Packaging advances needed to ensure IoT growth

Vik Chaudhry and Adrian Arcedera, Amkor Technology - July 26, 2016

Many see the Internet of Things (IoT) as the third wave of technology, with the personal computer boom of the late 80’s and early 90’s as the first and the cellular phone as the second wave. In this third wave, engineers will build upon the experience and infrastructure of the first two waves to make day-to-day chores more connected, especially as related to packaging. The transition to reduced size and increased functionality in the first two waves resulted from an equally dramatic transition from discrete packaged semiconductors to integrated circuits (ICs), and packaging changes of similar magnitude will be needed for the IoT to achieve its anticipated growth.

Low-cost, good power dissipation (low power for the silicon portion), and good RF shielding in packages that support multiple RF standards such as BTLE, Wi-Fi, or ZigBee are common IoT packaging requirements. Cavity-based solutions are popular when sensors are involved, especially when there are stimulus delivery requirements such as port holes in microphones. IoT packages must also be production ready, since waiting for a new custom package is often not an option due to time-to-market constraints. Finally, regardless of whether the solution is discrete or integrated, the footprint must be small.

The Case for a SiP Solution

The requirements outlined are increasing the popularity of integrated system-in-package (SiP) solutions. Some IoT applications are size and height constrained. SiPs are a perfect way to integrate sensors, embedded processors, and RF connectivity into a small form factor. This combination is referred to as sensor fusion, and it gives manufacturers the opportunity to combine different technologies very quickly without spending a lot of money on new mask sets. In addition to quick time to market, SiP approaches also allow manufacturers to use “off-the-shelf” components to build the solution. Because all the building blocks are already in product form, it becomes an easier task for engineers to rearrange them to get optimal performance in terms of antenna location, power dissipation, and the like.

The value proposition for SiP technology is that it enables the integration of multiple technologies and components in one package, such as combining MEMS and CMOS. Such a combination is not practical with conventional IC integration. While MEMS and CMOS devices share a number of similarities, there are also critical differences. First is the need for a method to deliver stimuli to MEMS devices, since they must interact with the environment. The second difference is that MEMS devices do not scale the same way as CMOS does with different processes.

This integration SiP technology offers is especially valuable for products like wearables, smart lights, or smart home applications, where space and size are important. Figure 1 illustrates several SiP design options that could include wafer-level packages, 2.5D or 3D structures, flip-chip, wire...
bonding, package-on-package, and more. A SiP can also include embedded passives, conformal shielding, filters, and an antenna.

Figure 1 SiP Design Options

Insightful package integration can reduce the size of an IoT solution. Figure 2 illustrates a highly integrated package for IoT applications. The same functions had a footprint of 10-mm² with discrete packages, but only 6-mm² is required with the integrated package solution — a reduction of 40%. Further space saving would be achieved by signal routing in the integrated solution.

Figure 2 Adding IoT blocks to a MEMS/Sensor Package

The industry is also seeing MEMS packaging migrate from QFN packages to laminate-based ones. These laminate designs may be either cavity-based packages or hybrid cavity packages, in which half of the package is molded and the other half provides a cavity for the MEMS device. The MEMS sensors need the in order to interact with the environment for sound, light, or gas detection. The molded part is more robust and able to withstand harsh conditions.

Standardizing Packaging for IoT Growth

Package designs for MEMS and sensors, and by extension IoT devices, are currently fragmented. Further, designers are re-using the same packages for multiple projects even though the packages are not always compatible with the specific application. Standardizing MEMS/sensor packages would help reduce costs and accelerate MEMS adoption, increasing manufacturers’ confidence to bring new products to market.
The problem is that when package types are fragmented, the data collected on reliability or field experience is also fragmented, delaying adoption by manufacturers. Standardization would provide the necessary reliability data, allowing manufacturers to stand behind new products. Figure 3 shows commonly used MEMS packages that could be adopted as industry standards.

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Figure 3 MEMS Standard Platforms

No one argues that the IoT will dramatically change people’s lives in the 21st century and beyond. Smart systems made up of sensors and actuators and a host of other commonly used electronic building blocks are enabling devices to communicate with each other and take specified actions. MEMS sensors are an essential part of an IoT system, but their high rate of adoption has caused severe ASP erosion. One way MEMS suppliers are addressing this is by providing more value by integrating multiple sensors using sensor fusion.

SiP solutions are becoming a popular way to integrate IoT solutions because they provide manufacturers the opportunity to combine different technologies very quickly and curtail costs by using “off-the-shelf” components. The size of an IoT solution can also be reduced with integration of
the package, further reducing costs.

With about $11.5 billion of incremental semiconductor opportunity in the IoT market expected by 2020, packaging technology will play an increasingly important role in the development of systems of the future.

Vik Chaudhry received his MS and MBA degrees from Arizona State U. in Tempe and is Sr. Director, Product Marketing and Business Development, Advanced Products, at Amkor Technology.

Adrian Arcedera received his degree in Chemical Engineering from the U. of the Philippines and is VP, MEMS/Sensors and WBBGA Products, at Amkor Technology.

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