Freescale Analog Product Overview: Making Embedded Systems Better with Robust Reliable Performance

EUF-IND-T0662

Emmanuel Carcenac | EMEA Analog Business Development

JAN. 2015
Agenda

• Introduction
• Analog product differentiation, applications & enablement tools
  – System Power Management & Interface
    ▪ PMIC and System Basis Chip solutions
  – Power Drivers and Switches
    ▪ High-side and low-side solutions
    ▪ H-bridges and 3-phase pre-driver solutions
  – Battery Management
    ▪ Battery cell controller solutions
  – Analog System Solution
    ▪ Valves and pump controller
We Are a Global Leader in Embedded Processing Solutions

Five Core Product Groups

>50 Year Legacy

>6,000 Patent Families*

Four Primary Markets

* a set of patents taken in various countries to protect a single invention
Analog and Sensors
Making Embedded Systems Real

Complete Embedded System Solutions + Automation

Preferred MCU partner
Bridges real-world to digital
Value add system integration

Differentiated Robust, Reliable Performance

Thermal and energy efficient
Precision sense and control
Extreme harsh environments

Leadership in Functional Safety

30+ years auto experience
System monitoring and failsafe
Revolutionized “Safe” systems

Low Power, Small Size, High Precision
## Analog Portfolio
Bridging Real-World Physics to Connected Digital Intelligence

<table>
<thead>
<tr>
<th>System Power Management and Interface</th>
<th>Power Drivers and Switches</th>
<th>Battery Management</th>
<th>Analog System Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Management IC</td>
<td>Gate Driver</td>
<td>Intelligent Battery Sensor</td>
<td>77 GHz Radar</td>
</tr>
<tr>
<td>System Basis Chip</td>
<td>Power Driver</td>
<td>Battery Cell Controller</td>
<td>Airbag</td>
</tr>
<tr>
<td>Physical Layer Transceiver</td>
<td>eXtreme Switch</td>
<td>Li-Ion Battery Charger</td>
<td>Valve Controller</td>
</tr>
<tr>
<td>Input Monitoring</td>
<td></td>
<td>Alternator Regulator</td>
<td>Programmable Solenoid Controller</td>
</tr>
<tr>
<td>LDO – DC/DC</td>
<td>Low $R_{D\text{Son}}$ – SPI</td>
<td>System in Package</td>
<td>Small Engine Controller</td>
</tr>
<tr>
<td>Safety – Monitoring</td>
<td>High Side – Low Side</td>
<td>800V – Balancing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diag. &amp; Protection</td>
<td></td>
</tr>
</tbody>
</table>
Growing Analog Leadership in Automotive

**Powertrain & Hybrid**
- Alternator regulators
- Stop/Start MOSFETs
- Intelligent battery sensors & cell controller
- DFI Solenoid Controller
- System Basis Chip
- H-Bridge DC & BLDC motor drivers

**Body Electronics**
- eXtreme power switches
- CAN / LIN transceivers
- System Basis Chip
- I/O switch detectors
- H-Bridge DC motor drivers
- BLDC motor pre-drivers
- IDC/MagniV relay drivers

**Driver Infotainment**
- Power Management IC
- CAN Transceiver

**Chassis**
- Braking: ABS, ESC, WSS control
- System Basis Chip
- BLDC motor pre-drivers
- CAN Transceiver

**Safety**
- ADAS 77GHz radar transceivers
- Airbag SBC & Squib Driver
- System basis chip
- CAN / DSI transceivers
Expand Analog in Industrial and Multi Market

Wearables & IoT (health & fitness, ePOS, smart watch,...)
- Power Management IC
- Battery charger
- Audio Codec
- Backlight LED driver

Industrial Transportation (heavy machinery, forklift, RV,...)
- Small Engine Control IC
- Gate & Power driver
- Valve System Controller
- eXtreme power switches
- System Basis Chip
- CAN transceiver
- H-Bridge DC & BLDC motor drivers
- Input Interface IC

Energy Management (energy storage, UPS, converters, eBike,...)
- Intelligent battery sensors & cell controller
- Gate & Power driver
- eXtreme power switches
- System Basis Chip
- CAN transceiver

Building Control (HVAC, elevator, access & security,...)
- Power Management IC
- Gate & Power driver
- eXtreme power switches
- System Basis Chip
- CAN transceiver
- H-Bridge DC & BLDC motor drivers
- Input Interface IC

Factory Automation (PLC I/O, safety, robotics, drives,...)
- Power Management IC
- Gate & Power driver
- eXtreme power switches
- System Basis Chip
- CAN transceiver
- H-Bridge DC & BLDC motor drivers
- Input Interface IC
### New Strategy for Analog Enablement Tool

<table>
<thead>
<tr>
<th>Analog Toolbox</th>
<th>Easy MCU attach development with Freedom and Tower systems <a href="http://www.freescale.com/analogtools">www.freescale.com/analogtools</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Freedom Platform</td>
<td>Environment for Kinetis MCU attach evaluation and development <a href="http://www.freescale.com/freedom">www.freescale.com/freedom</a></td>
</tr>
<tr>
<td>Tower System</td>
<td>MCU attach modular development platform for rapid prototyping <a href="http://www.freescale.com/tower">www.freescale.com/tower</a></td>
</tr>
</tbody>
</table>
| Technical Collateral | • Application notes, datasheets and user guides  
• Hardware, software and functional safety reference manuals [compass.freescale.net/go/ciaproject](http://compass.freescale.net/go/ciaproject) |
| Ongoing Developments | • MCU attach reference designs for target applications  
• Processor Expert library elements for key products  
• Drivers and target application example code |
## System Power Management and Interface Key Products

### Power Management IC

<table>
<thead>
<tr>
<th>Automotive</th>
<th>Industrial / Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMPF0100xxAZ</td>
<td>MMPF0100xxAN</td>
</tr>
<tr>
<td>MMPF0200xxAZ</td>
<td>MMPF0200xxAN</td>
</tr>
<tr>
<td>MC32PF3000</td>
<td>MC34PF3000</td>
</tr>
<tr>
<td>LDO Based architecture</td>
<td></td>
</tr>
<tr>
<td>MC33910/11/12</td>
<td>-</td>
</tr>
<tr>
<td>MC33903/4/5</td>
<td>MC34903/4/5</td>
</tr>
<tr>
<td>DC/DC Based architecture</td>
<td></td>
</tr>
<tr>
<td>MC33907</td>
<td>MC34FS6407</td>
</tr>
<tr>
<td>MC33908</td>
<td>MC34FS6408</td>
</tr>
<tr>
<td>MC33909</td>
<td>MC34FS4409</td>
</tr>
<tr>
<td>Physical Layer Transceiver</td>
<td></td>
</tr>
<tr>
<td>CAN</td>
<td></td>
</tr>
<tr>
<td>MC33897</td>
<td>-</td>
</tr>
<tr>
<td>MC33901</td>
<td>MC34901</td>
</tr>
<tr>
<td>MC33CM0902</td>
<td>MC34CM0902</td>
</tr>
<tr>
<td>LIN</td>
<td></td>
</tr>
<tr>
<td>MC33662/3</td>
<td>-</td>
</tr>
<tr>
<td>TPL</td>
<td></td>
</tr>
<tr>
<td>MC33664</td>
<td>-</td>
</tr>
<tr>
<td>DSI</td>
<td></td>
</tr>
<tr>
<td>MC33781/4</td>
<td>-</td>
</tr>
<tr>
<td>MC33AS0528</td>
<td>-</td>
</tr>
<tr>
<td>ISOLINK</td>
<td></td>
</tr>
<tr>
<td>MC33660</td>
<td>-</td>
</tr>
<tr>
<td>Input Monitoring</td>
<td></td>
</tr>
<tr>
<td>Switch Interface</td>
<td></td>
</tr>
<tr>
<td>MC33972/5/8</td>
<td>MC34972/5/8</td>
</tr>
</tbody>
</table>
Freescale PMICs & Processors mapping

**PF & VR Series PMIC**
- System level PMIC
- 3/5 V Power input
- Highly Flexible
- All Markets

**FS Series PMIC**
- System Basis Chip (SBC)
- 24 V Power input
- Safety & CAN support
- Auto/Indus

**i.MX Applications Processors**
- i.MX50/51/53
- i.MX 6
- Q/D/DL/S/SL/SX
- i.MX 7

**QorIQ & Layerscape**
- Digital Networking Processors

**Kinetis MCUs**

**Qorivva Automotive and Industrial MCU**
- MPC560xB, C, P
- MPC563xM
- MCP574xP

**Non Freescale CPU/FPGA**
Power Management Devices for i.MX & QorIQ Layerscape Processors
NXP 100/0200 Quick-turn Programmable System PMIC

Most economical quick-turn programmable 14-ch/11.7 A system power management solution with fully configurable voltages, sequencing and timings

Differentiating Points
- Optimized to work with i.MX 6 processors
- Quick-turn customizable output voltages, sequencing and timings
- Boost regulator to 5.0 V out for USB
- Field programmable OTP memory
- Power control logic with processor interface and event detection

Product Features
- 2.8 V to 4.5 V input voltage
- 14-ch, 11.7 A (PF0100); 12-ch, 7.5 A (PF0200)
- 4 to 6 Channel configurable buck converters
- 6 user programmable LDO
- Forced PWM or automatic operation
- Boost regulator, coin cell charger, DDR reference
- Programmable output voltage, current limit, soft-start, frequency switching, OTP fault interrupt
- High power 8x8 mm 56-lead E-QFN or WF-QFN

