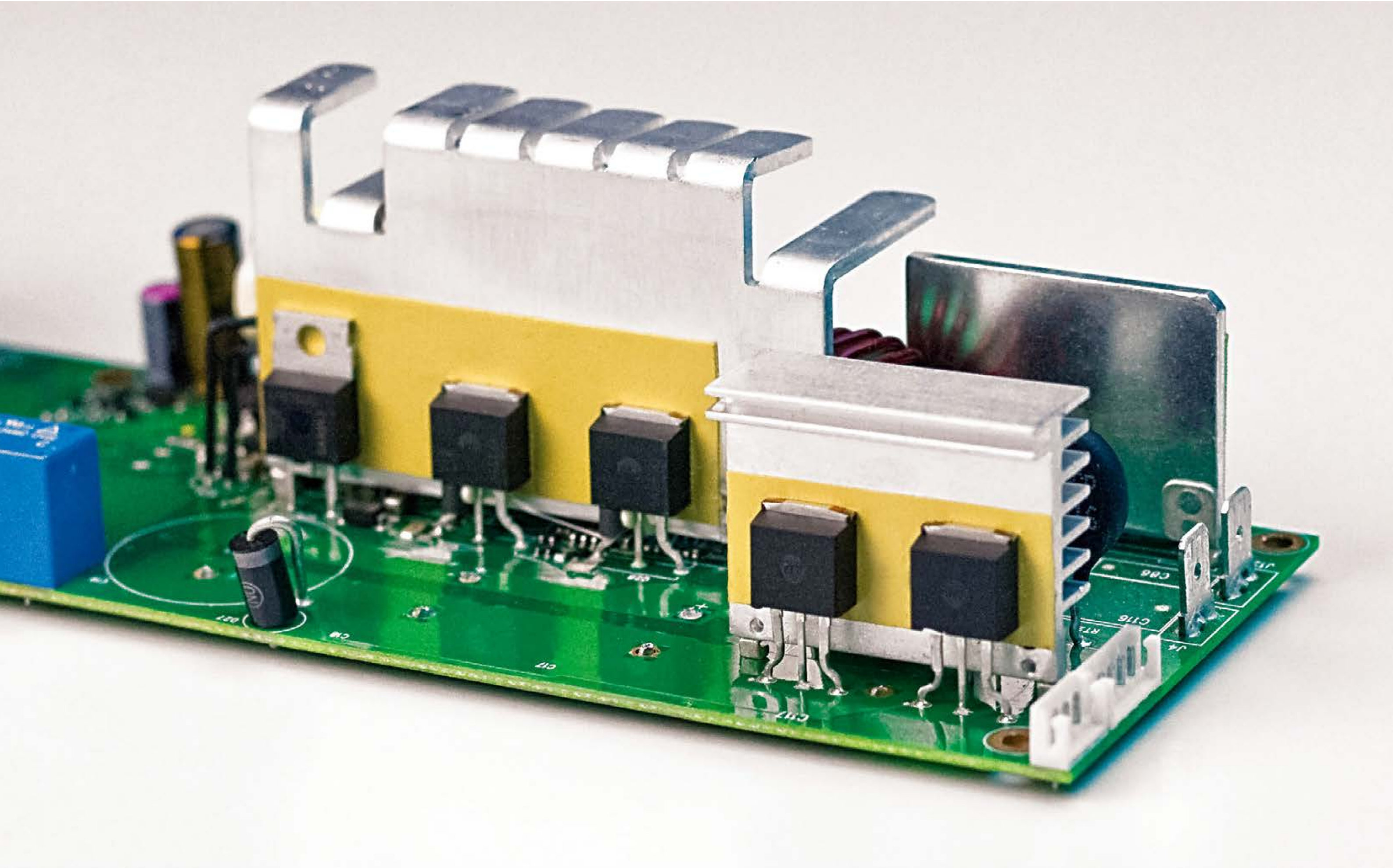
STICKING IT TO THE HEAT

Thermal Adhesives are Dual-Function Powerhouses of Structural Integrity and Heat Dissipation

Milad Amin

It's a common refrain: high functionality, greater complexity, and less space. This has been the continuous trend line of electronic systems design, and there is no end in sight. Consumers demand more power, reliability, and features—often in lighter, more compact footprints. While this is the ideal result for users, it certainly makes the task more challenging for designers.



Higher-density electronic structures require thorough heat dissipation to maximize operational fortitude and efficiency. However, given design intricacies and complex component orientations, it can be difficult to enable optimal thermal control using conventional thermal interface materials (TIMs) that require mechanical attachment. Many TIMs – whether pads, liquids, greases, or gels – must be secured to the heat sink or heat spreader (often the structure housing) mechanically with screws or clips.

