LUMILEDS

ILLUMINATION

LUXEON HL4Z

Assembly and Handling Information

Introduction

This application brief addresses the recommended assembly and handling guidelines for LUXEON HL4Z. Proper assembly and handling, as outlined in this application brief, ensures high optical output and the long-term performance of LUXEON LEDs.

Scope

The assembly and handling guidelines in this application brief apply to all the part numbers as described in the LUXEON HL4Z datasheet.

L1HZ–XXYY4C0000000		
Where:		
XX	–	designates nominal ANSI CCT (for example, 27=2700K, 30=3000K, 40=4000K, 50=5000K, 57=5700K, 65=6500K)
YY	–	designates minimum CRI (for example, 70=70CRI minimum)
C	–	designates performance options (for example, 0=Standard)

In the remainder of this document, the term LUXEON emitter refers to any product in the LUXEON HL4Z product family.

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1. Component

1.1 Description

The LUXEON HL4Z emitter consists of a single 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 dispensed with TiO2 silicone and film silicone on top without flat mold.

Each LUXEON HL4Z emitter includes a transient voltage suppressor (TVS) chip to protect the emitter against electrostatic discharge (ESD).

The bottom of the LUXEON HL4Z 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 gold plated. The semi-circle cut out on the thermal pad is the cathode pad reference marker to aid in identifying the cathode pad.

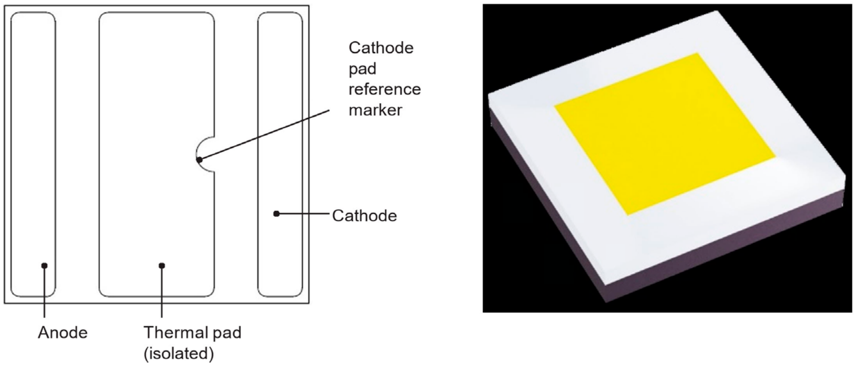

Figure 1. Bottom view (left) and top view (right) of the LUXEON HL4Z LED.

1.2 Optical Property

The theoretical optical center of LUXEON HL4Z (see Figure 2) is located 1.725mm from any corner of the square shape. Optical rayset files for LUXEON HL4Z are available at lumileds.com.

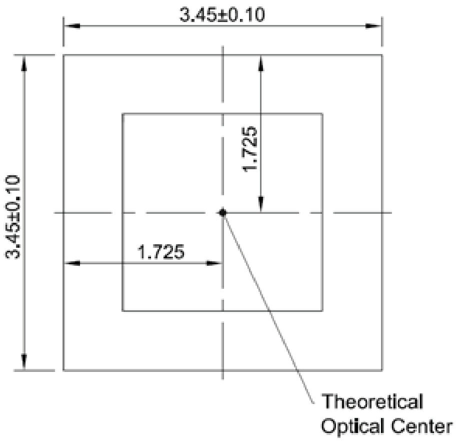

Figure 2. The theoretical optical center of LUXEON HL4Z. All dimensions are in millimeters.

2. Handling Precautions

LUXEON HL4Z 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 HL4Z emitters should only be picked up from the side of the ceramic substrate as illustrated in Figure 3.

