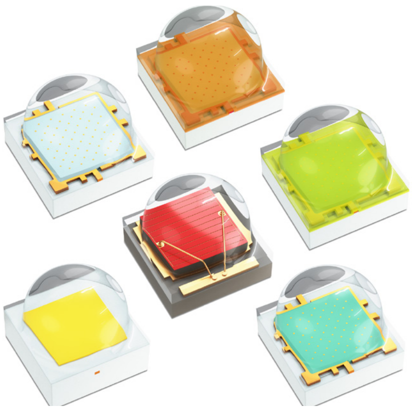
LUXEON C ES Color Line

Assembly and Handling Information



Introduction

This application brief addresses the recommended assembly and handling procedures for the LUXEON C ES Color Line. Proper assembly and handling, as outlined in this application brief, ensures high optical output and the long-term performance of LUXEON emitter.

Scope

The assembly and handling guidelines in this application brief apply to all the part numbers as described in LUXEON C ES Color Line datasheet. In the remainder of this document the term LUXEON emitter refers to any product in the LUXEON C ES family.

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1. Component

1.1 Description

The LUXEON C ES Color Line emitter consists of either an InGaN (indium gallium nitride) or an AlInGaP (aluminum indium gallium phosphide) LED chip mounted onto a ceramic substrate which is encapsulated in silicone to protect the underlying chip, wire bonds (in AlInGaP) and the phosphor layer (in white and PC Amber, Lime, Mint). The ceramic substrate provides mechanical support and thermally connects the LED chip to the bottom pads. The solder pads on the bottom of LUXEON C ES are finished with gold.

The bottom of LUXEON C ES contains three metallization pads, a large thermal pad in the center and an anode and a cathode. The cathode pad can be easily identified by referencing to the cathode reference marker (Figure 1).

LUXEON C ES is designed to be compatible with standard surface mount technology (SMT) process.

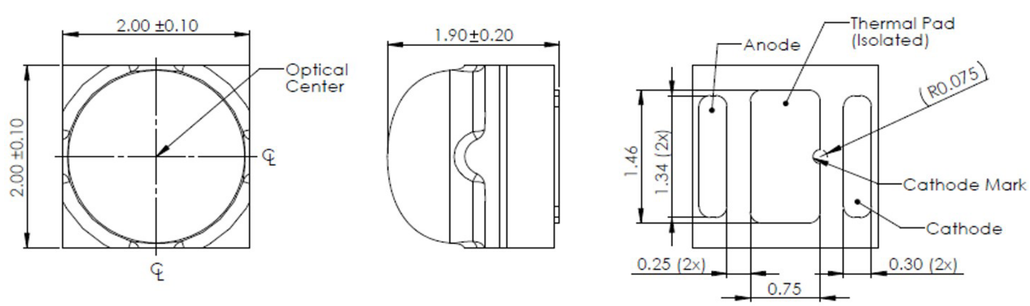

Figure 1. Mechanical Drawing of LUXEON C ES Color Line

1.2 Optical Center

The optical center coincides with the mechanical center of the LUXEON C ES Color Line emitter. Optical rayset data for the LUXEON emitter are available at lumileds.com.

1.3 Handling Precautions

The LUXEON C ES Color Line 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 LUXEON C ES Color Line emitter should only be picked up from the side of the package.

1.4 Cleaning

Any fine dust and debris on and around the package may cause a decrease in light output. Use a clean air blower (e.g. at 10psi) at a distance of about 6 inches from the emitter to remove any dust and/or debris after the emitter is reflowed onto a PCB. Make sure the PCB is secured first.

In the event that a LUXEON emitter requires additional cleaning, 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 stubborn dirt from the lens. Be careful that the dirt to be removed will not scratch the dome. Do not use any other solvents as they may adversely react with the LED assembly. For more information regarding chemical compatibility, see section 5.

It is safe to clean LUXEON C ES emitters with de-ionized DI water. Using municipal or city water may introduce other contaminants that may adversely react with the LED assembly.

1.5 Electrical Isolation

The thermal pad of the LUXEON 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. In such application design, the isolated thermal pad of the LUXEON emitter can be connected to the anode or cathode to minimize the possibility of electrical discharge across the anode/cathode to the thermal pad, for example when subjected to electrical isolation test ("hi-pot test"). As a reference, the nominal distance between the anode/cathode and the thermal pads of the LUXEON emitter is 0.25mm.

In order to avoid any electrical shocks 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 60950-1 ed.2.2, clause 2.10.4).

For more information about circuit board design to protect LED emitters during electrical overstress, please see Lumileds document AB06 "Circuit Design and Layout Practices to Minimize Electrical Stress."

1.6 Mechanical Files

Mechanical drawings for the LUXEON C ES Color Line emitter is available at lumileds.com.

1.7 Soldering

LUXEON C ES Color Line emitters are designed to be mechanically secured onto a heat sink. For detailed assembly instructions, see Section 3.

