LUXEON 7070

Assembly and Handling Information

Introduction

This application brief addresses the recommended assembly and handling guidelines for LUXEON 7070 emitters. LUXEON 7070 is a multi-die, high power package that provides high luminance from a super robust package to enable cost effective, single optic and directional fixture designs. LUXEON 7070 uses an industry standard 7070 surface mount package with a small Light Emitting Surface (LES). LUXEON 7070 is offered in 70, 80, 90 CRI with a wide range of CCTs, and offers hot-color targeting to ensure that the LEDs are within color target at application conditions of 85°C.

Scope

The assembly and handling guidelines in this application brief apply to LUXEON 7070 with the following part number designations:

L170-AABB70CC00000		
Where:		
A A	–	designates nominal ANSI CCT (22=2200K, 27=2700K, 30=3000K, 35=3500K, 40=4000K, 50=5000K, 57=5700K, 65=6500K)
B B	–	designates minimum CRI (70=70CRI, 80=80CRI, 90=90CRI)
C C	–	designates forward voltage (12=12V)

Therefore, the following part number is used for a LUXEON 7070, 4000K 70CRI, 12V:

L170-40707012 00000

In the remainder of this document the term LUXEON emitter refers to any product in the LUXEON series listed above.

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1. Component

1.1 Description

The LUXEON 7070 emitter (Figure 1) consists of a plastic molded lead-frame package with anode and cathode pads. The primary heat flow path out of the LED package is through the large anode pad which acts as a thermal pad. The light emitting surface (LES) is encapsulated with silicone and phosphor to protect the chips and generate white light (Figure 1). The LUXEON emitter is ESD HBM rated at ≥2kV (JEDEC JS-001-2012) and does not include a transient voltage suppressor (TVS) chip.

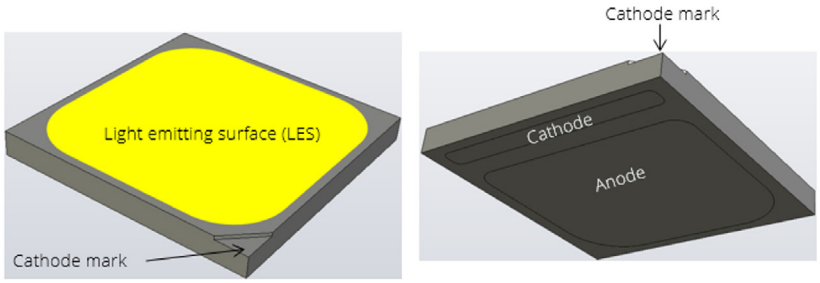

Figure 1. Package rendering of the LUXEON 7070 emitter.

1.2 Optical Center

The optical center coincides with the mechanical center of the LUXEON emitter. Optical rayset data for the LUXEON emitter are available on the Lumileds website at www.lumileds .com.

1.3 Handling Precautions

The LUXEON 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 encapsulation during handling, the LUXEON emitter should only be picked up from the side of the package (Figure 2).

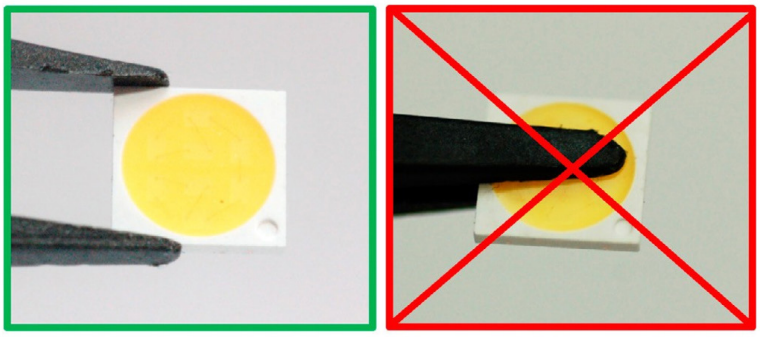

Figure 2. Correct tweezers handling of a representative LED package (left). Incorrect handling (right).

