Instruction Manual
(COB LED Package)

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1. Product Description

1-1. Introduction
Citizen Electronics has been seeking the highest level of brightness and efficacy in the LED package industry. In addition, we have endeavored to work out technical solutions for many years. Through our advanced manufacturing technique and packaging technology, Citizen Electronics COB LED package series product will bring you a lighting space full of delight and beauty.

1-2. Product Description of COB LED Package
The mechanical feature of COB LED package series shows in Figure1. COB LED package has Anode (positive electrode) and Cathode (negative electrode) on the aluminum board. The resin area is composed of mounting LED dices on the aluminum board and enclosing them by silicone resin including fluorescent substance.
Besides it is possible for COB LED Package to be assembled into the heatsink directly, though it is not possible for SMD type of LED package. Therefore it is not necessary to use the mounting flow and printed circuit board. COB LED Package has high thermal dissipation performance by mounting LED dies directly on the aluminum board.
COB LED package series makes it possible to design the LED light fixture downsized. Example application for using the COB LED package fixture is street light, down light, spot light, bulb.

Citizen Electronics COB LED Package series delivers “A world’s best Lumen performance and efficacy”, “High reliability and long life based on proven data by actual measurement”, “Extensive product lineup”. This application note provides recommendations for handling, soldering, mechanical assembly, thermal design, electrical connection, chemical Incompatibility, solutions.
2. Handling COB LED Package

2-1. Precaution for taking out from the tray

COB LED package series are supplied by packing tray which made from electrically conductive polystyrene. (Figure2) Please be aware to hold edge part of the tray and transport. (Figure3) If the force applied to the resin area inside of the tray, the bottom surface of the tray may press the resin area and have negative impact into the function, performance and reliability of these products.

The packing tray is designed stackable without contact and press this product, in the case trays are stacked on the same direction by matching the reference surface. (Figure8) Please be aware to open the tray on a flat surface and treat the LED package under the clean environment avoiding dust and particles, which may adhere to the resin area of the LED package.

In the case the reference surface is set on left bottom side, the direction of LED package (cathode and Anode electrical pad) is located like Figure4.

It is strongly recommended to use antistatic gloves for taking out from the packing tray, and not to handle by naked finger. (Figure5) In addition, please avoid the sharp objects like tweezers to catch and hold of LED packages, because they may affect the wire inside of the resin area to be disconnection, and it may affect the light break down.
2-2. Precaution for holding

Please be aware to avoid putting mechanical stress on the LED package especially the resin area. It may affect LED light break down.

Please handle the LED package with care. It is recommended to wear antistatic gloves to prevent dirt or other contaminants from adhering to the resin area. They may affect negative impact to the optical performance of LED package. Please ensure that any objects don’t attach and push the resin area.

Please do not use sharp objects like tweezers to catch and hold of LED packages. The wire inside of the resin part may be disconnection and it may affect the light break down.

The recommended way to handle shows in Figure6.

=Figure6 Recommended way to handle

<table>
<thead>
<tr>
<th>Correct</th>
<th>Wrong</th>
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</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Correct Image" /></td>
<td><img src="image2.png" alt="Wrong Image" /></td>
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</table>

- Strongly recommended to use antistatic gloves
- Do not use tweezers
- Do not touch with naked finger
- Do not touch the resin area
- Do not touch the resin area
2-3, Precaution for handling

i) The resin part is composed of the light emitting area and white dam area. Please avoid the sharp objections (Figure 7) to press the resin or stress, rub, attach and contact with. They might be affect the function, performance and reliability of this product to attack negatively impact.

