



# Analog and Sensors

## Overview

AUG. 2015



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# Analog & Sensors Group Strategy



# Analog and Sensors Portfolio

## Differentiated Specialty Solutions

### Automotive Safety

#### **Safety Systems**

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Most integrated system-on-chip solutions

- ADAS radar transceivers
- Braking SoCs
- Airbag SoCs

### IoT Miniaturization and Humanization

#### **Sensor Solutions**

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Smallest size, lowest power, highest accuracy

- Motion and orientation sensing
- Pressure sensing
- Wireless sensing nodes (TPMS)

### System Power Optimization

#### **Power Management Products**

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Performance optimized platforms

Out-of-the-box ready to program

- MCU/MPU system power management
- Functionally safe system basis chips
- Interface I/O and network transceivers

### Functionally Safe Electrification

#### **Driver and Energy Systems**

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Highest robustness, reliability, precision, safety

- Motor control power drivers and switches
- Energy management components
- Battery management sensors and controllers

# Analog and Sensors Value Proposition

Making IoT Embedded Systems Real

**#1** merchant auto MEMS  
**#3** inertial + pressure MEMS  
**#1** auto safety analog + MEMS



Embedded System  
Specialty Solution  
Portfolio

Preferred cross-sell MCU partner  
System BOM simplification  
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  
Health monitoring and failover  
Revolutionized “Safe” systems

**Low Power, Small Size, High Precision**

# Analog and Sensors for Automotive

## Battery and Energy Management

Alternator regulators  
Stop/Start MOSFETs  
Battery Management

## Engine Management

DFI solenoid controllers  
BAP/MAP pressure sensors  
Fuel Pressure Sensor

## Safety Automation

Braking: ABS, ESC, WSS control  
ADAS 77GHz radar transceivers  
Airbag ECU & crash sensors  
Seat occupancy pressure sensor  
TPMS wireless sensor nodes

## Power Drivers and Switches

Single chip MCU 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  
Accelerometers/Gyro

