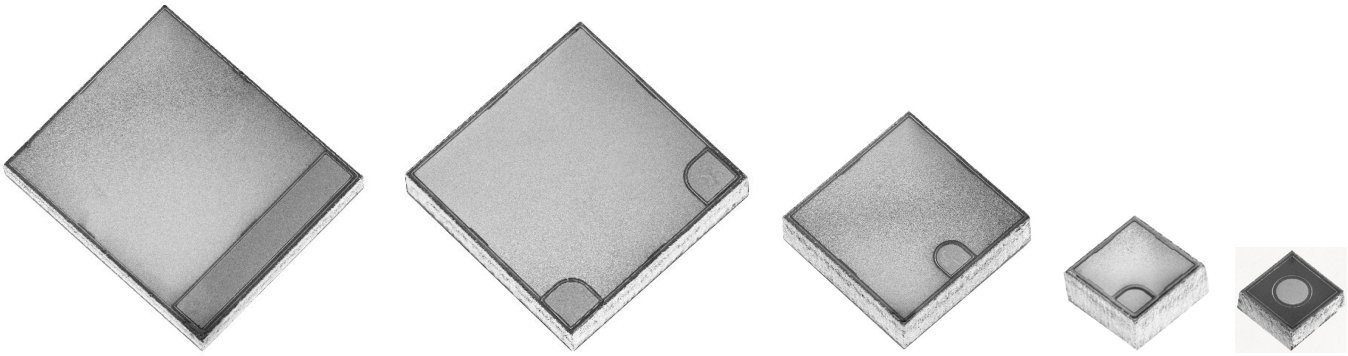
Cree LED EZ-p™ LED Chips
Handling and Packaging Recommendations



Introduction

This application note provides the user with an understanding of Cree LED's EZ-p™ p-pad up (anode up) LED chips, as well as recommendations on handling and packaging. Further details regarding performance and dimensional specifications of EZ-p LED chips can be found on the individual product data sheets at www.cree-led.com.

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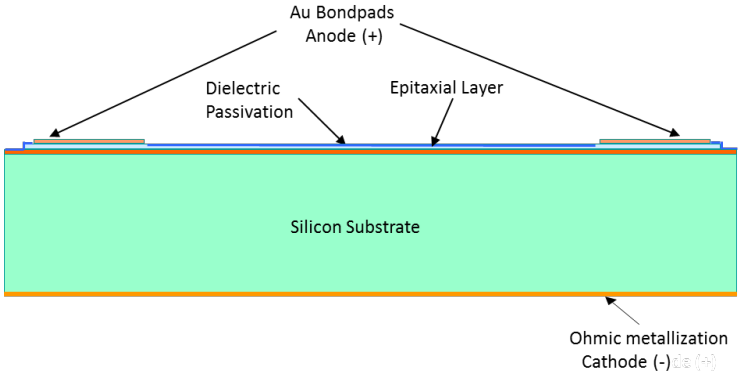
EZ-p LED Structure

A cross-sectional schematic diagram of an EZ-p LED chip is shown below. The EZ-p LED chip has a vertical structure with topside Au bond pad anode (+) terminal(s) and an Ohmic metal cathode (-) on the bottom of the substrate. The epitaxial emitting layer is metallically bonded to the substrate and the surface of the emitting area is passivated. Product specifications for the full line of EZ-p LED chips are available at www.cree-led.com.



EZ-p LED Chip Handling

In general, industry standard handling procedures can be used with the EZ-p LED chips. Both coaxial and radial lighting sources (ring or fiber lights) are recommended for pattern recognition systems in automated pick and place or bonding processes. Low angle side lighting may also be used to provide improved contrast.

The following guidelines include recommendations to maintain optimal performance:

- Minimize contact between metallic fixtures, equipment, tweezers, or other hard objects and the emitting surface and edges of the emitting layer. Excessive contact force can damage the device, leading to electrical leakage and reduced optical output.
- If possible, avoid application of tapes or adhesives to the emitting surface. Tape residue can contaminate the textured surface, leading to reduced light extraction efficiency or poor lamp encapsulant adhesion.

