Introduction to the New Sensor Products

APF-ENT-T0807

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Applications Engineer

April 2013

Consumer Sensor Applications

Mobile Devices

- Mobile Phones
- Tablets
- Laptops / Hybrids
- MID

Consumer Non-Mobile

- Digital Still Camera
- Remote Controls
- Gamin
- Pedometers
- GPS
- Watches

Growing Customer Base

SONY make.believe

RIM

LG

Canon

SAMSUNG

HUAWEI

ZTE中兴

ARCHOS Entertainment your way

GiONEE

Development

- Activity / fitness monitors
- Digital Cameras
- Sports training equip
- Hobbyist - RCs

C&I Accelerometer Family

MMA865x	MMA845x	MMA8450	MMA8491	FXLN83xx
• Digital Output	• Digital Output	• Digital Output	• Digital Output	• Analog Output
• Cost Efficient	• Extreme Perf.	• Low Voltage	• Extreme Low Power	• High Bandwidth
– 1mg/count sensitivity	– .25mg/count sensitivity	– 1.71-1.89V	– 0.35uA/Hz	– 4.9kHz
• High Perf.	• Extended Features		• Cost Efficient	• Low Voltage
• Rich Features	– FIFO		– 1mg/count sensitivity	– 1.71-3.6V
– P/L detection	– Configurable P/L trip angles		• Industrial Package	• Industrial Package
– High Pass Filter	– High Pass Filter			• Extended Temp Range: 105C
– Transient Detect	– Transient Detect			
• 2x2 mm package				
(Newton)	**(Veyron)**	**(Proton)**	**(Plutino)**	**(Pluto)**

Consumer	Industrial

Xtrinsic Low-G Sensors (Newton)
3-axis High-Performance Digital Accelerometers

Differentiating Points

- Output Noise (150ug/rHz)
- Offset and Sensitivity Accuracy
- Resolution up to 1mg/count

Product Features

- 1.95V to 3.6V supply voltage
- ±2g/±4g/±8g dynamically selectable
- Output data rate (ODR) from 800Hz to 1.563Hz
- I²C digital output interface w/interrupts
- Embedded orientation (Portrait/Landscape)
- Embedded High Pass Filter
- Embedded 32 sample FIFO

Typical Applications

- Smart Mobile Devices
- Digital Cameras
- PCs

MMA8652FC
12-bit output, 160ug/rHz noise
High Pass Filter w/ DSP functions
Configurable Orientation detect
FIFO

MMA8653FC
10bit output
Orientation detect

Package
2x2x1mm DFN, 0.4mm pitch

Availability
Samples: NOW
Production: NOW

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Xtrinsic Low-G Sensors (VeyronSPI)
3-axis High-Performance Digital Accelerometer

Differentiating Points

- Output Noise (99ug/rHz)
- Offset and Sensitivity Accuracy
- Resolution of 0.25mg/count

Product Features

- 1.95V to 3.6V supply voltage
- ±2g/±4g/±8g dynamically selectable
- Output data rate (ODR) from 800Hz to 1.563Hz
- SPI/I²C digital output interface w/interrupts
- Embedded orientation (Portrait/Landscape)
- Embedded High Pass Filter
- Embedded 32 sample FIFO

Typical Applications

- Laptops: HDD drop protect
- Washing Machine: Out of Balance detect

FXLS8471Q
14-bit output, SPI
High Pass Filter w/ DSP functions
Configurable Orientation detect
FIFO

Package
3x3x1mm QFN, 0.5mm pitch

Availability
Samples: NOW
Production: July '13

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Xtrinsic Low-G Sensors (Pluto)
3-axis High-Performance Analog Accelerometers

Differentiating Points
- Zero-g Level Offset Accuracy
- Board Mount Offset Shift
- Output Noise

Product Features
- 1.71V to 3.6V supply voltage
- ±2g/±4g/±8g/±16g dynamically selectable
- 150µg/√Hz noise
- Non-ratiometric Analog Parallel Outputs
- High Bandwidth: Up to 4.9kHz Capable
- Visible Solder Inspection Leads
- QFN 3x3x1.05mm 0.65mm pitch package

Typical Applications
- White Goods
- Factory Automation
- Gaming

Package
3x3x1mm QFN, 0.65mm pitch

Availability
Samples: April 2013
Production: November 2013
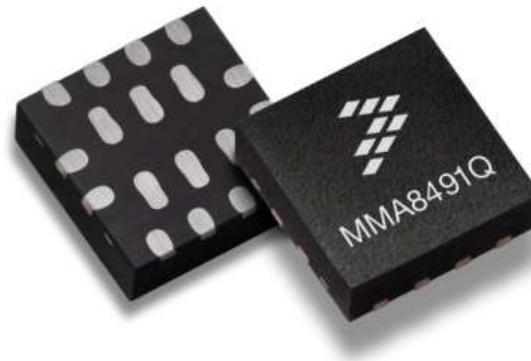
Industrial

FXLN8371Q
- 4.9kHz bandwidth
- ±2g, 228mV/g sensitivity
- ±8g, 57mV/g sensitivity

FXLN8372Q
- 4.9kHz bandwidth
- ±4g, 115mV/g sensitivity
- ±16g, 29mV/g sensitivity

FXLN8361Q
- ±2g, 115mV/g sensitivity
- ±8g, 29mV/g sensitivity

FXLN8362Q
- ±4g, 115mV/g sensitivity
- ±16g, 29mV/g sensitivity

Consumer

FXLN8351Q
- 4.9kHz bandwidth
- ±2g, 115mV/g sensitivity
- ±8g, 29mV/g sensitivity

FXLN8352Q
- ±4g, 115mV/g sensitivity
- ±16g, 29mV/g sensitivity

Xtrinsic MMA8491 (Plutino)
3-axis Extreme Low Power Digital Accelerometer

Differentiating Points
- Power Consumption (<0.35uA/Hz)
- Turn on time (<0.5ms)
- Ease of use (XYZ 45º tilt detect outputs)

Product Features
- 1.95V to 3.6V supply voltage
- ±8g range, 1mg/count sensitivity
- Sample rate from <1Hz to 800Hz+
- I²C digital output interface
- Enable pin for external power management
- 216µg/√Hz noise
- 3x3mm 0.65mm pitch w/ visual solder joint inspection

Typical Applications
- Remote Controls
- Smart Grid: Tamper Detect
- White Goods Tilt
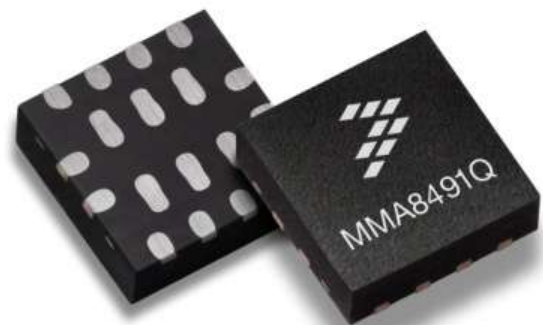
Package
3x3x1mm QFN, 0.65mm pitch

Availability
Samples: NOW
Production: NOW

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Xtrinsic MAG3110 (Maxwell)
3-Axis Magnetometer

Differentiating Points

- High accuracy compass function
- Decimator allows for lowest noise implementation with oversampling to remove RF noise and Idd induced mag fields

Product Features

- 1.95V to 3.6V supply voltage
- Maximum field of 10G (1000 uT)
- Output data rates (ODR) from 1.25Hz to 80Hz
- Magnetometer resolution of 0.1uT
- Current Consumption as low as 24uA at 1.25Hz
- I²C digital interface
- Extended temperature range of -40°C to +85°C.

Typical Applications

- Electronic Compass
- Enhanced User Interface
- Location Based Services

Package
2x2x0.85mm DFN, 0.5mm pitch

Availability
Now

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Xtrinsic FXOS8700CQ (Gauss)
6-Axis (3-axis Accelerometer, 3-axis Magnetometer)

Differentiating Points

- Lowest noise gcell and mcell
- Embedded Functionality to allow system fast response and power savings
- 32 sample FIFO with burst read

Product Features

- 1.95V to 3.6V supply voltage, I/O 1.6V – 3.6V
- ±2g/±4g/±8g accelerometer, ±15 Gauss Field range
- Output data rate (ODR) from 1.563Hz to 800Hz , 400Hz hybrid
- 14-bit gcell data, 800 counts per Gauss
- Low Offset Drift: 0.1mG per deg
- 4 channel motion detect ion- FF, Pulse, Transient, HPF, Tap
- Vector Magnitude for mcell, gcell

Typical Applications

- Electronic Compass
- Enhanced User Interface
- Location Based Services

Package
3x3x1.2mm QFN, 0.5mm pitch

Availability
Samples: December 2012
Production: April 2013

Xtrinsic FXAS21000 (Leon)
3-Axis Digital Gyroscope

Differentiating Points

- Angular acceleration resolution better than 0.2°/s
- Programmable interrupts
- Power saving features

Product Features

- 1.95-3.6V supply voltage
- Output data rates (ODR) from 1Hz to 200Hz
- Full scale range: ±1600°/s
- Bias stability over temperature: ±0.3°/s
- Random walk(over 1minute): ±0.007°/s

Typical Applications

- Controllers: Remotes, Games
- Mobile: Phones, Tablets, eReaders
- Sports Monitoring

Package

4x4x1mm QFN, 0.5mm pitch
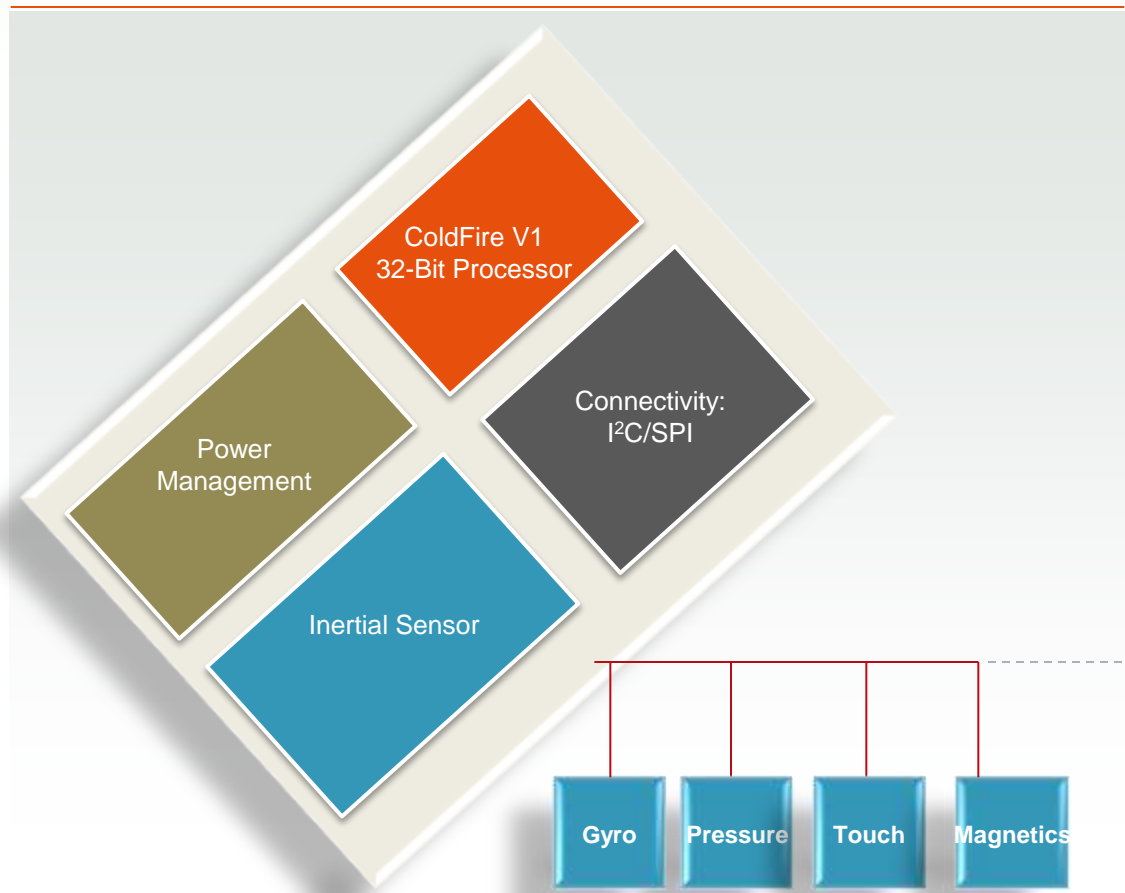
Availability

Samples: March 2013
Production: July 2013

MMA9550L At-a-Glance

MMA9550L Sensor

- ColdFire V1 32-Bit Processor
- Power Management
- Connectivity: I^2C/SPI
- Inertial Sensor

