Application Brief AB29

LUXEON never before possible

LUXEON® K2 Power LEDs

Assembly and Handling Information

Introduction

This application brief covers the recommended handling procedures for LUXEON® K2 Power Light Emitting Diodes (LEDs). Specifications and procedures are also included for the proper surface mounting of these emitters on printed circuit boards (PCBs).

The LUXEON K2 emitters have a silicone lens, which offers enhanced optical properties and improved reliability. However, silicone is a softer material and prone to attracting dust. These properties make proper handling imperative to avoid damage to the emitters.

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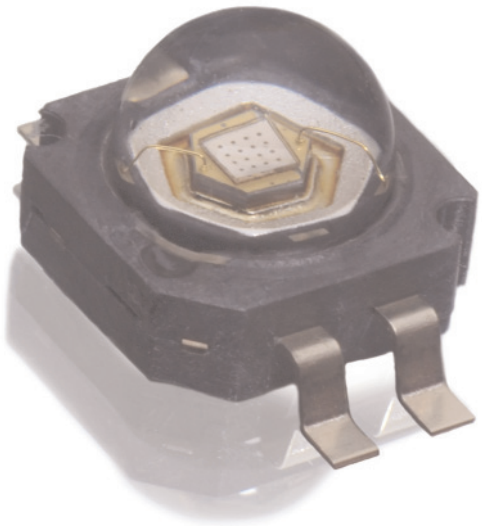

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Pick and Place

Automated pick-and-place equipment provides the best placement of LUXEON K2 emitters. For LUXEON K2 pick and place, Philips Lumileds is recommending pick-up from the lens but only under the guidelines below.

- The collet surface is the same profile as the LUXEON K2 lens
- The nozzle will suck up the LUXEON K2 unit from the tape while the tip of the collet is 0.2mm above the lens
- The pressure required to lift the LUXEON K2 is between -70 to -75Kpa
- The nozzle will purge the unit 0.15mm from the board surface with a pressure of 5-15Kpa
- The 0.15mm distance corresponds to the recommended thickness of the stencil
- Employ an active aligner with a camera that can adjust for any skew

Figure 1 shows an example of a pick-and-place nozzle suitable for use with LUXEON K2 emitters.

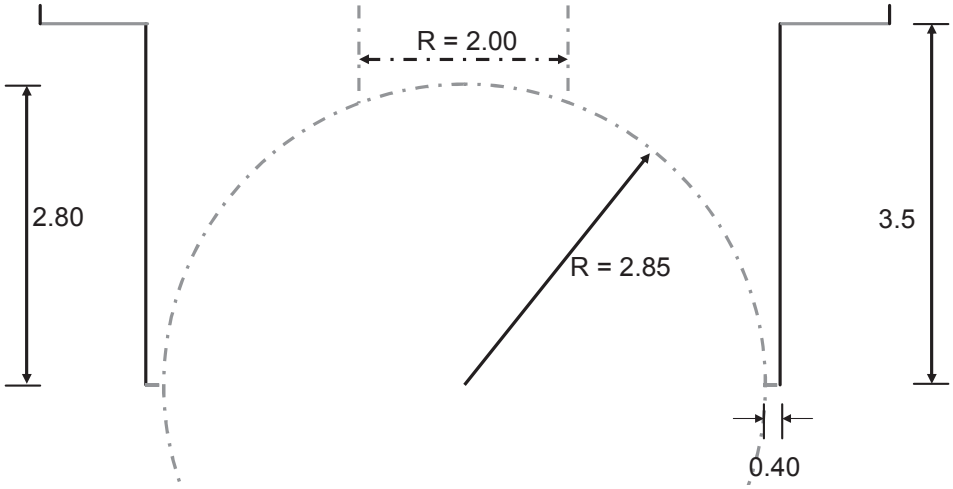

Figure 1. Pick-and-place collet.

Lens Handling

When utilizing a pick-and-place machine, the collet must not place excessive pressure on the lens of the LED. Ensure the inner surface of the collect is clean; the collet's dimensions are correct; and the correct pressure is applied.

Similar restrictions exist for manual handling. The LEDs should only be picked up by making contact with the sides of the LED body; the hand tool should not put any pressure on the lens. Do not puncture or push the lens. Figures 2 and 3 illustrate correct and incorrect handling.

