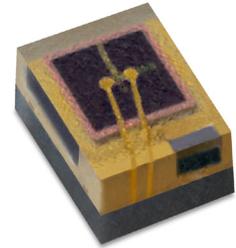


# LUXEON IR Compact Lens Attach

## Assembly and Handling Information



### Introduction

This application brief addresses the recommended assembly process of secondary lens attach onto a printed circuit board (PCB) together with PCB design rules to accommodate the lens attach process for LUXEON IR Compact emitters. These emitters deliver high efficiency as required in small spaces. Their compact and well-defined light source geometry allows them to be easily coupled into secondary lens for tight beam control and high optical performance.

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# 1. References

- [AB190 LUXEON IR Compact Application Brief](#)
- [DS190 LUXEON IR Compact Line Product Datasheet](#)

# 2. Equipment, Materials and Supplies

- Assembled LED board comprising of emitters and other electrical components on PCB
- Automatic fluid dispensing machine
- Temperature or Ultraviolet (UV) curable dispense glue (e.g. Sekisui, Delo, ThreeBond, Dymax, Dow Corning, Henkel)
- Pick and place machine
- Secondary lens
- SMT reflow oven, UV curing system or box oven with exhaust air system

# 3. Typical Process Flow

The typical process flow for attaching secondary lens onto an LED board is not much different from mounting LED package components onto a PCB. Figure 1 shows a typical process flow for the lens attach process. In this document, the adhesive/glue method is presented. The lens with screw mounting method, lens with press-fit fasteners and lens with double sided adhesive tape are not discussed here.

Lumileds recommends the automated in-line assembly process to eliminate handling, especially right after the lens are attached. This is to prevent possible movement of lens prior to glue curing.

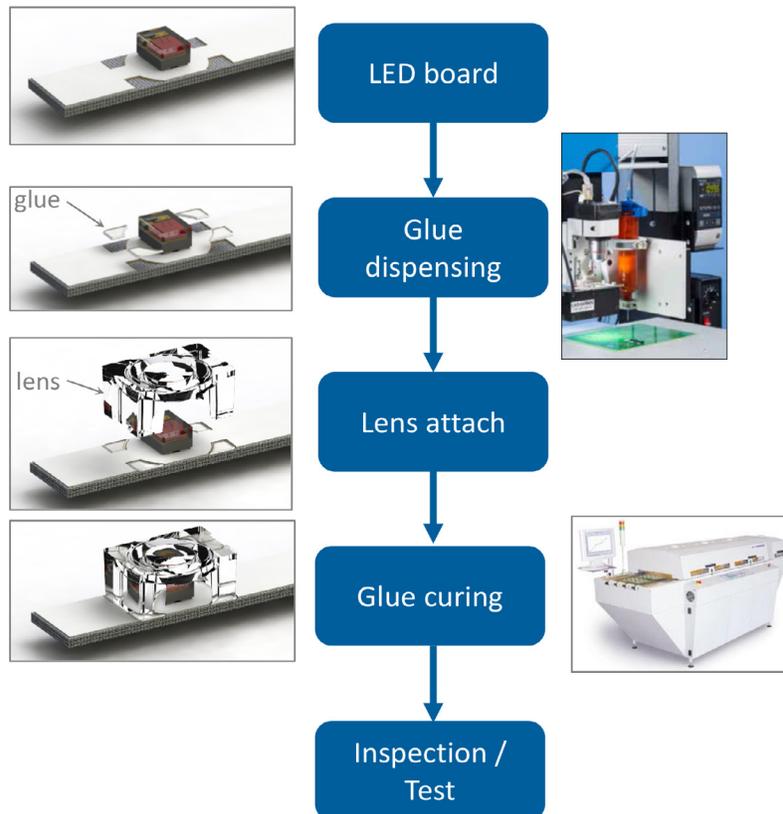


Figure 1. Typical lens attach process flow.

## 4. Handling Precaution

For reliable lens adhesion to PCB, the two surfaces to be bonded or glued must be clean from any contaminants. Please refer to lens manufacturer's guide for cleaning any lens as with any optical component, improper cleaning process or chemical used may reduce the lens optical performance.

## 5. PCB Design Guide

Below are important considerations when designing PCB for lens attach to achieve optimal bonding quality and optical performance.