Die Ejection

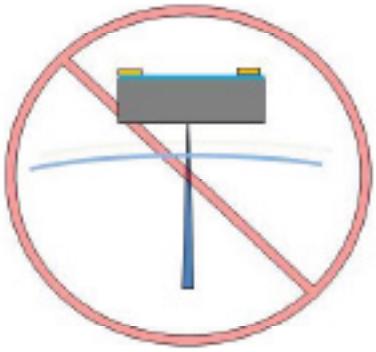
EZ-p LED chips are shipped from Cree LED with the epitaxial side up on the carrier tape. The application of excessive force during the die ejection process must be avoided. To minimize the risk of damage Cree LED recommends the following:

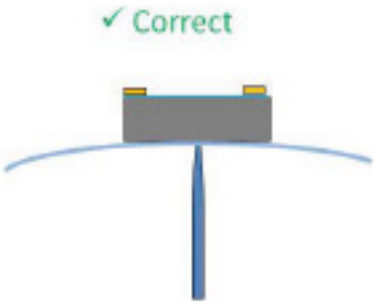
- Observe the following ejector pin minimum tip radius guidelines (Table 1)

Table 1: Recommended minimum ejector pin tip radius

EZ-p Chip	Minimum Tip Radius (µm)
Chip dimension < 400 µm	22
400 µm ≤ Chip dimension ≤ 1000 µm	50
Chip dimension > 1000 µm	125

- Minimize ejector pin speed and travel
- Synchronize pin travel with collet motion to minimize the force applied to the chip
- Adjust the ejection process to prevent pin penetration of the tape film





Collets

Rubber collets and handling fixtures with hardness in the approximate range of 80 (Shore A), or equivalent, are recommended. Harder plastic collets may be used, in which case minimization of die placement or bonding parameters (forces) is recommended. The selection of bonding force level should be confirmed through reliability testing. A variety of rubber and plastic collet materials, covering a range of use temperatures, are available for use with EZ-p chips, including Teflon®, Vespel®, silicone rubber, and Viton®.

Recommended collet inner diameters (ID) for use with the corresponding EZ-p chip designs are listed in Table 2. Customers should contact the collet manufacturers for recommendations on designs specific to their application and die bonding equipment. Supplier information is provided following Table 2. For more information or questions regarding collet recommendations please contact Cree LED.

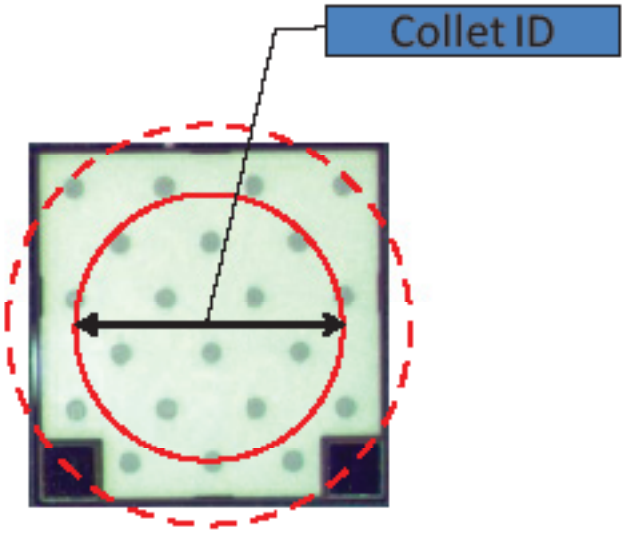


Table 2: Collet ID recommendations

EZ-p Chip	Colleet ID (µm)
Chip dimension < 400 µm	200-210
400 µm ≤ Chip dimension ≤ 700 µm	400-420
700 µm ≤ Chip dimension ≤ 1400 µm	750-770
Chip dimension > 1400 µm	1500-1520

Supplier Information

Micro Mechanics (www.micro-mechanics.com): Singapore, China, Taiwan, Japan

Small Precision Tools (SPT) (www.smallprecisiontools.com): USA, Singapore, China, Japan

