

Xtrinsic Sensors

Freescalar Sensing Solutions

Intelligent contextual sensing



freescalar.com/sensors



A New Era of Sensing Experience

Freescale Xtrinsic sensors go far beyond a sensor translating a signal—they enable greater levels of sensing context and intelligence. By increasing levels of modular integration with multiple sensor inputs, logic and other building blocks, Freescale brings greater value and decision making to the overall sensing solution. We've put our expertise at your fingertips so it is easy to tailor our sensing capabilities for your needs—your imagination is the only limiter.

Building on a Heritage of Sensor Innovation

Overview

For over 30* years, Freescale sensor products have helped make the world a safer and more interactive place with continuous sensor innovation. Globally, we have delivered more than two billion micro-electromechanical systems (MEMS)-based micromagnetic and CMOS state machine sensors. Building on our heritage of innovation, we continue to expand our sensor portfolio—supporting our customers' development of smarter and more power-efficient electronic solutions. Our new era of sensing experience involves intelligent contextual sensing where a sensor has decision

making capability within the context of its environment which enables a variety of use cases.

Freescale is a leading provider of acceleration, magnetic, pressure and touch sensors for the appliance, automotive, consumer, industrial and healthcare markets. The sensor ICs complement our broad portfolio of ZigBee® technology, MCUs, MPUs, DSPs, analog ICs, CodeWarrior IDE and other development tools to offer system solutions to customers.

*The Semiconductor Products Sector of Motorola, Inc. became Freescale Semiconductor, Inc. in 2004



Dimensions of Intelligent Contextual Sensing

Building on a Strong Portfolio of Diverse Sensor Types

- Inertial, magnetic, pressure and touch sensors
- Provide a multiplicity of sensor inputs for greater value to the overall solution
- Extract the maximum context from the environment

Intelligent Integration

- The right combination of leading sensor types, logic and other building blocks to solve use case needs efficiently
- Advanced, modular integration that can include multiple sensor types, connectivity and low power consumption
- Enables fusion of applications and high re-use of sensor data

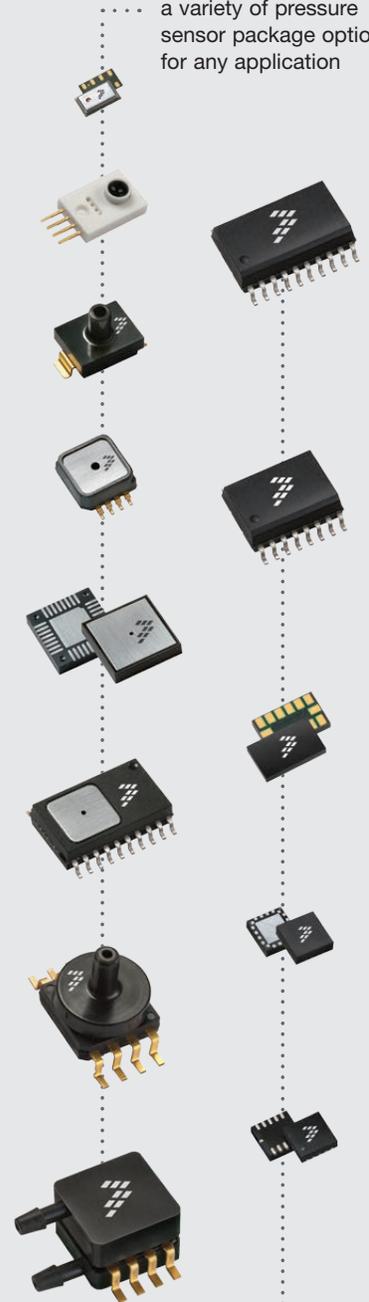
Amplifying Sensing

- Adds contextual analysis to sensor performance by including algorithms to make a decision
- The sensor can be a final or sub-level decision maker that feeds into a central point
- By providing interpreted sensing information and control over a number of sensing decisions, developers can focus on higher levels of innovation

Ingenuity of Design

- Novel ways for how the solution is designed and delivered that leverage our remarkable sensor portfolio and other intellectual properties, expertise and innovation
 - System partitioning
 - Packaging
 - Power management
 - Connectivity

Freescale can create a variety of pressure sensor package options for any application



Freescale inertial sensor package options offer top performance in a small footprint



With designers facing new challenges to create smarter products, Freescale is dedicated to meeting the needs of constantly evolving and expanding markets with intelligent accelerometers, pressure and capacitive touch-sensing solutions. Digital sensors are available that communicate on inter-integrated circuit (I²C) and serial peripheral interface (SPI) buses, providing a direct connection to the main system processor for communication simplicity and flexibility.

