C35 LED
APPLICATION NOTE

This application note is for C35 series products, and describes the handling, storage, measurement, and testing methods for C35 LEDs.

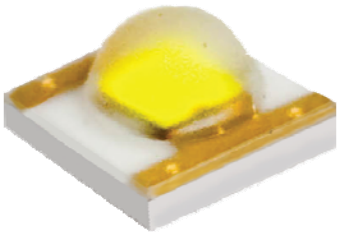
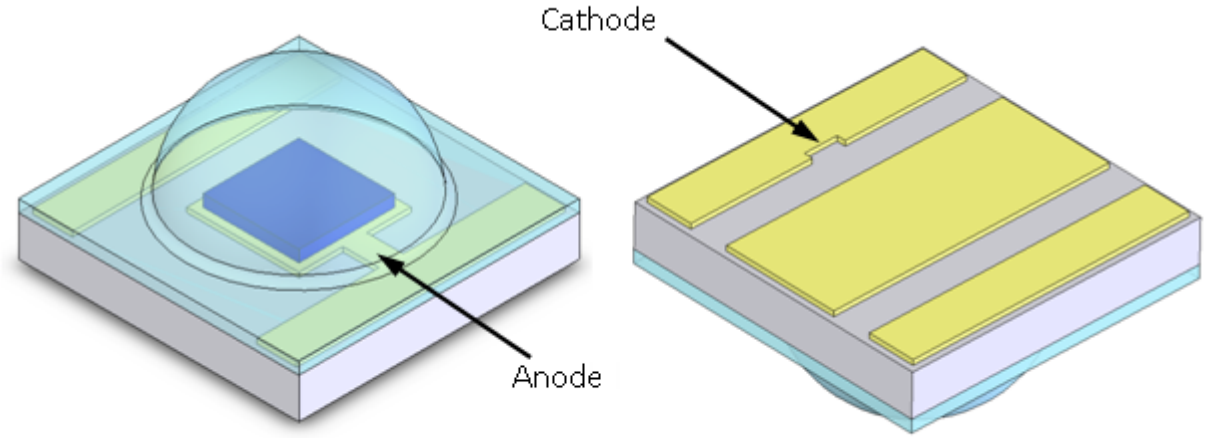


Table of Contents

RoHS Compliant

Recommended Solder Pad Design

There are 3 pads for C35 LEDs which are shown in Figure 1. N & P Pads are on the left-hand side and the right-hand side respectively, and the center pad is the thermal pad for heat conduction only.



Pads	Means
1	Cathode(N)
2	Thermal Pad
3	Anode(P)

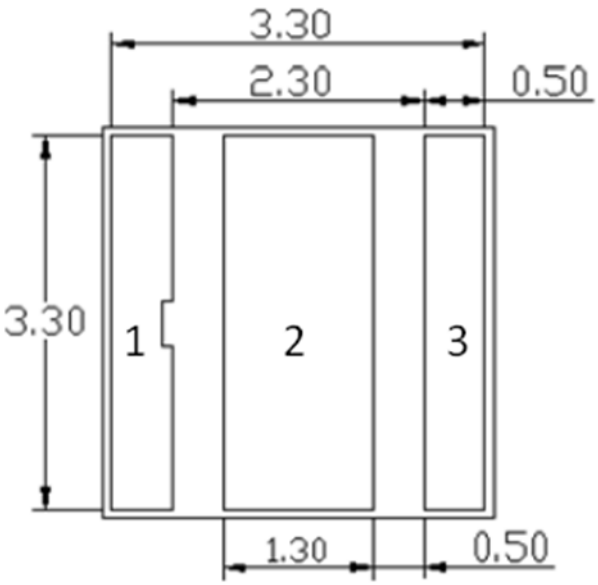
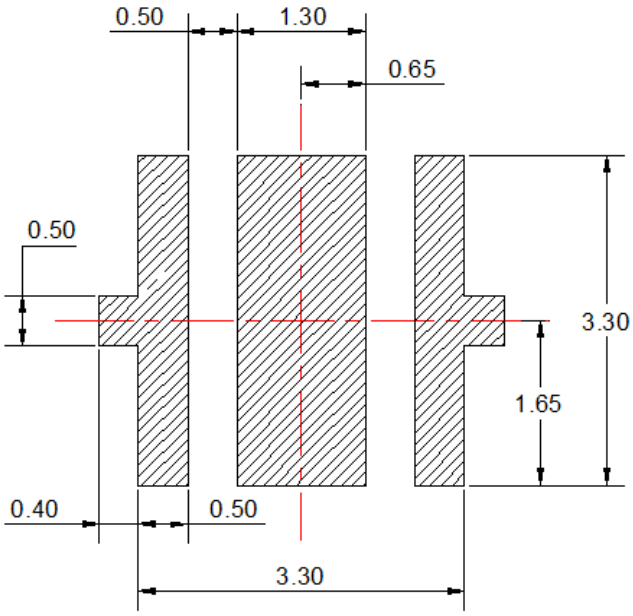


Figure 1. C35 LED Pad Configuration

Please identify the proper P/N pad positions carefully before SMT.

