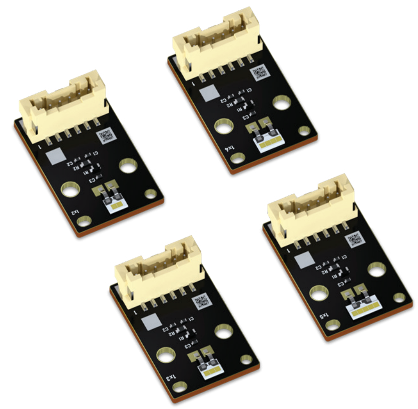
LUMILEDS

AUTOMOTIVE

# LUXEON Altilon TopContact PnP

## Assembly and Handling Information



## Introduction

This Application Brief covers recommended assembly and handling procedures for LUXEON Altilon TopContact PnP modules. LUXEON Altilon TopContact PnP modules are designed to deliver high luminous flux and efficacy in an easy-to-assemble package that facilitates automotive exterior lighting applications. Due to the small size and construction, they require special assembly and handling precautions.

Proper assembly, handling and thermal management, as outlined in this application brief, ensures high optical output, long term lumen maintenance and high reliability of Altilon TopContact PnP in automotive applications.

## Scope

The assembly and handling guidelines in this application brief apply to the following LUXEON Altilon TopContact PnP products:

| PRODUCTS |
| --- |
| A2F1–S0002BH0XXXXX |
| A2F1–S0003BH0XXXXX |
| A2F1–S0004BH0XXXXX |
| A2F1–S0005BH0XXXXX |

In the remainder of this document the term TopContact PnP module refers to the product as figured in the picture above, with an array of two to five light emitting LED chips closely spaced in a row. The position and orientation of the connector may be customized upon request. Please contact your Lumileds sales representative for further information.

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# 1. Component

## 1.1. Reference Document

The datasheet for the TopContact PnP modules are available upon request. Please contact your sales representative.

## 1.2. Description

The TopContact PnP consists of an array of 2, 3, 4, or 5 LED chips which are attached on a Cu-IMS PCB. The TopContact LED in combination with a Cu-IMS PCB is designed to minimize the thermal resistance between LED and the heatsink. Two aluminum ribbons connect the LED chips from anode and cathode to a 6-pin JST PA connector. Thermal and electrical protection devices as well as NTC and bin code resistor can be mounted between LED and connector.

The main components of the TopContact PnP module assembly are visualized in Figure 1.

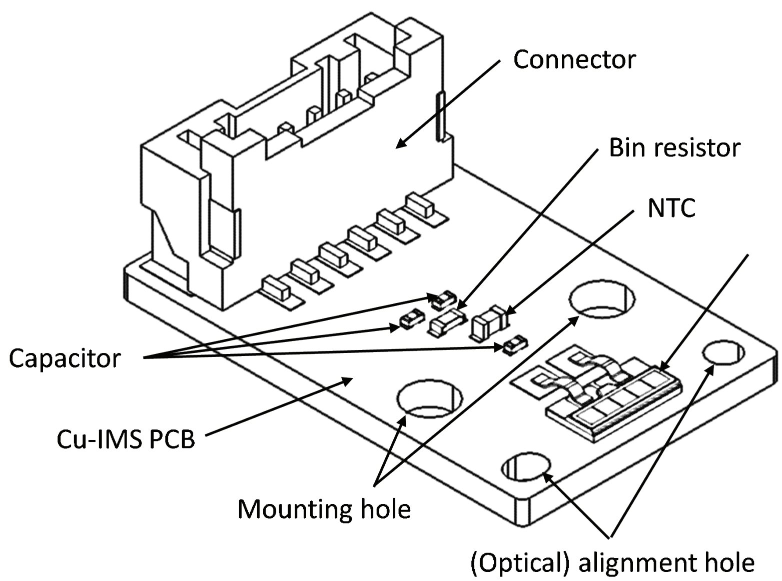



**Figure 1. Top View with main components of the TopContact PnP**

In the standard configuration, a UL listed side entry type JST PA BM06B-PASS-NI-TFT 6-pin connector is provided on a Cu-IMS PCB for easy electrical plug-in connection.

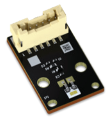
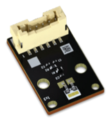
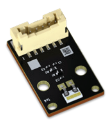
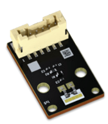
Two mounting holes -serve to attach the TopContact PnP module to the heat sink with pan head screws while two alignment holes enable the precise positioning of position the TopContact PnP modules' light emitting area relative to alignment features e.g. alignment pins on the heat sink.

A negative temperature coefficient thermistor (NTC) placed in the vicinity of the TopContact LED can be used for feedback purposes, e.g. to protect the TopContact LED from being damaged by excessive heat.

The TopContact LED includes an integrated transient voltage suppressor (TVS) chip to protect the LED chips against electrostatic discharges. (please see chapter 2.1)

The TopContact PnP module comes in one mechanical configuration with four different LED arrays, in Table 1.

