

# LUXEON CS Range CoBs

## Assembly and Handling Information



### Introduction

This application brief addresses the recommended assembly and handling procedures for the LUXEON CS Range CoBs emitters. LUXEON CS extends Lumileds CoB leadership for performance and reliability to an entirely new board footprint that enables easy designing for new luminaire programs and is a cost-effective replacement for existing solutions where an upgrade is desired. State-of-the-art LUXEON CoB technology delivers unmatched performance, quality of light, and uncompromising product quality.

### Scope

The assembly and handling guidelines in this Application Brief apply to the following LUXEON CoB products:

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LUXEON CS CoB

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LUXEON CS Pro CoB

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LUXEON CS CoB High Density Gen 3

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LUXEON CS CoB with CrispColor Technology

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LUXEON CS CoB with CrispWhite Technology

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

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# 1. Component

## 1.1 Description

The LUXEON CoB emitter consists of an array of LED chips which are mounted onto a metal-core printed circuit board (MCPCB) to facilitate assembly and handling. The MCPCB is made out of aluminum to ensure a good thermal path between the LEDs and the heat sink on which the LUXEON CoB is mechanically mounted.

The LED array is covered with a phosphor silicone mixture to enhance light uniformity and to shield the chip array from the environment. LUXEON CoB emitters include a transient voltage suppressor (TVS) chip under the silicone to protect the emitter against electrostatic discharge (ESD).

The backside of the MCPCB contains a 2D barcode which includes a unique serial number for each emitter.

## 1.2 Optical Center

The optical center coincides with the mechanical center of the LUXEON CoB emitter. Optical rayset data for the LUXEON CoB emitters are available at [lumileds.com](http://lumileds.com).

## 1.3 Handling Precautions

The LUXEON CoB 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 CoB emitter should only be picked up from the side of the package.

## 1.4 Cleaning

The LUXEON CoB 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 CoB 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 LUXEON CoB package. For more information regarding chemical compatibility, see Section 4.

## 1.5 Electrical Isolation

The aluminum substrate of the LUXEON CoB emitter is electrically isolated from the LED cathode and anode.

## 1.6 Mechanical Files

Mechanical drawings for the LUXEON CoB emitter are available at [lumileds.com](http://lumileds.com).

## 1.7 Soldering

LUXEON CoB emitters are designed to be mechanically secured onto a heat sink. For detailed assembly instructions, see Section 2.

## 2. Assembly Guidelines

### 2.1 Introduction

A typical assembly with LUXEON CoB emitter consists of a LUXEON CoB mounted onto a heat sink with screws through a use of a suitable CoB holder (Figure 1). A thermal interface material (TIM) is applied between the LUXEON CoB and the heat sink to improve thermal conductivity. Secondary optics typically can be added to the LED module and secured via the holder. The holder also acts as a conduit for making electrical connections to LUXEON CoB, also known as connector. Lumileds does not recommend soldering wires to the LUXEON CoB electrode pads.