In high-density designs or operations that require mass production automation, mechanical attachment methods may not be feasible. So, what's the solution?

No Screws or Clips, Just Strong Adhesion ...

In these circumstances, thermal adhesives emerge as the most practical and effective solution, liberating designers from the constraints of traditional approaches. Thermal adhesives eliminate the undesirable trade-offs between design limitations, structural integrity, production efficiency, and thermal performance, delivering advantages that include:

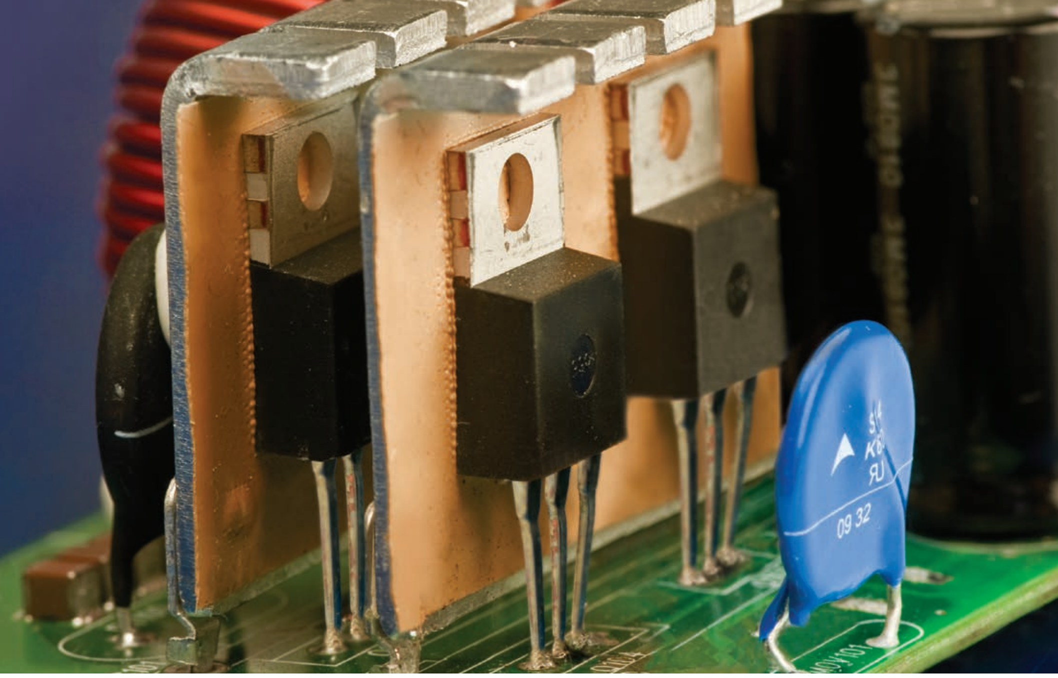
Tight Clearance and Multi-Orientation Capability
Limited mechanical clearance between a component and heat sink or housing may restrict the use of screws or clips. Likewise, components placed in vertical or slanted orientations make attachment with mechanical fasteners challenging. Thermally conductive adhesives overcome the limitations of space-constrained designs.

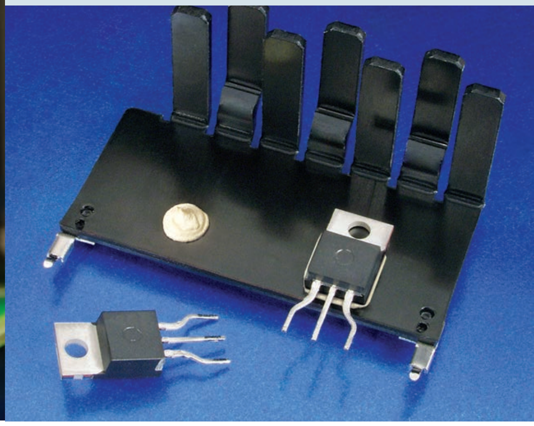
Reduced Mechanical Stress
In sensitive or high-vibration environments such as aerospace, automotive, or industrial equipment, thermal adhesives provide durable structural support across the entire surface area, minimizing the risk of any shifting during operation and increasing reliability.

Weight Reduction
Weight is a key factor in numerous applications, including electric vehicles (EVs), aircraft, and wearables. While conventional mechanical fasteners can add weight, thermal adhesives help reduce it.

Process Efficiency
Speed and automation capability are critical to achieving mass production targets. Here, thermal adhesives shine. Even in manual application situations, it is often faster and easier to apply a thermal adhesive than align, insert, and tighten screws.