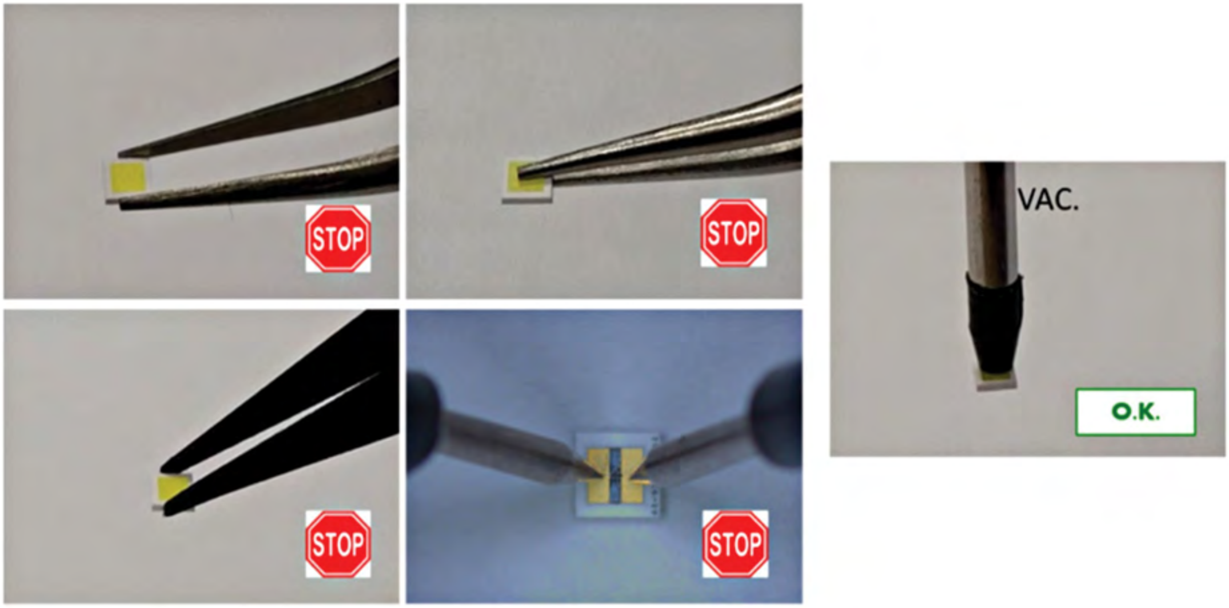

Figure 3. Illustration of incorrect handling (left & middle) and correct handling (right) of a representative domed LED package similar to LUXEON HL4Z.

Assembled boards must not be stacked up on top of each other or placed upside down as shown in Figure 4.

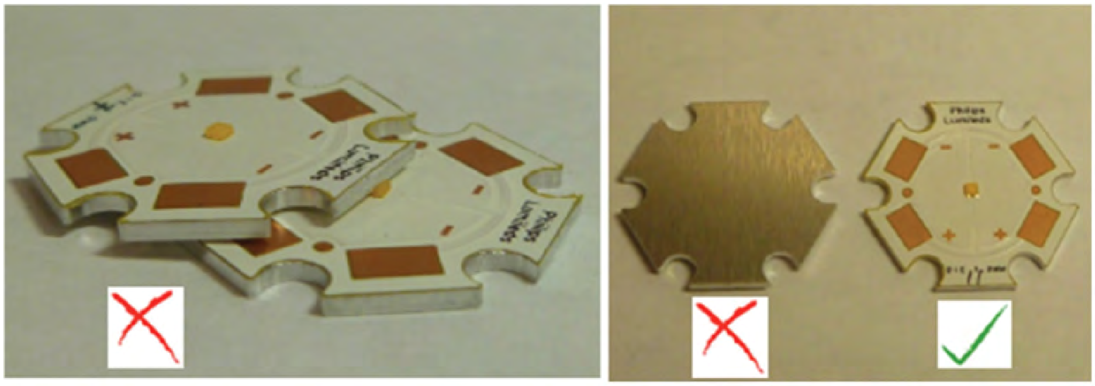

Figure 4. Illustration of correct placement of assembled board (left) and incorrect stacking of assembled boards (right).

3. Printed Circuit Board Design

LUXEON HL4Z is engineered to be surface mounted onto a ceramic or metal-core PCB (MCPCB) substrate. FR4 is not recommended due to its poor thermal resistance performance. To ensure optimal operation of the LUXEON HL4Z emitter, the PCB should be designed to minimize the overall thermal resistance between the LED package and the heat sink.

3.1 LUXEON Footprint and Land Pattern

LUXEON HL4Z has three electrode pads that need to be soldered onto corresponding land patterns on the PCB. Figure 5 shows the recommended PCB footprint.