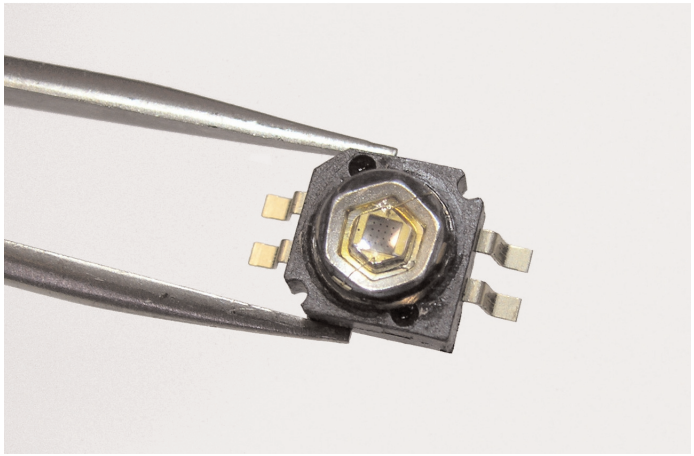

Figure 2. Correct handling of LUXEON K2 emitters.

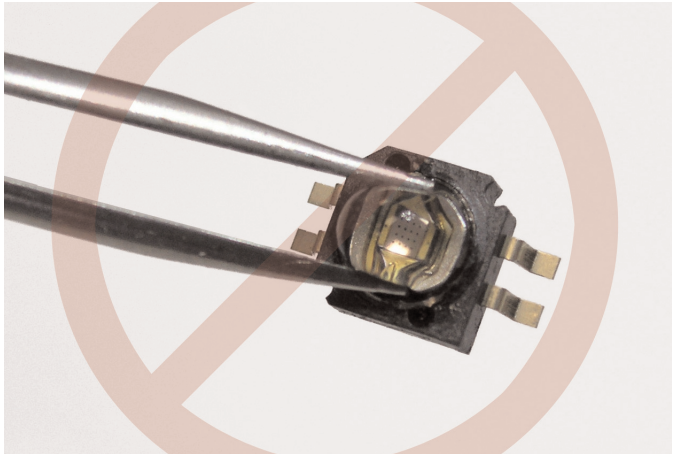

Figure 3. Incorrect handling - do not grip the lens.

Lens Cleaning

Each LUXEON K2 emitter has a silicone lens. There are many benefits to the silicone lens in terms of optical properties and improved reliability; however, silicone is a softer material and prone to attract dust. While a minimal amount of dust and debris on the LED will not cause significant reductions in illumination, steps should be taken to keep the emitter free of dust. These include keeping the LUXEON K2 Power LEDs in the manufacturer's package prior to assembly and storing assemblies in an enclosed area after installing the emitters.

In the event that an emitter requires cleaning, use isopropyl alcohol to gently remove dirt from the lens. Do not use other solvents as they may adversely react with the LED assembly.

Pad Layout

Users may be interested in creating a layout pad suitable for LUXEON K2 and LUXEON I, III, and V LED placement. This section shows a comparison of the footprint of a LUXEON I, III or V LED on a LUXEON K2 pad layout.

The pad layouts for LUXEON K2 and LUXEON I, III or V LEDs are shown in Figure 4 and 5. Figure 4 is the recommended pad layout to achieve the most accurate reflow result for LUXEON K2 LEDs. Figure 5 is the recommended pad for LUXEON I, III, and V LEDs.

Figure 6 shows the resulting placement if a LUXEON I, III or V device is placed on the LUXEON K2 pad layout. As indicated, the LUXEON I, III or V leads will hang beyond the LUXEON K2 pads. To compensate for the overhang, users can extend the LUXEON K2 pads to match the size of the pads for the other LUXEON LEDs.

Figure 7 shows the LUXEON K2 footprint on the LUXEON I, III or V pad layout. The unconnected LUXEON K2 lead pins are shown floating, with no pads. To achieve higher reflow accuracy, users can add two pads for the unconnected LUXEON K2 lead pins.

Philips Lumileds only recommends populating LUXEON K2 and LUXEON I, III, and V LEDs on the pads indicated in Figures 4 and 5 respectively.

