Course Introduction

Purpose

- The intent of this course is to provide you with a brief overview of sensor products, the MMA7260Q accelerometer, typical accelerometer applications, and orderable development tools and support.

Objective

- Explain the typical applications of the three sensor families.
- Identify the features and benefits of Freescale's three-axis low-g acceleration sensor.
- Explain g-Select sensitivity.
- Describe the six sensing functions.
- Describe Freescale's service and support.

Content

- 31 pages
- 6 questions

Learning Time

- 50 minutes

This course will provide you with a brief overview of sensor products, the MMA7260Q accelerometer, typical accelerometer applications, and orderable development tools and support.

More specifically, you will learn about Freescale's three-axis low-g acceleration sensor as well as its features and benefits. You will examine g-Select sensitivity, acceleration sensor examples, and the six sensing functions of acceleration sensors. Finally, you will learn about orderable reference designs and evaluation board demo kits, as well as Freescale services and support.

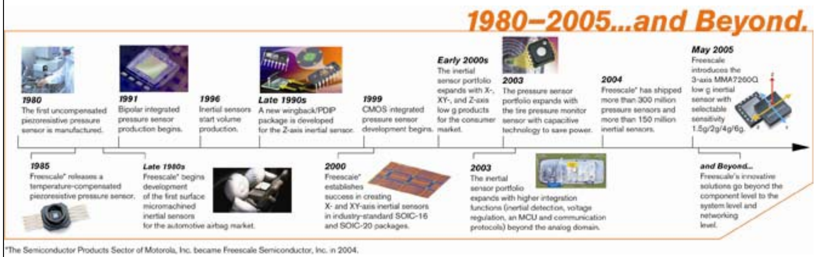
Sensing a Leader

In May 2005, Freescale Celebrated
25 Years in the Sensor Industry

Silver Anniversary
Freescale Semiconductor
SENSORS
25 Years

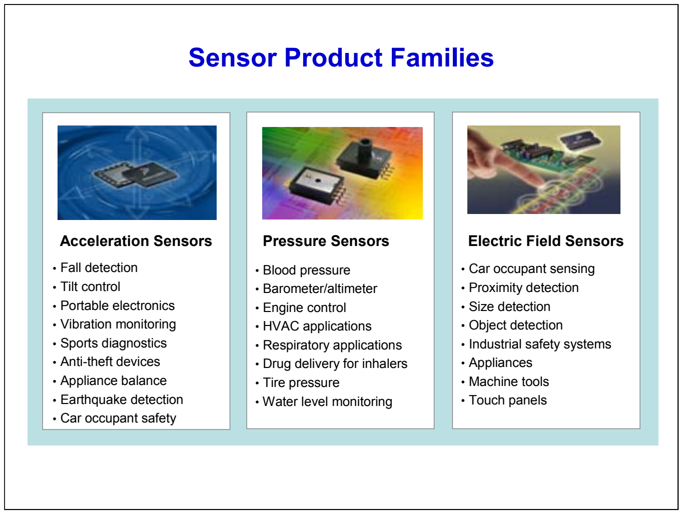
Freescale semiconductor has a legacy of 25 years in sensor products delivering on the promise of new technology. Over the past 25 years, the sensor products group has been innovating technology in micro-electromechanical systems (MEMS)-based sensors, including pressure sensors and accelerometers. This has made Freescale one of the top high-volume MEMS producers.

Sensor Product Milestones



Roll your mouse pointer over each date in the graphic to see more on the sensor product milestones.

Here are some of Freescale's accomplishments. From the release of the first sensor in 1980 to the development of an industry leading 3D accelerometer and the milestone of 600 million sensors shipped in 2005, Freescale continues to build on a strong foundation of innovation. Freescale's innovative solutions go beyond the component level to the system level and networking level. Freescale continues to leverage technology expertise in micromachining to produce more integration in embedded solutions.



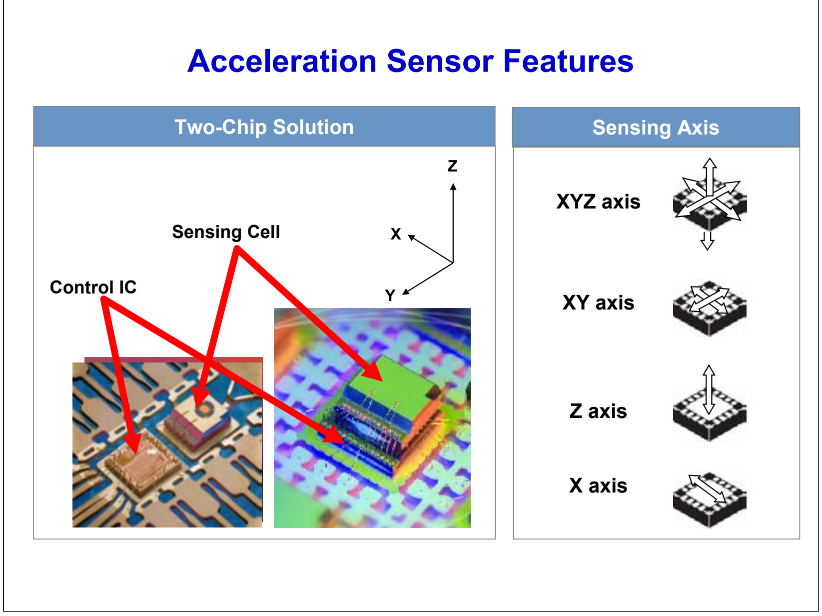
Sensor products consist of three families: Acceleration Sensors, Pressure Sensors, and Electric Field (E-Field) Sensors.

Here are some of the typical applications for each of these families. As you can see, they cover a wide range of products in multiple industries.

Acceleration sensors include fall detection, tilt control, portable electronics, vibration monitoring, sports diagnostics, anti-theft devices, appliance balance, earthquake detection, and car occupant safety.

Pressure sensors include blood pressure, barometer/altimeter, engine control, HVAC applications, respiratory applications, drug delivery for inhalers, tire pressure, and water level monitoring.

