



# LUXEON Mid-Power 3535 Emitters

## Assembly and Handling Information

### Introduction

This application brief addresses the recommended assembly and handling procedures for the LUXEON® Mid-Power 3535 emitters. These emitters deliver high efficacy and quality of light for distributed light source applications in a compact 3535 package. Proper assembly, handling, and thermal management, as outlined in this application brief, ensure high optical output and reliability of these mid-power emitters.

### Scope

The assembly and handling guidelines in this application brief apply to the following LUXEON Mid-Power 3535 emitters:

- MXM8-PW27-0000
- MXM8-PW30-0000
- MXM8-PW35-0000
- MXM8-PW40-0000
- MXM8-PW50-0000
- MXM8-PW57-0000
- MXM8-PW65-0000

In the remainder of this document the term mid-power emitter refers to any product in the LUXEON Mid-Power 3535 product family.

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# I. Component

## I.1 Description

The mid-power emitter (Figure 1) consists of a 3535 lead-frame package with an anode and a cathode. A small notch on the corner of the package marks the anode side of the emitter package. The anode and cathode also serve as thermal pads for the emitter. The mid-power emitter does not include any transient voltage suppressor (TVS) chip to protect the emitter against electrostatic discharges (ESD), but it is capable of withstanding up to 2000V for HBM and 400V for MM ESD discharge conditions. Appropriate precautions should therefore be taken when handling this device (see Section 4.5).

## I.2 Optical Center

The optical center coincides with the mechanical center of the mid-power emitter. Optical rayset data for the mid-power emitter is available on the Philips Lumileds website at [www.philipslumileds.com](http://www.philipslumileds.com) and [www.philipslumileds.cn.com](http://www.philipslumileds.cn.com).

## I.3 Handling Precautions

The mid-power emitter is designed to maximize light output and reliability. However, improper handling of the device may damage the silicone coating and affect the overall performance and reliability. In order to minimize the risk of damage to the silicone coating during handling, the mid-power emitter should only be picked up from the side of the package.

## I.4 Cleaning

The mid-power emitter should not be exposed to dust and debris. Excessive dust and debris may cause a drastic decrease in optical output. In the event that a mid-power emitter requires cleaning, first try a gentle swabbing using a lint-free swab. If needed, a lint-free swab and isopropyl alcohol (IPA) can be used to gently remove dirt from the silicone coating. Do not use other solvents as they may adversely react with the mid-power package. For more information regarding chemical compatibility, see Section 5.

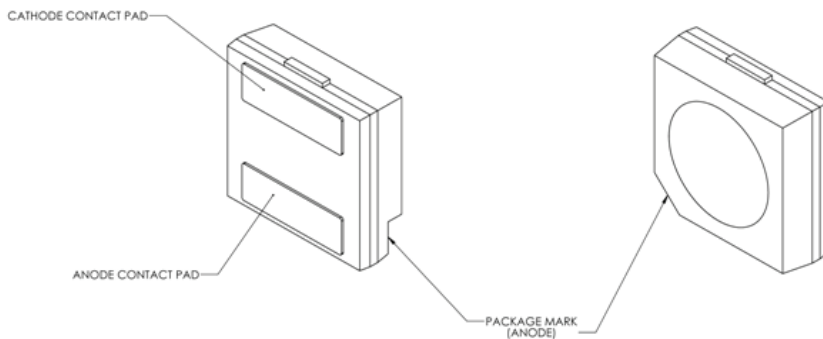
## I.5 Electrical Isolation

The mid-power emitter has two electrodes, with a nominal spacing of 1.45mm, at the bottom of the package. In addition, the mid-power emitter contains two tabs on the side of the package. These tabs are cut-off remnants of the lead-frame and are electrically connected to the anode and cathode, respectively. So it is important to keep sufficient distance between the mid-power emitter package and any other objects or neighboring mid-power emitters to prevent any accidental shorts.

In order to avoid any electrical shocks and/or damage to the mid-power emitter, each design needs to comply with the appropriate standards of safety and isolation distances, known as clearance and creepage distances, respectively (e.g. IEC60950, clause 2.10.4).

## I.6 Mechanical Files

Mechanical drawings for the mid-power emitter (2D and 3D) are available on the Philips Lumileds website at [www.philipslumileds.com](http://www.philipslumileds.com) and [www.philipslumileds.cn.com](http://www.philipslumileds.cn.com).



