6- & 9-Axis Sensors

Consumer Inertial Combos

Actors focus on sensor fusion when discrete sensors are flattening and combo sensors perform well. Next stop, wearables!
About The Authors

Guillaume GIRARDIN

Guillaume Girardin works as a Market & Technology Analyst for MEMS devices and technologies at Yole Développement. Guillaume holds a Ph.D. in Physics and Nanotechnology from Claude Bernard University Lyon I and a M.Sc. in Technology and Innovation Management from EM Lyon - School of Business.

Contact: girardin@yole.fr

Eric MOUNIER

In 1998, he cofounded Yole Développement. Eric is in charge of market analysis for MEMS, equipment & materials. He is Chief Editor of MEMSTrends & Micronews magazines. Before joining Yole Développement, Eric worked as a market analyst at CEA Leti. He has a PhD in microelectronics from the INPG in Grenoble.

Contact: mounier@yole.fr
Who Should Be Interested in this Report?

- MEMS device manufacturers
  - Evaluate market potential of future technologies and products
  - Understand the differentiated value of your products and technologies in this market
  - Build roadmaps for modules: what type of combos? When?
  - Identify new business opportunities
  - Identify potential strategic partners or technology providers
  - Monitor and benchmark your competition’s advancements
- MEMS foundries, material and equipment suppliers, packaging and test houses
  - Understand which applications will drive volumes in 2019
  - Identify new business opportunities and prospects
- Microcontroller and Application Processor specialists
  - Spot new opportunities and define diversification strategies
- Evaluate market potential of future technologies and products to differentiate your own products
- Evaluate the benefits of using these new technologies in your end-system; design architecture for the next generation of systems
- Screen potential new suppliers able to provide new functionalities, or cost and size savings
- R&D centers
  - Evaluate market potential of future technologies and products for new applicative markets
  - Identify the best candidates for technology transfer
- Financial & strategic investors
  - Understand the structure and value chain of the consumer inertial sensor industry
  - Estimate the value of players developing disruptive products and technologies such as monolithic integration and smart modules
  - Get the global list of main key players and emerging start-ups in this industry
- System integrators and developers (mobile devices, gaming, sports & fitness, etc.)
Companies Cited in this Report

Introduction

Combo sensors will almost triple from 2014 to 2015

• 2013, in the continuity of 2012, was a hot year for consumer combo sensors, with high volume adoption in platforms such as Samsung Galaxy S smartphones. Since then, many developments have occurred, and the market acceptance of combo solutions has been quick but as fast we expected, it’s true for 6-axis IMU (adopted in a growing number of platforms) but also for 6-axis e-compass (shipments are reaching new records every month). In addition, 9-axis solutions are being slowly introduced to the market with a major target, the wearable market. Innovative solutions should follow: with integration of pressure sensing, health sensors, processing units, and RF capabilities....

• The combo sensor market is estimated at $420M in 2013, $585M in 2014, growing to $1.4B in 2019. This represents 28% of the global inertial consumer market in 2014, and will grow to an impressive 60% by 2019. While smartphones and tablets are now driving volume increases and adoption of combos, the picture should be different in 2019. The next market wave should come from wearable electronics, where long-term market potential is huge. While combo sensors will take a significant portion of total market share, opportunities will remain for discrete sensors: from accelerometers used in basic activity trackers to gyroscopes for camera module stabilization.

• The road was not so easy for inertial combos and some challenges still need to be solved. Outside of the offering, which is still smaller than with discrete sensors, combo sensors are sometimes said to be inaccurate or to create constraints for placement on the board (for magnetic field detection: a tiny magnetometer die is often preferred than a larger combo package). Footprint reduction was the only argument in favor of combos in the past. However it is fair to say that significant achievements have been made in the past couple of months. Most of the past yield issues have been solved, leading to lower prices. In addition, combo solutions facilitate both qualification and testing at the integrator level, and development of sensor fusion. This report describes the motivations for each type of combo and analyzes the timing for market adoption for each end-application.
Introduction

4 players share 75% of the market, Is there any room for newcomers?

