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Summary for Products by Freescale in HEV

**Qorivva MCUs:**
Specific features required for complex algorithms in motor control and battery management:
- DMA, DSP functions, Flex PWM, msCAN, Memories, HAL, SW tools
- Single/Multicore MCU
- Multicore MCU

**PowerSBC** – MCU companion with Safety approach
HDTMOS / LFET 90V

**Xtrinsic battery sensor** and derivatives

Electric pump applications – **MagniV Technology**

**Functional Safety** – Freescale SafeAssure
Merge Freescale technology with car OEM and Tier1s in New Energy Vehicles.