- Gyro
- Pressure
- Touch
- Magnetics

Sensing Software

- Customer/Third Party Innovation
- Applications
- Scheduler
- Communications

Up to 12 Sensor Components
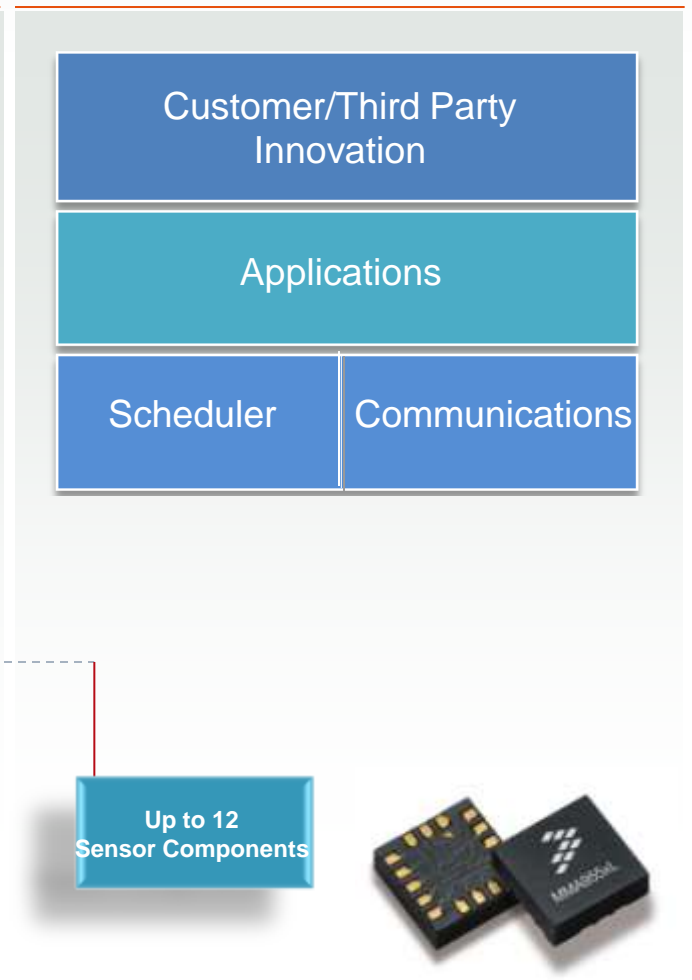
Xtrinsic MMA955xL (Eve)
3-Axis Accelerometer plus 32-bit ColdFire MCU

Differentiating Points

- Intelligent Motion Platform with embedded libraries
- Sensor hub capability
- Power management features and low power modes

Product Features

- 1.71 to1.89V supply voltage
- Output data rate (ODR) 488 Hz
- +/-2g, 4g, 8g configurable dynamic ranges available
- 14/12/10/8 bit resolution available
- 16K Flash, 2K RAM

Typical Applications

- Mobile: Phones, Tablets, eReaders
- Controllers: Remotes, Games
- Sports Monitoring

Variations

MMA9550L
> Infrastructure only functions
> User Flash: 6.5 Kbytes
> User RAM: 576 bytes

MMA9551L
> Infrastructure plus gestures
> User Flash: 4.5 Kbytes
> User RAM: 452 bytes

MMA9553L
> Infrastructure plus pedometer
> User Flash: 1.5 Kbytes
> User RAM: 200 bytes

MMA9559L
> Lightweight Infrastructure
> User Flash: 14 Kbytes
> User RAM: 1.5 bytes

Package
3x3x1mm LGA, 0.5mm pitch

Availability
Samples: NOW
Production: January 2013

Xtrinsic FXLC95000L (Galla)
3-Axis Accelerometer plus 32-bit ColdFire MCU

Differentiating Points

- Intelligent Motion Platform with embedded libraries
- Sensor hub capability
- Power management features and low power modes

Product Features

- 1.72 to 3.6V I/O supply voltage
- Output data rate (ODR) 488 Hz
- +/-2g, 4g, 8g configurable dynamic ranges available
- 14/12/10/8 bit resolution available
- 128K Flash, 16K RAM

Typical Applications

- Mobile: Phones, Tablets, eReaders
- Controllers: Remotes, Games
- Sports Monitoring
- Motion enabled accessories

Package
3x5x1mm LGA, 0.5mm pitch

Availability
Samples: NOW
Production: April 2013

Xtrinsic MPL3115A2
Precision Digital Altimeter

Differentiating Points

- Internally compensated, software is not needed
- Direct reading pressure in Pascals and altitude in meters
- On-board intelligence

Product Features

- Altitude resolution : < 1 foot / 0.3 m
- Pressure resolution: 1.5 Pa
- Pressure range: 20 – 110 kPa
- Calibrated pressure range: 50 – 110 kPa
- 1.95V to 3.6V supply voltage
- Variable output sampling rate (OST) up to 140 Hz
- Current Consumption:
- Standby mode: 2 µA
- Low-power mode: 8.5 µA at 1 Hz
- I²C digital interface

Typical Applications

- High Accuracy Altimeter
- Smartphones / Tablets
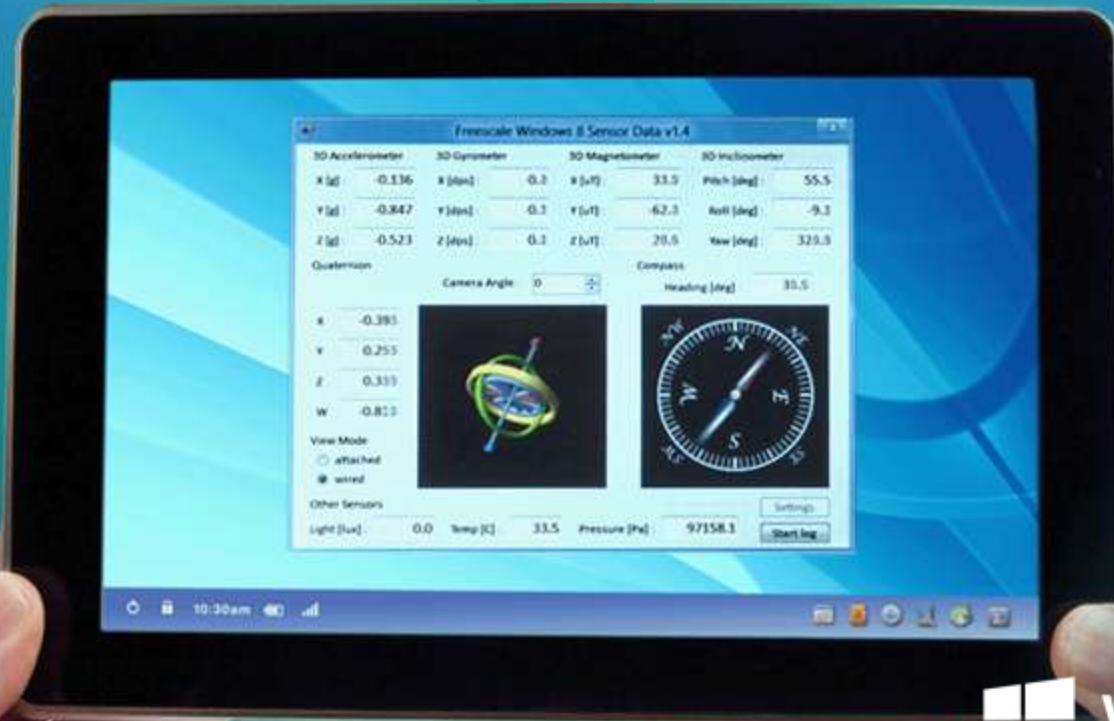- GPS Enhancement for Location Based Services
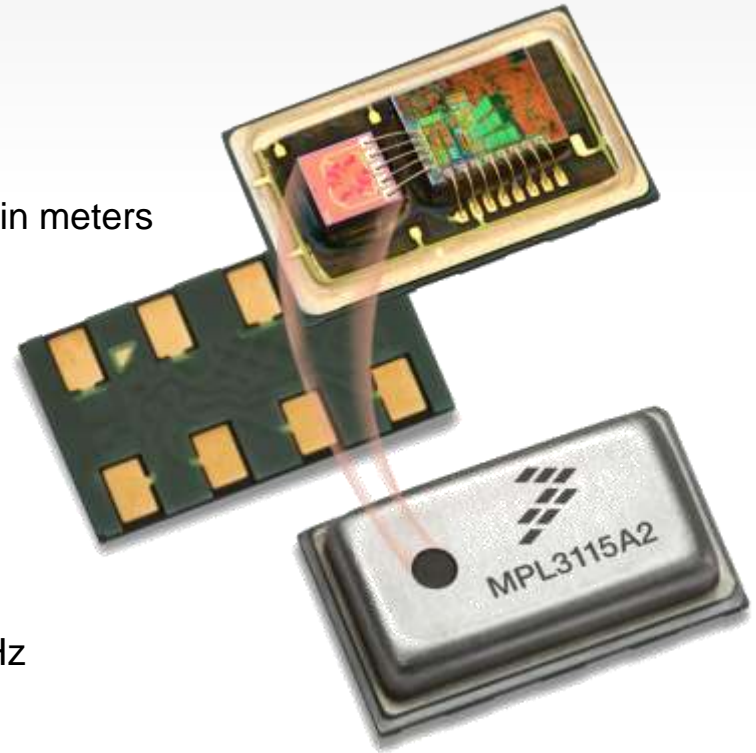
Package
3 x 5 x 1.1 mm LGA

In Production

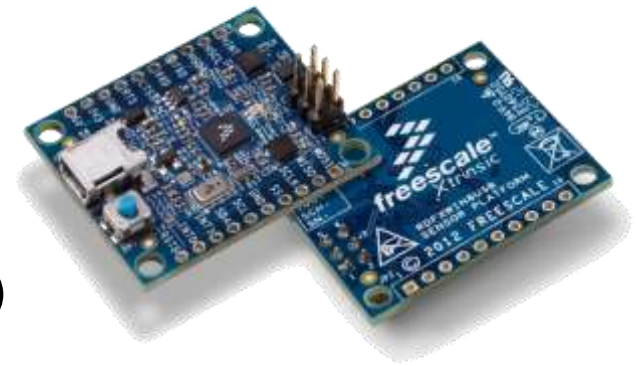# Windows 8 Freescale 12-Axis Xtrinsic Sensor Platform

Xtrinsic sensor fusion in tablets, slates, convertible/non-convertible laptops and other portable devices

Freescale 12-Axis Xtrinsic Sensor Platform

- **Freescale's parts:**
  - Xtrinsic MMA8451Q 3-axis accelerometer
  - Xtrinsic MAG3110 3-axis magnetometer
  - Xtrinsic MPL3115A2 precision altimeter
  - ColdFire+ MCF51JU128VHS MCU
  - Xtrinsic FXAS21000 3 axis Gyroscope (Q2)

- **Other parts:**
  - Ambient light sensor

- **12-axis solution** with IMU plus additional axes including ambient light sensor and temperature sensor