Electric field sensors include car occupant sensing, proximity detection, size detection, object detection, industrial safety systems, appliances, machine tools, and touch panels.



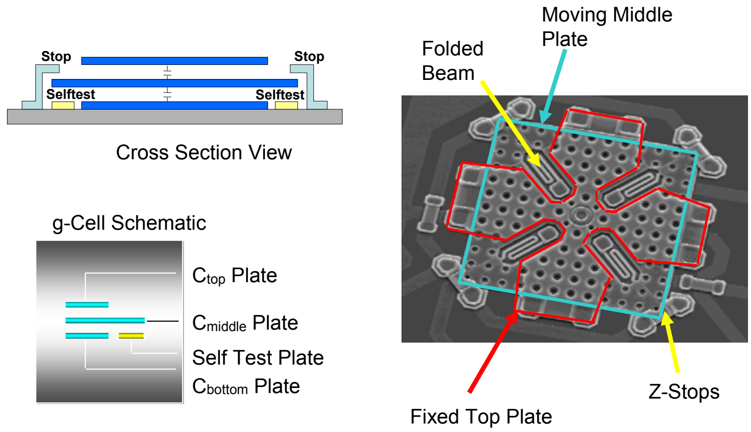
The Freescale series of acceleration sensors incorporate a surface micromachined structure. The force of acceleration moves a seismic mass, which then changes the g-cell’s capacitance.

Freescale accelerometers are two-chip solutions. There is a control IC on one die, and a sensing cell, also called the “g-cell."

The sensing cell and the g-cell are either side-by-side or in a stacked die configuration as in the Quad Flat No-Lead (QFN) package. Using the QFN package in an end use design is especially useful when size considerations could be a limiting factor.

We offer X-axis, Z-axis, XY-axis, and now XYZ-axis solutions in one package. These sensing axes options fulfill the designers requirements for single-, dual-, or triple-axis sensing. Note that orientation is not a problem because for each solution, the accelerometer can be mounted flat on the PCB.

Z-Axis g-Cell Overview

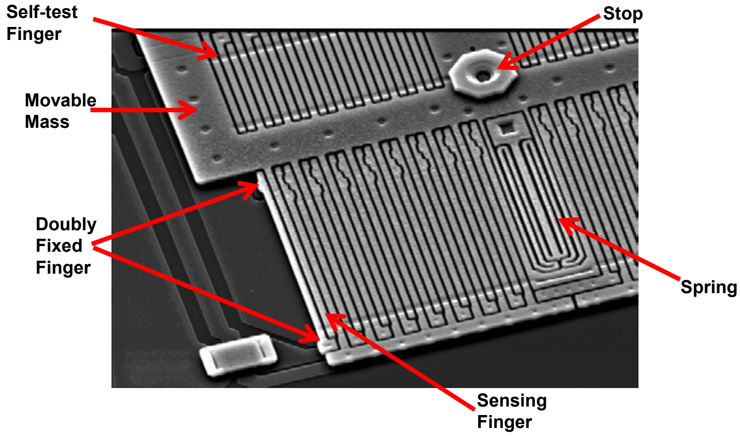


The g-cell is a surface micromachined capacitive sensing cell, of which there are two types. Let’s examine the first type, the Z-axis g-cell. This cell can be thought of as a capacitive trampoline where, as you sense acceleration, the trampoline will move, depending on the acceleration that it receives.

If you think of it as capacitive plates, you'd have two static capacitive plates, and a moveable plate in between, which moves with different accelerations. Here is another view of the capacitive plates in the g-cell schematic. Note that there is also a self-test feature on select accelerometer products. You can see the self-test plate on this diagram.

This is a Scanning Electron Microscope (SEM) image of the Z-Axis capacitive trampoline where, as you sense acceleration, the trampoline will move, depending on the acceleration that it receives. As the middle plate moves with acceleration, the distance between the plates changes and therefore, each capacitor's value will change. The change of capacitance between the plates is measured and the SMARTMOS™ ASIC uses switched-capacitor techniques to convert the measurement into an analog output voltage that is related to an acceleration movement.

X-Axis Lateral g-Cell



The second type of g-cell is the X-lateral technology with a moveable mass and doubly fixed fingers.

Each pair of g-cell fingers forms two back-to-back capacitors. As the central mass moves with acceleration, the distance between the fingers changes, so each capacitor value changes. The change in capacitance is then converted to a voltage output correlating to an acceleration using switched capacitive technology.

3-Axis Low-g Acceleration Sensor

Competitive Consumer, Industrial, and Medical Market Features:

- XYZ – three axes of sensitivity
- New feature: g-Selectable
- Low current consumption: 500 µA
- Fast turn on time: 1 ms
- Sleep Mode: 3 µA
- Low-voltage operation: 2.2V – 3.6V
- Low noise: can achieve higher resolution, more accuracy
- Package: low profile

Three axes of sensitivity: XYZ

The MMA7260Q is Freescale’s three-axis low-g acceleration sensor. It has some very competitive features for the consumer, industrial, and medical markets.

First, it has three axes of sensitivity in one package: x, y, and z.

Next, it uses the new feature, g-Select. This enables the sensitivity to be selected in one single device at any of these values: 1.5g, 2g, 4g, or 6g, just by changing the inputs of two pins of the accelerometer.

One of the requirements of many handheld electronics is to conserve battery power. Therefore, with a low current consumption of 500 µA and a fast turn on time of 1 millisecond, the MMA7260Q can save battery life during operation.

Sleep mode is ideal for handheld battery powered electronics. In sleep mode the current consumption drops to 3 µA and has a faster turn on time of 0.5 milliseconds. Sleep mode allows the end-use device to hibernate. This saves the battery, yet wakes up quickly when needed.

The MMA7260Q also has a low voltage operation of 2.2V to 3.6V, which works well with today's popular handheld electronics.