2. PCB Design Guidelines

2.1 PCB Footprint and Land Pattern

An example PCB footprint design for the LUXEON emitter is shown in Figure 2. In order to ensure proper heat dissipation to the PCB, it is best to extend the top copper layer of the solder pad beyond the perimeter of the LUXEON emitter as much as possible.

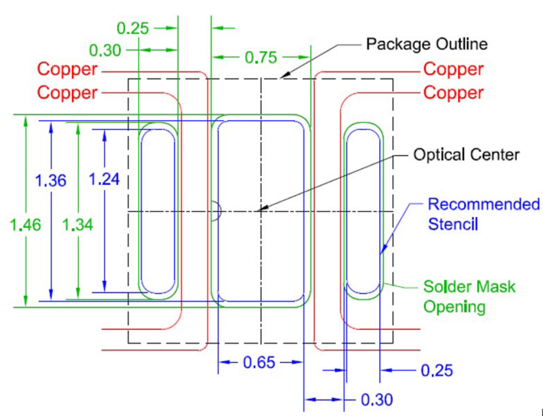

Figure 2. Recommended PCB solder pad layout for LUXEON C ES Color Line

2.2 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 when exposed to elevated operating temperatures. Customers are encouraged to work with their PCB suppliers to determine the most suitable solder mask options which can meet their application needs.

2.3 Surface Finishing

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

2.4 Minimum Spacing

Lumileds proposes a minimum edge to edge spacing between LUXEON emitters of 300μm, assuming the recommended LUXEON C ES PCB footprint is used and the pick and place machine has a placement accuracy of less than ±50μm. Placing multiple LUXEON emitters too close to each other may adversely impact the ability of the PCB to dissipate the heat from the emitters.

2.5 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-600K, 2020 "Acceptability of Printed Boards").

3. Assembly Process

3.1 Stencil Design

The recommended solder stencil thickness is 4 mils (102μm). It may be necessary to make some adjustments to the stencil thickness (for examples with the use of thicker solder mask) and aperture openings to optimize the quality of the solder joint under customer's own assembly process.

3.2 Solder Paste

Lumileds recommends lead-free solder for the LUXEON emitter. Good results have been obtained with lead-free solders such as SAC 305 solder paste from Alpha Metals (SAC305-CVP390-M20 type 3). 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.

3.3 Pick and Place Nozzles and Machines Settings

Automated pick and place equipment provides the best placement accuracy for LUXEON emitters. However, pick and place nozzles are, in general, customer specific and are typically machined to fit specific pick and place tools. Below is a general pick and place guidelines when handling LUXEON emitter:

• 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 or the dome 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 tip material made of NBR Rubber is successfully evaluated. Tip design is clearly shown in Figure 3. Its outer diameter is 2.30mm, inner diameter is 2.10mm and cavity depth is 1.4mm.

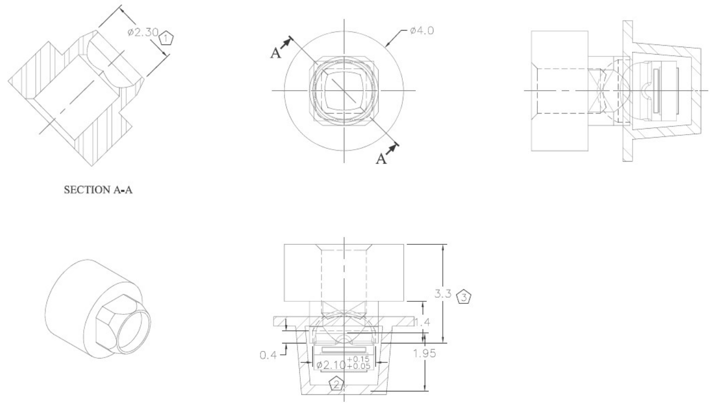

Figure 3. Nozzle design for Yamaha YS12. All dimensions are in millimeters

Table 1. Yamaha YS12 pick and place parameter

Pick Information	
Pick Height	0.000
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)	-1.000
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	
Lighting Level	6/8

3.4 Solder Reflow Profile

The LUXEON 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.

3.5 Electrostatic Discharge Protection

The LUXEON emitter does not include any transient voltage suppressor (TVS) chip to protect against electrostatic discharges (ESD). Therefore, Lumileds recommends observing the following precautions when handling the LUXEON 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 LUXEON emitter should be properly grounded.
- Use an ion blower to neutralize the static discharge that may build up on the surface and lens of the plastic housing of the LUXEON emitter during storage and handling.

LUXEON 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 (leaky diode). It is also important to take note that ESD can also cause latent failure, i.e. failure or symptoms as described above may not show up immediately but until after use. Hence continuous ESD protection is needed during assembly.

3.6 JEDEC Moisture Sensitivity

The JEDEC Moisture sensitivity level (MSL) for this LUXEON emitter is rated as level 1. Proper storage, handling and/or baking guidelines must be observed to prevent damage to the LUXEON emitter during reflow (see Table 2).

