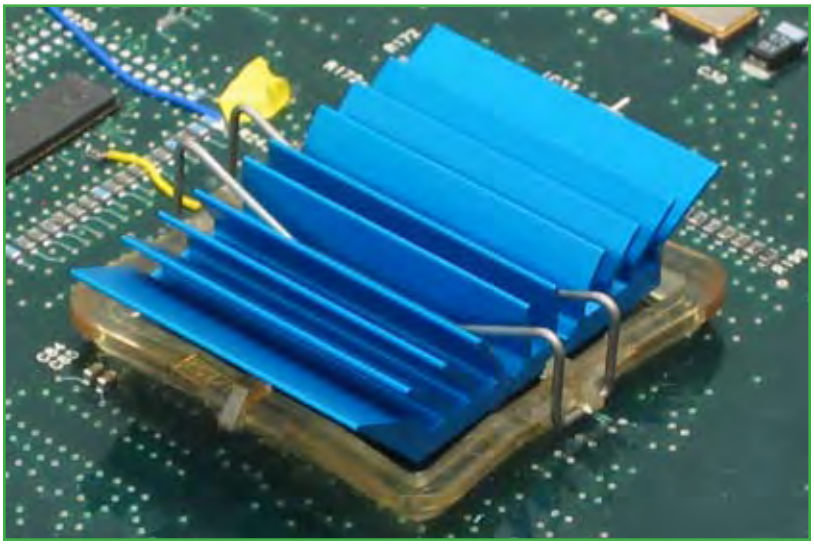
How the maxiGRIP™

Attachment System Impacts Component Mechanical Behavior



There is an increasing need for heat sink solutions to handle greater heat loads. The typical approach has been to design larger heat sinks and more robust heat sink attachment methods. It is important to understand how different attachment methods impact the mechanical behavior of the component being cooled. While many component types and heat sink attachment methods are available, this article focuses on a typical BGA component and the maxiGRIP™ heat sink attachment method that was designed by Advanced Thermal Solutions, Inc. (ATS).

Background and Discussion

The main purpose of a heat sink attachment system is to secure the sink to the component in a way that provides the best possible thermal bond between the component (typically its top surface) and the heat sink, while minimizing interfacial resistance. Most heat sink attachment methods include a fixed element and a spring element, as shown in Table 1.

The fixed element provides a platform from which the spring can exert the necessary force on the heat sink to keep it in place on the component.

Standoff fasteners and Z-clips are both popular attachment methods, but they have their drawbacks. First, their fixed elements must be mounted to the PCB, requiring that holes be drilled in the board. This makes signal routing a much bigger issue. A keep-out area is needed around the holes, limiting the space for components on the PCB surface. There is also the real possibility of the standoff or solder anchor causing a short during installation, which would result in significant damage to the board.

Table 1. Typical Heat Sink Attachment Methods

Attachment Method	Fixed Element	Spring Element
Fastener	Standoff	Compression Spring
Z-Clip	Solder Anchor	Wire spring clip in “Z” shape
Thermal Tape	None	None

Thermally conductive adhesive tape is another popular means of attaching heat sinks. Thermal tapes eliminate the need for holes in the board, but they also have some limitations. These tapes are typically only safe for mounting small heat sinks with low mass. The tapes tend to have higher thermal resistance than phase change interface materials (which typically require spring loaded attachment hardware). Thermal tapes also make re-work difficult, as damage to the component is likely.

To overcome these issues, ATS developed the maxiGRIP™ heat sink attachment solution. The maxiGRIP™ system features a frame clip (FC) and spring clip (SC), as shown in Figure 1.

The frame clip is made from a high performance plastic that is flexible and strong. It is installed around the BGA component using a special tool that expands all four of its sides simultaneously. Once in place, the wedge features on the FC are engaged beneath the substrate of the BGA, forming a solid fixed platform to which the heat sink and spring clip can be attached. A cutaway diagram is shown in Figure 2.

To understand the impact of this attachment system on the component's mechanical behavior it was necessary to study the force interactions generated by the maxiGRIP™ assembly. The main concern was whether the forces generated by the maxiGRIP™ hardware would cause cracking or mechanical failures in the BGA's solder balls.