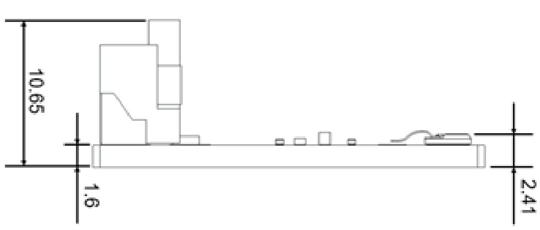
Table 1. Design features of TopContact PnP by part number

| PRODUCT | | PART NUMBER | NO. OF DIES |
|---|---|---|---|
|  | LUXEON Altilon TopContact PnP | A2F1–S0002BH0XXXXX | 2 |
|  | LUXEON Altilon TopContact PnP | A2F1–S0003BH0XXXXX | 3 |
|  | LUXEON Altilon TopContact PnP | A2F1–S0004BH0XXXXX | 4 |
|  | LUXEON Altilon TopContact PnP | A2F1–S0005BH0XXXXX | 5 |

## 1.3 Form Factor

The dimensional design for the TopContact PnP is outlined below in Figure 2. Refer to the latest datasheet for detailed dimensions and applicable tolerances.

| DIE | DIMENSION A |
|---|---|
| 1x2 | 3.70 mm |
| 1x3 | 4.00 mm |
| 1x4 | 5.00 mm |
| 1x5 | 6.10 mm |



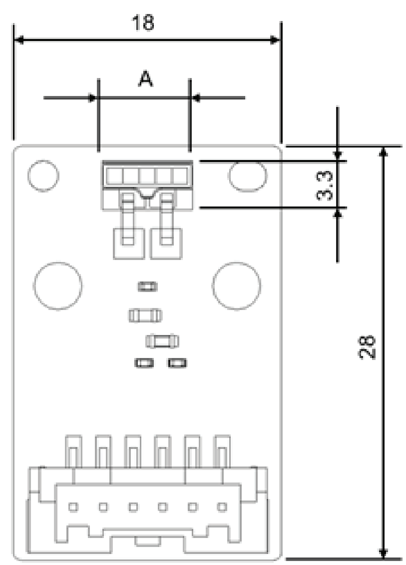




Figure 2. Outline dimensions for TopContact PnP

## 1.4 Optical Center

The TopContact PnP module has no lens (primary optics). The optical center is at the center location of the LED chip array as indicated by the red dot in Figure 3. Please refer to the TopContact PnP modules datasheet for applicable tolerances.

The optical center of the TopContact PnP module is referenced to the primary optic alignment holes, see Figure 3. It can be empirically determined by measuring the alignment holes position on the TopContact PnP module. The round hole determines the origin of the coordinate system while the long hole determines the rotation of the coordinate system.

The optical center of the LED array then can be found on the axis connecting the alignment holes, at 7 mm distance from the origin. This means that for odd LED chip arrays the optical center is located roughly in the middle of the center chip, while for even LED arrays the optical center is roughly located between the two inner LED chips.

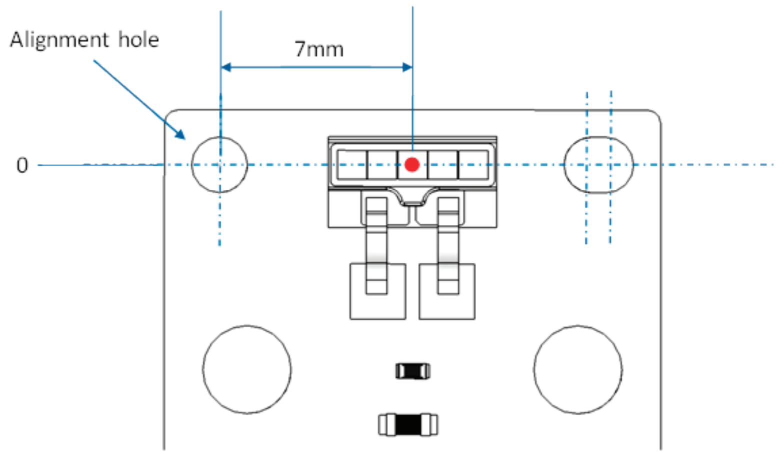



**Figure 3. Optical center of the TopContact PnP module (E.g. 1x5 array)**

The optical rayset data of each TopContact PnP type is available upon request

## 1.5 Product Identification

Each TopContact PnP module is provided with an individual serial number in form of a dot matrix code next to the connector on the front side of the printed circuit board (PCB), see Figure 4.

For details of the part and the serial number description, please see the appropriate paragraph in the datasheet.

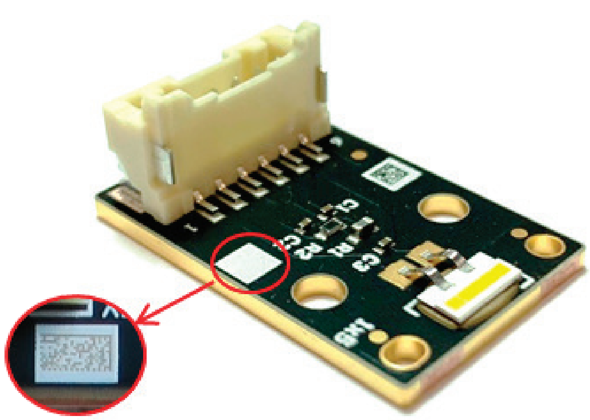


**Figure 4. Position of dot matrix code**

## 1.6 Configurability

The TopContact PnP module is available in the standard product configuration shown inFigure 1 and Figure 2. Additional, the product is designed for easy custom reconfigurability to meet the requirements of our customers.