Applications
- Performance tablets, eReaders, Navigation
- Industrial Single Board Computers
- Point of Sale (POS) terminals
- Automotive infotainment
- Human-machine interface, Home Automation
- Portable Medical

PF0200 is lower featured version of the PF0100. SW1C and SW4 regulators are removed in MMPF0200 and SW2’s current rating is reduced to 1.5 A
Xilinx Products Mapping With PMIC

SoC
- Zynq-7000 (7010, 7015, 7020, 7030, 7045) – system integration and optimization

FPGA
- Virtex
  - Virtex-4 – Optimized for high-performance logic, embedded and DSP
  - Virtex-5 – Optimized for high-performance logic, ultra-high bandwidth, DSP, embedded processing and/or low-power/ high-speed serial connectivity
  - Virtex-6 – Optimized for high-performance logic, ultra-high performance DSP, highest bandwidth/ low-power serial connectivity

CPLD
- 7-series (28 nm) – high-end FPGAs
  - Virtex-7 – Optimized for highest system performance and capacity

3D IC
- Kintex-7 – Optimized for best price-performance
- Artix-7 – Optimized for lowest cost and lowest power applications

Spartan
- Spartan – Low-end FPGAs
  - Spartan-3 – For Highest Density and Pin-Count Applications
  - Spartan-3E – Logic Optimized
  - Spartan-3A – I/O Optimized
  - Spartan-3AN – Non-volatile
  - Spartan-3 DSP – DSP Optimized
  - Spartan-6 (45 nm) – Low-power, optimized for lowest-cost logic, DSP, memory and connectivity

Configuration Memory
- 7-series (28 nm) – high-end FPGAs

Compatible supply from MMPF0100
PF0100 Supplying a FPGA System – Application Example

• Multiple PF0100s may be used simultaneously in systems where it is deemed necessary or appropriate.

• The PF0200, sister IC to the PF0100, may also be operated in conjunction with a PF0100/ individually, when the demand for the number of rails/ output capacity is not high.

See AN4991
Differentiating Points
- Compatibility with i.MX 6DL, S, SL, SX, UL & i.MX7 S, D processors, BSP in development
- Boost regulator to 5.0 V out for USB
- OTP memory to configure the start sequencing (less programmability than the PF0100/200), ideal balance between configurability and complexity
- Custom pre-programmed output voltages, sequencing, and timing available
- Power control logic with processor interface and event detection

Product Features
- **Vin up to 5.5 V Supply** (optional Front-End LDO)
- 4 Channel configurable buck converters
- 6 user programmable LDOs
- Boost regulator, Coin cell charger, DDR reference
- Programmable output voltage, current limit, soft-start, Fsw, OTP fault interrupt
- High power 7x7 mm, 48 E-QFN
- Smaller die for smaller package and cost optimization

Typical Applications
- Tablets, eReaders, Smartbooks, Navigation
- IPTV, IP Phone
- Automotive infotainment
- Human-machine interface, Home Automation
- Portable Medical

Samples availability: Jan 2015 & SOP June 2015
MC34VR500: Power Solution for Network Processor Systems

High Efficiency, Quad Buck regulator with up to 4.5A output

Differentiating Points

- Optimized to work with LS102x network processor systems
- High (3% better vs comp) full load efficiency with 92% peak
- Pre-programmed output voltages, sequencing, and timing available
- Dynamic regulator control via I2C
  - Voltage, Current Limit, Frequency, Low power Mode
- Power control logic with processor interface and event detection

Product Features

- Vin 2.8 V to 4.5 V Supply
- 4 independent buck converters
- 5 user programmable LDOs
- Forced PWM/PFM or APS operation
- DDR memory reference voltage LDO
- High power 8x8 mm QFN Wettable Flank package

VR500 Powers IoT Gateway

Typical Applications

- IoT Gateway
- Mobile Wireless Router
- MFP Printer
- Network Attached Storage
- Automatic Teller Machine
### MC34VR500VxES

<table>
<thead>
<tr>
<th>Processor Attach</th>
<th>LS1020A</th>
<th>LS1021A</th>
<th>LS1022A</th>
<th>LS1024A</th>
<th>LS1043A / LS1023A</th>
<th>T1023 / T1013</th>
<th>T1024 / T1014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registers/Part Numbers</td>
<td>MC34VR500V1ES/V2</td>
<td>MC34VR500V1ES/V2</td>
<td>MC34VR500V1ES/V2</td>
<td>MC34VR500V3ES</td>
<td>MC34VR500V4ES</td>
<td>MC34VR500V4ES</td>
<td>From the power number we can power this processor</td>
</tr>
<tr>
<td>Default I2C address</td>
<td>0x08</td>
<td>0x08</td>
<td>0x08</td>
<td>0x08</td>
<td>0x08</td>
<td>0x08</td>
<td></td>
</tr>
<tr>
<td>LDO2_VOLT</td>
<td>1.8 V</td>
<td>1.8 V</td>
<td>1.8 V</td>
<td>1.8 V</td>
<td>2.5 V</td>
<td>2.5 V</td>
<td></td>
</tr>
<tr>
<td>LDO2_SEQ</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>LDO3_VOLT</td>
<td>2.5 V</td>
<td>2.5 V</td>
<td>2.5 V</td>
<td>3.3 V</td>
<td>2.5 V</td>
<td>2.5 V</td>
<td></td>
</tr>
<tr>
<td>LDO3_SEQ</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>LDO4_VOLT</td>
<td>2.5 V</td>
<td>2.5 V</td>
<td>2.5 V</td>
<td>3.3 V</td>
<td>1.8 V</td>
<td>1.8 V</td>
<td></td>
</tr>
<tr>
<td>LDO4_SEQ</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>LDO5_VOLT</td>
<td>1.8 V</td>
<td>1.8 V</td>
<td>1.8 V</td>
<td>2.5 V</td>
<td>3.3 V</td>
<td>3.3 V</td>
<td></td>
</tr>
<tr>
<td>LDO5_SEQ</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>SW1_VOLT</td>
<td>1.0 V</td>
<td>1.0 V</td>
<td>1.0 V</td>
<td>1.2 V</td>
<td>1.5 V</td>
<td>1.5 V</td>
<td></td>
</tr>
<tr>
<td>SW1_SEQ</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>SW2_VOLT</td>
<td>1.0 V</td>
<td>1.0 V</td>
<td>1.0 V</td>
<td>1.5 V</td>
<td>1.8 V</td>
<td>1.8 V</td>
<td></td>
</tr>
<tr>
<td>SW2_SEQ</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SW3_VOLT</td>
<td>1.35 V</td>
<td>1.35 V</td>
<td>1.35 V</td>
<td>1.1 V</td>
<td>1.2 V</td>
<td>1.2 V</td>
<td></td>
</tr>
<tr>
<td>SW3_SEQ</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>12</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>SW4_VOLT</td>
<td>VTT / 1.8V for V2</td>
<td>VTT / 1.8V for V2</td>
<td>VTT / 1.8V for V2</td>
<td>VTT / 1.8V for V2</td>
<td>1.1 V</td>
<td>VTT</td>
<td>VTT</td>
</tr>
<tr>
<td>SW4_SEQ</td>
<td>3 / 4 for V2</td>
<td>3 / 4 for V2</td>
<td>3 / 4 for V2</td>
<td>1</td>
<td>12</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>REFOUT_SEQ</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>12</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>LDO1_VOLT</td>
<td>1.2 V</td>
<td>1.2 V</td>
<td>1.2 V</td>
<td>-</td>
<td>1.35 V</td>
<td>1.35 V</td>
<td></td>
</tr>
<tr>
<td>LDO1_SEQ</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PU CONFIG, SEQ_CLK_SPEED</td>
<td>1 ms</td>
<td>1 ms</td>
<td>1 ms</td>
<td>1 ms</td>
<td>1 ms</td>
<td>1 ms</td>
<td></td>
</tr>
<tr>
<td>PU CONFIG, SWDVWS_CLK</td>
<td>6.25 mV/us</td>
<td>6.25 mV/us</td>
<td>6.25 mV/us</td>
<td>6.25 mV/μs</td>
<td>6.25 mV/μs</td>
<td>6.25 mV/μs</td>
<td></td>
</tr>
<tr>
<td>SW1_CONFIG</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td></td>
</tr>
<tr>
<td>SW2_CONFIG</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td></td>
</tr>
<tr>
<td>SW3_CONFIG</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td></td>
</tr>
<tr>
<td>SW4_CONFIG</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td>2.0 MHz</td>
<td></td>
</tr>
</tbody>
</table>
MC34VR500 EcoSystem

Fast Evaluation of VR500 performance
- Generic Family Evaluation Platform kit
- EVB of VR500
  - Friendly Graphical Interface
  - USB interface

IoT Gateway Reference Board

LS1021 TWR (In Works)
T1023RDB (In Works)
LS1043RDB (In Works)

Ecosystem partners –
- TechNexion
- SysTech
- Analogue and Micro
- E14

Complete technical documentation to assist design
- Datasheet, EVB user guide
- Schematic and Layout application notes
MC34VR500 Powers LS1021A Devices