  Learn more at www.freescale.com/Windows8

12-Axis Xtrinsic Sensor Platform Block Diagram

USB to host

ColdFire+ Microcontroller 128 K Flash 32 K RAM

I2C & Interrupts

Xtrinsic Accelerometer

Xtrinsic Magnetometer

Xtrinsic Barometer/ Thermometer

Gyro

Analog

Control

Ambient Light Sensor
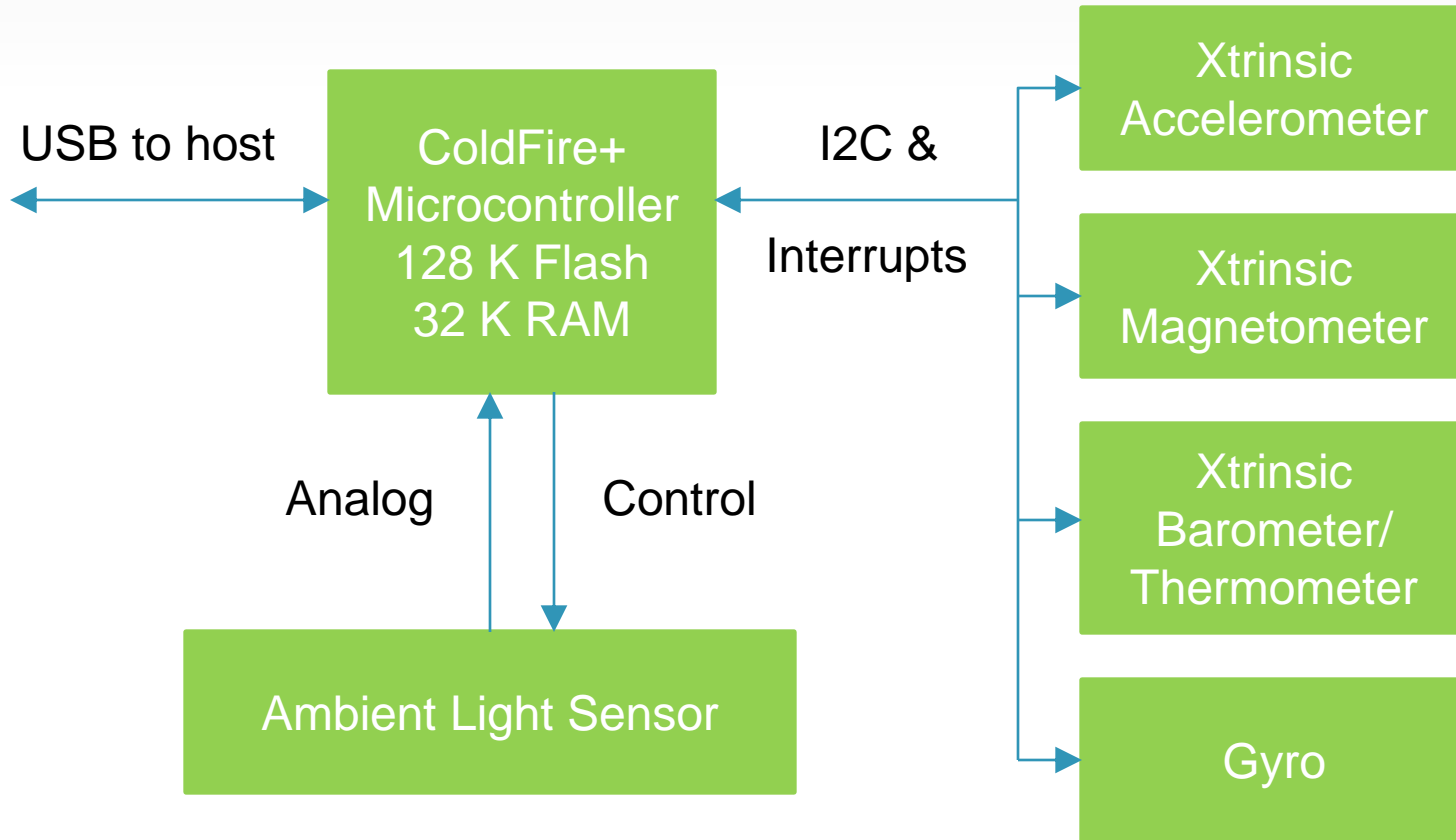
Android App: Xtrinsic Sensor Fusion Toolbox

- Educational variant of tool used internally for algorithm checkout.

- Experiment with various fusion techniques using the sensors already in your Android device

- Available today on Google Play. Search for "Sensor Fusion".

Xtrinsic iSPF
Intelligent Sensor Platform Framework

Differentiating Points

- Industry's First open Intelligent Motion Platform Framework
- Sensor hub capability
- Power management features enabling low power modes

Product Features

- Provides a single unified interface for sensor data regardless of sensor types
- Enables developer to concentrate on using sensor data, not getting sensor data.
- Eliminates intensive sensor integration effort.
- Provides power management of the platform to achieve lowest power mode of operation

Typical Applications

- Mobile: Phones, Tablets, eReaders
- Controllers: Remotes, Game
- Sports Monitoring Performance Monitoring
- Augmented Reality
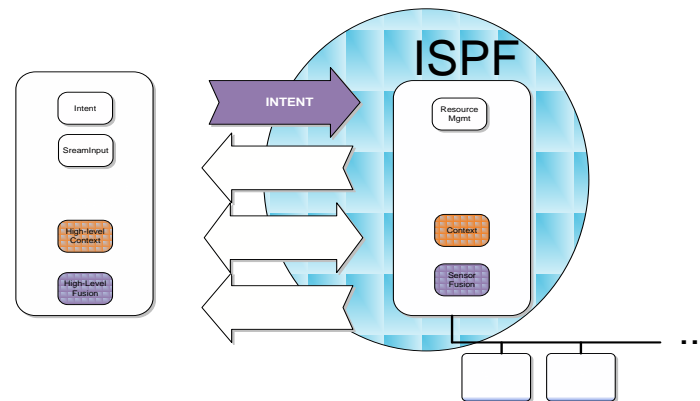
Availability
Download Available: April 2013

Transition to ARM & Freescale Kinetis Family

- Leverage FSL infrastructure - Freedom Board Platform
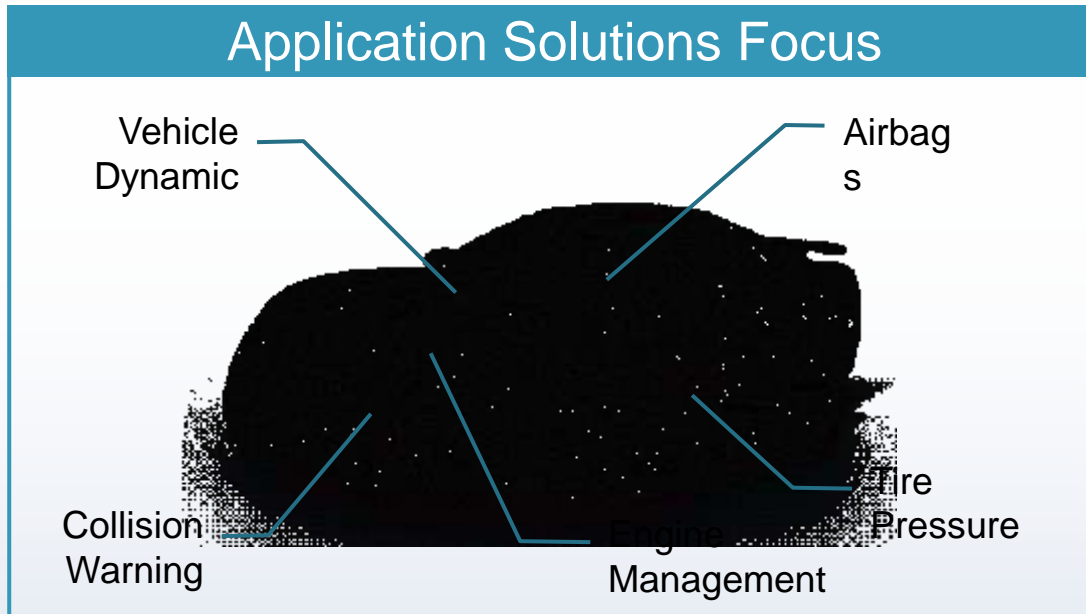- http://www.freescale.com/freedom
- Arduino-compatible form factor

FRDM-KL25Z (available now for $10) includes MMA8451Q on the board.

1st sensor "shield" available May 2013:
- FXAS2100 (Leon) Gyro
- Newton 3-axis accelerometer
- MAG3110 (Maxwell) 3-axis magnetometer
- FXOS8700CQ (Gauss) 6-axis mag + accel
- MMA9553LR1
- MPL3115A2 Pressure Sensor/Altimeter
- Optional Bluetooth Module

Sensor Automotive Market Focus

Automotive targeted Applications

Application Solutions Focus

Vehicle Dynamic — Airbags — Tire Pressure — Engine Management — Collision Warning

- **Inertial Sensors: high g** Accelerometers for Airbag
- **Tire pressure**: 9x9 mm system in package
- **Engine management**: Absolute Pressure sensor

Automotive Inertial Sensor Applications

1 to 20g - X, Z axis

ABS - ESP:
1 to 2g

Electrical Parking Brake: 1 to 2 g

Roll over:
1 to 5 g

Navigation:
1 to 5 g

Tilt monitoring:
1 to 5 g

Suspension Control:
10 to 15 g

20 to 480g - X, Z, XY axis

Crash detection:
20 - 100 g

Side crash detection and motorcycle airbag:
100 - 480 g

Airbag: You can find Freescale Sensors in ...

VW: Golf V, Passat
Opel: Corsa, Astra, Zafira, Insigna
Mercedes: Class A
PSA: C2, C3, C4 Picasso, 207cc
Renault: Logan, Mégane, Scénic
Volvo: C30, S40, S80
Fiat: Panda, Punto
Alfa Romeo: 147, 156
Ferrari: 612
Maserati: GT

And much more on:
 Toyota, Honda, Nissan,
 Chrysler, Ford, GM
 BYD ...

# FSL Sensors in Vehicle Dynamic Control Applications

MMA224xEG:
Low g Sensors for Active Suspension

Electronic Damper Control

- Resolving the conflict between high ride comfort and high driving safety and agility.

- Minimization of wheel load variation and chassis oscillation.

A low g sensor is mounted on each dampers and measures a displacement acceleration. Together with other information, it passes it along to the in-vehicle network. The vehicle's suspension and handling is then automatically adjusted based on this information.
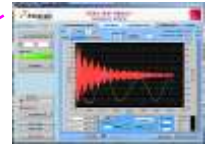
MMA2240/41KEG Features:

- From7g to 10g
- 2 pole filter
- Low voltage detect
- Clock monitor
- EPROM parity check status
- Calibrated Self-test
- SOIC16 package

AEC-Q100 Qualified

Vehicle Stability Control Sensors

- Dual XY axis Sensors with fully digital signal processing:
  - Overdamped Inertial sensing element
  - Digital output (SPI 11-bits)
  - Low offset accuracy over temperature
  - 3.3V or 5V Power Supply
  - Bi-directional Self-test
  - Programmability (filters, ...)
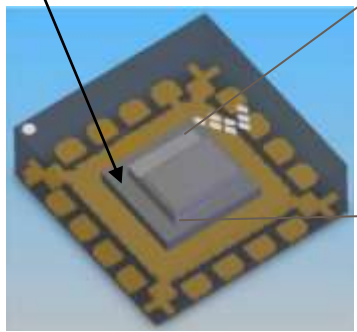

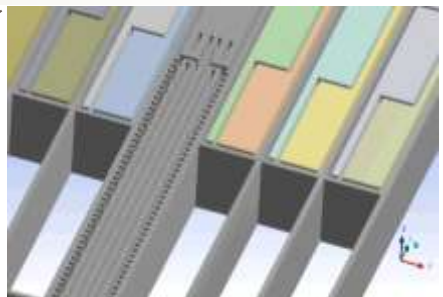
Car with and without VSC

VSC Module

Control ASIC

QFN Package

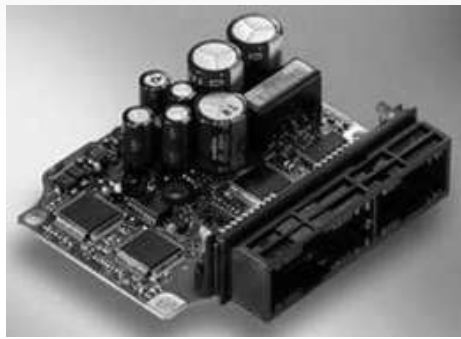High Aspect Ratio MEMS Sensing Element

Part Numbers:
MMA6900KQ ± 3.5g
MMA6910KQ ± 3.5g (Higher Offset Accuracy)
MMA6901KQ ± 5g

SOP: Now

AEC-Q100 Qualified

Latest Generation Main ECU Airbag Sensors

- **Dual XY-axis** Sensors with fully **digital** signal processing:
  - Overdamped inertial sensing element
  - Digital output (10-bits)
  - 3.3 V or 5 V power supply
  - Bi-directional self-test
  - Arming pins
  - Programmability

Airbag Central Module

Front Airbags

Control ASIC
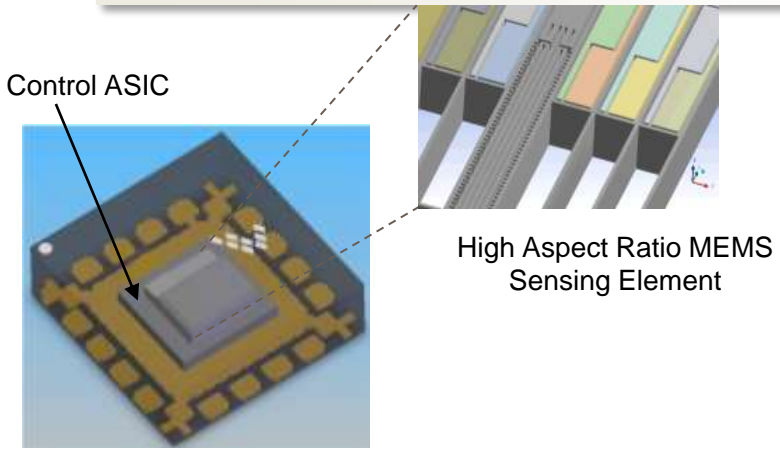
QFN Package

High Aspect Ratio MEMS Sensing Element

X Axis Range	X Axis Part Number	X Axis Range	Y Axis Range	XY Axis Part Number
25g	MMA6851KWR2	60g	25g	MMA6811KWR2
35g	MMA6852KWR2	50g	50g	MMA6813KWR2
50g	MMA6853KWR2	120g	25g	MMA6821KWR2
75g	MMA6854KWR2	120g	60g	MMA6823KWR2
120g	MMA6855KWR2	60g	60g	MMA6826KWR2
60g	MMA6856KWR2	120g	120g	MMA6827KWR2

