MEMS & SENSOR for SMART LIFE

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What’s Smart Life?

Existing Things augmented...

New Things to augment life

Smart City

Smart Home

Smart Car

Wearable
Wearables – Hot Topic at MWC’15
Inside the Apple Watch: Technical Teardown

STMicroelectronics gyroscope and accelerometer

At the top left corner of the S1 module we were expecting to see a motion sensor from InvenSense, but, surprise surprise, we have a brand new STMicroelectronics 3 mm x 3 mm land grid array (LGA) package featuring a 3D digital gyroscope and accelerometer. The package marks feature the letter C followed by a three digit numeric 4,5,1. Great job on STMicroelectronics for this socket win.

Brand new STMicroelectronics 3 mm x 3 mm LGA package featuring a 3D digital gyroscope and 3D digital accelerometer.
Making Things Smarter

- **Watch**: It used to tell you the time. **Now** it tells you what to do. **And** how you are doing.

- **Socks**: They used to keep your feet warm. **Now** they help you keep you and your feet fit.

- **Bracelet**: It used to remind you of someone close to your heart. **Now** it reminds you to take care of your heart. **And** exactly what you doing.

- **Glasses**: They used to help you see clearly. **Now** they help you to see more.
Paving the Road to a “Trillion Sensors”

“Thing”

- Sensors
- Low-power brain
- Ultra-low power connectivity
- Analog

Smart Energy management

Smart

Low power

Connected

Managed

Secure

Fitness & Wellness

Healthcare

Home or Office

City

Automotive /Industrial
The Internet of Things

Existing Things
augmented...

New Things to
augment life

Smart Home

Smart City

Wearable

Smart Car

life. augmented
Smart Everything
New Things to Augment Life

Smart City
Reduce traffic congestion
Better use of resources
Improve security

Smart Car
Reduce emissions
Increase safety
Save fuel

Smart Home
Make entertainment more interactive and immersive
Increase comfort
Save energy

Smart Me – Healthcare
Empower patients
Help physicians monitor and diagnose remotely

Smart Me – Wellness
Help to lead healthier lives
Optimize sports performance
Early warning of illness

Smart Industrial & Smart Services
Productivity gains
Efficiency, agility
MEMS for Sensing and Actuating

Physical change

Motion

Environmental

Audio

Sensors

Electro

MEMS

Mechanical

Micro-actuators

Optical

Micro-actuators

Fluidic

Micro-actuators

Signal

Electric
MEMS: A Unique Blend of Skills

- Electrical & Micro-Mechanical design
- MEMS-specific process
- CMOS process for ASICs
- Packaging design & Manufacturing
- Sensor fusion engine
- Ultra-low-power microcontrollers

ST has a unique ability to master the full MEMS chain.
A First Wave of Expansion

Motion MEMS enter the smartphone

Motion MEMS revolutionize gaming

Gyroscopes in high volume smartphones

Pressure sensors in high volume smartphones

Diversification of MEMS applications

ST the First Billion Dollar MEMS Company
ST Motion MEMS
The most complete MEMS Product Portfolio

Discrete
- Accelerometer
- U/I Gyro
- Magnetometer
- OIS Gyro

iNEMO 6-axis
- U/I Gyro
- Accelerometer
- Accelerometer
- Magnetometer

iNEMO 9-axis
- Accelerometer
- Magnetometer
- U/I Gyro

Smart Sensors
- U/I Gyro
- Accelerometer
- Accelerometer

including SW support
- Sensor Fusion;
- Sensor HUB SW solution
- Background Always On Processing
LSM6DS3: Accelerometer + Gyroscope
the 6x ULTRA experiences

- **Step Counter and Step detector**
  For Activity Monitoring

- **Significant Motion Detection**
  For trigger a change in user location

- **Tilt function**
  For system inclination monitoring

- **Embedded Time Stamp**
  For accurate data correlation

- **Sensor Hub & Ironing correction**
  External sensors connection and magnetometer correction

- **Smart FIFO**
  For data storage and system power saving

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LSM6DS3 - at a glance

The 6X Ultra

**Ultra low power**
- Industry leading low power performance for 3A+3G combo
- Down to 0.6mA in always-on mode
- **20% better** than the best alternative solution

**Ultra performing**
- Industry-best resolution for gyroscope and accelerometer
- Gyroscope rate noise down to 7mdps/√Hz (typ.)
- Accelerometer rate noise down to 90µg/√Hz (typ.)