LS1021A IOTGWY IoT Gateway by Freescale

AMLS1021-01 Module By A&M

EDM1-CF-LS1021A System-on-Module by TechNexion
PMICs for Medium & High Power Embedded & IoT

<table>
<thead>
<tr>
<th>MMPF0200</th>
<th>MC34PF3000</th>
<th>MMPF0100</th>
<th>MC34VR500</th>
<th>MC34PF8500</th>
<th>MC34PF8600</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.MX 6 DL</td>
<td>i.MX 6 DL</td>
<td>i.MX  QPlus</td>
<td>T1023</td>
<td>i.MX  Q Max</td>
<td>i.MX  V84</td>
</tr>
<tr>
<td>i.MX 6 S</td>
<td>i.MX 6S</td>
<td>i.MX  DPlus</td>
<td>T1013</td>
<td>i.MX  Q +</td>
<td></td>
</tr>
<tr>
<td>i.MX 6 SL</td>
<td>i.MX 6 SL</td>
<td>i.MX  Quad</td>
<td>LS1043A</td>
<td>i.MX  Q/D</td>
<td></td>
</tr>
<tr>
<td>i.MX 6 SX</td>
<td>i.MX 6 SX</td>
<td>i.MX  6 DL</td>
<td>LS1023A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i.MX 6 SL</td>
<td>i.MX 6 SL</td>
<td>i.MX  6 S</td>
<td>LS1024A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i.MX 7 Dual</td>
<td>i.MX  6 SX</td>
<td>LS1022A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i.MX 7S</td>
<td>i.MX  6 SL</td>
<td>LS1021A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i.MX 6 UL</td>
<td></td>
<td>LS1020A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cortex-A7  Cortex-A9  Cortex A5x  Power Arch
Safety Power Management Devices With Integrated Physical Layers
Connected Intelligence
Industrial Target Markets & Values

Leverage standard automotive values **to grow in industrial Market**
- Functional **Safety**
- Energy **Efficiency**
- **Connectivity**
- **Attach Strategy**

**SBC Industrial Focus on**
- **Inverters** and **Battery Management** Safety Critical
- **Motor Control** Safety Critical
- Transportations Systems (Mobile **Machines**, Trucks …)
- Factory Automation (**PLC** with Safety needs)
- **Robotics** – Internet of Things
MC34FS6407 and FS6408 – SBC Key Features

Differentiating Points

- **Availability**: wide voltage operation range from 2.7V to 36V
- **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

- **Bundles with** MCUs below 4 W of power dissipation
- Flexible DC/DC Buck pre regulator with optional Boost to fit with Low Voltage requirements
- Multiple supplies up to 1.5 A (up to 36 V operating voltage)
- Low Power Modes (30 μA)
- Analog Multiplexer & Battery sensing
- **Independent fail safe state machine** supporting functional safety standards
- Secure SPI interface
- Robust CAN physical layer with superior EMI/ESD performance
- LQFP48 with Exposed Pad (7 x 7mm)

Applications

- Automation (Safe PLC, Robotics)
- Building control (Elevator, Gas furnace)
- Transportation (Mobile machine, Military)
- Medical (Infusion pump, monitoring)
## Industrial & Automotive Specific SBC Solutions

<table>
<thead>
<tr>
<th>Change item</th>
<th>MC33907 / 908</th>
<th>MC34FS6407 / 6408</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Voltage Operating Range</strong></td>
<td>2.7 V to 28 V</td>
<td>4.6 V to <strong>36 V</strong></td>
</tr>
<tr>
<td><strong>Vpre</strong></td>
<td>Buck – Boost (optional)</td>
<td>Buck only (recommended)</td>
</tr>
<tr>
<td><strong>Ipre max</strong></td>
<td>2.0 A</td>
<td>1.7 A</td>
</tr>
<tr>
<td><strong>AMUX</strong></td>
<td>Vsense, Vi/o0&amp;1, Temp, Vref</td>
<td>Temp, Vref</td>
</tr>
<tr>
<td><strong>PHY</strong></td>
<td>CAN &amp; LIN</td>
<td>CAN only</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>-40°C / 125°C</td>
<td>-40°C / <strong>105°C</strong></td>
</tr>
<tr>
<td><strong>Market Target</strong></td>
<td>Automotive</td>
<td>Industrial</td>
</tr>
</tbody>
</table>
MC34FS4409 – SBC Key Features

Differentiating Points
- **Energy Management**: 36 V DC/DC Supply combined with 3 LDOs that can be switched in Low Power Mode
- **Integration** of 6 I/Os with Switch Inputs & Single CAN
- **Availability**: Ultra low voltage operation down to 2.5 V input voltage
- **Sense** of critical analog signals (Battery, Temp ..)

Product Features
- Efficient 2.0A DC/DC Buck pre regulator with optional Boost
- Advanced Low Power Modes (DC/DC, 6 I/Os, 1 CAN)
- Single CAN HS
- Safety Features
  - SAFE pin to drive external ICs in MCU fail mode
  - Secured critical changes of state machine with Programmable FS state
  - Configurable watchdog (timeout, window) & Secured SPI (parity checks, 8 clk count…)
- LQFP48eP Package (7x7mm size)

Applications
- Automation (Safe PLC, Robotics)
- Building control (Elevator, Gas furnace)
- Transportation (Mobile machine, Military)
- Medical (Infusion pump, monitoring)
<table>
<thead>
<tr>
<th>Part Number Box &amp; internal name</th>
<th>MC33910, 911, 912</th>
<th>MC33903/4/5 MC34903/4/5</th>
<th>MC33909</th>
<th>MC34FS4409</th>
<th>MC33907/8</th>
<th>MC34FS6407 MC34FS6408</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target Market</strong></td>
<td>Auto</td>
<td>Auto / IMM</td>
<td>Auto</td>
<td>IMM</td>
<td>Auto</td>
<td>IMM</td>
</tr>
<tr>
<td><strong>Product Status</strong></td>
<td>Production</td>
<td>Production</td>
<td>Feb 2015</td>
<td>Feb 2015</td>
<td>PPAP</td>
<td>Mar 2015</td>
</tr>
<tr>
<td><strong>6.5 V Pre-regulator</strong></td>
<td>N/A</td>
<td>N/A</td>
<td>2.0A B/B 440 kHz 2.7 / 28 V input</td>
<td>2.0A B/B 440 kHz 2.7 / 32 V input</td>
<td>2.0A B/B 440 kHz 2.7 / 28 V input</td>
<td>2.0A B/B 440 kHz 2.7 / 36 V input</td>
</tr>
<tr>
<td><strong>VCore / (MCU core)</strong></td>
<td>60 mA (LDO)</td>
<td>0.4 A (LDO) with ballast</td>
<td>0.5 A (LDO)</td>
<td>0.5 A (LDO)</td>
<td>0.8 A / 1.5 A (B_2.4 MHz)</td>
<td>0.8 A / 1.5 A (B_2.4 MHz)</td>
</tr>
<tr>
<td><strong>VCCA (I/O / ATD)</strong></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>100 mA (int) +/-1% 300mA (wPNP) +/-3%</td>
<td>100 mA (int) +/-1% 300mA (wPNP) +/-3%</td>
</tr>
<tr>
<td><strong>Auxiliary Supply Vaux</strong></td>
<td>N/A</td>
<td>N/A (903) Yes (904/5)</td>
<td>200mA (Tracker)</td>
<td>200mA (Tracker)</td>
<td>Up to 300 mA Tracker</td>
<td>Up to 300 mA Tracker</td>
</tr>
<tr>
<td><strong>Can_5V Supply -- VCAN</strong></td>
<td>N/A</td>
<td>100mA</td>
<td>200mA</td>
<td>200mA</td>
<td>100mA</td>
<td>100mA</td>
</tr>
<tr>
<td><strong>CAN Interfaces</strong></td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>LIN Interfaces</strong></td>
<td>1</td>
<td>0 / 1 / 2</td>
<td>0 / 1 / 2 / 3 / 4</td>
<td>0</td>
<td>0 / 1</td>
<td>0</td>
</tr>
<tr>
<td><strong>IOs</strong></td>
<td>4 W/U 2 LS drv (opt) Op Amp (opt)</td>
<td>2 / 4</td>
<td>6</td>
<td>6 (incl. F/S inputs)</td>
<td>6 (incl. F/S inputs)</td>
<td></td>
</tr>
<tr>
<td><strong>Watchdog</strong></td>
<td>TO, Wdw</td>
<td>TO, Wdw, Random</td>
<td>TO, Wdw, Random</td>
<td>TO, Wdw, Random</td>
<td>Challenger</td>
<td>Challenger</td>
</tr>
<tr>
<td><strong>Fit for ASIL</strong></td>
<td>QM</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>D</td>
</tr>
<tr>
<td><strong>LowQ LPOFF</strong></td>
<td>32µA</td>
<td>15µA</td>
<td>100µA</td>
<td>100µA</td>
<td>30µA</td>
<td>30µA</td>
</tr>
<tr>
<td><strong>AMUX &amp; Batt.Sense</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Fail Safe</strong></td>
<td>RST</td>
<td>Safe</td>
<td>Safe</td>
<td>Safe</td>
<td>Safe</td>
<td>Independ. I/O</td>
</tr>
<tr>
<td><strong>Package</strong></td>
<td>LQFP32</td>
<td>SOI32eP</td>
<td>LQFP48eP</td>
<td>LQFP48eP</td>
<td>LQFP48eP</td>
<td>LQFP48eP</td>
</tr>
</tbody>
</table>
PowerSBC Safety Features & Enablement Tools MC33907 & MC33908
MC33907 / MC33908 EcoSystem