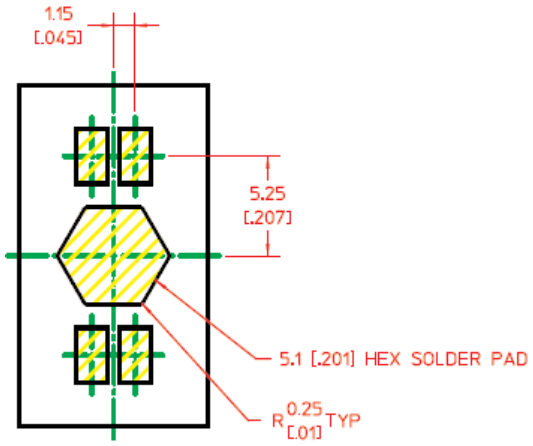

Figure 4. Recommended pad layout for LUXEON K2 devices.

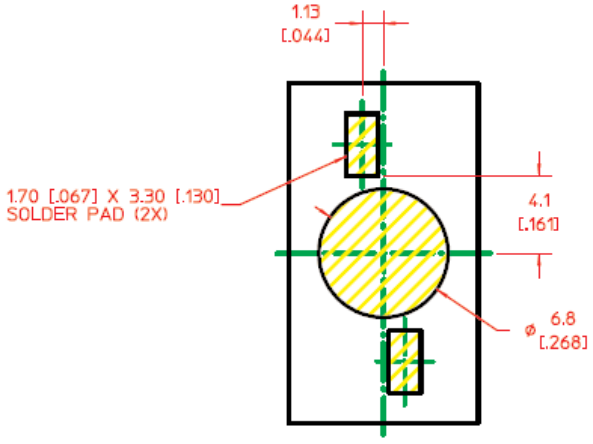

Figure 5. Recommended pad layout for LUXEON I, III, and V devices.

Pad Layout, Continued

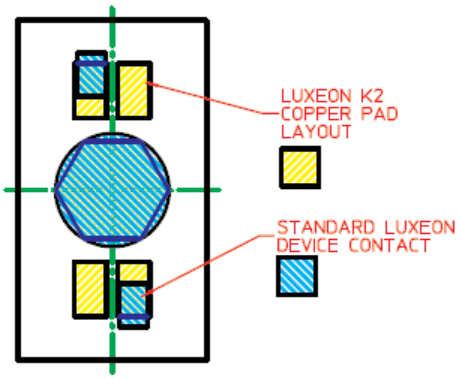

Figure 6. Standard LUXEON footprint on LUXEON K2 pad layout.

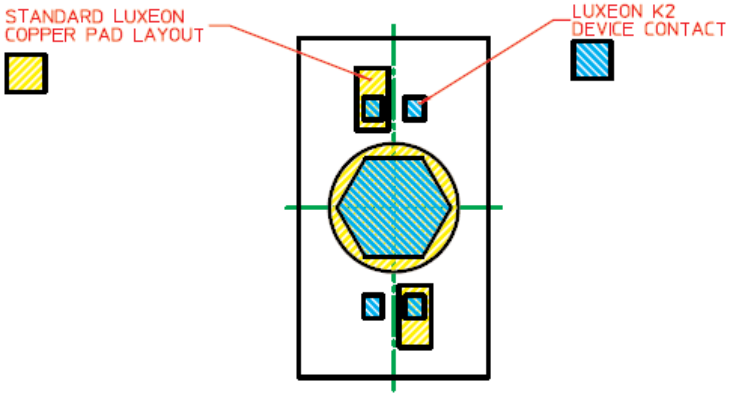

Figure 7. LUXEON K2 footprint on a LUXEON I, III or V pad layout.

Stencil Thickness and Coverage

The coverage on the pad and thickness of the stencil affect reflow accuracy. A thickness of 0.15mm and 100-percent stencil coverage are recommended for the LUXEON K2 emitters (see Figure 8). This configuration minimizes the voiding of the solder.

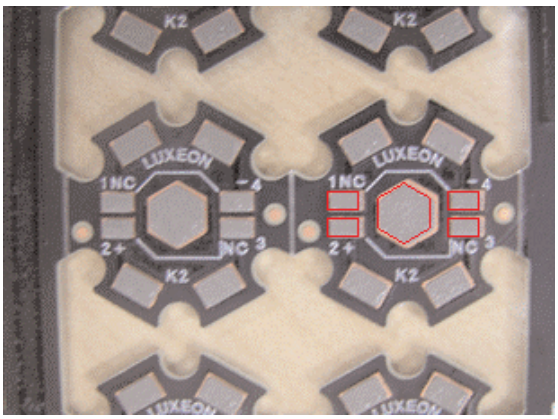

Figure 8. Stencil coverage (shown in red).