- Accelerometers are designed to detect changes in force resulting from fall, tilt, motion, positioning, shock and vibration. Freescale has created three ranges of accelerometers to detect these changes: low g (less than 20 g), medium g (between 20 g to 100 g) and high g (100 g to 500 g). For consumer electronics that require a fast response time, high sensitivity, low current consumption, low-voltage operation and a standby mode in a small profile package, our accelerometers are an ideal solution.
- Freescale supplies a very large pressure sensor portfolio containing a wide variety of pressure ranges, diverse packaging and porting options. High sensitivity and excellent long-term repeatability make Freescale pressure sensors suitable for the most demanding, high-performance applications. Freescale pressure sensors provide very low pressure measurements in inches of water up to 150 psi. Performance, competitive price and application versatility are other Freescale pressure sensor advantages.
- Freescale has a broad portfolio of hardware and software touch-sensing solutions to help you choose the best fit for your design. Touch-sensing technology can reliably replace buttons and switches to eliminate mechanical wear and tear. Freescale touch sensors can be configured into simple sliders, rotary wheels and touchpads to offer significant advantages for more intuitive user interfaces, allowing greater freedom for designers while reducing overall system cost.

- The Freescale touch-sensing software (TSS) suite is a set of complimentary licensed software libraries that enable any 8- or 32-bit MCU as a touch sensor, providing cost effective and flexible solutions for human-machine interfaces. TSS is a simple module to add to the customer’s design if they already have an MCU in their system and want to add touch-sensing functionality with multiple electrodes to their application.

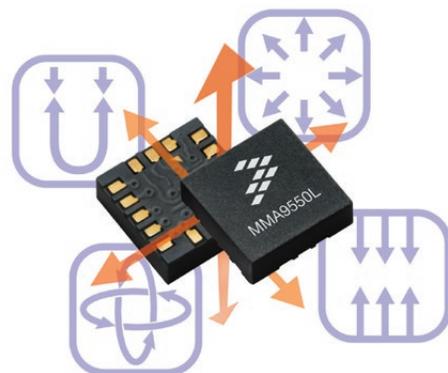
Our principle objective is to meet your market needs. We listen to you and turn your ideas into products. Our core competency is new product development using processes in place to shorten your development cycle time. As we work with you to meet your rapidly changing needs for small, cost-effective sensors, our technology is continuously expanding and evolving. We are also able to leverage complementary technologies from elsewhere in the corporation to strengthen your global competitiveness.

Integration

To help improve yields and drive down manufacturing costs, Freescale is developing highly integrated, multifunctional single package solutions that help our customers simplify their new product development and speed their products to market. For example, a combination of pressure sensor, MCU and radio frequency (RF) circuitry can be used in a wide range of remote sensing applications, such as direct tire pressure monitoring systems (TPMS). An integrated TPMS is a flexible and highly accurate safety system that can be more easily incorporated into the overall vehicle design. What’s more, tire localization capabilities can be added by integrating an XY-axis accelerometer into the package.

The MMA9550L is the industry’s first intelligent, high-precision motion-sensing platform that manages multiple sensor inputs and makes system-level decisions to enable new applications such as gesture recognition, pedometer functionality and e-compass tilt compensation. Its

highly configurable and customizable sensor decision engine enables complex calculations through interpreted sensing information and control over a number of system level sensing decisions—rather than simply processing raw data.



Creating new technologies that can sense and interact with the systems around them are essential to continually service the way we live, work and play



Low Power Consumption in End Applications

Freescale is a recognized leader in the design of high-performance, energy-efficient semiconductor products. Underscoring this, Freescale has introduced the Energy-Efficient Solutions mark to highlight selected products that excel in effective implementation of energy efficiency technologies that deliver market-leading performance in the application spaces they are designed to address. Visit the latest product list at freescale.com/energy.

Several Freescale sensors have earned the Freescale Energy-Efficient Solutions mark through a distinctive combination of advanced architectural and circuit techniques with the latest design methodology and process technology that deliver energy-efficient performance to provide the highest possible performance levels within a restricted energy budget. This is the result of Freescale working closely with customers in targeted markets to define their specific performance and energy requirements and then developing optimized solutions that yield exceptionally energy-efficient performance for the life of the application.

