Semiconductor industry demands for higher levels of integration and lower costs coupled with a growing awareness of complete system configuration have continued to drive the popularity of System in Package (SiP) solutions. Amkor’s SiP technology is an ideal solution in markets that demand smaller size with increased functionality. By assembling, testing and shipping more than one million SiP devices per day, Amkor Technology has a proven track record as the industry leader in SiP design, assembly and test. Contact us today and let us add you to our growing list of customers who have been successful with System in Package technology.

Markets for System in Package

Existing market uses for SiP include:
- RF and wireless devices
  - Power amplifiers, front end module, antenna switch, GPS/GNSS modules, cellular handset and cellular infrastructure, Bluetooth® solutions
- IoT for Wearable and Machine to Machine (M2M)
  - Connectivity, MEMS, microcontroller, memory, PMIC and other mix-mode devices
- Automotive applications
  - Infotainment and sensory modules
- Power Modules
  - DC/DC converter, LDO, PMIC, battery management and others
- Logic, analog and mixed-mode technology
  - Tablets, netbooks, display and audio
- Computing and networking
  - 5G networking and modems, data center, storage and SSD

System in Package technology allows multiple advanced packaging technologies to be combined to create solutions customized to each end application.

Amkor is heavily involved in providing SiP solutions for RF, digital and mixed-signal applications. With RF and high-speed digital design engineers on staff to assist customers in designing SiPs for their applications, Amkor is able to meet all design, material and manufacturing requirements for these advanced solutions.
What is System in Package?
System-in-Package technology is more than just an IC package containing multiple die. A SiP is characterized by any combination of one or more ICs of different functionality, which may include passive components and/or MEMS assembled into a single package that performs as a system or sub-system. Using wirebonding or flip chip technology or a combination of both for the ICs, the SiP can contain components that are traditionally found on a PC board.

Amkor’s emphasis is on functional integration and size reduction by using different package form factors and interconnect technologies, including:
- SiP Solutions (side by side, POSSUM™, stacked die, package on package (PoP), package in package (PiP), cavity, face-to-face (F2F) and others)
- Surface mount discrete passive (any common format including 01005 size)
- Integrated passive devices (IPD), either glass or silicon (Si) type
- Passives embedded inside or patterned on the substrate

The power of SiP technology is the ability to bring together many IC and package assembly and test techniques to create highly integrated products with optimized cost, size and performance.

SIP Module Design Options

Total System in Package Solutions
In a SiP approach, one must consider not only the traditional elements of package assembly, but also design aspects relative to the overall system functional requirements and manufacturing process, as well as supply chain management and test.

System design becomes paramount to the overall success of developing an effective SiP product. Early in the overall system design, the customer and Amkor discuss and agree upon all elements of the system requirements to ensure design success. With this in mind, Amkor has significantly expanded its electrical design capability to combine traditional layout expertise with digital and RF circuit design and system modeling and characterization. Amkor can also translate a customer’s reference designs for use in SiP development. Working closely with the customer, Amkor can model circuits electrically, mechanically and thermally, which reduces design iterations and minimizes time-to-market.

Questions? Contact us: sales@amkor.com
SiP Module Design Flow

**Thermal & Mechanical Solutions for SiP**

Inevitably, higher levels of integration result in thermal and mechanical challenges. As part of our co-design service, we capture not only electrical but also thermal constraints early on so that the package solution will meet all performance criteria. We conduct detailed mechanical test and simulations for mechanical SiP integrity such as warpage improvement, solder joint reliability, die strength and stress, flip chip bump fatigue, substrate trace cracking, temperature cycling, bend cycle, drop shock test, die strength, electro-migration. A part of our co-design service we help identify the optimum and most cost-competitive thermal and mechanical enhancements required to satisfy your customer’s operating conditions and field life expectations.

**SiP Testing**

Amkor has developed expertise in RF and digital testing including test system software/hardware development and manufacturing test. Our internally-developed, world-class test platform typically offers a 50% to 80% reduction in test time for common RF parts – PAs, LNAs and combinations in Integrated Front Ends (IFEs).