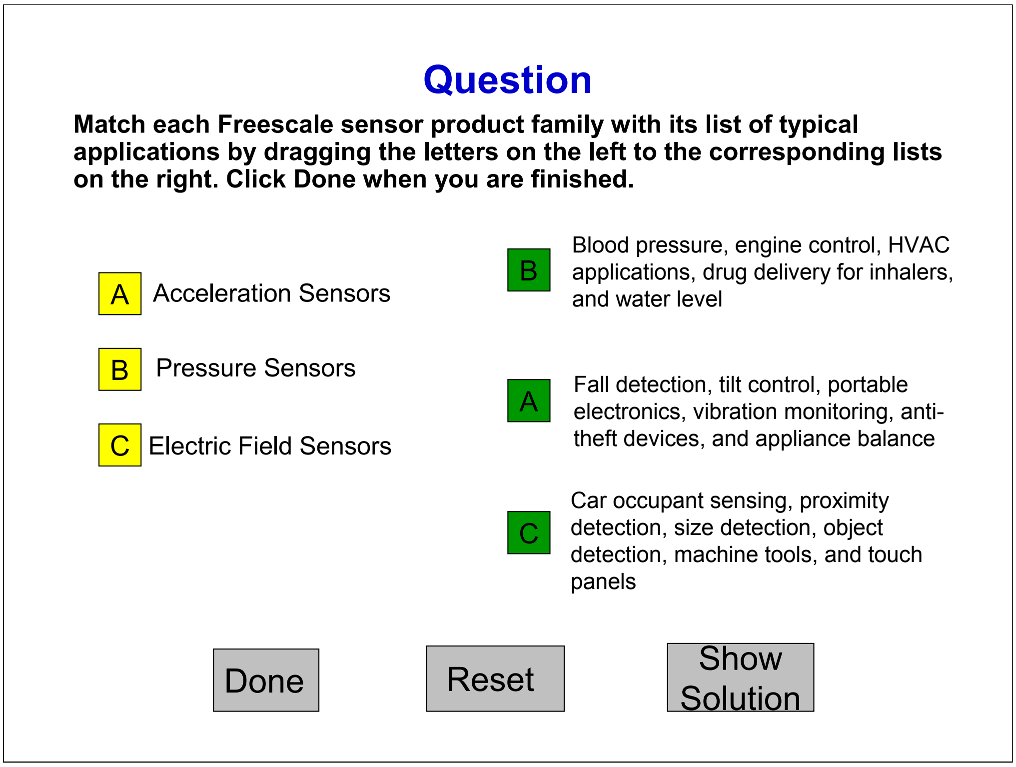
The low noise allows final designs to achieve higher resolution and accuracy, such as a very low degree of tilt, or very quick response to detecting freefall.

Another requirement for handheld electronics is a small footprint with a low profile package. The MMA7260Q package meets this requirement with a 16-lead 6 mm x 6 mm x 1.45 mm QFN.

Features and Benefits

MMA7260Q Features	Benefits
One device, 3 axes – XYZ	• Saves cost • Saves space on PCB
Selectable g-ranges from 1.5 to 6g	• Freedom to select the g level of acceleration detection for multifunctional applications
Current consumption of 500μA, a sleep mode consumption of only 3μA	Low power consumption
2.2 V – 3.6 V operating voltage	
Fast power up response time	

Reference material for previous page



Let’s review the sensor product families.

Correct.

There are many applications for each of the sensor product families in a wide range of industries. Acceleration sensors include fall detection, tilt control, portable electronics, vibration monitoring, anti-theft devices, appliance balance, and more. Pressure sensors include blood pressure, engine control, HVAC applications, drug delivery for inhalers, water level, and more. Electric field sensors include car occupant sensing, proximity detection, size detection, object detection, machine tools, touch panels, and more.

Question

What are some of the features of the MMA7260Q? Select all that apply and then click Done.

Three axes of sensitivity in one device

g-Select

Low current consumption

Sleep mode

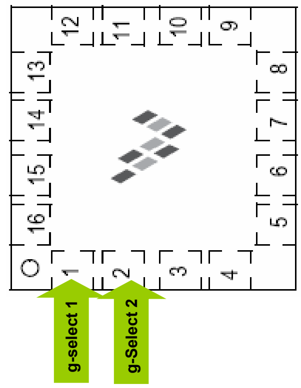
Done

Please select all statements that correctly describe the features of the MMA7260Q.

Correct.
All of the above are key features of the MMA7260Q 3-axis accelerometer. The MMA7260Q has three axes of sensitivity in one device; g-Select, which enables the sensitivity to be selected in one single device; a low current consumption of 500 µA; and sleep mode, which is ideal for handheld battery powered electronics.

g-Select – Sensitivity

1.5g –	**Freefall, accurate tilt compensation**
2g –	**Handheld motion detection Gaming controllers**
4g –	**Low vibration monitoring, shipping and handling**
6g –	**High vibration monitoring, Higher shock readings**



The g-Select sensitivity has two input pins, g-Select 1, and g-Select 2. By changing these inputs from either a high or a low value, you can select all these different g-ranges. This allows final designs to achieve the different resolution and different accuracy needed for many applications.

1.5g applications include highly sensitive end uses such as freefall or accurate tilt compensation.

2g applications provide more range for detecting small hand movements, which is better for hand motion detection and gaming controllers.

4g applications provide a larger range for low vibration monitoring and low shock detection such as shipping and handling detection and small smart motors.

6g applications can include high vibration monitoring, such as in washing machine out of balance applications and higher vibration smart motors.

The MMA7260Q can replace multiple chipsets with a singular product. Supply chain managers will see a purchasing benefit. This can reduce supply issues and the SKUs required for production can be minimized. The cost savings in purchasing one device rather than multiple devices is also a benefit.

g-Select

Solutions

Determine optimal sensitivity

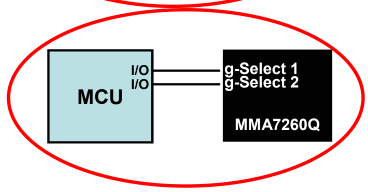
The MCU reads the accelerometer output. If a 1.5g setting is railed for 2 ms then the MCU can adjust the g-range to 2g and sample data again.