Advanced Packaging

Smaller is better when it comes to packaging. We develop cutting-edge, small footprint packaging for more cost-effective deployment without compromising the design, function or manufacturability of your application. A wide selection of package porting and mounting options gives you the flexibility to fine tune your designs to better meet your customers' needs. Our latest design improvement is its "wettable flank" visible solder packaging for the automotive market. Concave pockets on each solder pad enable a stronger, more reliable bond that can be visually inspected for critical applications like airbag systems.

Typical Sensor Applications



Appliance/Consumer

- Appliance balancing and monitoring
- Appliance control panels
- Black boxes/event recorders
- Smart portable electronics
- Camcorder stability
- Hard disk drive protection
- Weather stations
- Anti-theft devices
- Vacuum cleaners
- Refrigeration frost sensing
- Fall logs
- Fall detection
- Tilt controls
- Touchscreens
- Vibration monitoring

Healthcare Monitoring

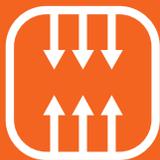
- Blood pressure monitors
- Invasive blood pressure monitors
- Intrauterine blood pressure monitors
- Hospital bed controls
- Respirators
- Sleep apnea monitors
- Sports diagnostic systems
- Dialysis equipment
- Drug delivery for inhalers
- Physical therapy

Industrial

- Process control
- Flow control and measurement
- HVAC systems
- Building airflow control
- Factory automation
- Boiler pressure indicators
- Liquid level measurements
- Seismic monitors
- Smart motor maintenance
- Robotics
- Motion control

Automotive

- Tire pressure monitoring systems
- Fuel level sensing
- Airbags
- Brake boosters
- Electronic stability control
- Manifold absolute pressure
- Barometric absolute pressure
- Seat controls
- Occupant detection and safety
- Airflow indicators
- Trailer brake controls
- Vehicle navigation
- Backup GPS



Pressure Sensors



Accelerometers



Touch Sensors



E-Compass Compensation



Gyro



Radar



Magnetometers



Temperature Sensors



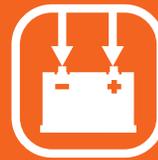
Tilt



Touch Sensing



Lighting

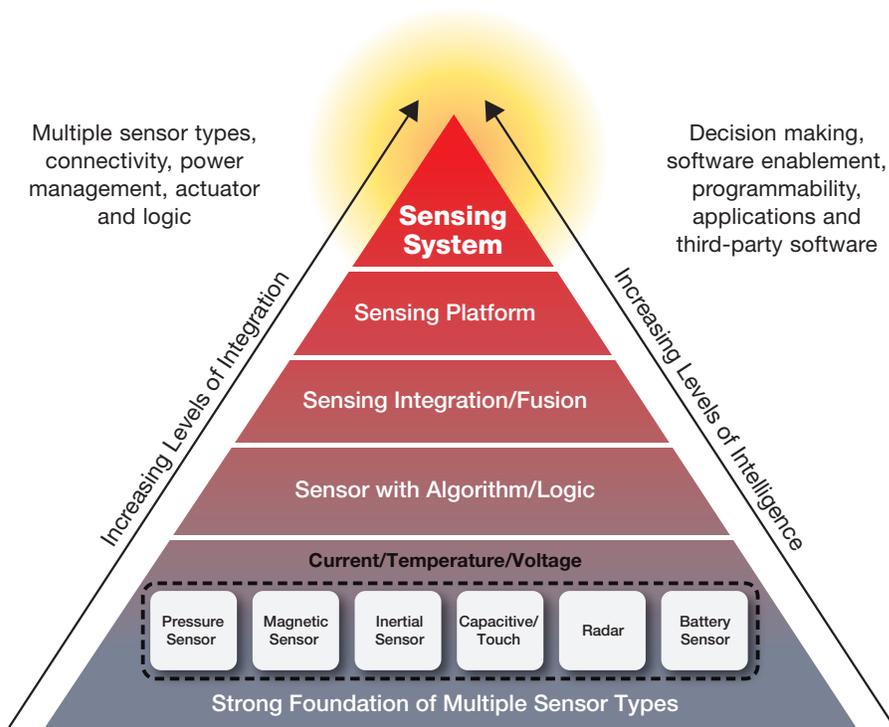


Battery Sensors

Intelligent Contextual Sensing Is Here

Freescale Xtrinsic sensing solutions simplify and amplify the use of sensors in your design. 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. Multiple sensor inputs are leveraged within the platform to perform multiple application functions. With Xtrinsic sensors, customers can choose among a wider range of scalable products at varying levels of integration, performance and price points.