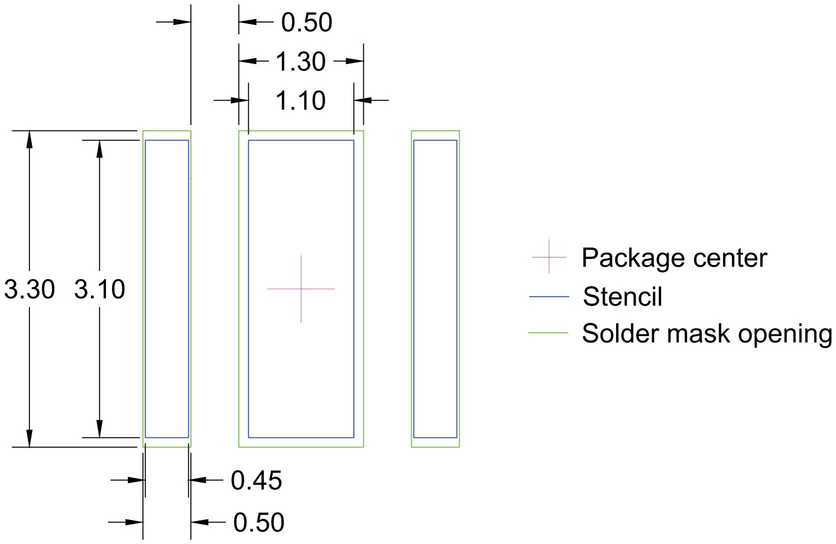

Figure 5. Recommended footprint layout with optional Ts (temperature sensor) location for LUXEON HL4Z. All dimensions are in millimeters.

3.2 PCB Substrate Selection and Designs

Table 1 provides a summary of various relevant performance characteristics of common PCB substrates to aid material selection.

Figure 6 shows various PCB constructions.

Table 1. General PCB substrate characteristics for consideration when designing a PCB for LUXEON HL4Z.

SUBSTRATE	MCPCB	CERAMIC PCB
Cost	Medium	High
PCB thermal resistance performance	Medium to excellent	High to excellent
Coefficient of thermal expansion (CTE)	Moderate CTE matching to LUXEON emitter	Good CTE matching to LUXEON emitter
LED assembly packing density (thermal resistance consideration)	Suitable for medium density applications with moderate spacing between LEDs. If high density packing is required, operating current must be reduced to ensure max T_j is not exceeded.	Suitable for high density applications with minimal spacing between LEDs and high current operation
Mechanical assembly and handling	Easy, as board does not easily break	Extra precaution to prevent ceramic breakage (hard & brittle)
Supplier availability	High	Limited

Specific PCB design considerations for each substrate material are summarized below.

Metal Core PCB

The most common MCPCB construction consists of the following layers (Figure 6):

- *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 is the most important layer in the MCPCB construction as it affects the thermal performance, electrical breakdown strength, and, in some cases, the solder joint performance of the MCPCB system. The typical thermal conductivity of the dielectric layer on a MCPCB is around 2-3 $Wm^{-1}K^{-1}$. A higher value is better for good thermal performance. A thinner dielectric layer is better for thermal performance as well but can negatively

impact the ability of the MCPCB to withstand a Hi-Pot (high potential) test to meet minimum electrical safety standards as required in certain lighting markets. The typical dielectric thickness layer is about 100µm. In critical applications, which need to meet strict solder joint reliability requirements, it is desirable to work with PCB manufacturers to design and engineer a low stress dielectric layer. The low stress dielectric layer can then absorb the stress generated when there is a moderate CTE mismatch between LUXEON HL4Z and the PCB substrate.

- ***Top copper layer***. A thicker copper layer improves heat spreading into the PCB but may pose challenges for PCB manufacturers when fabricating narrow traces or spaces. A thicknesses of 1oz (35µm) or 2oz (70µm) are common. For optimum thermal performance on both 1oz and 2oz copper design, the copper area should extend at least 3mm from the package outline.
- ***Solder mask***. See requirement in section 3.5.

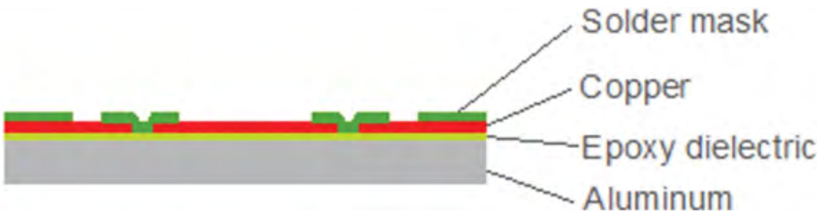

Figure 6. MCPCB typical cross section of the three-pad openings with aluminum substrate.

Ceramic PCB

Ceramic PCB construction consists of the following layers (Figure 7):

- ***Ceramic substrate***. Commonly used materials are alumina (Al_2O_3) or aluminum nitride (AlN). The thermal conductivity of alumina ranges from 20 to 30 $Wm^{-1}K^{-1}$, depending on the grades of alumina material in the substrate. The thermal conductivity of aluminum nitride ranges from 170 to 230 $Wm^{-1}K^{-1}$ 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 and is a very good electrical insulator. Therefore, there is no need to include any epoxy dielectric layer, allowing LUXEON HL4Z to be directly attached to the ceramic via copper and solder material. This enables very tight packing of multiple LUXEON HL4Z.