Possible adaptations comprise the size and shape of the Cu-IMS , all components next to the LED (connector brand and/or orientation, NTC brand and/or position, additional components as bin code resistors and/or capacitors and/or others, ...) as well as the position of attachment and alignment holes. Additional alignment holes will be added upon request, to e.g. allow precise positioning of primary optics next to the LED.

Please contact your local Lumileds sales representative for further information.

## 1.7 Mechanical Files

Mechanical drawings and CAD-files for the TopContact PnP are available upon request. For details, please contact your sales representative.

# 2. Handling Preauctions

## 2.1 Electrostatic Discharge Protection (ESD)

In order to prevent ESD, the TopContact LED is protected by an additional internal TVS device. This transient voltage suppressor (TVS) diode provides a current path for transient voltages (see Figure 5).

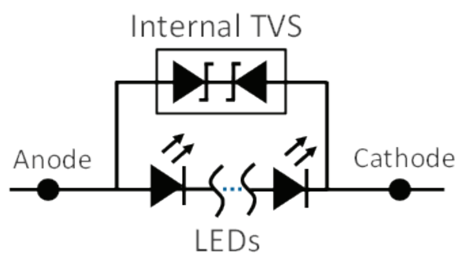



**Figure 5. Electrical schematic of a TopContact with bidirectional TVS**

It has independently verified that the module successfully passes ESD tests according AECQ102 for the different models and the voltages given below:

- Human Body Model (HBM): ± 8000 V
- Charge Device Model (CDM): ± 2000 V
- Machine Model (MM): ± 400 V

## 2.2 Enhanced ESD Protection Level

Additional external ESD protection for the LED may be needed if the TopContact PnP is used in non ESD-protected environments like repair shops and/or exposed to higher ESD voltages and discharge energy. For this an additional TVS (transient voltage suppressor) diode may be mounted on the PCB. By choosing the right component ESD protection according to ISO10605 and IEC 61000-4-2 (level IV) can be reached.

For further details please contact your local Lumileds sales representative.

## 2.3 Component Handling

TopContact PnP modules are designed to maximize light output and reliability. Improper handling may damage the module and affect the overall performance and reliability.

In order to minimize the risk of damage to the silicone coating during handling, TopContact PnP modules should only be picked from the sides of the Cu-IMS PCB substrate or by the connector.

- Do not touch the upper part which is close to Aluminum ribbon bond area.
- Do not apply excessive force on any component (LED chip, the connector, the bin resistor nor the NTC) or the Cu-IMS PCB.
- Do not touch the top surface of the TopContact LED with fingers or apply any pressure to it.
- Do not put TopContact PnP top side down on any surface.

In Figure 6 the admissible area to handle the TopContact PnP is marked with a green plane and areas of improper handling are marked as a red plane. Avoid an impact to the metal pins, if touching the connector for assembly. Figure 7 shows examples of improper handling.

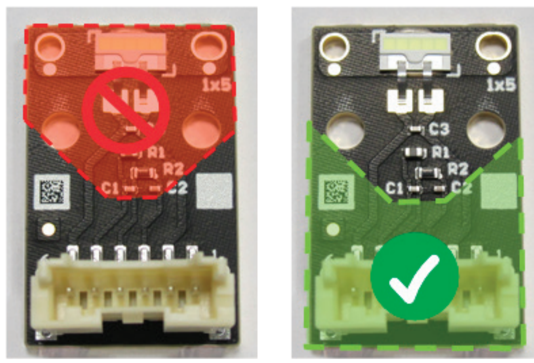



**Figure 6. Board handling**

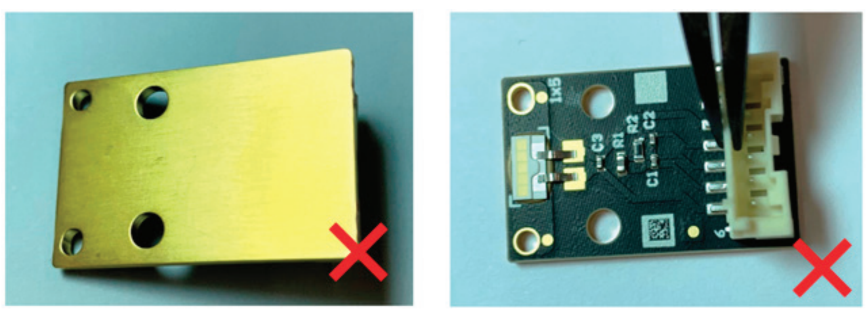


**Figure 7. Example of improper handling**

## 2.4 Cleaning

The TopContact PnP module should not be exposed to dust or debris. Excessive dust or debris may cause a drastic decrease in optical output. It is therefore recommended to keep a TopContact PnP in its original packaging until it is mounted into its application.