Freescale Xtrinsic sensors feature customizable software that extends sensor use cases through algorithms and analysis to reduce complexity and provide processing assistance. Design time can be accelerated through using a common software platform and common tools including the Sensor Toolbox, sensor Tower boards and CodeWarrior IDE. Program and innovate with software for sensor platforms that allow you to design exactly what you want and need the application to be.



It's more than a sensor translating a signal—it's greater levels of sensing context and intelligence

Support for Your Next Great Design

Greater Demand for Sensor Enablement

The sensing function must become more intelligent and integrated to manage all the data and abstract it sufficiently to aid the applications developer. For many new application areas, multiple sensing nodes are required to provide the full sensory data needed to interpret the use case. Sensor systems with software capabilities allow the customer and third parties to tailor the sensor output for their needs to innovate and offer differentiating feature sets.

Sensor Toolbox

The Freescale Sensor Toolbox is a collection of unified hardware, software and accessories for sensor applications. The Sensor Toolbox includes all three sensor types from our extensive portfolio of acceleration, magnetic, pressure and touch sensors.

This series of sensor boards can be ordered one board at a time or collectively. Interchangeable boards enable and promote reuse of hardware and software across multiple architectures.

All Sensor Toolbox evaluation kits are USB-enabled plug-and-play devices. The GUI uses a single software install that reduces complexity and improves reliability through

periodic software updates. The Sensor Toolbox is identified through a common packaging “look and feel” and is available online at freescale.com/sensortoolbox.

Tower System for Modular Platform Development

The Freescale Tower System is a modular development board platform for 8-, 16- and 32-bit MCUs and MPUs that enables advanced development through rapid prototyping. Featuring multiple development boards or modules, the Tower System provides designers with building blocks for entry-level to advanced MCU development.

Sensor modules are also included within the Tower System. The Tower System plug-in (TWRPI) kits support the full range of Xtrinsic sensors. Working with MCUs, the TWRPI development platform goes beyond simple device evaluation for sensor programming.



ZigBee Wireless Sensing Triple-Axis Reference (ZSTAR) Design

Freescale ZSTAR tools enable quick wireless sensor design that demonstrates accelerometer functionality for consumer applications with built-in power cycling, orientation, shake and tap features. The ZSTAR reference designs provide designers with two small, portable demo boards, a sensor transceiver board and a USB receiver board for demonstrating and evaluating a wide range of accelerometer-based applications with low-power wireless connectivity. A USB stick connects via the computer's USB port for communications, using a Freescale USB 2.0 full-speed 8-bit MC68HC908JW32 MCU.

Wireless communication is enabled by our MC13213, a ZigBee-ready 2.4 GHz low-power transceiver that also contains an 8-bit MCU as a system-in-package solution that reduces board space requirements. The MC13213 ZigBee platform is an IEEE® 802.15.4 standard compliant on-chip transceiver/modem capable of 16 selectable channels.

For more information, visit freescale.com/ZSTAR for tool availability and freescale.com/zigbee for wireless products.





World-Class MEMS Process Technology

MEMS process technology is our enabling technology for acceleration and pressure sensors. MEMS-based sensor products provide an interface that can sense, process and/or control the surrounding environment.

Our MEMS-based sensors are manufactured by building very small electrical and mechanical components on a single chip. MEMS-based sensors are crucial components in automotive electronics, healthcare monitoring equipment, consumer portable and wireless electronics, appliance and industrial applications.

