Xtrinsic MAG3110 Magnetometer

Highest resolution, lowest noise in very small package

Sensor and Actuator Products

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Over **One Billion** Freescale MEMS Devices Shipped

100 Million

200 Million

400 Million

800 Million

1 Billion Units Shipped

1992

Dedicated supplier to the critical care medical market through shipment of over 60 million units for the invasive blood pressure market

Late 1980's

Freescale begins developing the first surface micro-machined inertial sensors for the automotive airbag market

1980

We manufacture our first uncompensated pressure sensor

Early 2000s

Inertial sensor portfolio expands with X-, XY- and Z-axis low-g products for the consumer market

Nov. 2008

Synerject announces its ongoing use of Freescale pressure sensors for robust, cost-effective ECUs for two- and four-stroke engine management

April 2009

MMA7660FC Intelligent 3-axis digital accelerometer introduced for advanced mobile phone interfaces

30 Years of Commercial MEMS Design and Production Expertise

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*iSuppli 2011 Xtrinsic

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MEMS Are Becoming Pervasive In Our Daily Life

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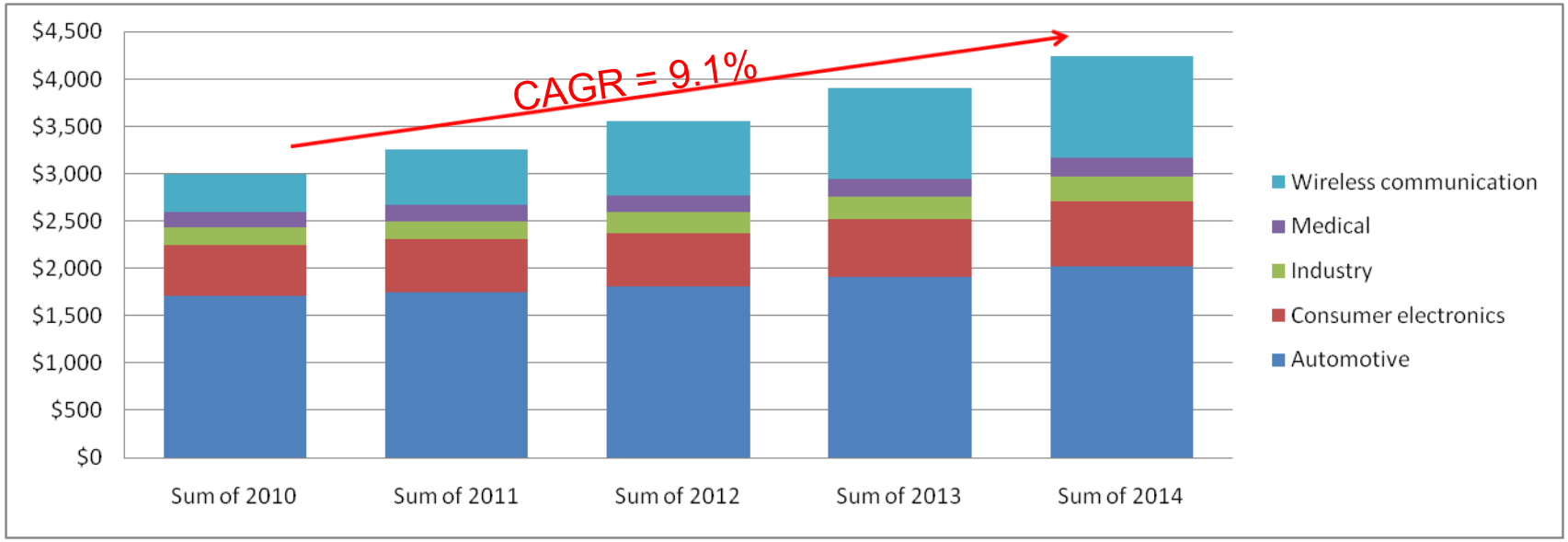
MEMS Forecast by Application (US$M)



Source: iSupply MEMS H2 2010 Market Tracker

MEMs: Micro-electromechanical systems (MEMS) are Freescale's enabling technology for acceleration and pressure sensors. MEMSbased sensor products provide an interface that can sense, process and/or control the surrounding environment.

