MEMS & Advanced Analog

Benedetto Vigna
General Manager, MEMS, Sensors and High-Performance Analog Division

MicroElectroMechanical Systems (MEMS)

- MEMS take advantage of the electrical and mechanical properties of silicon
  - Electronic circuits
  - Mechanical structures
- Semiconductor manufacturing
  - High volume
  - Small size
  - Low cost
Key Messages

- Leadership in MEMS for consumer market
  - Extended customer base
  - Nimble product development
  - Timely investment in state-of-the-art manufacturing

- In 2009, expanded accelerometer portfolio with
  - Gyroscopes, microphones, compasses
  - Smart sensors: iNEMO™
  …toward the “One-Stop MEMS Supplier” goal

- Leverage leading MEMS position and strong competence to increase presence in advanced analog

MEMS Leadership

ST is #1 in MEMS for consumer electronics and mobile handset market
2009 ST revenues = $218M; Market TAM = $1,170M*

ST leads accelerometer business in all market segments

Consumer electronics and mobile handsets*
2009 ST Market Share = 50%

All markets, including automotive and industrial*
2009 ST Market Share = 21%

Manufactured > 750M accelerometers and gyroscopes

* Source: iSuppli
### MEMS Motion Sensors

<table>
<thead>
<tr>
<th>Year</th>
<th>CAGR</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>9.6%</td>
<td>US$</td>
</tr>
<tr>
<td>2006</td>
<td>6%</td>
<td>US$</td>
</tr>
<tr>
<td>2007</td>
<td>15.3%</td>
<td>US$</td>
</tr>
<tr>
<td>2008</td>
<td>8%</td>
<td>US$</td>
</tr>
<tr>
<td>2009</td>
<td>25%</td>
<td>US$</td>
</tr>
</tbody>
</table>

**Consumer Markets Exceeding Automotive Markets in Units and Revenue**

**Source:** iSuppli

**ST Drives MEMS Avalanche**

- **2005:**
  We entered PCs

- **2006:**
  We entered Gaming

- **2007:**
  We entered Phones
ST Continues to Drive MEMS Avalanche

- **2008:**
  We entered Pockets

- **2009:**
  We entered Cameras

- **2010:**

Source: iSuppli reverse analysis of Apple iPAD

MEMS Enable New Applications

- Optical Image Stabilization
- Point Of Interest
- Location Based Services
- Enhanced User Interface & On Line Gaming
- Augmented Reality
MEMS for Optical Image Stabilization

Hand tremors cause blurred images

Gyroscope senses tremors and the micro-actuator compensates

MEMS and GPS Enable Location-Based Services

How much is that shirt?

Point Of Interest

Augmented Reality

Source: www.apple.com (Wikitude)
MEMS in Automotive Market

- Navigators
- Dangerous driving detection
- Crash recording
- Post-crash door unlock system
- Anti-theft systems

... and much more...

MEMS in Healthcare

- Sensing
  - Body motion
  - Pressure
  - Acoustic signals
  - Bio signals (ECG, BGCM)
  - Biosensors

- Drug Delivery
  - Pumps
  - Valves
  - Nozzles
2009: Not Only Accelerometers

Cristallo: Ultra-Low-Power and High Performance Accelerometer

Higher flexibility at lower current

Advanced power management
- Wide supply voltage down to 1.8V
- Ultra low current

High versatility
- Extended FS range (2/4/8/16g)
- Multiple configurable interrupt sources

Embedded features
- Programmable FIFO (32 levels)
- 3 auxiliary ADC channels

100x Lower Power
Gyroscopes: We Are On Time

In 2009, we announced more than 30 Multi-axis Gyroscopes

Application Segments:
- Enhanced motion user interface
- Image stabilization
- Gaming
- Navigation

Gyrosopes market for mobile and consumer TAM 2010: $246M CAGR 2010-2013: ~20%

Pressure Sensors as Altimeters

Absolute, temperature-compensated, ultra-compact pressure sensor with digital output

... make it small; make it accessible

Application Segments:
- Blood pressure sensors
- Navigation system
- Water level management