LEGEND: Analog Sensors

# Analog and Sensors for Internet of Tomorrow



## Products

Motor drivers, switches  
Multi-valve controller

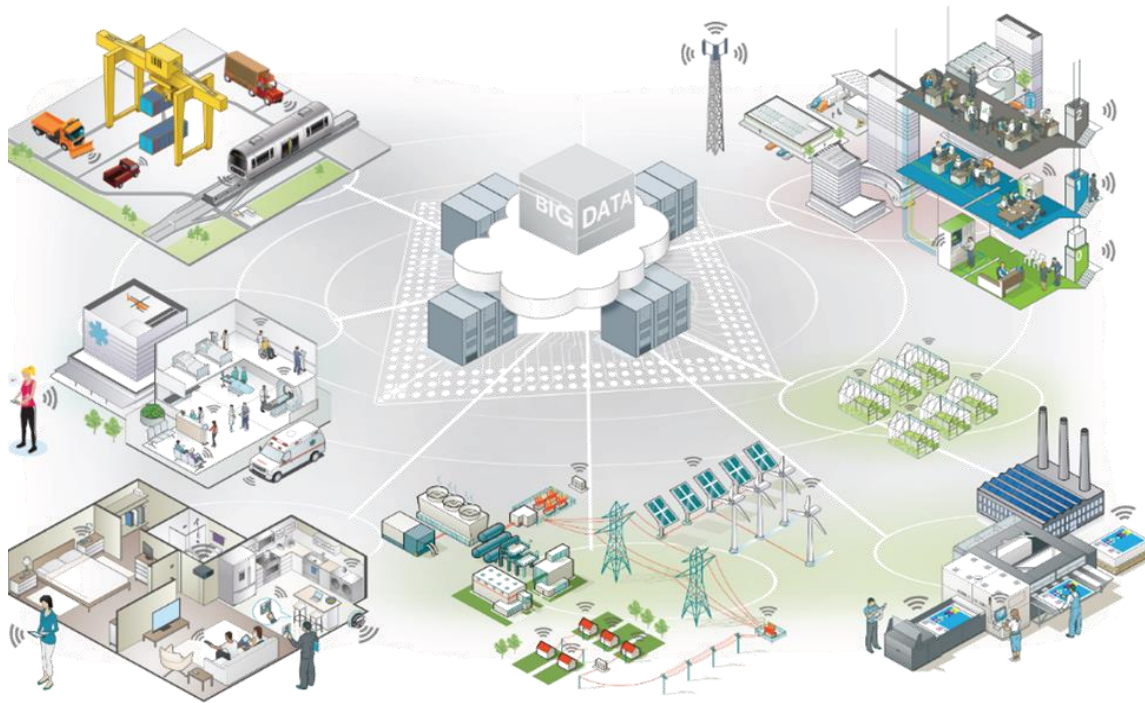
System basis chips  
Power management

Battery management  
Network transceivers

Switch detect interface  
Motion, pressure sensors

## Industrial Transportation

Heavy Machinery  
Forklifts  
Farm Equipment  
Trains  
Buses



## Building Control

HVAC  
Elevators  
Access / Security  
Automation  
Surveillance

## Connected Portables

Wearables  
ePOS  
Smart watch  
Medical devices  
Terminals  
Asset tracking

## Factory Automation

PLC I/O  
Safety Systems  
Robotics  
Motor Drives

## Conservation

Energy Storage  
Converters  
Smart metering  
Tools & Appliances





# Analog and Sensors Growth Drivers

## Vision

- Be the technological leader and preferred partner for embedded system customers

## Mission

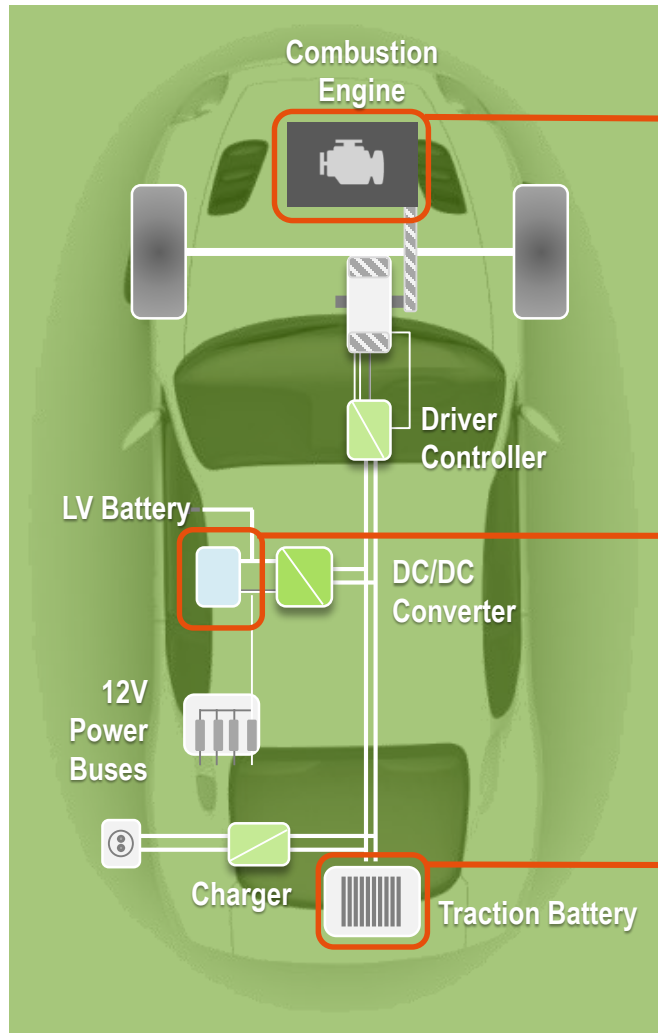
- Dominate focus segments globally
- Cross-sell system solutions with Freescale processors

## Strategy

- Target industry mega trends with leadership specialty solutions
- Reduce system BOM with robust, reliable solutions
- Differentiate by small size, low power, high precision
- Simplify and streamline design with Freescale processor aligned enablement tools

