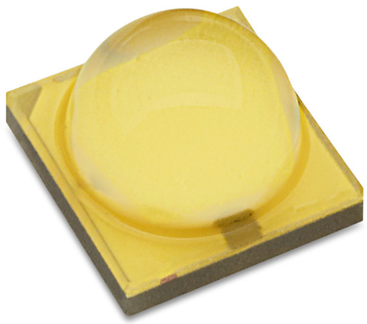
ILLUMINATION

LUXEON V

Assembly and Handling Information



Introduction

This application brief addresses the recommended assembly and handling guidelines for LUXEON V emitters. LUXEON V emitters are designed to deliver high luminous flux and efficacy from a compact optical source, enabling tighter beam control and higher punch due to a smaller apparent source size. Proper assembly, handling and thermal management, as outlined in this application brief, ensures high optical output and long lumen maintenance for LUXEON V emitters.

Scope

The assembly and handling guidelines in this application brief apply to the following products with the part number designations described below.

L1V1–AABB03VC0DDDD		
Where:		
A A	–	designates nominal ANSI CCT (27=2700K, 30=3000K, 40=4000K, 50=5000K, 57=5700K, 65=6500K)
B B	–	designates CRI (70=70CRI minimum, 7T=70CRI typical)
C	–	designates SDCM (3=3-step MacAdam ellipse, 5=5-step MacAdam ellipse, 7=7-step MacAdam ellipse)
D D D D	–	designates minimum luminous flux (optional)

In the remainder of this document, the term LUXEON emitter refers to any product in the LUXEON V product family.

Table of Contents

1. Component

1.1 Description

The LUXEON V emitter consists of an InGaN (indium gallium nitride) LED chip mounted onto a ceramic substrate. The ceramic substrate provides mechanical support and thermally connects the LED die to a thermal pad on the bottom of the substrate. An electrical interconnect layer connects the LED chip to a cathode and anode on the bottom of the ceramic substrate. The ceramic substrate is overmolded with a silicone dome.

Each LUXEON V emitter includes a transient voltage suppressor (TVS) chip to protect the emitter against electrostatic discharge (ESD).

The bottom of the LUXEON V emitter (see Figure 1) contains three metallization pads, a large thermal pad in the center (electrically isolated), an anode and a cathode. All the pads are silver plated. The semi-circle cut out on the thermal pad is the cathode pad reference marker to aid in identifying the cathode pad. From the top view, a chamfer feature (see Figure 1) indicates package orientation with respect to the cathode pad.

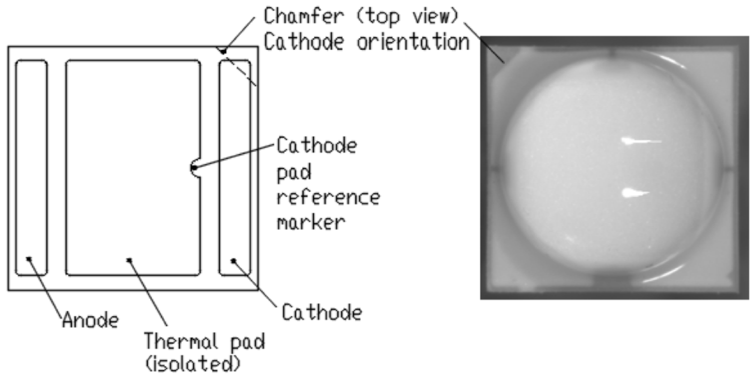


Figure 1. Bottom view (left) and top view (right) of the LUXEON V LED.

1.2 Optical Center

The theoretical optical center of LUXEON V (see Figure 2) is located 2.0mm from any corner of the square shape. Optical rayset files for LUXEON V are available at lumileds.com.

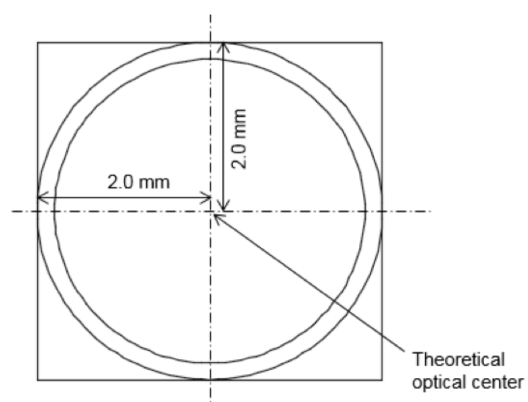


Figure 2. The theoretical optical center of LUXEON V.

1.3 Handling Precautions

LUXEON V is designed to maximize light output and reliability. However, improper handling of the device may damage the LED die and can affect its overall performance and reliability. In order to minimize the risk of damage to the LED die during handling, LUXEON V emitters should only be picked up from the side of the ceramic substrate as illustrated in Figure 3.

Figure 3. Incorrect handling (left & middle) and correct handling (right) of a domed LED package similar to LUXEON V.

1.4 Cleaning

LUXEON V emitters should not be exposed to dust and debris. Any fine dust and debris on and around the package may cause a drastic decrease in optical output. In the event that a LUXEON emitter requires cleaning, try gently swabbing it using a lint-free swab. If necessary, a lint-free swab and isopropyl alcohol (IPA) can be used to gently remove stubborn dirt from the lens. Do not use any other solvents as they may adversely react with the LED assembly. For more information regarding chemical compatibility, see section 6.

1.5 Electrical Isolation

The thermal pad of the LUXEON V emitter is electrically isolated from its cathode and anode. Consequently, a high voltage difference between electrical and thermal metallization may occur in applications where multiple emitters are connected in series. As a reference, the nominal distance between the electrical metallization and the thermal metallization of the LUXEON V emitter is 0.3mm.

In order to avoid any electrical shock and/or damage to the LUXEON emitter, each design needs to comply with the appropriate standards of safety and isolation distances, known as clearance and creepage distances, respectively (e.g. IEC 60950, clause 2.10.4).

1.6 Mechanical Files

Mechanical 3-D STEP file for LUXEON V is available from the Lumileds website at lumileds.com.

