MEMS

Oct. 2012

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MEMS

- **MEMS** is an acronym for Micro Electro Mechanical Systems
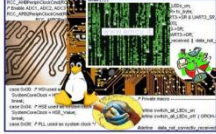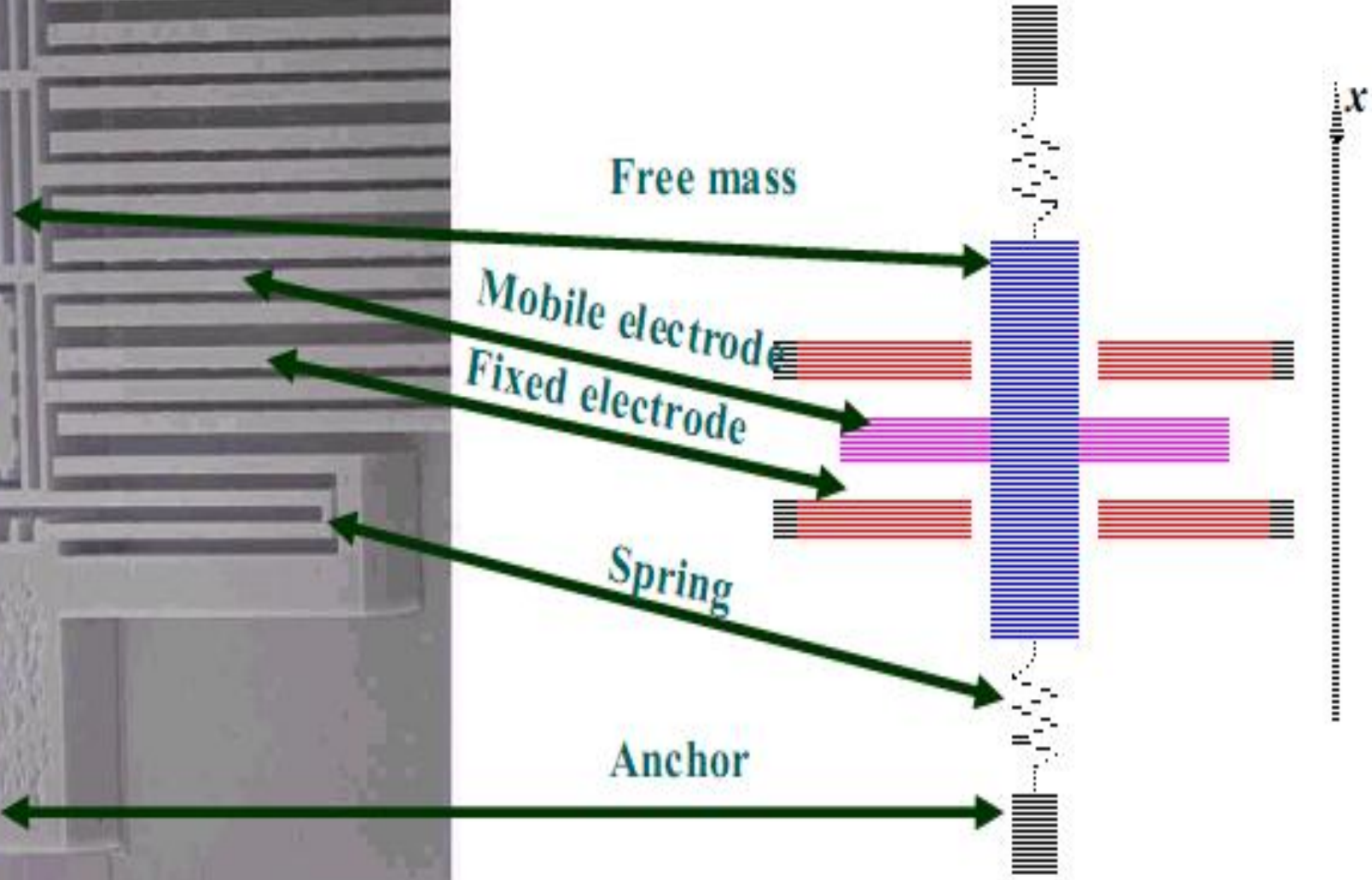