Mega-Trend	Market Segments	Strategic Vector
Fuel efficiency and emission regulations	Green powertrain and energy	Battery mgmt, DFI / IGBT / 48 V Driver
Driver assisted safety and autonomous driving	Advanced auto safety	Radar, TPMS, Braking, Airbag
System electrification	Automation and control, ESS	Motor drivers and switches, Battery mgmt
IoT end node humanization and miniaturization	IoT end nodes	Sensors, power mgmt
IoT system security, reliability and safety	Functional safety systems	SBC power mgmt

# Green Powertrain and Energy



## Fuel Efficient Engine Management

### Direct Fuel Injection (DFI) Solenoid Drivers



- Fast response, precision control
- Integration for low system BOM



## Mild-Hybrid/EV Battery Management

### 48 V/HV Battery Cell Controllers



- 61 V 14 cell, >800 V stackable
- ASIL-C with system diagnostics
- 2 Mbps transformer isolation
- Time aligned impedance Measure

## Low-Voltage Battery Management

### Intelligent Battery Sensors

### 14 V Battery Cell Controllers



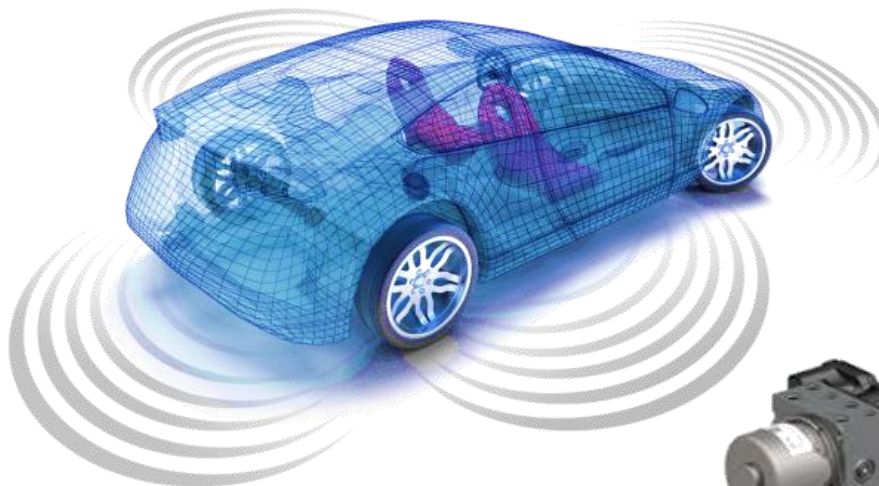
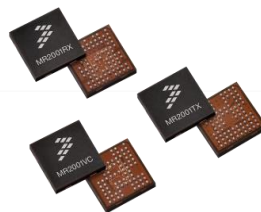
- 4 cell, 52 V sensing
- Integrated CAN



# Advanced Automotive Safety

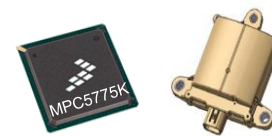
## Tire Pressure Monitoring Module

- Small 7x7 mm system footprint
- Low power consumption
- Accurate measurement over wide range



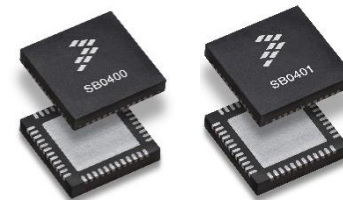
## ADAS 77 GHz Radar

- Scalable packaged 77 GHz radar ICs
- Radar processor with optimized API
- Next generation, high integration ICs



## Braking ESC and ABS

- Precision valve control
- Advanced motor drive



## Airbag Solutions

- High integration, including PMU and sensor interface
- Accelerometers, satellite crash sensors and pressure
- Leadership in both DSI and PSI standards