1.7 Packaging and Storage

As with any other packages with silver plated pads, proper storage is recommended to prevent the pad from tarnishing due to the presence of sulfide. Any unused parts must be stored in the original packing bag immediately after use without adding any items such as rubber bands, adhesive labels/tapes, printed papers and other desiccants not originally shipped with the packing bag. These items may contain sulfur which can cause the silver to tarnish and prevent good wetting during the soldering process.

The surrounding air where the packing bag is stored (if not air-tight sealed) must be free of chlorides and sulfides. Packing bags that are already opened should preferably be stored in a nitrogen filled desiccator.

2. Printed Circuit Board

The LUXEON V emitter is designed to be soldered onto a Metal Core PCB (MCPCB) or a ceramic PCB. FR4 is not recommended due to its poor thermal resistance performance. To ensure optimal operation of the LUXEON V emitter, the PCB should be designed to minimize the overall thermal resistance between the LED package and the heat sink.

2.1 LUXEON Footprint and Land Pattern

The LUXEON V emitter has three pads that need to be soldered onto corresponding pads on the PCB to ensure proper thermal and electrical operation. Figure 4 shows the recommended footprint layout for LUXEON V.

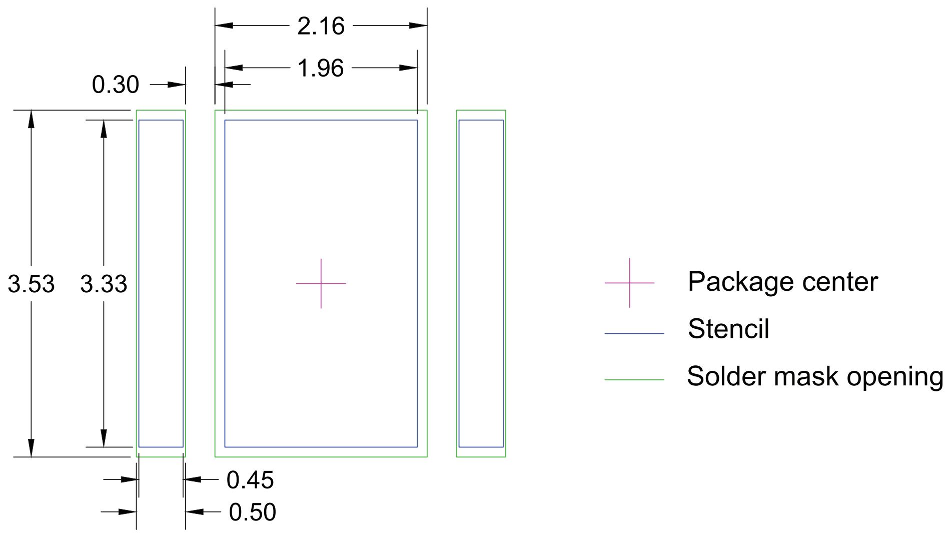


Figure 4. Recommended footprint layout for LUXEON V. All dimensions are in millimeters.

2.2 Surface Finishing

Lumileds recommends using a high temperature organic solderability preservative (OSP) or electroless nickel immersion gold (ENIG) plating on the exposed copper pads.

2.3 Minimum Spacing

Placing multiple LUXEON V emitters too close to each other may adversely impact the ability of the PCB to dissipate the heat from the emitters. Also, the light output for each LED may drop due to optical absorption by adjacent LED packages.

3. Thermal Management

3.1 PCB Designs

Table 1 summarizes the general characteristics of various PCB material systems available for LEDs.

Table 1. General PCB characteristics for designing with LUXEON V.

SUBSTRATE	FR4*	MCPCB	CERAMIC PCB
Cost	Low to Medium	Medium	High
PCB thermal resistance performance	Low to medium. Due to higher cost for a filled and capped via board and poor thermal performance, FR4 is not recommended for LUXEON V	Medium to excellent	High to excellent
Coefficient of thermal expansion (CTE)	Good CTE matching with LUXEON V substrate	Moderate CTE matching with LUXEON V substrate	Good CTE matching with LUXEON V substrate
LED assembly packing density (thermal resistance consideration)	Suitable for low density applications with large spacing between LEDs and operating at a low drive current	Suitable for medium density applications with moderate spacing between LEDs	Suitable for high density applications with minimal spacing between LEDs
Mechanical assembly and handling	Easy, as board does not easily break	Easy, as board does not easily break	Extra precaution to prevent ceramic breakage (hard & brittle)
Supplier availability	High	High	Limited

*Provided here for comparison purposes only. Lumileds does not recommend the use of FR4 for LUXEON V.

Figure 5 shows various PCB constructions.

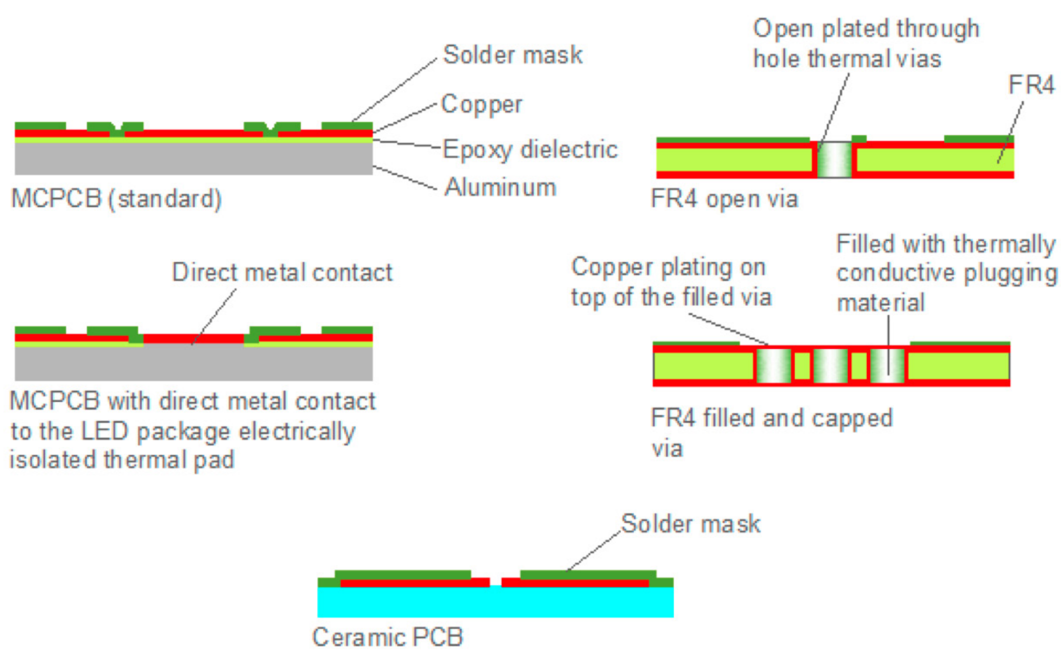


Figure 5. Schematic cross-section of MCPCB (left), FR4 (right) and ceramic (bottom) board constructions illustrate the important aspect of each board design (drawing not to scale).