Run multiple accelerometer applications

The MCU can toggle between a freefall detection algorithm with a 1.5g setting and a vibration algorithm at the 6g setting.

g-Select 2	g-Select 1	g-Range
0	0	1.5g
0	1	2g
1	0	4g
1	1	6g

Settings for Pins 1& 2 to set g-Range



The g-Select is best configured by connecting to the additional I/O ports of a chosen microcontroller. In this design, the sensitivity of the device can be easily changed in a quick software modification. Also, the software is configurable using g-Select. This means that you can use different sensitivities or g-ranges for several applications at once. This g-Select table shows the different input settings for g-Select 1 and g-Select 2 to achieve a particular g-range.

Here you can see the connection between the MCU's I/O ports and the g-Select 1 and g-Select 2 of the accelerometer.

The MMA7260Q can provide two key solutions with the g-Select feature; one is to determine the optimal sensitivity. In this case, the MCU reads the accelerometer outputs and analyzes if the values are railing for a preset amount of time, such as 2 milliseconds. If this occurs, the MCU can readjust the g-range to 2g and sample data again by modifying the g-Select inputs. This will allow the system to achieve a more accurate acceleration measurement, tailoring optimal sensitivity for the application.

The second key solution that the MMA7260Q can provide with the g-Select feature is to run multiple accelerometer applications. With this multiple application functionality, a system can run multiple accelerometer applications that usually require different ranges of acceleration. For example, the MCU can toggle between the freefall detection algorithm with a g-Select in the 1.5g range and a vibration algorithm that requires a 6g range in one software and hardware solution.

Question

What are the benefits of g-Select? Select all statements that correctly describe the benefits of g-Select, and then click Done.

It allows for multiple accelerometer applications with one device.

It allows the sensitivity to be selected at 1.5g, 2g, 4g, or 6g.

It enables you to find the optimal sensitivity for the application.

It can also perform pressure sensing operations.

Done

Please select all statements that correctly describe the benefits of g-Select.

Correct.

g-Select allows for multiple application functionality with one device. It allows the sensitivity to be selected at 1.5g, 2g, 4g, or 6g, just by changing the inputs of the pins of the accelerometer. g-Select enables you to find the optimal sensitivity for an application, allowing a system to achieve a more accurate measurement. It cannot perform pressure sensing operations.

Why Low-g Acceleration Sensors?

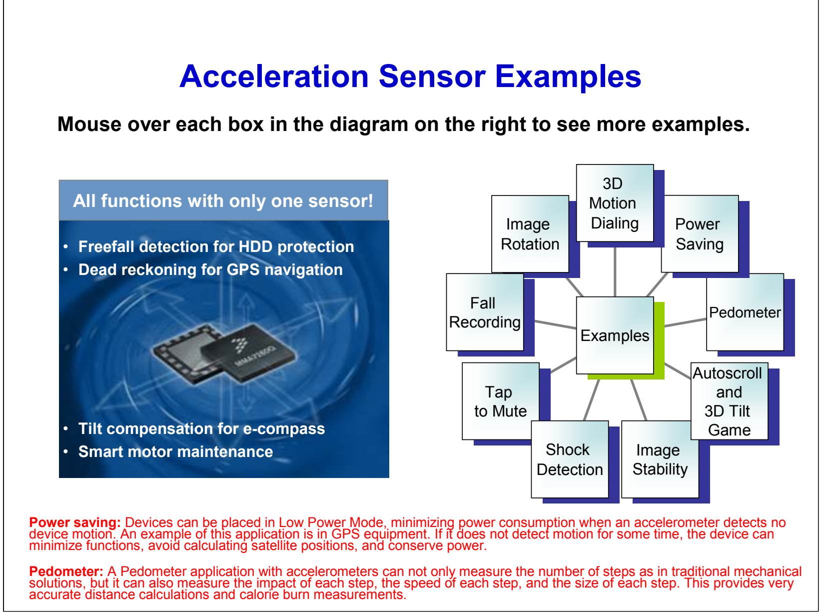
- Reliability and support
- Leading sensor technology
- Solutions are ready (evaluation boards and reference designs)

Device	Acceleration (g)	Sensing Axis	Sensitivity (mV/g)	Frequency (Hz)
MMA7260Q	1.5 / 2 / 4 / 6	XYZ	800 / 600 / 300 / 200	350 / 150
MMA6261Q	1.5	XY	800	300
MMA6263Q	1.5	XY	800	900
MMA6233Q	10	XY	120	900

Why choose Freescale's low-g acceleration sensors? One reason is that Freescale provides highly reliable devices and support.

Freescale is also an industry leader in sensor technology. Freescale's solutions are ready and we have orderable development tools available, such as evaluation boards and reference designs for all of the low-g products. Here you can see some of the new accelerometers being offered.

In addition to the MMA7260Q, there is the MMA6200Q series, a line of dual-axis devices with sensitivities of 1.5g and 10g, and a frequency range of 50 Hz, 150 Hz, 300 Hz, up to 900 Hz.



Now, we will look at only a few of the multitude of applications that can be achieved with acceleration sensors.

Hard Disk Drive (HDD) protection is available in the form of freefall detection when an HDD is falling. The accelerometer determines when an HDD is in freefall, and parks the drive’s head in a protected area to prevent damage to the device. In addition, when the accelerometer detects freefall, any memory that hasn't been written yet to the hard drive can be moved to temporary memory, so there is no data loss.

Dead reckoning is a concept where the acceleration signal can be double integrated to determine an accurate position. It is used in applications for GPS navigation when a GPS signal is blocked, and the accelerometer is used to translate movement from the position of the last GPS update. This is a very complex algorithm that needs to consider errors such as offset variation, and offset and temperature drift.

