

Miniaturization Spurs EMI Innovation at the Package Level

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Device designers and electronics specialists are all too familiar with the challenges surrounding electromagnetic interference, more well-known by its acronym, EMI. A disturbance to an electrical circuit due to electromagnetic coupling from external sources, EMI is quite common with radio-frequency (RF) emitting devices such as smartphones, tablets and IoT-enabled technologies, among others. In order to limit the spread of the interference from one component to another within an electronics assembly and/or reduce outside interference, effective isolation must be employed. Traditionally, this has been achieved through the use of EMI shielding caps, which are also often referred to as cans or faraday cages. These metal lids attach to grounding pads that cover a component or an assembly to minimize EMI between components within a design and eliminate cross talk of components on PCBs. **(Figure 1)** Historically, the attachment of the shield has occurred at the PCB assembly phase, but that's all changing.

With miniaturization comes greater integration at the package level. Not only are device dimensions becoming smaller with thinner package profiles, it's also quite common to have chips with higher and lower operating frequencies within the same package, as is the case with system-in-package (SiP) devices. Because conventional EMI shielding caps don't enable super-thin package dimensions or protect against in-package interference, new strategies must be used to effectively shield miniaturized devices and adequately isolate varying frequency chips within the same package. Two new approaches have emerged as alternatives to traditional EMI shielding techniques and effectively move EMI management from the board level to the package level.

Significant package-level EMI shielding progress has been achieved with an innovative, compartmental shielding method designed to allow separation of chips housed within the same device, protecting against signal interference. Using this technique, target dies are identified and a small channel is routed through the molded SiP via precise laser cutting. Once the trench is created, a high-flow, highly-conductive material is jet-dispensed into the trench and then cured. With this method, high aspect ratio (aspect ratio = X dimension/Y dimension) filling is critical and can be challenging, as the trenches are often quite narrow and high, ranging anywhere from aspect ratios of 5:1 up to 10:1. In order to completely fill the gap, simultaneous air displacement and paste deposition is required to protect against voiding and optimal EMI safeguarding. In addition, the conductive paste must have strong adhesion properties with minimal shrinkage to ensure no separation from the grounding floor and the mold compound sidewalls of the trench. Essentially, this technique, along with a conformal coating, creates multiple faraday cages around the targeted die without altering the footprint or the height of the component, while delivering highly-effective EMI protection.

Along with in-package chip isolation, a new process for ultra-thin, on-package shielding helps eliminate the use of conventional EMI caps, streamlines processing and offers a lower-cost alternative to other on-package techniques. Current methods that coat the exterior of a component with a protective EMI shielding material are usually quite capital-intensive. Sputtering, for example, is a physical vapor deposition process that requires substantial capital investment with low units per hour (UPH) and high maintenance costs. With sputtering, metal is deposited onto the plasma treated, molded package in a

vacuum chamber and normally entails depositing several layers of material. Another popular approach to on-package shielding is plating, where electroless copper and electrolytic copper/nickel are coated onto the mold compound. Plating delivers good thickness control like sputtering, but with respectable UPH at the strip level and a relatively low material cost. However, plating does have drawbacks, including environmental contamination which has raised high concerns and restricted mass deployment. In addition, surface pre-treatment and complex masking procedures must be used; no singulated packages can be processed as plating can only manage strip formats; and, it is a wet process that requires substantial floor space.

Given these realities along with the industry's desire to raise performance, increase UPH, lower cost and reduce process complexity, development of a new EMI conformal shielding solution was initiated. Building on atomization spray technologies used to coat PCBs and other electronics, the new spray-on EMI shielding material provides superior processing and performance advantages as compared to alternative metal coating techniques. Simple and easy to support in a batch process, a spray-coated, flowable and highly conductive material is applied to the molded component, ensuring full coverage of the top and sidewalls for maximum EMI protection. **(Figure 2)** The new spray coating method allows for very high UPH and multi-part processing in either singulated or strip formats for high throughput. No pre-treatment of organic surfaces is required for this single-layer application, which can be applied as thin as 3-5 μm to accommodate today's ultra-thin package profiles. The material delivers excellent shielding effectiveness with a simple process that provides a lower cost per package, much higher UPH, smaller floor space and easy scalability. In fact, as compared to sputtering, conformal shielding can reduce cost of ownership by as much as 60%, while raising UPH by a factor of four. And, for SiP devices that undergo compartmental shielding, the spray-on coating is completely compatible with trench filling materials, allowing packaging specialists to use both approaches for EMI shielding. **(Figure 3)**

As package- and chip-level functionality continues to increase so, too, will the need for novel and effective solutions for EMI shielding to accommodate ultra-small package profiles. Trench filling and conformal shielding are a significant, cost-effective step forward for in-package and on-package interference resistance. And, in the longer-term, shielding at the wafer level may become reality.