1. **Bonding surface.** For aluminum metal-core PCB (Al-MCPCB), it is best to attach to either the MCPCB dielectric layer or directly to the aluminum substrate. For FR-4 or CEM-3 PCB, it is best to attach directly to the substrate material. Avoid attaching lens directly to the top copper layer due to possible copper corrosion.
2. **Size of PCB lens feet or lens anchor area opening.** Since these areas are recessed, it is recommended to have 0.1mm clearance around the lens feet (see Figure 2) or the lens anchor protrusion. **Important:** The PCB lens feet or PCB lens anchor points define the optical centering of the lens to the LED emitter on the PCB plane (i.e. on x-y plane, with z-plane being the direction perpendicular to the PCB surface).

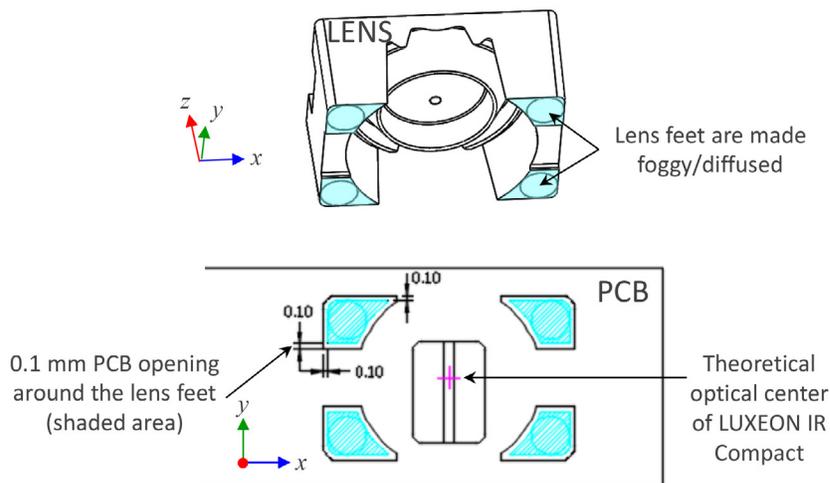


Figure 2. An example of PCB lens feet opening clearance. Top drawing is the lens with lens feet that are foggy/diffused to improve machine pattern recognition. Bottom drawing is the PCB. All dimensions are in millimeters.

3. **LED-lens distance.** This is the distance from the top of the lens to the top of the LED package (see Figure 3). This is critical for lens with feet. Depending on the depth of the recessed PCB feet, the lens may touch the top of the LED or placed too far away to achieve the desired optical performance. The depth of the recessed area along the z-axis depends on the thickness of the various PCB layers such as the solder mask, top copper (1 oz. or 2 oz.) and/or dielectric as shown in Figure 3. In addition, the package and solder joint thickness can affect the LED-lens distance. All of these factors must be taken into account during lens and PCB design, including tolerances. The top drawing in Figure 3 represents the cross-section of the lens feet on Al-MCPCB. The total lens height that defines the LED-lens distance is affected by the thickness of the solder mask layer plus copper (if attached directly to the dielectric) or affected by the additional dielectric layer thickness if attached to the aluminum substrate. The bottom drawing represents FR-4 PCB where the lens feet are attached to the FR-4 substrate. Assume glue bond line thickness is negligible otherwise it should be considered in the total lens height.

