Mounting Guideline for High Power Light Sources of the OSTAR® LED Product Family

Application Note

Abstract

With the availability of high power light sources such as the OSTAR® LED product family an appropriate mounting method takes on a new importance. At operating currents of several amperes and power dissipation of 10 Watts or more, the mounting method significantly contributes to the performance and lifetime of the LED light sources.

The selection of an inappropriate or insufficient mounting can lead to thermal and mechanical problems during operation, ultimately causing failure of the device.
In addition to providing a purely mechanical connection, the mounting also plays an important role in the optimization of heat transfer from the light source to the heat sink (see application note "Thermal Management of OSTAR® Projection“).

Mounting procedures

In principle, several mounting possibilities can be used to mount the OSTAR® LED light sources, such as:

- Screws
- Clamps
- Adhesive
- etc.

Regardless of the method employed, consideration should be given to the predefined requirements of each application area when choosing an appropriate mounting technique.

Mountings for use in automotive applications, for example, have higher requirements due to external factors (e.g. vibration) than those employed in office applications or in general lighting.

In general, it should be ensured that a good heat transfer exists between the OSTAR® LED light source and the heat sink, and that it is also guaranteed during operation (see application note "Thermal Management of OSTAR® Projection“).

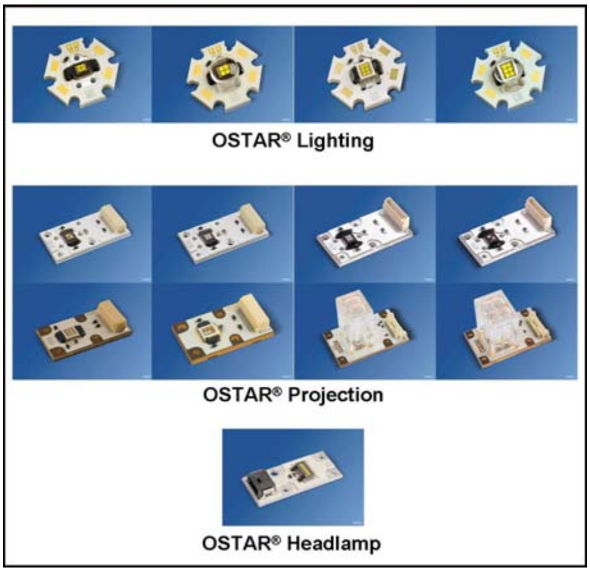

Figure 1: Overview High Power Light Sources of the OSTAR® LED Product Family

The mounting consists of two essential criteria:

- the actual mounting method and additional securing techniques which may be required (e.g. lock washers, spring washers, serrated washers, locking compounds, etc.);

- the optimization of heat transfer by means of thermal interface materials.

For most applications, it is generally recommended that the OSTAR light sources be fastened with screws, since sufficient contact pressure can be achieved with a screw connection.

Nevertheless, the OSTAR® LED light sources can also be mounted by means of clamps or adhesives.
When mounting with an adhesive, it should be observed that the adhesive not only has strong bonding properties, but that it also is thermally stable and possesses good heat transfer characteristics. Moreover, the thickness of the layer should be kept as thin as possible.

OSTAR® Headlamp
For the product group OSTAR® Headlamp, which is predominantly employed in automotive applications, mounting with M2 screws, a washer and locking compound is recommended. When mounting the screws, a torque of 0.2 to 0.3 Nm should be used.
Care must be taken to ensure that washer does not damage the compact light source, especially the primary optics, during the mounting process.

OSTAR® Projection
Since the OSTAR® Projection light sources are predominantly employed in office or TV applications such as projectors or RPTVs, mounting with M2 screws with a torque of 0.2 to 0.3 Nm is recommended. Clamps may also be used.

OSTAR®-Lighting
Specially developed for applications in the area of general lighting, the prescribed standards for lighting technology (IEC 60598-1) must be adhered to here.

In general, lamps can be divided in three safety classes (I, II and III), whereby depending on the class, different protective functions or measures must be fulfilled.

For lamps in Safety Class I, for example, a specific base insulator as well as a protective grounding of all conductive and accessible components (housings) must be present.
For Safety Class II, however, a base insulator and a protective housing with reinforced insulation are sufficient. Grounding is not required or permitted.
Lamps which operate at extremely low voltages (≤25 V) fall under Safety Class III and require no special safety measures.
All parts of the lamp, including the leads, can be contacted safely. The lamps are driven by an independent power supply.

Of the LED modules today available on the market, only the OSTAR® Lighting fulfills all requirements, e.g. electrical dielectric strength or insulation resistance, for unconditional use in lamps of Safety Class III. In addition, the module is designed for easy individual mounting.

Generally, the mounting method for the OSTAR® Lighting should be chosen dependent on the safety class of the final lamp, in order to fulfill the special requirements.