Target Applications

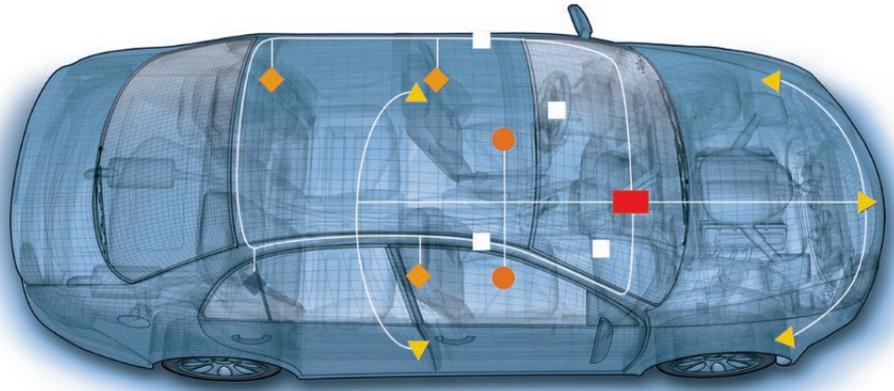
- In specialized healthcare monitoring applications, acceleration, magnetic, pressure and touch sensors provide key measurements for diagnostic and therapy applications as well as home portable applications. Extensive qualification and reliability testing is conducted including the Dynamic Part Averaging Test (DPAT) with AEC – Q001.
- Consumer applications contain gesture recognition elements like portrait to landscape, tap, shake, freefall and pedometer functionality where MEMS-based products can be used to activate these features by simply moving the phone.
- Appliances can benefit with real-time monitoring and feedback to replace traditional electromechanical devices. Examples include washing machines, vacuum cleaners, dishwashers and HVAC systems.
- Intelligent sensing technologies offer a cost-effective alternative to mechanical solutions to provide new levels of accuracy, usability and reliability in industrial control panel applications. Examples include robotics, shipping and handling monitoring, smart motor maintenance and free-fall detection.



MEMS process technology provides new levels of accuracy, usability and reliability in a wide variety of applications

MEMS in Automotive

For enhanced automotive safety, MEMS-based accelerometers provide crash detection for fast and efficient airbag deployment. Other automotive safety applications include electronic stability control (ESC) and TPMS. Beyond passive safety systems, active safety systems such as radar provides collision warning systems with automatic steering and braking intervention. Freescale adheres to quality standard certifications such as ISO/TS 16949 and the AEC-Q100.



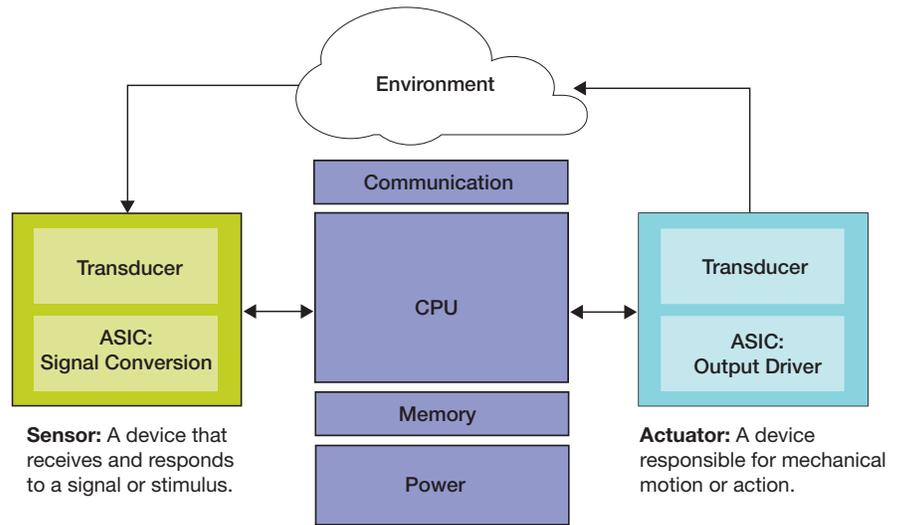
Technology Benefits

Freescale MEMS technology provides the following advantages:

- Cost efficiency
- Low power
- Miniaturization
- High performance
- Improved integration

Different functionalities can be integrated to reduce the component count and lower overall costs. There are two types of integrated microsystems: monolithic integration and system-in-a-package (SiP). Monolithic integration is when the MEMS device and the integrated circuit (IC) are incorporated onto the same piece of silicon. SiP is when the MEMS device and the IC are integrated into the same package.

MEMS Technology Overview



Sensor: A device that receives and responds to a signal or stimulus.

Actuator: A device responsible for mechanical motion or action.

Transducer: A device that converts input energy of one form into output energy of another form.

Freescale Technology



Micromachining

Bulk Micromachining

In bulk micromachining, the single crystal silicon, which is a very stable mechanical material, is etched to form three-dimensional MEMS devices. This is a subtractive process in which the silicon in the wafer is specifically removed using anisotropic chemistries. Sensors, such as piezoresistive pressure sensors, have been manufactured in high volume using this bulk micromachining method.

In the simplest implementation, the silicon is selectively etched in certain areas to form a diaphragm. In an absolute pressure sensor, the silicon wafer is then bonded with another wafer (either of silicon or glass) to form a vacuum-sealed cavity below the diaphragm. The diaphragm then deflects in response to applied pressure.

