

# Measurement and Design **Considerations for** Luminus Cube Surface **Mount Devices**



## **Table of Contents**

1.	Angular	Distribution		1
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## Introduction:

This document provides guidelines for lighting systems using the Luminus Cube surface mount LED. The Cube is a chip scale package (CSP) and as such has a number of unique performance characteristics. This document provides optical performance data as well as describing parameters which should be considered when designing Luminus Cube LEDs in solid state lighting systems.

## **Angular Distribution**

### **Emission Pattern**

The primary difference between a Chip Scale Package (CSP) such as the Luminus Cube and traditional LED packages is that light is emitted from more than one surface. In fact the Cube emits light from 5 surfaces and as a result the angular distribution of the emission from the device exceeds any prior packaging design. While all LEDs emit light in all directions, in traditional packaging the emission from the sides of the die is blocked by elements of the package such as the frame or potting compounds. Chip scale packages are designed so that very little of the side emitted light is blocked by elements of the packaging. This particular aspect of these devices can be utilized in a variety of means as this type of emission more closely resembles the emission from a tungsten filament than traditional LED sources. The CSP opens a new range of possibilities for solid state lighting designs as well as perfomance improvements in existing lighting products that utilize midpower LEDs. However in either case this additional range of emission should be considered in device characterization, stray light analysis, system performance as well as other design parameters.

1





Figures 1 and 2: The polar plot at left, and Cartesian plot at right show the angular distribution of the Luminus Cube light emission. The 50% beam angle is 182° and the 10% field angle is 196°.

![](_page_1_Figure_4.jpeg)

![](_page_1_Figure_5.jpeg)

![](_page_1_Figure_6.jpeg)

Figures 3 and 4: The diagram above shows rays emitted into a hemispherical detector. For more information regarding ray simulations of Luminus Cube devices, contact techsupport@luminus.com.

![](_page_2_Picture_0.jpeg)

## **Flux Measurement**

#### **PCB Reflector Material**

Due to the emission pattern of the Luminus Cube device, emitted light is likely to interact with the PCB upon which the device is mounted. As a result the absorptive and reflective properties of the PCB can significantly influence the measurement of the photometric flux. Luminus recommends using a PCB with high diffuse reflectance in order to maximize the efficiency of the devices mounted on the board. This may be achieved by applying reflective solder mask or a a mylar or teflon film to the PCB in areas between the Luminus Cube devices. The tables below list a number of materials which can improve the lumens per watt efficiency of the device by as much as 15%.

Reflective Solder Mask							
Manufacturer	P/N	Manufacturer	P/N				
Atotech	ELPEMER SD 2491 SG-TSW-R4	Tamura-Kaken	Light Reflecting Solder Mask				
Atotech	ELPENER SD 2491 SG-TSW-R4-B	Creative Materials	125-50				
Atotech	ELPENER SD 2491 SG-TSW-R5	Huntsman	Probimer-77 White				
Tai Yo	PSR-400 LEW1	Tai Yo	PSR-400 LEW3				

PCB Reflector Films							
Manufacturer	P/N	% Reflectance	<b>Temperature Rating</b>				
3M	Viktui ESR Film	96%	150°C				
W.L. Gore	Diffuse Reflector Product	99%	250°C				
White Optics	F-16A	97%	100°C				
White Optics	F-23A	98%	100°C				
Fusion Optix	WRF-150	97%	125℃				

### **Mounting Frame for Characterization Testing**

Just as the additional range of light emission affects Luminus Cube devices in a system, so to does this affect characterization measurements. Often designers and manufacturers of solid state lighting sytems wish to perform their own characterization testing in order to better understand the overall performance of their system. The chip scale package introduces performance elements that are typically not considered when measuring traditional suface mount LEDs.

The most notable perfomance element in this type of characterization are the reflectance and absorption characteristics of the test fixture and lead frame upon which the device is mounted. (Fig. 6.) Current test data shows that the use of a vacuum fixture or a fixture utilizing a reflective film vs. a white star board can influence the lumens, peak lumens and lumens per watt by a significant degree.

![](_page_2_Picture_10.jpeg)

Figure 5: Increasing the reflectivity of the mounting board and test fixture resulted in a 10% improvement in lumens and lumens per watt over parts tested on the star board.

![](_page_3_Picture_0.jpeg)

## **Measurement and Design Application Note**

## **PCB Layout**

Another aspect of the extremly wide emission profile of the Luminus Cube that must be considered is the placement of devices relative to one another in an array on a PCB. If devices are mounted too close to one another on a PCB then the over lapping emission could lead to undesireable interference effects and nonuniform illumination. Also devices spaced too closely will shadow one another and negatively impact the efficiency of the lighting system. Luminus recommends spacing the devices no less than 5mm apart in an array.

![](_page_3_Figure_4.jpeg)

Fig. 6

## **Reference Designs**

![](_page_3_Figure_7.jpeg)

![](_page_3_Picture_8.jpeg)

![](_page_3_Figure_9.jpeg)

4

![](_page_4_Picture_0.jpeg)

An example of some of the advantages of the wide emission angle of the Luminus Cube can be seen in the comparison simulation shown above in figures 7 and 8. These simulations compare the performance of a linear array similar to the type commonly used in T5 replacement bulbs. On the left is shown an array of five Luminus Cube devices mounted on a reflective surface illuminating a diffuser surface located 3mm above the LEDs. On the right is pictured an array of 2016 devices which feature a more narrow 50% beam angle of 120° illuminating a diffuser under the same conditions. The additional emission at high viewing angles of the Luminus Cube contributes to significantly improved illuminance uniformity at the diffuser. To achieve the same uniformity the 2016 must be placed at a distance of around 6mm. Thus the Luminus Cube allows for more compact assembly of the optical elements in this system.

Another example illustrating the benefits of the light distribution offered by the Luminus Cube is the A type bulb. Traditional midpower solutions need top reflectors to create down light. This reduces optical system efficiency, and thus adds more power, heat, LEDs, and cost. An A-bulb design featuring Luminus Cube devices is able to elimninate the top reflector and still meet the Energy Star beam angle requirement of 280°. For more information regarding these reference designs please contact techsupport@luminus.com

![](_page_4_Picture_4.jpeg)

Fig.9

PCB

![](_page_4_Figure_6.jpeg)

![](_page_4_Figure_7.jpeg)

![](_page_4_Figure_8.jpeg)

Fig. 11

Figures 9 and 10: The A -11 bulb pictured above is able to provide indirect lighting without the use of a top reflector

Figure 11: The emission pattern resulting from this design meets Energy Star requirements

Figure 12: Indirect lighting is achieved by placing the Luminus Cube devices as close to the edge of the PCB as possible, positioning the PCB well above the heatsink and ensuring that there is a gap between the PCB and bottom edge of the diffuser.

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Fig. 12

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