EZ-p LED Chip Die Attach

Eutectic/Solder Attach

For all solder attach processes, the following guidelines must be observed:

- The maximum reflow process conditions for EZ-p LED chips are 325 °C for 5 seconds. This process window is adequate for the reflow of the intrinsic die attach metallization and a range of other solders, including Pb-free solders. The temperature profile should be verified by direct measurement at the LED chip to ensure that the maximum process limits are not exceeded.
- If plasma cleaning is a customer consideration, Cree LED recommends that the EZ-p LED chips not be exposed to Hydrogen plasmas. Addition of Hydrogen to other types of plasma types should be minimized.
- Minimal pressure should be applied to the EZ-p chip during the soldering process. Pressure eutectic attach of EZ-p LEDs is not a Cree LED recommended process, however if the customer elects to use this process, then a maximum bonding force of 50 grams is recommended.
- Complete solder underfill of the EZ-p chip is required, especially at the edges of EZ-p chips with corner bond pads, to provide a rigid support for the chip and to reduce the risk of cracking/chipping during the subsequent wirebonding process.

Flux

Recommended fluxes for **Flux Eutectic Attach (FEA)** are listed in Table 3 along with the manufacturer's recommended cleaning agents. Alternative fluxes should be evaluated by the customer, as appropriate. Flux residue should be cleaned prior to encapsulation. Follow the flux manufacturer's recommended cleaning process or contact Cree LED for additional information.

Flux should be dispensed onto the substrate such that the EZ-p chip's cathode metallization will have complete coverage. Avoid using excessive flux to prevent die movement during reflow. Flux quantity may be optimized by seating the EZ-p chip into the dispensed flux during die placement and minimizing the amount of flux displaced around the base of the die. The required quantity of dispensed flux will vary depending on the EZ-p chip size and type of flux used.

Table 3: Recommended fluxes and cleaning agents

Flux	Cleaning Solution
Indium Tac007	Kyzen® Ionox® I3302
Arakawa WHP-002/WHP-002 LED	PINE Alpha series

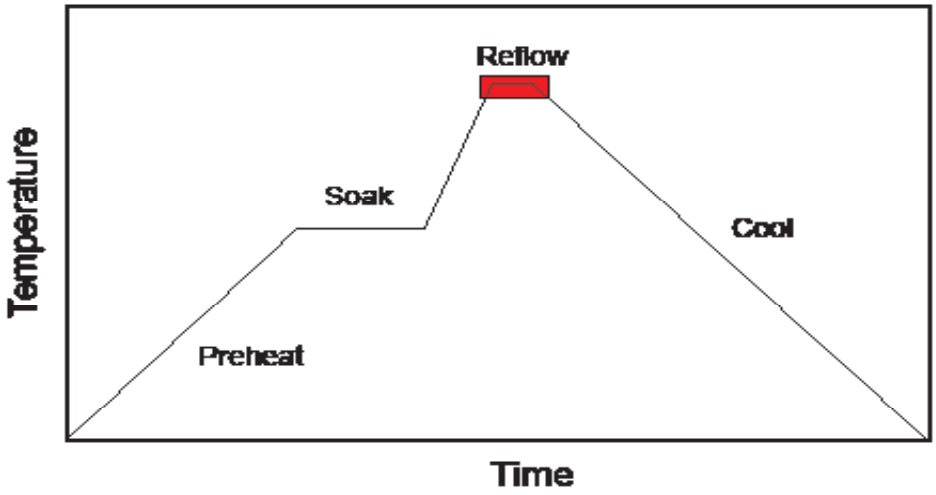
When using the intrinsic die attach metal for FEA, Cree LED recommends the following guidelines for substrate metal finish to enable good surface wetting and uniform metal bond formation.