In production

Remote Monitoring Systems

MPXY8600 Series contains four devices:

- Pressure sensing device (P-Cell)
- Accelerometer device (g-Cell)
- 8-bit microcontroller (MCU)
- RF transmitter device (RFX)

RF transmitter key features :
- 315/434 MHz
- FSK/ASK modulation
- Manchester/bi-phase encoding

"Smart" Sensors:
- MCU + pressure + accel
- Enhanced transfer functions
- Custom solutions

Acceleration sensor
Accelerometer options:
- dual-axis (XZ)
- single-axis (Z)

- Pressure sensor
- Remote Sensors:
  - MCU + pressure + accel +RF
  - Industry standard protocols
  - Low power consumption

RFX	MCU
g-Cell	P-Cell

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Freescale TPMS – MPXY8600 Series

- Pressure sensor
  - CMOS capacitive p-cell with integrated signal conditioning
- Motion detection sensor
  - Integrated XZ accelerometer for motion detection
- Microcontroller
  - 8-bit S08 core
  - 16KB flash (8KB firmware, 8KB customer) 512b RAM, 64 parameter registers
  - 10 bit ADC with 6 channels
  - Temperature sensor and thermal restart
  - LF detector and decoder
  - 2-channel 16-bit timer, pulse width module
  - Up to 8 MHz clock, 1 kHz LFO with wake-up
- RF transmitter
  - Frac-N PLL based transmitter, 315/434 MHz
  - FSK/ASK modulation
  - Manchester or bi-phase encoding
  - -10 dBm to +8 dBm output power
- Package
  - 9x9mm QFN with media protection
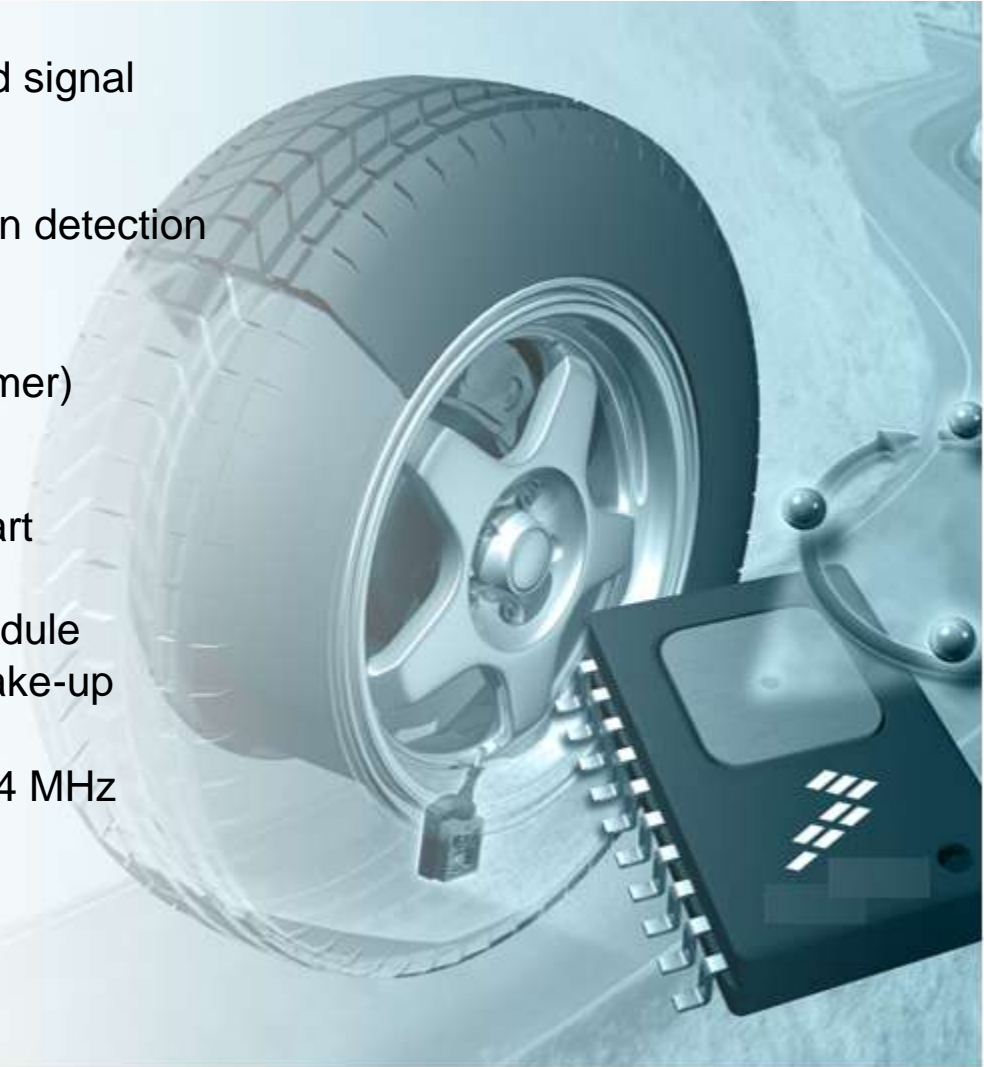
Patient Monitor
病人监护仪

Blood Pressure Monitor Module
MPXM2051 (Measurement)+MPXM2053(Protection)
MPXV5050
CO2 Module
MPXV2010 (Flow measurement)
MPL115A1 (Digital Barometer)

MPXM2051 key Features:

- Pressure range 0~50kPa Gauge
- Temperature Compensated Over 0°C to +85°C
- Linearity: +/- 0.3%
- Full Scale Span: 40 +/- 1.5mV
- Offset: 0+/- 1.0mV
- Available in Easy-to-Use Tape & Reel
- Ratiometric to Supply Voltage
- Gauge Ported

Respirator Machine
呼吸机

Air Flow Measurement
MPX2010
MPXV7002DP
MPXV5004DP
Barometric Measurement
MPXH6115A
MPL115A
MPL3115A

IPS for Respiratory Device:

- Wide product portfolio for different pressure range requirement to cover from negative to positive pressure.

- Low pressure range family (+/- 2kPa, 4kPa, 6kPa, 10kPa) offer design flexibility.

- Easy to implement (no amplifier needed), ideally suited for Microprocessor or Microcontroller-Based Systems

- Barometer to offset altitude influence.

System to support patient breathing during times of diminished lung capacity.

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Sleep Apnea Therapy
睡眠呼吸暂停治疗

Cycle of Obstructive Sleep Apnea

Sleep Onset

Snoring

Airway Collapses

Breathing Stops

Sleep Disrupted
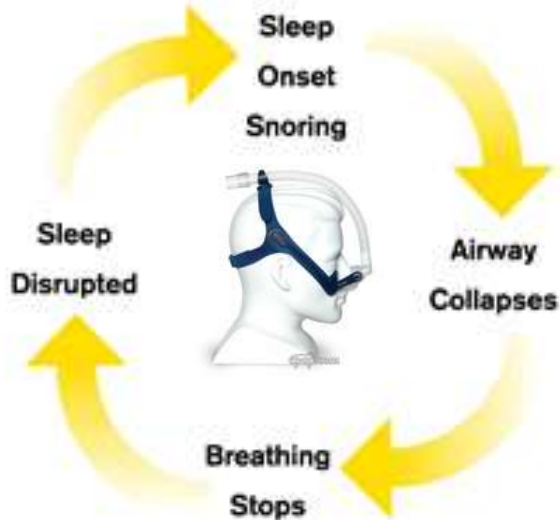
Continuous
Positive
Airway
Pressure
(C.P.A.P.)

Air Pressure Management System
MPXV5004GC6T1
MPXV7002DP

Barometric Measurement
MPL115A
MPL3115A

- Positive Airway Pressure (PAP) is a method of respiratory ventilation used primarily in the treatment of sleep apnea.

- Barometric measurement is also critical in some application to avoid altitude deviation.

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Invasive Blood Pressure
有创血压
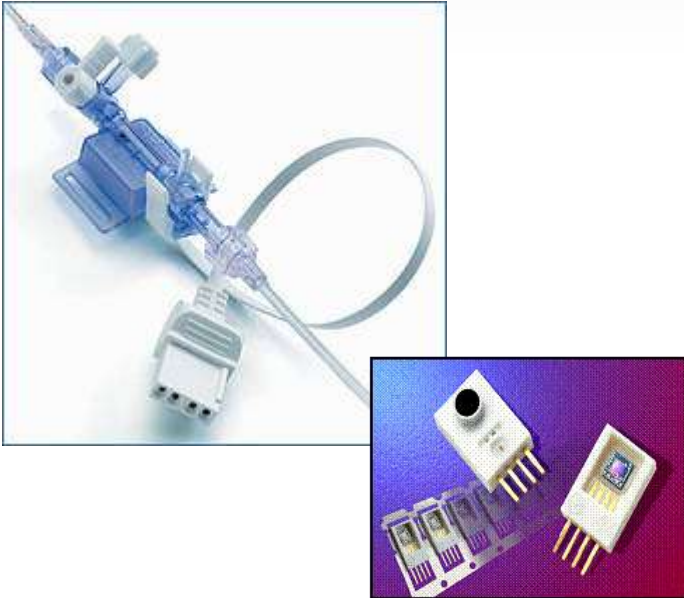
In-line measurement Application:
- Pulse / Pressure measurement.
- IV Drip counting

Disposable Pressure Sensors MPX2300DT

- **Key features:**
  - Pressure range is from 0 to 300mmHg
  - Low cost
  - High volume
  - Miniature package
  - Integrated temperature compensation and calibration
  - Ratiometric to Supply Voltage
  - Polysulfone case material (Medical, Class V Approved)

A standard invasive blood pressure monitoring kits is sterile, single-use kits that relay blood pressure information from a pressure monitoring catheter to a patient monitoring system.

33

Medical Bed / Air Mattress
病床 / 气垫

To avoid necrosis of the muscle and pressure sores ulceration.

Dual-chamber beds only ▶

Application Needs:

- Gage pressure measurement
- Pressure range <10kpa
- Potential for multiple sensors
- Calibrated / Compensated.
- MCU interface capability.

Pressure Control
MPX5010DP
MPXM2010GS

Blood Circulation Therapy
血液循环治疗
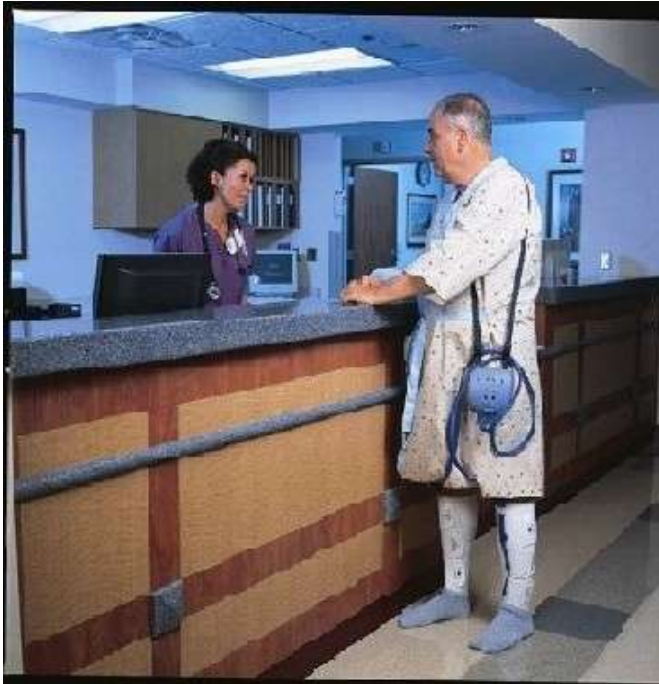
Continuous
Enhanced
Circulation
Therapy
(C.E.C.T.)

Air Pressure Management System
MPX2010
MP3V5010G
MP3V5050G

- The system provides the optimal hemodynamic profile by applying intermittent, sequential **pressure** to the patient's leg in a systematic pattern, increasing the peak venous velocity (PVV) of venous blood flow and reducing the risk of clot formation.

Negative Pressure Wound Therapy
负压创口护理

Negative
Pressure
Wound
Therapy
(N.P.W.T.)

Air Pressure Management System
MPL115A
MPL3115A
MPXM2053GS
MPXV5100GC6U

- Negative Pressure Wound Management, or Closed Wound Suction (CWS) is a noninvasive treatment by which controlled localized **negative pressure** (suction) is delivered to a wide variety of acute, subacute, and chronic wounds.