Recommended Soldering Pad Design (Unit: mm):



Recommended Stencil Pattern Design (Marked area is the opening) (Unit: mm):

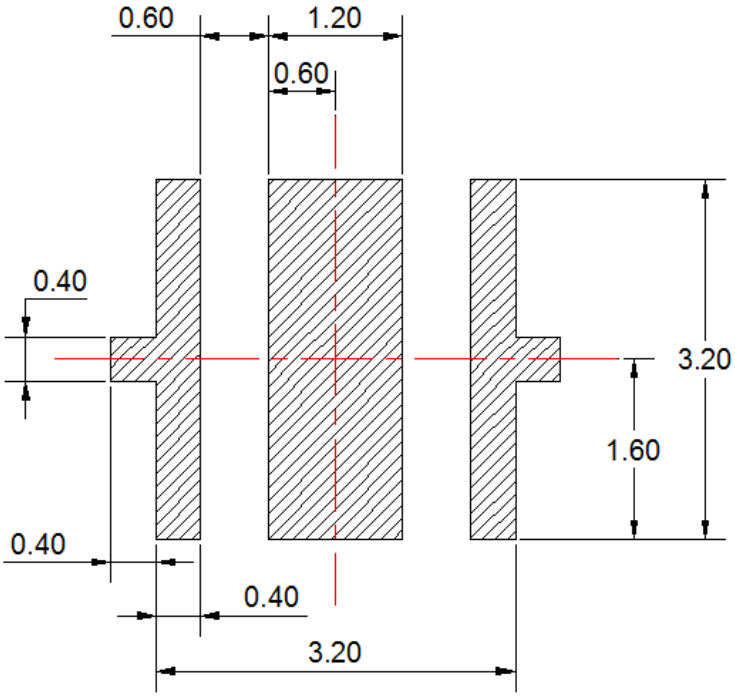


Figure 2. C35 recommended solder pad and stencil pad layouts

Recommended Cleaning and Coating Methods

C35 LED Cleaning

C35 was 100% cleaned before shipping. In normal use it does not need to be cleaned again before SMT. In the case where a minimal amount of dirt and dust particles are present during shipping & use, a suitable cleaning solution can be applied to the lens surface.

1. During handling, keep the environment clean.
2. Gently swab the lens using a lint-free swab.
3. If needed, use a lint-free swab and IPA (isopropyl alcohol) to gently remove dirt from the lens surface. Do not use other solvents as they may directly react with the LED lens.
4. Do not use ultrasonic cleaning since this may damage the LED.
5. Do not press or apply pressure on the lens.

Recommended Conformal Coatings

SemiLEDs has found that the following conformal coatings are safe to use with C35 products. Conformal coating should not be applied directly to or over the LED emitting area as it may hinder the LED's optical performance and reliability.

- Dow Corning 3140
- Dow Corning 3-1953
- SIL-More SCE 3990

Harmful chemicals

SemiLEDs has found the following chemicals to be harmful to C35. The fumes from even small amounts of these chemicals may damage the LEDs. Figure 3 shows the color shift after solvent penetrating into the lens. Sometimes, the phenomena will recover after baking the LED for a while as in Figure 4.

Figure 3. Color shift due to solvent penetrating inside the LED

Figure 4. Recovery after baking

- Toluene, benzene, xylene
- Methyl acetate or ethyl acetate
- Cyanoacrylates
- Glycol ethers
- Formaldehyde or butadiene
- Dymax 984-LVUF conformal coating
- Loctite Sumo Glue
- Gorilla Glue
- Clorox Clean-Up Cleaner spray
- Clorox bleach
- Loctite 384 adhesive
- Loctite 242 threadlocker
- Loctite 7387 activator

Above chemicals will affect C35 series characteristics; please do not use.