1.4 Cleaning

The LUXEON 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 LUXEON 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 package of the LUXEON emitter. For more information regarding chemical compatibility, see Section 6.

1.5 Electrical Isolation

The LUXEON emitter has two pads on the package bottom. On the LUXEON emitter, the exposed minimum creepage distance is between the anode and cathode pads. In order to avoid any electrical shocks, flashover 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. IEC60950, clause 2.10.4).

1.6 Mechanical Files

Mechanical drawings for the LUXEON emitter are available on the Lumileds website at www.lumileds .com.

2. PCB Design Guidelines

The LUXEON 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 PCB Footprint and Land Pattern

The recommended PCB footprint design for the LUXEON emitter is shown in Figures 3a and 3b. In order to ensure proper heat dissipation from the emitter to Al-MCPCB for example, it is best to extend the top copper layer of the thermal pad of the PCB beyond the perimeter of the LUXEON emitter outline by 7mm or more. For optimum heat conduction, the top copper layer has "U" shape around the large anode pad which also functions as a thermal pad.

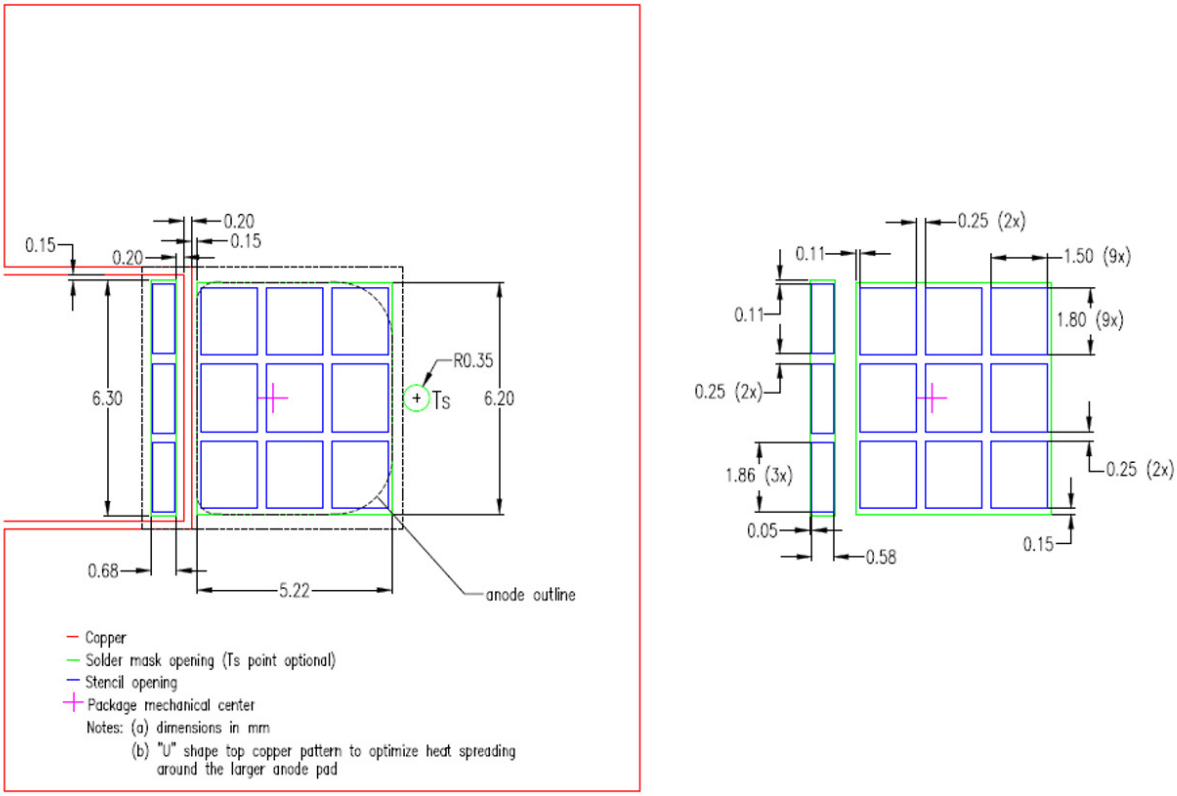

Figure 3a. Recommended PCB footprint showing solder mask and stencil opening for LUXEON 7070. Dimensions are in mm.