Each of these constructions has its own merits as discussed below.

Metal Core PCB

The most common MCPCB construction consists of the following layers:

- ***A metal substrate, typically aluminum***. In some applications, a copper substrate may be more appropriate due to its higher thermal conductivity than aluminum (401 $Wm^{-1}K^{-1}$ versus 237 $Wm^{-1}K^{-1}$) but more expensive.
- ***Epoxy dielectric layer***. This layer is typically engineered to improve the thermal conductivity from the top metal foil to the metal substrate. The typical thermal conductivity of the dielectric layer on a MCPCB is between 2 and 3 $Wm^{-1}K^{-1}$. This layer also functions as an electrical barrier during a Hi-Pot (high potential) test. The thickness of this layer is critical (75μm to 100μm are common) and impacts both the thermal resistance and the ability of the board to withstand a Hi-Pot test. Note that these two parameters are inversely related (i.e. a higher Hi-Pot test value, which can be achieved by increasing the dielectric thickness layer, will have a negative impact on the PCB thermal resistance).
- ***Top copper layer***. A thickness of 1 oz. (35μm) or 2 oz. (70μm) are common.
- ***Solder mask***. A white reflective solder mask is desirable to maximize light output extraction.

Another factor which may impact the PCB thermal resistance is the size of the top copper layer around the LUXEON V thermal pad. A direct metal contact of the metal substrate to the LUXEON V thermal pad without any epoxy dielectric layer in between can further reduce the MCPCB thermal resistance significantly as shown on the left in Figure 5. This type of board provides the best thermal resistance. However, the Hi-Pot test between the metal substrate and the LUXEON V electrode pads need to be considered.

FR4 PCB (for information only)

FR4 board construction (not recommended for use with LUXEON V) consists of the following layers:

- ***FR4 sheet (woven fiber glass fabrics reinforced epoxy laminate)***. This material has excellent electrical insulation properties, but has very poor thermal conductivity.
- ***Top and bottom copper layers***. A thickness of 1 oz. (35μm) or 2 oz. (70μm) is most common.
- ***Solder mask***. A white relfective solder mask is desirable to maximize light output extraction.

In order to increase the thermal performance of FR4 boards, employing thermal vias will reduce the thermal resistance significantly. Two common approaches include:

- Open vias with plated through holes
- Filled and capped thermal vias as shown in Figure 5 (this gives better thermal performance than open via design)

It is important to determine the minimum number of thermal vias and via diameter for optimum thermal performance. Adding more thermal vias beyond this minimum quantity will not reduce the PCB thermal resistance significantly but may increase PCB manufacturing cost and may mechanically weaken the PCB board. Due to added complexity and the cost of making such an FR4 board, it is better to design a MCPCB board for LUXEON V assembly.

Ceramic PCB

Ceramic PCB construction consists of the following layers:

- ***Ceramic substrate***. Commonly used materials are alumina (Al2O3) or aluminum nitride (AlN). The thermal conductivity of alumina ranges from 20 to 30 Wm-1K-1, depending on the grades of alumina material in the substrate. The thermal conductivity of aluminum nitride ranges from 170 to 230 Wm-1K-1 depending on the additives added during the ceramic manufacturing process.
- ***Top copper layer***.
- ***Solder mask***. A white relfective solder mask is desirable to maximize light output extraction.

Since ceramic has an excellent thermal conductivity but very poor electrical conductivity, the LED thermal pad can be directly attached to the ceramic via copper and solder layer, allowing LEDs to be closely packed. This makes ceramic very attractive in high density packaging.

However, ceramic is brittle and expensive, and requires extra handling precautions during assembly and handling.

3.2 Other Thermal Assembly and Design Considerations

Thermal Interface Materials (TIM) Selection

Once the suitable PCB board material and design has been made, the TIM selection should be made with the following considerations:

- ***Pump out***. Some TIMs will move out of the thermal path during extreme temperature excursions and will create voids in the thermal path. These materials should not be used.
- ***TIM thickness***. Excessive thickness of some TIMs will present an unacceptable thermal resistance even though the thermal conductivity of the material may be high.
- ***Surface roughness***. In order to fill the air gaps between adjacent surfaces, choose the appropriate TIM that minimizes the interfacial contact resistance.
- ***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.
- ***Out-gassing***. Out-gassing of some TIMs at design temperatures may produce undesirable optical or appearance qualities (e.g. fogging) in a sealed system. Special consideration must be given to limit this effect.
- ***Clamping force***. TIMs, such as thermal tape or pads, perform better when the right pressure is applied.

LED Component Spacing (Density)

Depending on the drive current and intended LED spacing, the right PCB material must be chosen. See Table 1 for general guidance. As more LEDs are packed closely together, thermal crowding effect becomes more important and will affect the ability of the PCB to dissipate heat.

Electrical Power Distribution

When large drive current is transported to operate many LEDs, the PCB trace width and length can affect the electrical resistance and causing localized heating and voltage drop. Some important considerations on copper trace pattern layout to optimize electrical and to some extent thermal performance:

- Trace width. There are many third party online tools that performs PCB trace width calculator such this one here (http://circuitcalculator.com/wordpress/2006/01/31/pcb-trace-width-calculator/) to determine the voltage drop and the acceptable copper trace temperature rise. Note: an improper design of copper trace width can be a source of unwanted heat generation.
- Trace routing. Layout the circuit to keep trace length as short as possible. For LEDs with many parallel strings, having a symmetric trace pattern layout with respect to LED positioning help to reduce light output non-uniformity.