**Ultra smart**
- Embedded efficient and reliable motion tracking, pedometer and context awareness
- Saving power and enabling faster system reaction time

**Ultra small size**
- Tiny size to fit in the smallest, wearable and Internet of Things devices
- 2.5mm x 3.0mm x 0.8mm

**Ultra capable**
- 8kbytes “smart” FIFO memory to batch more data before system wake-up
- **2 times larger** than the best alternative solution

**Ultra scalable**
- Ideal companion for the ultra-low power STM32 family of microcontrollers
- The best combination of 6-axis sensor plus sensor hub
Environmental Sensors
Broadening the Portfolio

Around 65 million Pressure sensors shipped in 2014
Introduced world’s smallest pressure sensor in tiny package

UV index
Introduced and ramped the world’s first sensor to provide a direct digital output of the Ultraviolet Index (UVI)

Temperature & Humidity
Combined temperature & humidity sensor in production
Absolute Pressure Sensor
LPS25HB

- Unique ultra thin full-molded package
- Dust-free and water resistant
- High shock survivability
- 260 to 1260 hPa absolute pressure
- Low power consumption: down to 4 μA
- SPI and I²C interfaces
- Embedded FIFO
- Supply voltage: 1.7 to 3.6 V

Main features

2.5 x 2.5 x 0.76 mm
Humidity and Temperature Sensor

HTS221

Main features

- Humidity and temperature sensor
- 0 to 100% RH range
- -40 to 120 °C temperature range
- Low Power Consumption: 1 µA @ 1Hz ODR
- Humidity Accuracy: ±4.5%RH (20%RH to 80%RH)
- SPI and I²C interfaces
- Supply voltage: 1.7 to 3.6 V

Home automation
Weather station
Air density monitoring
HVAC, respiratory equipment
Condensation level monitoring
UV Index Sensor
UVIS25

Main features
- 0 - 15 UV index output range
- Resolution: UVI / 16
- Selectable Read out :1 Hz ODR/ one shot
- SPI and I2C interfaces
- Supply voltage: 1.7 to 3.6 V
- transparent molded package 2.5x2.5x0.8mm 10L

UVI index

UV radiation Problems
- Skin Cancer
- Suppression of the immune system
- Premature aging of the skin

UVIS25

Health and wellness
Weather station
Wearables and smartphone
MEMS Microphones

- Withstand reflow temperature without performance change
- Enhanced audio performance vs conventional ECM
- Easy-to-design in multiple-microphone applications
- Higher application robustness

Main features
- Vibration robustness
- Performance matching
- Silicon based technology
- Small form factor
- SNR 65dB, AOP 130dBSPL

Silicon based MEMS technology, analog or digital output

MP34DT01/-M, MP34DB02, MP23AB02B

RHLGA 3.5 x 2.65 x 0.98 mm
What is Open.MEMS?

Open.MEMS licensing program is born to offer to our customers an easy way to evaluate, program and play with sensors, speeding up production development and shortening time-to-development.

STM32 Open Development Environment

- **ULP Microcontrollers & Memories**
- **Sensors**
- **Software**
  - Ultra-low power connectivity
  - Smart Energy Management
  - Analog and mixed signal components
Open.MEMS web site address: www.st.com/openmems

Open.MEMS licensing program is born to offer to our customers an easy way to evaluate, program and play with sensors, shortening time-to-development.

The program makes freely available to all the customers and open-community developers drivers, middleware, and application software to develop with ST sensors using the STM32 open ecosystem.

The first important SW for MEMS to be licensed under the Open.MEMS framework is the sensor fusion, which combines data from several sensors achieving the high level of accuracy required by portable and wearable devices and other emerging applications, such as the IoT.

