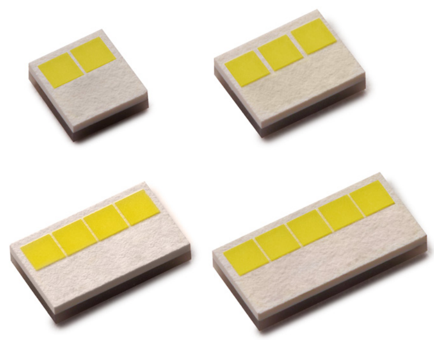
LUMILEDS

AUTOMOTIVE

LUXEON Altilon SMD

Assembly and Handling Information



Introduction

This application brief covers recommended assembly and handling procedures for LUXEON Altilon SMD emitters. LUXEON Altilon SMD emitters are designed to deliver high luminous flux and efficacy in an easy-to-assemble SMD package that facilitates assembly in automotive exterior lighting applications. Proper assembly, handling, and thermal management, as outlined in this application brief, ensures high optical output and long LED lumen maintenance for LUXEON Altilon SMD.

Scope

The assembly and handling guidelines in this application brief apply to the following products:

PRODUCTS
LUXEON Altilon SMD 1x2 (A1SB-58502DH0XXXX0)
LUXEON Altilon SMD 1x3 (A1SB-58503DH0XXXX0)
LUXEON Altilon SMD 1x4 (A1SB-58504DH0XXXX0)
LUXEON Altilon SMD 1x5 (A1SB-58505DH0XXXX0)

Any assembly or handling requirements that are specific to a subset of LUXEON Altilon SMD products is clearly marked. In the remainder of this document the term LUXEON Altilon SMD refers to any product in the LUXEON Altilon SMD product family.

Table of Contents

1. Component

1.1. Reference Document

The LUXEON Altilon SMD datasheet is available upon request. Please contact your Lumileds Sales Representative.

1.2. Description

The LUXEON Altilon SMD emitter consists of an array of LED chips mounted onto a ceramic substrate. This substrate provides mechanical support and thermally connects the LED chips to a thermal pad on the bottom of the substrate. An electrical interconnect layer connects the LED chips to cathode and anode pads on the bottom of the ceramic substrate. There are two additional thermal pads directly underneath the LED chips, which are electrically isolated. The topside of the substrate is coated with white silicone to shield the chip from the environment. The LUXEON Altilon SMD emitters include a transient voltage suppressor (TVS) chip to protect the emitters against electrostatic discharges (ESD). See Figure 1.

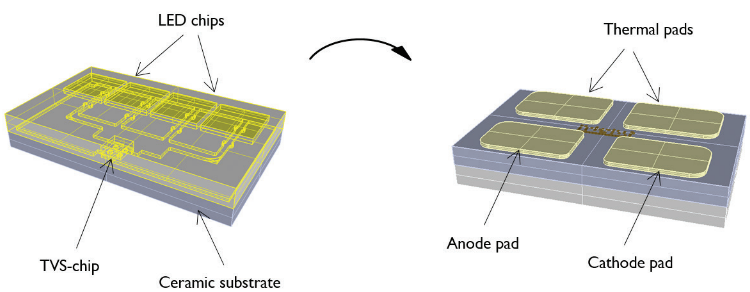
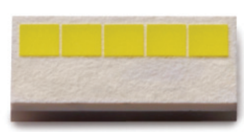
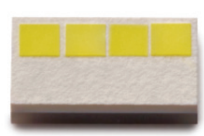


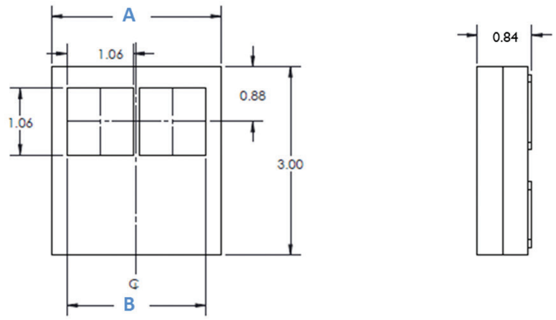
Figure 1. Layout of LUXEON Altilon SMD.

Table 1. Design features of LUXEON Altilon SMD.

PRODUCT	PHOTO	DESCRIPTION	
LUXEON Altilon SMD – 1x5 Array		Part number: Nominal Drive current: Die size: Numbers of dies:	A 1 S B - 5 8 5 0 5 D H 1000mA 1mm² 5
LUXEON Altilon SMD – 1x4 Array		Part number: Nominal Drive current: Die size: Numbers of dies:	A 1 S B - 5 8 5 0 4 D H 1000mA 1mm² 4
LUXEON Altilon SMD – 1x3 Array		Part number: Nominal Drive current: Die size: Numbers of dies:	A 1 S B - 5 8 5 0 3 D H 1000mA 1mm² 3
LUXEON Altilon SMD – 1x2 Array		Part number: Nominal Drive current: Die size: Numbers of dies:	A 1 S B - 5 8 5 0 2 D H 1000mA 1mm² 2

1.3. Form Factor

LUXEON Altilon SMD comes in four different LED arrays as mentioned in Table 1. The outline dimensions are listed in Figure 2. See the LUXEON Altilon SMD datasheet for the applicable tolerances.



Led array	Dimension [mm] A	Dimension [mm] B
1x2	2.70	2.21
1x3	3.85	3.36
1x4	5.00	4.51
1x5	6.15	5.66

Figure 2. Outline dimensions for LUXEON Altilon SMD family.

1.4. Optical Center

The LUXEON Altilon SMD 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. See the LUXEON Altilon SMD datasheet for the applicable tolerances.

Optical rayset data of each LUXEON Altilon SMD part is available upon request.

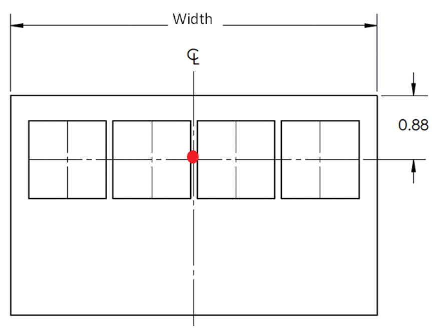


Figure 3. Theoretical optical center for LUXEON Altilon SMD.

1.5. Dot Matrix Code

The LUXEON Altilon SMD has a Dot Matrix Code (DMC) on the bottom side of the device (see figure 4). This is a unique traceability code and does not contain any color or flux information. Specific performance and manufacturing information is linked to this DMC and can be retrieved by special request. Please contact your Lumileds sales representative for details.

The DMC applies to:

- ISO standard ISO/IEC 16022:200
- Symbol attribute according ECC 200
- Dot size: 40–50 μm
- Dot Matrix: 8 x 32 dots

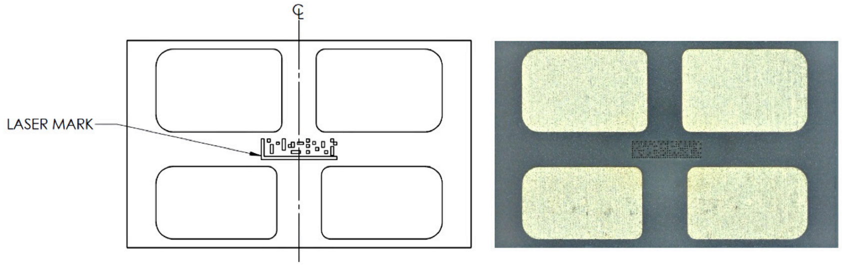


Figure 4. Example of a dot matrix code on bottom side of LUXEON Altilon SMD.