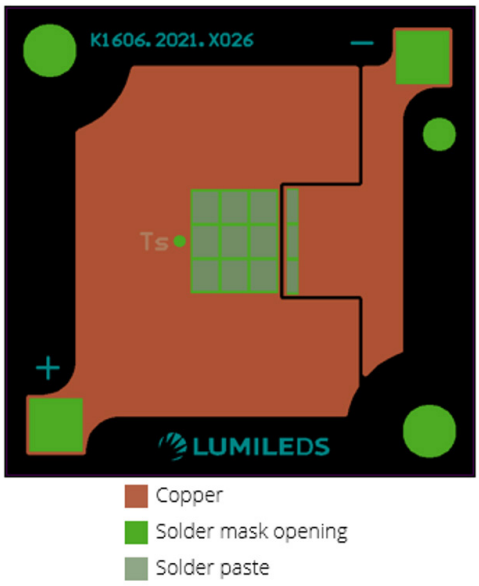

Figure 3b. An example of a LUXEON 7070 gerber drawing.

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

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. Thermal Management

The overall thermal resistance between a LUXEON emitter and the heat sink is strongly affected by the design and material of the PCB on which the emitter is soldered. Al-MCPCBs have been historically used in the LED industry for their low thermal resistance and rigidity.

A typical LED module assembly consists of LUXEON 7070 soldered onto a PCB which is then mounted on a suitably rated heatsink via thermal interface material (TIM). The PCB design, TIM and heatsink are secured via screws to improve the overall thermal management of the LED system

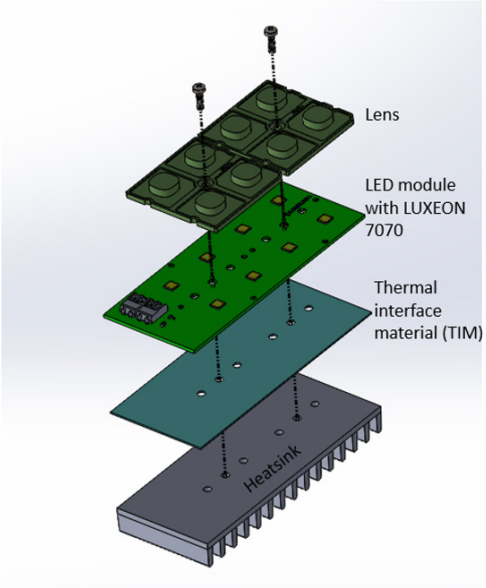

Figure 4. A typical LED system shown with heatsink.

4. Thermal Measurement Guidelines

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

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

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. A practical way to determine the junction temperature of the LUXEON emitter is by measuring the temperature T_s of a predetermined sensor pad on the PCB with a thermocouple instead of T_{case}.

The recommended location of the sensor pad is shown in Figure 3a and Figure 5. To ensure accurate readings, the thermocouple (TC) tip must make contact to the top copper of the PCB onto which the LUXEON 7070 anode (thermal) pad is soldered, i.e. any solder mask or other masking layer must first be removed before mounting the TC 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 (T_s) and the LUXEON emitter junction was simulated to be 1.4 K/W (electrical) based on the MCPCB with the following construction: 2oz copper, 0.1mm dielectric with thermal conductivity of 2 W/(m.K). The thermal resistance of the PCB from land pattern (anode pad) to the bottom of the PCB is simulated to be 1.1 K/W (heat)

The junction temperature can then be calculated as follows:

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

It is recommended to secure 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. Make sure to dispense sufficient epoxy onto the TC to secure it on the PCB. However, do not flood the TC with epoxy. Putting more epoxy than needed may change the thermal behavior of the surrounding area.