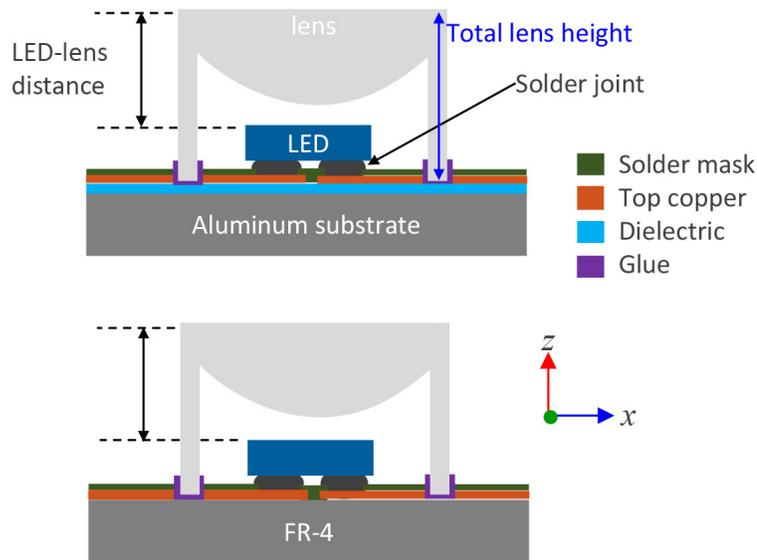


Figure 3. Top drawing represents cross-section of the lens feet on Al-MCPCB. Bottom drawing represents FR-4 PCB where the lens feet are attached to the FR-4 substrate. Drawings are not to scale.

4. Lens design without feet. As shown in Figure 4, the depth of the recessed area on the PCB should accommodate the lens anchor point protrusion, which serves as the fiducials for aligning the lens to the LED optical center. The depth should also include the desired glue bond thickness.

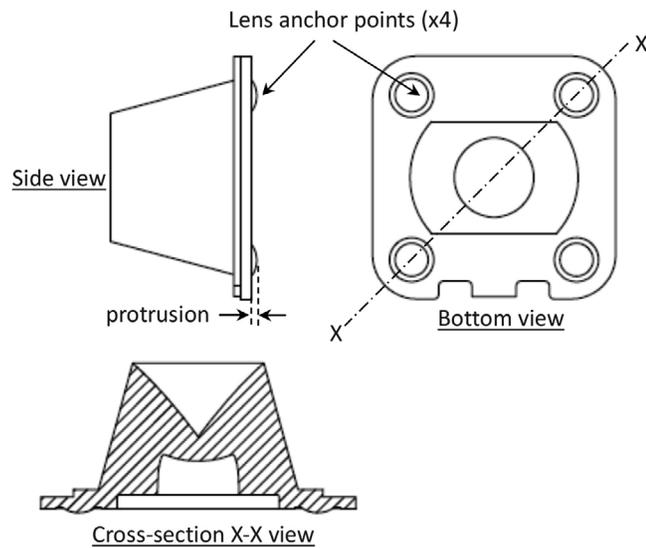


Figure 4. An example of a lens design without “feet.” The depth of the PCB required to accommodate these anchor points is labeled as protrusion. It should also include the glue bond line thickness.

## 6. Glue

Since there are many types of glue suppliers (e.g. Sekisui, Delo, ThreeBond, Dymax, Dow Corning, Henkel, etc.) in the market, a temperature or UV curable glue, or a combination of both properties, is a good starting point to use in attaching lens to the PCB. Glue selection should meet assembly and end product application needs. As with all types of industrial glues, please refer to the appropriate material safety datasheet (MSDS) first.

Typical desired glue characteristics, for example, would be a temperature curable glue such as Sekisui LT-1001C “LT series”:

- Low temperature thermal curing point, preferably at 80°C if the lens is made of polymethyl-methacrylate (PMMA) plastic lens
- Reasonable fast curing time (at 80°C for at least 5 mins for Sekisui glue)
- Clear or white color, as not to interact with the light emitted from the LED
- High bond strength to meet desired end product application requirement
- High-Pot life at room temperature (>24 hours) for ease of manufacturability
- Minimal VOC emission or outgassing

For storing unused glue, please refer to the glue manufacturer's specification. For Sekisui LT series glue, store below -15°C, for example.

Notable glue types in which UV cured is done first (tack-curing) to hold the lens securely and then followed by temperature cure for full and final curing is also a suitable choice.

For further technical details, please refer to respective glue manufacturers.

## 7. Glue Dispensing

To properly control the amount of glue and accurate placement of glue in high volume manufacturing environments, it is recommended using an automatic fluid (glue) dispensing machine with a high precision dispense controller and an accurate positional movement and vision system.

The amount of glue dispense needed should generally be based on the glue supplier's recommendation, if any, and the overall surface area to be bonded. As a general rule of thumb, putting more glue than is needed may generate more VOCs and may cloud the lens during curing, cause glue runoff to the adjacent area during lens attach and possible lens feet “floating” on the glue, which may reduce placement accuracy during curing or may require longer curing time. Putting too little glue may reduce the bonding strength. For closed loop feedback on bonding strength optimization, it is best to quantify this using shear force test equipment, for example.