- **Quick performance Evaluation Board (EVB)**
  - Easy-to-use EVB for MC33907AE and MC33908AE
  - KIT33908AEEVB and KIT33907AEEVB (with GUI) – 150$

- **Attach Strategy : Easy to Design Evaluation Module (EVM)**
  - Mother Board MC33908 - KIT33908MBEVBE – 350$
  - Daughter Board MPC5643L - KITMPC5643DBEVM (+ SW) – 150$
  - **Complete kit part number – KIT908-5643EVM (+ SW) – 550$**
  - Panther Daughter board coming soon

- **Technical support**
  - Datasheet
  - EMC/ESD, compliance reports
  - Apps Notes (AN4442, AN4661, AN4843, AN4766, MPC5744PEV144UG)
  - SafeAssure Documentation (**FMEDA, Safety Manual**)

- **Tools:**
  - **Power Dissipation** prediction tool
  - Friendly **Graphical Interface**
  - SW example code
  - FAQ
  - Training
  - Complete support team here in Toulouse
MC33907/8: Functional Safety Strategy

Single Point Failure (SPF)
- Fail Safe State Machine as Independent checker
- Physical and electrical independance
- Own Reference, clock, Supply

Latent Failure (LF)
Built-In Self Test
Analog (ABIST)
Logic (LBIST) – covering 90%
Checker activated at each init phase

“Failure that results from a single point fault and leads directly to the violation of a safety goal”
Requires a Quick detection

“Failure, resulting from the combination of several independent faults, which leads directly to the violation of a safety goal”
Can become dangerous in conjunction with a second fault
Periodic detection necessary

Common Cause Failure (CCF)
Independent Failure Monitoring Machine covering
Independant Vsup, Reference Voltage and current, Clock
Fail Safe Signal Monitoring
Fail Safe Output Management

“Failure that results either in the loss of a safety function or in the loss of a Safety Detection Mechanism”
MC33907_8: EVB / EVM Graphical User Interface

Select reg(s) to read

Bit=1 = Green
Bit=0 = white

Read 1 reg or all reg

Send SPI cmd to read

Generic status register read

Select reg(s) to write

BIT=1
BIT=0

Send SPI cmd to write

Last SPI cmd sent
**MC33907_8: Thermal Tool**

<table>
<thead>
<tr>
<th>Package maximum Pins: 200W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Regulator</td>
</tr>
<tr>
<td>External PNP</td>
</tr>
</tbody>
</table>

**Vpre - Buck operation only**

**SMPS equations valid in CCM only (Continuous Current Mode)**

<table>
<thead>
<tr>
<th>Component</th>
<th>Symbol</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cl</td>
<td>C_l</td>
<td>200 nF</td>
<td></td>
</tr>
<tr>
<td>ESR_Cl</td>
<td>R_l</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Core</td>
<td>T_l</td>
<td>12.0 nH</td>
<td></td>
</tr>
<tr>
<td>ESR_Core</td>
<td>R_{l,esr}</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Lcore</td>
<td>V_{l}</td>
<td>16.0</td>
<td></td>
</tr>
<tr>
<td>Inductor</td>
<td>R_{l}</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Freq</td>
<td>V_{l}</td>
<td>44.0 kHz</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vpre SMPS</th>
<th>Vore SMPS</th>
<th>Converter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cl</td>
<td>R_{p,1}</td>
<td>1.0 kΩ</td>
</tr>
<tr>
<td>ESR_Cl</td>
<td>C_{p,1}</td>
<td>0.05</td>
</tr>
<tr>
<td>Core</td>
<td>T_{p,1}</td>
<td>12.0 nH</td>
</tr>
<tr>
<td>ESR_Core</td>
<td>R_{p,1,esr}</td>
<td>0.05</td>
</tr>
<tr>
<td>Lcore</td>
<td>V_{p,1}</td>
<td>16.0</td>
</tr>
<tr>
<td>Inductor</td>
<td>R_{p,1}</td>
<td>0.15</td>
</tr>
<tr>
<td>Freq</td>
<td>V_{p,1}</td>
<td>44.0 kHz</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supply current</th>
<th>Vpre</th>
<th>Vore</th>
<th>Converter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vdrop_MOS</td>
<td>14.0 mV</td>
<td>0.0 mV</td>
<td>4.8 V</td>
</tr>
<tr>
<td>P_Cin</td>
<td>0.02 V</td>
<td>0.02 V</td>
<td>0.02 V</td>
</tr>
<tr>
<td>P_S</td>
<td>0.02 V</td>
<td>0.02 V</td>
<td>0.02 V</td>
</tr>
<tr>
<td>P_L</td>
<td>0.02 V</td>
<td>0.02 V</td>
<td>0.02 V</td>
</tr>
<tr>
<td>P_Diode</td>
<td>0.02 V</td>
<td>0.02 V</td>
<td>0.02 V</td>
</tr>
<tr>
<td>P_Loss_IC</td>
<td>0.02 V</td>
<td>0.02 V</td>
<td>0.02 V</td>
</tr>
<tr>
<td>η</td>
<td>95.0%</td>
<td>95.0%</td>
<td>95.0%</td>
</tr>
</tbody>
</table>

**IC power dissipation summary:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Symbol</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vpre</td>
<td>P_{l}</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Vore</td>
<td>P_{l}</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Vaux</td>
<td>P_{l}</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Vcan</td>
<td>P_{l}</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>CAN transceiver</td>
<td>P_{l}</td>
<td>0.02</td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL PDIS** = 0.565 W

---

**Power Distribution Vpre**

**Power Distribution Vore**

**Main contributors to the IC's Power dissipation**

---

**freescale™**

External Use | 32
SafeAssure KIT – EK5744

- Partnership by Freescale and MicroSys
- Based on Freescale Solutions
  - Qorivva MPC5744P MCU
  - MC33907 System Basis Chip

- Safety Standards addressed
- TUV Sud will review the KITs and capabilities

SafeAssure KIT
- Will be orderable on Freescale.com (miriac-EK5744)
- Support will be from Freescale (at MPC5744P and MC33907 level) and from MicroSys at system level

1st KIT to provide an industrial safety solution using an MCU and SBC with an integrated safety architecture (MPC5744P and MC33907)
System Power Management Solutions

System power management solutions for Freescale processors and microcontrollers

<table>
<thead>
<tr>
<th>Freescale Automotive</th>
<th>Freescale i.MX</th>
<th>Layerscape</th>
<th>Freescale Kinetis</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBCs with Functional Safety</td>
<td>PMICs</td>
<td>VR500 IoT Gateway</td>
<td>Battery Chargers</td>
</tr>
</tbody>
</table>

![Images of different applications and technologies related to power management solutions.]
Physical Layers
MC33901/34901 Single CAN High Speed Transceiver

Differentiating Points

- **System Performance and Cost:**
  High 1 Mbit/sec EMC performance without choke
- **Efficient:** Low quiescent current in low power modes (down to 8 µA)
- **Scalable:** Family of four products supporting automotive and industrial, with and without wake up

Product Features

- Pinout and function compatible with CAN ISO11898-2 and -5 standards
- I/O compatible with both 5 V and 3.3 V MCU digital levels
- **Tx dominant timeout** for automotive (MC33901) which is removed for industrial (MC34901) and low baud rate applications
- Low power modes and wake up capability

Robustness

- **ESD without choke:** +/-6 kV ESD contact discharge according to IEC61000-4-2, 150 pF-330 ohms
- **Noise Immunity without choke:** Meets 36 dBm DPI without external protection and 39 dBm DPI with additional capacitors
- Bus pins protected against automotive transients
- **SOIC-8 Package**

<table>
<thead>
<tr>
<th></th>
<th>Automotive Timeout</th>
<th>Industrial No Timeout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wake Up</td>
<td>MC33901W</td>
<td>MC34901W</td>
</tr>
<tr>
<td>Standard</td>
<td>MC33901S</td>
<td>MC34901S</td>
</tr>
</tbody>
</table>
High EMC performance without common mode choke filter

- Target DPI (Direct Power Injection) 39 dBm immunity and CE (Conducted Emission) limit
- Emission performance exceeds industry standard
- Standard 500Kbps data rate and also 1Mbps data rate (2x standard)
CM0902 Dual CAN High Speed Transceiver

Robust, system-cost effective CAN High Speed Physical Layer offering low quiescent current while exceeding stringent EMC/ESD requirements, without added circuitry

Differentiating Points
- **System Performance/Cost:** 500kbit/sec EMC compliant w/o Common Mode Choke
- **Scalable System Solution:** Seamless attach to Freescale MCUs
- **Robustness:** Automotive OEM certified (MC33CM0902)