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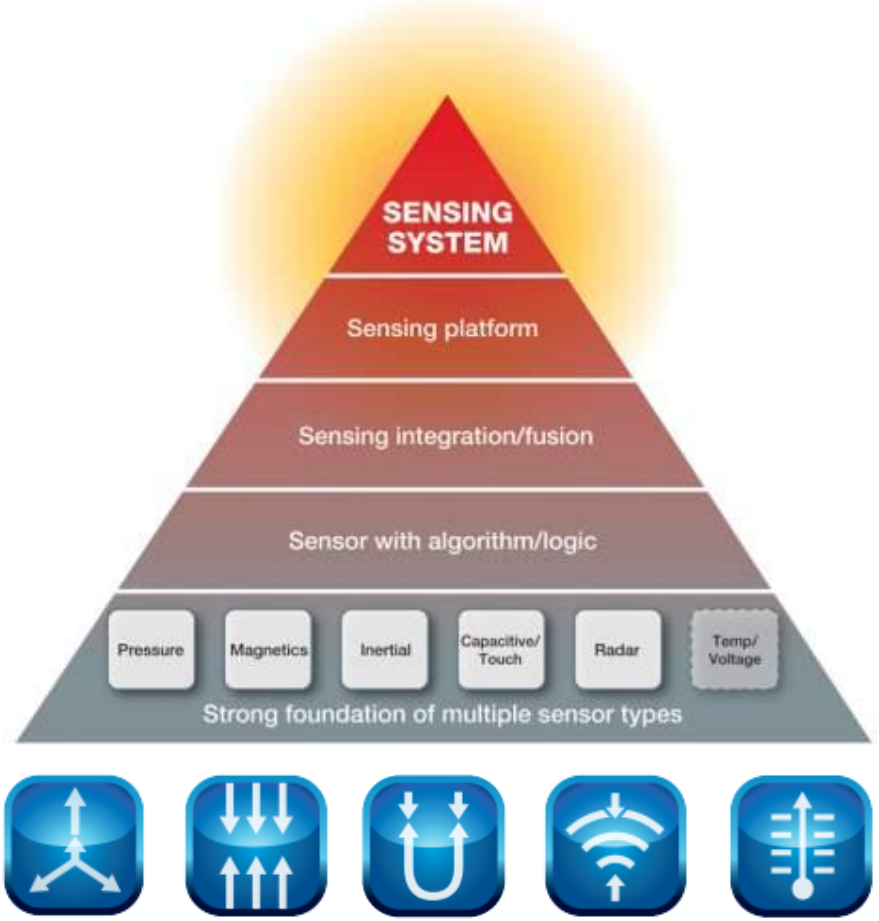
Freescale's New Era of Xtrinsic Sensing

Intelligent Contextual Sensing – *more than translating a signal*

Freescale Xtrinsic sensing solutions offer increased levels of modular integration combined with multiple sensor inputs, logic and other building blocks to bring greater value and decision making to the overall sensing solution.

Xtrinsic Sensing Solutions

- **Increasing levels of intelligence**
  - Decision making
  - Software enablement
  - Programmability
  - Applications
  - Third-party software
- **Increasing levels of integration**
  - Sensor fusion
  - Non-volatile storage
  - Connectivity
  - Power management
  - Logic
  - Actuation



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Xtrinsic Sensor Key Messages

Freescale is defining a new era of sensing experience

Our Xtrinsic sensors offer the right combination of intelligent integration, logic and customizable software to help you deliver smarter, more differentiated applications

Contextual Sensing

- Contextual sensing is more than a sensor translating a signal—it's extracting the maximum context from your environment to help make intelligent decisions

Intelligent Integration

- Increasing levels of modular integration combine with multiple sensor inputs, logic and other building blocks to bring greater value and decision making to the overall sensing solution

Customizable Software

- Freescale Xtrinsic sensors feature customizable hardware and software modules that allow you to design exactly what you *want* and *need* the application to be