1.6. Handling Precautions

Like all electrical components, there are handling precautions that need to be taken into account when setting up assembly procedures. The following cautions are noted for LUXEON Altilon SMD:

1. Electrostatic Discharge (ESD) protection:

Electrostatic Discharges, rapid transfers of charges between two bodies due to an electrical potential difference between those bodies, can cause unseen damage to electronic components. In LED devices, ESD events can result in a slow degradation of light output and/or early catastrophic failures. In order to prevent ESDs from causing any damage, Lumileds devices include a Transient Voltage Suppressor (TVS) chip. This TVS chip breaks down under high voltages, providing a current path in parallel with the LED chip (see Figure 5).

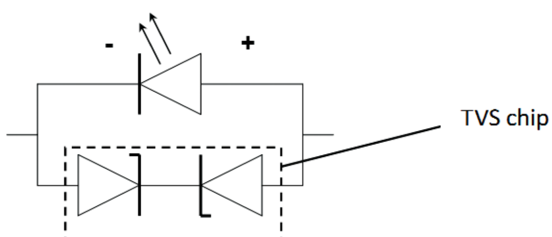


Figure 5. Electrical schematic.

Common causes of ESD include the direct transfer of charges from the human body or from a charged conductive object to the LED component. In order to test the susceptibility of LEDs to these common causes of ESDs, three different models are typically used:

- Human Body Model (HBM)
- Machine Model (MM)
- Charged Device Model (CDM)

LUXEON Altilon SMD emitters have been independently verified to successfully pass ESD tests under HBM, MM and CDM conditions. For the respective test voltages of these tests please refer to the latest LUXEON Altilon SMD datasheet. Nevertheless, Lumileds strongly recommends that customers adopt handling precautions for LEDs similar to those which are commonly used for other electronic surface mount components which are susceptible to ESD events.

Additional external ESD protection for the LED may be needed if the LED is used in non-ESD protected environments and/or exposed to higher ESD voltages and discharge energy, e.g. as described in ISO 10605 or IEC 61000-4-2 (severity level IV). For details please contact your Lumileds sales representative.

2. Minimize all mechanical forces exerted onto the silicone overcoat layer of LUXEON Altilon SMD:

For manual handling with tweezers, always pick up from the sides of the ceramic substrate and never from the sides of the silicone overcoat. "L" shaped tweezers (e.g. Knipex precision tweezers 923229) with the pointed tip in parallel to the LED's ceramics is more appropriate and easier to use than "straight" tweezers. To reduce the chance of any damage to the LED part and provide stability during pick up and manual placement on the board, it is recommended that the thickness height of the tweezers tip and the thickness of the ceramic sides are the same (~0.4mm).

Alternatively, a vacuum pen can be used instead of tweezers. The suction tip should be made of a soft material such as rubber to minimize the mechanical force exerted onto the top surface of the silicone overcoat layer. It should be avoided that the soft material contaminates the top side surface of the LED.

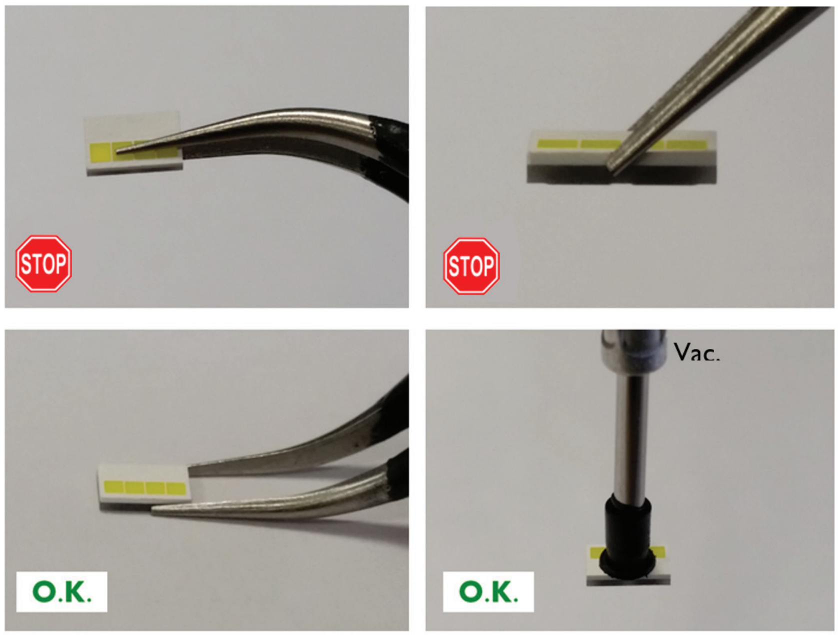


Figure 6. LED handling.

Do not touch the top surface with fingers or apply any pressure to it when handling finished boards containing LUXEON Altilon SMD LEDs. Do not stack finished boards. The LED can be damaged by the other board outlines. In addition, do not put any boards with LUXEON Altilon SMD emitters top side down on a surface for probing. The surface of a workstation may be rough or contaminated and may damage the silicone coating.

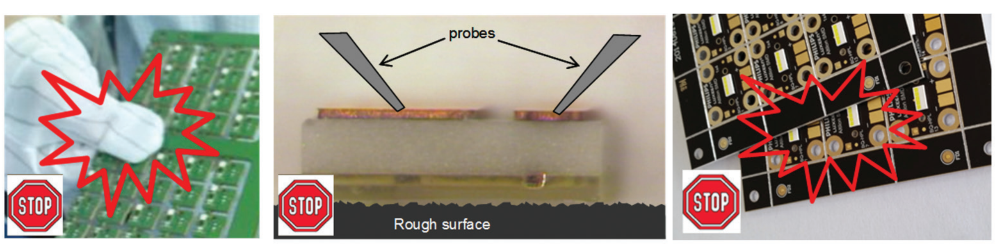


Figure 7. Board handling.

1.7. Cleaning General

The surface of the LUXEON Altilon SMD emitter should not be exposed to dust and debris. Excessive dust and debris on the LED chip array may cause a decrease in optical output. It is best to keep LUXEON Altilon SMD emitters in their original shipping reel until actual use.

In the event that the surface requires cleaning, a compressed gas duster or an air gun with 1.4 bar (at the nozzle tip) at a distance of 15cm will be sufficient to remove the dust and debris. Make sure the parts are secured first.

One can also use a lint-free swab and optional isopropyl alcohol (IPA) to gently swab the surface. Do not use solvents that are listed in Table 11 as they may adversely react with the LED assembly. Extra care should be taken to not disturb the white silicone coating around the LED chips. Always verify that there are no large particles or debris left on the surface before swabbing.

1.8. Electrical Isolation

The thermal pads of LUXEON Altilon SMD are electrically isolated from the anode and cathode pads of the LED.

1.9. Mechanical Files

Mechanical drawings for LUXEON Altilon SMD (2D and 3D) are available upon request. For details please contact your Lumileds sales representative.

2. Printed Circuit Board

2.1. PCB Requirements

The LUXEON Altilon SMD can be mounted on a multi-layer FR4 Printed Circuit Board (PCB) or an Insulated Metal Substrate (IMS). To ensure optimal operation of the LUXEON Altilon SMD, the thermal path between the LED package and the heatsink should have a thermal resistance as low as feasible.