Product Features
- Pinout and function compatible w/CAN ISO11898-2 and -5 standard products
- I/O (SPI) is compatible with both 5 V and 3.3 V MCU digital levels
- Vdd and IO voltage monitoring, ability to respond in ‘fail-safe’ manner
- Low power modes and wake up capability
- **15 uA quiescent** current in low power mode
- **Robustness:**
  - **ESD without choke:** +−6 kV ESD contact discharge according to IEC61000-4-2, 150 pF-330 ohms
  - **Noise Immunity without choke:** Meet 36 dBm DPI without external protection and 39dBm DPI with additional capacitors
  - Bus pins protected against Automotive Transients
- Automotive (AEC-Q100) and Industrial versions available
  - Automotive: MC33CM0902 (Tx Dominant Timeout)
  - Industrial: MC34CM0902 (No Timeout - Low baud rate applications)
- **SOIC-14** and DFN14eP (planned)

Typical Applications
- Auto Powertrain & Safety
- Motor control - Safety Critical
- Robotics
- Factory Automation

Samples and EVB: Now
Production Release: Q1 2015
Input Monitoring
3978 Configurable I/O

Analog switch interface multiplexer for translating 22 I/Os onto a single MCU SPI bus with low power auto-wake modes and configurable wetting currents

Differentiating Points

- Proven performance & robust ESD above 15 kV
- Quiescent current of 30 uA; 1/3rd that of competitors and 1/100th that of discrete solutions
- Operating voltage range: 4.5 V-36 V to meet auto load dump
  - 48% better than competition
- 5*5 mm QFN available compared to 6*6 mm for competition
- Integrated battery sense

Product Features

- 22 inputs:
  - 14 switch-to-ground
  - 8 programmable switch to battery or ground
- Wake-up upon signal detection
- 24-1 analog multiplexer
- Programmable wetting current from 2 mA to 20 mA
- Integrated temperature sensor

Preliminary Schedule

- Samples: Now
- Production: 1Q 2015

Applications

- Multiple switch detect in Body-Control modules
- Engine Control Modules
- Front-of-Dash Modules
- Wire Harness
- Junction Box

Preliminary Information – Changes and/or discontinuation of product offerings are possible without notification
### Power Drivers and Switches Key Products

#### Gate Driver

<table>
<thead>
<tr>
<th>Type</th>
<th>Automotive</th>
<th>Industrial / Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-Bridge Pre-Driver</td>
<td>MC33883</td>
<td></td>
</tr>
<tr>
<td>BLDC Pre-Driver</td>
<td>MC33937</td>
<td>MC34937 – MC34GD3000</td>
</tr>
</tbody>
</table>

#### Power Driver

<table>
<thead>
<tr>
<th>Type</th>
<th>Automotive</th>
<th>Industrial / Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-Bridge &amp; DC Motor Driver</td>
<td>MC33886 – MC33926</td>
<td>MPC155xx – MC34933</td>
</tr>
<tr>
<td></td>
<td>MC33931/2</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>MC33HB2000/1</td>
<td>-</td>
</tr>
<tr>
<td>BLDC Driver</td>
<td>MC33882</td>
<td>MC34929</td>
</tr>
<tr>
<td>Low / High Side Switch</td>
<td>MC33880 – MC33879</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>MC33996 – MC33999</td>
<td>-</td>
</tr>
</tbody>
</table>

#### eXtreme Switch Family

<table>
<thead>
<tr>
<th>Type</th>
<th>Automotive</th>
<th>Industrial / Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low $R_{D_{son}}$</td>
<td>MC33981/2/4/8</td>
<td>MC34981/2/4/8</td>
</tr>
<tr>
<td>Medium $R_{D_{son}}$</td>
<td>MC12XS6</td>
<td>MC12XSF</td>
</tr>
<tr>
<td></td>
<td>MC24XS4</td>
<td>MC36XSD</td>
</tr>
</tbody>
</table>
eXtreme Switches
eXtreme Switch Composition

SMARTMOS™

**Protection and diagnostic**
- Over temperature (175°C)
- Over current shutdown
- Over/under voltage
- Short circuit
- Reverse battery
- Loss of ground/Vbat
- Energy discharge protection

**SPI Interface**
- Easy connection to the uP
- Programmability
- Daisy chain using SPI
- Programmable over current trip level
- Watchdog
- Embedded PWM module

**Vertical Power stage**

**Best-in-class Technology**
- Planar HD5 and TrenchFet LFET
- 45 V & 65 V BV

**Protection in the power stage**
- Temperature sensor
- Current sensor

**Power package**

**PQFN low cost power package**
- 0.5 mm thick lead frame
- Die soldered attached
- Rthj-c < 0.5°C/W

**SOICeP32 and 54**
- designed for high power
- Large AL wire capability
- Pb-free compliance
What are the Primary eXtreme Switch Features?

- **System Diagnostic**
  - Open load ON – OFF – LED
  - Load Shorted to Battery
  - Current sense

- **Switch Protection**
  - Over temp
  - Ground loss
  - Reverse Battery

- **System Protection**
  - Over-under voltage
  - Module output short-circuit
  - Load short-circuit
  - Overload
**24 A / 36 V eXtreme Switch**


Dual 6mΩ  Dual 10mΩ  Dual 16mΩ  Dual 22mΩ  Dual 50mΩ

Scalable, programmable family of 24 A/36 V SPI-driven, dual-channel, smart high-side switches with lowest RDSon for up to a 30% board reduction

**Differentiating Points**

- **Robustness**: Unique over-current latch-off protection, full digital & analog diagnostic and protection features with embedded failsafe mode
- **Integration**: Unique daisy-chainable SPI control for dual low RDSon channels in a single package
- **Accuracy**: 5X better current sensing accuracy over temperature & supply voltage range with unique accurate temperature sensing capability
- **Scalable**: Compatible PCB foot print and SPI software driver among the 24 A/36 V product family
- **Lowest RDSon in Dual Configuration**: 20% smaller PCB due to lower power dissipation when using 12 A/channel or 24 A/dual in a thermally enhanced package

**Product Features**

- Dual 24 A/36 V high side switch with 6, 10, 16, 22 or 50 mΩ RDSon channels
- Normal operating range: 8.0 – 36 V, extended range: 6.0 – 58 V
- Flexible load management 1-24 A with possible parallel output operating modes
- **Programmable dynamic threshold over current protection** and over-temperature protection with programmable auto-retry functions
- 3.3 V and 5.0 V compatible **16-bit Daisy chainable SPI control**
- ±5°C temperature and synchronous / asynchronous current (±10%) sensing
- Individually programmable internal/external PWM clock signals

**Typical Applications**

Transportation 12 / 24 V
- 24 V Lighting and capacitive loads
- Valves
- DC motors

Industrial
- High current / highly inductive loads (solenoids)
- DC Motor control
- Factory automation
Configurable & Programmable Over-Current Detection Profiles

CONF bit = 0
Static Bulb lamp over-current protection profile activated

CONF bit = 1
Dynamic DC Motor over-current protection profile activated

Static multi-stage over current protection profile protects lamps without shutting down the supply during inrush current

Activation by a turn-ON event

Dynamic over current protection window protects DC motors without shutting down the supply during short stall-periods

Activation by $I_{\text{load}} > I_{\text{OCL}}$
22 A / 18 V Gen4 Penta eXtreme Switches
MC07XSF517 / MC17XSF500

Scalable family of 22 A/18 V programmable penta high-side switches with wide range diagnostic current sensing and lowest RDSon for up to 30% smaller PCB and 50% lower component count

Differentiating Points

- **Robustness**: Unique over-current latch-off protection, full digital and accurate analog diagnostics, and protection features with embedded failsafe mode
- **Integration**: 5 configurable low RDSon channels with daisy-chainable SPI
- **Density**: Thermally enhanced package for affordable high switch count modules with up to 30% lower power, 30% smaller PCB footprint and 50% fewer components
- **Accuracy**: Advanced current sensing over temperature and supply voltage range allowing accurate current monitoring from 25 mA to 22 A
- **Scalability**: Pin and SW driver compatible family
- **Best thermal efficiency**: Lowest RDSon in penta configuration

Product Features

- Penta 5x 17mΩ and penta 3x 7mΩ + 2x 17mΩ configurations
- Operating voltage range from 6 – 18 V with sleep current < 5.0 µA
- **Flexible** load management up to 11 A, 22 A with enhanced thermal management
- Enhanced output **current sense (down to 27.5 mA)** with programmable synchronization signal, ±5°C temperature and ± 1% battery voltage feedback
- 5.0 MHz 16-bit daisy chainable SPI control
- Full **diagnostic and protection** including over-current profiles, output-ON and –OFF open load detections, thermal shut-down, pre-warning, and fault reporting
- Individually programmable internal/external **PWM signals with 8 bit duty cycle** control
- **Watchdog** and **failsafe** mode
- External smart power switch control

Typical Applications

Transportation
- 12 V Lighting from High beam to LEDs
- Valves
- DC motors

Industrial
- High current / highly inductive loads (solenoids)
- DC motor control
- Factory automation PLC
## eXtreme Switch Product Family

