Freescale Analog Product Overview: Robust, Reliable Performance

FTF-IND-F0180

Rick Beale | Analog & Sensor Marketing and Strategy

APR. 2014
Analog Products Overview Session Introduction

• This session will explain:
  – What Freescale analog products are available
  – How they are differentiated
  – How they fit with Freescale embedded processors for a variety of embedded system applications targeting industrial, automotive and consumer markets

• Rick Beale reports to James Bates, the SVP/GM of Freescale’s Analog and Sensor Group and is responsible for overall world-wide marketing and strategy

• This one hour session is intended to be an interactive presentation with opportunities for questions during and at the end
Analog Products Overview Session Objectives

• After completing this session you will be able to:
  − Identify key market trends with Freescale analog products
  − Associate Freescale analog products with relevant MCU/MPU products and embedded system applications
  − Describe the differentiating features and target applications of key Freescale analog products
  − Evaluate applicability of Freescale analog products to your embedded system designs
Agenda

• Freescale Analog Value Proposition
• Analog Portfolio and Leadership Overview
• MCU Attach Embedded System Solutions
• Analog Product Differentiation and Applications
  – System Power and Battery Management Solutions
  – Safety Automation Solutions
  – Power Drivers and Switches
  – Interface Solutions
• Wrap Up
Analog and Sensors
Making embedded systems better with robust reliable performance

Complete Embedded System Solutions
Preferred MCU partner
Bridges real-world physics to connected digital intelligence
Turnkey reference designs with algorithms and software

Differentiated Performance + Reliability
Thermal and energy efficient
Precision sense and control
Designed for extreme harsh environments
Trusted supplier with long term product commitments

Leadership in Functional Safety + Safety Automation
30+ years auto experience
Integrated health monitoring and failover
Support resources and third party alliances
## Positioned to Address Key Market Trends

### Analog and Sensors Market Leadership

<table>
<thead>
<tr>
<th>Market Trends</th>
<th>System Applications</th>
<th>ASG Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial &amp; auto functional safety</td>
<td>Process automation and control</td>
<td>System basis chips, transceivers, motor drivers, eXtreme Switch</td>
</tr>
<tr>
<td>Internet of Things</td>
<td>Motion processing</td>
<td>Sensors and sensor interface</td>
</tr>
<tr>
<td></td>
<td>Connected processing</td>
<td>MPU power management</td>
</tr>
<tr>
<td>Electrification</td>
<td>Energy storage systems</td>
<td>Battery sensors, eXtreme Switch, alternator-regulators, motor drivers</td>
</tr>
<tr>
<td></td>
<td>Hybrid battery systems</td>
<td></td>
</tr>
<tr>
<td>Automotive energy efficiency</td>
<td>Direct fuel injection</td>
<td>Precision DFI pre-drivers</td>
</tr>
<tr>
<td>Automotive safety systems</td>
<td>ADAS radar</td>
<td>77 GHz radar transceivers</td>
</tr>
<tr>
<td></td>
<td>Tire pressure monitoring system</td>
<td>7x7 dual-axis wireless sensor node</td>
</tr>
</tbody>
</table>

Source: IHS and Freescale calculations
Analog Portfolio
Bridging real-world physics to connected digital intelligence

MCU System Power Management and Communication
- Auto Infotainment
- Auto Power Train
- Industrial HMI Display
- Embedded Computer
- Safety Controller
- Elevator Control

Power Drivers and Switches
- Auto Throttle, Window Lift
- DFI Solenoid Control
- Lighting, I/O PLC
- Camera, Printer
- Heavy Machinery
- Motorbike, Mowers

Battery and Energy Management
- Hybrid Electric Auto
- Alternator Regulator
- Battery Supplied UPS
- Energy Storage System
- Point of Sale Terminal
- Portable Charger

Safety Automation
- ADAS Radar
- Surveillance Camera
- Intrusion Detection
- Airbag Systems
- ABS/ESC/WSS Braking

PMICs for MPUs
- PowerSBC, SBC
- HS CAN Transceiver

Kinetis / Qorivva MCU, i.MX / LS1 MPU

BLDC Motor Pre-Driver
- H-Bridge DC Motor Driver
- eXtreme Switch, Solenoid Driver, Small Engine Cntrl

Kinetis / S12 / Qorivva
- MCU, DSC, LS1 MPU

Intelligent Battery Sensor
- Battery Cell Controller
- Li-Ion Battery Charger

Kinetis MCU, i.MX MPU, DSC

77 GHz Radar Transceiver
- Airbag Controller
- Braking Controller

Qorivva MCU
Growing Analog Leadership in Automotive

**Battery and Energy Management**
- Alternator regulators
- Stop/Start MOSFETs
- Intelligent battery sensors

**Engine Management**
- BAP/MAP pressure sensors
- DFI solenoid controllers

**Safety Automation**
- ADAS 77GHz radar transceivers
- Airbag ECU & crash sensors
- Braking: ABS, ESC, WSS control
- TPMS wireless sensor nodes