However, ceramic can be brittle, and may require extra handling precautions during assembly and handling.

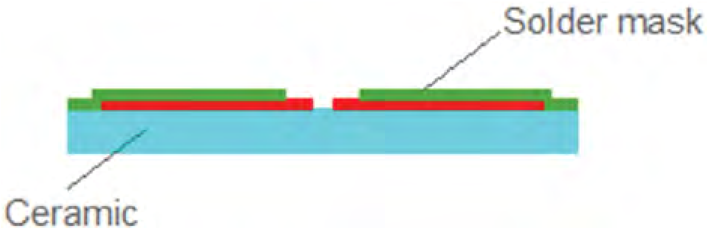

Figure 7. Cross section of ceramic based PCB. Note that there is no dielectric epoxy layer between copper (red) layer and the ceramic substrate which make ceramic PCB an excellent solution for high current operation with high density packing.

3.3 Component Spacing

Using the footprint as illustrated in shown in Figure 5, pick and place machine with placement capability of less than ±20µm and Lumileds SMT processes conditions, it is possible to achieve package to package spacing of 150µm.

3.4 Top Copper Layer Pattern Design

For Al-MCPCB, for best thermal performance always extend the top copper area as much as possible around the LUXEON emitter pads. Extends a minimum of 2mm of top copper area around the LED package as shown in Figure 8 as indicated by the red dotted square.

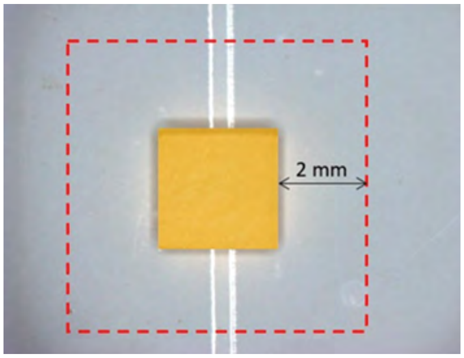

**Figure 8. LED package mounted on Al-MCPCB with top white solder mask.
The red dotted square shows the minimum top copper area that surrounds the LED package.**

3.5 Surface Finishing on Copper

For small pad dimensions and pitch, Lumileds recommends using electroless nickel immersion gold (ENIG) or high temperature organic solderability preservative (OSP) on the exposed copper pads. Hot air solder leveling (HASL) should not be used because it yields poor co-planarity (leveling) and is, therefore, not suitable for fine pitch assembly. In addition, HASL may yield poor solder joints, potentially resulting in open failures.

3.6 Solder Mask

A stable white solder mask finish (typically a polymer compound with inert reflective filler) with high reflectivity in the visible spectrum will typically meet most application needs. The white finish should not discolor over time (change of reflectance properties) when exposed to elevated operating temperatures, back-scattered light or pollution (photo-thermal-chemical degradation of polymers). Customers are encouraged to work with their PCB suppliers to determine the most suitable solder mask options which can meet their application needs.

Lumileds has positive testing result of the performance of Taiyo PSR-4000 LEW3 solder mask.

3.7 Silk Screen or Ink Printing

Ink markings within and around the LUXEON HL4Z outline should be avoided because the height of the ink may interfere with the LED emitter self-alignment during reflow and solder stencil printing process. If needed, the ink printing should be at least 2mm away from the package outline.

3.8 PCB Quality and Supplier

Select PCB suppliers that are capable of delivering the required level of quality. At a minimum the PCBs must comply with IPC standard (IPC-A-600H, 2010 “Acceptability of Printed Boards”).

A maximum of 50µm masking mis-registration tolerance (Figure 9) between the copper trace pattern and solder mask is preferred to achieve optimum solder joint contact area using the recommended footprint as shown in Figure 5. Large misalignment between solder mask opening and copper trace will cause one of the two copper land patterns to be smaller than the other.

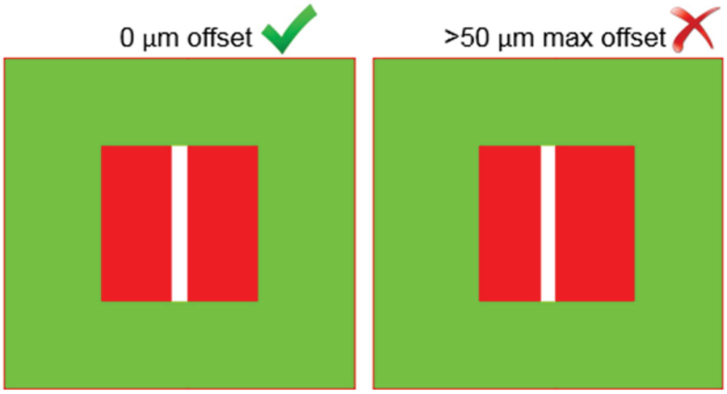

Figure 9. A maximum of 50µm mis-registration between solder mask (green) and copper pattern (red) is preferred.