Blood Pressure Monitors
血压监测仪
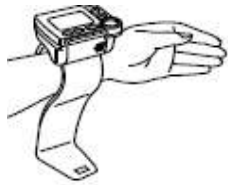
Position cuff on left wrist with left thumb facing upward

Press start button. Position sensor detects correct placement of arm in relation to the heart.

Once wrist is in the correct position the cuff will inflate and take the measurements.

Reading is displayed on the LCD screen

Bluetooth Radio

Voltage Regulation

Power Source

Display

MCU

Tilt Sensor (Accelerometer)

Keypad

Pressure Sensor

Motor

Motor Control

Bleed Valve

Valve Control

Optional Modules
Sensors
Analog
Peripherals
MCU
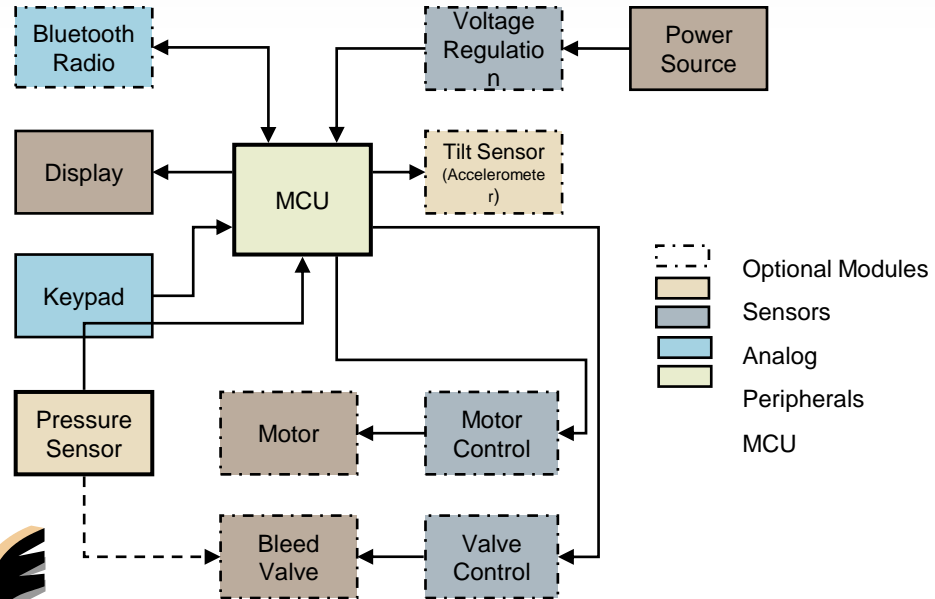
Pressure Monitoring
MPXV5050GP
MPXM2053GS

Water Level Monitor
水位监测
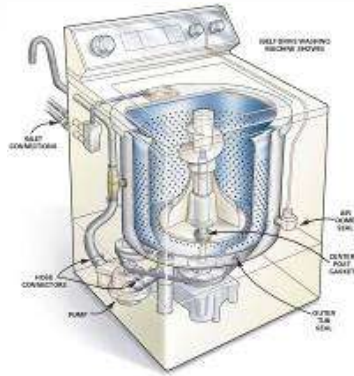
Washing Machine:
- Tub Water Level Monitoring (up to ~100cm)
- Smart Washer Functions
- Blend Sensing
- Water Conservation

Dishwasher:
- Basin water level monitoring
- Water Filter monitoring
- Countdown to Cycle completion
- Water Conservation

Gauge Pressure Sensor: MPX10/12, MPX2010, MPXV4006G, MPXV5004G, MPXV5010G

Water Level Monitor
水位监测

Calculation:

$$Pout = P1 - Atm$$

Where:

$$P1 = Plevel + Atm$$

Result:

$$Pout = Plevel$$

h = Pout / (r * g)

r = density
g = gravity constant
h = liquid height
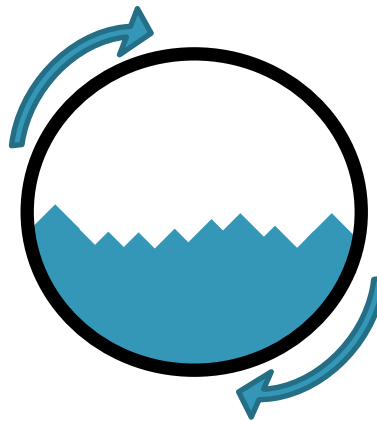
Atmospheric pressure (Atm)

Pressure Sensor

MPVZ4006G

Tubing

Tank

Air Column (P1)

Water Level (Plevel)

40cmH2O ~ 4kPa

What is the most probable reason for this stop in the middle of the desert?

- **Most probably a battery failure !!**

- **Battery field failure rates are ranging from 1000 to >10000 ppm for Batteries older 3+ years !**

Summary MM912J637 - Intelligent 12V Car Battery

Primary Application: 12V Car Battery Monitoring

Determination of key battery characteristics:
State of Health (SoH)
State of Charge (SoC)
State of Function (SoF)

requires
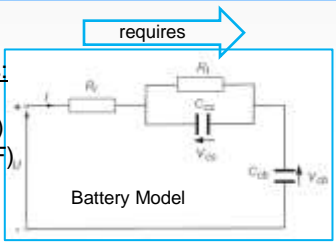
Precision Measurement of Battery Current, Voltage & Temperature

Battery Model

Battery Plus Pole
Battery Minus Pole

R_{SENSE}
C_{BAT}
R_{SHUNT}
ISENSEL
ISENSEH
VSENSE
GND
ISNA
LIN
LIN
C_{LIN}
Chassis Ground
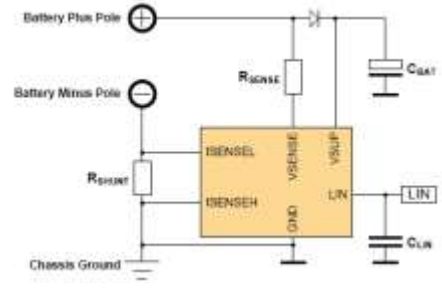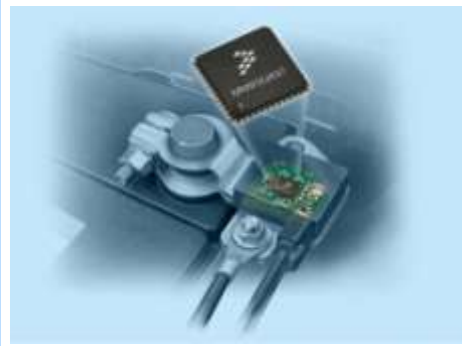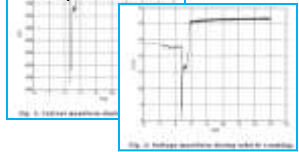
MM912J637 – Key Characteristics

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

Mixed-Signal Chip
- LIN Physical Layer (ESD 15kV w/o cap- 25kV w/ cap)
- Watchdog
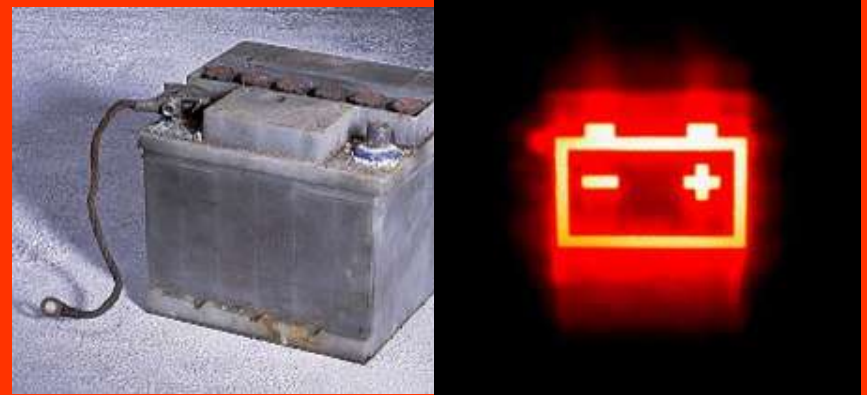- Standby Current <100µA (1sec Isense)
- Operating Voltage 3.5..28V
- RAM Contents Guaranteed :2.5...3.5V
- 3x ADC (2nd Order Sigma Delta) 16bit
- Current Measurement
  - Relative Accuracy <0.5%
  - Absolute Accuracy <500nV
- Voltage Measurement
  - Relative Accuracy <1%
  - Absolute Accuracy <5mV
- Temperature Measurement
  - Relative Accuracy <2K
  - Absolute Accuracy <0.5K

Operating Temperature -40°C<Ta<125°C

Product Demonstrator Available
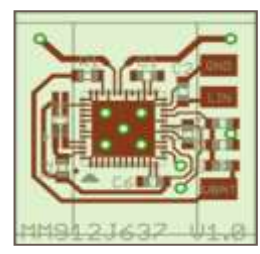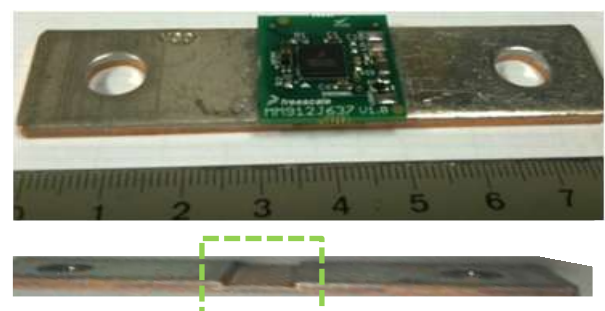
Shunt Resistor

EVB Available

MM9Z1_638 Device Detail
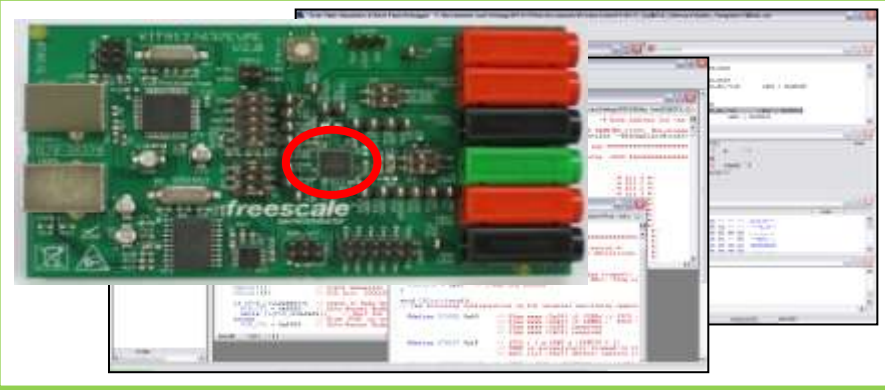
Key Characteristics

MCU S12Z Core (32-bit ALU, 50MHz)
Flash   96k/128k
EEPROM   4k
RAM   8k
CAN controller

Analog Mixed-Signal Chip
LIN Physical Layer
Watchdog
Standby Current <100µA (1sec Isense)
Vreg capability of 150mA
Operating Voltage 3.5..28V
RAM Contents Guaranteed :2.5...3.5V
3x ADC (2nd Order Sigma Delta) 16bit

Current Measurement
        Relative Accuracy <0.5%

Voltage Measurement
        Four attenuated Voltage inputs (10V, 16V, 28V, 52V ranges)
        Up to five non-attenuated Voltage inputs
        Relative Accuracy <0.15%

Temperature Measurement
        One internal and up to five external Temp inputs
        Relative Accuracy   <2K

Operating Temperature   -40°C<Ta<125°C

System-In-Package Wiring Diagram
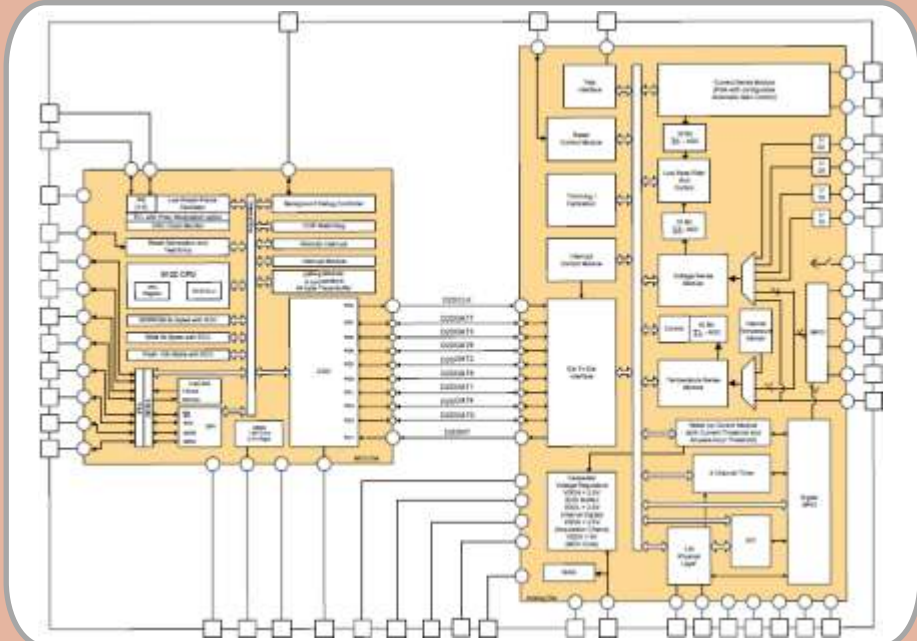
Package: QFN with wet-able flanks
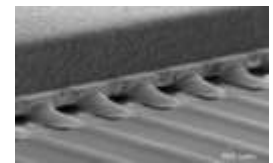
Enables more cost effective (optical) inspection of QFN package soldering at customer assembly, avoiding expensive X-ray inspection.