A hypothetical example. Consider LEDs arranged and connected as shown in Figure 6 where the electrical schematic represents actual trace and LED layout. The input current IF, will flow from left to right. The equivalent schematic of the trace width can be represented as trace resistance R as shown in the middle drawing of Figure 6 with LED#N being located furthest away from the input current. If the trace width is insufficient, it will cause significant voltage drop across R, leaving the last LEDs (LED#N) to appear the dimmest while the left most LED#1 will be the brightest. In such configuration, best to optimize trace width to keep the trace resistance negligible and/or reduce the number of LEDs in parallel and/or route the IF current through LED#N/2. Note that in the last approach, it is still possible that LED#1 and LED#N will appear dimmest due to trace resistance voltage drop but can be made negligible with proper trace width.

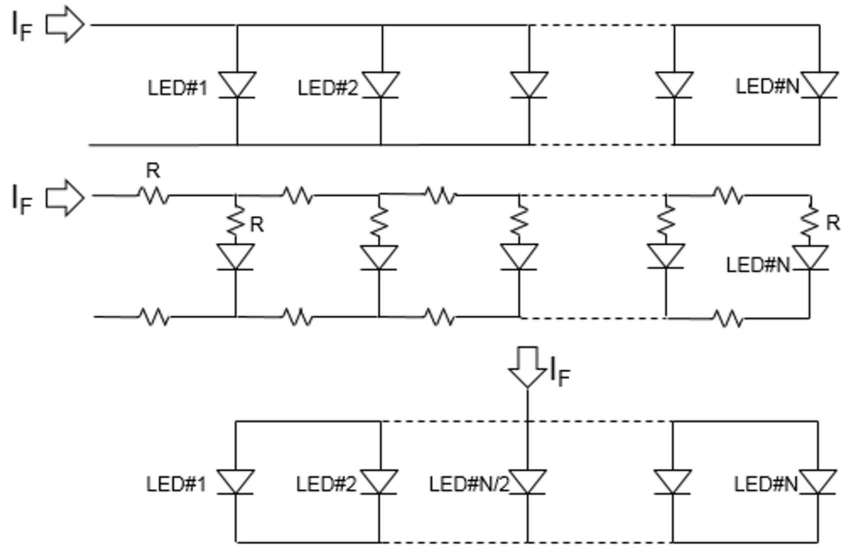


Figure 6. Effect of trace resistance and routing pattern on LED light output performance as described.

Figure 7 shows a real-life example of an application design concept as described above. Left and right pictures are thermal images of the same board operating at the same drive current. The narrow PCB copper trace, as indicated in the left picture, carries very high current to feed several LEDs connected in parallel. The picture on the right shows a modified electrical trace routing for the input current, similar to the bottom drawing of Figure 6. Notice that the right picture shows more uniform temperature distribution than the left picture after adjusting the electrical power distribution of the circuit.

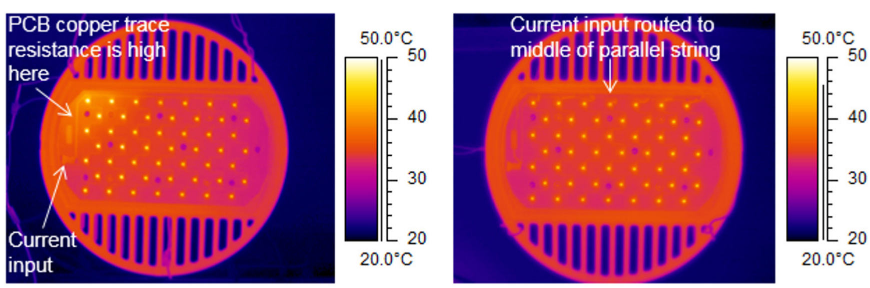


Figure 7. A real-life example of an application design concept.

4. Thermal Measurement Guidelines

4.1 Thermal Basics

This section provides general guidelines on how to determine the junction temperature of a LUXEON V in order to verify that the junction temperature in the actual application during regular operation does not exceed the maximum allowable temperature specified in the datasheet.

The typical thermal resistance ($R\theta_{j\text{-thermal pad}}$) between the junction and the thermal pad for LUXEON V is specified in the LUXEON V datasheet. In LUXEON V emitters, most of the heat is conducted via the large thermal pad at the base of the package. With this information, the junction temperature (T_j) can be determined according to the following equation:

$$T_j = T_{\text{thermal pad}} + R\theta_{j\text{-thermal pad}} \cdot P_{\text{electrical}}$$

In this equation, $P_{\text{electrical}}$ is the electrical power going into the LUXEON V emitter and $T_{\text{thermal pad}}$ is the temperature at the bottom of the LUXEON V thermal pad.

4.2 Temperature Sensor Pad (T_s) and Thermocouple (T_c) Attachment

Although, in typical applications it may be difficult to measure the thermal pad temperature ($T_{\text{thermal pad}}$) directly. Therefore, a practical way to determine the LUXEON V junction temperature is by measuring the temperature (T_s) of a predetermined sensor pad on the PCB right next to the LUXEON V emitter with a thermocouple (TC). The junction temperature can then be calculated as follows:

$$T_j = T_s + R\theta_{j\text{-}s} \cdot P_{\text{electrical}}$$

In the above equation. $P_{\text{electrical}}$ is the combined electrical power going into the LUXEON V emitter. The thermal resistance from junction to the T_s point ($R\theta_{j\text{-}s}$) depends on several factors such as the PCB type and construction (e.g. MCPCB dielectric layer thickness), the location of the T_s point, type and volume of the adhesive used to attach the TC wire, and the LED emitter packing density.

To ensure accurate readings, the TC must make direct contact with the copper of the PCB onto which the LUXEON V thermal pad is soldered (i.e. any solder mask or other masking layer must first be removed before mounting the TC onto the PCB). The TC must be attached as close as possible to the primary heat flow path of the thermal pad of the LUXEON V emitter as shown in Figure 8. The TC wire must be in contact with the top copper layer of the thermal pad on LUXEON V with proper dispensed amount of thermal conductive epoxy to secure the TC wire.