The X-CUBE-MEMS2 includes a library called osxMotionFX that is the evolution of NEMO Engine PRO, ported in STM32 open development environment. As its predecessor, osxMotionFX is filtering and predictive software that uses advanced algorithms to integrate and read in real-time outputs from multiple sensors, achieving accurate position information, independently of environmental conditions.

The X-CUBE-MEMS2 SW package includes STM32F4 Cube distribution and osxMotionFX sensor fusion libraries, which will be also available standalone.

X-CUBE-MEMS2 must be used in combination with NUCLEO-F401RE board. You can download the software from ST.com. When installed on your pc, it must be activated through a licensing wizard tool (included into the MotionFX distribution package).

What do you need to start a sensor fusion design?

1) Hardware requirements:
   - NUCLEO-F401RE, STM32F401 Nucleo board
   - X-NUCLEO-IKS01A1 Sensor expansion board

2) Software requirements:
   - X-CUBE-MEMS2 (includes STM32F4 Cube distribution and osxMotionFX libraries)
Takeaways

**Sensors are now spreading over the world**

Influence **all the aspects** of our lives

Bring exciting ways of **interacting** with the world

A key building block of the **Internet of Things & Wearable**

**Wearable & IOT market is growing**

**ST remains at the center** of this evolution

Continuous **innovation**

**Diversification** of the sensors portfolio

Reliable **supply chain**

Strong **ecosystem** of partners
Thank you!

ST stands for
life.augmented
The Internet of Things

Existing Things augmented...

New Things to augment life

Smart Home

Smart City

Wearable

Smart Car
Smart Everything
New Things to Augment Life

Smart City
- Reduce traffic congestion
- Better use of resources
- Improve security

Smart Car
- Reduce emissions
- Increase safety
- Save fuel

Smart Home
- Make entertainment more interactive and immersive
- Increase comfort
- Save energy

Smart Me – Healthcare
- Empower patients
- Help physicians monitor and diagnose remotely

Smart Me – Wellness
- Help to lead healthier lives
- Optimize sports performance
- Early warning of illness

Smart Industrial & Smart Services
- Productivity gains
- Efficiency, agility
• High performance 14-bit accelerometer
• Supply voltage @ 1.8V
• Dynamically selectable full scale:
  • ±2g / ±4g / ±8g / ±16g
• Long FIFO: 256 Level FIFO
• ODR: 1Hz – 6.4kHz
• Anti-aliasing filter
• I2C/SPI digital output interface
• Embedded temperature sensor
• Low power consumption down to 2uA in active mode

• **Smart embedded features**
  • Free Fall, Wake Up
  • Tilt, Step Counter and Step Detector
  • Significant Motion Detection
LSM303AH / LSM303AGR
Ultra-compact 6-axis eCompass

The LSM303A/LSM303AGR integrates a high-performance three-axis magnetic field sensor with a high performance three-axis accelerometer

**Main Features**

- 3-axis accelerometer: up to ± 16g full-scale
  - LSM303AGR based on LIS2DH12
  - LSM303AH based on LIS2DG
- 3-axis magnetic sensor: ± 30Ga
- Embedded temperature sensor
- Embedded Self test for A and M
- I²C/SPI interfaces
- Package: LGA-12, 2 x 2 x 1 mm
- Board compatible with
  - LSM303C
  - LIS2HH12
  - LIS2DH12

**Advanced Features**

- Programmable interrupt generators
- FIFO for accelerometer data
- Advanced power management functionality
- Smart Magnetic sensor low power management
- Embedded magnetic offset compensation
**LSM9DS1**

9-axis iNemo Inertial Modules

High performance and “always-on”

- Always-on” eco power mode down to 1.9 mA
- Magnetic sensor power consumption 16 times smaller than competitors
- Monolithic technology solution for magnetic part and single resonant frequency
  - No technology mismatch between the axis

**Main features**

- 3-axis accelerometer: up to ± 8g
- 3-axis gyroscope: up to ± 2000dps
- 3-axis magnetic sensor: up to ± 16Ga
- Embedded FIFO and temperature sensor
- Power Supply range: 1.9V to 3.6V
- Low power magnetometer
- Position and motion detection functions
- Click/double-click recognition

3.5x3x1 mm