**Power Drivers and Switches**
- MagniV relay drivers
- H-Bridge DC motor drivers
- 3-phase BLDC motor pre-drivers
- eXtreme power switches

**System Power & Connectivity**
- Infotainment PMICs
- System basis chips
- CAN / LIN transceivers
- I/O switch detectors
Expanding with Embedded Systems for Industrial

**Functional Safety Controller**

- MC34908 Power Management and Safety System IC
- MC34906 System Basis Chip
- MC34937 3 Phase Gate Driver for BLDC motor
- MCPC5744P dual core lock-step MCU
- MC06XSD200 eXtreme Switch Safe Motor Control System

**Elevator Control System**

- Safe Motor Control System
  - MPC5744P dual core lock-step MCU
  - MC34908 System Basis Chip
  - MC34937 3 Phase BLDC Motor Driver
  - MC06XSD200 eXtreme Motor Control System

**Floor Control Panel**

- Kinetis MCU
- MC34904 SBC/CAN

**Ground Floor Display Panel**

- i.MX MPU
- PF0100 Power Management
- MC34901 CAN PHY

**Portable POS Terminal**

- Kinetis MCU
- MC34904 SBC/CAN

**Security Camera**

- MC34932 5A Dual H-Bridge Driver IC
- MRD2001 Radar RF Chipset
- MMA865x MMA845x MMA8491

- Accelero-meter
- Tap to wake-up
- Landscape/Portrait detection
- Floor Control Panel
- Ground Floor Display Panel

**ISO 26262**

**IEC 61508**

**ISO 13849**

**External Use | 8**
SMARTMOS™ Technology Integration Leadership

More than driving loads

- Cost effective high voltage (>150 V BD) power analog process platform
- Low $R_{DS(on)}$ * Area (27 mΩ-mm² @ 45 V) for thermal efficiency in high current applications
- High precision for sensor interface integrated with power applications
- Advanced Isolation capability (-40 V) and robust system transient ESD/EMC immunity
- Low power devices to reduce overall system power consumption
- Extreme temperature operation for harsh application environments (-55 to +175ºC)
<table>
<thead>
<tr>
<th><strong>Analog Toolbox</strong></th>
<th>Easy MCU attach development with Freedom Platform and Tower systems <a href="http://freescale.com/analogtools">freescale.com/analogtools</a></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sensor Toolbox</strong></td>
<td>Reference designs for Freedom Platform – Customizable tools for easy MCU attach development <a href="http://freescale.com/sensortoolbox">freescale.com/sensortoolbox</a></td>
</tr>
<tr>
<td><strong>Freedom Platform</strong></td>
<td>Environment for Kinetis MCU attach evaluation and development <a href="http://freescale.com/freedom">freescale.com/freedom</a></td>
</tr>
<tr>
<td><strong>Tower System</strong></td>
<td>MCU attach modular development platform for rapid prototyping <a href="http://freescale.com/tower">freescale.com/tower</a></td>
</tr>
</tbody>
</table>
| **Technical Collateral** | • Application notes, datasheets and user guides  
• Hardware, software and functional safety reference manuals [freescale.com](http://freescale.com) |
| **Ongoing Developments** | • MCU attach reference designs for target applications  
• Processor Expert library elements for key products  
• Drivers and target application example code |
Power Management Solutions
System Basis Chip Segmentation
Different solutions for different system needs

**CAN PHY**
- **HS CAN, CAN FD & CAN Partial Networking**
- **Robust EMC/ESD without External Choke**
- Kinetis / Qorivva MCU, i.MX / QorIQ / LS1 MPU

**CAN LDO**
- **Low Power Modes**
- **Robust EMC/ESD**
- S12 / Kinetis MCU

**SBC**
- **Ultra Low Power Modes**
- **Flexible Power Management**
- **Medium Functional Safety**
- Kinetis / Qorivva MCU

**PowerSBC**
- **85% Efficiency, 25uA Iq**
- **High Current (2.0A)**
- **ASILD Functional Safety**
- Qorivva MCU

Scalable family of products supporting a wide range of MCU and power segmentation architectures
Embedded System Power Management Solution

Differentiation

• Optimized for i.MX / LS1 MPU systems
  - 14-ch, 11.7 A (PF0100/200 for i.MX 6)
  - 12-ch, 7.2 A (PF0300 for i.MX 7)
  - 8-ch, 10 A (VR500 for LS1)