Inventory Management
Instead of sourcing and storing multiple fasteners, screws, and clips in varying sizes, a single thermal adhesive solution can be used for many different component types and form factors. This helps reduce costs and complexity while making production operations more streamlined.





... And Thermal Control

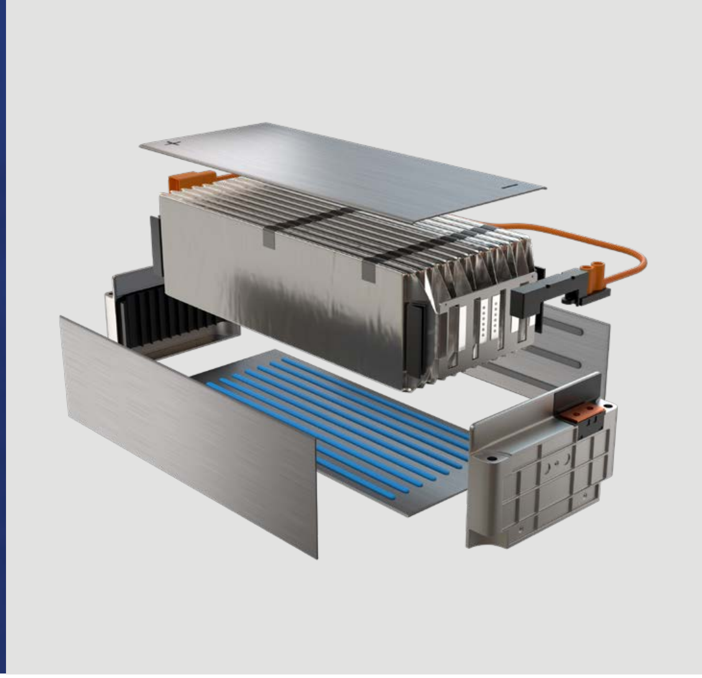
Securing the heat source to the heat sink with strong adhesive capability provides the requisite structural integrity and component stability, while the thermal conductivity of thermal adhesive materials delivers efficient heat transfer to the cooling plate. This dual functionality is significant for numerous electronic systems, offering design leverage without sacrificing critical thermal control. The combination provides:

Lower Thermal Resistance
The combination of adhesion and thermal conductivity in a single material allows heat to transfer more efficiently than using a TIM and separate adhesive in combination.

Excellent Heat Transfer and Reliability
Minimal bond line thickness and excellent wet out to irregular surfaces ensure thorough coverage, filling microscopic deviations and limiting air insulation to encourage heat dissipation. Ensuring optimized thermal transfer improves operational performance and reliability.

Adaptable Formats
To satisfy dynamic production requirements, Henkel thermal adhesives are supplied in tape and liquid formats. Tapes are ideal for bonding two surfaces with mismatched thermal expansion rates, with bonding strength that increases over time. Liquid thermal adhesives create strong post-cure bonds, provide excellent stress absorption, and achieve good gap filling.

Varied Chemistries
Just as different formats are needed to satisfy specific objectives, selection of varying chemistries may also be required. Henkel thermal adhesives are available in silicone-, epoxy-, and acrylic-based materials.