Reflow Profile

LUXEON K2 emitters are compatible with surface mount technology and lead-free reflow. This greatly simplifies the manufacturing process by eliminating the need for adhesives and epoxies. The robustness of the emitters is evident in that LUXEON K2 LEDs can be reflowed three times without degrading performance. The reflow solder profile is compatible with JEDEC 020c (see Figure 9). The profile feature points are shown in Table 1, where all temperature points refer to the top side of the package, measured on the body surface of the package.

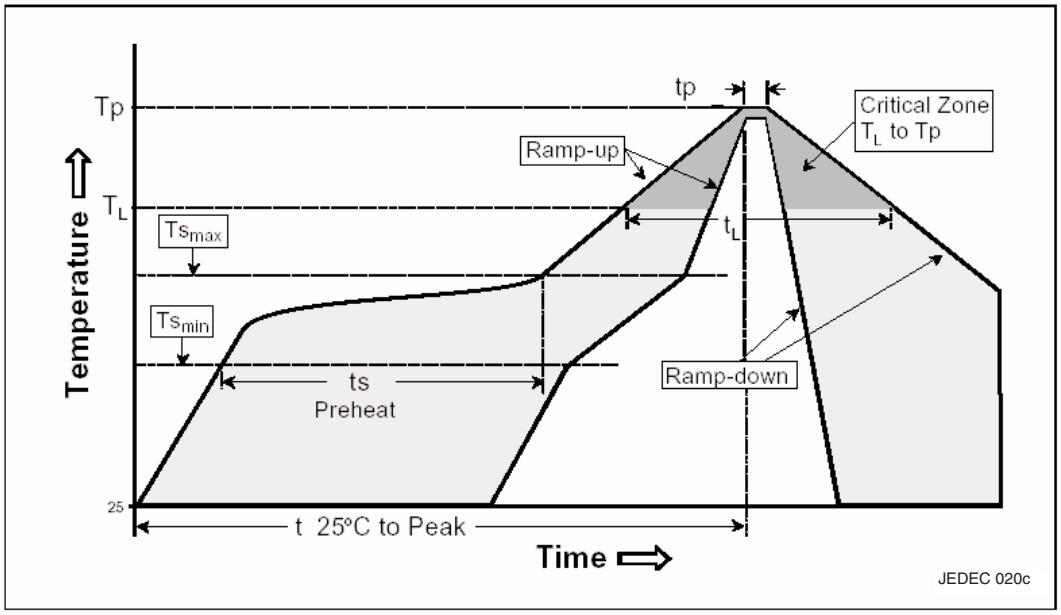

Figure 9. JEDEC 020c reflow solder profile.

Table 1. JEDEC 020c profile feature points.

Profile Feature	Lead Free Assembly
Average Ramp-Up Rate (Ts_{max} to T_p)	3°C / second max
Preheat Temperature Min (Ts_{min})	150°C
Preheat Temperature Max (Ts_{max})	200°C
Preheat Time (ts_{min} to ts_{max})	60 - 180 seconds
Temperature (T_L)	217°C
Time Maintained Above Temperature (T_L)	60 - 150 seconds
Peak / Classification Temperature (T_P)	260°C
Time Within 5°C of Actual Peak Temperature (T_P)	20 - 40 seconds
Ramp-Down Rate	6°C / second max

Electrical Slug Isolation

Similar to the LUXEON I, III, and V, the slug of the LUXEON K2 must be electrically isolated from the anode, cathode, and other slugs. This requirement stems from the basic internal construction of InGaN LUXEON K2 devices (see Figure 10).

The InGaN LED is placed onto a silicon submount consisting of zener diodes. The zener diodes, which provide ESD protection to the LED, are connected to the slug and LED as shown in Figure 11. If the slug were not electrically isolated but connected to the anode, cathode, or other LED slugs, the zeners could shunt the current away from the LED.