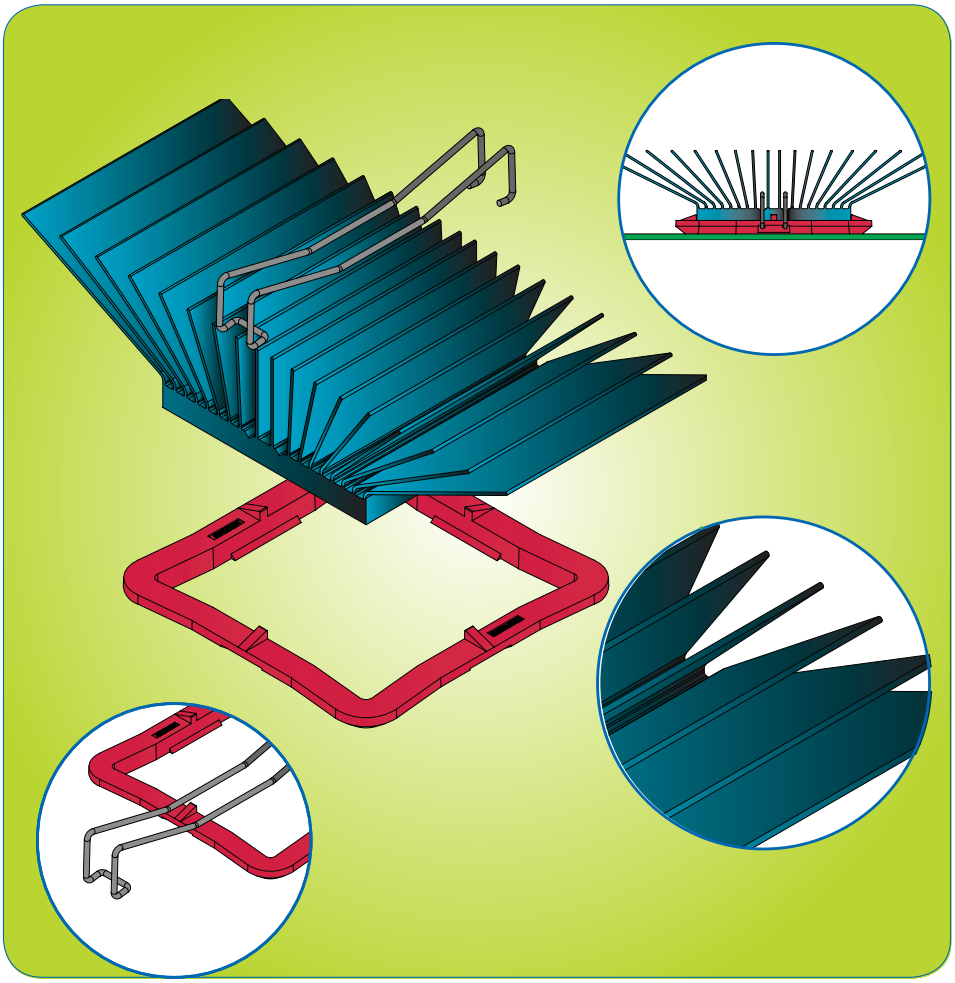


Figure 1. The maxiGRIP Heat Sink Assembly.

As Figure 2 shows, both the FC and SC exert forces on the component. These can be separated into normal and in-plane forces. Normal forces generated by the SC tend to pull the component substrate and heat sink together. They do not directly affect the solder balls, provided that the component substrate is sufficiently rigid. In-plane forces, generated by both the SC and FC, tend to drive the wedge of the

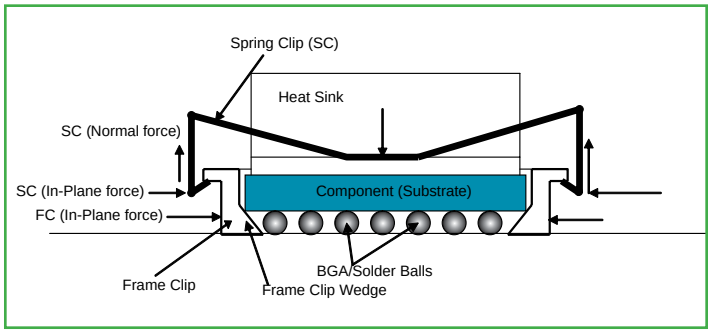


Figure 2. Cutaway of BGA Component with maxiGRIP Heat Sink Attachment.