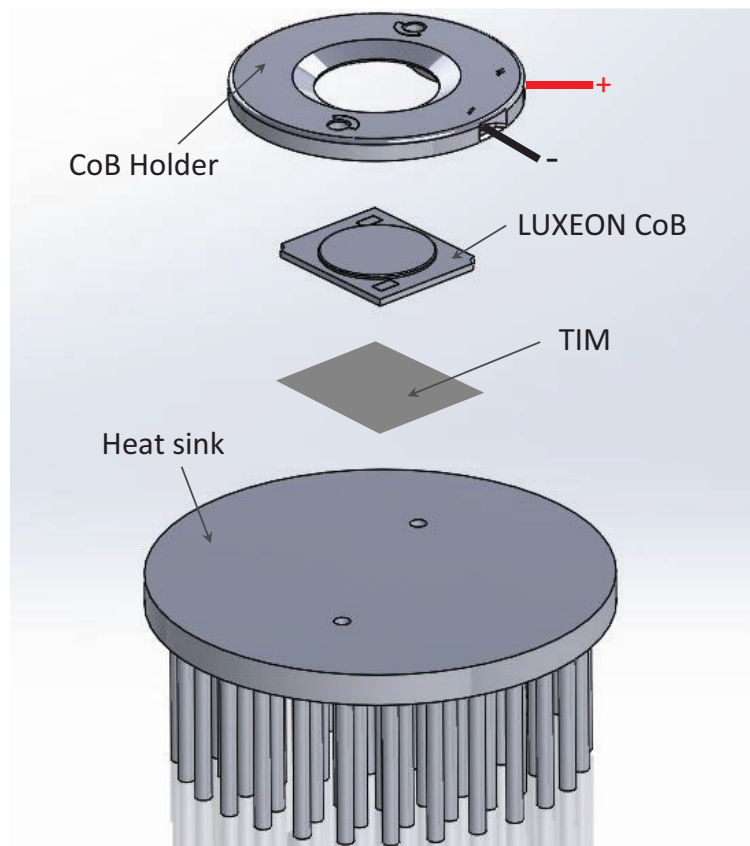


Figure 1. A typical LUXEON CoB assembly

## 2.2 Solder-less Connector Assembly Guideline

Figure 2 shows solder-less connectors for the LUXEON CoB emitters. While there are multiple connector solutions, the assembly process is essentially the same and consists of four steps; heat sink preparation, Thermal Interface Material (TIM) application, LED/connector assembly and wire attachment.

1. Prepare the heat sink according to the connector manufacturers recommendations. This usually consists of drilling clearance holes for locating pins and drilling and tapping threaded holes at the screw locations. Once this is done, the heat sink should be cleaned thoroughly to remove any trace of tapping lubricants and metal shavings.
2. TIM should be applied to the back of the LUXEON CoB emitter or to the heat sink in preparation for the next step. Application method is dependent upon the type of TIM selected. For more details regarding suitable TIMs, see Section 3.1
3. Mounting of the LUXEON CoB is dependent upon the type of solder-less connector chosen. For some types of solder-less connector solutions, the LUXEON CoB device must be snapped into place in the solder-less connector before placing the assembly onto the heat sink. For other types of solder-less connectors, place the LUXEON CoB onto the heat sink, align and drop the solder-less connector into place. Install mounting screws to the torque specified by the solder-less connector manufacturer.
4. The final step is to install wire leads to the connectors as recommended by the manufacturer and power up the device to test the connections.



Figure 2. A typical LUXEON CoB connector

## 2.3 Direct Attachment of LUXEON CoB to a Heat Sink

This method is not recommended for production. It is provided for information only.

### Part 1 — Make Electrical connections to LUXEON CoB:

Follow these steps to attach the electrical wires to the LUXEON CoB emitter:

Please Note: The phosphor layer should be covered when wires are soldered to the LUXEON CoB emitter. Please ensure that no solder flux or debris lands on the phosphor layer because this may impact the long-term performance of the LUXEON CoB emitter.

1. Prepare the electrical wires:
  - a. Cut the wires to size.
  - b. Strip a few millimeters of insulating material from the ends of the wires.
  - c. Pre-tin the wires with a small amount of solder.
2. Prepare the LUXEON CoB emitter:
  - a. Clean the electrical pads of the LUXEON CoB emitter with a lint-free swab and isopropyl alcohol to remove any debris or particles.

- b. The substrate of the LUXEON CoB emitter is designed to dissipate heat quickly. This may make it difficult to get the temperature of the electrical pads to a point where the solder will reflow. Therefore it is important to place the LUXEON CoB emitter on a thermally insulating surface. Alternatively, place the LUXEON CoB emitter on a pre-heated hot plate set to 100°C/212°F, not to exceed 120°C/250°F.
    - c. Place the tip of the soldering iron on the electrical pad, apply solder and allow it to wet the electrical pad. Do not place the soldering iron on the electrical pad for more than 3 seconds to prevent any damage to the LUXEON CoB emitter.
  3. Solder the pre-tinned wires to the pre-tinned electrical pads:
    - a. Place the pre-tinned LUXEON CoB emitter on a thermally insulating surface. Alternatively, place the LUXEON CoB emitter on a pre-heated hot plate set to 100°C/212°F, not to exceed 120°C/250°F.
    - b. Place the pre-tinned wire on the pre-tinned electrical pad.
    - c. Place the tip of the soldering iron on the electrical pad and allow the solder to reflow around the wire. Do not place the soldering iron on the electrical pad for more than 3 seconds to prevent any damage to the LUXEON CoB emitter. If a solder joint cannot be established within this time, allow the LUXEON CoB emitter to cool before reapplying the heat.
    - d. Remove the soldering iron and allow the solder to joint to cool.