Storage

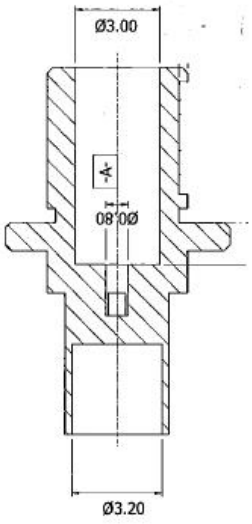
Please store C35 LEDs in a dry box. The recommended storage conditions are: 5~30℃; RH<50%.
After opening the package:

1. The LEDs should be soldered within one day.
2. If unused LEDs remain, they should be stored in moisture proof packages or in a dry box. The storage conditions are: 5~40°C; RH<30%.
3. If unused LEDs are stored for more than one week, baking treatment should be performed with the following baking conditions: more than 4 hours at 60±5 °C.

Handling

Recommended Handling

1. C35 emitter is a SMT type device, and it is strongly recommended that automated pick and place machines are used to assemble the LED onto the PCB. The material of pickup head should be plastic or metal to avoid damage to the emitters during pick and place.
   Recommended pickup head dimensions are shown in Figure 5.



Note:
1. All dimensions are in millimeters.
2. Drawings not to scale.
3. General tolerance are ±0.05 mm unless otherwise indicated

Figure 5. Recommended pickup tooling dimensions

2. If manual pick and place is to be applied, only plastic tweezers should used. Do not touch the lens with the tweezers or fingers. Use tweezers to grab the C35 Emitters at the base gently and put onto the PCB with solder paste carefully, as in Figure 6.

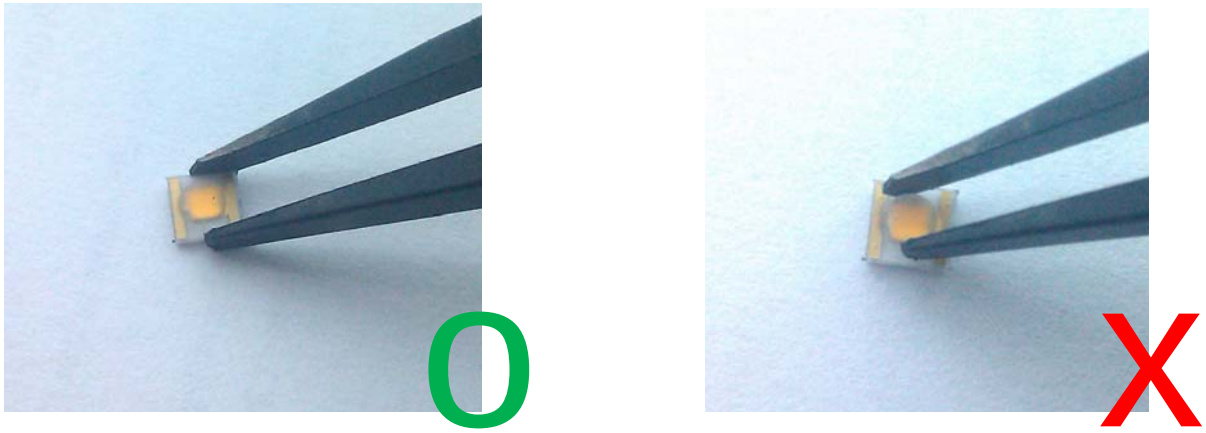


Figure 6. Proper use of tweezers

If metal tweezers have to be used, do not use the one shown in Figure 7.

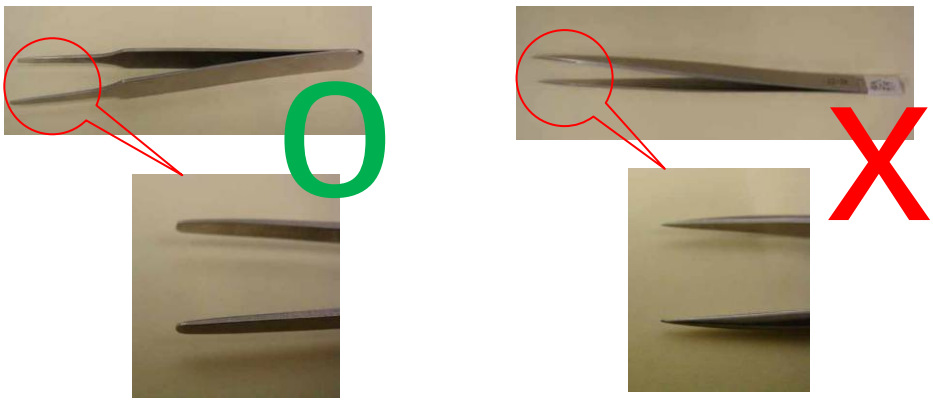
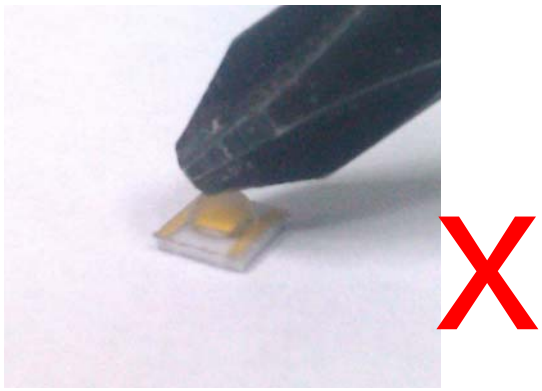