Depending on the PCB manufacturer and SMT assembly process capability, it may be necessary to increase the area of the solder mask opening at the expense of possible reduction in the LED placement accuracy from LED self-alignment during reflow.

4. Assembly Process Guidelines

LUXEON HL4Z is designed to be compatible with traditional SMT processes. A SMT process typically consists SMT components (LED emitters), PCB, solder paste, die attach or pick and place machine, solder heat reflow and optional flux cleaning system.

4.1 Solder Paste

Lumileds successfully mounted LUXEON HL4Z LEDs on PCBs with ALPHA LM P-39 solder. Given the large variety of solder pastes and varying application use conditions/ requirements, customers should always perform their own solder paste evaluation in order to determine if a solder paste will meet the application requirements in terms of solderability, solder joint reliability and overall long-term optical performance.

4.2 Stencil Printing

The recommended stencil thickness for LUXEON HL4Z is 4mils. It may be necessary to make some adjustments to the stencil thickness and size opening to optimize quality of the solder joint under customer's own assembly process. There are several important factors for consideration in obtaining good quality stencil printing (Figure 10). They are:

1. The aperture (stencil opening) wall should be smooth, free of debris, dirt, and/or burrs, and have a uniform thickness throughout the stencil plate. Nano-coat the aperture walls can aid smooth release of solder paste.
2. Positional tolerance between the stencil plate and the PCB substrate must be small enough to ensure that the solder paste is not printed outside the footprint area. Hence both the stencil plate and the PCB must be secured properly.
3. During solder paste dispense, the stencil plate must be flush with the top of the solder mask. Large particles between the stencil plate and PCB may prevent a good contact.
4. The PCB substrate must be mechanically supported from the bottom to prevent flexing of the PCB during solder paste dispenses.

Using an automatic stencil printing machine with proper fiducials or guiding feature on the PCB and the stencil plate will yield the best accuracy and repeatability for the solder paste deposition process. A manual stencil printing process is not recommended for the small pad features of LUXEON HL4Z.

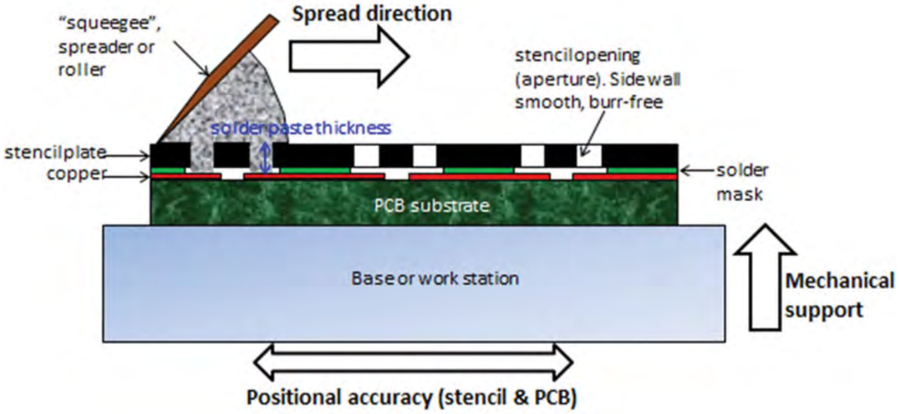

Figure 10. Stencil printing process.

4.3 Pick and Place from Tape and Reel

Automated pick and place equipment provide the best placement accuracy for LUXEON HL4Z. 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 when handling LUXEON HL4Z:

- The nozzle tip should be clean and free of any particles since this may interact with the silicone surface of LUXEON emitter during pick and place.
- During setup and the first initial production runs, it is a good practice to inspect the top surface of LUXEON emitter under a microscope to ensure that emitters are not accidentally damaged by the pick and place nozzle.
- Observe for emitters sticking to the nozzle or emitters coming out from the pocket tape during the initial run.
- Check that the emitter orientation is correctly placed onto the PCB board.

Nozzle Material

The nozzle material should be selected to achieve the desirable number of pick and place cycles and to prevent LUXEON HL4Z from sticking to the nozzle tip. Lumileds has successfully evaluated nozzles made out of the following materials:

- metal
- zirconia
- ESD POM

Feeder System

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 11). Electric feeders often also contain a panel which allows an operator to control the electric feeder manually.