# Motor Drivers for System Automation and Control

## DC Motor H-Bridge Drivers

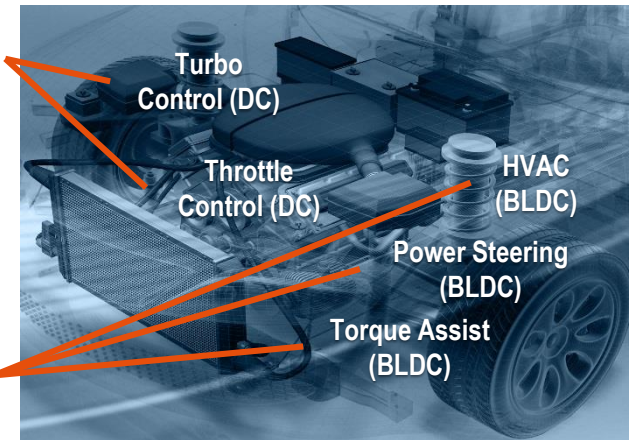
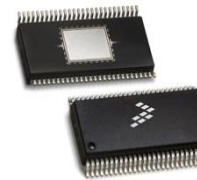
- High current, high temp operation
- High thermal efficiency with auto back-off
- Real-time load current monitoring

## BLDC Motor 3-Phase Gate Drivers

- Thermally efficient for high current applications
- Transient spikes & charge injection robustness
- Rich diagnostics and protection

## High Side Drivers

- Small footprint for high density, high current applications
- 5x better current sensing accuracy
- Full diagnostics and protection with failsafe



Combustion Engine Management



Industrial Automation



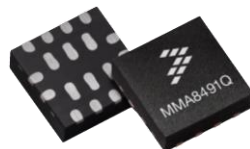
Building Control

# Sensors and Power Management for IoT End Nodes

## Smart monitors and anti-tampering sensors

Accelerometer, Gyro, e-Compass,  
Motion Processor

- Applications triggered sampling
- Low energy per sample
- Superior long term performance



## Bio-media compatible sensors

Altimeter / Absolute pressure sensor

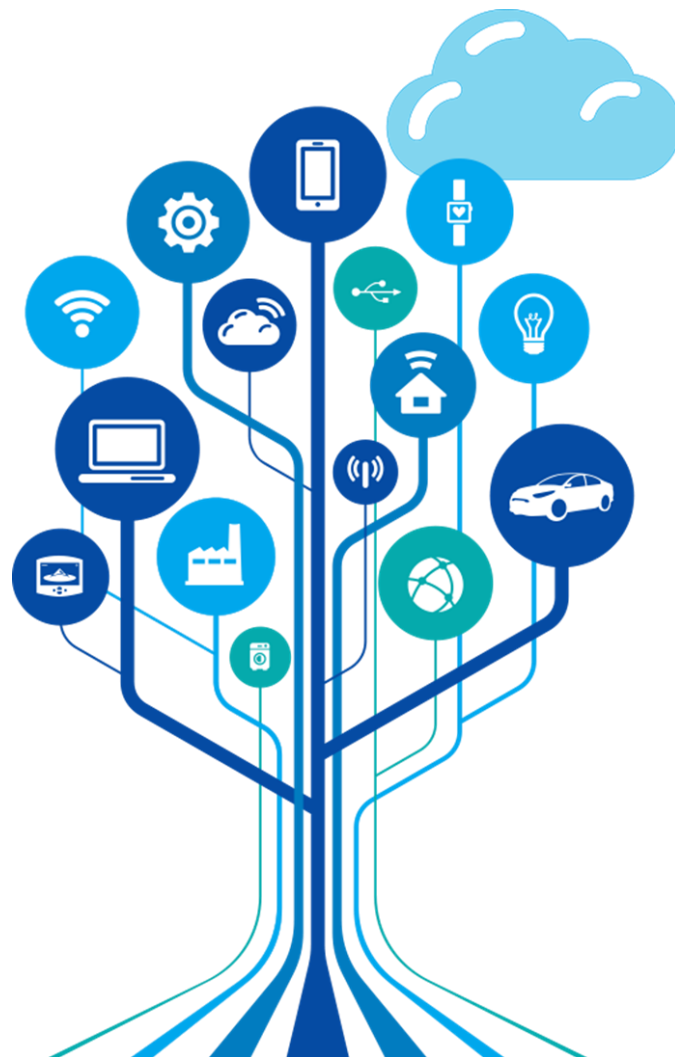
- Low current consumption
- Intelligent condition triggers
- FDA approved materials