• Quick-turn customizable output voltages, sequencing and timings

• Three to six buck converters

• Multiple general purpose LDOs

• Field programmable OTP memory
System Power Management Application Example

PF0100
- SW1A 0.3 to 1.875 V
- SW1B 0.3 to 1.875 V
- SW1C 0.3 to 1.875 V
- SW2 0.4 to 3.3 V
- SW3A 0.3 to 3.3 V
- SW3B 0.3 to 3.3 V
- SW4 0.3 to 3.3 V
- SW_BST 5 - 5.15 V
- VGEN1 0.8 to 1.55 V
- VGEN2 0.8 to 1.55 V
- VGEN3 1.8 to 3.3 V
- VGEN4 1.8 to 3.3 V
- VGEN5 1.8 to 3.3 V
- VGEN6 1.8 to 3.3 V
- VSNVS 1.8 to 3.3 V
- VREFDDR
  - Vout = ½ Vin

MPU + Memory Sub-system
- i.MX6 Quad
- 1GB DDR3

SW1A 1.375V, 2.5A
SW1B 1.375V, 2A
SW1C 3.3V, 2A
SW2 1.5V, 2.5A
SW3A 1.8V, 1A
SW3B 5V, 0.6A
SW4 1.5V, 100m
VGEN1 1.5V, 100mA
VGEN2 1.5V, 250mA
VGEN3 2.5V, 100mA
VGEN4 1.8V, 350mA
VGEN5 2.8V, 100mA
VGEN6 3.3V, 200mA
VSNVS 3.0V, 400μA
VREFDDR 0.75V, 10mA

GPS (optional)
- Barometer MPL3115
- Gyroscope FXAS21000

Audio

Peripherals
- Camera x2

Sensors
- NOR Flash

Interface
- SD Slot
- eMMC Memory
- HDMI
- USB
- LVDS
- SATA
- mPCIe
- eCompass FXOS8700
- USB Ethernet
- Ethernet

Coin Cell

4.2V

3.3V

2.5V

1.8V

1.5V

5V, 0.6A

MPU + Memory

Sub-system

Sensors

Interface

External Use | 14
**Intelligent Battery Sensors (IBS)**

- 12 V Pb-Acid, 14 V Li-Ion, HV junction box
- 4 cell with 52 V measurement capability
- First IBS in production with CAN
- Lower average system current
- Configurable filters off-load MCU
- LIN conformance, robust EMC/ESD
- Reduces BOM count and footprint

**Overview**

- MC912J637 for Pb Acid
- MM9Z1J638 for Pb Acid / Li-Ion
Safety Automation Solutions
MR2001 77GHz Radar Chipset Platform

Differentiation

• Scalable to 4 transmit, 12 receive
• Best phase noise performance
  - -85 dBc/Hz at 100 kHz offset
  - -95 dBc/Hz at 1 MHz offset
• Low 2.5 W power consumption
• 38 GHz LO for low distribution loss and system interference
• Advanced BGA packaging

Applications

• Automotive ADAS
• Industrial safety
• Security intrusion detection
• Robotic vision
Braking System Solution Family

Differentiation
- ABS, ESC, and ESP/ESC
- 8x / 12x valve drivers with ± 5% regulated current
- 36 dBm EMC chokeless CANs
- Low BOM with MCU PMIC & recirculating high side drivers
- 4x wheel speed sensor interfaces
- 16 kHz pump motor pre-driver enabling quiet operation

Applications
- Automotive ABS, ESP/ESC braking systems
- Industrial machinery brakes
Advanced Passive Safety Solutions

- Airbag system controllers
  DSI/PSI interface, sensors
- Scalable solutions
- Device drivers and software API

Custom Airbag SOC
- 4x DSI3 Sensor Interface
- 6x Firing Loops
- 1x CAN XCVR
- ISO2626
- 2 ASIL-D

MC33789 Airbag SOC
- 4x PSI5 Sensor Interface
- Passenger Detection

DSI Satellite Interface
- 2x DSI3 Sensor Interface

MCU
- Safing sensor
- Airbag SoC
- Satellite
- Main G sensor
- Extended 2ch Squib Driver
- 8ch
- 1ch
- Squibs

MC3380X Airbag SOC
- Now

MC3390X Airbag SOC
- Q3 15
- Squib driver & sensor interface

Slave DSI/PSI Body Node
- Q3 15

Master DSI/PSI Body Node
- Now

Slave DSI/PSI Complex Sensors
- Q3 15

Released

2014 1Q 2Q 3Q 4Q
2015 1Q 2Q 3Q 4Q
2016 1Q 2Q 3Q 4Q
Power Drivers and Switches
**eXtreme Switches**