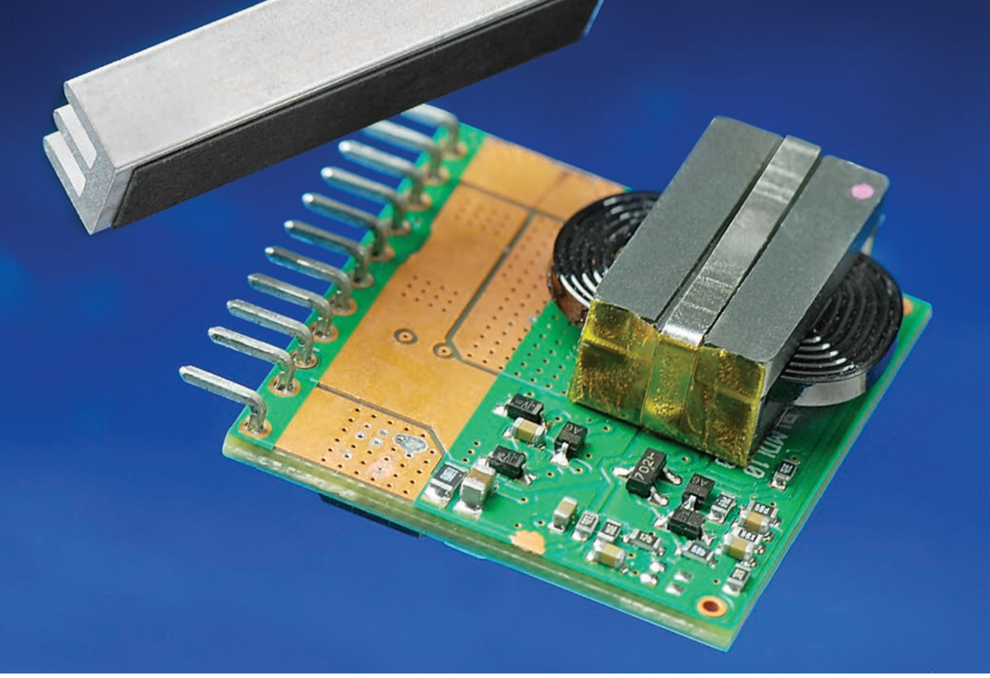
Proven Performance from Lighting to EVs

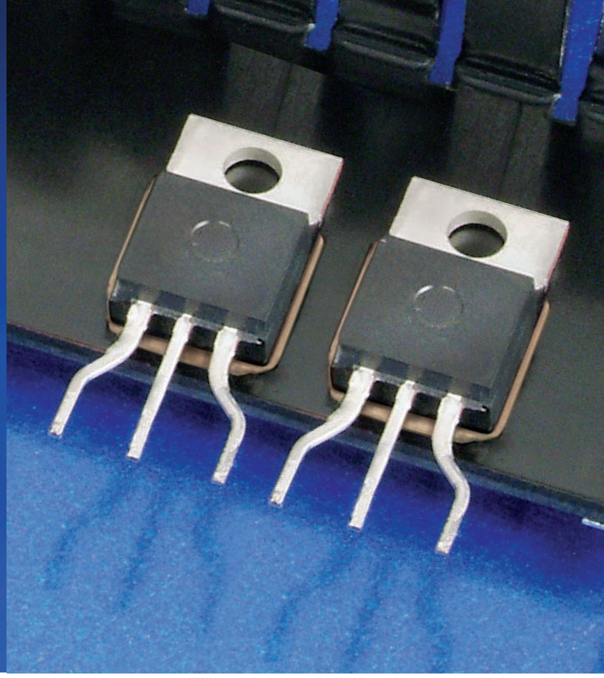
Henkel's line of BERGQUIST LIQUI BOND and BERGQUIST BOND PLY thermally conductive adhesives are integrated into diverse applications, providing design leverage and reliable thermal control. In the lighting sector, for example, BERGQUIST BOND PLY adhesive tapes are used to secure LED lighting strips to their heat-spreading housings, allowing both heat removal and electrical isolation in a sophisticated design. The materials simplify the assembly process, eliminate mechanical approaches, and enable higher output.

And, in the EV market, where liquid gap fillers were used historically, the industry is making a profound shift toward thermal adhesives.

> **Assembly speed, conformity to irregular surfaces, strong adhesion, and outstanding thermal characteristics to prevent thermal runaway are the primary objectives of EV applications.**

Thermal adhesives are used to bond EV battery modules to cooling plates and have become the preferred solution. There are numerous other examples – from power supplies to sensors– where dual-function thermal adhesives excel.





Perfect for Some, Not for All

While thermal adhesives are indispensable for some electronic designs, they aren't the right choice for every application. The materials form a permanent bond and are not reworkable, so they aren't appropriate if repair and reworkability are priorities. Some thermal adhesives require time to cure and may limit production speed. There are also high-power density applications like CPUs or GPUs, where the highest priority is heat dissipation. In this case, a thermal grease or phase change TIM may be preferable. Finally, liquid thermal adhesives require special deposition equipment and extreme precision, so these factors require thorough analysis. It's important to consider these limitations when evaluating the suitability of thermal adhesives for a particular application.

> **But, when adhesion and thermal control are the objective, design constraints prevent conventional approaches, and production objectives dictate speed and efficiency, thermally conductive adhesives are unmatched.**

Milad Amin

The Author

Milad Amin is an Application Engineer at Henkel, specializing in thermal interface materials (TIMs) within the company's Adhesive Technologies business unit. Milad, who has an impressive thermal design and engineering background, joined Henkel in 2023 and is focused on technical customer support, product application development, and collaboration with sales and marketing teams to deliver optimized thermal solutions for customers.

Broad experience in the electronics, power, and industrial markets underpin Milad's unique insight and his drive to help customers select the most appropriate thermal solution for their application. He is passionate about bridging technical expertise with commercial strategy to secure customer and business success.

Milad holds a bachelor's degree in mechanical engineering and a master's in computational thermofluid engineering from The Friedrich-Alexander Universityof Erlangen-Nuremberg. He is based in Henkel's Düsseldorf headquarters in Germany.

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