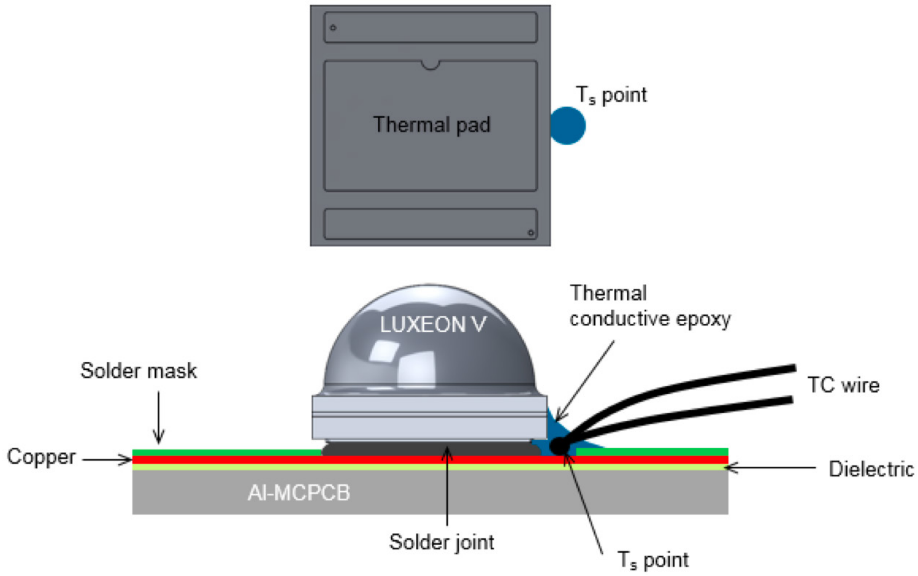


Figure 8. Drawings showing the recommended location of the T_s point (top).

An example of a suitable thermal conductive epoxy is a two-part Artic Silver™ thermal adhesive used in combination with a TC wire gauge of AWG 40 or 36. Excessive dispense of thermal adhesive may impact the accuracy of the T_s temperature reading. In particular, if the thermal adhesive spills over onto the top of the package or blocks some side light, the T_s reading may increase due to absorption of the optical energy. The use of thermally insulated epoxy is not recommended.

4.3 Effect of Placing T_s Point Further Away from LED Package

As described in 4.2, one of the factors that can affect the T_s measurement is its location. Ideally, the most accurate method to determine T_j is by placing the TC wire directly underneath the center of the thermal pad and then using the typical LED package thermal resistance, which is published in an LED datasheet, to calculate the T_j.

The further away the T_s point is from the primary heat flow path, the less sensitive the T_s temperature reading is to the changes in the heat dissipation from the LED package.

4.4 Thermal Simulation Result

A 1.6mm thick Al-MCPCB star board with 2 oz. top copper, dielectric thickness of 0.1mm and dielectric thermal conductivity of 2.7 $Wm^{-1}K^{-1}$ was used in the T_s point thermal resistance ($R\theta_{j-s}$) measurement. This value was characterized to be 2.7K/W for this Al-MCPCB star board design.

$$T_j = T_s + (2.7K/W) \cdot P_{electrical}$$

For other PCB designs, an experiment or thermal simulation may need to be conducted to determine $R\theta_{j-s}$.

5. Assembly Process Guidelines

5.1 Stencil Design

The recommended stencil design is shown in Figure 4 with a stencil thickness of 5 mils thick (127μm).

5.2 Solder Paste

Lumileds recommends a lead-free, no clean solder paste to mount LUXEON V emitters onto a PCB. Lumileds successfully tested a solder paste from Senju, M705-GRN360-K2-V SAC305, type 3 solder. However, since application environments vary widely, Lumileds recommends that customers perform their own solder paste evaluation in order to ensure it is suitable for the targeted application.

5.3 Solder Paste Screen Printing

In general, there are three methods to align the stencil to the PCB during solder paste screen printing:

1. The stencil is manually aligned to the PCB prior to printing. No adjustments are made during printing.
2. The stencil is manually aligned to the PCB prior to printing. During printing, the machine keeps track of the PCB fiducial mark(s) and makes any necessary adjustments to maintain proper alignment with the PCB.
3. A technician performs a crude alignment of the stencil to the PCB. During printing, the machine keeps track of the PCB fiducial mark(s) and the stencil fiducial mark(s) and maintains proper alignment between the fiducials throughout the process.

Method 1 has the worst accuracy and repeatability of the three methods discussed. Method 2 offers the same accuracy as method 1 but ensures better repeatability. Method 3 has the best accuracy and best repeatability of the 3 methods discussed.

Depending on what screen printing method is used, the size of the anode and cathode solder mask openings on the PCB may have to be enlarged to compensate for any misalignments between the stencil and the PCB panel. Note, though, that any enlargement in the solder mask opening for anode and cathode pads may reduce the solder reflow placement accuracy.

In order to ensure proper alignment between the stencil and the PCB, as well as reliable transfer of solder paste onto the PCB, all PCB panels should be rigidly supported during solder paste printing. Instead of placing the PCB panel on multiple support pins, it is best to place the PCB panel on a single solid plate. This is particularly important for PCB panels which contain v-scores or perforated holes for de-paneling purposes.

5.4 Pick and Place

Automated pick and place equipment provides the best placement accuracy for LUXEON V emitters. Figure 9 is a generic nozzle's tip design that is not constrained to any PnP machine. Figure 10, Figure 11 and Figure 12 show various pick and place nozzle designs and corresponding machine settings for Juki, Samsung and Panasonic machines, respectively, which were successfully tested for LUXEON V.

Note that pick and place nozzles are customer specific and are typically machined to fit specific pick and place tools. Based on these pick and place experiments, Lumileds advises customers to take the following general pick and place guidelines into account:

- The nozzle tip should be clean and free of any particles since this may interact with the silicone coating of the LUXEON V during pick and place.
- During setup and the first initial production run, it is good practice to inspect the top surface of the LUXEON V emitters under a microscope to ensure that emitters are not accidentally damaged by the pick and place nozzle.