**Differentiation**
- 18/36 V high current, low $R_{DS(on)}$ high-side switches (4 to 50 mΩ)
- 30% smaller footprint and 75% fewer MCU I/O for high I/O systems
  - High thermal efficiency
  - High density daisy chain
- 5x better current sensing accuracy
- Full diagnostics and protection with failsafe mode

**Applications**
- Automotive lighting and valves
- Factory automation PLC I/O
- High current inductive solenoids
- DC motor control
Low Voltage H-Bridge Family for DC and Stepper Motors

Differentiation
- 9 IoT actuator variants
- Operation from 2 V to 15 V
- Peak current 0.4 A to 3.8 A
- Independent PWM drivers
- PWM frequency up to 200 kHz
- Single and dual configurations

Applications
- Digital cameras
- Video conference
- DVD players
- Personal care products
- Medical
MC3x931/2 28 V, 5 A 1x/2x H-Bridge DC Motor Drivers

**Differentiation**
- High current, high temp operation
- 2x lower thermal impedance
- High efficiency $125 \, \text{mΩ} \ R_{DS(on)}$
- Automatic thermal back-off for maximum drive operation
- Real-time load current monitoring
- >10 A over current threshold

**Applications**
- Throttle control
- Exhaust gas recirculation
- Shock absorber / braking
- Tube motors
- Robotics / factory automation
- POS, ATM, vending kiosks
MC3x937 1 A / 58 V 3-Phase Gate Driver for BLDC Motor

**Differentiation**
- >50% larger gate drive (>1 A) for high current applications
- 0 – 10.5 µs wide dead time range
- Protection against large transient spikes & reverse charge injection
- Rich diagnostics and protection
- SPI configurable

**Applications**
- Portable electric power tools
- Electric bicycles and wheelchairs
- Fans and pumps
- Robotics
- Vacuum cleaners
MM912_634 Relay Driver with MCU for Motor Control

Differentiation
- Auto (18 V, 125°C), industrial (30 V, 85°C)
- Small footprint with MCU + drivers
- 20 Mhz S12 MCU, 6 kB SRAM, 64 kB flash
- 2x 50 kHz low-side with 10 mJ Eclamp
- 2x 50 kHz high-side drivers
- Current sense for anti-pinche control
- Rich diagnostics and protection
- 18 V/40 mA external supply
- 6x 18 V switch detect inputs

Applications
- Auto window-lift and sunroof motors
- Machine tools, industrial robots
- Building automation, vending machines
MC3x816 72 V DFI Programmable Solenoid Controller

**Differentiation**
- 4 programmable controllers drives up to 6 solenoids
- 16x faster response (0.9 uS)
- Precision output current profiles in dynamic load environments
- 13% system BOM cost reduction

**Applications**
- Gasoline/diesel direct injection (GDI/DDI)
- Dual clutch transmissions
- Industrial precision solenoid control
Small Gas Engine EFI Controller

- Reduces pollution emissions for HC 40% and CO 80%
- Increases fuel efficiency 20%
- Scalable for 25 – 1000cc four stroke engines from 1 to 4 cylinders
- Flexible Fuel compatibility
MC3x901 Chokeless CAN High Speed Transceiver

**Differentiation**
- Low emissions, high immunity
- Exceeds EMC / ESD requirements without external choke
- 2 Mbps CAN FD performance
- Lowest quiescent current @ 8 µA

**Applications**
- Automotive, transportation
- Motion control
- Factory automation
- Backplanes (networks, servers)
- Aviation systems
**MC33978 Configurable I/O Switch Detect**

### Differentiation
- Translates state of 22 analog inputs to MCU SPI, reducing MCU I/O requirement
- 2 – 20 mA programmable current sourcing for driving LEDs or wetting contacts
- 24:1 analog multiplexer
- 48% wider operating voltage, 4.5 – 40 V
- 3x lower quiescent current @ 30 µA
- Proven robust ESD >15 kV
- Smallest package with 5*5 mm QFN

### Applications
- Automotive body electronics
- Automotive power train
- Relay closure detection
- Industrial control
- Security systems
Analog Overview Summary

• Expanding strong automotive position and diversifying into adjacent markets
• Enabling delivery of complete embedded system solutions with MCU attach
• Bridging real world physics with connected processor intelligence
• Delivering robust, reliable, performance
  - Analog power mixed-signal system solutions
  - Leveraging differentiated power technologies
  - Extensive systems knowhow with complementary MCU/MPU solutions