Table 4: Substrate surface finish parameters

Design Item	Dimension (µm)
Substrate Roughness	Ra ~0.7, Rz < 2

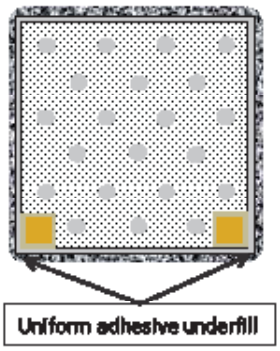
Reflow

The reflow profile for EZ-p LED chips will vary due to the thermal mass of the leadframe or substrate. A schematic reflow profile is shown below. Cree LED recommends that the pre-heat, thermal soak and cooling profile conform to the flux manufacturer's recommendations. The target reflow zone for the intrinsic AuSn die-attach metallization should be limited to 300-320 °C for less than 30 seconds.

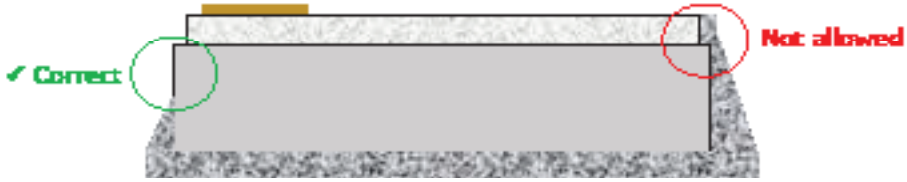


Adhesive Attach

EZ-p LED chips require an electrically conductive adhesive. The adhesive must completely underfill the EZ-p LED chip to ensure adequate die adhesion, good thermal conductivity and rigid support to the chip during subsequent wirebonding. Adhesive should be visible around the entire perimeter of the chip after die placement, especially at the edges of chips with corner bond pads, as shown below.

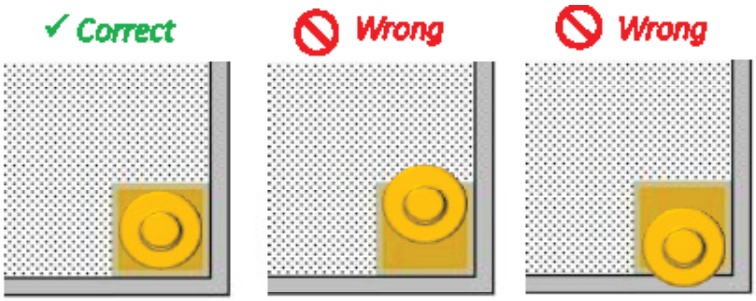


Adhesive contact on more than 50% of z-height is not recommended. Adhesive contact to the top surface of the chip is not allowed as this can lead to electrical leakage and reduced device performance.



EZ-p LED Wire Bonding

EZ-p LED chips are designed for Au-ball wirebonding. Aluminum wedge bonding is not a Cree LED recommended process. It is important that the entire ball bond remain within the confines of the bond pad area and that no metal contact the emitting surface. Care must be taken to prevent the wire capillary fixture from contacting the emitting surface as this can damage the LED junction. EZ-p chip designs feature bond pads adjacent to the edge of the junction mesa, therefore wire bonds must not exceed the bond pad area. Contact with the mesa edge could lead to shunting leakage and/or junction damage.



The following guidelines should be observed for optimal wirebonding of EZ-p LED chips:

- Wirebonding force and ultrasonic power should be minimized
- Capillary geometry should be chosen to minimize the force required for ball formation
- Wirebonding process temperatures should be adjusted to minimize the required bonding forces/powers

Absolute bonding parameters for EZ-p LED chips cannot be specified since bonding equipment and materials vary greatly. Table 5 lists suggested maximum parameters that may be used as a guideline for wire bond development. The customer is advised to optimize bonding parameters for their specific equipment, tooling, and bonding wire.

Table 5: Target wirebonding parameters

Wirebonding Parameter *	Maximum Value
Bond Time	12 ms
Bond Force	40 g-force
Ultrasonic Power	100 mW

* Parameters based on settings for ASM Eagle 60 Au-ball bonder using AW99 1.2 mil Au wire at 160 °C bonding temperature, Gaiser 1572-17-437GM-20D capillary, 138 kHz ultrasonic frequency.