Historically, IMS has been used for its low thermal resistance and rigidity, however, IMS is not always the most economical solution for certain applications. A two layer FR4 board (with filled and capped vias), in contrast, often offers a much lower cost solution for a thermally efficient package.

For reference, here are the applicable IPC standards when designing PCB boards.

General PCB standards:

- IPC A-600H: Acceptability of Printed Boards
- IPC A-610F: Acceptability of Electronic Assemblies
- IPC 2221A: General Standard on Printed Board Design
- IPC 7093: Design and Assembly Process Implementation for Bottom Termination Components

Filled and capped via boards:

- IPC 4761: Design Guide for Protection of Printed Board Via Structures
- IPC 2315: Design Guide for High Density Interconnects and Micro Vias
- IPC 2226: Design Standard for High Density Interconnect Printed Boards

2.2. Footprint and Land Pattern

For LUXEON Altilon SMD we recommend using solder mask defined pads. Due to this, the copper layer can be extended for better heat spreading and results in better thermal performance.

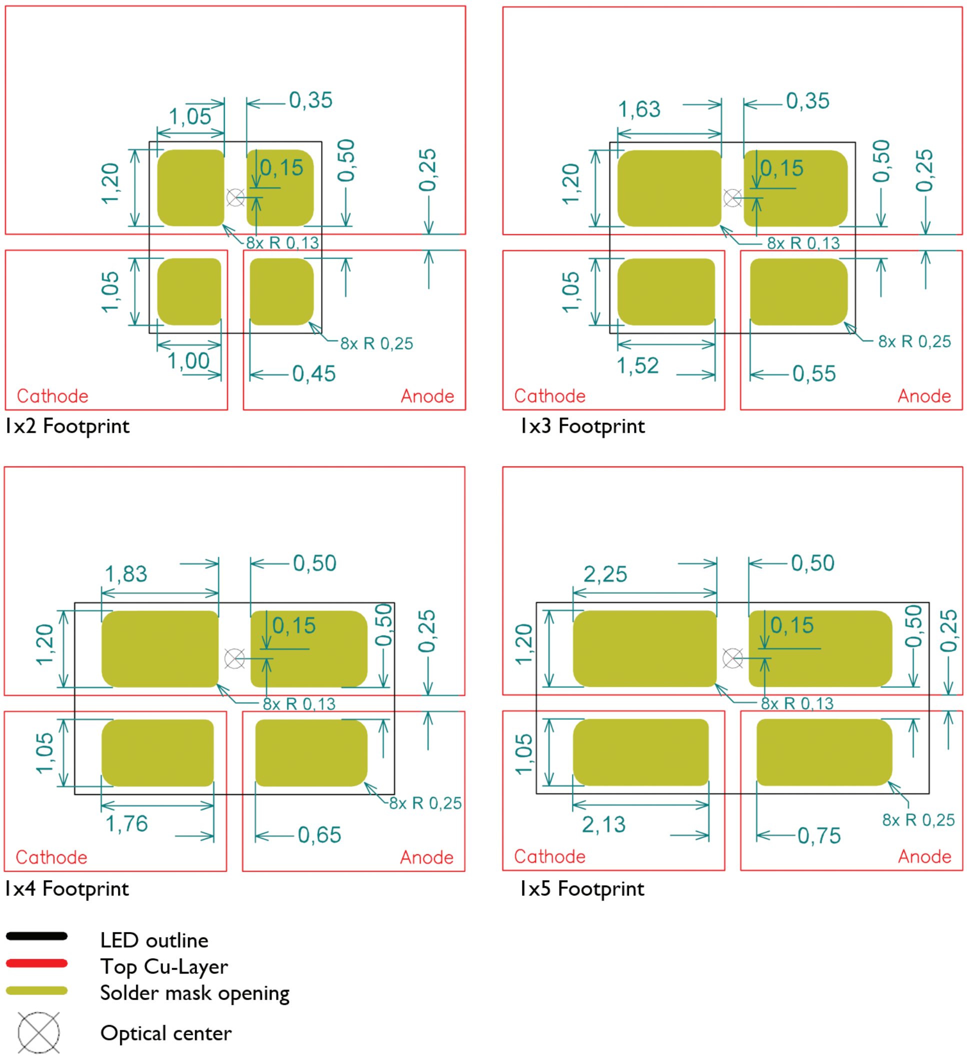


Figure 8. Land pattern design 1x2 to 1x5 for LUXEON Altilon SMD.

2.3. Thermal Resistance

The thermal resistance between the junction of the LED and the bottom side of the PCB $R_{th,j-b}$ depends on the following key design parameters of a PCB:

- PCB dielectric materials
- Cu plating thickness
- Connection of the thermal pad to the board:
  - pedestal to bridge the removed dielectric layer of IMS boards
  - thermal vias in FR4 boards
- Solder pad pattern and bond line thickness

Lumileds conducted simulations to evaluate the thermal performance of different PCB design concepts.

Simulation Details

Simulation Model

- Altilon SMD 1x4 on board and plate heatsink
- Heat conduction only
- Board + TIM on heatsink
- Bottom of heatsink is assumed to be ideally heat-sunk to ambient

Heatsink and TIM Parameters

- Heatsink size: 50mm x 50mm x 5mm
- Heatsink material: Al – 200 W/(mK)
- TIM thickness: 100 µm
- TIM th. cond.: 1 W/(mK)

Board Parameters

- Board area: 25 x 25mm
- Board thickness: 1.5mm
- Cu layer thickness: 70 µm
- Solder mask: 20 µm
- IMS diel. thickness: 75 µm or 38 µm

Board Thermal Conductivities

- Cu: 390 W/(mK)
- Al: 200 W/(mK)
- IMS dielectric: 2.2 or 3 W/(mK)
- Fr4 epoxy: 0.3 W/(mK)
- Vias plating: 390 W/(mK)
- Vias filling: 0.3 W/(mK)
- AlN ceramic: 170 W/(mK)
- Al2O3 ceramic: 25 W/(mK)

Solder Parameters

- Thickness (BLT): 100 µm or 150 µm
- Th. conductivity: 56 W/(mK)

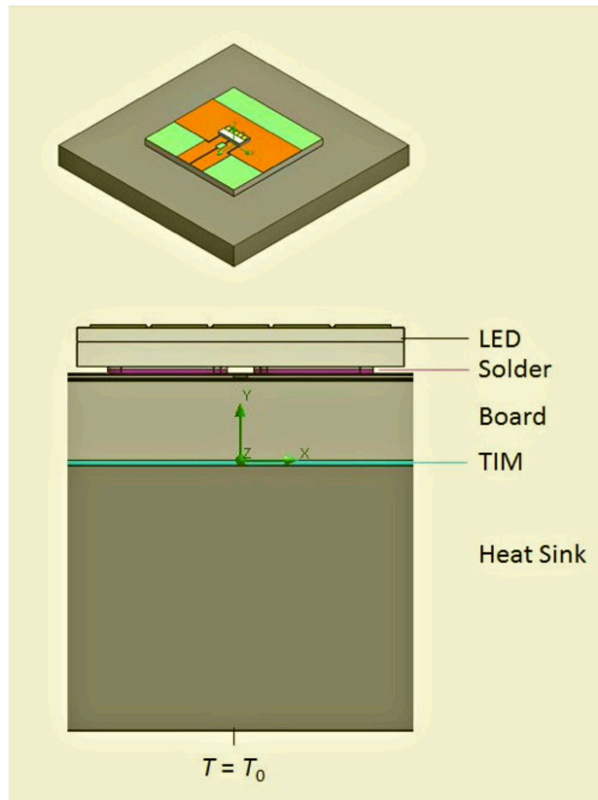


Figure 9. Model geometry of LUXEON Altilon SMD.