Electrical Slug Isolation, Continued

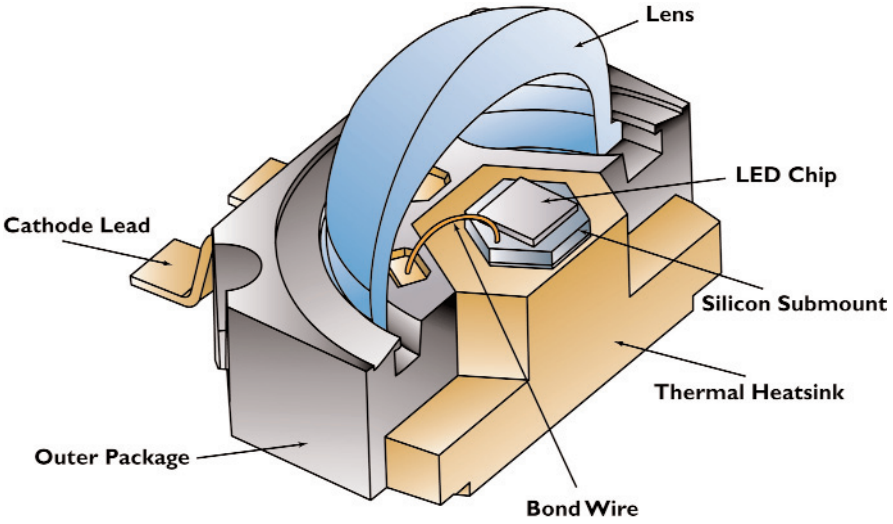

Figure 10. Basic construction of the InGaN LED.

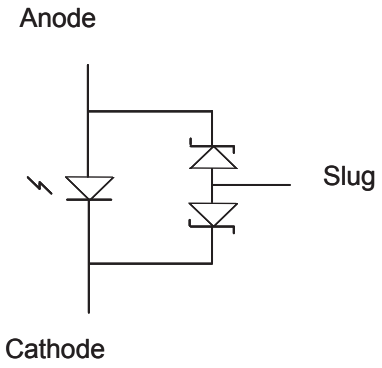

Figure 11. Zener diode connection to slug and LED.

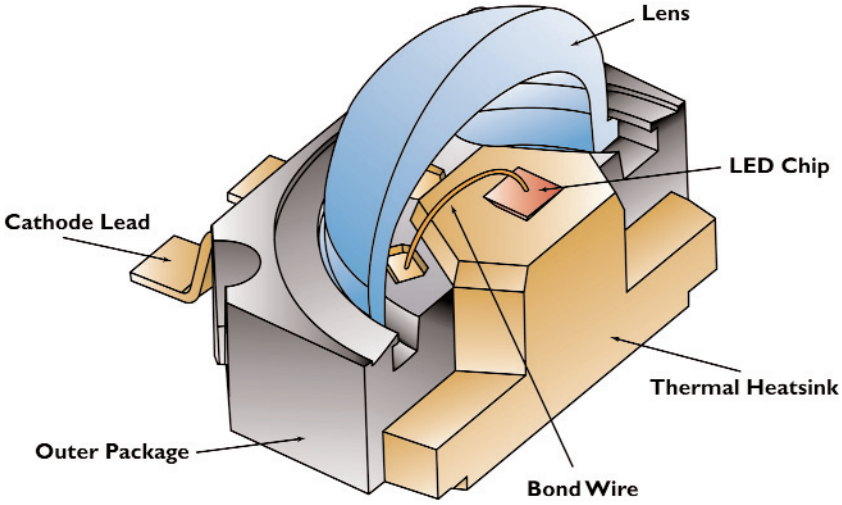

Figure 12. Basic construction of the LUXEON K2 AlInGaP LED.

Electrical Slug Isolation, Continued

Consider a situation where three InGaN LEDs are connected in series with an electrically common slug. This schematic is shown in Figure 13.

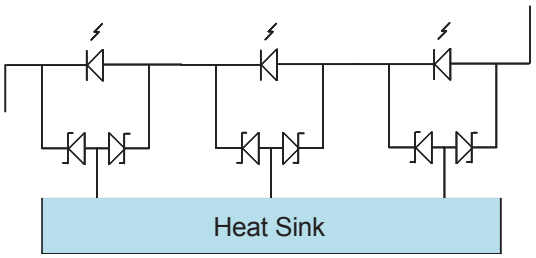

Figure 13. Three InGaN LEDs in series with the slug on the same potential.

This configuration shorts the inner four zeners so that only the two outer zeners will protect the LEDs. The breakdown of one zener set can occur at levels as low as 7V. If the zeners break down, current will pass through the zeners and not the LEDs. This situation is shown in Figure 14.