## Performance optimized power management

PMICs for Freescale processors (i.MX, LS1, Kinetis)

- Integration for reduced system BOM
- High light load efficiency
- OTP flexibility and configurability



# Functional Safety Systems

## System Basis Chips

- Flexible functional safety architecture independently monitors safety-critical parameters and availability
  - Enables redundancy without replication
- Power efficient dual DC/DC converter topology
  - High availability operation down to 2.7V



### Automotive and Transportation

HEV / EV  
Cars

ADAS

Safety  
Systems

Railway  
Systems

Anti-skid  
control

### Industrial and Medical

Sensor &  
Comms  
Gateway

Robotics &  
Industrial  
Automation

Wind Power

Medical  
Systems

### Power Management

### Voltage Supervisor & Diagnostics

#### Fail Safe Inputs

- MCU Fault Collection Control Unit monitoring
- Redundant MCU Vcore monitoring
- Redundant External IC fault monitoring

#### Isolated Fail Safe State Machine

#### Watchdog Time Monitoring

#### Secured SPI

### Fail Safe Outputs & Reset Management

### Analog / Digital Self Test

### Communication PHYs

# SafeAssure Functional Safety Process

## ISO 26262 certified hardware development process for analog and sensor products

- Certification assessment by SGS TUV Saar, an independent accredited assessor
- Development rules, processes and tools certified as compliant with ISO 26262 standard part requirements applicable to semiconductor suppliers
  - ISO 26262-2:2011 – Safety Management
  - ISO 26262-5:2011 – Hardware Development
  - ISO 26262-7:2011 – Production
  - ISO 26262-8:2011 – Supporting Processes
  - ISO 26262-9:2011 – Safety Analysis





# Completing the Embedded System Solution

System solution cross-sell with Freescale processors for reducing system BOM complexity and cost

Processor enablement tool alignment for simplifying and streamlining system design

Freedom boards

Tower boards

Board Support Packages for PMICs

Integrated Sensor Framework software

Analog Processor Expert software

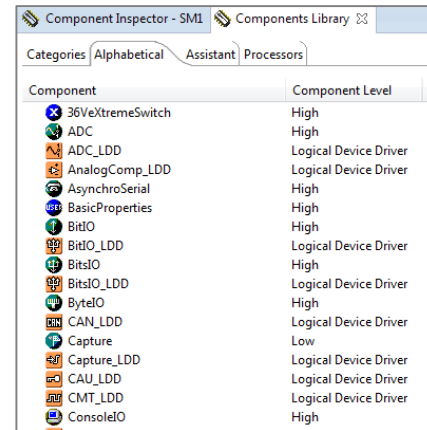




# Processor Expert and ISF 2.1 Enablement

## Simplifies Embedded System Design

- Makes external analog and sensor devices appear as integral processor resources
- Generates device drivers / start-up code
- Sensor fusion library integrated as an “Orientation” sensor
- 2 analog, 8 sensor products supported today
  - 7 analog, 2 sensor additions by end 2015