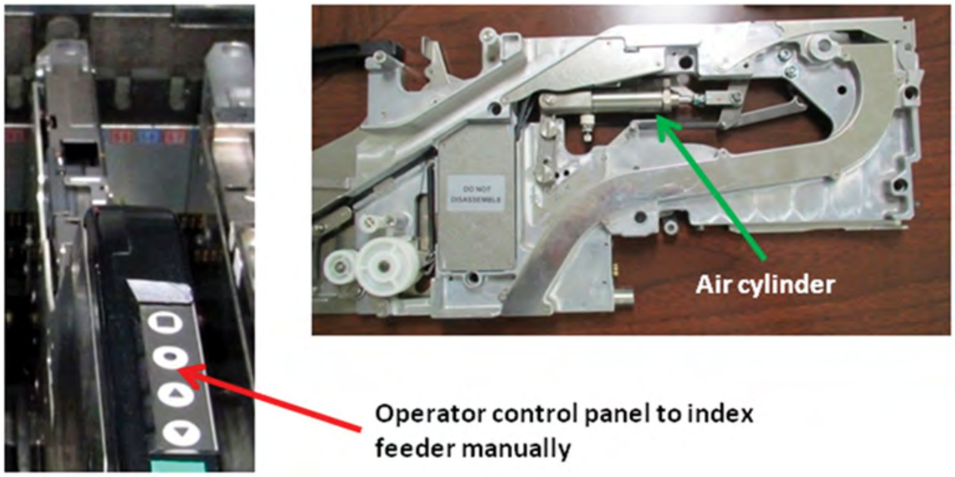

Figure 11. Examples of an electric feeder (left) and a pneumatic feeder (right) which are typically used in pick and place machines to advance the tape with LEDs.

General pick and place machine optimization for LUXEON HL4Z

As there are numerous pick and place machines in the market, below is a pick and place general setup guideline to achieve good release of LUXEON HL4Z.

a. Vacuum – generally set to minimum level. For pick and place machine without the vacuum control and if the vacuum is too strong, check if there is a slight purge (blow) function during package release onto PCB. Note purging can blow away parts so extra care should be taken when using this option.

b. Pick-up transfer speed from reel to PCB – the shorter the better as less time for the LUXEON HL4Z to be under vacuum hold.

c. Z-height placement – as shown in Figure 12, the z-height starting point should be 1/3rd of the solder paste thickness. When the LUXEON HL4Z is in contact with the solder paste, it creates a certain pull force (surface tension) between the pads (solid) and the solder paste (liquid) interface. This will aid the release of LUXEON emitter from the tip of the nozzle. In some instances, one can also evaluate releasing the LUXEON HL4Z just above the solder paste.

d. For machines with nozzle head unit assembly that accommodates multiple nozzle tips, consider reducing the number of nozzles during troubleshooting.

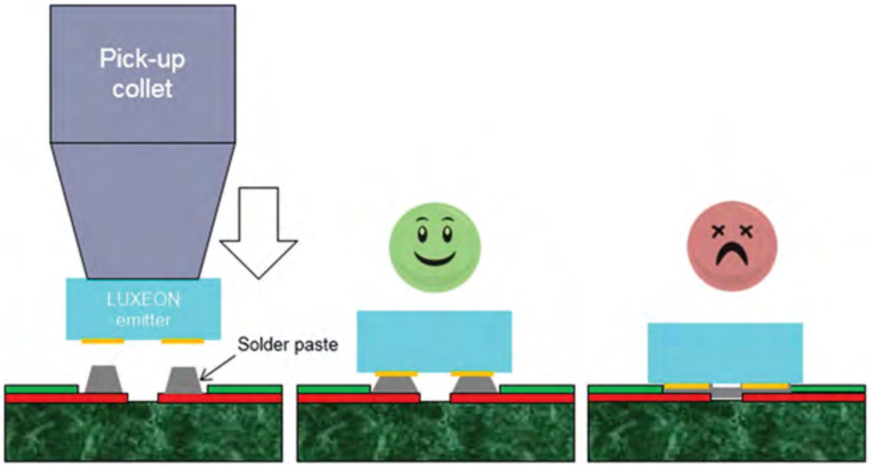

Figure 12. A proper starting point for the mounting z-height of LUXEON HL4Z is 1/3rd of the stencil thickness with reference to the top of the stencil paste, i.e. the collet should be in an under-travel position. Center picture shows the optimum result for the collet height setting. Right picture shows over-travel position and may result in bridging of the solder paste on adjacent pads prior to reflow, increasing the likelihood of electrical shorts.