The model geometry is shown in Figure 9 (top) and a side view of the model is shown in more detail in Figure 9 (bottom). The heatsink is modeled as a 50mm x 50mm x 5mm block. A constant temperature boundary condition ($T = T_0 = 25°C$) is imposed at the bottom. Different board types are used in the simulations of the schematics which are shown in Figure 8. Table 2 contains more detailed information on the board types and lists the corresponding thermal junction-to-board resistances ($R_{th,j-b}$) for the different LED configurations obtained from the simulations. The thermal junction-to-board resistances ($R_{th,j-b}$) have been evaluated using the simulated junction temperature and the maximum temperature on the bottom side of the board.

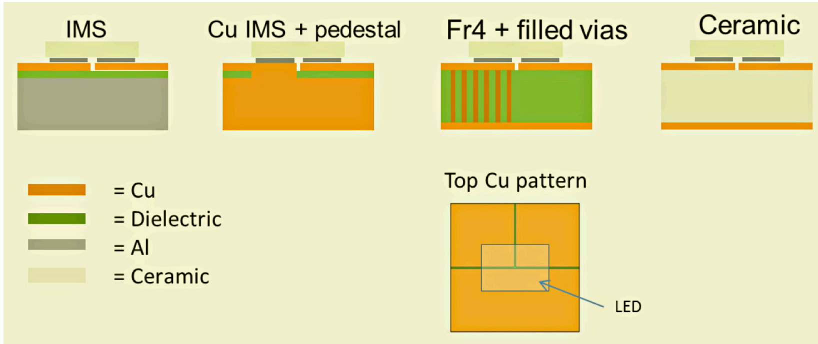


Figure 10. Layer stacks and top side pattern.

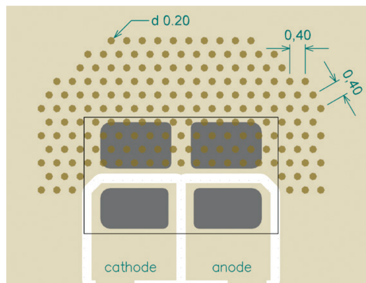


Figure 11. FR4 design with filled and capped via.

Simulation Results

Lumileds recommendation to optimize the thermal performance of the system is to use metal-core boards with pedestals for the thermal pads or AlN-based ceramic boards.

The thermal resistances in Table 2 are based on electrical input power. They have been calculated from the real thermal resistance ($R_{th,real}$) obtained from the simulations using $R_{th,el} = R_{th,real}$ x (1-WPE) and assuming a typical WPE (wall plug efficiency) of 0.25. To convert the $R_{th,el}$ values into $R_{th,real}$ again, the numbers in Table 2 have to be multiplied by 4/3.

Table 2. Simulated 1x4 LED-junction-to-board-bottom thermal resistances $R_{th,jb}$ for different types of board.

BOARD MATERIAL/DIELECTRIC/BLT	LUXEON ALTILON SMD LED			
	1x2	1x3	1x4	1x5
	$R_{th,\,j\text{-}b}$ (el. POWER)			
FR4 1.5mm + filled & capped vias, 150 µm BLT	6.4 K/W	4.4 K/W	4.1 K/W	3.4 K/W
FR4 1.2mm + filled & capped vias, 150 µm BLT	6.2 K/W	4.2 K/W	3.9 K/W	3.3 K/W
Al-IMS, 3 W/(mK) – 38 µm diel., 100 µm BLT	4.2 K/W	2.8 K/W	2.3 K/W	1.9 K/W
Al-IMS, 2.2 W/(mK) – 75 µm diel., 100 µm BLT	5.1 K/W	3.3 K/W	2.9 K/W	2.4 K/W
Cu-IMS + pedestal, 150 µm BLT	3.6 K/W	2.3 K/W	1.9 K/W	1.6 K/W
Ceramic Al2O3 1.0mm, 150 µm BLT	4.6 K/W	3.1 K/W	2.6 K/W	2.1 K/W
Ceramic AlN 1.0mm, 150 µm BLT	3.5 K/W	2.3 K/W	1.8 K/W	1.5 K/W

2.4. Surface Finishing

Lumileds recommends using ENIG (Electroless Ni Immerged Au) plating according IPC-4552. Other surface finishes are possible, but have not been tested by Lumileds.

3. Thermal Management

The reliability expectations, as mentioned in the LUXEON Altilon SMD datasheet, are based on the LED case temperature (T_c).

3.1. Thermal Measurement Guidance

The use of a temperature probe may be desirable to verify the overall system design model and expected thermal performance. Depending on the required temperature measurement accuracy, different methods are possible to determine T_c as described in Table 3. The more accurate the measurement is, the closer T_c can be designed to the maximum allowable T_c as specified in the LUXEON Altilon SMD datasheet. Figure 12 schematically describes the LED soldered to a PCB, including the relevant temperatures as defined for specific positions in the setup.

Table 3. Temperature measurement methods.

METHOD	ACCURACY [°C]	EFFORT	EQUIPMENT COST
Thermo sensor (e.g. thin wire thermocouple)	±2.0	Low	Low
Forward Voltage Measurement	±0.5	High	High

Temperature Probing by Thermo Sensor

A practical way to verify the case temperature (T_c) is to measure the temperature (T_{sensor}) on a predefined sensor pad close to the case by means of a thermocouple or a thermistor (see Figure 12).

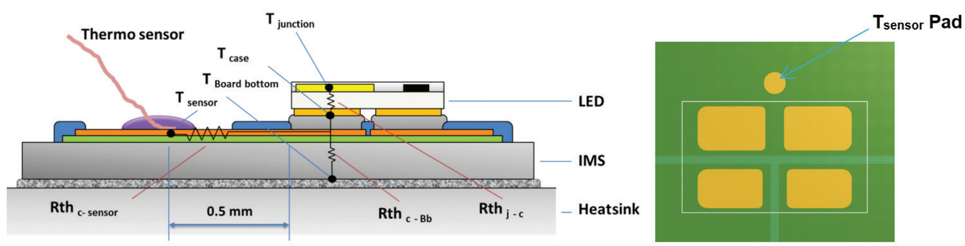


Figure 12. Temperature probing by thermo sensor (schematically).

The case temperature (T_c) can be calculated according the following equation:

$$T_c = T_{sensor} + R_{th,c\text{-}sensor} \times P_{electrical}$$

In this equation T_{sensor} is the sensor temperature at the predefined location and $P_{electrical}$ is the electrical power going into the LUXEON Altilon SMD emitters.

The $R_{th,c\text{-}sensor}$ is application specific and can be determined with help of thermal simulations and measurements. The Lumileds Application Support team offers support to determine this value. Please contact your sales representatives.

Lumileds has determined the typical $R_{th,c\text{-}sensor}$ for LUXEON Altilon SMD 1x4 on different board types (see Table 4). T_j can be calculated from T_c using the $R_{th,j\text{-}c}$ value given in the datasheet.

Table 4. Typical $R_{th,c\text{-}sensor}$ values per board concept.