#### **Part 2 — Attach the LUXEON CoB to the heat sink:**

1. Prepare the heat sink
  - a. Ensure that the heat sink surface is clean and flat, with no crowns or peaks in the mounting area; crowns or peaks on the heat sink surface may adversely impact the thermal conductance between the LUXEON CoB emitter and the heat sink.
  - b. Wipe the heat sink surface clean with isopropyl alcohol (IPA).
  - c. Apply thermal interface material (TIM) onto the heat sink. For more details regarding suitable TIMs, see Section 3.1.
2. Place the LUXEON CoB emitter onto the heat sink and align the screw slots in the substrate with the tapped screw holes in the heat sink
3. Secure the LUXEON CoB emitter to the heat sink with two screws.

## **3. Thermal Measurement Guidelines**

### **3.1 Thermal Interface Materials (TIM) Selection**

Due to the low thermal resistance of the LUXEON CoB emitter and its large thermal footprint, a variety of thermal interface materials can be used to thermally connect the emitter to the heat sink (e.g. phase change materials, thermal tapes, graphite sheets). However, TIM selection should be made with the following considerations:

1. Pump out—Some TIMs will move out of the thermal path during extreme temperature excursions and create voids in the thermal path. These materials should not be used.
2. TIM thickness—Excessive thickness of some TIMs will present an unacceptable thermal resistance even though the thermal conductivity may be high.
3. Surface roughness—In order to fill the air gaps between adjacent surfaces, choose the appropriate TIM that minimizes the interfacial contact resistance.
4. Operating temperature—Some TIMs perform poorly at elevated temperatures. Care should be exercised to select a TIM that will perform well under the anticipated operating conditions.
5. Out-gassing—Out-gassing of some TIMs at design temperatures may produce undesirable optical or appearance qualities (e.g. fogging) in a sealed system. Special consideration must be given to limit this effect.

6. Clamping force—TIMs such as thermal tape or pads perform better when the right pressure is applied. Screws on corners only may not be suitable for certain TIMs which require high contact pressure between the substrate of LUXEON CoB and the heat sink. See Figure 3 and Figure 4 for more information.

Table 1 lists several TIMs that have been tested with LUXEON CoB. This data is provided for informational purposes only. Lumileds cannot guarantee the performance of the listed TIMs since LED operating conditions and long-term performance specification will vary with the application design

**Table 1. List of TIM materials that meet the TIM considerations outlined in this section. Note, though, that the actual performance of these TIM materials will depend on the final application**

MANUFACTURER	TIM
Arctic Silver	Arctic Silver® #5
GrafTech	Graphite Sheet 1205
Thermalloy Inc.	Thermal Joint Compound (white)

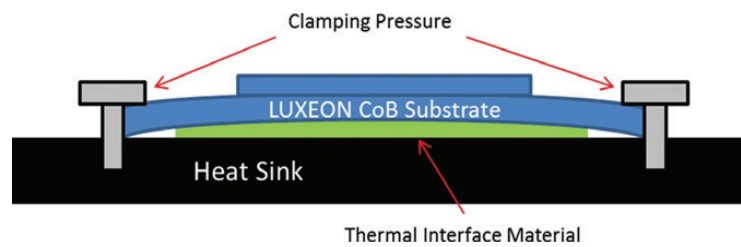


Figure 3. Example of poor TIM selection with direct attachment method. Clamping pressure causes deformation of the substrate at the edges because of TIM hardness. This method requires softer TIM types