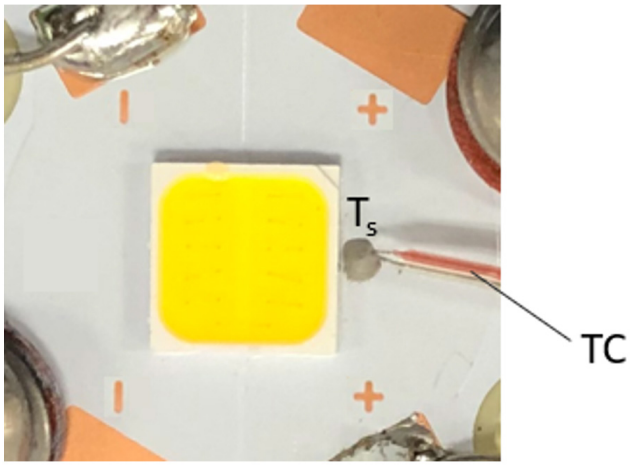

Figure 5. A representative placement of thermocouple (TC) wire of size AWG 40 is secured with thermal conductive epoxy at the T_s location of an arbitrary LED package. The thermal epoxy volume should be kept to minimum as shown.

5. Assembly Process Guidelines

5.1 Stencil Design

Lumileds has successfully evaluated a solder stencil thickness of 4 mils (0.102mm).

5.2 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 OM-340 type 3. However, since the application and assembly environments vary widely, Lumileds recommends that customers perform their own stencil thickness and solder paste evaluation in order to ensure it is suitable for the targeted application.

5.3 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.

5.4 Pick and Place

The LUXEON emitter is packaged and shipped in tape-and-reel which is compatible with standard automated pick-and-place equipment to ensure the best placement accuracy. Note that pick and place nozzles are customer specific and are

typically machined to fit specific pick and place tools. Lumileds advises customer to take the following general pick and place guidelines into account:

a. The nozzle tip should be clean and free of any particles since it may interact with the top surface of the silicone encapsulation of the LUXEON emitter package.

b. During setup and the first initial production runs, it is a good practice to inspect the top surface of the LUXEON emitters after reflow under a microscope to ensure that the emitters are not accidentally damaged by the pick and place nozzle.

Below are a list of nozzle designs and pick and place parameter setups that will be suitable as a starting point for optimizing the pick and place process for LUXEON 7070 for three machine suppliers (Samsung, Juki and Panasonic). Note any similar nozzle tip design with inner diameter of 6.5mm and outer diameter of 7.2mm as shown in Figure 6, 8 and 10 will be suitable to handle LUXEON 7070 emitter while minimizing physical contact to the LES area (Figure 1).

5.4.1 Samsung SM421

Nozzle designed by Ching Yi Technology Pte Ltd (https://chingyi.com.sg/). Part number SAM-0320/16, drawing number 13734.

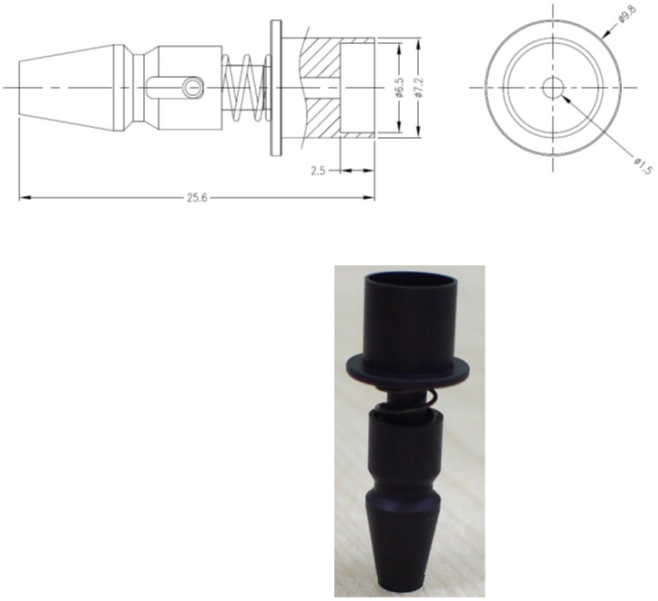

Figure 6. Samsung SM421 nozzle (metal). Dimensions in mm.