BOARD CONCEPT	$R_{th,c\text{-}sensor}$ 1x4 (0.5mm from top side edge emitter center)
Double layer FR4 1.5mm with filled and capped vias, 70 µm Cu	1.9 K/W
IMS with dielectric of 3 W/(mK), 38 µm thickness, 70 µm Cu	1.0 K/W
IMS with Cu-pedestal	0.6 K/W

Please see section 2.3. Thermal Resistance of this document for more detailed information regarding the design parameters.

Temperature Measurement by Forward Voltage Measurement

The Forward Voltage Measurement uses the temperature dependency of the LED's forward voltage. The forward voltage change after switching off the thermally stabilized system is measured and analyzed. By using a thermal model of LUXEON Altilon SMD, the case temperature (T_c) can be calculated. To ensure high accuracy, a precise and fast Voltage Measurement System is needed. In addition, the relationship between forward voltage (V_f) and temperature needs to be properly characterized for individual LED.

Please contact your Lumileds sales representative for further support on this topic.

3.2. Thermal Impact on the PCB Assembly

The junction temperature is not necessarily the limiting parameter for operation of the LED in the application. Please also check carefully the operating temperature of each component and interconnect of the assembly, e.g. PCB dielectric, connector, solder material, ribbon bonds, others.

4. Assembly Process Recommendations and Parameters

4.1. Board Attach Recommendation

Due to the thermo mechanic stress in solder interface caused by coefficient of thermal expansion (CTE) mismatch between LED and board material, the process parameters depend on chosen board material, solder material and solder joint reliability requirements.

An increased solder bond line thickness (BLT) can be used to improve thermal cycling performance. We do not recommend using a standard thickness of <80 µm. Additionally, an epoxy underfill can be used to enhance the performance, refer to section 4.10 Underfill. Table 5 shows which combinations of these parameters are recommended.

Table 5. Solder vs. TCT requirements for LUXEON Altilon SMD.

ITEM	LED	BOARD MATERIAL [1]	BOND LINE THICKNESS	SOLDER MATERIAL	SOLDER PROCESS	UNDERFILL	THERMAL CYCLING PERFORMANCE [2]
1	1x2, 1x3, 1x4	Al-IMS	220 µm	SAC305	conv. Reflow	no	>300 cycles
2	1x2, 1x3, 1x4	Cu-IMS	150 µm	SAC305	conv. Reflow	no	>600 cycles
3	1x2, 1x3, 1x4, 1x5	Cu-IMS	150 µm	Innolot	Vacuum Reflow	no	>1000 cycles
4	1x2, 1x3, 1x4, 1x5	AL-IMS	100 µm	SAC305	conv. Reflow	yes	>1000 cycles
5	1x2, 1x3, 1x4, 1x5	Cu-IMS	100 µm	SAC305	conv. Reflow	yes	>2000 cycles
6	1x2, 1x3, 1x4, 1x5	FR4 filled vias	150 µm	Innolot	Vacuum Reflow	no	>1000 cycles [3]

1. IMS dielectric layer considered as hard dielectric material.
2. Thermal cycling performance is related to a passive test according JEDEC standard J-ESD22-A104E: Condition G -40/+125°C, 10s transition, 30min dwell.
3. Expected to be similar to item 3, limited experimental results..

4.2. Stencil Design

Different methods in solder paste printing can be used to achieve required increased bond line thickness.

- Increase of stencil thickness
- Extension of stencil aperture
- Use of pre-soldered boards or solder preforms

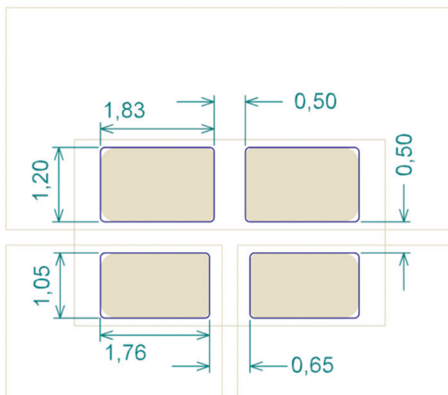
Table 6. Stencil design vs. bond line thickness.

STENCIL THICKNESS	APERATURE	BOND LINE THICKNESS
4 mil (100 µm)	90%	65 µm*
6 mil (150 µm)	100%	100 µm
8 mil (200 µm)	100%	130 µm
8 mil (200 µm)	115%	150 µm
6 mil (150 µm)	150%**	150 µm
8 mil (200 µm)	150%**	190 µm
8 mil (200 µm)	175%**	220 µm

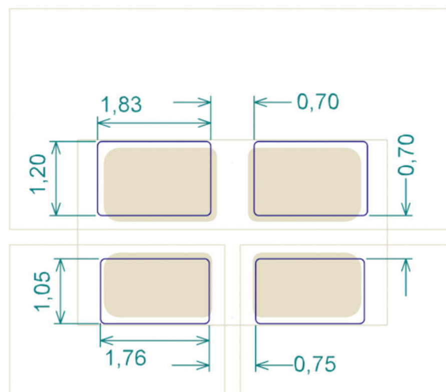
** For large overprint, a Z-height controlled LED placement is needed to avoid solder balling.

* A commonly used stencil thickness of 4 mil (100 µm) with 90% aperture is not recommended in a standard reflow process, since it can result in uncontrolled solder voiding.

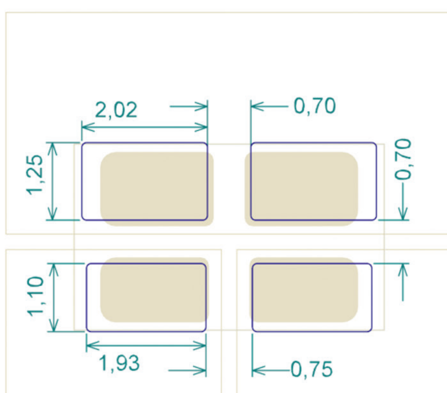
The following stencil aperture designs can be used to generate the above mentioned bond line thicknesses:



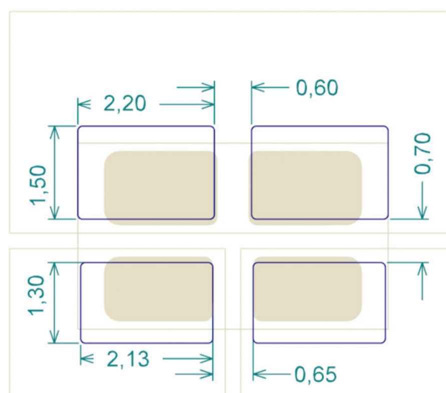
A: 1x4, 6 mil thick stencil with 100% aperture —> 100 µm bond line thickness



B: 1x4, 8 mil thick stencil with 100% aperture plus 100 µm offset —> 130 µm bond line thickness



C: 1x4, 8 mil thick stencil with 115% aperture plus 100 µm offset —> 145 µm bond line thickness



D: 1x4, 8 mil thick stencil with 150% aperture plus 100 µm offset —> 185 µm bond line thickness

Figure 13. Stencil aperture designs for LUXEON Altilon SMD.

All other LED stencil designs (1x2 to 1x5) can be implemented accordingly.

For designs where overprint is used, the solder paste is printed on top of the solder mask. This area should be flat. A trench in the copper layer underneath or close to it should not be used because solder paste may be trapped during reflow, leading to solder balling.

4.3. Solder Paste

For reflow soldering a standard lead free SAC Solder paste with no clean flux can be used. The Indium 8.9 HF SAC305 paste shows reasonable reflow and voiding performance for the given settings.