## 8. Lens Attach

### 8.1 Lens Feature for Machine Vision

As the lens is transparent, some features must be added to the lens to aid the machine vision system in recognizing these features (reference point) for accurate pick and place onto the PCB. For secondary lens such as the one shown in Figure 5, the lens feet are intentionally made foggy or diffused (frosted) to create contrast during machine visioning process. The four feet can then be used to calculate and define the optical center of the lens.

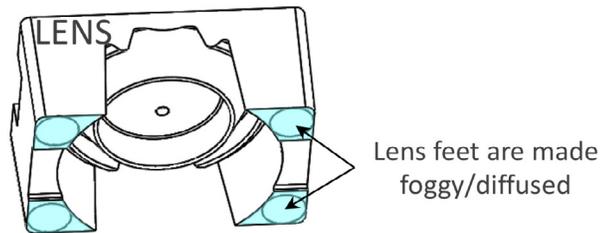


Figure 5. Foggy/diffused lens feet (cyan colored areas).

## 8.2 Nozzle Tip Design

The nozzle tip material chosen should be softer than the lens material to avoid damaging the surface of the top lens. A rubber tip is suitable for lens picking. As a reference, typical PMMA lens shore D hardness is about 85, so any nozzle material with hardness lower than this would work well. Most importantly, keep the nozzle tip clean.

## 8.3 Pick and Place Machine

Most modern pick and place machines will work, but must be able to do vision recognition of the bottom of the lens feet for accurate lens placement. Check with the lens supplier if the lens are shipped in loose parts, which then require a feeder bowl in a tray or in a tape & reel system when selecting a pick and place machine.

Lumileds recommends an XY placement tolerance of lens to the PCB of less than 100µm. Larger tolerances will impact the positional accuracy of the lens and may therefore have a negative impact on the optical performance. Unlike SMT solder reflow, the lenses that are placed cannot self-align during glue curing. Hence, do not disturb or move the lens prior to glue curing. At this stage, lens rework is still possible but not recommended.

# 9. Glue Curing

If temperature curable glue is used, the curing temperature must stay well below the plastic Vicat softening temperature, i.e. the temperature at which the plastic gradually becomes soft and can be easily deformed. For PMMA lens, the optimum curing temperature is at 80°C. The curing period is provided by the glue manufacturers.

Two common methods of glue curing are:

1. **Box oven.** The oven should have an air circulation with exhaust and typically suitable for prototyping build.
2. **Reflow oven.** Similar to the one used in surface-mount technology (SMT), solder reflow can be used if the temperature-time profile required for curing the glue is met. Reflow oven can be configured for in-line assembly, thus, minimizing handling which may cause lens movement.

UV curable glue is widely used and generally engineered to be fast curing upon UV light exposure when compared to temperature curable glue.

# 10. Inspection, Testing and Reliability (Optional)

## 10.1 Functional Test and Visual Inspection

An optional, functional test and visual inspection to check for compliance can be considered. For visual inspection, such as the lens and LED board as shown in Figure 2, one might consider inspecting if any of the lens feet are outside the PCB lens feet openings. This is an indication that the lens and the LUXEON IR Compact emitters are significantly offset, which may have an impact on the light output performance. Also inspect for lens tilt and damage.

## 10.2 In-Process Check

The use of shear force test equipment provides immediate feedback if there is a change in the bonding strength of the lens to the PCB due to poor curing, contaminated surfaces or insufficient glue.

## 10.3 Reliability Testing

To ensure the bonding integrity during handling, transportation or the intended end product use application, there are a list of common tests (not all-inclusive):

- Vibration test, such as JEDEC JESD-B103 “Vibration, Variable Frequency”
- Mechanical shock test, such as JEDEC JESD-B104 “Mechanical Shock”
- Drop test in box/container, such as IEC 60068-2-32 “Basic environmental testing procedures: Free Fall”
- Suitable packaging for safe transportation, such as those specified by International Safe Transit Association ([www.ista.org](http://www.ista.org)); document ISTA 1A 2001 and ISTA 3A 2008.

## About Lumileds

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To learn more about our lighting solutions, visit [lumileds.com](http://lumileds.com).

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