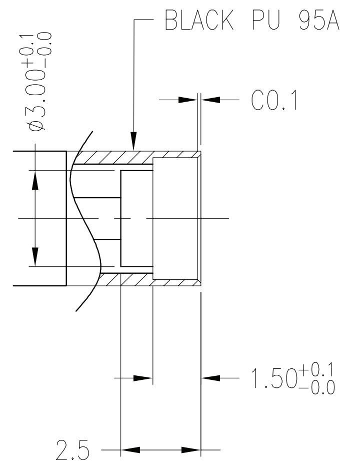


Figure 9. Generic nozzle's tip design. Outside diameter is 4.2mm and interior diameter is 3.8mm. All dimensions are in millimeters.

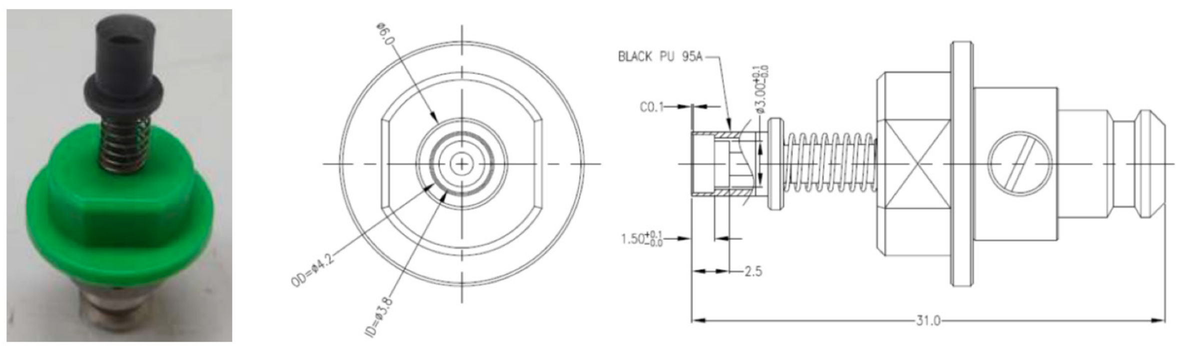


Table 2. Juki KE-2080L pick and place parameters.

PICK AND MOUNT INFORMATION	
Placing Stroke	0.0mm
Picking Stroke	1.0mm
XY Speed	Fast 2
Picking Z Down	Fast 2
Picking Z Up	Fast 2
Placing Z Down	Fast 2
Placing Z Up	Fast 2
Laser Position	-0.54mm
VISION INFORMATION	
Centering Method	Laser
Comp Shape	Corner Square

Figure 10. Nozzle design for Juki KE-2080L (part number: JUK-0004/16, drawing number: 13542 from Ching Yi Technology Pte. Ltd.). All dimensions are in millimeters.

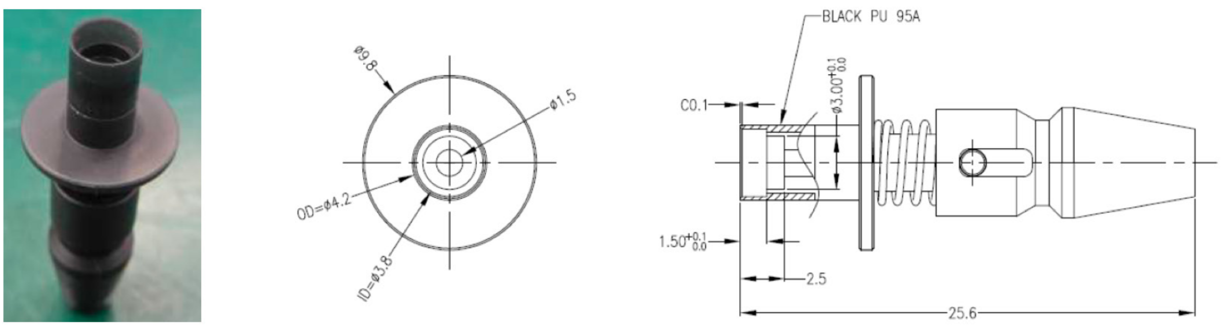


Table 3. Samsung SM421 pick and place parameters.

PICK AND MOUNT INFORMATION	
Pick Height	-1.0mm
Mount Height	0.0mm
Delay – Pick Up	30 msec
Delay – Place	30 msec
Delay – Vac Off	0 msec
Delay – Blow On	0 msec
Speed – XY	1
Speed – Z Pick Down	1
Speed – Z Pick Up	1
Speed – R	1
Speed – Z Place Down	1
Speed – Z Place Up	1
Z Align Speed 2	1
Soft Touch	Do not use
VISION INFORMATION	
Camera No	Fly Cam5
Side	5
Outer	5

Figure 11. Nozzle design for Samsung SM421 (part number: SAM-0002/16, drawing number: 13540 from Ching Yi Technology Pte Ltd.). All dimensions are in millimeters.

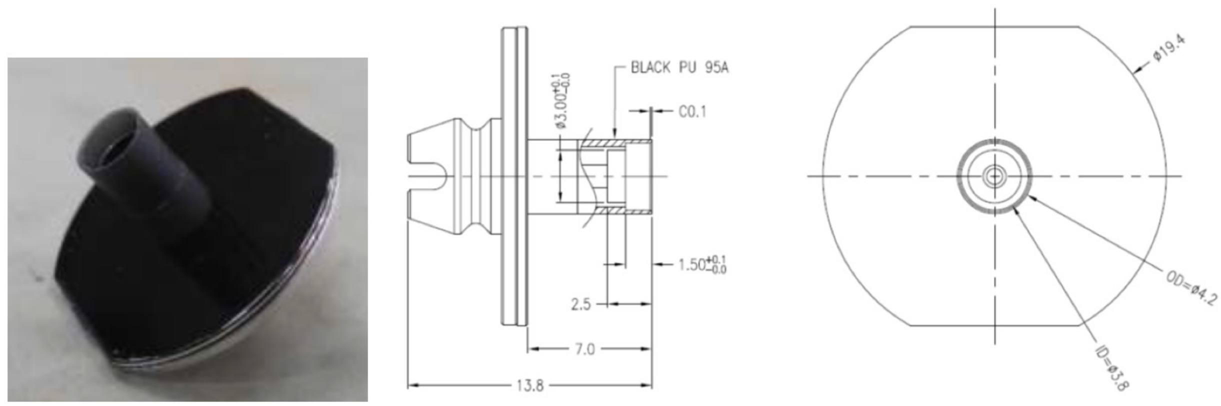


Table 4. Panasonic CM402 pick and place parameters.