Tilt compensation is incorporated into digital compasses using accelerometers. For lower cost e-compasses, they have to be mounted at a certain level to be accurate. Therefore, the accelerometer detects when it's being held at a certain level, allowing accurate output. Higher level e-compasses detect the orientation of tilt with an accelerometer and compensate for this tilt angle.

Finally, smart motor maintenance requires an accelerometer to monitor a motor’s vibration signature. The accelerometer then determines when the vibration signature changes to send a warning when the motor is going to start to fail--before it actually fails completely.

Suggested g-Levels

Understanding the range of acceleration for an application enables a product to be designed with the optimal accelerometer. This graph shows applications and their respective acceleration ranges. This starts at 1.5g, as in freefall, all the way up to 10g applications, for pedometer applications. As you can see, every acceleration range has different applications.

Freescale has acceleration sensors with detection ranges from 1.5g to 10g in the low-g portfolio of accelerometers, 40g to 100g in the medium-g portfolio, and 150g up to 250g in the high-g portfolio.

Six Sensing Functions

Fall	Fall detection, freefall protection, HDD protection, fall log, motion control & awareness
Tilt	E-compass, inclinometer, gaming, text scrolling/user interfacing, image rotating, LCD projection, physical therapy, camera stability
Movement	Motion control, pedometers, general movement detection
Positioning	Personal navigation, car navigation, back-up GPS, anti-theft devices, map tracking
Shock	Fall log, black boxes/event recorders, HDD protection, shipping and handling monitor
Vibration	Seismic activity monitors, smart motor maintenance, appliance balance & monitoring, acoustics

Freescale has outlined six sensing functions of acceleration sensors: Fall, Tilt, Movement, Position, Shock, and Vibration.

Fall detection is used for freefall protection, which can be integrated into HDDs. It is also used for fall log and motion control and awareness.

Tilt can be applied to an e-compass, inclinometer, gaming devices, text scrolling and user interfacing, image rotating, LCD projection, physical therapy, and camera stability.

Movement covers motion control, pedometers, and general movement detection.

Positioning applications require more complex algorithms for double integrating the acceleration to determine position. Position applications include personal navigation (where a person holding a cell phone or GPS equipment determines how far they walk with the accelerometer), car navigation, back-up GPS (when the GPS signal is lost, the accelerometer with software algorithms is used to detect their relative position from the last accurate GPS update), anti-theft devices (if a laptop is moved, the accelerometer detects the movement of the laptop and then sends monitoring information of its new position), and map tracking.

Shock applications include fall logs, black box event recorders, HDD protection, and shipping and handling monitoring.

Vibration applications include high sensitivity and high frequency accelerometers for seismic activity monitors, smart motor maintenance, appliance balance and monitoring, and acoustics.

Question

Understanding the range of acceleration for an application enables a product to be designed with the optimal accelerometer. Match the g-level to the correct application by dragging the letters on the left to the g-level on the right.

A	1g - 2g	A	**Freefall detection and tilt control**
B	2g - 8g	B	**Shock detection**
C	8g - 10g	C	**Vibration**
D	10g - 20g	D	**Pedometer**

Let's review the information on suggested g-levels.

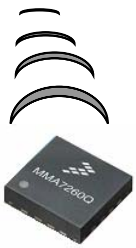
Correct.

Freefall detection and tilt control is in the 1g to 2g range. Shock detection is in the 2g to 8g range. Vibration is in the 8g to 10g range, and a pedometer is in the 10g to 20g range.

Measuring Freefall

Things to Consider:
- g-Range will typically be +/-1g.
- What is the cross axis acceleration?
- What is the height requirement for detection?

Three types of falls:
- **Linear**
- **Rotational**
- **Projectile (thrown)**



- **Linear freefall requires three axes for detecting when in complete freefall.**
- **Rotational and projectile freefall require complex algorithms for monitoring freefall signature.**
- **Height of the fall is measured by sampling the time between start of fall and impact.**

$$fall\_height = \frac{1}{2} * 9.8 \text{ m/s}^2 * t^2$$

Now, let's take a closer look at the sensing functions that are achievable through using accelerometers. Let's start with the things to consider when measuring freefall. The g-range will typically be +/- 1g. What is the cross-axis acceleration? Is it in freefall and being moved, or is it just in freefall? And also, what is the height requirement for detection? Some people will require a height of one meter, while others will require a height of a couple inches. Detection in both instances is achieved by the sampling rate of the microprocessor, and how involved the algorithm is with the micro-controller.

Three types of freefall can be determined: linear, rotational, and projectile. With linear, the accelerometer will be dropped in one translation down from the height to the earth. For rotational, the accelerometer will drop, but it will also have a spin to it, and a rotation. Third, the projectile fall is when you throw the device, so not only will it have a horizontal movement as well as a vertical movement, but it also will have a slight rotation in it as well.

Linear freefall requires three axes for determining when it is in complete freefall. Rotational and projectile require, in addition to the three-axis device, very complex algorithms for monitoring the freefall signature. With linear, rotational and projectile falls, you can determine the height of the fall by sampling. This means knowing the rate that the accelerometer is sampled by the microcontroller, the time that an object starts to fall, and the time that impact occurs. This gives a difference equal to the time of the fall. This information can be taken with an equation to determine the height of the fall.

Measuring Tilt

Things to Consider:
- What is the angle of reference?
- How is the accelerometer mounted?

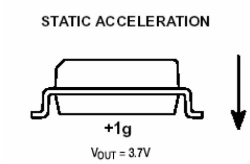
Mount the accelerometer so the axis of sensitivity is parallel to the earth's surface.

Typical Tilt Equation

$$V_{OUT} = V_{off} + \left(\frac{\Delta V}{\Delta G} \times 1.0G \times \sin\theta\right)$$

where:

V_{OUT} = Output of accelerometer
V_{off} = Zero accelerometer
$\Delta V/\Delta G$ = Sensitivity
1.0G = Earth's gravity
θ = Tilt angle



Now, let's look at the two things to consider when measuring tilt. First, consider the angle of reference. To achieve the highest resolution of tilt, the angles of operation are needed to determine the sensing axis that would be optimal for the application. The second thing to consider is how the accelerometer is mounted. How is the accelerometer going to be mounted on the PCB and how is the PCB going to be mounted on the equipment?