**Figure 1. Package rendering of the LUXEON Mid-Power 3535 emitter.**

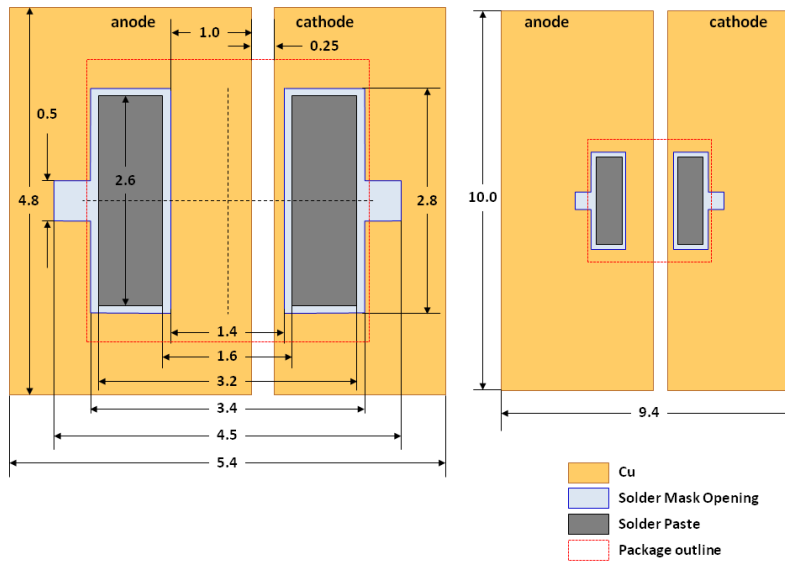


Figure 2. Recommended PCB footprint design for the mid-power emitter (left).

In order to ensure proper heat dissipation from the package electrodes to the PCB, it is best to extend the top copper layer of the PCB beyond the package of the mid-power emitter (right). All dimensions are in mm.

## 2. PCB Design Guidelines for the Mid-Power Emitter

The mid-power emitter is designed to be soldered onto a Printed Circuit Board (PCB). To ensure optimal operation, the PCB should be designed to minimize the overall thermal resistance between the LED package and the heat sink.

### 2.1 Mid-power Footprint and Land Pattern

The recommended PCB footprint design for the mid-power emitter is shown in Figure 2 (left). In order to ensure proper heat dissipation from the emitter electrodes to the PCB, it is best to extend the top copper layer of the PCB beyond the perimeter of the mid-power emitter by 3mm – 4mm, as shown in Figure 2 (right).

### 2.2 Surface Finishing

Philips Lumileds recommends using a high temperature organic solderability preservative (OSP) on the copper layer.

### 2.3 Minimum Spacing

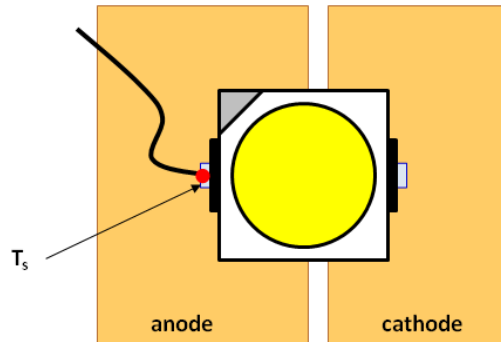
Philips Lumileds recommends a minimum edge to edge spacing between mid-power emitters of 0.5mm. Placing multiple mid-power emitters too close to each other may adversely impact the ability of the PCB to dissipate the heat from the emitters and may cause accidental shorts between the metal stubs on the side of neighboring mid-power emitters.

## 3. Thermal Measurement Guidelines

The typical thermal resistance  $R\theta_{j-case}$  between the junction and the solder pads of the mid-power emitter is provided in the datasheet. With this information, the junction temperature  $T_j$  can be determined according to the following equation:

$$T_j = T_{case} + R\theta_{j-case} \cdot P_{electrical}$$

In this equation  $T_{case}$  is the temperature at the bottom of the solder pads of the mid-power emitter and  $P_{electrical}$  is the electrical power going into the emitter. In typical applications it may be difficult, though, to measure the temperature  $T_{case}$  directly. Therefore, a practical way to determine the junction temperature of the mid-power emitter is by measuring the temperature  $T_s$  of a predetermined sensor pad on the PCB with a thermocouple.