Figure 7. Proper selection of tweezers

1. C35 LEDs are designed to be reflow soldered to a board. Reflow soldering should be done by a reflow oven. Normally, hotplate is not recommended. The reflow soldering profile is listed on page 10. (If hot plate is used, follow the conditions: Temperature<250 °C; and Time<15 seconds for each one.)
2. Do not use wave soldering or iron.
3. Incorrect handling methods during assembly are shown in Figure 8.

Pressing on the lens

Picking up on the lens



Screw driver striking the LED

Figure 8. Incorrect handling during assembly

Soldering Notes

a. Solder Methods: C35 is designed to be soldered onto a PCB. Users could solder C35s on the PCB by a reflow oven or a hotplate (examples shown in Figure 9) and following the reflow soldering profile listed on the reflow information.

Do not hand solder or wave solder C35 LEDs. Hand or wave soldering can damage the C35 LED.

Figure 9.

b. Solder Paste Type

SemiLEDs recommends the following solder paste compositions: SnAgCu

c. Solder Paste Thickness

A solder stencil printer or an automated dispensing system is recommended for the most consistent results. SemiLEDs recommends using solder thickness range between 2～3mil (50-75μm).

Recommended Manual Rework Procedure

Step 1: Set up the hot plate temperature properly. Do not put the PCB on the hot plate before the temperature is stable at the set value.

Step 2: Use tweezers to take the C35 from the PCB carefully once the solder paste has melted.

Step 3: Check the solder pads condition. Make sure the solder pads are covered by the solder paste.

Step 4: Put the LED back to the PCB properly. The time from step 2 to step 4 should be completed within 30 seconds.

Step 5: Take the PCB out of the hot plate and put it on a heat sink to cool down the PCB temperature.

Notes:

1. Avoid solder balls which may short anode, cathode or thermal pad, such as in Figure 10.
2. Avoid external mechanical force applied on the LED lens or substrate.
3. Do not touch the lens surface with sharp objects or fingers.
4. Leakage path may exist when sub-mount cracks or chips due to damage from un-suitable handling.
5. Final inspection and test is suggested after SMT process for each emitter.

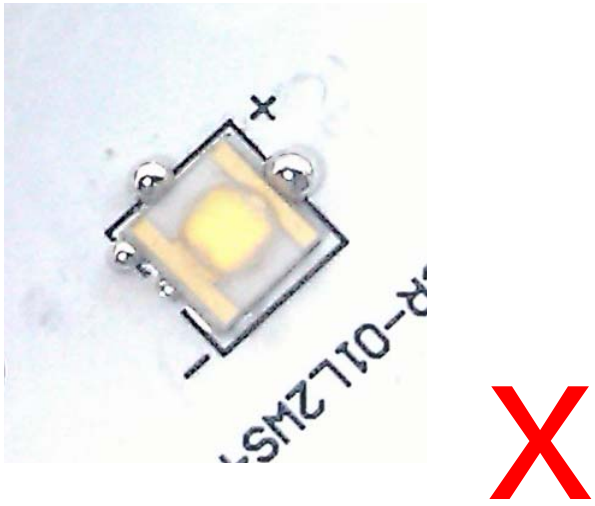
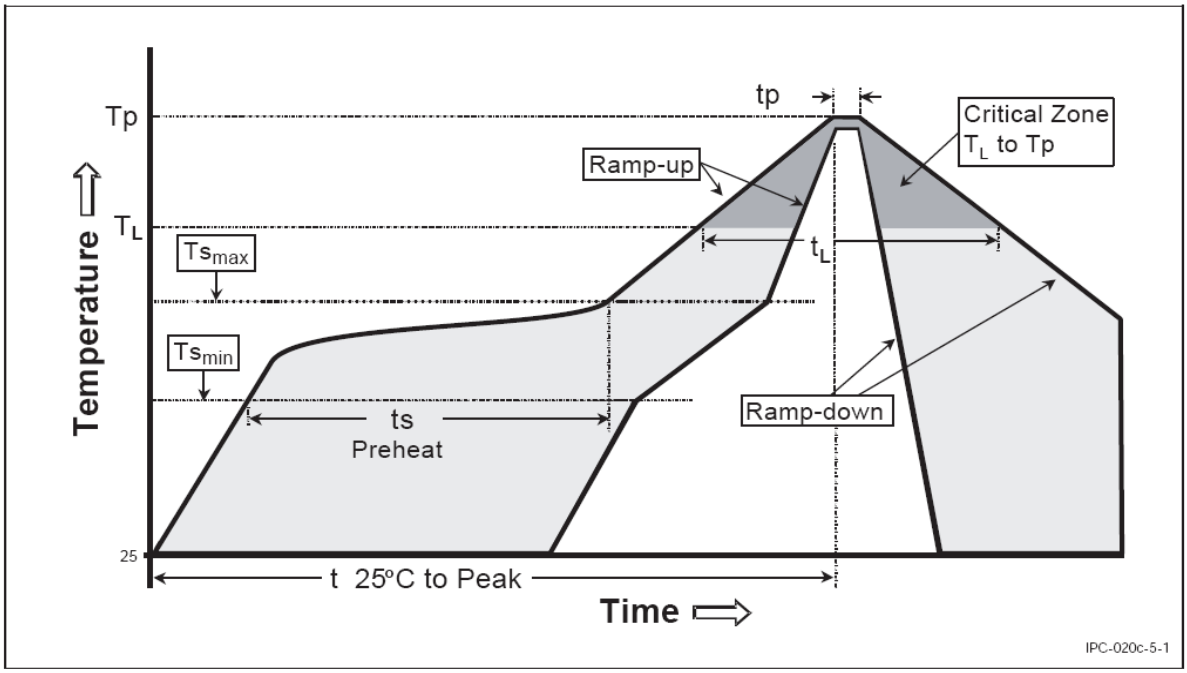