### 12V Family Devices

<table>
<thead>
<tr>
<th>Generation</th>
<th>Part Number</th>
<th>Outputs # and On-Resistance</th>
<th>Total Outputs #</th>
<th>Package</th>
<th>Low Operating Voltage</th>
<th>High Operating Voltage</th>
<th>Max PWM frequency</th>
<th>Pin to Pin Compatibility</th>
<th>SW Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC12XSC</td>
<td>MC07XSC200EK</td>
<td>Dual 7mΩ</td>
<td>2</td>
<td>32-pin SOICEP</td>
<td>6V</td>
<td>20V</td>
<td>1 kHz</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>MC10XSC425EK</td>
<td>Dual 10mΩ, Dual 25mΩ</td>
<td>4</td>
<td>32-pin SOICEP</td>
<td>6V</td>
<td>20V</td>
<td>1 kHz</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>MC07XSF517EK</td>
<td>Triple 7mΩ, Dual 17mΩ</td>
<td>5</td>
<td>54-pin SOICEP</td>
<td>7V</td>
<td>18V</td>
<td>400 Hz</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>MC17XSF500EK</td>
<td>Penta 17mΩ</td>
<td>5</td>
<td>32-pin SOICEP</td>
<td>7V</td>
<td>18V</td>
<td>400 Hz</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>MC40XSF500</td>
<td>Penta 40mΩ</td>
<td>5</td>
<td>32-pin SOICEP</td>
<td>7V</td>
<td>18V</td>
<td>400 Hz</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>MC08XSF421</td>
<td>Dual 08mΩ, Dual 21mΩ</td>
<td>4</td>
<td>32-pin SOICEP</td>
<td>7V</td>
<td>18V</td>
<td>400 Hz</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>MC17XSF400</td>
<td>Quad 17mΩ</td>
<td>4</td>
<td>32-pin SOICEP</td>
<td>7V</td>
<td>18V</td>
<td>400 Hz</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

### 36V Family Devices

<table>
<thead>
<tr>
<th>Generation</th>
<th>Part Number</th>
<th>Outputs # and On-Resistance</th>
<th>Total Outputs #</th>
<th>Package</th>
<th>Low Operating Voltage</th>
<th>High Operating Voltage</th>
<th>Max PWM frequency</th>
<th>Pin to Pin Compatibility</th>
<th>SW Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC36XSD</td>
<td>MC06XSD200FK</td>
<td>Dual 6mΩ</td>
<td>2</td>
<td>24-pin PQFN</td>
<td>8V</td>
<td>36V</td>
<td>1 kHz</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>MC10XSD200FK</td>
<td>Dual 10mΩ</td>
<td>2</td>
<td>24-pin PQFN</td>
<td>8V</td>
<td>36V</td>
<td>1 kHz</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>MC16XSD200FK</td>
<td>Dual 16mΩ</td>
<td>2</td>
<td>24-pin PQFN</td>
<td>8V</td>
<td>36V</td>
<td>1 kHz</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>MC22XS4200BEK</td>
<td>Dual 22mΩ</td>
<td>2</td>
<td>32-pin SOICEP</td>
<td>8V</td>
<td>36V</td>
<td>1 kHz</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>MC50XS4200BEK</td>
<td>Dual 50mΩ</td>
<td>2</td>
<td>32-pin SOICEP</td>
<td>8V</td>
<td>36V</td>
<td>1 kHz</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

### Main Switch Devices

<table>
<thead>
<tr>
<th>Generation</th>
<th>Part Number</th>
<th>Outputs # and On-Resistance</th>
<th>Total Outputs #</th>
<th>Package</th>
<th>Low Operating Voltage</th>
<th>High Operating Voltage</th>
<th>Max PWM frequency</th>
<th>Pin to Pin Compatibility</th>
<th>SW Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC12XSB</td>
<td>MC34981ABFK</td>
<td>Single 4mΩ</td>
<td>1</td>
<td>16-pin PQFN</td>
<td>6V</td>
<td>27V</td>
<td>60kHz</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>MC34982CHFK</td>
<td>Single 2mΩ</td>
<td>1</td>
<td>16-pin PQFN</td>
<td>6V</td>
<td>27V</td>
<td>1 kHz</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>MC34984CHFK</td>
<td>Dual 4mΩ</td>
<td>2</td>
<td>16-pin PQFN</td>
<td>6V</td>
<td>27V</td>
<td>1 kHz</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>MC34988CHFK</td>
<td>Dual 8mΩ</td>
<td>2</td>
<td>16-pin PQFN</td>
<td>6V</td>
<td>27V</td>
<td>1 kHz</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Extreme Switch Tower Board and Processor Expert SW Driver Enablement Tools

eXtreme Switch Analog **Tower** System Plug-In Modules

Development KIT for devices compatible with industrial application requirements:

Interact, Explore, Create with Tower Geeks Online Community (www.towergeeks.org)

Supported Software Design Resource: **Processor Expert** (MCU Driver Suite)

Available Nov. 2014
PEx for Analog Components Philosophy

• PEx provides an interface between hardware and software so applications can be MCU independent / agnostic
  – **Hardware Abstraction Layer** (HAL) encapsulates peripherals of MCU
  – PEx analog components attach analog devices to MCU
### PEx eSwitch Component Methods

#### Global Methods
- `bool XSD1_Init()`
- `XSD1_result XSD1_GetStatus(uint16_t *statusData)`
- `XSD1_result XSD1_GetFaultInfo(uint16_t channel, uint16_t *faultInfo)`
- `XSD1_result XSD1_Diagnosis(uint16_t *diagData)`

#### Generic register access
- `bool XSD1_WriteRegister(uint8_t regAddr, uint16_t *regVal)`
- `bool XSD1_ReadRegister(uint8_t regAddr, uint16_t *regVal)`

#### WatchDog
- `XSD1_result XSD1_ConfigureWatchdog(bool state, uint32_t deviceMask)`
- `XSD1_result XSD1_FeedWatchdog()`

#### Output control with PWM
- `XSD1_result XSD1_SetPWMDuty(uint8_t channel, uint16_t *dutyValues)`
- `XSD1_result XSD1_SetPWMState(uint8_t *channelStates)`

#### Current/Temp monitoring (SPI, ADC depend)
- `XSD1_result XSD1_ConfigureMonitoring(uint16_t *selection)`

---

Preliminary Information – Changes and/or discontinuation of product offerings are possible without notification.
Power Driver & Gate Driver
7.0 Volt 1.4 Amp Platform for DC Motors and Bipolar Stepper Micro Motor

**Applications**
- Small and portable applications
- Home Care products
- Lens focus systems
- Card readers
- Micropumps
- Low power actuators

**MCU Features**
- Ultra low power, and low voltage operation
- 16-bit Timer/PWM
- 12-bit ADC
- Up to 32 KB Flash
- Single cycle I/O access.
- HW Bit Manipulation

**MC34933**
- 7.0 V, 1.4 A Protected dual H-Bridge driver
- 2.7 to 5.5 V logic operation with charge pump
- Typ 186 µA operating current
- PWM up to 200 kHz
- Shoot through prevention
- Low voltage and thermal detection
- Stepper or dual DC motor drive
- 3 x 3 mm QFN-16 package

**MC34933EP**
USD 0.50 @ 1Ku
28 Volt 5.0 Amp Platform for Dual DC Servo Motor

Applications
- Small and portable applications
- Home Care products
- Lens focus systems
- Card readers
- Ticket systems
- Actuators
- Robotics

MCU Features
- True 5 V low power
- EMI/EMC robust
- SIL Safety support
- 16-bit Timer/PWM
- 12-bit ADC
- Single cycle I/O access.
- HW Bit Manipulation

MC34932
- Dual 28 V, 5.0 A Protected H-Bridge driver
- 3.3 V and 5.0 V TTL/CMOS compatible
- Built-in charge pump for level shifter
- PWM up to 11 kHz
- Load current feedback signal
- Fault status flag: Undervoltage, Overcurrent and Overtemperature
- 10 x 18 mm SOIC-54

MC34932EK
USD 2.57 @ 1Ku
58 Volt 3-Phase Servo Motor Control Platform

Applications
- BLDC and PMSM motor drives
- E-Bike, Scooters
- Traction systems
- Hospital beds
- Electric chairs
- Power tools
- Robotics

Features
- 150 MHz CPU with DSP/FPU support
- 12 channel eFlexPWM timer
- Dual 1.9 MSPS ADC
- Cyclic Redundancy Check (CRC)
- SIL Safety Support

MC34937
- 6.0 V...58 V MOS FET pre-driver
- 3.3 V and 5.0 V TTL/CMOS compatible
- FET gate drive capability of >1.0 A
- Dead time control with shoot-through protection
- Reverse charge protection
- Overcurrent, desaturation, and phase fault-detection
- 10 x 18 mm SOIC-54

MC34937APEK
USD 2.24 @ 1Ku
## Motor Driver IC Line-up (Excerpt)
MC33...- Automotive | MC34...- Industrial | MC17 - Consumer

<table>
<thead>
<tr>
<th>Type</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Voltage, Small Signal</strong></td>
<td></td>
</tr>
<tr>
<td>34933</td>
<td>Dual H, Stepper</td>
</tr>
<tr>
<td>17510</td>
<td>H-Bridge &amp; HS Switch</td>
</tr>
<tr>
<td>17511</td>
<td>H-Bridge &amp; HS Switch</td>
</tr>
<tr>
<td>17529</td>
<td>Dual H, Stepper</td>
</tr>
<tr>
<td>17531A</td>
<td>Dual H, Stepper</td>
</tr>
<tr>
<td>17533</td>
<td>Dual H, Stepper</td>
</tr>
<tr>
<td>17C724</td>
<td>Dual H, Stepper</td>
</tr>
</tbody>
</table>

| **Medium Power up to 28 Volt** | |
| 33926 | H-Bridge, Servo | 3/5V Logic | 5.0...28 | 5.0 | 120 | 20 | Yes | Yes | QFN-32 |
| 34931 | H-Bridge, Servo | 3/5V Logic | 5.0...28 | 5.0 | 120 | 11 | Yes | Yes | SOIC-32 |
| 34932 | Dual H, Servo | 3/5V Logic | 5.0...28 | 5.0 | 120 | 11 | Yes | Yes | SOIC-54 |

| **Pre Driver for 3-Phase High Power Inverters** | |
| 34937A | 3-phase Pre-driver | 3/5V Logic | 6.0...58 | >1.0 | - | 20 | Yes | Yes | SOIC-54 |
H-Bridge Motor Drivers for DC Brushed Applications
MC33HB2000 (235 mΩ) & MC33HB2001 (120 mΩ)

The MC33HB2000/1 are advanced H-Bridge Motor Drivers designed to provide enhanced safety features for high safety integrity, thermal management for continuous operation and SPI control for increased flexibility.