An Innolot based solder paste can improve thermal cycling reliability performance under certain conditions. We recommend Heraeus F640IL Innolot in combination with Cu-IMS boards and 150 µm bond line thickness. Void level needs to be controlled <5% to keep the advantage of this high reliability material and increase strength in solder interface. Vacuum soldering equipment can be used to achieve this low void level.

4.4. Reflow Profile

The LUXEON Altilon SMD is compatible with standard surface-mount and lead-free reflow technologies. This greatly simplifies the manufacturing process by eliminating the need for adhesives and epoxies. The reflow step itself is the most critical step in the reflow soldering process and occurs when the boards move through the oven and the solder paste melts, forming the solder joints. To form good solder joints, the time and temperature profile throughout the reflow process must be well maintained.

A temperature profile consists of three primary phases:

1. Preheat: the board enters the reflow oven and is warmed up to a temperature lower than the melting point of the solder alloy.
2. Reflow: the board is heated to a peak temperature above the melting point of the solder, but below the temperature that would damage the components or the board.
3. Cool down: the board is cooled down rapidly, allowing the solder to freeze, before the board exits the oven.

As a point of reference, the melting temperature for SAC 305 is 217°C, and the minimum peak reflow temperature is 235°C.

Lumileds successfully used the typical reflow profile defined in JEDEC J-STD-020E, as shown in Figure 14 and Table 7.

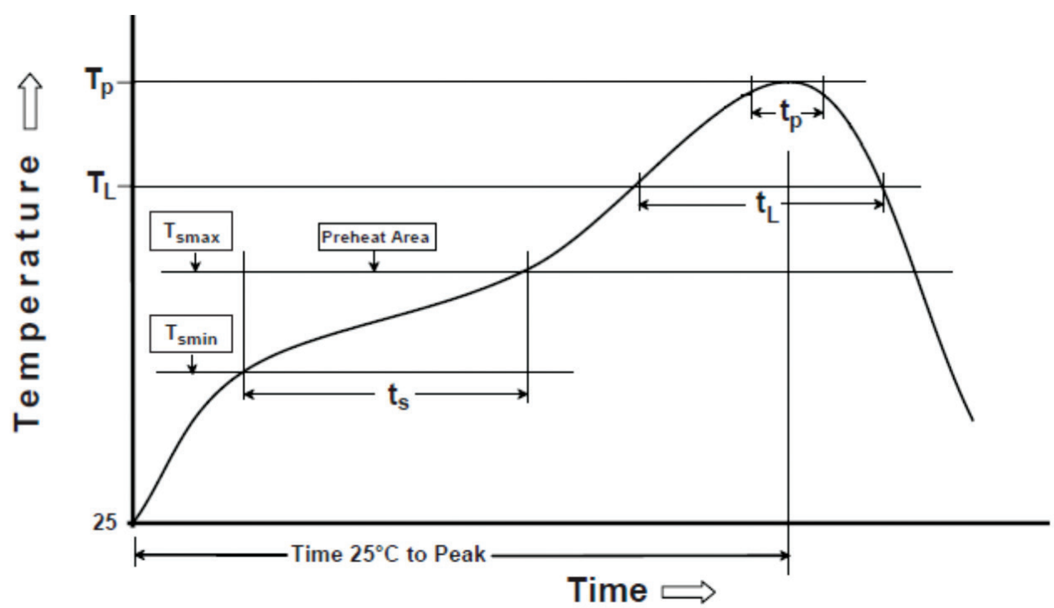


Figure 14. Reflow profile LUXEON Altilon SMD using SAC solder paste.

Table 7. Recommended reflow profile, in accordance with JEDEC J-STD-020E for Pb-free assembly.

PROFILE FEATURE	MINIMUM VALUE	TYPICAL VALUE FOR SAC	MAXIMUM VALUE
Ramp-Up Rate (T_{smax} to T_p)		2°C / second average	3° / second
Preheat Minimum Temperature (T_{smin})		150°C	
Preheat Maximum Temperature (T_{smax})		200°C	
Preheat Time (T_{smin} to T_{smax})	60 seconds	100 seconds	120 seconds
Liquidus Temperature (T_L)		217°C	
Time Maintained Above Temperature T_L (t_L)	60 seconds	60 seconds	120 seconds
Peak / Classification Temperature (T_p)		240°C	260°C
Time Within 5°C of Actual Peak Temperature (t_P)	10 seconds	20 seconds	30 seconds
Ramp-Down Rate (T_p to T_L)		2.5°C / second average	6° / second
Time 25°C to Peak Temperature	240 seconds	310 seconds	480 seconds

All temperatures refer to the application Printed Circuit Board (PCB), measured on the surface adjacent to the package body.

4.5. Pick and Place Nozzle

The LUXEON Altilon SMD is packaged in a tape and reel with the light emitting surface facing upward. Automated pick and place equipment provides the best handling and placement accuracy for LUXEON Altilon SMD emitters.

Lumileds recommends taking the following general pick and place guidelines into account:

a. The pick-up area is defined in Figure 15
b. The nozzle tip should be clean and free of any particles since this may interact with the top surface coating of the LUXEON Altilon SMD during pick and place.
c. During setup and the first initial production run, it is good practice to inspect the top surface of LUXEON Altilon SMD emitters under a microscope to ensure that the emitters are not accidentally damaged by the pick and place nozzle.
d. To avoid any mechanical overstress, it is a good choice to use soft material for pickup; rubber nozzles are available from some suppliers.

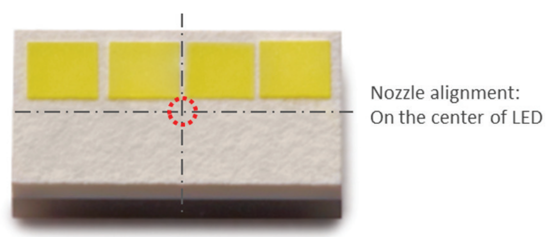


Figure 15. Pick-up area of LUXEON Altilon SMD.

Since LUXEON Altilon SMD has no primary optics or lens which can act as a mechanical enclosure protection for the LED chips, the pick-up and placement force applied to the top of the package should be kept well controlled.

Standard nozzle:

Table 8 shows the standard pick and place nozzle designs which can be used to handle the LUXEON Altilon SMD emitters in general.

Table 8. Standard nozzles for use in handling LUXEON Altilon SMD.

STANDARD NOZZLE	03054923-01	3110502-01
Supplier:	Micro-Mechanics PTE LTD	Micro-Mechanics PTE LTD
Nozzle form:	Rectangular	Round
Material (Housing,Tip):	Rubber, 79 shore A	Rubber, 79 shore A
Name:	R3-37	R3-708
Measurements [mm]:	A=3.75x2.50, a=2.95x1.70	R=ø2.50, r=ø1.90
SUITABLE FOR LED:		
LUXEON Altilon SMD	1x5 LED array	1x3 LED array
LUXEON Altilon SMD	1x4 LED array	1x2 LED array