Figure 10. Soldering Problem

Reflow Information

The LEDs can be soldered using the parameters listed below. As a general guideline, the users are suggested to follow the recommended soldering profile provided by the manufacturer of the solder paste. Although the recommended soldering conditions are specified in the list, reflow soldering at the lowest possible temperature is preferred for the LEDs.



Profile Feature	For solder with Pb	For Lead free solder
Temp ramp up rate (Tsmax to Tp)	3℃/second max.	3℃/second max.
Pre-heat - Min. Temp(Tsmin) - Max. Temp(Tsmax) - Time(tsmin to tsmax)	 100℃ 150℃ 60-120 seconds	 150℃ 200℃ 60-180 seconds
Stable Condition: - Temp.(TL) - Time(tL)	 183℃ 60-150 seconds	 217℃ 60-150 seconds
Peak Temp.(Tp)	215℃	260℃
Time in Peak Temp.(tp)	10-30 seconds	20-40 seconds
Ramp down rate	6℃/second max.	6℃/second max.
Time from 25℃ to Peak temp.	6 minutes max.	8 minutes max.

Notes: After reflow process, the LED lens surface may be polluted by flux or contamination which may impact the LED optical performance. It is suggested to clean the lens surface by alcohol or IPA. Please refer to “C35 LED Cleaning”.

Storage and Handling of Assembled Parts

Recommendations

Do not stack PCBs or assemblies containing C35 emitters. The C35 emitter may be damaged during this stacking. The PCB should be stacked in a way to allow enough spacing above the LED lens as in figure 11.

Figure 11. Correct Storage Method

Incorrect Method

PCBs with C35 emitters should not be stacked on top of each other, as shown in Figure 12.