If the surface requires cleaning, a compressed gas duster or an air gun with 1.4 bar (at the nozzle tip) and a distance of 15 cm will be sufficient to remove the dust and debris. Make sure the TopContact PnP is properly secured.

One can also rinse with isopropyl alcohol (IPA). Do not use solvents listed in Table 5, as they may adversely react with the LED assembly. Extra care should be taken not to damage the housing around the LED chips and the aluminum ribbon bond. Lumileds does not recommend ultrasonic supported cleaning for LEDs.

## 2.5 Soldering

Do not reflow the TopContact PnP module.

TopContact PnP is designed to be mechanically secured onto a heat sink. Soldering of the TopContact PnP module is not foreseen and may lead to loss of components and weakening of component to PCB interconnect. The electrical connector eliminates the need to solder any wires onto the TopContact PnP module.

# 3. Thermal Management

## 3.1 Thermal Measurement Guidance

The junction temperature can be calculated based on the thermal resistance given in the datasheet and the temperature at the bottom of the PCB of the TopContact PnP module. In the actual application, it has to be verified that the LED junction temperature $T_j$ and the temperature at the bottom of the module's PCB $T_b$ do not exceed the maximum allowable temperatures as specified in the datasheet. The TopContact PnP is equipped with a negative temperature coefficient (NTC) thermistor that can be used for derating. The relation between the NTC temperature and the junction and board temperature depends on the thermal connection between the board and the heat sink, i.e. the thermal interface material, the die count, the drive current and the ambient operating conditions. This section provides general guidelines on how to determine the junction temperature and board temperature of the TopContact PnP and on how to relate them to the temperature reading of the NTC thermistor on the board. These relations known, system-specific derating based on the NTC resistance can be established to protect the TopContact PnP from overheating.

## 3.2 Junction Temperature Estimation Based on Temperature Readings for $T_{sensor}$

In typical applications it may be difficult to measure the junction temperature $T_j$ or the temperature at the bottom of the board $T_b$ directly. A practical way to determine these temperatures is to measure the temperature $T_{sensor}$ at a predetermined position on the PCB by means of a sensor, e.g. a thin-wire thermocouple. The recommended location of the thermocouple is at the Cu core of the board at 0.5 mm from the LED edge as indicated in Figure 8. The thermocouple is glued on the Cu core of the board. To assure proper thermal contact to the board, the solder resist layer should be carefully removed at the measurement point before attaching the thermocouple. This can be done by gently scratching away the solder resist. In case that the glue used for the LED attach extends to the point where the thermocouple is to be mounted, the glue should as well be gently removed, e.g. scratched away, in this region. To ensure accurate readings, the thermocouple should be attached using a thermally conductive glue.

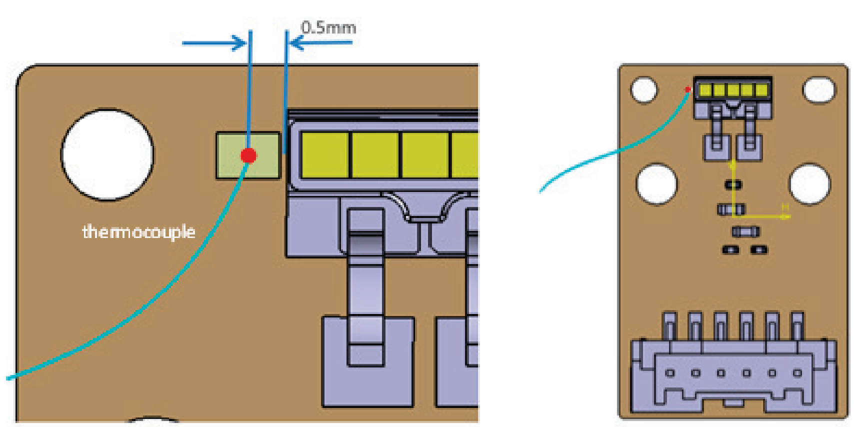



**Figure 8. Thermocouple measurement point**

Due to the high thermal conductivity of Cu, it can be assumed that the board temperature Tb and the temperature at the sensor position $T_{sensor}$ are close to identical. Accordingly, it is $T_b \approx T_{sensor}$, which means that the board temperature $T_b$ can be directly measured with the thermocouple placed at the sensor location. In consequence, the thermal resistance between junction and sensor $R_{th,j\text{-}sensor}$ can be assumed to be equivalent to the thermal resistance junction-to-board-bottom $R_{th,j\text{-}b}$, which is specified in the datasheet.

The junction temperature Tj can then be determined according to

$$T_j = T_{sensor} + R_{th,j\text{-}b,el} \cdot P_{el} \approx T_b + R_{th,j\text{-}b,el} \cdot P_{el},$$

$$T_j = T_{sensor} + R_{th,j\text{-}b,real} \cdot P_{th} \approx T_b + R_{th,j\text{-}b,real} \cdot P_{th},$$

where Pel is the electrical power going into the TopContact PnP emitters, and $P_{th}$ the thermal power. The relationship between the electrical and the thermal power is given by $P_{th} = P_{el} * (1\text{-WPE})$, with WPE denoting the wall-plug efficiency of the LED. Please note that the WPE is not constant and depends on drive condition, temperature, and flux binning class.