- STMicroelectronics is still the global leader in the inertial consumer sensor market with almost 40% market share. But competition with Bosch and InvenSense is getting more and more intense, both are the only ones able to compete with him today and are taking market share over ST. It is key to be able to control the different technologies or to establish the right partnerships to sell a large range of combo solutions. ST started to sell its own magnetometer in 2013, a market with a growth expected, while Bosch has been very active in launching new product lines since 2012. InvenSense has just partnered with Melexis as an alternative source to AKM for the magnetometer die in 9-axis solutions, although this is not official information.

- ST, InvenSense and Bosch are the three big competitors in the 9-axis race with a strong focused on wearable market.

- Price is still sharply dropping, with IMUs sold to some large volume customers below $1 in 2013. To stay in the race, the 3 leaders are going to introduce technical innovations: monolithic integration of 6- to 9-axis, use of TSV, chip scale packaging, and active capping…

- Current challengers and newcomers are eyeing this combo opportunity and expect to take market share while the supply chain is not yet mature. Kionix, Freescale, Alps Electric, Fairchild, Maxim and more than 10 other companies are targeting this market space. New business models are built and more fabless companies are likely to be involved in the combo market. Details on newcomer technologies and roadmaps are provided in the report.
**Introduction**

Value is moving to function delivery with embedded sensor fusion

- Sensor fusion developments is taken seriously. Recent acquisition of companies like Movea, or Wifislam or CSR is a proof of high interest of the sensor fusion. There has been hype about it for many years and now we start to see commercial implementation. The first real products with sensor fusion are already on the market, such as sensor hubs in the latest smartphones and tablets from Samsung and more recently from Apple, with the M8 processor in iPhone 6 & 6 Plus. In addition, GPS chipsets with indoor navigation capability relying on MEMS sensors are now available from CSR, Qualcomm and Broadcom.

- The report provides a detailed understanding of the sensor fusion roadmap and how it will impact the MEMS industry:
  - New market opportunities: For instance, context awareness functionalities are on the roadmap of various players
  - New architectures: Sensor hubs as MCUs or low-power application processor core play an increasing role, while standardization initiatives are ongoing
  - Technical impact: Better inertial performance can be requested for some functions
  - Change in value repartition: Different types of companies are playing in the sensor fusion ecosystem. We see the first signs of consolidation as collaborations along the value chain are set up (Qualcomm with Cisco Systems and CSR, Aruba acquisition of Meridian, Apple acquisition of WiFiSLAM, InvenSense acquisition of Movea...)

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Motivation for Combo Solutions

Synthesis

- Combo sensors are increasingly adopted, driven by benefits linked to integration:
  - Possibility of reducing both cost and footprint by combining several sensors into one package with a single ASIC
  - Significant benefits are now proven for most combo solutions:
    • Often cost benefit and total footprint benefit
    • Simplification of supply chain and qualifications
    • Over time those benefits become more obvious, increasing the interest in combos for many applications
  - However there are still challenges for adoption:
    • Combo package size is a critical item especially when it contains magnetometer
    • Risk at the supply chain level: not wide offering so far
    • Over time those limitations decrease (miniaturization…), enabling the adoption of combos

- The second key motivation for using combo sensors relies on sensor fusion
  - New functionality can now be offered using multiple sensing elements
    • We see a strong evolution from sensors to solutions
    • See examples of new applications in the sensor fusion part
Combo Sensor Roadmap

Level of integration


+ RF + sensor fusion +...