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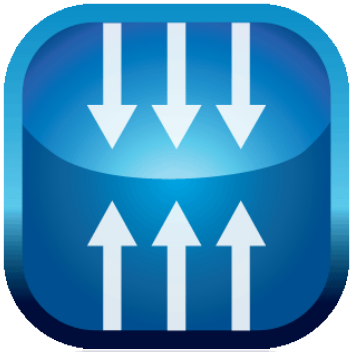
Freescale Offers a Full Portfolio of MEMS & Sensors

eCompass

Magnetometers

Accelerometers



Touch Sensors

Gyro(2012)

Altimeter / Pressure

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Market Challenges for Mobile Industry

- Embedded developers increasingly tasked to design for location based services (LBS) using various sensor products
- Increased demands for high accuracy, performance and functionality
- More affordable solutions through reuse of existing or low-cost technologies in mobile devices
- Richer context awareness involving more sensors
- More intuitive and improved user interfaces
- LBS provides a host of capabilities that consumers find desirable, including local navigation and smart mapping, shopping aids, entertainment and information of the immediate surrounding area

Freescale is shifting sensor product mix to novel MEMS and micro-magnetic devices to serve key consumer sensor segments

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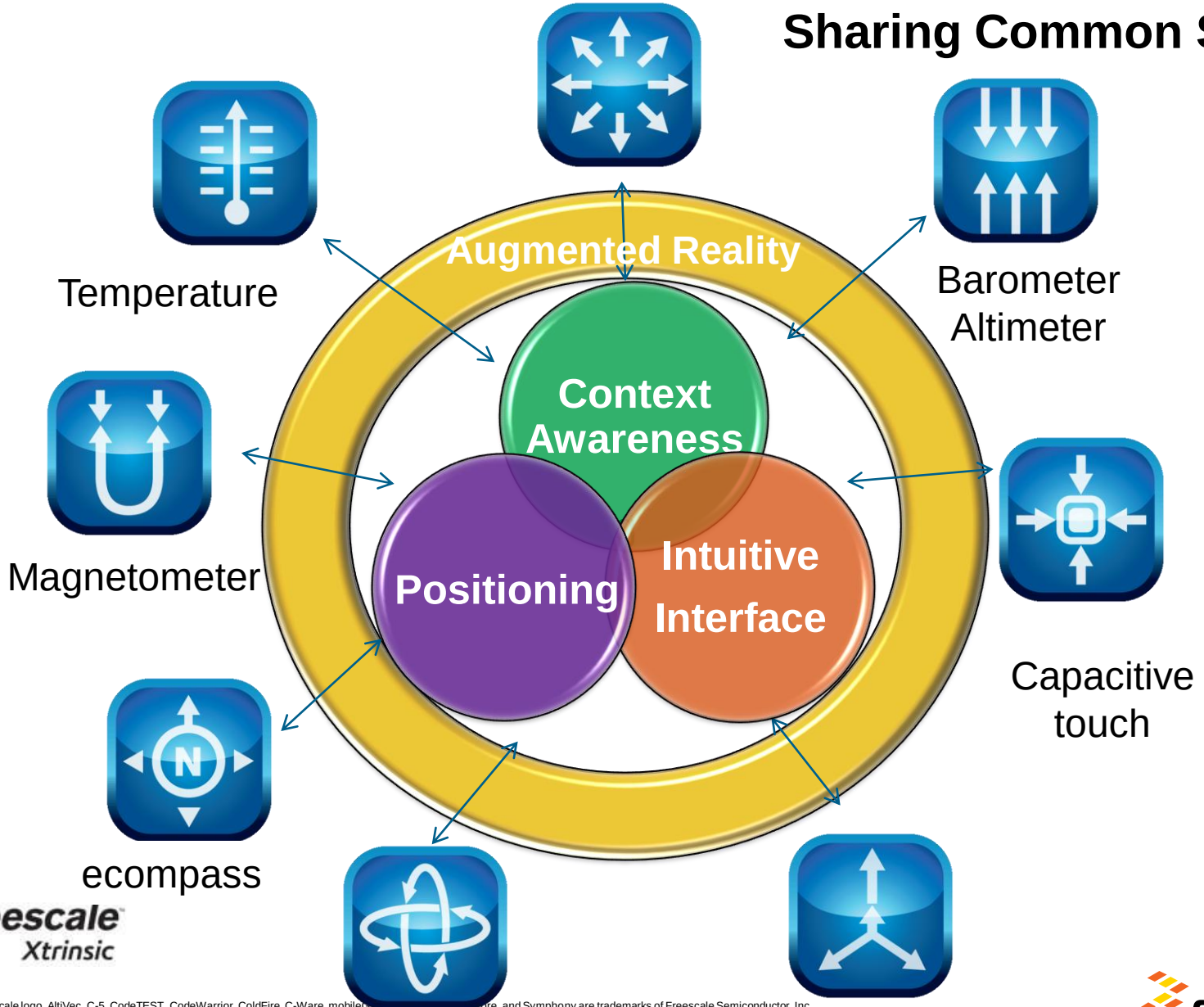
Context Awareness - Positioning - Intuitive Interface Sharing Common Sensors