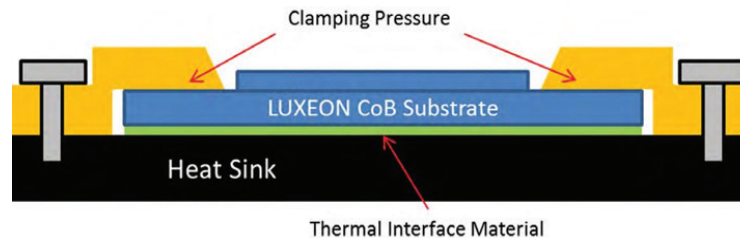


Figure 4. Example of a proper match between the TIM and attachment method. The clamping pressure in this example is more uniform and is less likely to cause substrate distortion even with harder style TIMs

## 3.2 Heat Sink

A suitably rated heat sink (cooling capacity) should be selected and evaluated to allow the operation of LUXEON CoB to be operated below the maximum rated junction temperature under a wide range of operating conditions (can be influenced by installation and environment).

## 3.3 Temperature Probing and Characterization

The typical thermal resistance  $R\theta_{j-c}$  between the junction and case for the different LUXEON CoB emitter configurations are published in the datasheet. With this information, the junction temperature  $T_j$  can be calculated according to the following equation:

$$T_j = T_c + R\theta_{j-c} \cdot P_{\text{electrical}}$$

In this equation  $T_c$  is the case temperature at the bottom of the LUXEON CoB emitter and  $P_{\text{electrical}}$  is the electrical power going into the LUXEON CoB emitter.

In typical applications it may be difficult to measure the case temperature  $T_c$  directly. Therefore, a practical way to determine the junction temperature of a LUXEON CoB emitter is by measuring the temperature  $T_s$  of a predetermined sensor pad with a thermocouple. Each LUXEON CoB emitter has a circular sensor pad area in the lower right hand corner of the emitter. Proper thermocouple attachment to the  $T_s$  or sensor pad area is shown in Figure 5.

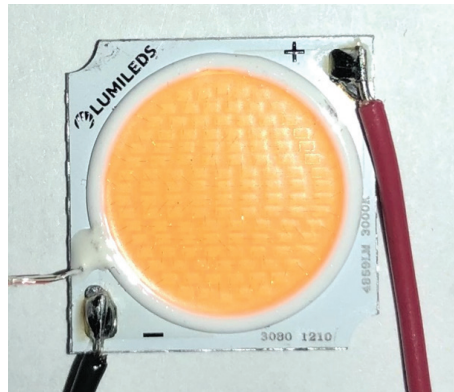


Figure 5. The example of thermocouple attachment for 1210

The thermal resistance  $R\theta_{j-s}$  between the sensor pad and the junction of the LUXEON CoB emitter was experimentally determined. Table 2 summarizes the typical thermal resistance values for each LUXEON CoB emitter configuration.

Table 2. Typical thermal resistance from junction to  $T_s$  point of LUXEON CoB

PRODUCT FAMILY	MODEL	TYPICAL $R\theta_{j-T_s}$ (K/W)
LUXEON CS CoB	L02S	1.24
	L02	1.24
	L03	0.97
	L04	0.70
	L05	0.43
	L06	0.40
	L08	0.33
	L10	0.28
	L11	0.24
	L13	0.19
	L16	0.12
	R12	0.10
	R18	0.043
LUXEON CS HE CoB	L08	0.33
	L11	0.24
LUXEON CS Pro CoB	L08	0.33
	L10	0.28
	L11	0.24
LUXEON CS CoB with CrispColor Technology	L02s	1.24
	L03	0.97
	L04	0.70
	L05	0.43
	L08	0.33
	L11	0.12

LUXEON CS CoB with CrispWhite Technology	1202s	0.72
	1203	0.44
	1204	0.35
	1205	0.26
	1208	0.2
	1211	0.14
LUXEON CS G2 HE CoB	1204	0.29
	1206	0.22
	1208	0.16
	1210	0.12
	1216	0.07
LUXEON CS Gen1 CrispWhite	1202s	0.83
	1203	0.52
	1204	0.38
	1205	0.29
	1208	0.18
	1211	0.13

### 3.4 Thermal Measurements

This section describes in detail how to mount a thermocouple onto the LUXEON CoB emitter in order to determine the junction temperature  $T_j$ .