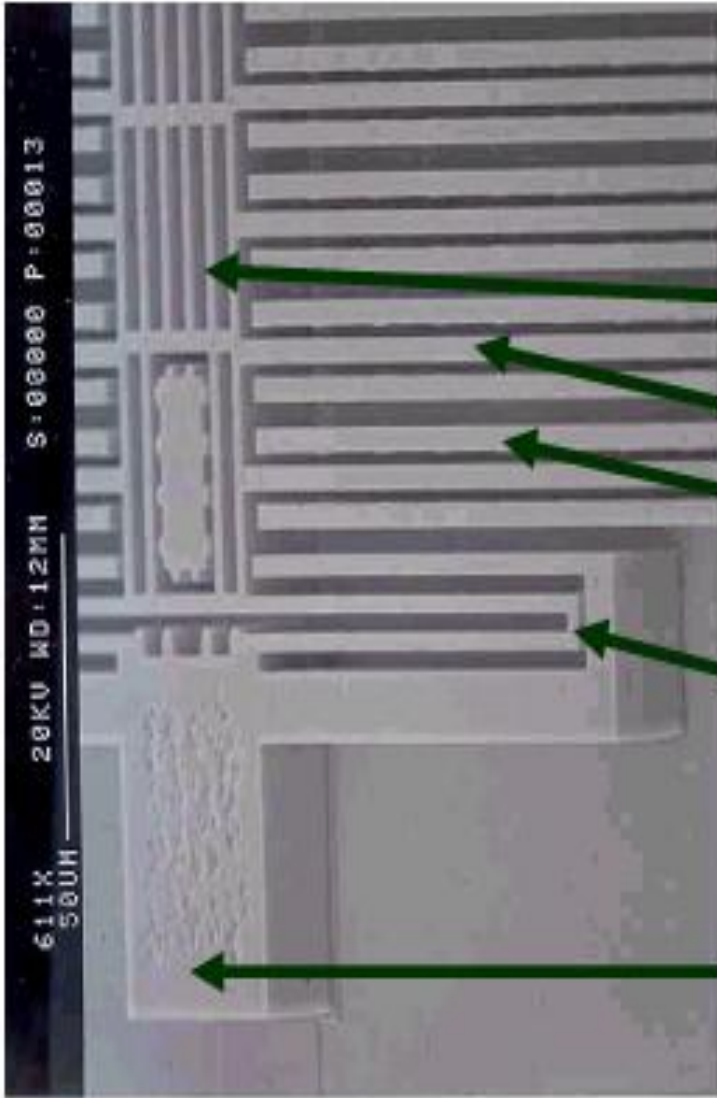- They contain 3-dimensional structures realized through a specific process called Micro-Machining
- They are micron-size devices that interact with external world for sensing and actuation