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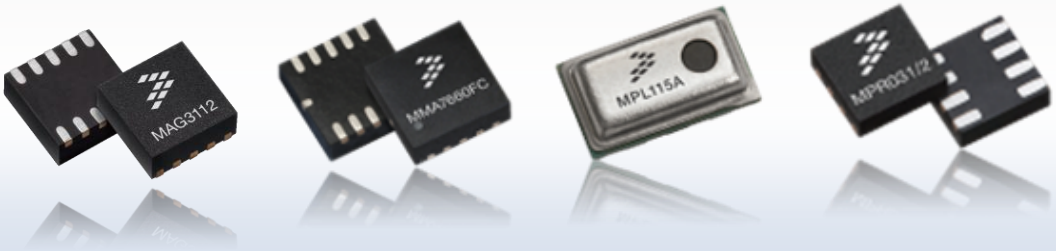
Sensor and Actuator Solutions



- Rapid expansion of sensing technologies with Freescale's addition of magnetic and radar sensors to existing accelerometer, pressure and touch sensor portfolio
- Pervasive sensors are needed to reflect the richness of our environment
- Proliferation of embedded control at the sensing point enables sensor integration and boosts software performance
- Freescale uniquely positioned with portfolio cross-selling for embedded control system solutions

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Freescale Introduces First Magnetic Sensor