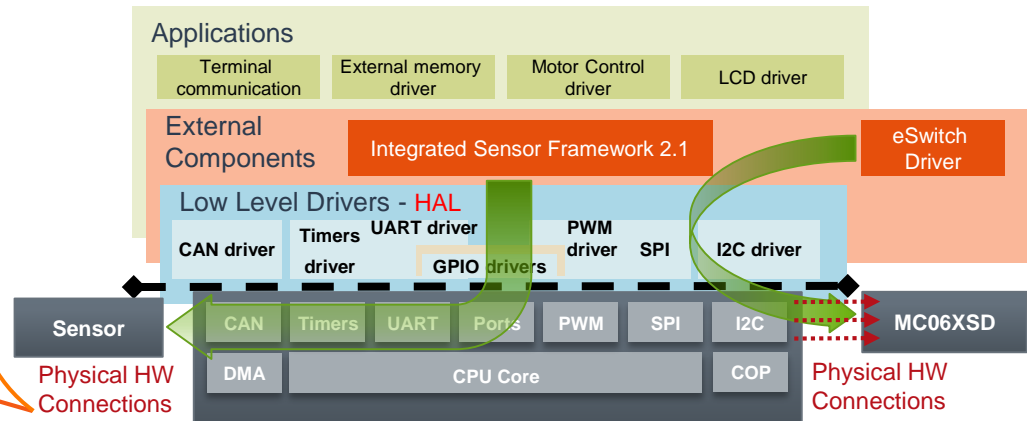
CodeWarrior

IAR  
SYSTEMS

KEIL™  
An ARM® Company



Hardware Platform



Processor Expert Software Model

# Analog and Sensors Process Technology



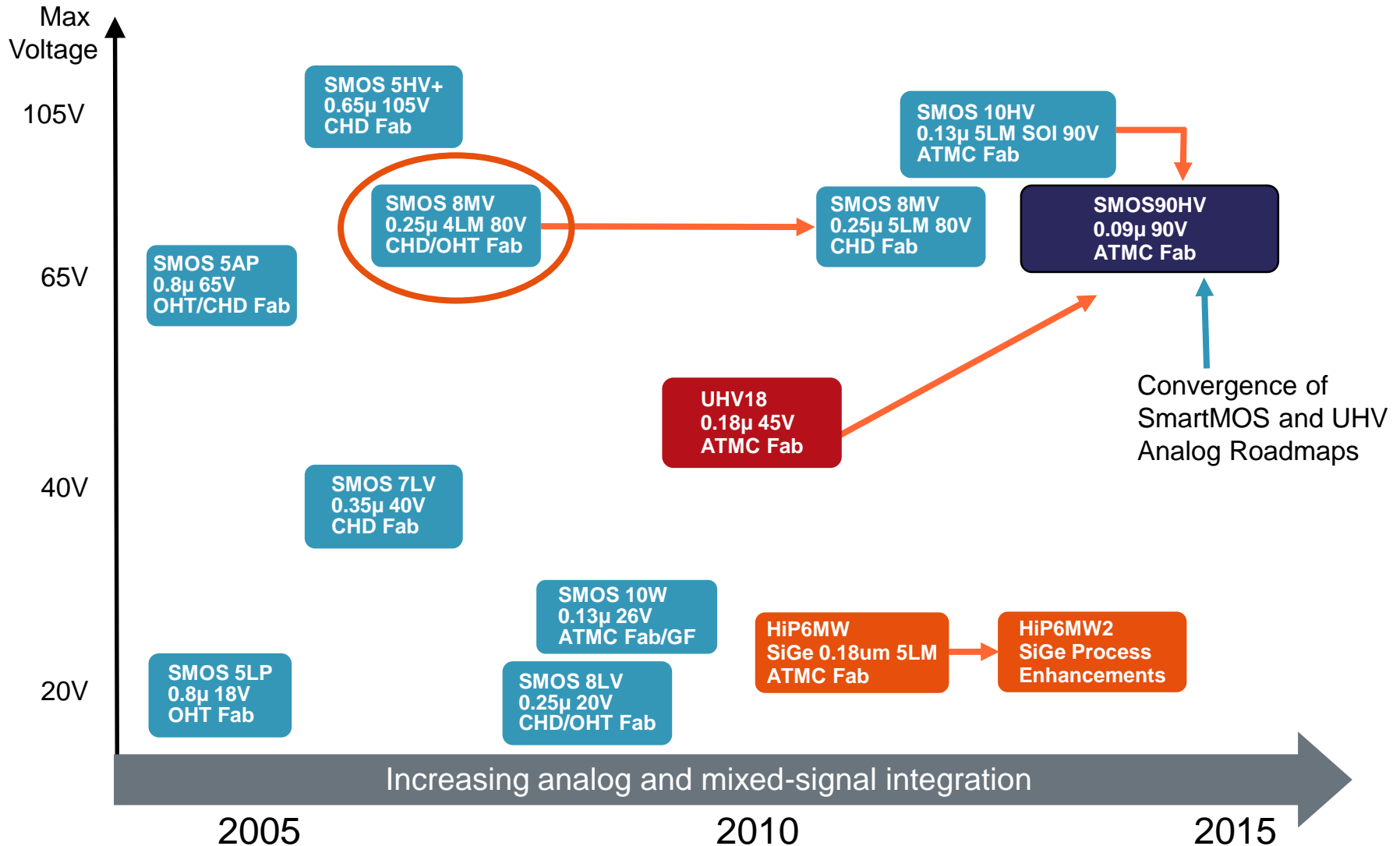
# SMARTMOS™ Technology Integration

## More than driving loads

- Cost effective high voltage (110 V) power analog embedded system process platform
- Low  $R_{DS(ON)} \cdot A$  (30 mΩ-mm<sup>2</sup>) for thermal efficiency in high current applications
- High Precision for sensor interface integrated with power applications
- Advanced Isolation capability (-40V) and robust system transient ESD/EMC immunity
- Low power devices to reduce overall system power consumption
- Extreme temperature operation for harsh application environments (-40 to +175°C)