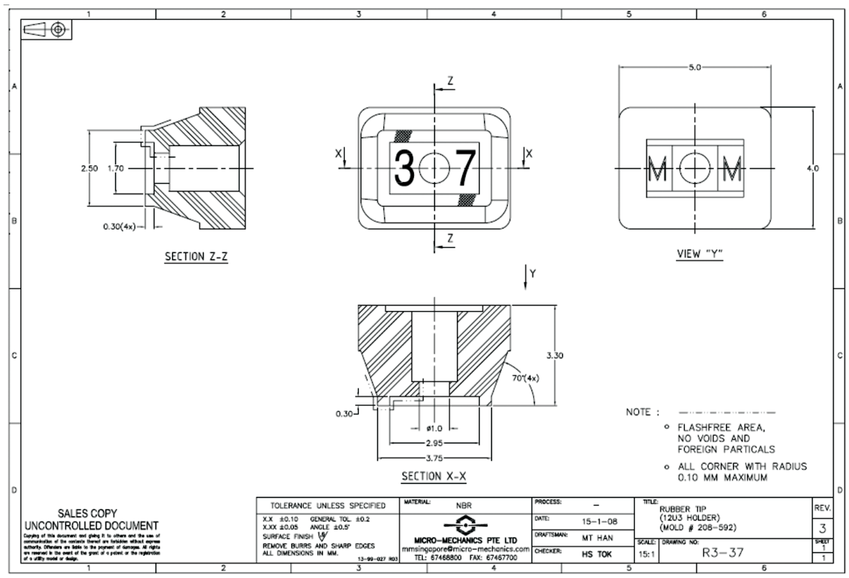


Figure 16. Standard nozzle for LUXEON Altilon SMD 1x5 and 1x4 LED array.

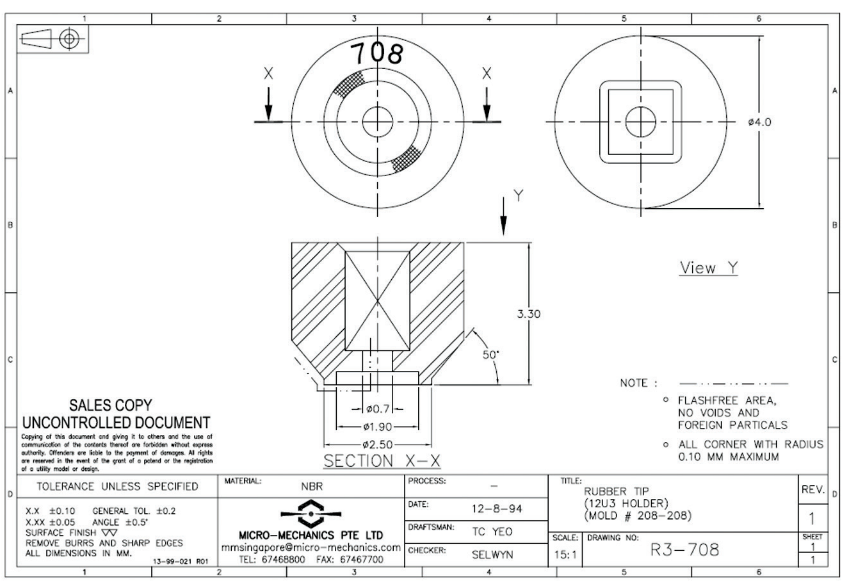


Figure 17. Standard nozzle for LUXEON Altilon SMD 1x3 and 1x2 LED array.

Nozzles for specific equipment platforms are under analysis and will be added in the future. Please contact your Lumileds sales representative if you have further questions regarding Pick and Place.

4.6. Placement Force/Height Control

In combination with thick solder paste printing, the placement process needs to be tightly controlled to minimize squeeze out of solder paste, which can lead to solder balling and solder bridging. Lumileds recommends using low placement forces or a Z-height controlled placement during pick and place process. Additionally, an increased paste viscosity can help to minimize paste squeeze out during placement.

4.7. Placement Accuracy

In order to achieve the highest placement accuracy, Lumileds recommends using an automated pick and place tool with a vision system that can recognize the bottom metallization of a LUXEON Altilon SMD (4 pads).

4.8. Reflow Accuracy

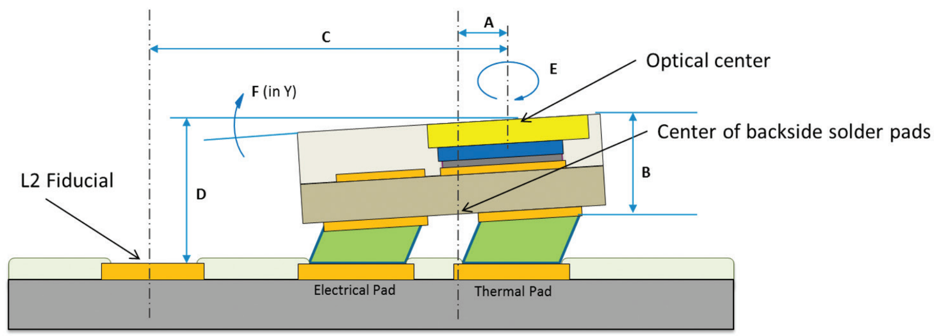


Figure 18. L1 and L2 tolerance definition.

Table 9. Dimension and placement tolerances.

ITEM	DESCRIPTION	MAXIMUM VALUE (5σ)	TYPICAL VALUES (5σ)
A	L1: Optical center to back-side metal X/Y	±75 μm	±60 μm in X ±65 μm in Y
B	L1: Total thickness Z	±75 μm	±50 μm
C	L2: Optical center to L2 fiducial, X/Y **	±125 μm	±100 μm
D	L2: Optical center to L2 fiducial, Z **	±105 μm	±75 μm
E	L2: Optical center to L2 fiducial, Theta **	±1.0°	±0.5°
F	L2: LED package Tilting to Board **	—	±1.5° in X ±2.5° in Y

** Depends on EMS supplier capabilities and PCB quality level. The given values are for 150 μm bond line thickness and were measured during Lumileds internal testing.

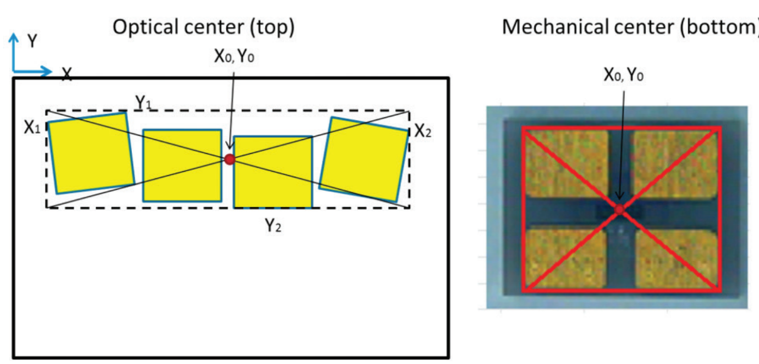


Figure 19. Definition of optical and mechanical center for LUXEON Altilon SMD.

4.9. Void Inspection

A large percentage of voids in the thermal path will increase the thermal resistance. Figure 20 shows the change in the thermal resistance of the solder as a function of void percentage based on calculated data. The value of the bond line thickness was taken to be 150 µm for the 0% void situation and assumed to increase with increasing void level in a way that the total solder volume remains constant.

An inline X-ray machine can be used to inspect on voids after reflowing.

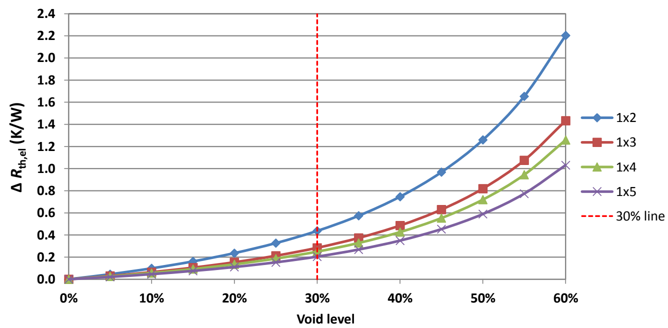


Figure 20. Impact of voids in the solder joint on the thermal resistance. The thermal resistance values are based on electrical input power.