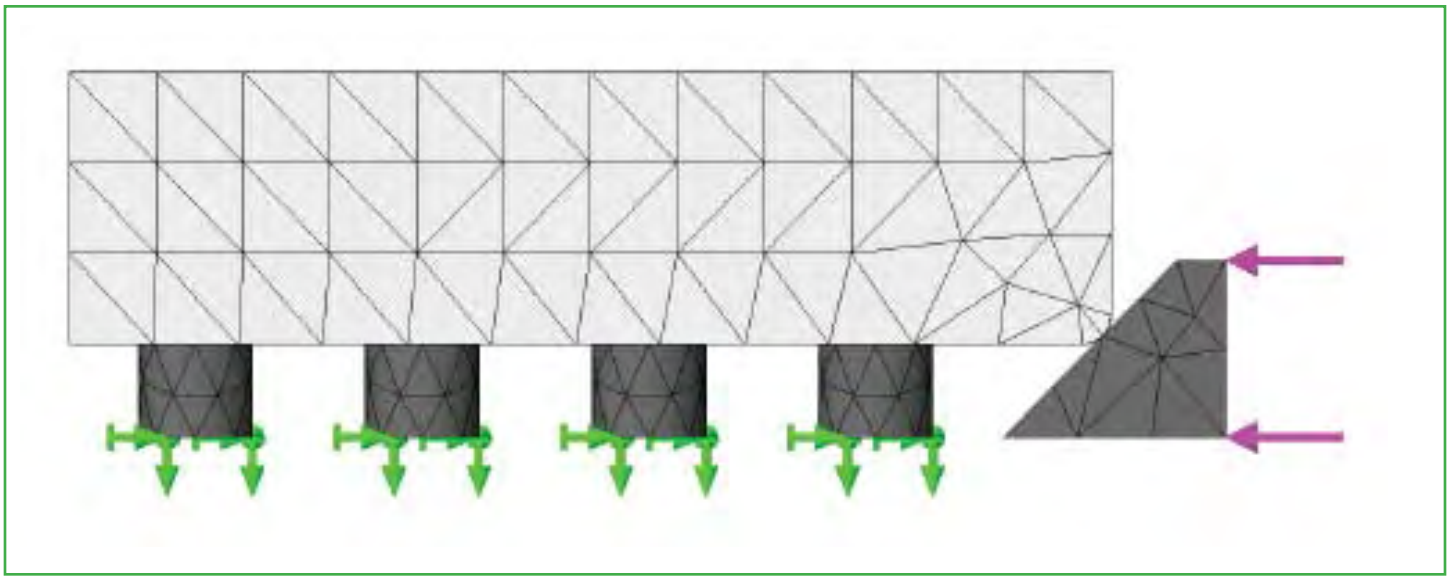


Figure 3. Model of BGA Component with Frame Clip (FC) Wedge Interaction.

frame clip beneath the component substrate, causing stress on the nearby solder balls. Figure 3 and 4 show the FEA boundary conditions and resulting von Mises stress plot for this situation.

By understanding the mechanical impact on the component, ATS engineers have been able to design the maxiGRIP™ attachment system so that the SC and FC forces are sufficient to hold the heat sink in place, yet low enough so they don't overstress the solder balls on the BGA. The maxiGRIP™ system has been used widely in industry with no reported failures, and has passed NEBS shock and

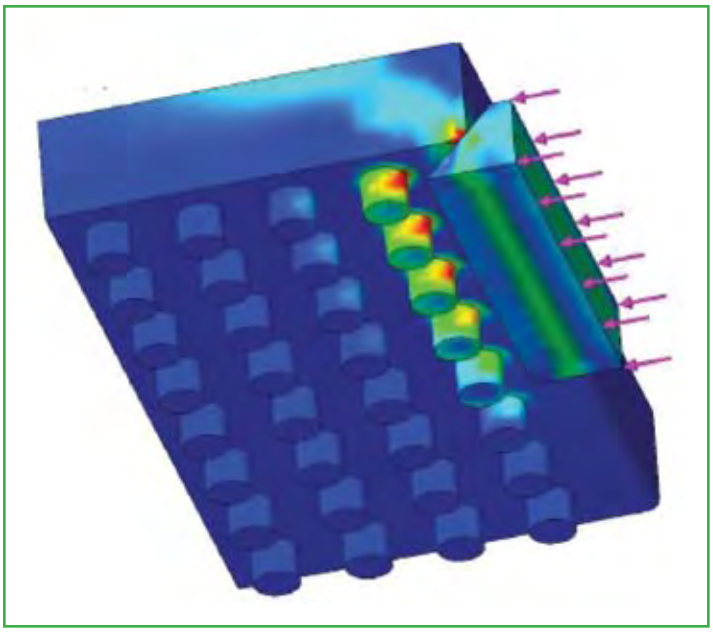


Figure 4. von Mises Stress Plot for BGA with maxiGRIP™ Frame Clip Installed.

vibration testing [1].

Conclusion

The continuing rise of component power levels necessitates the use of larger and/or higher performance heat sinks. These heat sinks require specialized attachment solutions, which may cause an impact on a component's mechanical behavior. To answer these challenges, ATS developed the maxiGRIP™ heat sink attachment system. Extensive FEA modeling and experimental testing were done to understand and prevent component failure due to mechanical issues. The maxiGRIP system has been independently tested and approved by NEBS for shock and vibration. Continued field use of maxiGRIP™ assemblies has proven that it is a robust means for heat sink attachment and offers significant advantages over other attachment methods. It eliminates the need for holes in the board, and reduces keep out areas around the component. ■

Reference:

1. NEBS (Network Equipment Building Systems) Certification Testing for maxiGRIP™ Assembly.