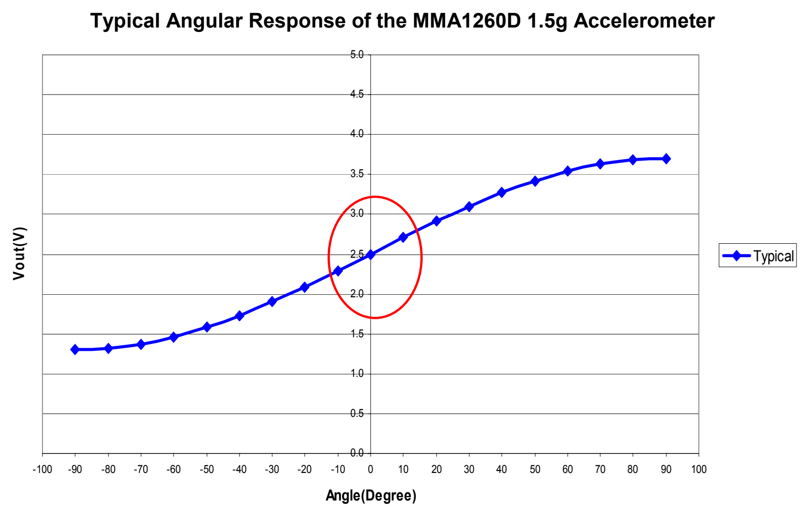
Let's take some time to examine the typical tilt equation displayed here. Vout equals the sensitivity of the accelerometer multiplied by 1g times the sine of the tilt angle, all added to the offset voltage of the accelerometer.

The offset voltage of the accelerometer is half of the voltage supply of the accelerometer. For the MMA1260D, the offset voltage is 2.5V. For the MMA7260Q, the offset voltage is 1.65V.

The accelerometer output will vary from –1.0g to +1.0g when it is tilted from -90° to +90°. However, the output is nonlinear so a sine function has to be used in the equation.

It is important to note that since the output is not linear, the mounting orientation that achieves the most sensitivity is when the sensing access is parallel to the earth's surface.

Measuring Tilt



Here is a typical response of the MMA1260D 1.5g accelerometer. The typical analog output voltages of capacitive, micromachined accelerometers is non-linear and more like a sine function.

This graph shows degrees of tilt from -90° to +90°. The slope in the middle is a lot higher than on the sides of the graph. This location is where there is the most sensitivity, as the slope of the curve is actually the sensitivity of the device. The change in tilt angle is directly linked to acceleration. This is due to gravity’s force component changing on the accelerometer at degree angles.

Measuring Position/Movement

Considerations:
- What is the displacement?
- What is the g-range?
- What is the sensitive axis?

To determine velocity, integration is used. To determine position, double integration is performed on the acceleration data.

$$\Delta V = \int_0^{T1} a(t)dt$$

Here are some considerations for measuring position and movement. First is the displacement: how far will the accelerometer be moving to detect the change in movement? What is the g-range of the device? If it's going to be on a person, the levels are at a higher g-force and require a higher g-range accelerometer. If it's going to be a very small change, such as in a g-mouse, it requires an accelerometer that's even more sensitive. In this case, a lower g-range accelerometer is needed. After this, the sensing axis has to be determined. Where is it going to be moving: in the X plane, the Y plane, or Z plane, or all three? This answer will determine how many sensing axes are required in the accelerometer.

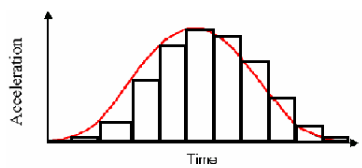
For determining velocity, integration is used. To determine position, a double integration is performed on the acceleration data. This repeated integration involved in the equation compounds the errors from the original acceleration data. So error compensation needs to be taken into account. Depending on the object, the g-force can range from 2g to 20g in motion.

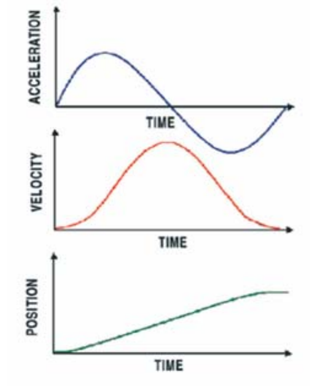
Measuring Position/Movement

Considerations:
- What is the acceleration range?
- How is the accelerometer mounted?

Position data is obtained when double integration is performed on the acceleration data.

$$x(t) = \iint a(t)\, dt$$





Let’s continue looking at position and movement measurements. What is the acceleration range? How is the accelerometer mounted?

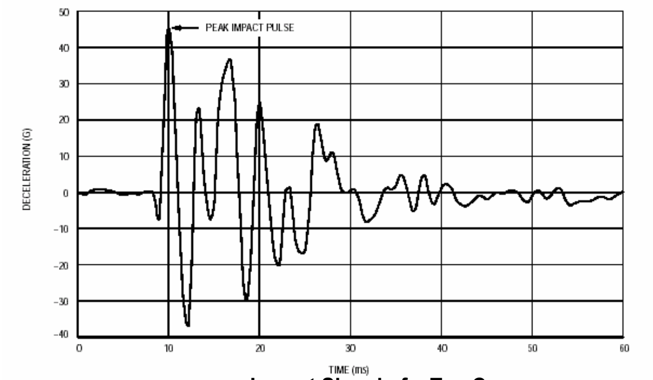
Here are some graphs that show changes in acceleration, and the respective velocity that can be extracted for different acceleration changes. From velocity is position detection, with its respective graph.

Position data is obtained when double integration is performed on the acceleration data. This graph showcases the double integration that is determined in the area under the curve of acceleration. What is actually noted is that acceleration data is not continuous. The accelerometer samples the acceleration data only at certain times, so an approximate integration in the calculation is done.