#### Supplies and Equipment

Below is a list of supplies and equipment that is needed for  $T_j$  measurements:

- Type T precision fine wire (0.003" gauge diameter) thermal couple from Omega Engineering Inc. (part number: 5SRTC-TT-T-40-36)
- Eccobond one component, low temperature curing, thermal conductive epoxy adhesive from Emerson and Cuming (part number: E 3503-1) or Arctic Alumina Thermal Adhesive compound from Arctic Silver Inc. (part number: AATA-5G)
- Disposable 3CC barrel syringe from EFD Inc. (part number: 5109LL-B)
- Disposable 0.016" inner diameter fine needle tip from EFC Inc. (part number: 5122-B)
- Kapton tape
- Convection oven (for curing of Eccobond epoxy)
- Thermometer
- Magnifying glass or low power microscope (e.g. 5x to 30x)

#### Thermocouple Mounting Procedure

1. Familiarize yourself with the manufacturer's Material Safety Data Sheet (MSDS) and preparation procedures for the epoxy or adhesive compound.
2. Place the thermocouple tip on the sensor pad area  $T_s$ . The thermocouple must touch the substrate of the LUXEON CoB emitter to ensure an accurate reading. Special care should be taken when attaching the thermocouple so that it does not interfere with the electrical connection or compromise the thermal measurement.
3. Use Kapton tape to secure the thermocouple wire onto the LUXEON CoB emitter.
4. Follow step a or step b below depending on the compound or adhesive that is used to thermally connect the thermocouple to the LUXEON CoB emitter.
  - a. Eccobond Thermal Adhesive Epoxy
    - i. Thaw the thermal conductive epoxy per manufacturer's recommendations.

- II. Dispense sufficient epoxy into the 3CC barrel syringe with the fine needle tip. Store the balance per manufacturer's recommendations.
  - III. Drop a small amount of thermal conductive epoxy just enough to cover the thermocouple tip.
  - IV. Cure the epoxy per the manufacturer's recommendations. Make sure that the oven temperature does not exceed the maximum rated temperature of the LUXEON CoB emitter.
  - V. Let the board cool down to room temperature before starting any measurements.
- b. Arctic Alumina Thermal Adhesive compound
- I. Since this is a two part epoxy system with an approximate pot-life at room temperature after mixing of 3–4 minutes, make sure that proper setup is done to ensure that the epoxy can be dispensed within the pot-life span.
  - II. After mixing, put the epoxy immediately into the 3CC barrel syringe with the fine needle tip and dispense onto the thermocouple tip. Close to the end of the pot-life, it becomes difficult to dispense.
  - III. Alternatively, you can dip the fine needle tip into the epoxy mix and then “touch” the thermocouple tip to dispense the epoxy via surface tension.
  - IV. Cure the epoxy at room temperature (25°C) for at least two hours.
5. Once the epoxy/compound has hardened, the LUXEON CoB emitter can be mechanically mounted onto the heat sink as explained in Section 2.
  6. Plug in the thermocouple connector to the thermometer. The thermocouple now measures the temperature  $T_s$ .
  7. Connect the power supply to the LUXEON CoB emitter and power up the emitter with a drive current that corresponds to normal operating conditions. If possible, attach all fixtures (e.g. heat sink, lens and any cover) to closely simulate the actual application environment.
  8. Record the temperature  $T_s$  once the LUXEON CoB emitter stabilizes. This may take several minutes or more depending on the overall design and thermal mass.
  9. The junction temperature can then be estimated as follows:

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

## 4. Packaging Considerations—Chemical Compatibility

The LUXEON CoB 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 CoB 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 CoB 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 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 CoB 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. 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 overcoat of the LUXEON 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
Roisin Flux	Solder Flux <sup>[1]</sup>
Acrylic Tape	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. Solder flux should not spit onto the LUXEON emitter surface or leave excessive secondary solder flux residue on the PCB when operating LEDs in an air tight enclosure or poorly ventilated enclosure.

## About Lumileds

Lumileds is a global leader in LED and microLED technology, innovation, and solutions for the automotive, display, illumination, mobile, and other markets where light sources are essential. Our approximately 3,500 employees operate in over 15 countries and partner with our customers to deliver never before possible solutions for lighting, safety, and well-being.

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



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