**Figure 3. The recommended temperature measurement point  $T_s$  is located right next to the anode of the mid-power emitter on the PCB.**

The recommended location of the sensor pad is right next to the anode of the mid-power emitter on the PCB, as shown in Figure 3. To ensure accurate readings, the thermocouple must make direct contact with the copper of the PCB onto which the mid-power emitter pads are soldered, i.e. any solder mask or other masking layer must be first removed before mounting the thermocouple onto the PCB. The thermal resistance  $R_{\theta_{j-s}}$  between the sensor pad and the mid-power emitter junction was experimentally determined to be approximately 40K/W on an FR4 PCB. The junction temperature can then be calculated as follows:

$$T_j = T_s + 40 \cdot P_{\text{electrical}}$$

## 4. Assembly Process Guidelines

### 4.1 Stencil Design

The recommended solder stencil thickness is 125 $\mu$ m.

### 4.2 Solder Paste

Philips Lumileds recommends lead-free solder for the mid-power emitter. Philips Lumileds tested SAC 305 solder paste from Alpha Metals (OM338 grade 3 and OM 325 grade 4) with satisfactory results. However, since application environments vary widely, Philips Lumileds recommends that customers perform their own solder paste evaluation in order to ensure it is suitable for the targeted application.

### 4.3 Solder Reflow Profile

The mid-power 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 rapidly, allowing the solder to freeze, before the board exits the oven.

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

Pick and Mount Information		Vision Information	
Pick Height	-0.1 mm	Camera No	Fly Cam5
Mount Height	0	Side	15
Delay – Pick Up	90 msec	Outer	0
Delay - Place	50 msec		
Delay - Vac Off	0		
Delay – Blow On	0		
Speed – XY	2		
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	Not used		
Mount Method	Normal		



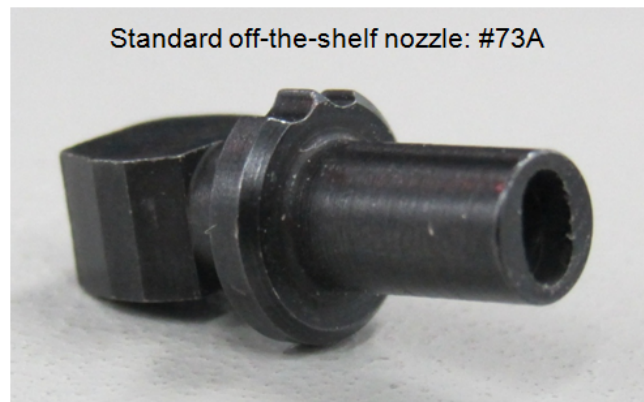
**Figure 4. Pick and place machine settings for Samsung SM421 in combination with the off-the-shelf nozzle CN220 (inner diameter: 2.2mm, outer diameter: 3.6mm).**

#### 4.4 Pick and Place

The mid-power LED is packaged and shipped in tape-and-reel which is compatible with standard automated pick-and-place equipment to ensure the best placement accuracy. Figure 4 – Figure 7 show various off-the-shelf pick and place nozzle designs and corresponding machine settings which were successfully used for the mid-power emitters with pick and place equipment from Samsung, Yamaha, Panasonic, and Juki.

Note that pick and place nozzles are customer specific and are typically machined to fit specific pick and place tools.

Pick and Mount Information		Vision Information	
Pick timer	0 s	Alignment group	Chip
Mount timer	0 s	Alignment type	Std.Chip
Pick height	0.1 mm	Alignment module	Fore & Back & Las
Mount height	0 mm	Light selection	Main + Coax
Mount action	Normal	Lighting level	5/8
Mount speed	100%	Comp. threshold	N/A
Pickup speed	100%	Comp. tolerance	30
Vacuum Check	Normal Chk	Search area	2.0mm
Pick Vacuum	20%	Comp. intensity	121
Mount vacuum	60%	Auto threshold	Use



**Figure 5. Pick and place machine settings for Yamaha YV100X in combination with the off-the-shelf nozzle #73A.**

Pick and Mount Information		Vision Information	
Mount Gap	0mm	REF	89 (direct)
Pick Gap	0mm	Lamp 1	0
Pick height	-0.1mm	Lamp 2	0
Mount height	0mm	Lamp 3	0
Pickup speed	100	Lamp 4	140
Mount speed	100	Lamp 5	0
Frd drive time	Std	Lamp 6	0
Pickup keep time	Std	Lamp 7	0
Mount keep time	Std	Lamp 8	0
		Recognition Speed	Auto [fast]
		Recognition height	0mm



**Figure 6. Pick and place machine settings for Panasonic CM402 in combination with the off-the-shelve nozzle 140.**



Pick and Mount Information		Vision Information	
XY	Fast2	Centering method	
Pick depth	0	LNC 60/61 laser	
Picking stroke	0	Comp shape	
Pick Z down	Fast2		
Pick Z up	Fast2		
Placing stroke	0		
Place Z down	Fast2		
Place Z up	Fast2		
Theta (measure)	Fast		
Theta (other)	Fast		