PICK AND MOUNT INFORMATION	
Pick Height	-0.25 mm
Mount Height	0 mm
Delay – Pick Up	30 ms
Delay - Place	30 ms
Delay - Vacuum Off	0
Delay – Blow On	0
Speed – XY	1
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	1
Soft Touch	Not Used

VISION INFORMATION	
Camera No	Fly 6 Cam5
Side	15
Outer	11

Figure 7. Pick and place machine setting for Samsung SM421 machine.

5.4.2 Juki KE2080L

Nozzle designed by Ching Yi Technology Pte Ltd (https://chingyi.com.sg/). Part number JUK-0321/16, drawing number 13735.

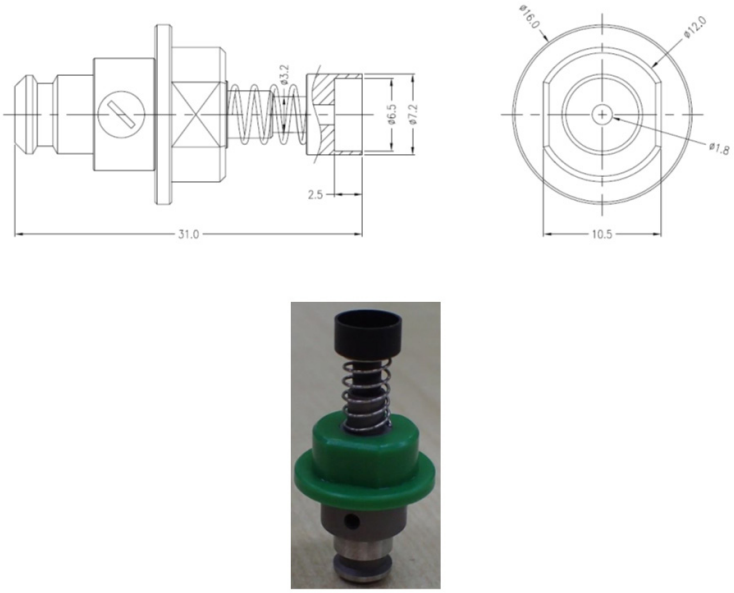

Figure 8: Juki KE2080L nozzle (metal). Dimension in mm.

PICK AND MOUNT INFORMATION	
Placing Stroke	0 mm
Picking Stroke	0.2 mm
XY Speed	Fast 2
Picking Z Down	Fast 2
Picking Z Up	Fast 2
Placing Z Down	Fast 2
Placing Z Up	Fast 2
Laser Position	-0.56

VISION INFORMATION	
Centering Method	Laser
Comp Shape	Corner Square

Figure 9: Pick and place machine setting for Juki KE2080L machine.

5.4.3 Panasonic CM4020

Nozzle designed by Ching Yi Technology Pte Ltd (https://chingyi.com.sg/). Part number KME-0322/16, drawing number 13736.

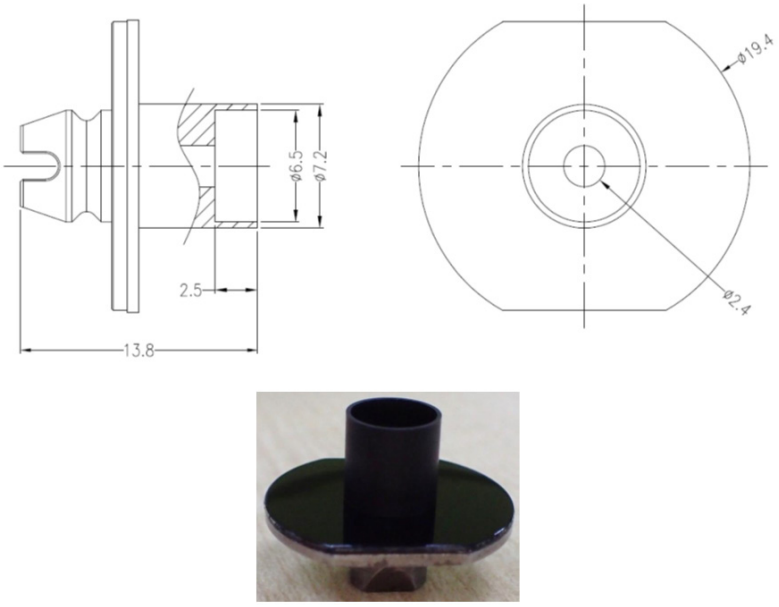

Figure 10: Panasonic CM402 nozzle (metal). Dimension in mm.