Some examples of pick and place machines: Samsung SM421, Juki KE-2080L, Panasonic CM402, and Yamaha YS-12. For pick and place operation, a good starting point is to consider the standard off-the-shelf nozzles and machine settings as shown in the figures below.

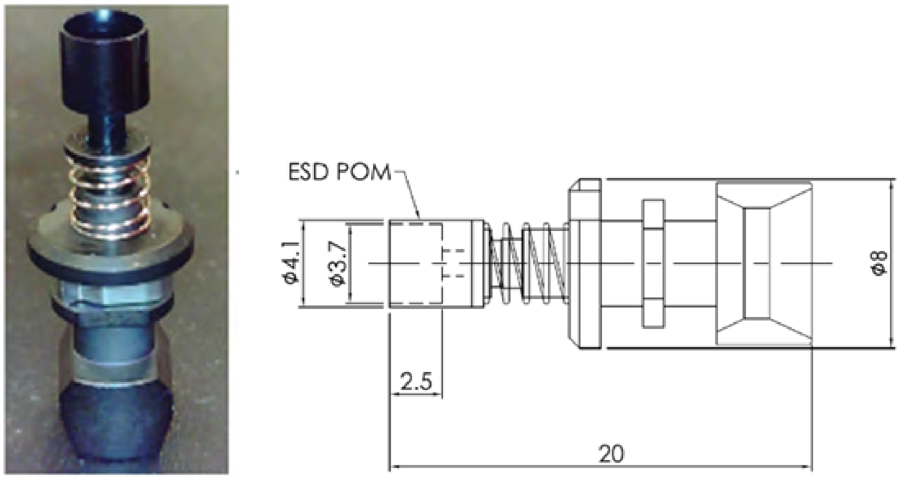

Figure 13. Standard off-the-shelf nozzle "YSM20" (inner diameter 3.7mm, outer diameter 4.1mm) for Yamaha YS-12 machine.

Table 2. Yamaha YS-12 pick and place parameters.

PICK INFORMATION	
Pick Height (mm)	1.000
Pick Timer (sec)	0.00
Pick Speed (%)	100
XY Speed (%)	100
Pick & Mount Vacuum Check	Normal Chk
Pick Start	Normal
Pick Action	Normal
Position Definition	Automatic
MOUNT INFORMATION	
Mount Height (mm)	-0.700
Mount Timer (sec)	0.00
Mount Speed (%)	100
XY Speed (%)	100
Pick & Mount Vacuum Check	Normal Chk
VISION INFORMATION	
Camera	Fly Cam
Light Main	√
Light Coax	√
Light Side	
Lighing Level	6/8

4.4 Rework

Since rework of PCB typically involves manual processes such as heating up a section of a PCB for repair/component replacement, manual cleaning of PCB pads, manual dispensing of solder paste and manual placement of replacement component, all these can create uncontrollable processes which may yield unpredictable long term performance result. Lumileds currently does not provide any guideline on how to rework LUXEON HL4Z.

5. Thermal Measurement Guidelines

5.1 Thermal Basics

This section provides general guidelines on how to determine the junction temperature of a LUXEON HL4Z in a 1-up configuration 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 ($R\theta_{\text{j-thermal pad}}$) the junction and the thermal pad for LUXEON HL4Z is specified in the LUXEON HL4Z product datasheet. In LUXEON HL4Z, both the anode and cathode pads act as a thermal pad which is the primary heat flow path. With this information, the junction temperature T_j can be determined according to the following equation:

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

In this equation, $P_{\text{electrical}}$ is the electrical power going into the LUXEON HL4Z emitter and $T_{\text{thermal pad}}$ is the temperature at the bottom of the LUXEON HL4Z thermal pads.

5.2 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 LED junction temperature is by measuring the temperature (T_s) of a predetermined sensor pad on the PCB right next to the LED 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 LED package. 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 and its thermal conductivity), 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 LED package 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 LED emitter pad which can be the cathode of LUXEON HL4Z. Figure 14 (left image) shows the thermal gradient of the Al-MCPCB. The temperature drops off quickly when the T_s points moves further away from the LED package, hence making the T_s point less sensitive in estimating the junction temperature.