For use in lamps governed by Safety Class III, the OSTAR®-Lighting can be mounted by means of M3 screws. The screws should be secured with a maximum torque of 0.8 Nm.
In order to achieve a good thermal connection, the contact pressure should typically lie in the range of 0.35 MPa.
For use in lamps covered by Safety Classes I or II, however, mounting with clamps or adhesive is recommended.
However in general the safety requirements of luminaire standards should be considered for fixing the OSTAR®-Lighting.

Electrical connection of the OSTAR®-Lighting

For electrical connection of the OSTAR®-Lighting LEDs, several solder pads (anode/cathode) are provided on the metal core board.
To attach the connection cable, a simple, conventional soldering iron can be used. The solder time is primarily determined by the solder temperature, not by the soldering tip.
For connections with wires with a maximum diameter of 1.02 mm (e.g. AWG 18) the following soldering data may be used to assure a reliable solder connection:

Solder Tip	Temperature	Solder Time
3.2 mm	250 °C	16 sec.
3.2 mm	350 °C	6 sec.

Table 1: Sample soldering data for AWG 18 cable (lead-free solder)

Typically, cables with smaller diameters such as AWG 20 or AWG 22 are used depending on the forward current.

Interface Resistance

When mounting a component to a heatsink, it should generally be kept in mind that two solid surfaces must be brought into close physical contact.

Technical surfaces are never really flat or smooth, however, but have a certain roughness due to microscopic edges and depressions. When two such surfaces are joined together, contact occurs only at the surface peaks. The depressions remain separated and form air-filled cavities (Figure 2).
Since air is a poor conductor of heat, these cavities should be filled with a thermally conductive material in order to significantly reduce the thermal resistance and increase the heat flow between the two bordering surfaces.

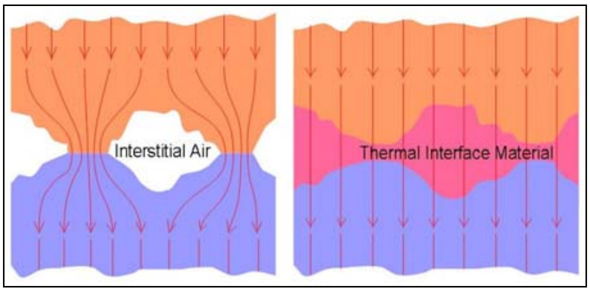

Figure 2: Heat flow with and without heat conductive material

Without an appropriate, optimally effective interface, only a limited amount of heat exchange occurs between the two components.

Contact conditions encompass a number of areas including: surface roughness, surface cleanliness, paint finishes and intermediate results. The surface roughness of the heat sink material should be no greater than 0.02 mm over the area where the device is mounted. Surface cleanliness during assembly of device and heat sink is imperative, even if a thermal interface material is subsequently added.
In order to improve the heat transfer capability and reduce the thermal contact resistance, several materials are suitable.

Thermal Grease

This usually consists of silicone grease loaded with a good thermal conducting material such as aluminum. Thinly applied, these compounds are advantageous as they fill the air gaps and do not further increase the distance between the surfaces. Thickly applied, they can hold the two contact surfaces apart and increase the contact resistance.
In general, it can be said that when applied correctly, thermal transfer pastes and bondings have the lowest interface resistance; they require particular care in handling, however.

Interface Pads

Interface Pads are silicone elastomer pads filled with thermally conductive ceramic particles, often reinforced with glass fiber or dielectric film for added strength. These elastomers are available in thicknesses from about 0.1 mm. Elastomers do not flow freely like the grease compounds, but will deform if sufficient compressive load is applied to conform to surface irregularities.
At low pressures, the elastomer cannot fill the voids between the surfaces and the thermal interface resistance is high.
As pressure is increased, more of the microscopic voids are filled by the elastomer and the thermal resistance decreases.
Contact pressure eliminates the interstitial voids and reduces the interface resistance to a minimum.
Contact pressure must be permanently maintained by using fasteners or springs to hold the two surfaces together.

Phase change materials

One of the problems that interface pads have is the forces required for good thermal contact.
Phase change materials are solid in nature until raised above a certain temperature, at which point they become a viscous fluid.
This change from solid to viscous occurs every time the temperature reaches this level. This fluidity means that with an adequate contact force, the air gaps can easily be filled and good thermal contact can be made.

Summary

The selection of a mounting method for the OSTAR LED light source is ultimately dependent on the application area, the associated requirements and the operating parameters.
Automotive applications have higher requirements regarding mounting techniques, compared to office or general lighting applications.

Due to the high power density of the OSTAR® LED light sources, it should be ensured that a good thermal connection to the heatsink is provided, regardless of the type of mounting employed.

Numerous materials are suited for optimization of heat transfer. The success of a thermal interface material is predominantly determined by the quality, the processing of the material and the thoroughness of the design. In addition, the mounting technique (e.g. contact pressure) is also influential.

Only through the combination of an appropriate mounting and a good heat transfer can operation with optimal performance be guaranteed, and thermal and mechanical problems be prevented.

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