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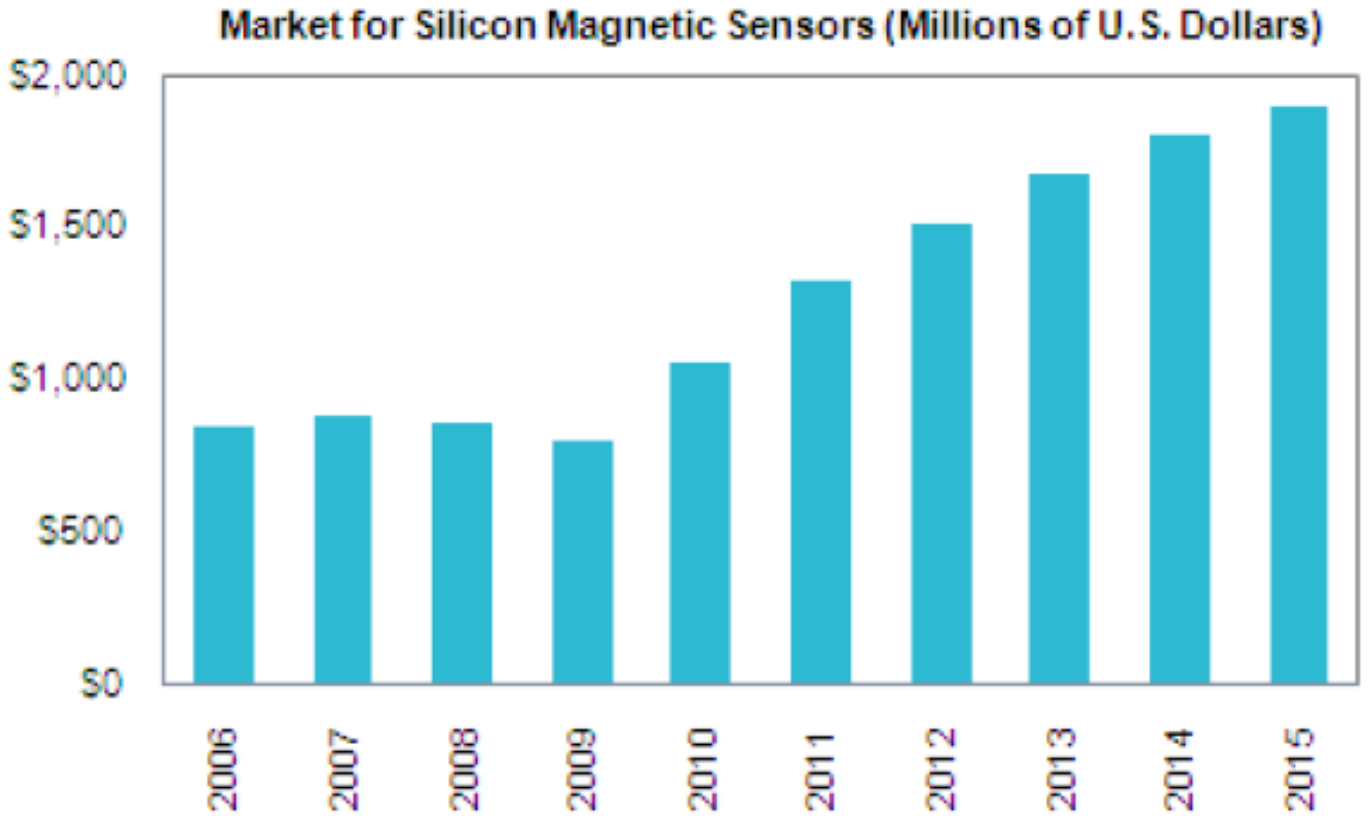
Market Brief for Magnetic Sensor



exuberant 38% jump in sales in 2010 over 2009. Going forward the market will reach $1.9 billion in 2015, up from $1.1 billion in 2010—a CAGR of 12%.

Global demand for digital compasses is rising rapidly, increasing to 263 million units in 2010, up 354 percent from 58 million in 2009. By 2015, shipments will rise to 1.28 billion units. Not only are digital compasses becoming a standard feature in tablets and in GPS mobile phones, the devices are also starting to find their way into gaming, cameras, and other consumer devices.

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MAG3110 Magnetic Sensor Key Advantages

Freescale demonstrates innovation with smart magnetic sensor

Our first MAG3110 3-axis magnetometer offers the highest resolution, lowest noise in the smallest package for navigation, dead reckoning and location tracking in mobile applications

High Resolution

- Freescale's **MAG3110** magnetometer with its very low noise and high resolution provides highly accurate and reliable heading information.

Low-Power

- The **MAG3110** magnetometer is greatly optimized for low power consumption for longer battery life in navigation, dead reckoning and location tracking applications.

Efficient Software

- The **MAG3110** magnetometer is enabled by efficient application development in terms of software size and efficiency of sensor data re-use for a variety of applications.

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MAG3110 Magnetic Sensor Details

▶ Features

- Wide dynamic range: +/- 1,000 µT
- High resolution in full dynamic range: 0.1 µT
- Lowest noise
- Power consumption: 24 µA at 1.25 Hz in normal mode
- Selectable Output data rate (upto 80 Hz)
- I^2C interface at 400 kHz
- Supply voltage: 1.95 to 3.6 V
- Drivers available
- Small 2 x 2 x 0.8 mm 10-pin µDFN package
- -40° C to +85° C operating temperature range

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MAG3110 Advanced Features and Benefits

Features	Specification	Benefits
Wide Dynamic Range	+/- 1,000 µT	Allows operation in PCBs with high extraneous magnetic fields and flexibility in PCB placement.
High resolution in full dynamic range	Down to 0.1 µT	Allows for the full specification resolution in all ranges
Low Noise (at 80 Hz ODR)	0.1 µT	Enables high resolution applications with low averaging requirements for decreased latency
Power Consumption	Normal Mode: 24 µA at 1.25 Hz	Lower power for significant battery savings
Sample rate	80 Hz maximum	Increased bandwidth to provide higher data rates
Supply voltage	1.95 to 3.6 V	Wide range for various applications