MEMS

Free mass

Mobile electrode

Fixed electrode

Spring

Anchor
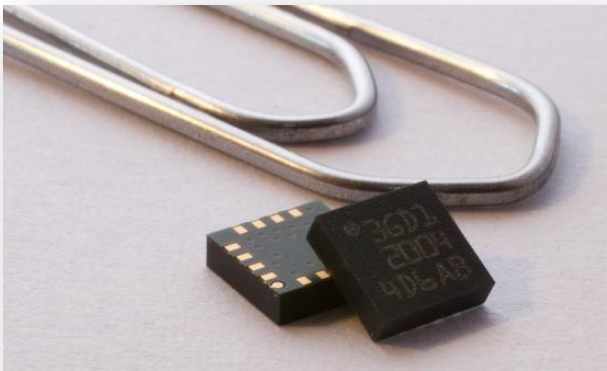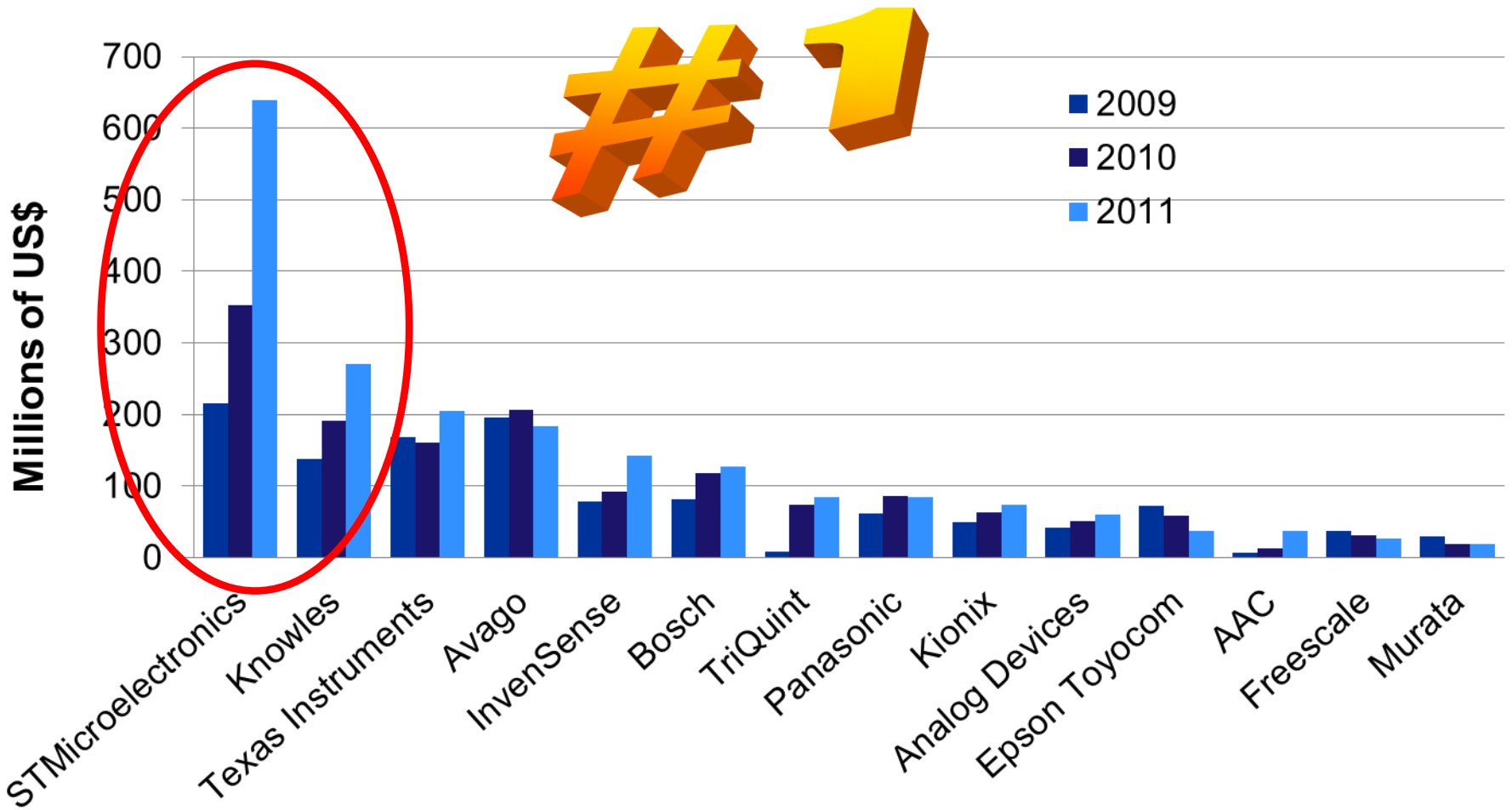
MEMS