Baking information:

Baking is required before SMT when any of the following condition occur:

1. The shelf life is more than one year.
2. The vacuum-sealed bag has an air leak.
3. The humidity indication card has color change at 30% RH at the time of opening the vacuum sealed bag.
4. The vacuum-sealed bag has been opened and exceeded the MSL lever floor time.

Baking method:

The SMD LED should not be baked within the packaging bag. The baking condition is 65ºC, +/-5 ºC for 24 hours. The oven door should not be opened frequently during the baking process.

Table 2. JEDEC Moisture sensitivity levels for LUXEON C ES Color Line

LEVEL	FLOOR LIFE		SOAK REQUIREMENTS STANDARD	
	TIME	CONDITIONS	TIME	CONDITIONS
1	Unlimited	≤30°C / 85% RH	168 Hours +5 / -0	85°C / 85% RH

4. Thermal Management

The overall thermal resistance between a LUXEON emitter and the heatsink is strongly affected by the design and material of the PCB on which the emitter is soldered.

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

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

In this equation, T_{case} is the temperature at the bottom of the solder pads of the LUXEON 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 LUXEON emitter is by measuring the temperature (Ts) of a predetermined sensor pad on the PCB with a thermocouple.

The recommended location of the sensor pad is right next to the LUXEON emitter, on the center line between anode and cathode, as shown in Figure 4. To ensure accurate reading, the thermocouple (TC) tip must make direct contact to the copper of the PCB onto which the thermal pad of the LUXEON emitter is soldered (i.e. any solder mask or other masking layer must first be removed before mounting the thermocouple onto the PCB). The tip of the TC wire should be placed as close as possible to the LUXEON emitter package.

The thermal resistance ($R\theta_{j\text{-}S}$) between the sensor pad and the LUXEON emitter junction was experimentally determined (see Table 3) on a 1.2mm thick Al-MCPCB with the following PCB properties: 2 oz. copper foil and 75um thick dielectric layer with 3 W/(m·K) thermal conductivity. The junction temperature can then be calculated as follows:

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

It is recommended securing the tip of TC wire to the exposed copper area with a good thermal conductive epoxy such as Artic Silver™ thermal adhesive. Note that the Artic Silver™ epoxy is not formulated to conduct electricity. During dispensing of epoxy, avoid flooding the TC wire with too much epoxy but sufficient enough to secure the TC wire for measurement. Putting more epoxy than needed may change the thermal behavior of the surrounding area. Lumileds has successfully used a two-part Artic Silver™ thermal adhesive in combination with a TC wire gauge of AWG 40 or 36.

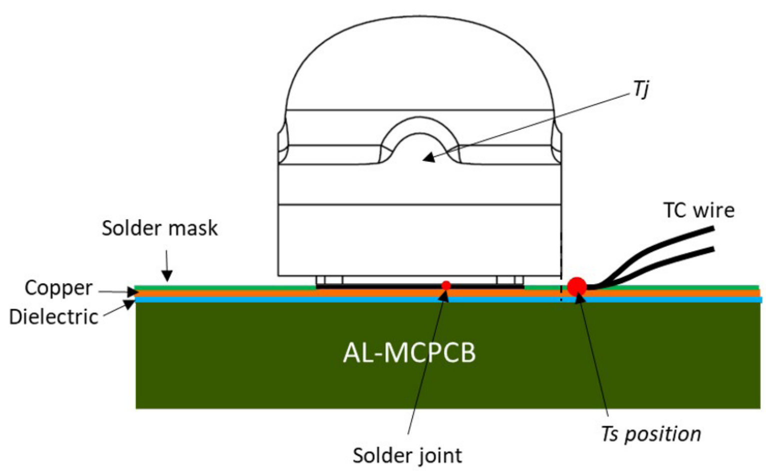

Figure 4. Cross sectional view of LUXEON C ES Color on Al-MCPCB and the corresponding temperature location. Actual mounting of thermocouple wire closest to the center line between anode and cathode of the LUXEON C ES Color package on Al-MCPCB

Table 3. Typical thermal resistance from junction to Ts point of LUXEON C ES Color Line

PRODUCT	COLOR	TYPICAL $R\Theta_{J-TS}$ (K/W)
LUXEON C ES Color Line	Blue	3.0
	Cyan	3.5
	Deep Red	2.4
	Green	3.7
	Lime	2.9
	Mint	2.9
	PC Amber	3.4
	Royal Blue	2.2
	Red	3.1

5. Packaging Considerations - Chemical Compatibility

The LUXEON C ES Color Line 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 LUXEON C ES Color Line 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 LUXEON C ES Color Line 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 2 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 4 are typically not directly used in the final products that are built around LUXEON C ES Color Line 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 heat sinks. 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 4. List of commonly used chemicals that may damage the silicone overcoat of LUXEON C ES Color Line

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

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To learn more about our lighting solutions, visit lumileds.com.

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