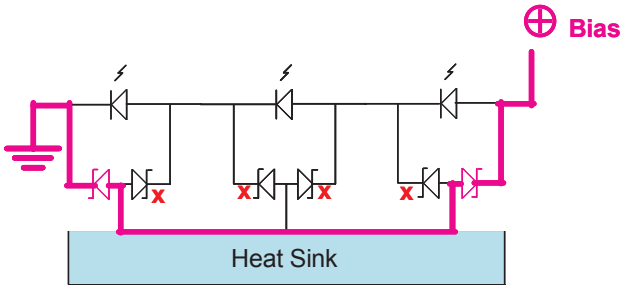

Figure 14. Result of electrically common heatslugs for InGaN LEDs.

The same situation can be considered for an AlInGaP LED where the slug is electrically connected to the anode. The effects of connecting three AlInGaP LEDs in series with an electrically common heatslug are shown in Figure 15. This situation will render two LEDs non-active.

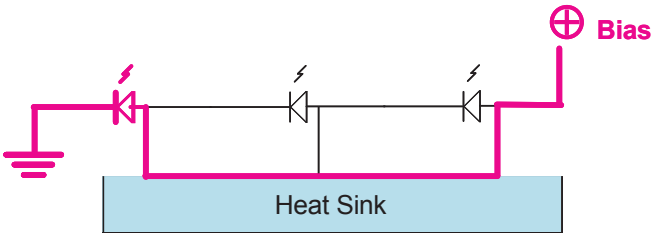

Figure 15. Result of electrically common heatslugs for LUXEON K2 AlInGaP LEDs.

Board Placement Tolerance

For many PCB designs, accurate placement of the LUXEON K2 is critical. To meet accuracy requirements, the center of the LUXEON K2 emitter must be correctly determined in respect to the center of the hexagonal pad. This can be accomplished using the following procedure (see Figure 16):

1. Locate the two "bite" marks on the LUXEON K2 emitter package.
2. Find the center of the circle formed from the "bite" marks.
3. Draw a line connecting the centers of the two circles.
4. The midpoint of the line is the center of the LED.
5. Record the coordinates of this point (x1, y1).

The center of the LUXEON K2 hexagonal pad is found as follows (see Figure 17):

1. Draw a circle that touches the six hexagonal points of the pad.
2. The center point of this circle is the center of the hexagonal pad
3. Record this point (x2, y2).

The offset between the LED center and the center of the hexagonal pad is (x1-x2) and (y1-y2). Philips Lumileds utilized the OGP Smart Scope for this exercise. Any scope or shadowgraph that is capable of finding and storing the centers of circles may be used for this measurement.

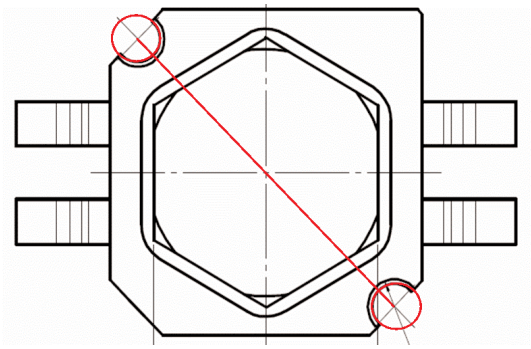

Figure 16. Finding the center of the LED.

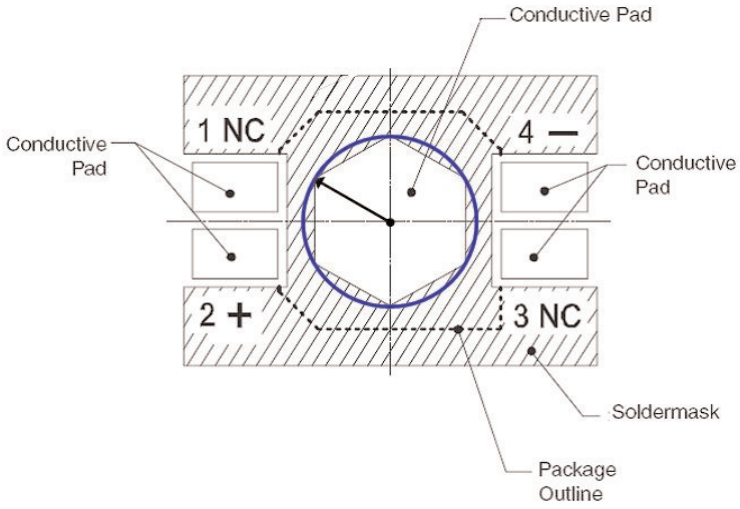

Figure 17. Finding the center of the pad.