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Freescale's MAG3110 magnetometer has phenomenal performance due to the combination of TMR (Tunnel Magneto Resistive) technology, high resolution analog design and dedicated embedded logic

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Xtrinsic MAG3110 Magnetometer

Target Markets and Resources

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Magnetic Sensor Focus Markets

Consumer

- Mobile phones
- eCompass
- Location based services
- Dead-reckoning for GPS
- Air mouse
- Pointing devices
- Low-cost virtual gyroscope
- Tablets

Medical

- Hospital location tracking
  - Patients
  - Assets
- Navigation
- Magnetic field monitoring

Industrial

- Asset tracking
- Advanced HMI
- Factory Automation

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Magnetometer Applications

Mobile phones

- Next Gen User Interface
- Electronic compass (eCompass)
- Map orientation
- GPS assist with dead-reckoning
- Location tracking assist in mobile applications
- Flip/display position

Gaming

- Virtual, low-cost gyroscope replacement
- 3D motion control and heading

Remote Controls/Air Mouse/Pointers

- Virtual, low-cost gyroscope replacement
- 3D motion control and heading

Navigation

- Electronic compass (eCompass)
- Map orientation
- GPS backup with dead-reckoning
- Location tracking in mobile applications

Smartbooks/eReaders/Netbooks/Laptops

- Location tracking assist in mobile applications
- Faster Bootup assist
- User interface

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Michelle Kelsey
8/19/2010

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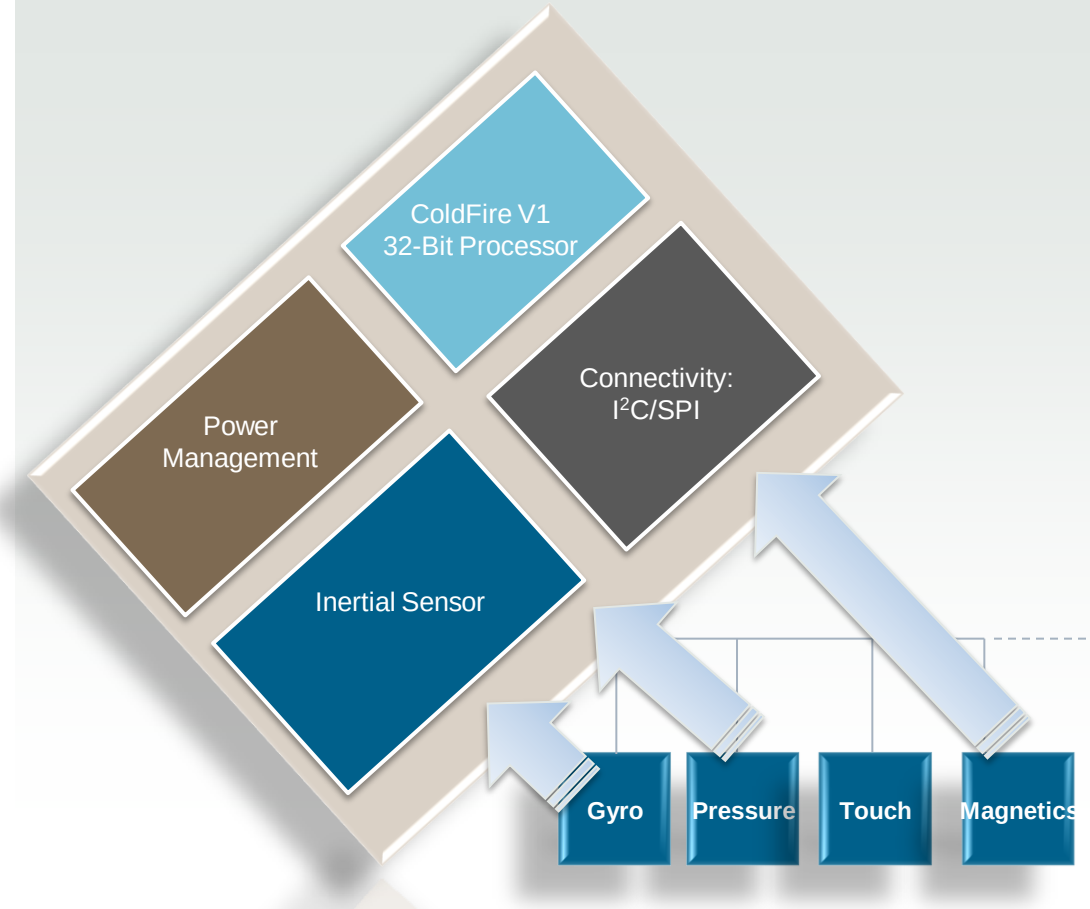
Performance and Fusion in Application Example