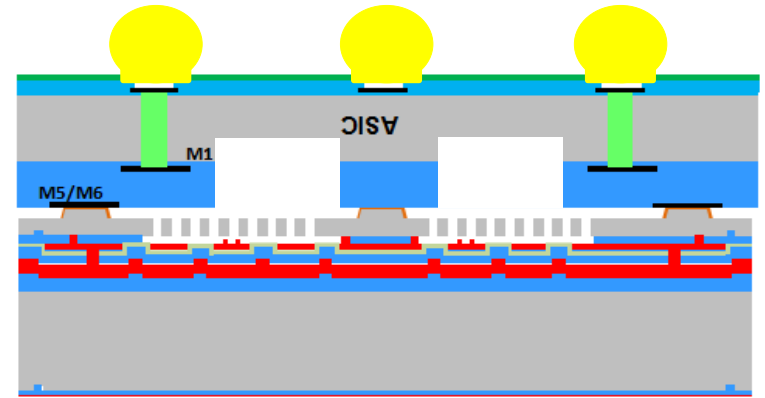
# Analog Technology Roadmap



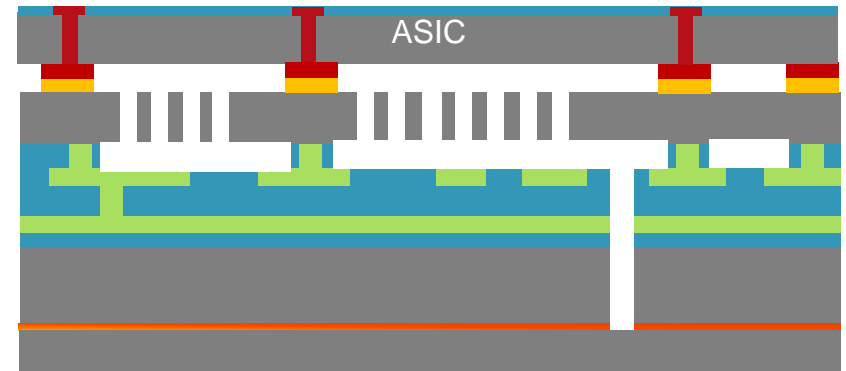
# UMEMS Sensor Technology

## Leapfrog Game Changer

- Combines capabilities of 7 current sensor process technologies
- Sensor SoC integration capable
  - Motion and pressure coexistence
  - 6 DOF + pressure on single die
- Chip scale package compatible
  - TSV interconnect vs bond wires
- Non-physical stimulus test
- First products 4Q15

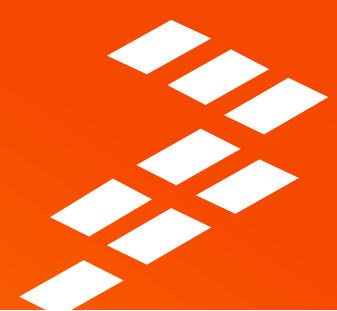


Integrated UMEMS (2015)



6 DOF + Pressure UMEMS (2016)

# Analog and Sensor Summary





# Freescal Analog and Sensors Overview

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# Secure, embedded processing solutions for the Internet of Tomorrow





[www.Freescale.com](http://www.Freescale.com)