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Technology Milestones

$7x5mm^2$　　$5x5mm^2$　　$4x5mm^2$　　$4x4mm^2$　　$3x5mm^2$　　$3x3mm^2$　　$2x2mm^2$
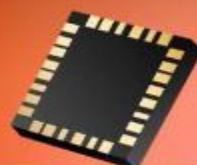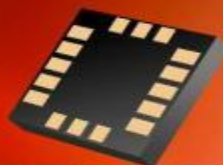
1cm　　2cm　　3cm　　4cm　　5cm

**ST has manufactured more than 2,000M units
of Accelerometers, Gyroscopes and eCompass**

MEMS

Dedicated 8" MEMS FAB in Milan & Catania

MEMS

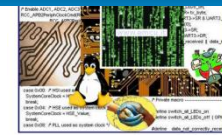MEMS sensors are commonly used in many consumer and industrial devices to enable motion-based applications

MEMS

- Accelerometers
- Gyroscopes
- Pressure
- Digital Compasses
- iNEMO Inertial Modules

Sensor fusion software
9-axis sensors

MEMS – 3-axis Accelerometers

Smaller size

Higher resolution /performances

LIS332AX 100µg/√Hz ±2g		
3 x 3 x 0.9		

LIS331DL 8-bit ±2/±8g
3 x 3 x 0.9

LIS331DLM 6/8-bit ±2/±4/±8g
3 x 3 x 0.9

LIS331DLH 12-bit ±2/±4/±8g
3 x 3 x 0.9

LIS331HH 12-bit ±6/±12/±24g
3 x 3 x 0.9

LIS3DH 12-bit ±2/±4/±8/±16g
3 x 3 x 0.9

LIS3DSH 16-bit data out ±2/±4/±8/±16g
3 x 3 x 0.9

LIS302DL 8-bit ±2/±8g
3 x 5 x 0.9

LIS344ALH 50µg/√Hz ±2/±6g
4 x 4 x 1.5

LIS3LV02DL 12-bit ±2/±6g
4.4 x 7.5 x 0.9

High runner

Analog

Digital

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MEMS High Performance Accelerometers

LIS331DLH

FEATURES

- User selectable from ±2g up to ±8g
- 16 bit data output
- Package - 3x3x1mm LGA
- 2 independent programmable interrupt generators for free-fall and motion detection
- Sleep to wake-up function

LIS3DSH
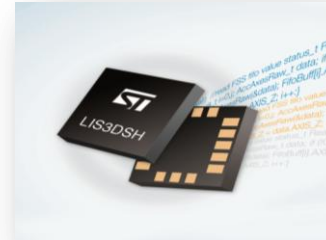
FEATURES

- User selectable form ±2g up to ±16g
- 16-bit data output
- Package - 3x3x1mm LGA
- **Embedded FIFO**
- **Embedded Finite State Machine**
- Higher performances – more functionalities integrated inside the sensor
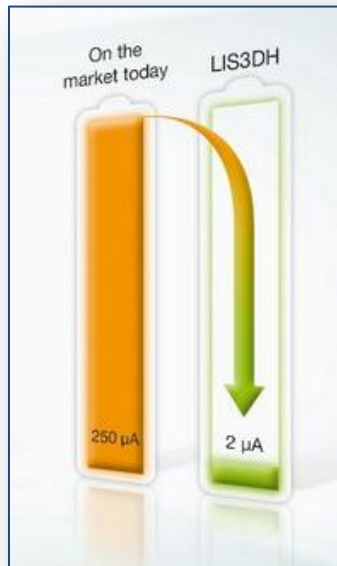- Complete customizable motion recognition

MEMS - Ultra low-power

LIS3DH

FEATURES – High runner

- Selectable Full-scale from ±2g up to ±16g
- High resolution
- Ultra low power consumption
- 4D/6D orientation detection
- Programmable interrupts
- Embedded FIFO
- Power-down and Sleep mode
- Digital Interfaces I2C/SPI
- Small Package 3x3x1mm LGA