4.10. Underfill

When LUXEON Altilon SMD are used on board materials with high CTE like Al-IMS, the thermo mechanic stress can lead to solder fatigue in thermal cycling conditions and results in low cycle count.

By using Underfill after SMD reflow attach, the stress can be lowered and thermal cycling performance can be increased by a factor of 3–5. A flux residue cleaning is not necessary most times, but can be used to increase adhesion strength and further improve cycle performance.

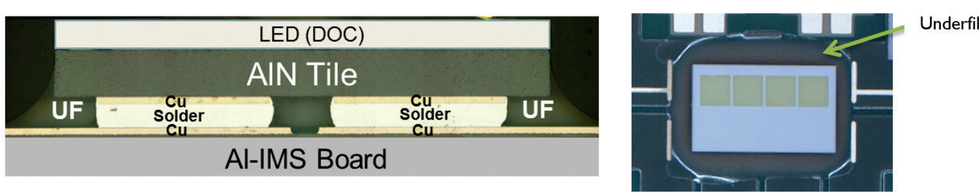


Figure 21. Cross section LED with Underfill.

For selecting a proper Underfill material, some properties are important:

- Good adhesion to AlN ceramic and solder mask
- Good cohesion, Young's Modulus (>8 GPa at 25°C)
- High T_g >125°C
- Low CTE (<30 ppm/°C)

In order to achieve sufficient thermal cycling reliability improvement, the underfill compatibility needs to be checked in combination with solder resist type and solder type (flux residue).

Compatibility issues with flux residue might have an impact on the electrochemical migration between anode and cathode pads. Explicit validation of the processes and the materials used in the target application is recommended. An additional flux cleaning step can reduce the risk of electrochemical migration further if required.

Lumileds successfully tested Henkel Hysol E1172A epoxy as underfill material in combination with Nanya LP4G solder resist.

Detailed process and material information are available upon request, please contact your Lumileds sales representative.

4.11. Electro Chemical Migration

The footprint of the electrical pads of LUXEON Altilon SMD LEDs have been designed to prevent failures due to electrochemical migration. A relevant standard for this topic is IPC-TR-476A "Electrically Induced Failures in Printed Wiring Assemblies." This implies that, depending on the voltage between anode and cathode, a certain distance is required to minimize the risk of electrical failures induced by electrochemical migration. Depending on the electrical circuit and the PCB design (e.g. several LUXEON Altilon SMD on one board in close proximity or one common potential for all thermal pads on one board or a high bias voltage between thermal and electrical pads) it can occur that a specific board design does not comply with above mentioned IPC standard.

It is the responsibility of the board designer to check the customer specific PCB layout for compliance.

4.12. FR4 Board Handling

The substrate of a LUXEON Altilon SMD is made of ceramic, a relatively brittle material. Even though this product has a small form factor and is unlikely to cause any problems, forces on the package should be kept to a minimum. In particular, excessive bending forces on the package may crack the ceramic substrate or break the solder joints.

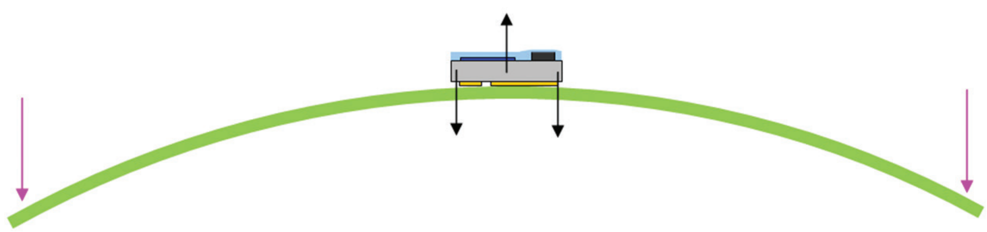


Figure 22. Forces acting onto package when board is bent.

Figure 22 shows what forces may, inadvertently, be applied to a LUXEON Altilon SMD when a flat assembled board is bent. This can happen, for example, when "punching-off" or "breaking-off" LED strips of a PCB panel (Figure 23).

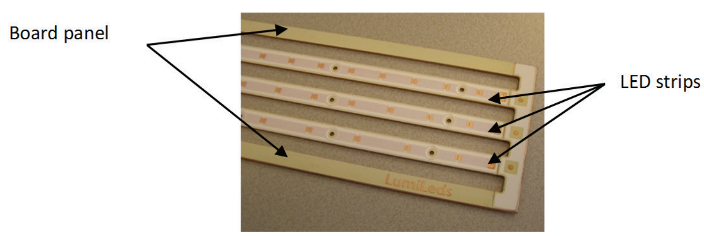


Figure 23. PCB panel consisting of several strips of LEDs.

A printed circuit board may warp after reflow when layers with different CTE are applied to the top and bottom of the boards. If the PCB is subsequently secured to a flat surface, a vertical force is applied to the ceramic package (see Figure 24). If this force is large enough, the ceramic substrate package may break. To minimize the chance of cracking the ceramic package, orientate the package such that the long side of the package is perpendicular to the dominant warpage direction.

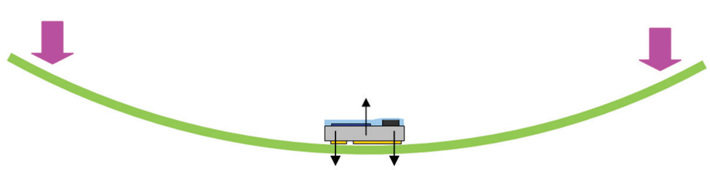


Figure 24. Board warpage after reflow.

5. JEDEC Moisture Sensitivity Level

The LUXEON Altilon SMD has a JEDEC moisture sensitivity level of 1. This is the highest level offered in the industry and highest level within the JEDEC standard.

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.

Moisture sensitivity level 1 allows the device to be reflowed three times under the specifications as described in the respective LUXEON Altilon SMD datasheets. JEDEC has defined eight levels for moisture sensitivity, as shown in Table 10.

Table 10. 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	4 weeks	≤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 +2/-0	30°C /60% RH	20 +0.5/-0	60°C /60% RH
5	48 hours	≤30°C /60% RH	72 +2/-0	30°C /60% RH	15 +0.5/-0	60°C /60% RH
5a	24 hours	≤30°C /60% RH	48 +2/-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		

6. Product Packaging Consideration—Chemical Compatibility

The LUXEON Altilon SMD package contains a silicone overcoat to protect the LED chip 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 in LUXEON Altilon SMD 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 LUXEON Altilon SMD emitters 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 11 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 that may affect LED performance.

The chemicals in Table 11 are typically not directly used in the final products that are built around LUXEON Altilon SMD 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 11. List of commonly used chemicals that may damage the silicone overcoat of LUXEON Altilon SMD.

CHEMICAL NAME	NORMALLY USED AS
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

Lumileds is the global leader in light engine technology. The company develops, manufactures and distributes groundbreaking LEDs and automotive lighting products that shatter the status quo and help customers gain and maintain a competitive edge.

With a rich history of industry "firsts," Lumileds is uniquely positioned to deliver lighting advancements well into the future by maintaining an unwavering focus on quality, innovation and reliability.

To learn more about our portfolio of light engines, visit lumileds.com.

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