## 3.3 Temperature Measurement by NTC Thermistor

The LUXEON Altilon TopContact PnP is equipped with an NTC thermistor that can also be used to estimate the junction temperature. Since the thermal connection of the TopContact PnP board to the heat sink has an impact on the heat spreading in the Cu board, the difference between the NTC thermistor temperature TNTC and the board temperature Tb generally also depends on this connection. More precisely, this means that parameters such the thermal interface material, the die count, the drive current and the in affect the temperature difference TNTC-Tb. Thus, TNTC-Tb has to be individually characterized for each application setup to derive a good estimation for the board or junction temperature from the NTC reading. For illustration, Figure 9 shows the measured temperature difference TNTC-Tb for TopContact PnP 1x2 and 1x5 modules operated at 1 A drive current DC for two different thermal interface materials.

Lumileds clearly recommends to calibrate the NTC by determining the temperature difference between NTC thermistor and board bottom for the desired application setup. Only then, the NTC signal can be used to get a reliable temperature estimation to protect the LED from overheating. The board temperature needed for the NTC calibration can be determined using one of the methods described in this application brief.

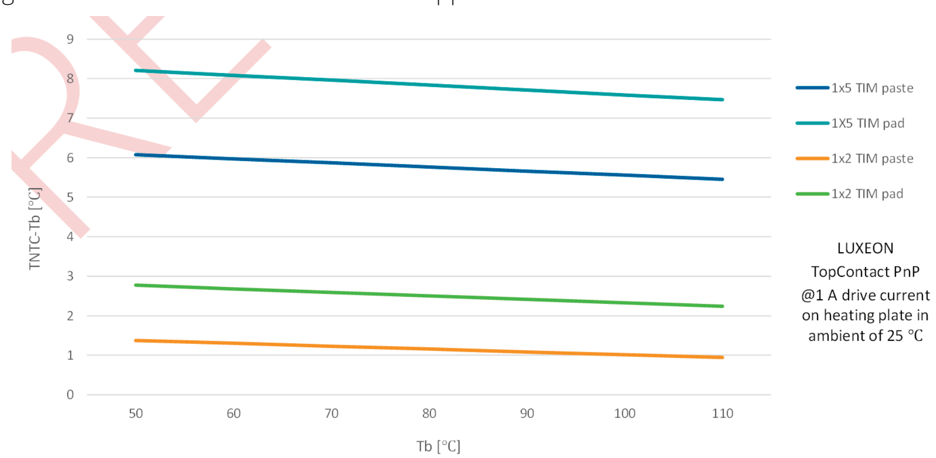



**Figure 9. Examples of temperature differences between NTC and bottom of the PCB for different TIM materials**

## 3.4 Temperature Measurement by Forward Voltage Measurement

To directly measure the junction temperature Tj of the LED on the TopContact PnP module the temperature dependence of the forward voltage Vf of the LED can be used. The forward voltage change after switching off the thermally stabilized system is measured and analyzed to obtain information on the LED junction temperature. To ensure high accuracy, a precise and fast voltage measurement system is needed. In addition, the relationship between the forward voltage and the junction temperature needs to be properly characterized for each individual module.

## 3.5 Heat Sink

The LUXEON Altilon Top Contact PnP must be mounted onto a properly sized heat sink in order to keep the junction temperature below the maximum temperature as specified in the datasheet. The required size of the heat sink depends on the temperature boundary conditions of the application.

## 3.6 Thermal Interface Material (TIM) Selection

The LUXEON Altilon Top Contact PnP must be mounted onto a properly sized heat sink in order to keep the junction Due to the low thermal resistance of the TopContact PnP and its large thermal footprint, a variety of thermal interface materials can be used to thermally connect the emitter to the heat sink, e.g. thermal grease, thermal glue, thermal pads, graphite sheets.

However, TIM selection should be made with the following considerations:

1. Pump out—Some TIMs will move out of the thermal path during extreme temperature excursions, which will create voids in the thermal path. These materials should not be used.

2. TIM thickness—Excessive thickness of some TIMs will present an unacceptable thermal resistance even though the thermal conductivity of the material may be high.

3. Surface roughness—In order to fill the air gaps between adjacent surface, choose the appropriate TIM that minimizes the interfacial contact resistance.

4. Operating temperature—Some TIMs perform poorly at elevated temperatures. Care should be taken to select a TIM that will perform well under the anticipated operating conditions.

5. Out-gassing—Out-gassing of some TIMs at design temperature may produce undesirable optical or appearance qualities (e.g. fogging) in a sealed system. Special consideration must be given to limit this effect.

6. Screwing force—TIMs such as thermal tape or pads perform better when the right pressure is applied. For applicable forces see the applicable TIM data sheet and the chapter 3.7.

7. TIM softness—Lumileds observed especially for soft pads that during mounting the Cu-IMS PCB tends to be bend on soft TIM pads.

Table 2 lists some thermal interface materials which Lumileds has successfully used in the past to ensure a good transfer of heat between the copper core and a heatsink. This data is provided for informational purpose only.