**Product Highlights:**
- **Enhanced Safety features:** ISO26262 ASIL B/C
- **Thermal Management:** best-in-class package thermal resistance, lowest RDS(ON), temperature dependent current limit for continuous operation
- **Greater Flexibility:** slew rate & current limit programmability, status flag and/or SPI diagnostics, configurable as two Half Bridges, PWM input or SPI control, daisy chainable, real time current mirror with +/- 5% accuracy, and drop-in replacements, no need to change pin-out or software when changing motor drive power requirement.

**Features/Benefits:**
- **Diagnostic reporting via SPI:** short to PWR & GRND, over current & temperature, over & under voltage, open & short load
- **Safe shutdown:** outputs can be disabled for safe shutdown
- **ESD 4 kV** at outputs, I/O Pins 18 V proof to protect against accidental shorts
- **Low RDS(ON) outputs:** < 235 mΩ & < 120 mΩ @ TA = 150°C, VG = 6.0 V
- **4 selectable Current Limits via SPI:** 5 / 6.5 / 8.1 / 10 Amp typical
- **8 selectable Slew Rates via SPI:** 0.25 V/µs to 40 V/µs for EMI vs. efficiency
- **Half-Bridge independently via SPI:** to drives inductive loads in a full H-Bridge and half-bridge configuration
- **High side recirculation:** (braking) mode during over current protection
- **Two Packages:** SOIC-EP / PQFN for low thermal resistance < 1°C/Watt
- **Operation Voltage:** 4.3-28 Volts

SAMPLES*: NOV, 2014
*MC33HB2001EK, SOIC-EP 32, 10A max
PRODUCTION: Q3 2015

Preliminary Information – Changes and/or discontinuation of product offerings are possible without notification.
MC34GD3000 3-phase Pre-drive IC

Features
- Small package: 8x8mm
- 6.75x6.75mm exposed pad
- Up to 58 V operating voltage range
- PWM to 20 kHz
- > 1.0 A peak gate drive current
- Wide SPI programmable dead time
- Protection against transient spikes and reverse charge injection

Typical Applications
- Drones
- E-Bikes
- Power Tools
- Robotics
- Fans

Product Options
- Availability
  - 56-lead, QFN-EP
  - 8x8 mm
  - -40 to 125°C
  - MC34GD3000EP/R2
  - Samples: March, 2015
  - Production: June, 2015

Preliminary Information – Changes and/or discontinuation of product offerings are possible without notification.
Power Driver & Gate Driver Enablement Tools
MC33931, MC33932, MPC175xx, MC34933 & MC34937
Medium Voltage Motor Drivers EcoSystem

Development Kits with Evaluation Board

- Evaluation boards drive from PC using USB to SPI interface board
- Tower System modular development system board for MC33/34926 & MC33/34931*
- Process Expert Software in development

Complete Technical Documentation available to ease Design

- Datasheets and Application notes
- Power Dissipation prediction tool
- Technical Training and hands on training on demand

Production: NOW

Evaluation Boards: NOW

* Tower System Plug-in module: Q1/15 release

<table>
<thead>
<tr>
<th>FSL part</th>
<th>Kit name</th>
<th>Associated boards</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC33887EK</td>
<td>KIT33887EKEVBE</td>
<td>KITUSBSPIDGLEVE</td>
</tr>
<tr>
<td>MC33936PNB</td>
<td>KIT33936PNBEVBE</td>
<td>KITUSBSPIDGLEVE</td>
</tr>
<tr>
<td>MC33931EK*</td>
<td>KIT33931EKEVBE</td>
<td>KITUSBSPIDGLEVE</td>
</tr>
<tr>
<td>MC34931EK*</td>
<td>KIT33931EKEVBE</td>
<td>KITUSBSPIDGLEVE</td>
</tr>
<tr>
<td>MC33932EK</td>
<td>KIT33932EKEVBE</td>
<td>KITUSBSPIDGLEVE</td>
</tr>
<tr>
<td>MC34932EK</td>
<td>KIT33932EKEVBE</td>
<td>KITUSBSPIDGLEVE</td>
</tr>
</tbody>
</table>
Low Voltage Motor Drivers EcoSystem

Development Kits with Evaluation Board

- Freescale Freedom development platform for Kinetis KL02 MCUs with Motor drive evaluation board for all nine parts

- Tower System plug-in module for MPC17510 & MPC34933*

- Process Expert Software in development

Complete Technical Documentation available to ease Design

- Datasheets and Application notes
- Power Dissipation prediction tool
- Technical Training and hands on training on demand

Production: NOW

FRDM EVBs: Nov. 2014

*Tower System plug-in module: Q1/15 release

<table>
<thead>
<tr>
<th>FSL part</th>
<th>Kit name</th>
<th>Associated boards</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPC17510EJ</td>
<td>FRDM-17510EJ-EVB</td>
<td>FRDM - KL25Z</td>
</tr>
<tr>
<td>MPC17511EV</td>
<td>FRDM-17511EV-EVB</td>
<td>FRDM - KL25Z</td>
</tr>
<tr>
<td>MPC17529EV</td>
<td>FRDM-17529EV-EVB</td>
<td>FRDM - KL25Z</td>
</tr>
<tr>
<td>MPC17531ATEV</td>
<td>FRDM-17531ATEV-EVB</td>
<td>FRDM - KL25Z</td>
</tr>
<tr>
<td>MPC17531ATEP</td>
<td>FRDM-17531ATEP-EVB</td>
<td>FRDM - KL25Z</td>
</tr>
<tr>
<td>MPC17533EV</td>
<td>FRDM-17533EV-EVB</td>
<td>FRDM - KL25Z</td>
</tr>
</tbody>
</table>
Freescale Freedom Development Platform Connectivity with H-Bridge EVBs

FRDM Board

FRDM Interface Connectors

Feedback Signals to FRDM board

Power Connector

Stepper Motor Output

FRDM Interface Connectors

Test Pins
Freescale Freedom Development Platform GUI Interface

Sample GUI

Supported Firmware only for FRDM KL25Z

ARM EMBED Freescale-Brushed-DC-FRDM-Evaluation

GUI
Digital I/O to FRDM (via USB)

IN
Board ID

OUT
EVB Ready

PWM and DC

AUX ON/OFF

Braking CST / DYN

PWM Frequency

500 Hz

Duty Cycle

75 %

Stop
Run

Quit
Configurable Octal Switch EcoSystem

Development Kit with Evaluation Board

- MC33879A evaluation board*
- Compatible with all current FRDM boards (14 total)
- SPIGen configuration file**
- KL25Z CodeWarrior sample code**
- Mbed sample code**

Complete Technical Documentation available for EZ Design

- Datasheet, user guide, software documentation

Production: NOW
Evaluation Boards: *Q1/15
**Q1 release

<table>
<thead>
<tr>
<th>FSL part</th>
<th>Kit name</th>
<th>Associated boards</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC33879A</td>
<td>KIT33879AEKEVB</td>
<td>All FRDM boards (as of 2014.12.11)</td>
</tr>
</tbody>
</table>
MC34937 EcoSystem

MC34937 EVAL Board: KIT33937AEKEVBE

Tower LV Motor Control Board: TWR-MC-LV3PH

3-Phase LV Motor Control Kit: 3PHASELV

ORDERABLE PARTS

<table>
<thead>
<tr>
<th>Parts Number</th>
<th>Temp. Range</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC34937APEK</td>
<td>-40°C to 125°C</td>
<td>54 pin SOICW-EP</td>
</tr>
<tr>
<td>MC34937APEKR2</td>
<td>-40°C to 125°C</td>
<td>54 pin SOICW-EP</td>
</tr>
<tr>
<td>(tape &amp; reel)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Battery Management Key Products

#### Intelligent Battery Sensor
<table>
<thead>
<tr>
<th>Type</th>
<th>Automotive</th>
<th>Industrial / Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIN-Based</td>
<td>MM912_637</td>
<td>-</td>
</tr>
<tr>
<td>CAN-Based</td>
<td>MM9Z1_638</td>
<td>-</td>
</tr>
</tbody>
</table>

#### Battery Cell Controller
<table>
<thead>
<tr>
<th>Type</th>
<th>Automotive</th>
<th>Industrial / Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-Cell</td>
<td>MC33771</td>
<td>-</td>
</tr>
<tr>
<td>Isolated Physical Layer</td>
<td>MC33664</td>
<td>-</td>
</tr>
</tbody>
</table>