The piezoresistive effect has been widely used as the transduction mechanism. In piezoresistive materials, applied mechanical stress causes a corresponding change in electrical resistance. Thus, when implanted piezoresistors are formed at the diaphragm's maximum stress points, the deflection under pressure causes a change in the resistance. Typically, these piezoresistors are formed as a bridge network and the voltage applied between two terminals causes an output voltage to be measured between the other two terminals.

Surface Micromachining

In surface micromachining, the MEMS sensors are formed on top of the wafer using deposited thin film materials. Structural materials are used to form the sensor device, and sacrificial layers are deposited and then removed to form the mechanical spaces, or gaps, between the structural layers.

Many of the surface micromachined sensors use the capacitive transduction method to convert the input mechanical signal to the equivalent electrical signal. In the capacitive transduction method, the sensor can be considered to be a mechanical capacitor in which one of the plates moves with respect to the applied physical stimulus. This changes the gap between the two electrodes with a corresponding change in the capacitance. This change in capacitance is the electrical equivalent of the input mechanical stimulus.



Freescale is a high-volume manufacturer of MEMS-based sensors and has been developing MEMS-based sensors for over 30 years

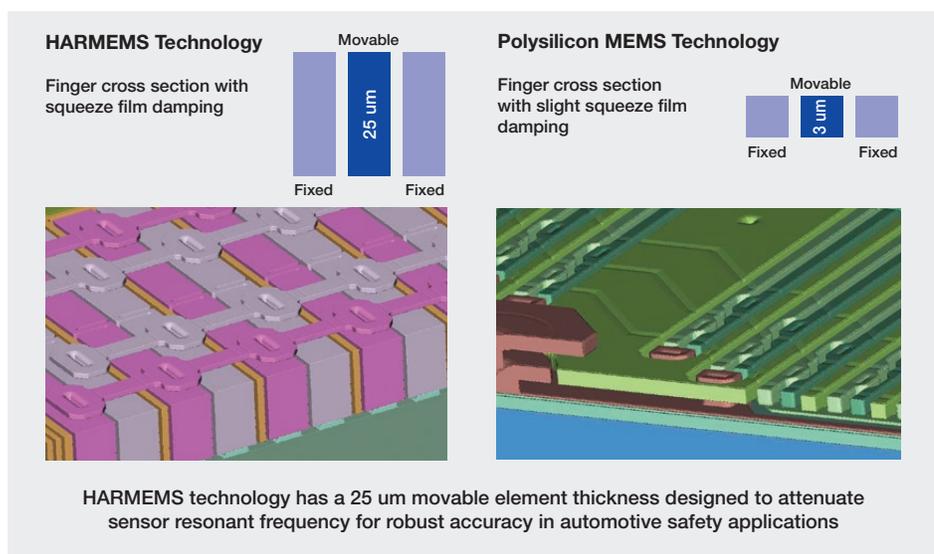


HARMEMS Technology

Our next-generation high aspect ratio micro-electromechanical systems (HARMEMS) technology is a proven technology for airbag sensing applications. The accelerometers have an advanced transducer design that enhances sensor offset performance. HARMEMS technology provides over-damped mechanical response and exceptional signal-to-noise ratio to address customer requirements.

Since the airbag main ECU system is installed in the vehicle cabin, over-damped HARMEMS technology enables a high degree of immunity to high-frequency, high-amplitude parasitic vibrations. HARMEMS technology has also been introduced in dual-axis accelerometers used in electronic stability control to measure the lateral acceleration of the vehicle.

Technology Comparison



How to Reach Us

Freescale Semiconductor prides itself on world-class support. Assistance is just a click away at freescale.com/support.

Technical Information Center

The engineers in our Technical Information Center offer assistance via phone or online to meet the specific needs of customers around the world.

Local Technical Support

Our Field Application Engineers are located close to our direct customers and are available for direct contact and visits to customer sites.

FAQs

Our vast knowledge base of frequently asked questions (FAQs) is online to offer support 24 hours a day, seven days a week and is updated and maintained by product experts.

Technical Documents

Available at freescale.com

- Engineering bulletins
- Reference manuals
- Data sheets

Freescale Forums

Our forums are moderated by product experts and feature discussions on Freescale MCUs and development tools, allowing our customers to communicate their ideas on a global scale.

This brochure is not intended to represent the entire Freescale portfolio of sensor products. Contact us to discuss what we can do for your application.

For more information, visit freescale.com/sensors