9 Axis Sensors: Consumer Inertial Combos
Typical package footprint for sensors used in mobile devices

<table>
<thead>
<tr>
<th>Year</th>
<th>Accelerometers</th>
<th>Magnetometers</th>
<th>Gyrosopes</th>
<th>6-axis IMU</th>
<th>9-axis</th>
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<td>3x5 mm²</td>
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<td>1.6x1.6 mm²</td>
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<td>3x3 mm²</td>
<td>2.2x2.2 mm³</td>
<td>4x4 mm²</td>
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<tr>
<td>2012</td>
<td>2x2 mm²</td>
<td>3x3 mm²</td>
<td>2x2 mm²</td>
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<tr>
<td>2013</td>
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<td>1.4x1.4 mm²</td>
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<tr>
<td>2014</td>
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<td>2.2x2.2 mm³</td>
<td>3x3 mm²</td>
<td></td>
<td></td>
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<tr>
<td>2015</td>
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<td>1.6x1.6 mm²</td>
<td>3x3 mm²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Global Market Evolution

Combo sensors strongly impact the market!

• The global inertial market is growing from $2.06B in 2013 to $2.34B in 2019
• The market for discrete sensors starts to decline
  • However opportunities remains with applications such as wearable electronics or camera module OIS
• Combo sensors will represent the majority of the market during 2018
  • 6-axis IMUs and then 9-axis solutions should dominate
  • ASP keeps decreasing and competition is stronger than ever! IMUs were already priced below $1 in 2013.
• Smartphones remain the application that will drive the market for the next few years
  • Then wearable electronics is the most promising high-volume opportunity at medium to long term
Mobile Phones and Wearable Electronics are Driving Growth

2012-2019 Market (Munits)

- Sensor volumes are booming
- Cell phones are still driving the growth in volume
- At long term, wearable electronics is also a very high volume opportunity
Competitive Situation

Consolidation is happening with the 4 big players that share more than 75% of the business.
Apart from Magnetometers, STMicroelectronics is the Dominant Company by Far

Top Inertial MEMS Suppliers in the Consumer Market
- 2013 Revenue ($M) - Breakdown by Product Type -
Sensor Fusion makes waves in the value chain

Players moves toward the function/application

- Value chain of sensor fusion is moving a lot!

- Value is no more in the core product, sensor fusion is about software. Companies have to find value in the application, therefore, acquisitions are booming.

- Many companies acquired software vendors, but some of them did it differently related to their position. For instance, Bosch, MEMS manufacturer, develops internally and collaborates with Hillcrest Labs on sensor fusion.

- Two types of chain consolidation is emerging. InvenSense structures his chain from core product toward application by acquiring Movea and Trusted positioning. Apple, with WifiSlam, tries to capture value with software in the other direction.

- In the middle, chipset makers’ strategy, like Audience or Qualcomm, is to develop where opportunities are.
Available MEMS Reports

- Uncooled Infrared Imaging Technology & Market Trends
- Status of the CMOS Image Sensors
- Status of the MEMS Industry
- MEMS for Cell Phones and Tablets
- Inertial MEMS Manufacturing Trends 2014
- Emerging MEMS patent
- MEMS Front-End Manufacturing Trends
- Infrared Detectors Technology & Market Trends
- RF Filters, PAs, Antenna Switches & Tunability for Cellular Handsets
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- Motion Sensors for Consumer & Mobile applications
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- Thin Wafer Handling
- MEMS Cosim+ MEMS Manufacturing Cost Simulation Tool
- Status of the MEMS Industry
- New! New! New!
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Our Offices & Contact Information

• Japan Office
  • For custom research: Yutaka Katano, General Manager, Yole Japan & President, Yole K.K.
    Phone: (81) 362 693 457 - Cell: (81) 80 3440 6466 - Fax: (81) 362 693 448 - Email: katano@yole.fr
  • For reports business: Takashi Onozawa, Sales Asia & General Manager, Yole K.K.
    Email: onozawa@yole.fr

• European and North America Office
  • Jean-Christophe Eloy, Email: eloy@yole.fr

• Yole Développement Headquarter, France: David Jourdan, Sales Coordination & Customer Service, Tel: +33 472 83 01 90, Email: jourdan@yole.fr

• Korea Office
  • Hailey Yang, Business Development Manager, Phone: (82) 2 2010 883 - Cell: (82) 10 4097 5810
    - Fax: (82) 2 2010 8899 – Email: yang@yole.fr
For More Information…

Take a look at our websites

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