**Sputtering Conformal Shielding Solution**

Amkor has developed an excellent sputtering shielding technology to solve electromagnetic radiation effects among electronic components within SiP components and surrounding environment. Conformal shielding is used to replace bulky metal shielding. It has zero impact on package size and weight, with excellent electrical and magnetic shielding performance.

Near Field Conformal Shielding Performance Measurements from 100 MHz to 6 GHz

**Unshielded SiP**

**SiP with Sputtering Conformal Shielding**
Manufacturing Excellence

Amkor’s “Center of Excellence” for substrate-based SiP technology is located in our largest volume manufacturing facility in K4 Kwangju, South Korea. The large-scale manufacturing capabilities in this factory can achieve significant volume production support with very short cycle times. The manufacturing equipment is the latest advanced technology that supports high speed, high accuracy chip and component placement. Amkor’s SiP design rules are the most advanced in the industry and are available to customers through a web portal access system. Amkor production lines have full automation, in-line inspection, RFID control and other process control methods to ensure the highest yields and quality while minimizing any potential loss of bill of material (BOM) components.

Amkor SiP factories are equipped with the latest generation surface mount equipment to provide these attributes:

1. Ultra-high-speed SMT placement machines which have leading-edge component placement accuracy – best quality and lowest cost.
2. Flexible placement machines which are better suited for odd-form component placement.
3. Capable of placing any common component format available in tape and reel format down to and including the smallest 01005 size.
4. Capable of mounting bumped die directly from wafer tape.
5. Support for solder paste stencil printing, flux stencil printing, flux jetting or flux dipping processes.
6. Automated 100% in-line optical inspection of solder paste to reduce BOM component loss.
7. Support for all common RoHS/Green compliant solder alloys.

After modeling, Amkor supports Engineering Build Requests (EBRs) on dedicated rapid-turn “New Product Introduction” lines. These lines are exactly the same as the high volume manufacturing lines, so transfer to production is seamless and efficient. In the RF market sector, Amkor often needs to support a large number of rapid-turn EBRs to facilitate RF tuning of the parts. Fast turn is critical to product success and time-to-market, our experts work closely with our customer’s to facilitate this collaborative process.

Supply chain considerations play a major factor in the success of SiP product realization and impact both design and manufacturing. Amkor has expanded its traditional supply chain expertise into passive components, and other parts not traditionally found in the package assembly environment. Amkor can manage the supply chain to ensure successful SiP development and production.

System in Package Benefits

Similar to a System on Chip (SoC) approach, Amkor’s SiP technology is an ideal solution in markets that demand smaller size with increased functionality. However, SiP has the added benefit of compatibility with die design changes and integration of various die technologies (e.g., Si, GaAs, SiGe, SOI, MEMS) without the high cost and lead time associated with SoC development and manufacturing.

Additional Benefits of System in Package Approach

- Smaller size solution than individually-packaged ICs
- Higher performance through shorter interconnect paths, better dimensional tolerances and local shielding
- Lower overall cost of ownership
  - Eliminate packaging (multiple ICs now in one package)
  - Reduced system board space and complexity and layer count by moving to a SiP solution
  - Reduced overhead for the customer (Amkor offers turnkey solutions for assembly, test, supply chain management and value-added services)
- Known good modules
- Lower overall cost of ownership
- Reduced time-to-market
  - Modules and main system assembly can be developed concurrently
  - Changes can be made to the SiP without costly changes to the system board
  - Design flexibility and easy redesign versus complex SoC design
  - SiP allows plug-and-play insertion into one or multiple systems

With proper consideration to design, Amkor’s SiP packages are able to meet JEDEC L3/260 moisture resistance and are passing Amkor's internal SQLb.

System in Package is the modular design approach offering unprecedented flexibility in product development. The end user benefits from a faster time-to-market, reduced cycle times for system design, lower development risk compared to SoC IC development, flexibility, tuned functional performance, and, in the end, a lower overall cost of ownership.

Visit Amkor Technology online for locations and to view the most current product information.

www.amkor.com

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