PICK AND MOUNT INFORMATION	
Gap - Mount	0.0mm
Gap - Pick	1.0mm
Pickup Position - Z	0.0mm
Fdr Drive Time	Std
Pickup Keep Time	Std
Mount Keep Time	Std
Pickup Speed	100
Mount Speed	100
VISION INFORMATION	
Ref	88
Recognition Speed	Auto (Fast)
Recognition Height	0.0mm
Lamp 1	0
Lamp 2	0
Lamp 3	0
Lamp 4	120
Lamp 5	0
Lamp 6	0
Lamp 7	0
Lamp 8	0
NOZZLE LIBRARY DATA	
VU, Vacuum Rise Time	5
VD, Vacuum Break Time	-2
TT, Pickup Holding Time	5
MT, Mounting Holding Time	0
PM, Failure Judgement Pressure	-20
PF, Nozzle Clogging Detection Pressure	-85

Figure 12. Nozzle design for Panasonic CM402 (part number: KME-0003/16, drawing number: 13541 from Ching Yi Technology Pte Ltd.). All dimensions are in millimeters.

5.5 Nozzle Tip Material

Nozzle tip material made from polyurethane (PU) with shore hardness of 95A was successfully evaluated. Nozzle made from metal does not seem to perform as well as PU material.

5.6 Pick and Place Machine Optimization

Pick and place machines are typically equipped with special pneumatic or electric feeders to advance the tape containing the LEDs. In pneumatic feeders, air pressure is used to actuate an air cylinder which then turns the sprocket wheel to index the pocket tape; electric feeders, in contrast, use electric motors to turn the sprocket wheel (see Figure 13). Electric feeders often also contain a control panel which allows an operator to adjust the electric feeder manually.

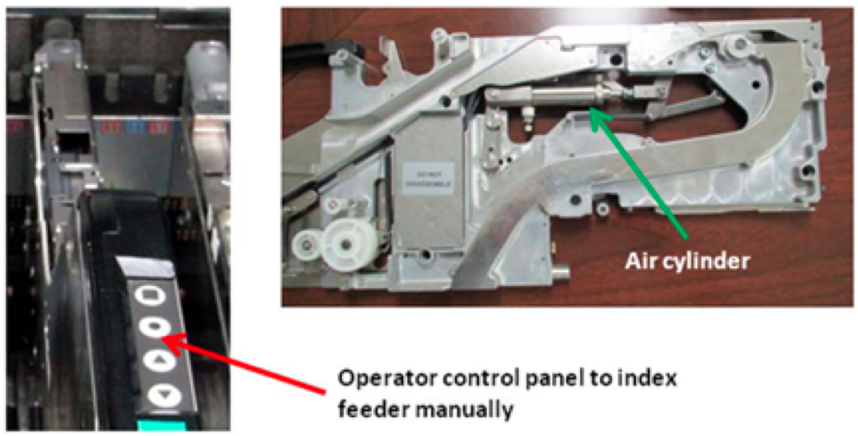


Figure 13. Examples of an electric feeder (left) and a pneumatic feeder (right), which are typically used in pick and place machines to advance the tape with LEDs.

The indexing step in the pick and place process may cause some LEDs to accidentally jump out of the pocket tape or may cause some LEDs to get misaligned inside the pocket tape, resulting in pick-up errors. Depending on the feeder design, minor modifications to the feeder can substantially improve the overall pick and place performance of the machine. Figure 14 shows the feeder designs of Samsung and Juki pick and place machines used in this study.

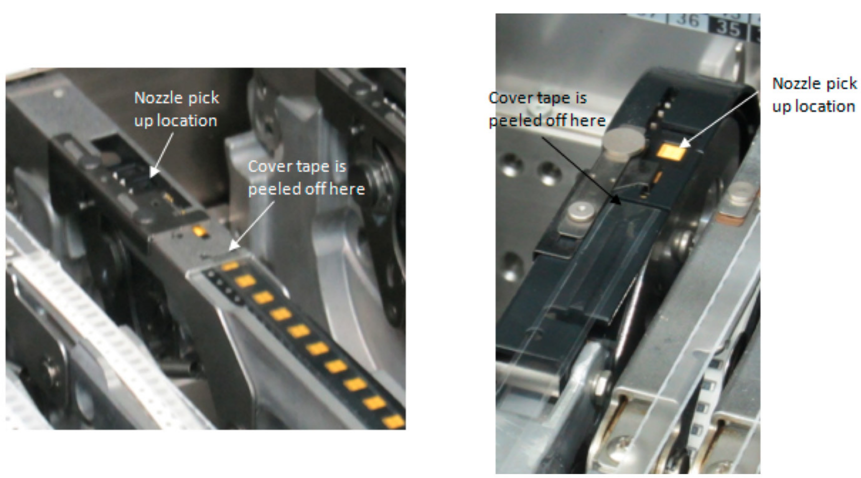


Figure 14. Examples of Samsung SM421 (left) and Juki KE-2080L (right) pick and place feeders used to pick and place LUXEON domed packages.

There are many types of pick and place feeder designs available. Some feeders can be used as-is without any further modifications, some feeders require a shift in the position where the cover tape is peeled off the tape, and yet other feeders require the shutter to be completely removed so that the cover tape peeling position can be adjusted. Since there are many different feeder designs, it is important to understand the basic principle behind modifying the feeders so that effective modifications can still be carried out when different feeder designs are encountered. Refer to Figure 15 and Figure 16 for examples of feeder modifications.