Figure 1: Conventional EMI shielding caps are limiting for modern, streamlined designs.

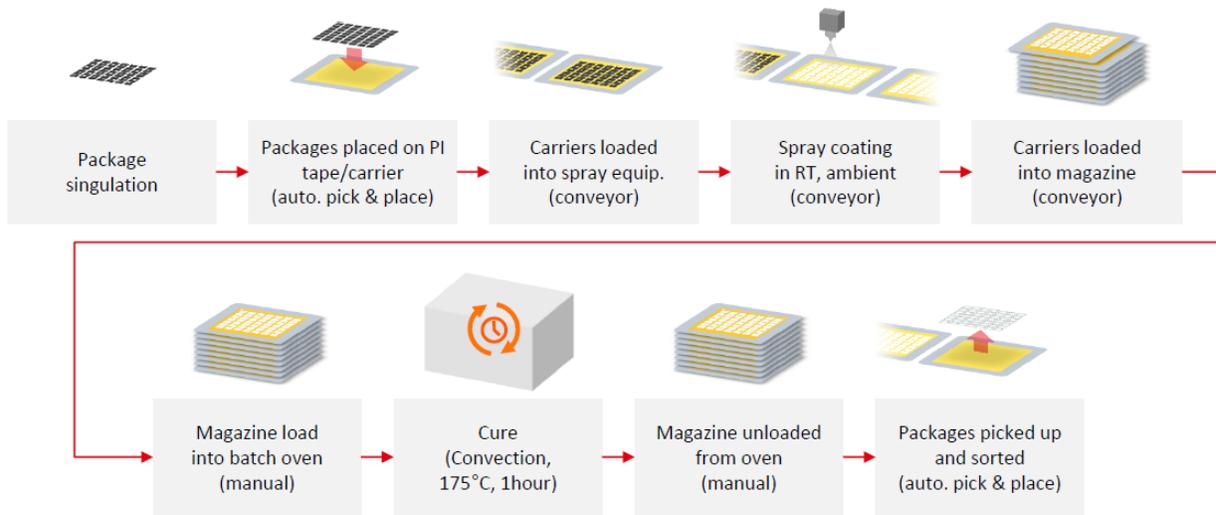


Figure 2: The EMI conformal shielding process dramatically raises throughput with the ability to process either singulated or strip formats, resulting in a much lower cost per part while delivering ultra-thin protection for today's thinner designs.

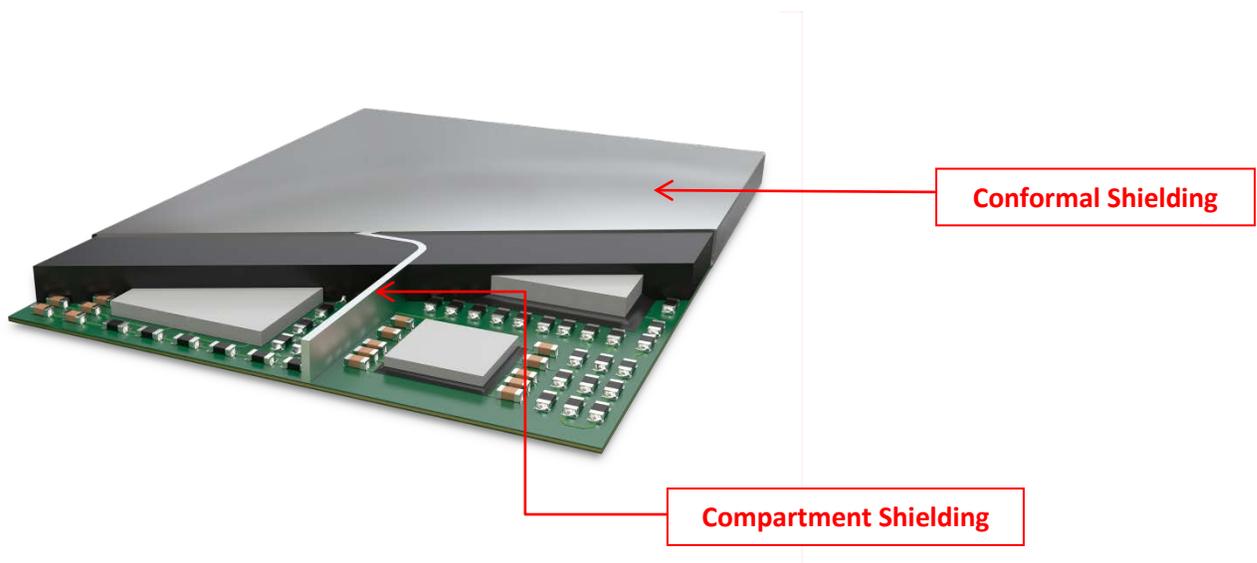


Figure 3: Compartment shielding isolates chips within a package, while ultra-thin conformal shielding coats the package exterior for maximum EMI protection.