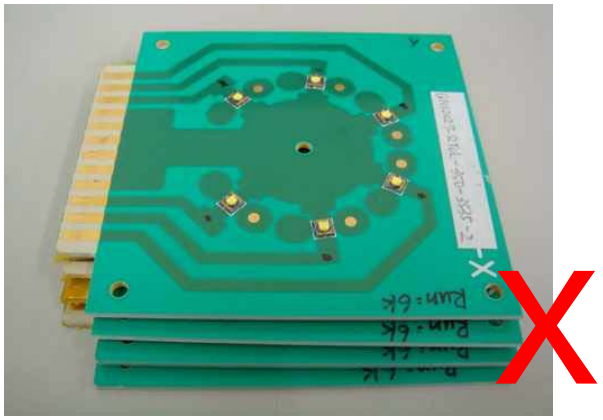
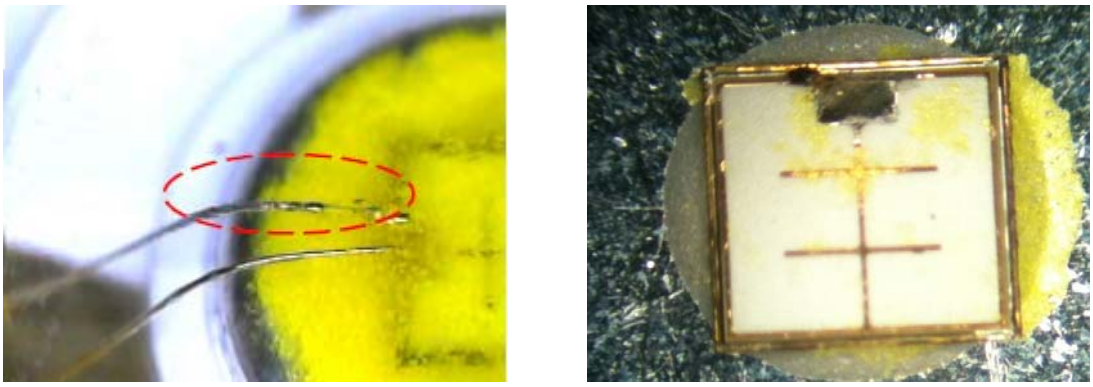


Figure 12. Incorrect stacking of PCBs with C35 emitters

Light Up Test

1. The voltage should be limited when using a power supply to light up the LEDs after SMT. Voltage should not exceed 4V for each LED. When the voltage is 4V, the current will be in excess of 1500mA. This may damage the emitter due to wire or pad burn out as in Figure 13.

e.g. If there is a module with 3 LEDs in series, the maximum voltage of the power supply should be lower than 12V.



Wire burn out Bonding pad burn out

Figure 13

2. Check the polarity of the emitter. Reverse voltage and current may damage the Zener diode. Figure 14 shows the C35 I-V curve in forward and reverse operation.

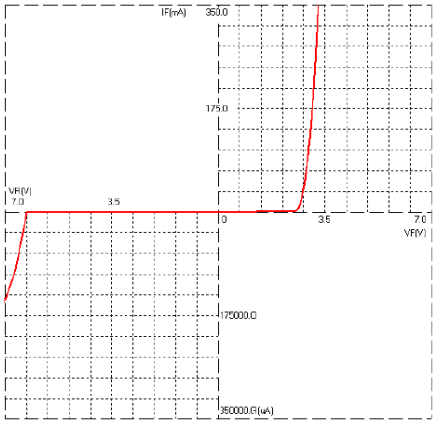


Figure 14. C35 LED I-V curve

3. If using a constant current limited voltage driver to light up the LED module, please connect the power supply and the LED module before plugging the power supply into the AC power cord. This can reduce the probability of surge current damaging the LED modules.