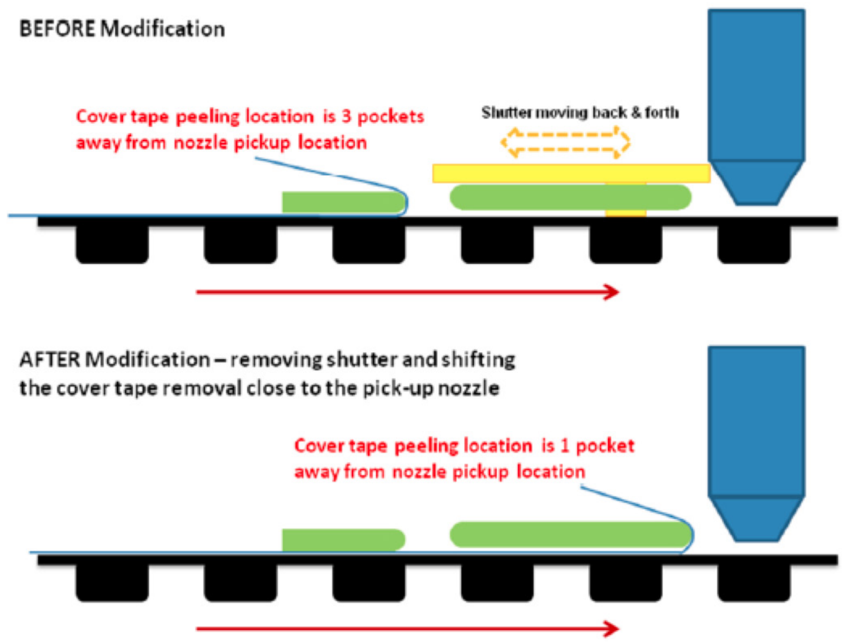


Figure 15. Illustration of the general principle behind the feeder modification where, in some cases, there may be a need for the LED emitter to be picked up immediately after the cover tape is peeled off.

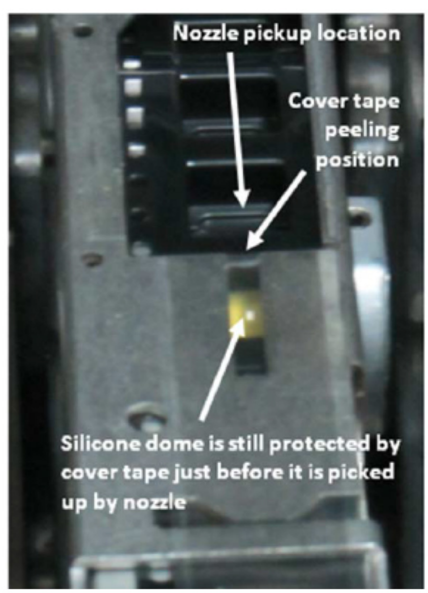


Figure 16. An actual example of a modified feeder, which protects the LED silicone dome with cover tape still on prior to pick up.

To minimize the jerking of components in pneumatic feeders during indexing, it may be necessary to install an air pressure control valve (Figure 17). In some pneumatic feeder designs, this control valve is already integrated by the machine supplier; in others, an external control valve may have to be installed.

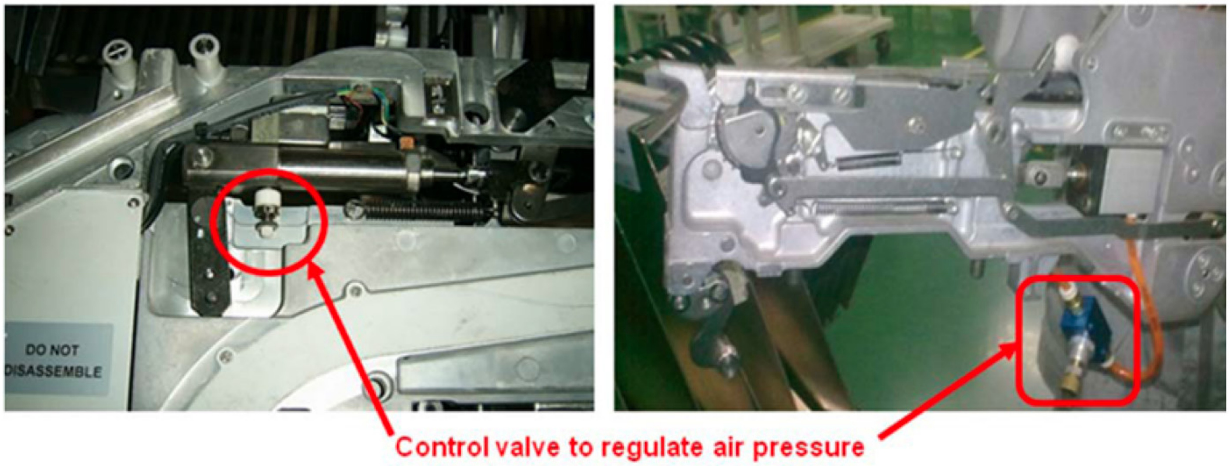


Figure 17. Pneumatic feeder with integrated air pressure control valve (left) and modification made to the pneumatic feeder by installing air pressure control valve (right).

5.7 Solder Reflow Profile

The LUXEON V emitter 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, allowing the solder to freeze, before the board exits the oven.

As a point of reference, the melting temperature for SAC 305 solder system is 217°C. A typical reflow profile that follows the profile shown in the LUXEON V datasheet (taken from the IPC/JEDEC J-STD-020D moisture/reflow sensitivity classification document), with a peak temperature setting of 240°C, can be used as a starting point in the reflow profile process optimization study.

5.8 Placement and Reflow 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 pads of the LUXEON V emitter. The pad's size and location are shown in Figure 2.

5.9 JEDEC Moisture Sensitivity Levels

LUXEON V emitters have a JEDEC moisture sensitivity level of 1. This is the highest level offered in the industry and highest level within the JEDEC standard. This ensures ease of use since the user no longer needs to be concerned about bake out times and floor life.

6. Packaging Considerations—Chemical Compatibility

The LUXEON V package contains a silicone dome 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 in the LUXEON V emitters is gas permeable. Consequently, oxygen and volatile organic compound (VOC) gas molecules can diffuse into the silicone dome. 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 V 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. Under heat and "blue" light, the VOCs inside the silicone coating may partially oxidize and create an appearance of 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 and may restore the original optical properties of the LED.

Determining suitable threshold concentration 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 that may affect LED performance.

The chemicals in Table 5 are typically not directly used in the final products that are built around LUXEON V 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 overcoat of LUXEON V.

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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