JEDEC Moisture Sensitivity Level

LUXEON K2 Power LEDs are shipped in vacuum-packed airtight containers. Breaking this vacuum allows the introduction of moisture into the LED, and can potentially result in damage to the package during assembly. During soldering or reflow, the moisture will expand as the temperature rises, causing the package to crack.

JEDEC has defined eight levels for moisture sensitivity, as shown in Table 2.

The LUXEON K2 emitter offers superior performance with a Moisture Sensitivity Level of 2a and a floor life of four weeks before any bake out is required. For emitters that exceed the shelf life, the bake out condition is 67 days at 40°C, as shown in Table 3.

Table 2. JEDEC Moisture Sensitivity Levels.

Level	Floor Life		Soak Requirements			
			Standard		Accelerated Environment	
	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[2] + 5/-0	30°C / 60% RH	120 +1/-0	60°C / 60% RH
3	168 hours	≤ 30°C / 60% RH	192[2] + 5/-0	30°C / 60% RH	40 +1/-0	60°C / 60% RH
4	72 hours	≤ 30°C / 60% RH	96[2] + 2/-0	30°C / 60% RH	20 +0.5/-0	60°C / 60% RH
5	48 hours	≤ 30°C / 60% RH	72[2] + 2/-0	30°C / 60% RH	15 +0.5/-0	60°C / 60% RH
5a	24 hours	≤ 30°C / 60% RH	48[2] + 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		

JEDEC Moisture Sensitivity Level, Continued

Table 3. JEDEC Bake Out Specifications.

		Bake at 125°C		Bake at 90°C ≤ 5% RH		Bake at 40°C ≤ 5% RH	
Package Body Thickness	Level	Saturated @ 30°C 85% RH	At Limit of Floor Life +72 hr @ 30°C 60% RH	Saturated @[1] 30°C 85% RH	At Limit of Floor Life +72 hr @ 30°C 60% RH	Saturated @ 30°C 85% RH	At Limit of Floor Life +72 hr @[1] 30°C 60% RH
≤ 1.4 mm	2a	5 hours	3 hours	17 hours	11 hours	8 days	5 days
	3	9 hours	7 hours	33 hours	23 hours	13 days	9 days
	4	11 hours	7 hours	37 hours	23 hours	15 days	9 days
	5	12 hours	7 hours	41 hours	24 hours	17 days	10 days
	5a	16 hours	10 hours	54 hours	24 hours	22 days	10 days
≤ 2.0 mm	2a	21 hours	16 hours	3 days	2 days	29 days	22 days
	3	27 hours	17 hours	4 days	2 days	37 days	23 days
	4	34 hours	20 hours	5 days	3 days	47 days	28 days
	5	40 hours	25 hours	6 days	4 days	57 days	35 days
	5a	48 hours	40 hours	8 days	6 days	79 days	56 days
≤ 4.5 mm	2a	48 hours	48 hours	10 days	7 days	79 days	67 days
	3	48 hours	48 hours	10 days	8 days	79 days	67 days
	4	48 hours	48 hours	10 days	10 days	79 days	67 days
	5	48 hours	48 hours	10 days	10 days	79 days	67 days
	5a	48 hours	48 hours	10 days	10 days	79 days	67 days

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Company Information

LUXEON® is developed, manufactured and marketed by Philips Lumileds Lighting Company. Philips Lumileds is a world-class supplier of Light Emitting Diodes (LEDs) producing billions of LEDs annually. Philips Lumileds is a fully integrated supplier, producing core LED material in all three base colors (Red, Green, Blue) and White. Philips Lumileds has R&D centers in San Jose, California and in The Netherlands and production capabilities in San Jose and Penang, Malaysia. Founded in 1999, Philips Lumileds is the high-flux LED technology leader and is dedicated to bridging the gap between solid-state LED technology and the lighting world. Philips Lumileds technology, LEDs and systems are enabling new applications and markets in the lighting world.

Philips Lumileds may make process or materials changes affecting the performance or other characteristics of our products. These products supplied after such changes will continue to meet published specifications, but may not be identical to products supplied as samples or under prior orders.

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EUROPE:
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LUXEON.EUROPE@FUTUREELECTRONICS.COM

ASIA:
800 5864 5337 OR
LUMILEDS.ASIA@FUTUREELECTRONICS.COM