4. Brightness has a strong relationship with driving current as shown in Figure 15.

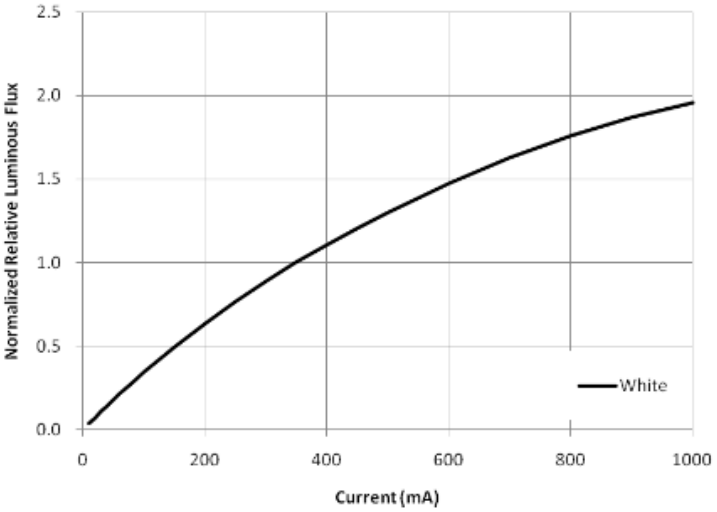


Figure 15. C35 LED L-I curve

Current	350mA	500mA	600 mA	700mA
Normalized Relative Lm	100%	125%	152%	170%

Thermal management

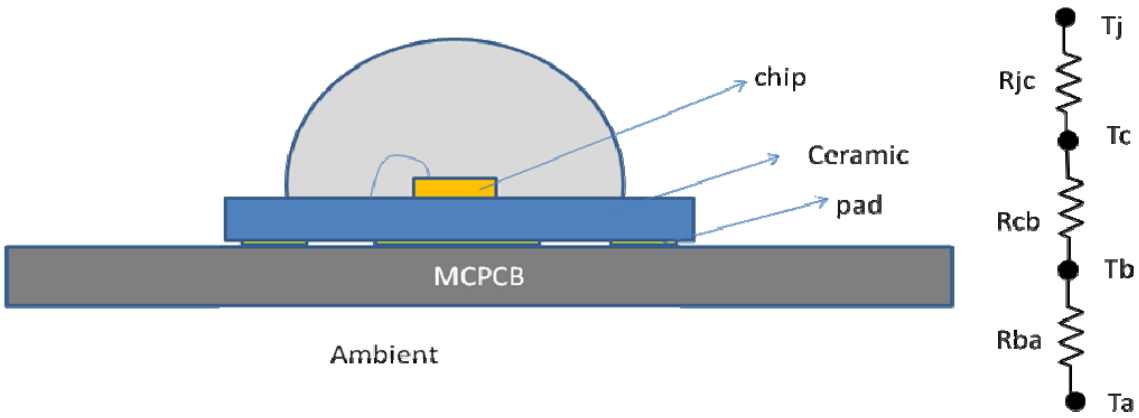


Figure 16. C35 LED L-I curve

Thermal resistance

Figure 16 shows a cross-section and a simple thermal model for a C35 soldered on the MCPCB . A simple thermal model or thermal circuit can illustrate the heat flowing through a MCPCB. Heat release path from location of heat generation for LED chip to ambient is as below:

LED chip →Die-attach resin → ceramic → MCPCB →Ambient

Where:

Tj is the temperature at the junction of the device

Tc is the temperature at the Ceramic

Tb is the temperature at the point of MCPCB

Ta is the ambient air temperature

Rjc is the thermal resistance from junction to case of the Ceramic

Rcb is the thermal resistance between the case of the Ceramic and the MCPCB

Rba is thermal resistance between MCPCB and ambient

Unit of thermal resistance is °C /W,

For example, 10°C/W means that temperature goes up 10°C per every input power 1W.

Equation 1 be low represents the relationship between Tj and Ta.

$$Tj = Ta + Rba \times Pd + Rcb \times Pd + Rjc \times Pd$$
$$= Tb + Rcb \times Pd + Rjc \times Pd$$
$$= Tc + Rjc \times Pd$$

Equation 1

In real case, it is hard to measure Tj directly, so it will be easier to get the Tj by measuring Tb or Ta. Then the equation 1 can be simplified to equation 2

Tj=Ta+Rja×Pd or Tj=Tb+Rjb×Pd

Equation 2

When using C35 in luminaires, it's better to control the Tb temperature below 70°C. This will keep the Tj of C35 below 125°C. For example, the Rjb of C35 in the datasheet is 8 °C/W.

Tj is calculated as below if Tc is 70°C@500mA, Vf=3.4V

Tj=Tb + Rjb x Pd=70 + 8 x(0.5x 3.4)=83.6°C.

When heat gathers inside the LED, it causes degradation of luminous efficacy and lifetime, and results in degradation of expected performance. It's essential to have a good thermal design to release the heat to the ambient.

Measurement and Calibration

Integration Time

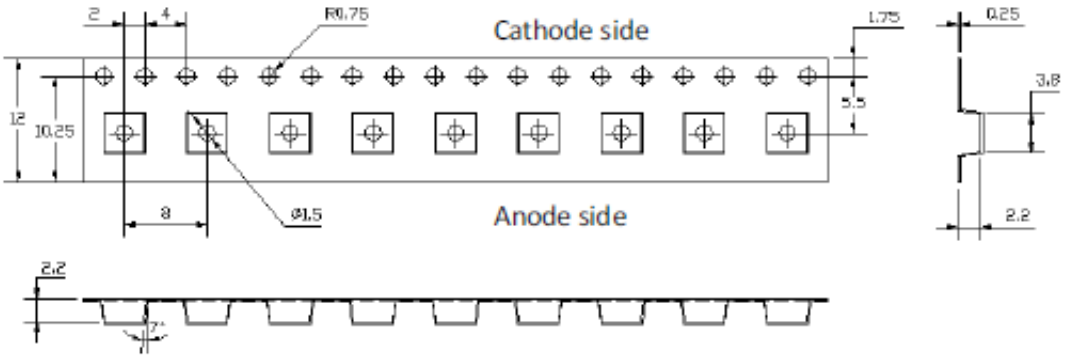
A long integration time will induce thermal issues in LED measurements. If the integration time is 1 sec, the LED junction temperature (Tj) may reach over 50℃, which results in the light output dropping more than 5%. It is recommended that the integration time is shorter than 25ms in high power LED measurements.