MMA9550L Sensor



Sensing Software

eCompass – MAG3110 Magnetometer

Gestures

Pedometer (3rd party)

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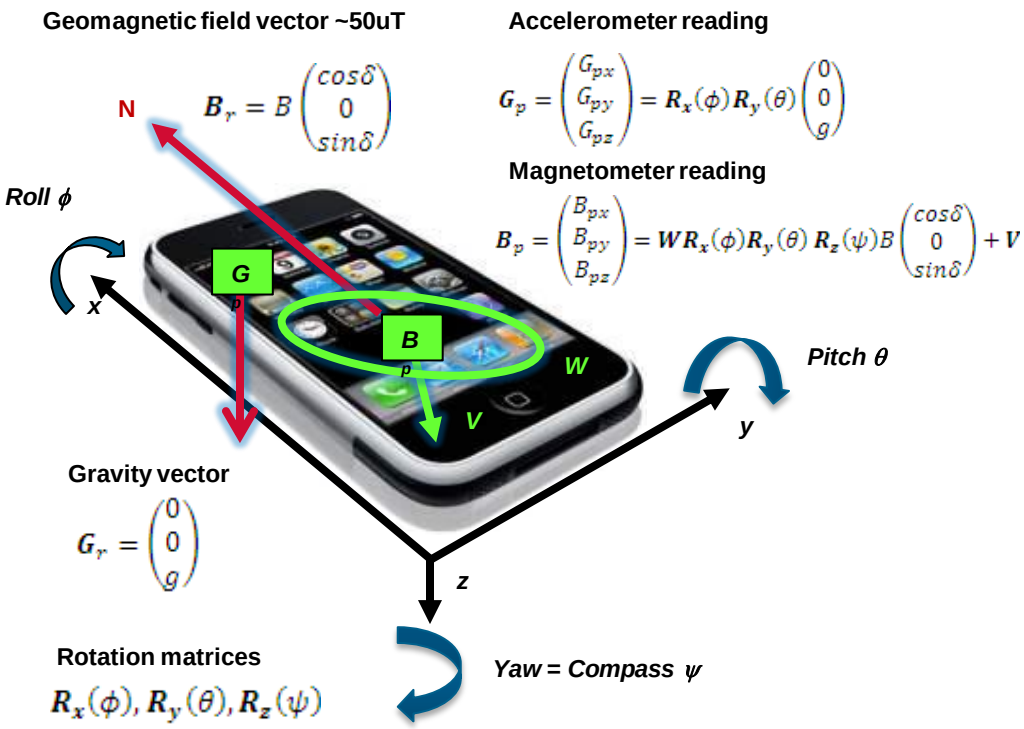
Tilt-Compensated eCompass Sensor Fusion

- **Demonstration Hardware Option 1:**
  - MMA8451Q accelerometer + MAG3110 magnetometer
  - Software executes on external processor
- **Demonstration Hardware Option 2:**
  - MMA9550L Motion Sensing Platform + MAG3110 magnetometer
  - All algorithms run on the MMA9550L motion sensing platform

- **Tilt-compensated** e-compass
- Real-time calculation and compensation of **hard and soft iron magnetic interference**