**Figure 7. Pick and place machine settings for Juki KE2080L in combination with the off-the-shelf nozzle 505 (inner diameter: 1.7mm, outer diameter: 3.5mm).**

#### 4.5 Electrostatic Discharge Protection

The mid-power emitter does not include any transient voltage suppressor (TVS) chip to protect against electrostatic discharges (ESD). Therefore, Philips Lumileds recommends observing the following precautions when handling the mid-power emitter:

- During manual handling always use a conductive wrist band or ankle straps when positioned on a grounded conductive mat.
- All equipment, machinery, work tables, and storage racks that may get in contact with the mid-power LED should be properly grounded.
- Use an ion blower to neutralize the static discharge that may build up on the surface and lens of the mid-power's plastic housing during storage and handling.

Mid-power emitters which are damaged by ESD may not light up at low currents and/or may exhibit abnormal performance characteristics such as a high reverse leakage current, and a low forward voltage. To determine whether any device is damaged by ESD, measure the light output and forward voltage of the emitter which is suspect. A forward voltage above 2.0V for a drive current of 0.1 mA typically indicates that the LED is not damaged.

## 5. Packaging Considerations – Chemical Compatibility

The mid-power emitter package contains a silicone overcoat to protect the LED chip and extract the maximum amount of light. As with most silicones used in LED optics, care must be taken to prevent any incompatible chemicals from directly or indirectly reacting with the silicone.

The silicone overcoat used in the mid-power emitter is gas permeable. Consequently, oxygen and volatile organic compound (VOC) gas molecules can diffuse into the silicone overcoat. VOCs may originate from adhesives, solder fluxes, conformal coating materials, potting materials and even some of the inks that are used to print the PCBs.

Some VOCs and chemicals react with silicone and produce discoloration and surface damage. Other VOCs do not chemically react with the silicone material directly but diffuse into the silicone and oxidize during the presence of heat or light. Regardless of the physical mechanism, both cases may affect the total LED light output. Since silicone permeability increases with temperature, more VOCs may diffuse into and/or evaporate out from the silicone.

Careful consideration must be given to whether mid-power LED 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 dome. Under heat and “blue” light, the VOCs inside the dome may partially oxidize and create a silicone discoloration, particularly on the surface of the LED where the flux energy is the highest. In an air rich or “open” air environment, VOCs have a chance to leave the area (driven by the normal air flow). Transferring the devices which were discolored in the enclosed environment back to “open” air may allow the oxidized VOCs to diffuse out of the silicone dome and may restore the original optical properties of the LED.

Determining suitable threshold limits for the presence of VOCs is very difficult since these limits depend on the type of enclosure used to house the LEDs and the operating temperatures. Also, some VOCs can photo-degrade over time.

Table I provides a list of commonly used chemicals that should be avoided as they may react with the silicone material. Note that Philips 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 I are typically not directly used in the final products that are built around mid-power emitters. 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 heat sinks. Philips 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 1. List of commonly used chemicals that will damage the silicone dome of the mid-power emitter.  
Avoid using any of these chemicals in the housing that contains the LED package.**

Chemical Name	Normally Used as
hydrochloric acid	acid
sulfuric acid	acid
nitric acid	acid
acetic acid	acid
sodium hydroxide	alkali
potassium hydroxide	alkali
ammonia	alkali
MEK (Methyl Ethyl Ketone)	solvent
MIBK (Methyl Isobutyl Ketone)	solvent
Toluene	solvent
Xylene	solvent
Benzene	solvent
Gasoline	solvent
Mineral spirits	solvent
dichloromethane	solvent
tetrachlorometane	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

# Company Information

Philips Lumileds is a leading provider of LEDs for everyday lighting applications. The company's records for light output, efficacy and thermal management are direct results of the ongoing commitment to advancing solid-state lighting technology and enabling lighting solutions that are more environmentally friendly, help reduce CO<sub>2</sub> emissions and reduce the need for power plant expansion. Philips Lumileds LUXEON® LEDs are enabling never before possible applications in outdoor lighting, shop lighting, home lighting, consumer electronics, and automotive lighting.

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, Singapore 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 technology and the lighting world. More information about the company's LUXEON LED products and solid-state lighting technologies can be found at [www.philipslumileds.com](http://www.philipslumileds.com).

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