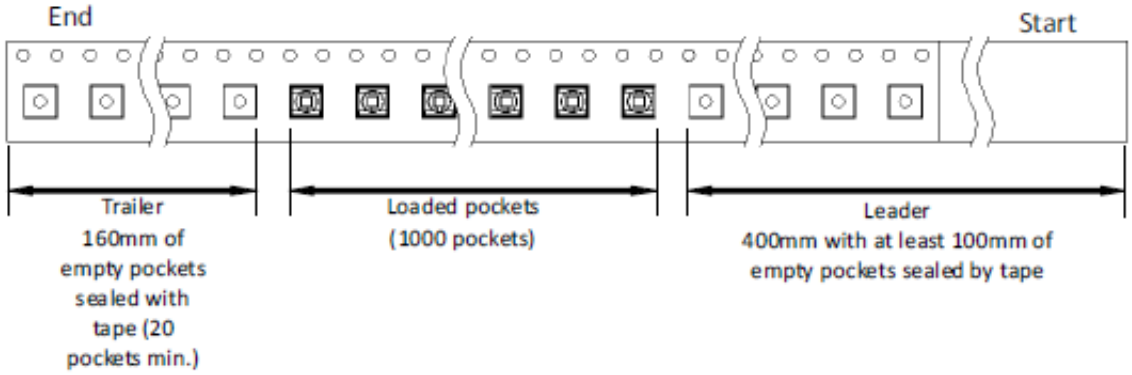
Recommended Method

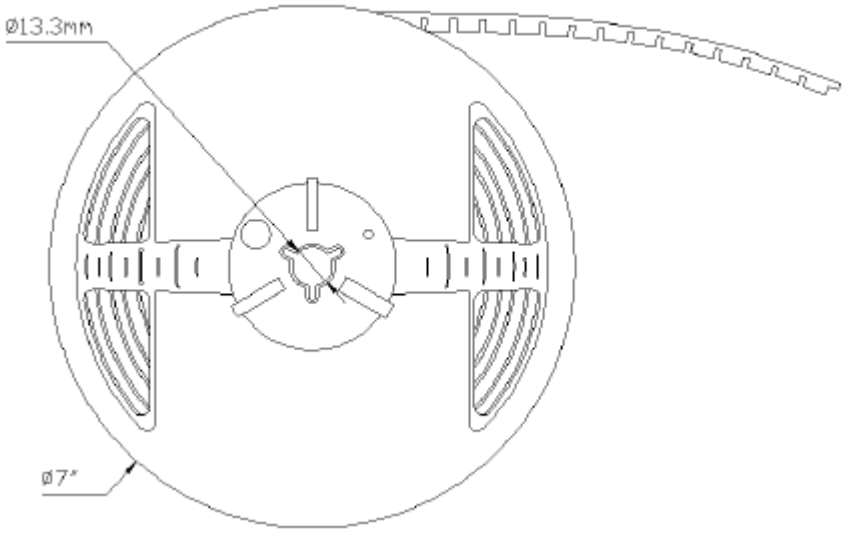
1. Use measurement instruments which follow the CIE 127 standards. The integration time should be shorter than 15ms.
2. If the operator uses non-standard testers, calibrate the tester with the golden sample before measurement. The golden sample should be measured by the instrument following CIE 127 standards (ea. IS CAS 140B).

Packing

The carrier tape conforms to EIA-481D.







Note:

1. All dimensions are in millimetres

About Us

SemiLEDs Corporation is a US based manufacturer of ultra-high brightness LED chips with state of the art fabrication facilities in Hsinchu Science Park, Taiwan. SemiLEDs specializes in the development and manufacturing of vertical LED chips in blue (white), green, and UV using a patented copper alloy base. This unique design allows for higher performance and longer lumen maintenance. In December 2008, The World Economic Forum recognized SemiLEDs innovations with the 2009 Technology Pioneer Award. SemiLEDs is fully ISO 9001:2008 Certified

SemiLEDs is a publicly traded company on NASDAQ Global Select Market (stock symbol "LEDS"). For investor information, please contact us at **investors@semileds.com.**

For further company or product information, please visit us at **www.semileds.com** or please contact **sales@ semileds.com.**

SEMILEDS

www.semileds.com

ASIA PACIFIC
3F, No. 11, KeJung Rd.
Chu-Nan Site
Hsinchu Science Park
Chu-Nan 350, Miao-Li County
Taiwan, ROC

Tel: +886-37-586788
Fax: +886-37-582688
sales@semileds.com