Freescale SBC segmentation
Different standard Solutions for different system needs

Physical Layer
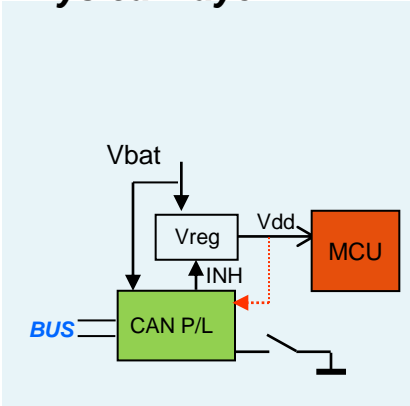
entrySBCs
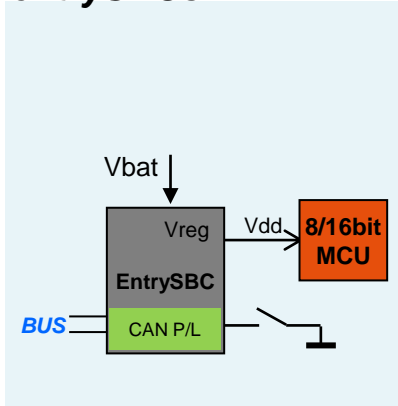
SBCs

PowerSBCs

Values
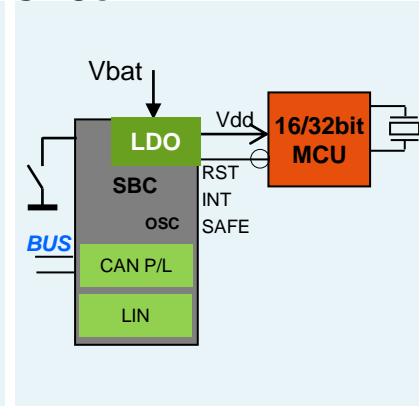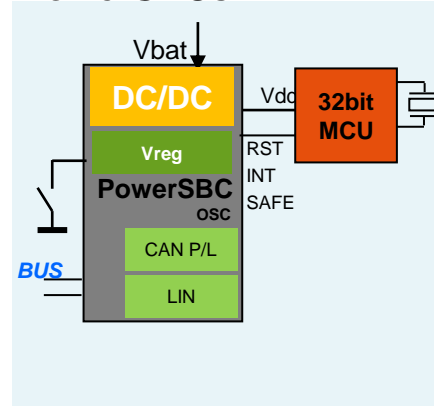
Physical Layer	entrySBCs	SBCs	PowerSBCs
High Robustness EMC/ESD	**Simple Low Power Modes**	**Ultra Low Power Modes**	**Energy efficient (>85%)**
Design for Cost	**Robustness**	**Flexible Power Management**	**High Current (up to 2.0A)**
CAN Partial Networking *Selective Wake up*	**Design for Cost**	**Medium Functional Safety**	**High Functional Safety** *(fit for ASILD applications)*

PowerSBC : Architecture overview

PowerSBC05/10/20 – MC33906/7/8

Voltage Supervisor

Boost Driver	**Vcore 2.4MHz 0.9 to 5.0V configurable**
Vpre 440kHz Buck	VI/O - 3.3 / 5.0V
Battery sense	Vaux 1,8V / 3.3 / 5.0V
	Vcan - 5.0V

Flexible Energy Management to supply 32bit MCUs

Various Wake Up :
- I/Os,
- CAN, LIN

Robust InVehicle Network Communication

Configurable I/Os (6)

Fail Safe Inputs

Analog & Digital BIST

CAN Physical Layer

LIN Physical Layer

Energy Management State Machine

INT

SecuredSPI

Fail Safe State Machine

RST

MCU Challenger

Analog Multiplexer

2.5 V Ref.

Temp.

Fail Safe Inputs

Fail Safe Output Static&Dynamic

Going Green
Ultra Low Power Modes - 25µA

Safety
Independant Fail Safe State Machine

System Basis Chip & Physical Layers Roadmap

Features

PowerSBCs
DC/DC architecture
Low Power Modes
Advanced Functional
Safety (ISO26262)
CAN HS & LIN P/Ls
Target 32bit MCUs

Pin Compatible Families

MC33908 – PowerSBC20

MC33907 – PowerSBC10

MC33906 – PowerSBC05

MC33909 – CANopy LV
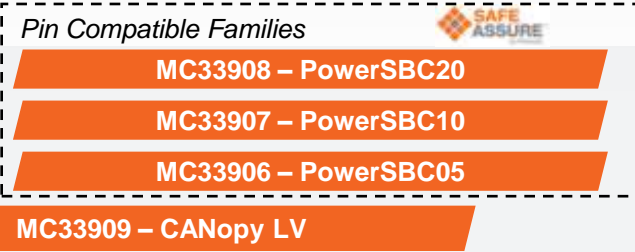
SBCs
LDO architecture
Ultra Low Power Modes
Fail Safe features
CAN & LIN P/Ls
Target 16/32bits MCUs

MC33905

MC33904

MC33903

entrySBCs
LDO architecture
Low Power Modes
Simple Safe modes
CAN OR LIN P/Ls
Target 8/16bits MCUs

MC33912

MC33911

MC33910
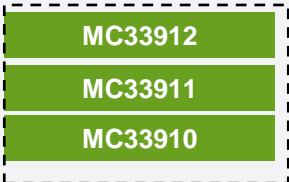
Physical Layers
Stand alone P/Ls
High performance
EMC/ESD

MC33663 – Dual LIN

MC33662

Proposal

Planning

Execution
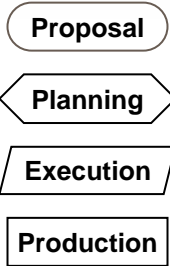
Production

First
Sample
Date (left edge)

Product
Qualification
(right edge)

2011				2012				2013				2014			
1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q

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Freecale SBC solutions – Features Table Overview

Part Number	33903	33903P	33903S	33903D	33904	33905S	33905D
Pin to Pin Compatibility	33904 33905S 33905D	33903S 33903D	33903P 33903D	33903P 33903S	33903 33905S 33905D	33903 33904 33905D	33903 33904 33905S
Product Status	PPAP	PPAP	PPAP	PPAP	PPAP	PPAP	PPAP
V_{MCU} (Vdd)	5.0V/3.3V 100mA +/-2%	5.0V/3.3V 150mA +/-2%	5.0V/3.3V 150mA +/-2%	5.0V/3.3V 150mA +/-2%	5.0V/3.3V 150mA +/-2%	5.0V/3.3V 150mA +/-2%	5.0V/3.3V 150mA +/-2%
V_{MCU} Pw Sharing	-	+300mA	+300mA	+300mA	+300mA	+300mA	+300mA
Vaux (ext ballast)	-	-	-	-	5.0/3.3V	5.0/3.3V	5.0/3.3V
Vcan	5V/100mA	5V/100mA	5V/100mA	5V/100mA	5V/100mA	5V/100mA	5V/100mA
CAN HS P/L	1	1	1	1	1	1	1
LIN2.1 / J2602 P/L	-	-	1	2	-	1	2
I/Os	1	3	3	3	4	4	4
LowQ Voff/Von	15/25 µA	15/25 µA	15/25 µA	15/25 µA	15/25 µA	15/25 µA	15/25 µA
Battery sense	-	Yes	Yes	Yes	Yes	Yes	Yes
AMUX	-	Yes	Yes	Yes	Yes	Yes	Yes
Fail Safe	-	Yes	Yes	Yes	Yes	Yes	Yes
Watch Dog	Yes / Adv	Yes / Adv	Yes / Adv	Yes / Adv	Yes / Adv	Yes / Adv	Yes / Adv
SPI	16b / Safe	16b / Safe	16b / Safe	16b / Safe	16b / Safe	16b / Safe	16b / Safe
Package	SOIC32eP	SOIC32eP	SOIC32eP	SOIC32eP	SOIC32eP	SOIC32eP	SOIC54eP
Attach strategy MCU Supply	SO8 S12XS / XE MPC5604B LE	S12XE MPC5604B / P MPC5634M	S12XE MPC5604B / P MPC5634M	S12XE MPC5604B / P MPC5634M	S12XE MPC5604B / P MPC5634M	S12XE MPC5604B / P MPC5634M	S12XE MPC5604B / P MPC5634M

ECU and PowerSBC connection

Vcore

Reset

Fail safe outputs

FCCU monitoring
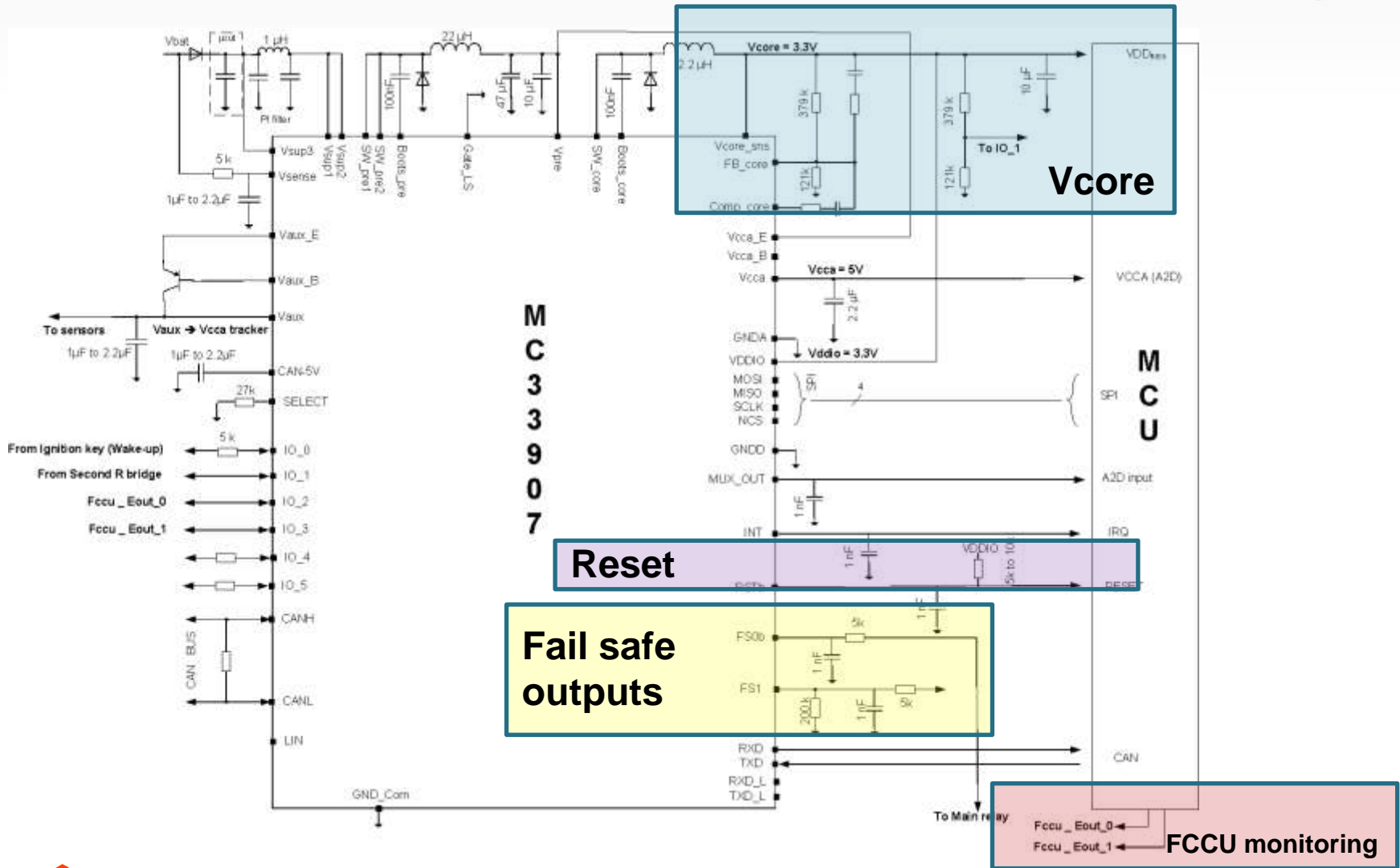
Freescale PowerSBC solutions – Features Table Overview

