



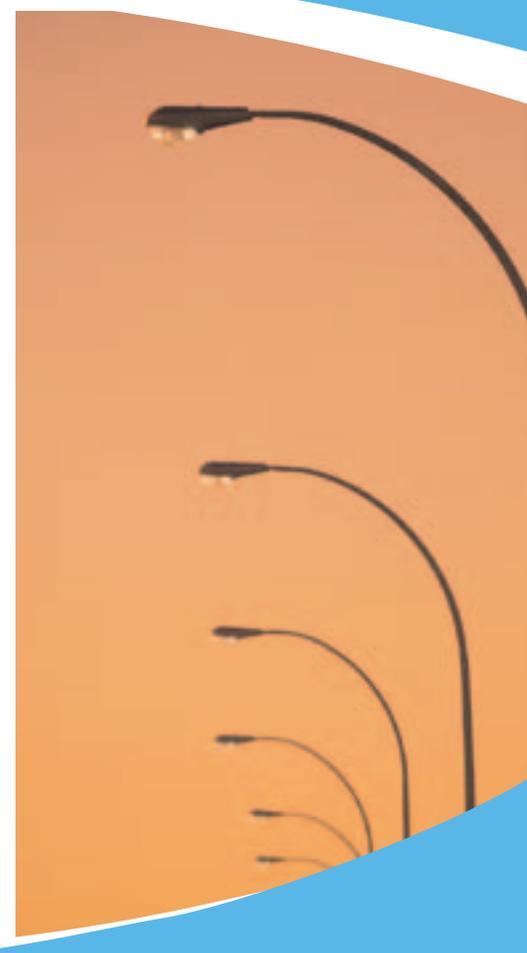
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### Thermal Management Materials allow LED systems to: Shine Brighter, Last Longer and Maintain Color Control

Laird Technologies produces some of the world's highest-rated thermally conductive materials for use in electronic packaging.

The thermal management product line includes gap fillers (including putties), phase change materials, thermal greases, thermally conductive circuit boards, thermal electric coolers and thermally conductive insulator materials.

| Thermal Material Type          | Thickness Range, mils | Thermal Conductivity Range, Watt/m-K | Deflection @ 50 psi | Dielectric Breakdown, Vac | Form         |
|--------------------------------|-----------------------|--------------------------------------|---------------------|---------------------------|--------------|
| Gap Fillers                    | 20 - 200              | 1 - 5                                | 10 - 50%            | 1,000 - 10,000            | Pad          |
| Grease                         | N/A                   | 0.5 - 3                              | N/A                 | 0                         | Liquid paste |
| Phase Change Materials         | 5 - 20                | 0.8 - 3.5                            | N/A                 | 0                         | Pad          |
| Thermally Conductive Insulator | 5 - 20                | 0.8 - 5                              | N/A                 | 3,500 - 9,000             | Pad          |
| IMPCB                          | 4 - 8                 | 2 - 3                                | N/A                 | 1,500 - 6,000             | PCB          |



## Integrated Heat Sink Solution

Direct mounting of the LED to a thermally conductive PCB provides the best combination of a thermal solution and ease of manufacture. The TLam system provides an integrated heat spreader and PCB. TLam PCBs can be panelized and are compatible with pick and place automated assembly processes.

Everything about the LED's performance is related to temperature, and the TLam system is the workhorse of thermal solutions. It is the best at keeping temperature under control.

The TLam system provides two thermal solutions. It pulls (dissipates) the heat into the integrated aluminum heat sink, and spreads the heat over the surface of the board. The benefit of spreading the heat creates a package where all the LED's are operating at the same temperature.

## Direct or Indirect Mounting to Heat Sink

The LED circuit assembly can be mounted to an active heat sink, or to the outside enclosure to keep the LEDs cool. FR4 circuit assemblies are typically used in lower wattages and cost sensitive applications.

When the circuit assembly is mounted indirectly to the enclosure; there is a dimensional stack up tolerance. This application needs a soft, conformable material to insure the interface is filled with thermally conductive material. Individual thermal pads are placed under the LEDs. Gap Fillers provide a range of thickness, performance and conformability to meet the application.

When the circuit assembly is mounted directly to the heat sink or enclosure, the assembly requires a thermal material with electrical isolation characteristics. Thin Gap Fillers or Thermally Conductive and Electrically Insulative materials are the best choice for the thermal solution.

These materials minimize the pressure required to produce a good thermal path, and less pressure means less stress on the circuit board.

When a LED circuit assembly utilizes the TLam system, the PCB board is electrically isolated. The assembly can be mounted to an active heat sink to provide additional cooling. This application is ideal for Grease and Phase Change Products. Grease and Phase Change materials are high performance thermal interface materials used in PC CPUs and GPUs that continually push thermal performance to new levels.

## Extreme Requirements

*How do I keep the LED cooler than its environment or at a constant temperature?* Thermoelectric Modules (TEM) are the answer. Thermoelectric Modules are solid state heat pumps that electronically cool the LED. The Thermoelectric Module can regulate the temperature of the LED assembly creating consistent color and brightness.