PICK AND MOUNT INFORMATION	
Gap - Mount	0 mm
Gap - Pick	0.25 mm
Pickup position	0 mm
Fdr drive time	Std
Pickup keep time	Std
Mount keep time	Std
Pickup speed	100
Mount speed	100

VISION INFORMATION	
Ref	88
Recog speed	Auto (Fast)
Recog hgt	0.00 mm
Lamp 1	0
Lamp 2	0
Lamp 3	0
Lamp 4	90
Lamp 5	0
Lamp 6	0
Lamp 7	0
Lamp 8	0

NOZZLE LIBRARY DATA	
VU, Vacuum rise time	5
VD, Vacuum break time	-2
TT, Pickup holding time	5
MT, Mounting holding time	0
PM, Failure judgement pressure	-20
PF, Nozzle clogging detection pressure	-85

Figure 11: Pick and place machine setting for Panasonic CM402 machine.

5.5 Acceptability of PCB Assembly

Unless there is a specific acceptance requirements or agreements between a customer and the SMT PCB assembly service, a good starting point when evaluating the quality of PCB assembly standard can be found in the IPC standard, specifically IPC-A-610H, 2020, “Acceptability of Electronic Assemblies”. This standard covers a wide range of general acceptance criteria for PCB assembly such as solder voiding, package tilt, solder balling, etc.

5.6 Electrostatic Discharge Protection

The LUXEON emitter does not include any type of 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.

5.7 JEDEC Moisture Sensitivity

The JEDEC moisture sensitivity level (MSL) for this LUXEON 7070 is rated as level 3. Proper storage, handling and/or baking guidelines must be observed to prevent damage to the LUXEON emitter during reflow (see Table 2).

Table 2. Storage and baking conditions. Note that if any of the temperature, relative humidity, humidity indicator card or the period is not met, baking is required. For more information, see IPC/JEDEC J-STD-033D.

OPERATION	PACKING BAG STATUS	TEMPERATURE	RELATIVE HUMIDITY (RH)	HUMIDITY INDICATOR CARD	PERIOD
Storage	As received	≤30°C (non-condensing atmospheric environment)	≤90%	n/a	Within 24 months of shipment date code
Storage	After opening bag	≤30°C	≤60%	If 60% color spot is no longer blue	168 hours
Baking (drying)	Units in tape & reel	60 ±5°C	≤5%	n/a	5 hours

6. Packaging Considerations—Chemical Compatibility

The LUXEON 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 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 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, VOCs captured inside the silicone 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 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 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 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 3. List of commonly used chemicals that will damage the silicone of the LUXEON emitter. Avoid using any of these chemicals in the housing that contains the LED package.

CHEMICAL NAME	TYPICAL USE
Hydrochloric Acid	Acid
Sulfuric Acid	Acid
Nitric Acid	Acid
Acetic Acid	Acid
Ammonia	Alkali
Potassium Hydroxide	Alkali
Sodium Hydroxide	Alkali
Acetone	Solvent
Benzene	Solvent
Dichloromethane	Solvent
Gasoline	Solvent
MEK (Methyl Ethyl Ketone)	Solvent
MIBK (Methyl Isobutyl Ketone)	Solvent
Mineral spirits	Solvent
Tetracholorometane	Solvent
Toluene	Solvent
Xylene	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
Cyanoacrylate	Adhesive

Note for Table 3:
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, the solder flux should not spit onto the LUXEON emitter surface or leaving 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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AB164 LUXEON 7070
Application Brief 20210919