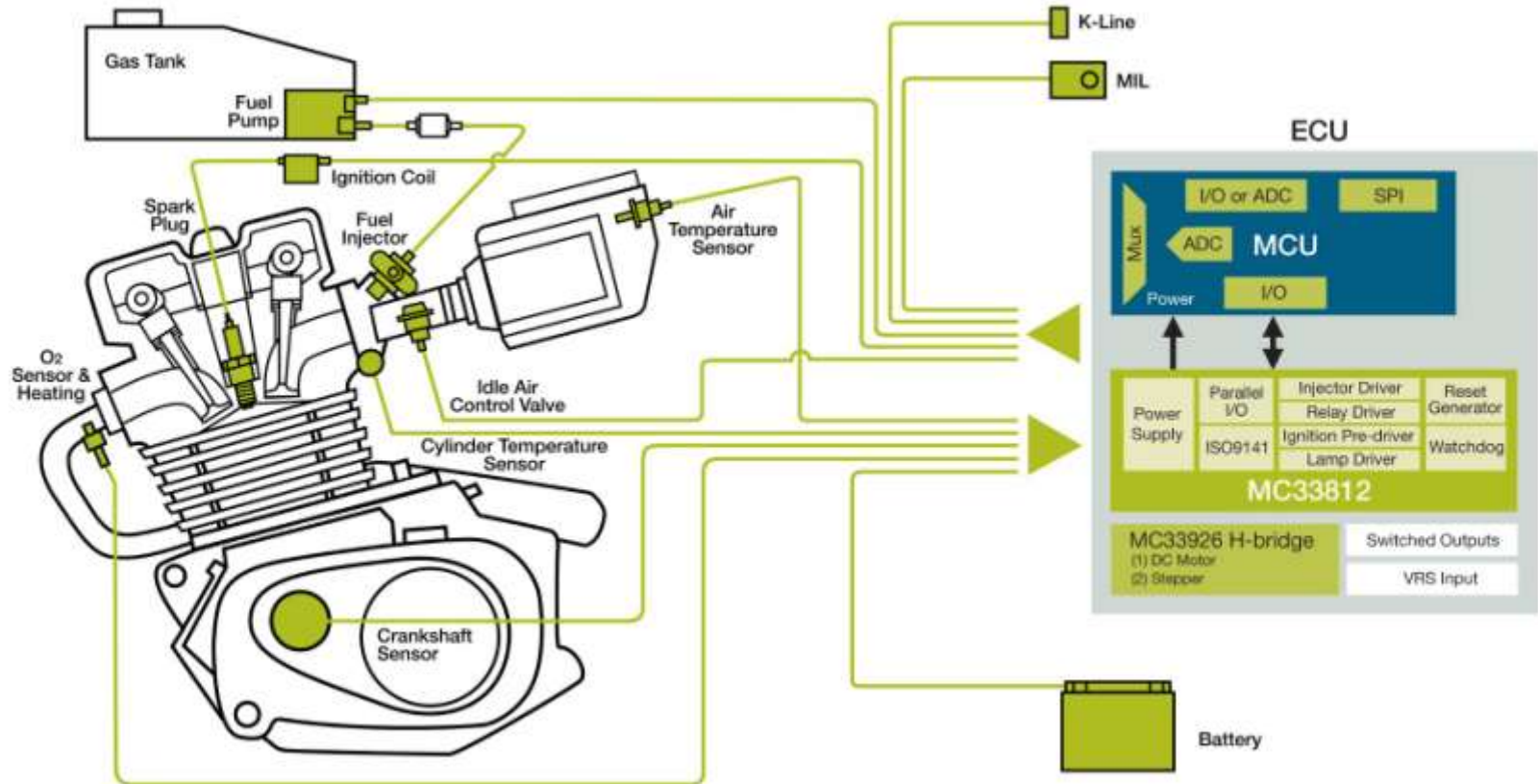| Part Number	MC33909 CANopy	MC33906 PowerSBC05	MC33907 PowerSBC10	MC33908 PowerSBC20
Product Status	1st Silicon available	1st Silicon Dec 11	1st Silicon Dec 11	1st Silicon Dec 11
Pre-regulator 5%	1.0A (B-B_440kHz)	1.0A (B-B_440kHz)	1.5A (B-B_440kHz)	2A (B-B_440kHz)
MCU core supply VCore / 2%	0.5A (Linear)	0.5A (Linear)	0.8A (B_2.4MHz)	1.5A (B_2.4MHz)
MCU I/O / ATD supply VCCA /1%	No	No	100 mA (int) +/-1% Or 300mA (ext.) +/-3%	100 mA (int) +/-1% Or 300mA (ext.) +/-3%
Auxiliary ECU supply Vaux / 3%	200mA (Tracker)	*Up to 300 mA Tracker / Auxiliary*	*Up to 300 mA Tracker / Auxiliary*	*Up to 300 mA Tracker / Auxiliary*
Can_5V Supply -- VCAN	200mA	100mA	100mA	100mA
CAN Interfaces	2	1	1	1
LIN Interfaces	4	1	1	1
IOs	16	6 (incl. F/S inputs)	6 (incl. F/S inputs)	6 (incl. F/S inputs)
Watchdog	Timeout, window, random configurable	Challenger	Challenger	Challenger
LowQ Voff/Von	50μA	25μA	25μA	25μA
AMUX & Battery Sense	Yes	Yes	Yes	Yes
Fail Safe	Output (Static/Dynamic)	Independant I&O	Independant I&O	Independant I&O
Package	LQFP64eP	LQFP48eP	LQFP48eP	LQFP48eP
Target Market	BCM, HVAC	BCM HE, Transmission, HVAC, Dashboards	EPS, Radar, Battery Mgt, Gateway	Radar, Vision/ADAS, Engine Management,
FSL MCU Companion (90nm)	MPC560xB	MPC560xB, MPC563xM MPC560xP,MPC560xS	MPC564xL, MPC564xA, MPC5668G, MPC564xS	MPC567xK, MPC567xF, MPC577xR
Target MCU companion (55nm) precise assessment following Silicon availability	Calypso, Bolero	K2, Calypso	Mc Kinley, Panther	MatterHorn, Racerunner

Small Engine Control Integration

MC33812 (Sea Breeze) One Cylinder

O2 sensor

Sidestand

Manifold pressure

Accelerator Position

Inlet Air Temp

Tilt

Engine Temp

Clutch

Diag/Clustr

Smart MOS 8MV

ADC

Timers   CAN

SCI   **MCU**

INTR.   **S12P**

ISO9141

Reset   **Power**   SPI   I/O

Watchdog

+5V

+5 V Regulator

Parallel

Injector   **2A**   **Fuel Injector**

Relay   **2A**   **Relay**

Ignition   **IGBT or Darlington coil driver**

Lamp   **.5A**   **MIL Lamp**

MC33812 (Sea Breeze)

Available today !

freescale™
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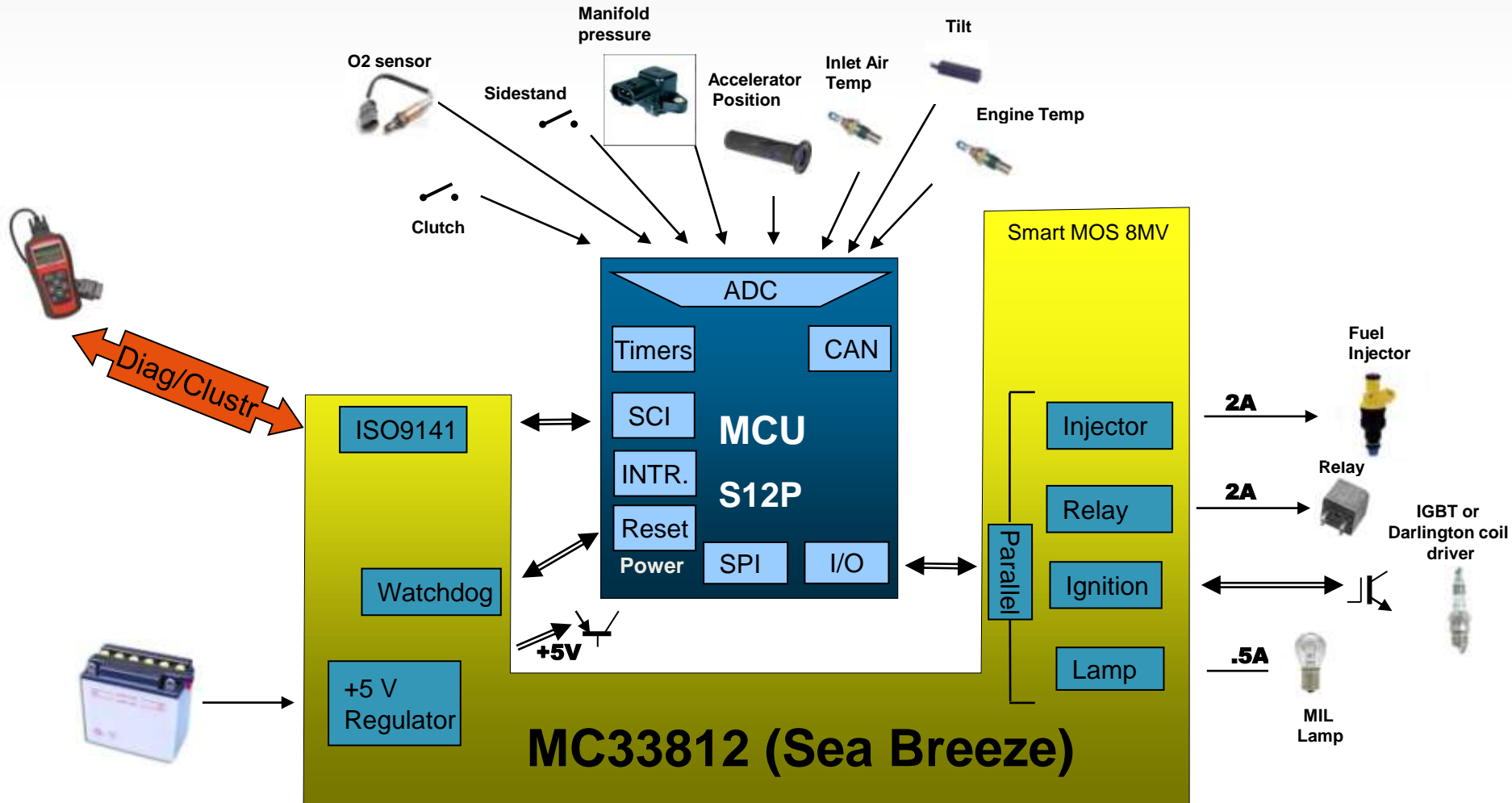
S12P96/128 S12XS128 & MC33812 SiP Packaging

S9S12P96/128
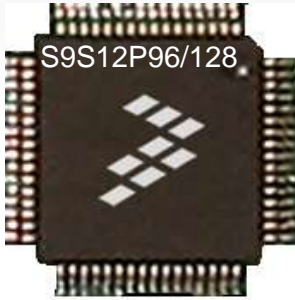
12 X 12 mm
64 Lead LQFP

MC33812

10.3 X 11 mm
32 Lead SOICW-EP

Samples Available Now !