Sensor Fusion of Accelerometer plus Magnetometer



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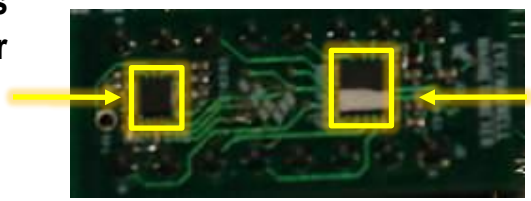
Demonstration Platform

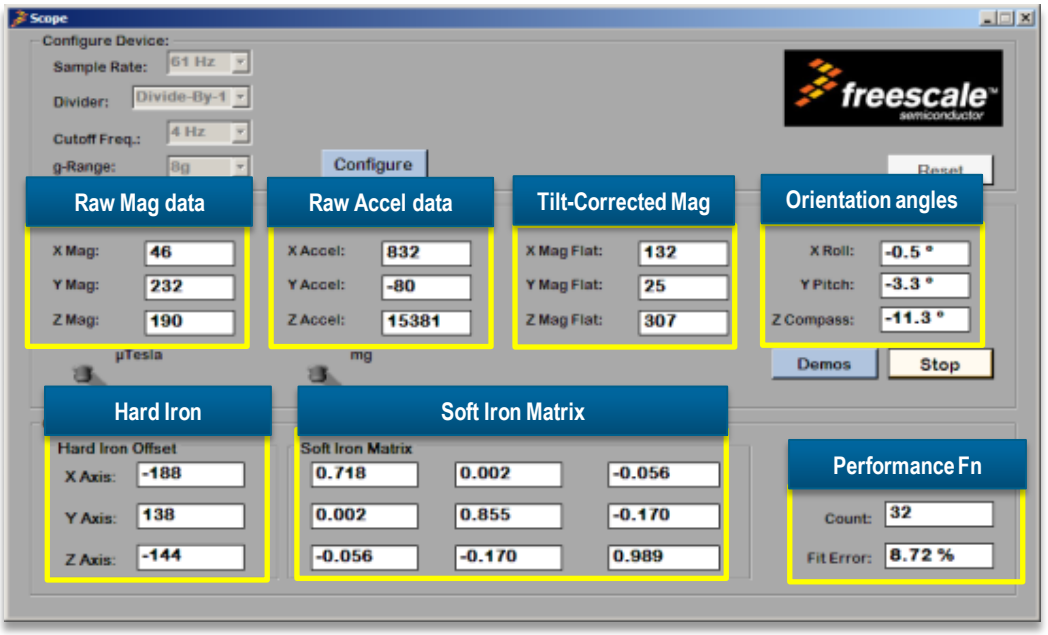
MAG3110 3-axis Magnetometer



MMA9550L 3-axis Accelerometer + ColdFire MCU

All algorithms run on the MMA9550L motion sensing platform

PC GUI simply displays results



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Development Tools & Documentation

► LFSTBEB3110 Sensor Toolbox Kit

- Includes a self identifying MAG3110 magnetometer development board
- Works with the USB communication board
- Includes Sensor Toolbox demo and evaluation software
- Will be available at: www.freescale.com/sensortoolbox

► RD4247MAG3110 Sensor Toolbox Bundle

- This Sensor Toolbox kit comes with the MAG3110 magnetometer development board and the USB board
- Will be available at: www.freescale.com/sensortoolbox

► Application Notes *(Coming Soon)*

- Calibrating for Soft Iron and Hard Iron Distortions (AN4246)
- PCB Layout Guidelines and Recommendations (AN4247)
- Using the MAG3110 Magnetometer for an eCompass Application (AN4248)
- Using the MAG3110 Magnetometer for an Air Mouse Application (AN4249)

RD4247MAG3110 Sensor Toolbox Bundle

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A New Era of **Xtrinsic Sensing** with Magnetic Sensors

- Freescale has expertise in **micro-magnetic** and **MEMS technology**
- Freescale's **extensive sensor expertise** for over **30 years** continues to advance with intelligent sensing
- Sensors continue with **lower power, higher function** in **smaller footprints**
- Freescale's **consumer and industrial market dedication** helps the customer with *exactly* what the customer *wants* the application to be
- The Xtrinsic high accuracy, 3D **MAG3110** magnetometer has phenomenal performance that is **best in class in the industry**

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