Pressure sensors market for mobile and consumer TAM 2010: $47M CAGR 2010-2013: ~27%
Microphones Enhance User Experience

Your mobile phone becomes your conference-call solution

- Excellent sound quality
- Superior reliability and robustness
- Small size (3 X 4 X 1mm)

Microphone market for mobile and consumer TAM 2010: $176M
CAGR 2010-2013: ~24%

Application Segments:
- Mobile phone
- Digital camera/camcorder
- Laptop PC
- Gaming

Compass Shows Heading

A look from the Inside... ...and from the Outside

Application Segments:
- Navigation
- Mobile phone
- Pictures geo-tagging
- Location based services
iNEMOTM: The Smart Sensor

Smart sensor: combination of sensors, data processing and information transmission

What’s Next in iNEMOTM family?

3x accelerometer (LIS3DH)
3x digital gyroscope
7.5x4.4 mm²

3x accelerometer (LIS331DLH)
2x P&R or P&Y gyroscope (analog)
7.5x4.4 mm²
MEMS are Advanced Analog Products

- **MEMS** means Micro Electro Mechanical Systems … taking advantage of the mechanical **AND** electrical properties of silicon
- Three key elements:
  - **Micron-sized Transducer** realized through a specific process called Micro-Machining (THELMA)
  - An **Advanced Analog Chip** with embedded smart functionalities
  - Dedicated **package** and **calibration** features

![THELMA @ 1 um + ASIC @ 130 nm = 3 Axis Gyroscope](image)

MEMS are Advanced Analog Products

*A typical Analog Signal Chain*

- Supply Monitor
- Power Management
- Audio Amplifier
- Control Unit
- Digital to Analog Converter
- Amplifier
- Digital Interfaces
- RF Interfaces
- Wireless Node
- Sensor
- Gyroscope
- Amplifier
- Analog to Digital Converter
- Control Unit

All available in Stand Alone, ASSP and ASIC products
Analog: an IMS Competitive Advantage

**Analog Ranking 2009 Analog ICs** # 2

<table>
<thead>
<tr>
<th>Key product family</th>
<th>Key Target Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>High End Analog Front End</td>
<td>Healthcare, Industrial, Portable Devices</td>
</tr>
<tr>
<td>Mixed Signal ICs</td>
<td>Mobiles, Peripherals, Portable Medical</td>
</tr>
<tr>
<td>Low Voltage Operational Amplifiers</td>
<td>Mobiles, PDAs, e-Books</td>
</tr>
</tbody>
</table>

*Ranking refers to total ST Analog ICs sales

**Competitive Advantages:**

- Can integrate Analog and Power (chip or package) in Power Conversion and Power Management applications
- System know-how to design dedicated ICs for complex applications
  - Variety of reference designs for medium and small customers
- Delivery of System Solutions including Sensors, Analog ICs, Microcontrollers and Power Discrete
- The World’s largest and most cost-effective 6” Front End in Singapore

Source: iSuppli, ST

Sensors Complement ElectroCardioGraph

First samples available Q4 2010

- **Remote monitoring and telemetry**
  - HM221R 2 Channel + Microcontroller + Accelerometer + BTLE
  - HM222R 2 Channel + Microcontroller + Accelerometer
  - HMX11D HMX11D+Isolation

- **Diagnostic ECG/EEG and AED + Bedside monitoring**
  - HM301D 3 Channel
  - HM201D 2 Channel
  - HM101D 1 Channel

Source: STMicroelectronics
Smart Sensors: New High-Growth Opportunities

- MEMS
- RF
- Building
- Factory
- Automation
- Logistics
- Healthcare
- Sport & Wellness

Sustaining Growth

- New Sensors and Analog Products
- Two main paths
  - Expanding MEMS Leadership in new Arenas
- STMicroelectronics

STMicroelectronics
Takeaway Messages

- 2010 will be “Year of the Gyroscope”
- ST will continue to drive MEMS avalanche and extend presence in new markets
- ST investing heavily in MEMS and Advanced Analog products to sustain growth
- ST well positioned to become undisputed leader in Smart Sensors, bridging analog world to digital brain
- Sensors will enhance presence in the advanced analog world