Measuring Shock

Considerations:
- What is the g-range?

- **The accelerometer uses the deceleration of the object to determine the shock.**
- **The algorithm varies for each design.**



Impact Signal of a Toy Car

Now looking at shock measurements, the biggest thing to consider is the g-range. What kind of shock are you going to see? What is the type of acceleration?

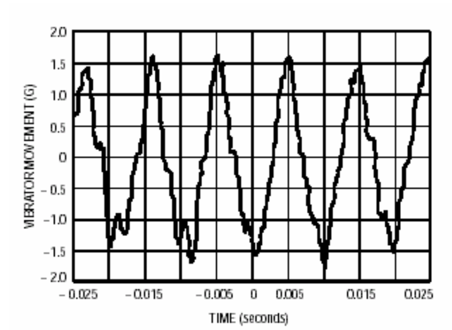
The accelerometer uses the deceleration of the object being measured to determine the shock. For example, a force of +/-1g is measured for shock detection during tapping or measured up to +/-250g during a car crash. The algorithm for each design also varies with the type of shock or fall that its receiving. The algorithm entails setting the threshold at a predetermined shock level.

The graph shown here is an example of a typical shock that a toy car receives when it hits an object.

Measuring Vibration

Considerations:
- What is the frequency of vibration?
- What is the g-range?
- Where is the accelerometer mounted?

- **Each harmonic component is a "vibration" signature.**
- **The g-force can range from 2g to 20g.**
- **The closer the accelerometer is mounted to the vibration source, the higher the g-range.**



Example:
+/-2g Pager Vibration Waveform

For measuring vibration, the first thing to consider is the frequency of the vibration. This will determine the type of roll-off frequency for the different devices that Freescale offers. The second thing to consider is the g-range, depending on the vibration measured or the strength of the motor, there will be a different type of g-range. This means you might have to go with a small +/- 2.5g accelerometer for a pager vibration (shown here), all the way up to a 10g accelerometer for a washing machine out-of-balance detection. The third thing to consider is the accelerometer and where it's mounted. Depending on the mounting, there will be a different acceleration, which also depends on the cross-axis sensitivity of the accelerometer.

To achieve the measurement of vibration, a fast fourier transform is integrated into the software. This allows the vibration signal to be broken down into different harmonic components. Each motor vibration has a different set of harmonic components, which is called its vibration "signature." Depending on the motor or the object that is vibrating, the g-force can range from 2g to 20g. In addition, the closer the accelerometer is mounted to the vibration source, the higher the g-range. So, when you're measuring a washing machine that is out of balance, if the accelerometer is mounted on the outer tub, you'll receive a smaller g-range than if it were mounted on the inner tub of the washing machine.

Question

Match each sensing function with a question you should ask to determine its considerations by dragging the letters on the left to the corresponding question on the right. Click Done when you are finished.

A	Measuring freefall	E	What is the frequency of vibration?
B	Measuring tilt	D	What is the peak impact?
C	Measuring position/ movement	B	What is the angle of reference?
D	Measuring shock	C	What is the displacement?
E	Measuring vibration	A	What is the height requirement for detection?

Done | Reset | Show Solution

Let's review the six sensing functions of acceleration sensors.

Correct.

When measuring freefall, the best things to consider are g-range, cross axis acceleration, and the height requirement for detection. When measuring tilt, the best things to consider are the angle of reference and how the accelerometer is mounted. When measuring position and movement, the best things to consider are displacement, g-range, the sensitive axis, the acceleration range, and how the accelerometer is mounted. When measuring shock, the best thing to consider is the peak impact. When measuring vibration, the best things to consider are the frequency of vibration, the g-range, and where the accelerometer is mounted.

References and Demo Kits

RD3112MMA7260Q – Sensing Triple-Axis Reference Design (STAR) Board

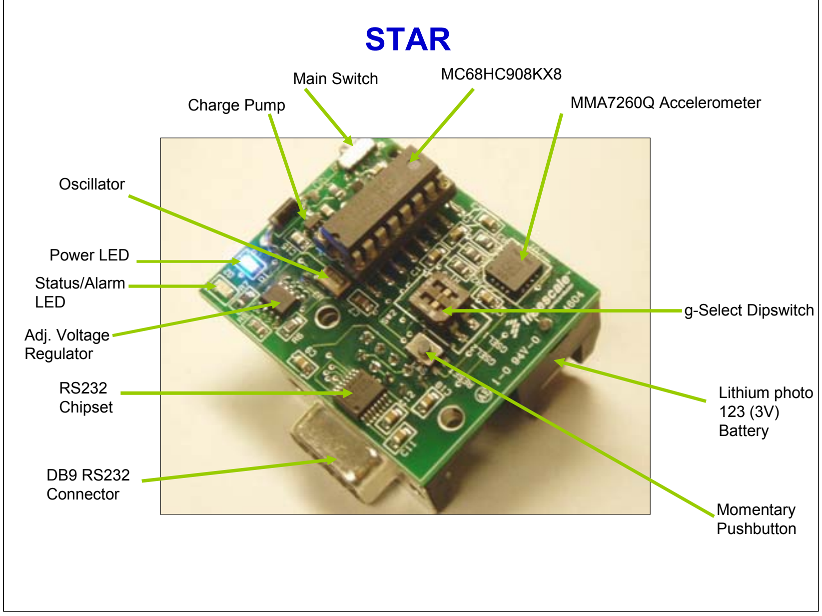
Software Available

KIT3109MMA7260Q – 3-Axis Acceleration Sensing Evaluation Board

Freescale offers orderable reference designs and evaluation board demo kits for all of our low-g accelerometers. In addition, there are two new kits available for testing and evaluating the three-axis device. The first kit, RD3112MMA7260Q is a three-axis acceleration sensing referencing design, also called the Sensing Triple Axis Reference (STAR) board. It is designed to allow visualization of key accelerometer applications in the consumer industry.