Lumileds cannot guarantee the performance of the listed TIMs since LED operating conditions will vary with the application design.

**Table 2. List of TIMs that meet the TIM considerations outlined in this section. Note that the actual performance of these TIMs will depend on the final application**

| MANUFACTURER | TIM-TYPE | TIM |
|---|---|---|
| Laird | Thermal grease | Laird T2500 |
| Shin-Etsu | Thermal grease | G-777 |

## 3.7 Application of Thermal Interface Material - Thermal Grease

Lumileds has successfully used thermal grease to ensure a good heat transfer between the TopContact PnP module and a heat sink.

The resulting layer thickness will depend on the properties of the selected grease and the clamp force of the screws. A dispensed thermal grease volume of approximately 4 $mm^3$ can be used as a starting point for process optimization.

Please note that the thermal grease performance will vary with the LED operating conditions and the application design. Lumileds recommends to test the performance and reliability of the TopContact PnP module under application conditions.

Please also note that unevenly distributed thermal grease may pose a considerable mechanical resistance during bolting the module. In extreme cases the Cu--PCB may bend under the applied forces when a lever over the TIM paste is created. Lumileds therefore recommends to screen print the thermal grease as thin as possible, see item 2 in paragraph 3.6.

A stencil scheme for grease printing can be provided upon request. Please contact your local sales representative for further assistance.

Dispensing the thermal grease will result in equally distributed dots and spreading of the thermal grease with low forces during module placement is an alternative to screen-printing the thermal grease. Lumileds recommends to optimize the process to prevent bending of the Cu- PCB during bolting.

Once the thermal grease is applied, the TopContact PnP module is ready to be placed onto the heat sink.

## 3.8 Application of Thermal Interface Material – Thermal Pad

Lumileds does not recommend the use of soft thermal pads as the Cu- PCB of the TopContact PnP module can bend during bolt attach.

## 3.9 Application of Thermal Interface Material – Glue

Lumileds has successfully used thermal glue to ensure a good heat transfer between the TopContact PnP module and a heat sink.

Please note that the thermal glue performance will vary with the LED operating conditions and the application design. Lumileds recommends to test the performance and reliability of the TopContact PnP modules under application conditions.

## 3.10 No Thermal Interface Material

Mounting the TopContact PnP to a heat sink without additional thermal interface material might result in undefined air gaps between the module and heat sink, leading to poor thermal performance due to the high thermal conductivity of air. Lumileds does not recommend to use the TopContact PnP modules without thermal interface material.

# 4. Electrical Management

## 4.1 General recommendations

The TopContact PnP module is designed to be fixed on a heat sink to assure a stable mechanical positioning, hereby the steady optical alignment and a proper thermal junction (see chapter 3). To facilitate a fixation, two mounting holes are available (see Figure 1 and Figure 10).

A widely-used assembly technology is to screw the module on a heat sink at the two designated mounting holes. M3 pan head screws with diameter of 3 mm are recommended. Lumileds recommends to tighten each screw with a torque of 40-80 N cm [3.5-7 lb in], by using a calibrated torque screwdriver to prevent an undue torque. The use of pan head screws will ensure that the screws do not extend above the optical plane of the LED.

Independent of the assembly method, any torsional or bending stress should be minimized. Required are a planar and clean mounting base, a homogeneous distribution and as thin a layer as possible of thermal interface material and the same contact pressure at both mounting holes. It is essential not to use higher torque than recommended, because this will lead to an unintended bending of the Cu-IMS PCB.

See In Figure 10, a schematic arrangement of heat sink, TIM and the TopContact PnP, for a proper fixation.

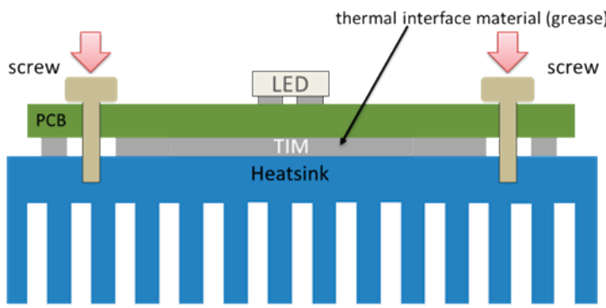



Figure 10. Mounting the PCB to a heat sink

## 4.2 Securing the PnP module

An exemplary application as described in chapter 4.1, requires a sequence of steps:

1. The heat sink must fulfill all thermal and mechanical requirements
2. All conditions for the fixing elements regarding the joining method should be prepared and available (e.g. screwing according to the recommendations of chapter 4.1 needs threaded holes)
3. The planarity of the mounting surface should be considered
4. The surface must be free from grease and dust
5. Deposit an adequate thermal interface material onto the heat sink surface (see details in chapter 3.6)
6. Place the PnP module targeted to the alignment holes (consider chapter 2)
7. Fix the module to the heatsink using the methodology recommended in chapter 4.1. Initially tighten both screws until they are finger tight, before applying the recommended torque of 40 – 80 Nm

## 4.3 Alignment Holes

To interface an optic to the TopContact PnP modules' light emitting area, a combination of an alignment hole/slot-hole could be incorporated in the Cu-IMS PCB. If additional alignment holes are necessary, they can be added upon request.