LIS2DH

FEATURES

- Selectable Full-scale from ±2g up to ±16g
- High resolution
- Ultra low power consumption
- 4D/6D orientation detection
- Programmable interrupts
- Embedded FIFO
- Power-down and Sleep mode
- Digital Interfaces I2C/SPI
- **Small Package 2x2x1 mm LGA**

On the market today LIS3DH

250 µA — 2 µA

MEMS - Gyroscopes Portfolio

High runner

Axis

+

3-axis

L3G4200D	L3GD20
4 x 4 x 1	4 x 4 x 1

Gaming, Pointing Devices and Navigation

2-axis

LPY450AL ±500 °/s	LPY4150AL ±1500 °/s	LPY430AL ±300 °/s
4 x 5 x 1	4 x 5 x 1	4 x 5 x 1

LPY403AL ±30 °/s	LPY410AL ±100 °/s
4 x 5 x 1	4 x 5 x 1

Analog

Gaming, Pointing Devices and Navigation

Single-axis

-

LY330ALH ±300 °/s	LY3100ALH ±1000 °/s	LY3200ALH ±2000 °/s
3 x 5 x 1	3 x 5 x 1	3 x 5 x 1

Analog

Gaming, Pointing Devices and Navigation

Smaller size

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MEMS - L3GD20 3-Axis D-Gyroscopes

L3GD20 Features

❖ Selectable Full Scale from ±250 up to ±2000 dps

❖ Any supply voltage over the range of 2.4 to 3.6V

❖ Programmable interrupts

❖ Digital Interfaces I2C/SPI

❖ Embedded Power-down and sleep modes

❖ Embedded FIFO

❖ It integrates low- and high-pass filters with user-selectable bandwidth

❖ Temperature sensor

❖ LGA Package 4x4x1mm

Gyroscope Development Roadmap: More features in smaller packages

MEMS - eCompass

Accelerometer + **Magnetic Sensor** ⇒ **eCOMPASS**
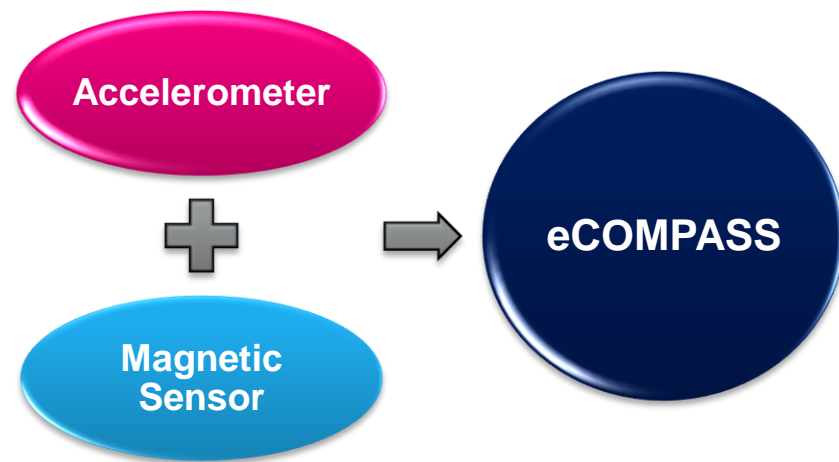
Integration of different sensors in the same package

- More compact, robust and easy-to-assemble solutions
- Superior stability over time and temperature
- Particularly suitable for applications such as location-based services, pedestrian dead reckoning, map/display orientation, and direction finding

MEMS - LSM303DLHC – 3-axis XL + 3-axis Mag

LSM303DLHC Features

- **Magnetometer Specification**
  - 3-axis Magnetometer
  - FS from $\pm$1.3 gauss up to $\pm$8.1 gauss

- **Accelerometer Specification**
  - 3-Axis Digital Output (I2C)
  - FS from $\pm$2g up to $\pm$ 16g

- **6 DOF Module Package**
  - I2C Interface & Programmable Interrupts
  - Operating current consumption < 100 µA

Advantages

- **Space-Saving** with LGA 3x5x1 mm
- **Power- Saving** Operating consumption < 100 µA
- **Magnetic sensing resolution**: 2m Gauss

MEMS - **Pressure**

The **LPS331AP** is an ultra compact absolute piezoresistive pressure sensor. It includes a monolithic sensing element and an IC interface able to take the information from the sensing element and to provide a digital signal to the external world.