The software available is shown here. These are just some of the modules available to give customers ideas for implementing accelerometers. Accelerometer applications have grown dramatically since their entrance into the consumer market. This tool shows many of those applications.

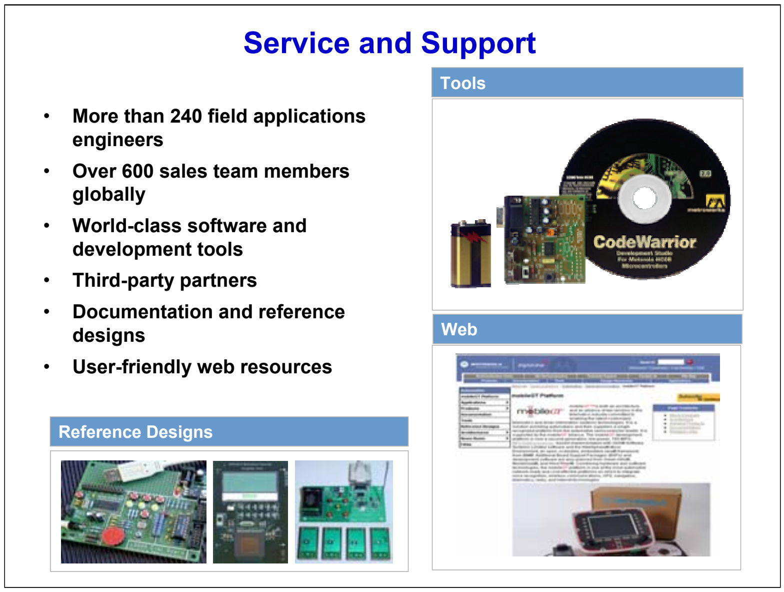
The second kit, part number KIT3109MMA7260Q, is an evaluation board. It allows the customer to quickly test the device without requiring the time to design a PCB to accommodate the more complex QFN packaging. Just by soldering wires to the six pads of the evaluation board, a customer can apply power, ground, and connect the three acceleration outputs to an oscilloscope, a microcontroller, or a prototype and get started with prototype testing quickly.



Now let's take a closer look at the STAR design. There are many components onboard this development tool.

The STAR board uses a low-cost, 8-bit microcontroller for processing the accelerometer data. The MCU sends data via an RS232 port to a CPU for further processing and graphical display of the acceleration data. In stand alone operation, the MCU can store acceleration, motion, or position data to a set of external EEPROMs. This data can be downloaded later to an excel file through the serial connection using the demo software provided. During stand alone operation, there are Status LEDs and a Piezo-electric buzzer allowing the MCU to display program modes.

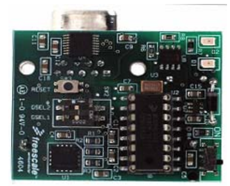
The dipswitches located on the STAR Board allow for the manual setting of the g-range. The On position indicates a logic “1”, which is equal to Vdd of the MMA7260Q. The Off position is a logic “0” or Vss of the MMA7260Q. For a final design, the g-Select is best configured to the additional I/O of a chosen microcontroller. In that case the sensitivity of the device could be easily changed with a quick change in the software I/O ports. In addition, the software can be configured so that different sensitivities can be used for several applications, where the MCU drives the g-Select during different modes of operation.



Now, let’s take a moment to consider the service and support that Freescale offers. With 240 field application engineers, Freescale provides service and support for all of its accelerometers. In addition, there are over 600 sales team members globally for Freescale’s world-class software and development tools. These sales team members are available for online orders through Development Tools Direct. Freescale also has many third-party partners. In addition, documentation and reference designs are available on product summary pages and user-friendly web resources.

Question

Drag and Drop the letter next to the part number below to the appropriate box on the right



Sensing Triple Axis Reference (STAR) Board
Allows visualization of key accelerometer applications while connected to a CPU

3-Axis Acceleration Sensing Evaluation Board
Simple PCB for prototype evaluation of the MMA7260Q using an oscilloscope and external power supply.

A. RD3112MMA7260Q
Reference Design

B. KIT3109MMA7260Q
Evaluation Board

Match the following development tool part numbers with their respective photo and description. Click Done when you are finished.

Correct!
Freescale offers the RD3112MMA7260Q Sensing Triple Axis Reference (STAR) Board which allows visualization of key accelerometer applications while connected to a CPU. Freescale also offers the KIT3109MMA7260Q 3-Axis Acceleration Sensing Evaluation Board that is a simple PCB for prototype evaluation of the MMA7260Q using an oscilloscope and external power supply.

Course Summary

The Strength and Stability of an Established Leader:

- Sensor product family overview
  - Automotive, consumer, industrial, networking and wireless markets
  - 25-year legacy: Built on market success of the X, XY and Z-axis low-g accelerometer products
- Features and benefits of the MMA7260Q acceleration sensor
- g-Select
- Six sensing functions
- Reference designs and demo kits

Freescale has had 50 years of innovation in semiconductors, focusing on the needs of the designer with reliable, well-supported products. Freescale Semiconductor, Inc. is a global leader in the design and manufacture of embedded semiconductors for the automotive, consumer, industrial, networking and wireless markets. In addition, Freescale has a 25-year legacy with sensor products, which became the cornerstone for the success of our X, XY, Z-axis and now XYZ low-g accelerometers.

In this course, you learned about the features and benefits of the various sensor product families, and the MMA7260Q accelerometer, which is a three axis low-g acceleration sensor. You learned that Freescale focuses on the needs of the designer by identifying the features required. For example, the needs identified for handheld electronics resulted in features such as Sleep Mode for battery savings and an improved 2.2V to 3.6V interface allowing many of today's MCU and I/O systems to interface with the accelerometers.

You learned about g-Select sensitivity and typical accelerometer applications. Finally, you examined the six sensing functions of acceleration sensors and you learned about orderable reference designs and evaluation board demo kits. Finally, you learned about the services and support that has made Freescale an established leader.