The vertical height of the light emitting area depends on several factors, like the board design, the fixation method, the contact pressure, the planarity of the heat sink and the thickness and material properties of the TIM. Please ask your local Lumileds sales representative for further information.

### 4.4 Reliability of the Module to Heat Sink Connection

The reliability of module fixation depends on fixation method, the material properties and the conditions of the application process. Lumileds recommends to perform reliability tests with any chosen configuration.

## 5. Electrical Management

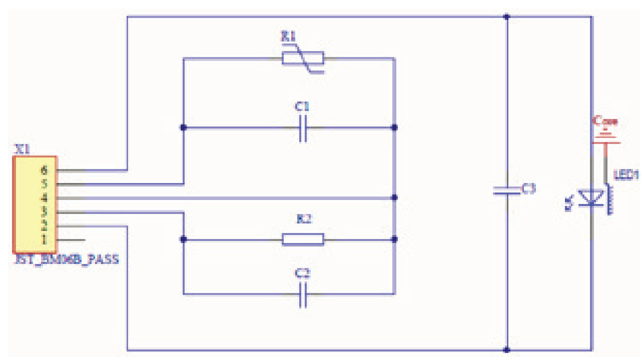
### 5.1 Connector

The TopContact PnP module is equipped with a built-in 6-pin UL rated JST PA series SMT top entry type shrouded header connector. Please contact your local JST sales representative for the mating parts that fit your local automotive grade requirements, as well as for their specific use and handling precautions.

The individual pin assignment of the connector is described in Table 3).

**Table 3. Pin information for the built-in connector on LUXEON Altilon SMD PnP**

| PIN # | DESCRIPTION |
|---|---|
| 1 | |
| 2 | LED Cathode |
| 3 | Bin Resistor |
| 4 | NTC/Bin Resistor |
| 5 | NTC |
| 6 | LED Anode |




The type, position and orientation of the connector may be customized upon request. Please contact your local Lumileds sales representative for further information.

### 5.2 Electrical Isolation

The Cu base material of the TopContact PnP module is electrically isolated from anode and cathode of the LED.

### 5.3 Overheating Protection

On the TopContact PnP module a 10 kΩ negative temperature coefficient (NTC) thermistor is present. The NTC is connected to the center pins #4 and #5 of the connector, see the electrical scheme in Table 3.

The NTC measures the temperature on the Cu-IMS board by the change of its temperature dependent resistance, according to the R/T characteristics of Murata NCU18XH103F6SRB. Please see www.murata.com for further information and details. The resistance tolerance of the NTC is ±1%.

The measured temperature can be used to judge the junction temperature of the LED, see chapter 3.3. In case of overheating the TopContact PnP module can be protected by controlled current de-rating.

Alternative SMD 0603 thermistor types, as e.g. positive transient voltage (PTV) thermistors or other NTC thermistor types can be used on the TopContact PnP module upon customer request. Please contact your local Lumileds sales representative for further information.

## 5.4 Bin Code Resistor

The bin code resistor enables the electronic driver circuit to provide the appropriate current to achieve the desired lumen output. The choice of bin code resistor will be dependent on the flux bin of the LED.

- See Technical Data Sheet for lookup table standard resistors
- Customer specific bin code resistor ranges are optional
- Device shape: SMD 0603

## 5.5 Capacitors

The NTC, bin resistor and LED have 3 individual capacitors to protect them from electrical surges. The capacitors are Murata GCM155R71H103KA55D, 10nF, 50 V, SMD 0402. Please see www.murata.com for further information and details.

## 5.6 Grounding

See also section 5.2 electrical isolation

As anode and cathode are electrically isolated from the Cu-IMS base material, grounding of the LED must be, if desired, provided via the connector connection to the LED driver.

# 6. JEDEC Moisture Sensitivity Level

The LUXEON Altilon Top Contact PnP has a JEDEC moisture sensitivity level of 1. This is the highest level offered in the industry and highest level within the JEDEC standard for moisture sensitivity, as shown in Table 4.

**Table 4. JEDEC Moisture Sensitivity Levels**

| LEVEL | FLOOR LIFE | | SOAK REQUIREMENTS | | | |
|---|---|---|---|---|---|---|
| | | | STANDARD | | ACCELERATED EQUIVALENT1 | |
| | TIME | CONDITIONS | TIME (HOURS) | CONDITIONS | TIME (HOURS) | CONDITIONS |
| 1 | Unlimited | ≤30 °C/85% RH | 168 +5/-0 | 85 °C/85% RH | — | — |
| 2 | 1 Year | ≤30 °C/60% RH | 168 +5/-0 | 85 °C/60% RH | — | — |
| 2a | 1 Week | ≤30 °C/60% RH | 696 +5/-0 | 30 °C/60% RH | 120 +1/-0 | 60 °C/60% RH |
| 3 | 168 Hours | ≤30 °C/60% RH | 192 +5/-0 | 30 °C/60% RH | 40 +1/-0 | 60 °C/60% RH |
| 4 | 72 Hours | ≤30 °C/60% RH | 96 +5/-0 | 30 °C/60% RH | 20 +0.5/-0 | 60 °C/60% RH |
| 5 | 48 Hours | ≤30 °C/60% RH | 72 +5/-0 | 30 °C/60% RH | 15 +0.5/-0 | 60 °C/60% RH |
| 5a | 24 Hours | ≤30 °C/60% RH | 48 +5/-0 | 30 °C/60% RH | 10 +0.5/-0 | 60 °C/60% RH |
| 6 | Time on Label (TOL) | ≤30 °C/60% RH | TOL | 30 °C/60% RH | — | — |