Key Features

- 260 to 1260 mbar absolute pressure range
- High-resolution mode: 0.020 mbar RMS
- Low power consumption:
  - Low resolution mode: 5.5 µA
  - High resolution mode: 30 µA
- High overpressure capability: 20x full scale
- Embedded temperature compensation
- Embedded 24-bit ADC
- Selectable ODR from 1 Hz to 25 Hz
- SPI and I2C interfaces
- Supply voltage: 1.71 to 3.6 V
- High shock survivability: 10,000 g
- Small and thin package
- ECOPACK® lead-free compliant

HCLGA-16L
(3 x 3 x 1 mm)

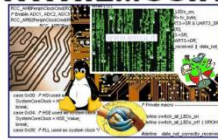# MEMS - iNEMO System In Package

Accelerometer

Gyroscope

iNEMO Inertial Modules

LSM330DLC Features

❑ **Gyroscope Specification**

  ❑ 3- axis Digital Output (I2C/SPI)

  ❑ FS from ±250dps up to ±2000dps

  ❑ Programmable Interrupts

❑ **Accelerometer Specification**

  ❑ 3- Axis Digital Output (I2C/SPI)

  ❑ FS from ±2g up to ± 16g

  ❑ Programmable Interrupts

❑ Module Package 4x5x1 mm LGA
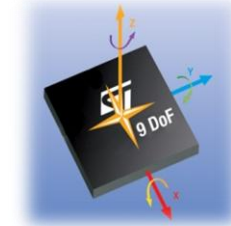
MEMS - iNEMO System In Package

6-Axis family

FEATURES

- 3-Axis Accelerometer + 3-Axis Digital Gyro
- Advanced digital features embedded
- High accuracy of the sensing axis alignment
- High stability over temperature
- LGA package – up to 10,5mm^2
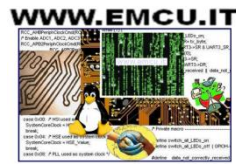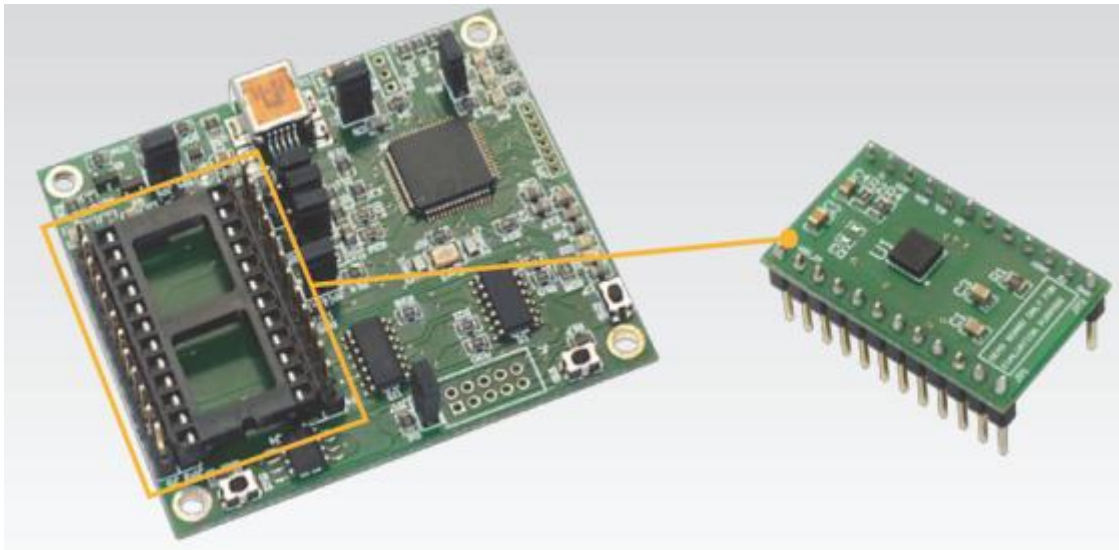
9-Axis family