#### Li-Ion Battery Charger
<table>
<thead>
<tr>
<th>Type</th>
<th>Automotive</th>
<th>Industrial / Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear Charger</td>
<td>-</td>
<td>MC34671/3/4/5</td>
</tr>
<tr>
<td>Switching Charger</td>
<td>-</td>
<td>MC32BC3770</td>
</tr>
</tbody>
</table>

#### Alternator Regulator
<table>
<thead>
<tr>
<th>Type</th>
<th>Automotive</th>
<th>Industrial / Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-Protocol</td>
<td>TC80500 (Die)</td>
<td>-</td>
</tr>
<tr>
<td>LIN-Based</td>
<td>TC80600 (Die &amp; TO220)</td>
<td>-</td>
</tr>
</tbody>
</table>

---

**Battery Management**

**Intelligent Battery Sensor**

**Battery Cell Controller**

**Li-Ion Battery Charger**

**Alternator Regulator**

**System in Package**
- 800V – Balancing
- LIN – CAN – TPL
Freescale Battery Management System Solutions
Battery Cell Controller
MC33771 14 Cell Li-ion Battery Cell Controller

Scalable ISO26262 ASIL-C compliant controller for 48 to >1000 V packs with 2 Mbps transformer coupled daisy chain transceivers, cell balancing FETs and current sensors reducing BOM cost 50%

Differentiating Points
- Single chip 48 V battery control scalable to > 1000 V
- ASIL-C functional safety compliant at 50% system BOM cost
- 300 mA cell balancing transistors and 0.5% current sensors
- 2 Mbps differential communication transceiver
- >2.5x higher transformer coupled daisy chain isolation (3750 V)
- Companion communication interface IC for MCU SPI isolation
- 2 mV voltage measurement accuracy
- 65µs one shot synchronized cell impedance determination
- Fast data acquisition: 3.6 ms for 96 cells, 4.5 ms for 112 cells
- Functional verification & diagnostics supporting ISO26262
- Automotive robustness: ESD, EMC, Hot plug, AEC Q-100

Product Features
- 9.6 V ≤ VPWR ≤ 61.6 V operation, 70V transient
- 14x differential cell voltage + stack voltage measurement
- 7x ADC + GPIO + temperature sensor Inputs
- Low power modes
- 64 pin QFP package
- Low-level drivers to simplify SW development

Typical Applications
Automotive hybrid and electric vehicles
- 48 V BMS and HV BMS (>1000V)
Industrial
- Energy storage systems (ESS)
- Uninterrupted power supply (UPS)
- E-bikes, E-scooters

Preliminary Information – Changes and/or discontinuation of product offerings are possible without notification
Battery Cell Controller (BCC) | Isolated Communication

Overview

Premium BCC
MC33771ASP (SPI comm)
MC33771ATP (TPL comm)
- Precise differential cell voltage measurement
- Cell OV/UV, O/U temperature
- Synchronized current measurement
- Coulomb Count
- Cell balancing
- Temp measurement
- Functional verification and diagnostics
- Communication:
  - 2 MHz half duplex differential
  - SPI 4 MHz
- Package: 64-lead LQFP EP
- Temp range: -40 C to +105 C

Advanced BCC
MC33771ASA (SPI comm)
MC33771ATA (TPL comm)
- Precise differential cell voltage measurement
- Cell OV/UV, O/U temperature
- Cell Balancing
- Temp Measurement
- Functional verification and diagnostics
- Communication:
  - 2 MHz half duplex differential
  - SPI 4 MHz
- Package: 64-lead LQFP EP
- Temp range: -40 C to +105 C

Basic BCC
MC33771ASB (SPI comm)
MC33771ATB (TPL comm)
- Precise differential cell voltage measurement,
- Cell OV/UV
- Communication:
  - 2 MHz half duplex differential
  - SPI 4 MHz
- Package: 64-lead LQFP EP
- Temp range: -40 C to +105 C

Transformer Physical Layer
MC33664ATL1
- Differential transformer driver / receiver
- Bus and MCU wake-up
- SAFE output (Fail-Safe implementation)
- Operating voltage down to 3.5 V (cranking)
- On-board oscillator
- Analog bit filter
- Package: 16-lead SOIC
- Temp range: -40 C to +105 C

BCC Samples: Now
Production: Q4 2015

TPL Samples: Now
Production: Q1 2015
MC33771 | MC33664 Battery Cell Controller Enablement

- Fast Evaluation of device performance
  - Evaluation boards for MC33771 and MC33664
    - KIT33771ASP1EVB
    - KIT33664EVB

- Reference Designs
  - 48 V battery management systems (BMS)

- Technical Documentation for ease with design
  - Data sheets
  - EVB user guide content
  - Safety assessment / FMEDA in development
  - EMC/DPI reports

Orderable at freescale.com/analogtools

KIT33771ASP1EVB and KIT33664EVB

High voltage battery management system
Freedom Platform + MC33664 + daisy chain MC33771
# Analog System Solution Key Products

<table>
<thead>
<tr>
<th>Product</th>
<th>Automotive</th>
<th>Industrial / Consumer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>77 GHz Radar</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VCO, TX, RX Packaged chipset</td>
<td>MC33MR2001V/T/R</td>
<td>-</td>
</tr>
<tr>
<td><strong>Airbag</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MC33789 – MC33797</td>
<td>-</td>
</tr>
<tr>
<td>Reference Platform</td>
<td>RDAIRBAGPSI5</td>
<td>-</td>
</tr>
<tr>
<td><strong>Valve Controller</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Octal SoC</td>
<td>-</td>
<td>MC34SB0800</td>
</tr>
<tr>
<td>Quad SoC</td>
<td>-</td>
<td>MC34SB0410</td>
</tr>
<tr>
<td><strong>Programmable Solenoid</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct Fuel Injection up to 6-cyl.</td>
<td>MC33816</td>
<td>-</td>
</tr>
<tr>
<td><strong>Small Engine Controller</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine control for 1-to-4 cylinder</td>
<td>MM912_812, MC33813 – MC33814</td>
<td>-</td>
</tr>
</tbody>
</table>
Valve and Pump Controller
MC34SB0800 / MC34SB0410 Integration Solution

Hydraulic Systems

On/Off Valve controls
Proportional Valve controls
Safe protected
Supervision

Pneumatic Systems

Pump control
Diagnostic
Configurable

VAPS System-on-Chip
up to 36 V

MCU
MC34SB0800 / MC34SB0410 – Valves and Pump Controller

Differentiating Points
- Best thermal efficiency due to exposed pad (<2°/W) and low Rds(on) (<300 mΩ)
- Design-in simplicity thanks to SPI interface
- Real-time valve current regulation
- Robust and secure solution thanks to safe MOSFET switching off all the valves in case of issue

Product Features
- 8 x valve drivers
  - 4 x PWM or precision current regulated +/- 6% w/o calibration up to 2.25 A (300 mΩ)
  - 4 x PWM up to 5 kHz, 5 A (225 mΩ)
- Integrated valve protection including HS pre-driver
- Integrated DC pump motor pre-driver controller 500Hz PWM
- Self protected high-side driver (1.0 Ω)
- Self protected low-side drivers (14 Ω)
- Die temperature warning
- Fault management & State Machine
- 6 V to 36 V continuous operation, 40 V transient
- 10-bit Analog-to-Digital Converter
- 16-bit SPI interface with watchdog
- 3.3 V & 5.0 V TTL/CMOS compatible

Typical Applications
- Hydraulic & Pneumatic systems
- Motor pump control
- Safe systems (agricultural, pharmaceutics, cryogenics…)

Samples / EVB availability: Now

Preliminary Information – Changes and/or discontinuation of product offerings are possible without notification
MC34SB0800 – Supervision Embedded

Criticality Function Level

<table>
<thead>
<tr>
<th>Function Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF Latched</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Fault Flag Set</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Monitoring</td>
</tr>
</tbody>
</table>

General System Faults

- Undervoltage
- Overvoltage
- Clock Fail
- Watchdog Error
- External Reset
- Over-Current
- Load Leakage

High Side pre-Driver Safe Switch

- Low Side Driver (valves)
- DC Motor Pump Pre-Driver
- High Side Driver
- Low Side Driver

Faults on Function

- Over-Current
- Over-Temperature
- Open Load
- VDS Monitoring (real time)

- Detected on
  - Low Side Driver (valves)
  - DC Motor Pump Pre-Driver
  - High Side Driver
  - Low Side Driver

Internal Monitoring

- External Signal Monitoring
- Internal Digital Supply Voltage
- Internal Analog Supply Voltage
- Internal Charge Pump Supply Voltage
- Internal 10V Supply Voltage
- Internal 12V Supply Voltage
- Die Temperature

Pressure Sensor Example

Detected on

ADC (10Bit)
Conclusion

Making …
Embedded …
Systems …
Better!
Freescale Analog MCU Attach
Making embedded systems better

Power Driver

Power Switch

System Power Management & Interface

Battery Management

Analog System Solution
Analog and Sensor Summary

- Bridging real world physics to connected processors
- Preferred partner for complete embedded system solutions
- Leveraging MCU attach to diversify customers and markets
- Expanding strong automotive position
- Extending leadership with differentiated products

Robust Reliable Performance

Freescale.com/analog
Freescale.com/sensor

For more information, Emmanuel.Carcenac@freescale.com