White Paper

Side Fill Technology

Harsh environmental conditions can fracture and damage ball grid arrays (BGA) and solders by inducing thermal and mechanical stress. Innodisk's side fill technology is a simple, well-tested and cost efficient solution whereby applying resin to three sides of the DRAM integrated circuits (IC) the allover robustness of the module is strengthened.



Introduction

With the continuous demand for smaller DRAM modules, the size of BGAs has similarly decreased. What this means is that the BGA solder has become smaller and consequently less robust. At the same time DRAM modules see operation in increasingly inhospitable environments, where mechanical stress from shock, vibration and severe thermal variations are part of daily operation.

There are measures that can be taken to mitigate these challenges, among them are side fill and underfill. Due to the ambiguity surrounding these two terms, this paper defines the technologies as such :

- Side fill: a resin is applied to 3 of the DRAM IC sides to strengthen the connection between the printed circuit board (PCB) and the BGA

- Underfill: using a resin to completely fill the space between the PCB and the BGA

This paper aims to explain the challenges facing the embedded industry in harsh environments and why side fill is the optimal solution.

Background

Side fill as a concept was first proposed in the 1960, and although technology has taken great strides since then, the basic concept of side filling remains the same. The technology did not see wide usage at the time, as PCBs of the era was generally robust enough. However, computers are now commonplace in even the most challenging environments – making requirements for robustness higher than ever.

Challenges

What smaller PCBs consequently lead to is a decrease in size of BGA balls and pitch. This translates into an overall reduced robustness of the link between the PCB and the BGA.

Many embedded applications see rough thermal cycling, such as satellites moving from sunlight to the cold dark side of the earth in cycles just over an hour. These temperature changes lead to a constant cycle of expansion and contraction that can eventually cause damage to the onboard modules - and with only a short distance between the PCB and BGA, there is not much leeway. This is especially true for modules with thermal mismatching where the material in the PCB and the BGA have different expansion/ contraction rates.

Many systems undergo shock and sustained vibration, e.g. in vehicles operating in rough terrain or airplanes in turbulence etc. This can cause solder points to gradually weaken until they eventually fail, and can also lead to fractures in the PCB.

Solution

Side fill

Side fill is a proven and cost efficient method to increase PCB to BGA connection robustness. Tension tests show that with side fill applied, modules tolerate up to 2 times the force before finally coming loose.
The resin will also function as a thermal expansion absorber; in other words when the module is undergoing expansion/contraction, the resin allows for more movement while maintaining BGA connection integrity. The resin also functions as a heat sink by increasing heat dissipation, thus raising the threshold for thermal variations.

With the resin applied, mechanical and thermal stress is more evenly distributed, causing less stress on each individual solder point and increasing overall endurance.

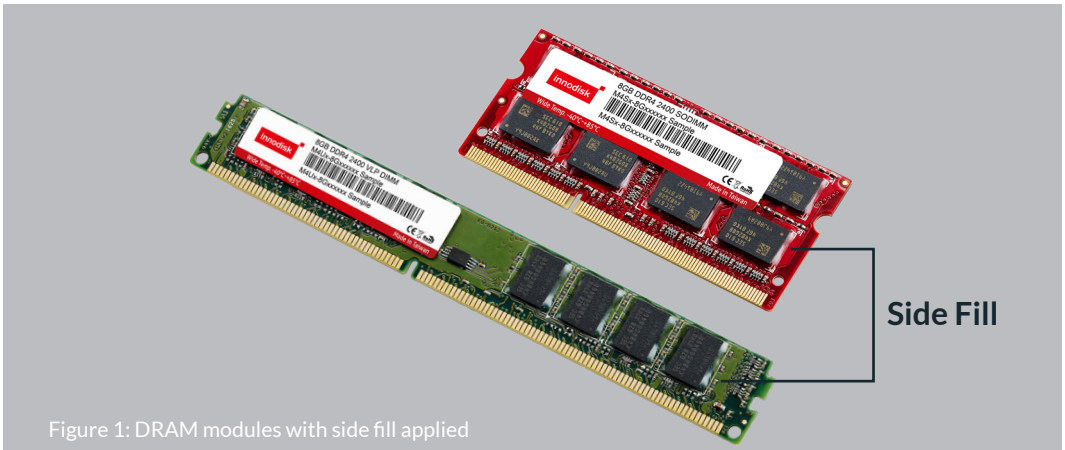


Figure 1: DRAM modules with side fill applied

The advantages of side fill vs underfill

While underfill in theory offers the same benefits as side fill, there are certain advantages that make the latter the stronger candidate.

- More cost efficient: side fill uses less resin and application time is faster, thus lowering costs
- Easier to repair: compared to underfill, the resin is easier to remove when it is only applied to the sides of the IC & PCB. This also lowers the risk of damage to the PCB when the module undergoes repair
- Lighter weight: Minimizing the burden on weight-sensitive devices
- Air pockets: By filling the entirety of the space between the BGA and the PCB, there is an increased risk for trapped air pockets. By only adding resin to three sides, this problem is effectively mitigated

Conclusion

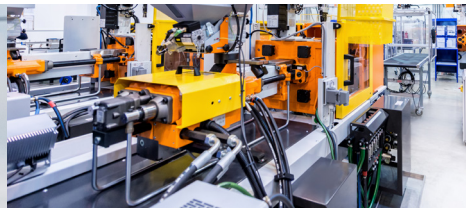
Moore's law is still in effect; as such devices will keep decreasing in size and therefore lose some of the robustness that was inherent in larger legacy modules. Addressing this challenge is essential for DRAM modules that see operation in extreme environments. This is where side fill comes in as a simple and well-proven solution. In a simple cost vs benefit analysis, side fill easily comes out on top as by device failure the impact on the bottom line is much more severe.

Vertical Markets and Product Series

Side fill technology is especially suited for these vertical markets:

In-vehicle

Aerospace & Defense

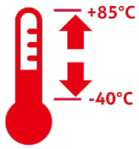


Automation

Side fill is optional for Innodisk products, however it is highly recommended for the below mentioned product series.

Very low-profile series (VLP)

Rugged DRAM



Wide Temperature series

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