NEW

FEATURES

- 3-Axis Accelerometer + 3-Axis Gyro + 3-Axis Magnetometer
- Smart power management
- Advanced design for easy user system integration
- LGA package – up to 16mm^2
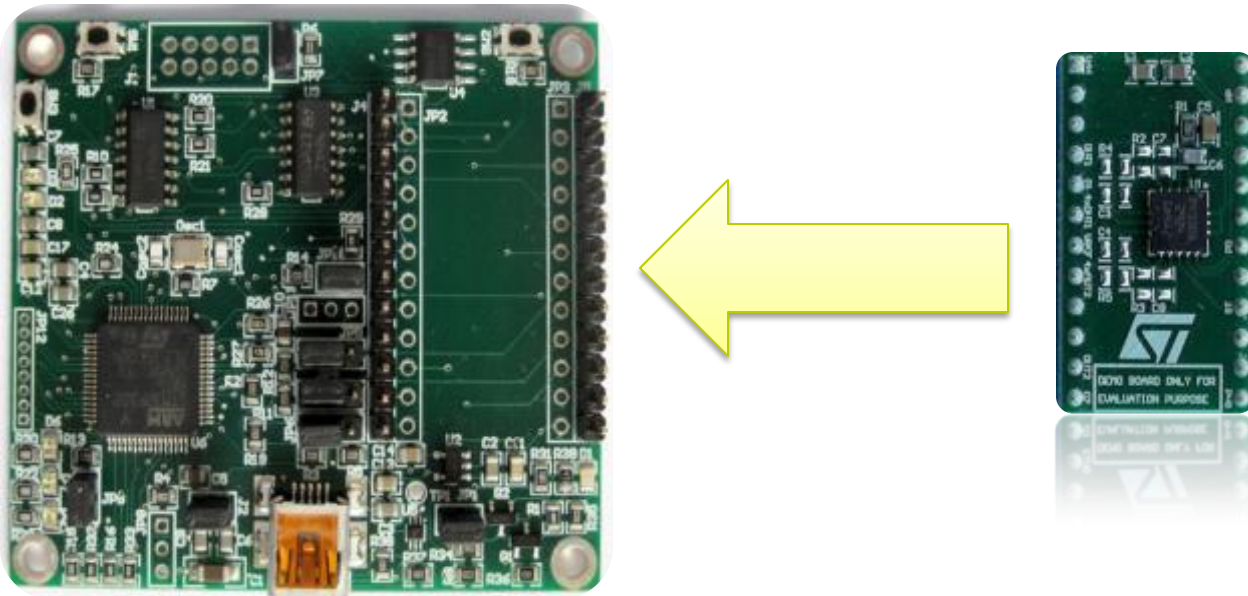- **Device Status Preview**

MEMS - *Evaluation Tools*

Oct. 2012

MEMS – Eva-Board

- New generation of MEMS demonstration board

- ST MEMS motherboard based on STM32

- Compatible with all ST MEMS adapters

Order code:**STEVAL-MKI109V2**

MEMS - Eva-Board

STEVAL-MKI119V1 == STEVAL-MKI109V2 + STEVAL-MKI108V2 (9-axis)

- Ready to support iNemoEngine_PW8
- Controlled by the STM32F103 high performance ARM 32-bit Cortex™-M3 CPU
- DFU compatible for USB microprocessor firmware update
- L3GD20 and LSM303DLHC 9 axis module designed to be plugged into a standard DIL24 socket

Order code:STEVAL-MKI119V1

STEVAL-MKI108V2

STEVAL-MKI109V2

SILICA
An Avnet Company

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MEMS – Eva-Board SW

http://www.emcu.it/MEMS/MEMS.html#Accelerometer_eva-board