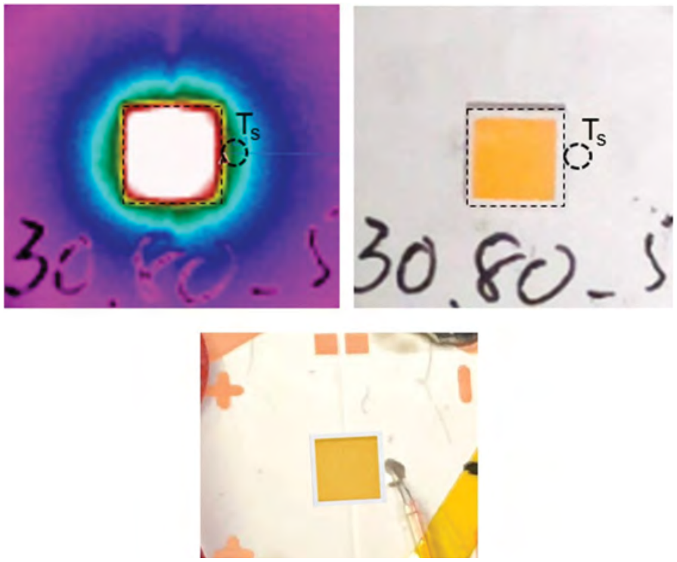

Figure 14: The T_s location should be placed close to the package as shown. The Rθj-s is characterized based on this placement position. The further away the Ts point is, the calculated junction temperature will then be under-stated.

Lumileds has successfully used a two-part Artic Silver™ thermal adhesive 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 since this may increase the thermal time constant of the setup (increase in heat capacity of the thermal adhesive). The use of non-conductive thermal epoxy is not recommended since there may be a possibility of getting some epoxy residue underneath the TC wire tip and the exposed PCB copper trace which will affect the $R\theta_{j\text{-}s}$ measurement.

5.3 Thermal Measurement Result

A 1.0mm thick Al-MCPCB star board with 2 oz copper foil, dielectric (NanYa NPRCA) thickness of 0.1mm with thermal conductivity of $3W{\cdot}m^{-1}{\cdot}K^{-1}$ was used in the characterization of the T_s point thermal resistance ($R\theta_{j\text{-}s}$). The average value of $R\theta_{j\text{-}s}$ for LUXEON HL4Z is 3.0K/W for this Al-MCPCB star board design. Use the equation below to estimate the junction temperature.

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

For other PCB designs and materials, an experiment or thermal simulation may be needed to determine proper $R\theta_{j\text{-}s}$ values.

5.4 Thermal Performance on Close Packing Assembly

The $R\theta_{j\text{-}s}$ value in section 5.3 cannot be used to determine the device junction temperature for close packing (high density) assembly of LUXEON emitters. In such scenario, the hottest LED emitters are usually in the center of the LED clusters surrounded by outer LED emitters. The coldest LED emitters are usually at the outer perimeter of the LED clusters where surrounding adjacent LED emitters are at minimum. Thus the limiting factor of the LED clusters depend on the hottest LEDs. Proper layout of the underlying PCB copper trace pattern and the type of PCB substrate (ceramic vs MCPCB) need to be considered when designing close packing of LED emitters.

Figure 15 shows temperature distribution taken via thermal imaging camera of two arbitrary close packing designs. Notice that where the hottest and coldest LED emitters are located (see the false rainbow color legend of each image).

Determining the junction temperature of the hottest LEDs in close packing assembly design involves either thermal simulation or the use of thermal imaging camera.

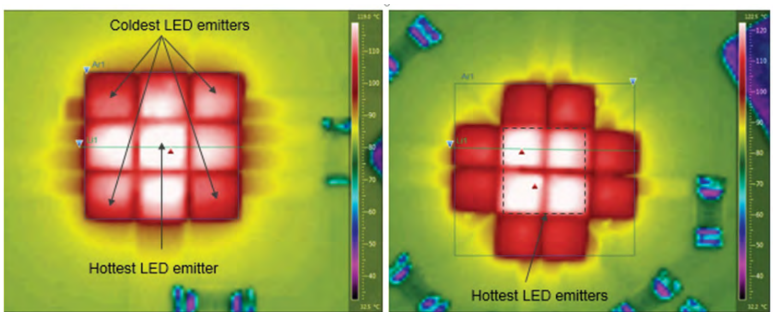

Figure 15. Thermal imaging camera results for LED clusters (150um spacing) with close packing on Al-MCPCB (1oz copper, 3W/(m.K) 100µm dielectric).

6. Packaging Considerations—Chemical Compatibility

The LUXEON HL4Z 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 HL4Z 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 HL4Z 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 3 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 3 are typically not directly used in the final products that are built around LUXEON HL4Z 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 HL4Z.

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 [1]
Acrylic Tape	Adhesive

Note for Table 5:

1. Other than the use of no-clean solder paste qualified by customer. Avoid secondary solder flux, for example, when manually soldering wires close to LUXEON emitter, solder flux should not spit onto the LUXEON emitter surface or leave excessive secondary solder flux residue onto the PCB when operating LEDs in an air tight enclosure or poorly ventilated enclosure.

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.

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