16 X 16 mm
100 Lead LQFP

S12P/MC33812
SiP
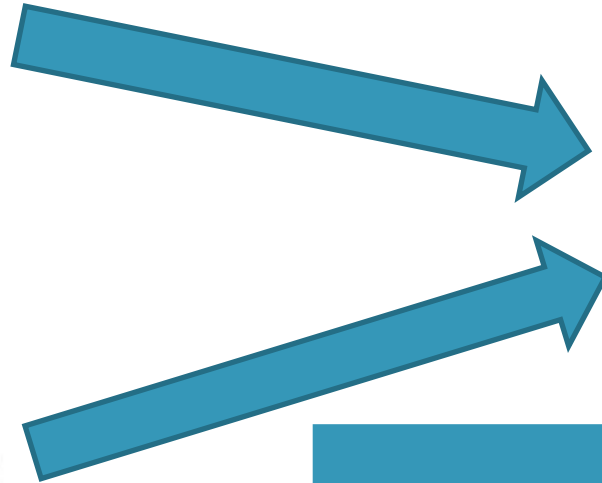
	Two Chip	One Chip
Board Area	271.2 mm^2	256.0 mm^2
Leads	96	100
Security	No	Yes
Cost	More	Less

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(MC33813) Sea Zephyr One Cylinder
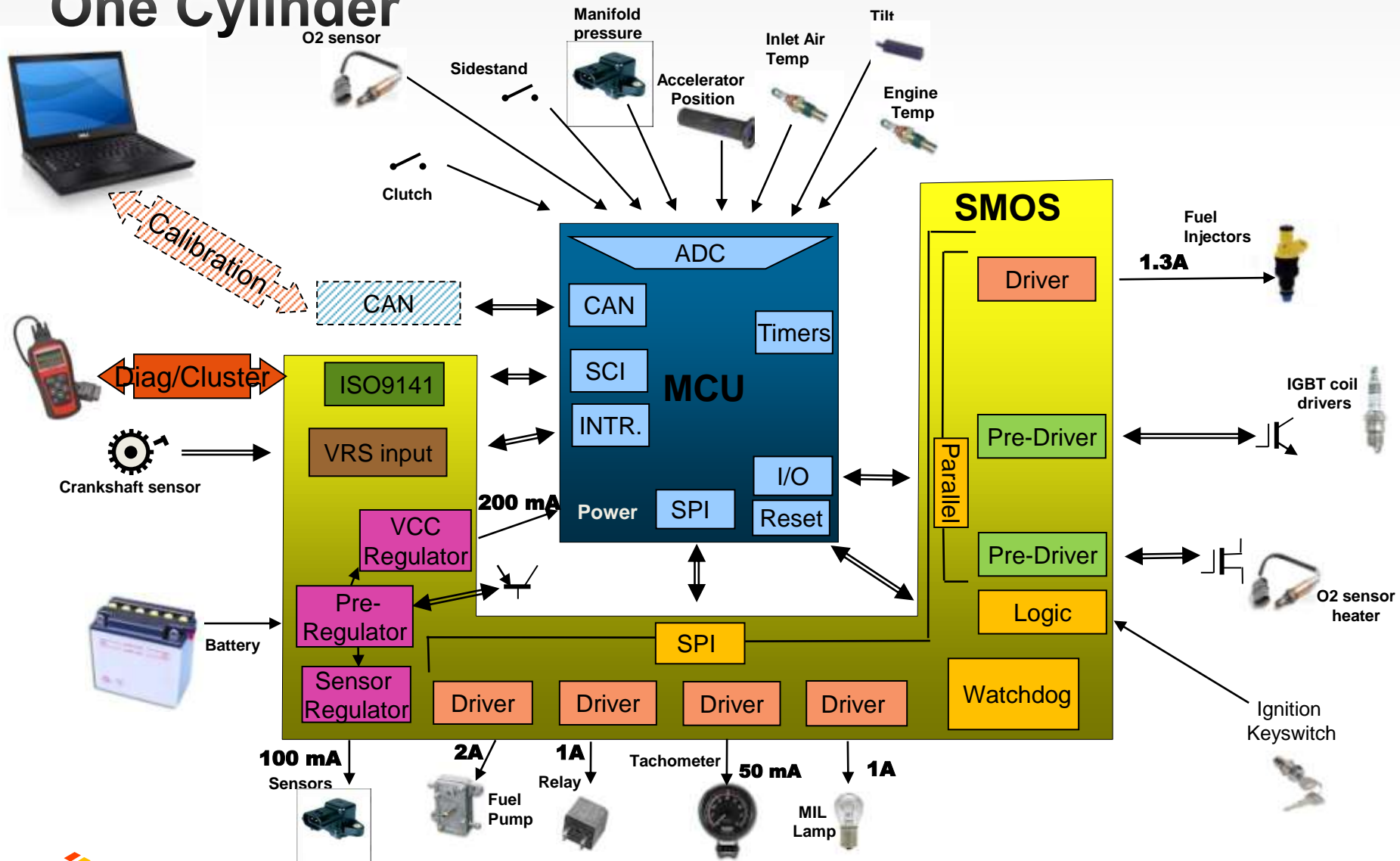
(MC33814) Sea Gust Two Cylinder

Tilt

O2 sensor

Sidestand

Manifold pressure

Inlet Air Temp

Accelerator Position

Engine Temp

Clutch

Calibration

CAN

Diag/Cluster

ISO9141

VRS input

Crankshaft sensor

VCC Regulator

200 mA

Pre-Regulator

Battery

Sensor Regulator

100 mA

Sensors

MCU
- ADC
- CAN
- SCI
- INTR.
- Timers
- I/O
- SPI
- Reset
- Power

SMOS
- Driver — 1.3A — Fuel Injectors
- Driver — 1.3A
- Pre-Driver — IGBT coil drivers
- Pre-Driver
- Pre-Driver — O2 sensor heater
- Logic
- Watchdog
- Parallel

SPI

Driver — 2A — Fuel Pump

Driver — 1A — Relay

Driver — Tachometer

Driver — 50 mA — MIL Lamp

1A

Ignition Keyswitch

53

Freescale eXtremeSwitch:
much more than a Switch

- Example: MC10XS3435 GEN3 FEATURE List
  - Four protected 10 mΩ and 35 mΩ high side switches
  - Operating voltage range of 6.0V to 20V - extended mode from 4.0V to 28V
  - Ultra low standby current < 5.0 µA
  - 8 MHz 16-bit 3.3V and 5V SPI control and status reporting with daisy chain capability
  - PWM module using external clock or internal oscillator with programmable outputs delay management (MCU off load)
  - Protection Features: smart over-current shutdown, severe short-circuit, over-temperature protections with programmable # of auto-retry and fail-safe mode in case of MCU damage
  - Load type detection (bulb / LED) during OFF and ON states – Load failure diagnostic for bulb and LED
  - Short-to-battery detection
  - Analog current feedback with selectable ratio
  - PCB Temperature sensing

MC10XS3435 Simplified Application Diagram
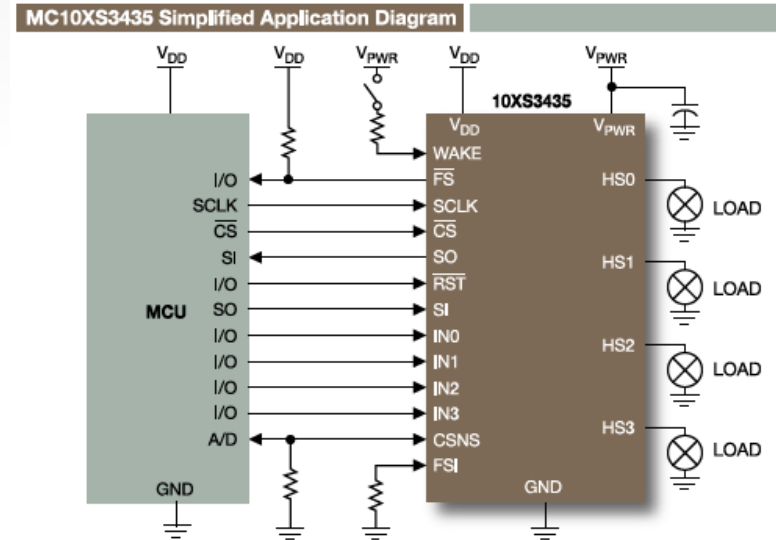
eXamples

Application	Loads
Lighting	Halogen & incandescent lamps, LEDs, Xenon HID, …
DC motor	Fuel pump, wiper, fan, …
Solenoid	Xenon shutter, relay coil…
Resistor	0² heater, seat heater, …
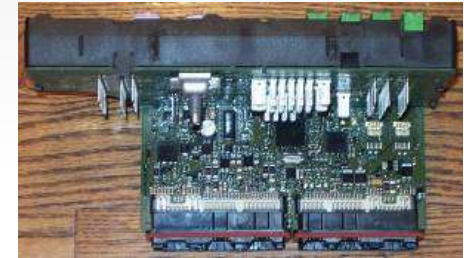
Fuse Box (Gen2)

Body / lighting (Gen3)


24V app SPDxx

Fuel Pump (Viper)

Part Number	Number of Outputs and On-Resistance	Over Current Protection Window Type See Below	Nickname	Package	System Voltage	Datasheet Status	Sample Date	Qualification Date	Evaluation Board
MC10XS3412D	Dual 10mΩ, Dual 12mΩ	Static	SPQ1012	24-pin PQFN	12V	final	in production	qualified	yes
MC10XS3435D	Dual 10m Ω, Dual 35mΩ	Static	SPQ1035	24-pin PQFN	12V	final	in production	qualified	yes
MC15XS3400D	Quad 15mΩ	Static	SPQ15	24-pin PQFN	12V	final	in production	qualified	yes
MC35XS3400D	Quad 35mΩ	Static	SPQ35	24-pin PQFN	12V	final	in production	qualified	yes
MC10XS3535	Triple 10mΩ, Dual 35mΩ	Static	SPP1035	24-pin PQFN	12V	final	in production	qualified	yes
MC35XS3500	Penta 35mΩ	Static	SPP35	24-pin PQFN	12V	final	in production	qualified	yes
MC10XS3425	Dual 10mΩ, Dual 25mΩ	Static	SPQL1025	**32-pin SOICEP**	12V	preliminary	Sept-11	Dec-12	Mar-12
MC09XS3400	Quad 9mΩ	Static	SPQL09	24-pin PQFN	12V	preliminary	Aug-11	qualified	yes
MC07XS3200	Dual 7mΩ	Static	SPDL07	**32-pin SOICEP**	12V	preliminary	Sept-11	Dec -12	Mar-12
MC06XS3517	Triple 6mΩ, Dual 17mΩ	Static	SPPL0617	24-pin PQFN	12V	preliminary	Aug-11	qualified	yes
MC06XS4200	Dual 6mΩ for trucks	Static/Dynamic	SPD6_24	24-pin PQFN	**24V**	preliminary	now	Sep-12	yes
MC10XS4200	Dual 10mΩ for trucks	Static/Dynamic	SPD10_24	24-pin PQFN	**24V**	preliminary	now	qualified	yes
MC20XS4200	Dual 20mΩ for trucks	Static/Dynamic	SPD20_24	24-pin PQFN	**24V**	preliminary	now	qualified	yes
MC33981B	Single 4mΩ, 60KHz	Motor control	Viper	16-pin PQFN	12V	final	in production	qualified	yes
MC33982C	Single 2mΩ	Dynamic	SPSS+	16-pin PQFN	12V	final	in production	qualified	yes
MC33984C	Dual 4mΩ	Dynamic	SPD4+	16-pin PQFN	12V	final	in production	qualified	yes
MC33988C	Dual 8mΩ	Dynamic	SPD8+	16-pin PQFN	12V	final	in production	qualified	yes
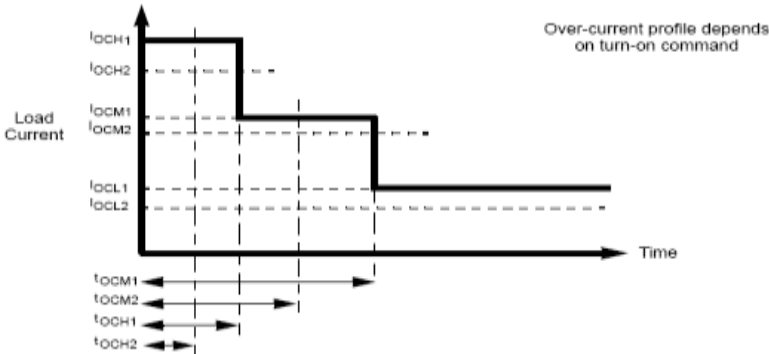
Over Current Protection Window Type -Static multi-stage over current protection
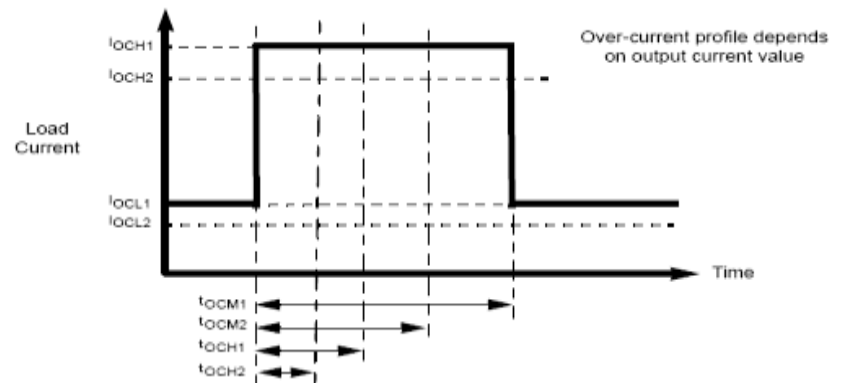
Over Current Protection Window Type-Dynamic over current protection window