This provides the customer with ease of assembly. The customer no longer needs to be concerned about bake out times and floor life. No bake out time is required for a moisture sensitivity level of 1.

# 7. Packaging Consideration—Chemical Compatibility

The package contains a silicone overcoat to protect the LED chips and extract the maximum amount of light. As with most silicones used in LED optics, care must be taken to prevent any incompatible chemicals from directly or indirectly reacting with the silicone.

The silicone overcoat is gas permeable. Consequently, oxygen and volatile organic compound (VOC) gas molecules can diffuse into the silicone overcoat. VOCs may originate from adhesives, solder fluxes, conformal coating materials, potting materials and even some of the inks that are used to print the PCBs. Some VOCs and chemicals react with silicone and produce discoloration and surface damage. Other VOCs do not chemically react with the silicone material directly but diffuse into the silicone and oxidize during the presence of heat or light. Regardless of the physical mechanism, both cases may affect the total LED light output. Since silicone permeability increases with temperature, more VOCs may diffuse into and/or evaporate out from the silicone.

Careful consideration must be given to whether the LEDs are enclosed in an “air tight” environment or not. In an “air tight” environment, some VOCs that were introduced during assembly may permeate and remain in the silicone overcoat.

Under heat and “blue” light, the VOCs inside the silicone overcoat may partially oxidize and create a silicone discoloration, particularly on the surface of the LED where the flux energy is the highest. In an air rich or “open” air environment, VOCs have a chance to leave the area (driven by the normal air flow). Transferring the devices, which were discolored in the enclosed environment back to “open” air, may allow the oxidized VOCs to diffuse out of the silicone overcoat and may restore the original optical properties of the LED.

Determining suitable threshold limits for the presence of VOCs is very difficult since these limits depend on the type of enclosure used to house the LEDs and the operating temperatures. Also, some VOCs can photo-degrade over time.

Table 5 provides a list of commonly used chemicals that should be avoided as they may react with the silicone material. Note that Lumileds does not warrant that this list is exhaustive since it is impossible to determine all chemicals thatmay affect LED performance.

The chemicals inTable 5 are typically not directly used in the final products that are built around the LEDs. However, some of these chemicals may be used in intermediate manufacturing steps (e.g. cleaning agents). Consequently, trace amounts of these chemicals may remain on sub-components, such as heatsinks. Lumileds, therefore, recommends the following precautions when designing your application:

When designing secondary lenses to be used over an LED, provide a sufficiently large air-pocket and allow for “ventilation” of this air away from the immediate vicinity of the LED. Use mechanical means of attaching lenses and circuit boards as much as possible. When using adhesives, potting compounds and coatings, carefully analyze its material composition and do thorough testing of the entire fixture under High Temperature Over Life (HTOL) conditions.

**Table 5. List of commonly used chemicals that may damage the silicone encapsulant of the LED**

| CHEMICAL NAME | TYPICAL USE |
|---|---|
| Hydrochloric Acid | Acid |
| Sulfuric Acid | Acid |
| Nitric Acid | Acid |
| Acetic Acid | Acid |
| Sodium Hydroxide | Alkali |
| Potassium Hydroxide | Alkali |
| Ammonia | Alkali |
| MEK (Methyl Ethyl Ketone) | Solvent |
| MIBK (Methyl Isobutyl Ketone) | Solvent |
| Toluene | Solvent |
| Xylene | Solvent |
| Benzene | Solvent |
| Gasoline | Solvent |
| Mineral spirits | Solvent |
| Dichloromethane | Solvent |
| Tetracholorometane | Solvent |
| Castor Oil | Oil |
| Lard | Oil |
| Linseed Oil | Oil |
| Petroleum | Oil |
| Silicone Oil | Oil |
| Halogenated Hydrocarbons (containing F, Cl, Br elements) | Misc. |
| Rosin Flux | Solder Flux |
| Acrylic Tape | Adhesive |

# About Lumileds

Companies developing automotive, mobile, IoT and illumination lighting applications need a partner who can collaborate with them to push the boundaries of light. With over 100 years of inventions and industry firsts, Lumileds is a global lighting solutions company that helps customers around the world deliver differentiated solutions to gain and maintain a competitive edge. As the inventor of Xenon technology, a pioneer in halogen lighting and the leader in high performance LEDs, Lumileds builds innovation, quality and reliability into its technology, products and every customer engagement. Together with its customers, Lumileds is making the world better, safer, more beautiful—with light.

To learn more about our lighting solutions, visit lumileds.com.

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