Figure 7 Prohibitions of press the resin area

![Wrong](#)

NG Screw Driver

NG Pen

NG Finger

NG Tweezer

NG Screw

ii) Please make sure the resin area should not be attached and contact by any other parts during assembly process. (Figure 8)

Figure 8 Prohibition of contact between the resin area and other parts

Correct

Wrong

NG Assembly part contact the emitting surface.

iii) Please be aware not stack this product. It might occur damage into the LED package such as peeled, clacked, wire disconnected. (Figure 9)

Figure 9 Prohibition of stacking LED packages

Wrong

NG
3. Soldering Process

3-1. Recommended Soldering Process

This product is not adaptable to reflow process. The conditions below are recommended for soldering.

**Recommended soldering condition**

- **Output of soldering iron:** Soldering bit temperature shall be 350°C or less
- **Heating time:** 3.5 seconds or less per land

No external force shall be applied to the resin area. In addition, please ensure that the soldering bit has no contact with the resin area. Next process of soldering should be carried out after the product has returned to ambient temperature.

3-2. Recommended Soldering Appearance

3-2-1. Appearance Condition of Soldering Lead Wire

Make sure following the items.
1. The soldering fillet is formed.
2. The core part is soldered well.
3. The solder has shiny appearance.
4. There is no protuberance or extreme raised on soldering.
5. The lead wire doesn’t float up from the pad.
6. The solder covers well around outside and the side surface of lead wire.
7. There is no attach soldering (e.g. soldering ball, soldering flux) at out of the designated pad for soldering extremely.
   The solder lands on the 2/3 space of pad of LED package board.
   The conductive part of lead wire doesn’t land on the 9, outside of the soldering pad.
   The height of the conductive part of lead wire and the 10, soldering don’t put over the height of the insulated plastic part.

3-2-2. Position of Soldering Lead Wire on the soldering pad

Please refer the positioning between the lead wire and the soldering pad at pictures below. (Figure 10)

- Figure 10  The way for soldering lead wire

**Correct**

- Not over the conductive part of wire from soldering pad.

**Wrong**

- NG The conductive part of wire is over from soldering pad.
- NG Over at front edge
- NG Over at bottom edge
4. Mechanical Assembly

4-1-1, Reference Assembly1:
M3 Screw, Thermal conductivity two sided adhesive sheet

Regarding assembling COB LED package CLL020, CLL022, CLL030, CLL032, CLL040, CLL042, CLL050, CLL052, CL-L100 series it is possible to fix on heatsink directly with M3 screw by using Ti M (thermal interface material). A reference assembly of a lighting system is showing in Figure 11. It may be applied to mounting screws is 0.6 Newton-meters. Please follow the position information of Figure 12 for fixture with M3 screws. It is strongly recommend to tightening screws on heatsink by second time, at first fix each side of screw temporarily, and tightening them finally in order not to put over power of mechanical stress into LED package.
In order to reduce the thermal resistance at assembly, please use TIM on whole contact surface of the product. In the case of using thermal grease as the TIM, it is recommend to apply uniformly on the contact surface of the product. For using thermal sheet as the TIM, it is recommend to make sure that the product is not strained by stress when the screws are tightened for assembly.
In addition, regarding assembling COB LED package CLL010, CLL012, please use the thermal conductivity two-sided adhesive sheet to fix on heatsink. As a reference information, we offer the information of TC-20SAS (Shin-Etsu Chemical Co., Ltd.). Dielectric voltage withstand test has been conducted on this product to see any failure after applying voltage between active pads and aluminum section of the product, and to pass at least 500V. Please confirm your final product for electrical safety of your product.

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Figure 11 Reference assembly as fixing with M3 screws

![Diagram of Reference assembly as fixing with M3 screws](image)

Figure 12 Recommended screw location and pitch

![Diagram of Recommended screw location and pitch](image)

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CLL020
CLL022
CLL030
CLL032
CLL040
CLL042
CLL050
CLL052
CL-L100 series
4-1-2, Reference Assembly2: Connector

A reference assembly of a lighting system using COB LED package shows in Figure13,14. Connector, COB LED package, TIM, Heatsink are assembled like Figure13. Please use TIM for better condition of heat dissipation. There is information about the recommended connector on “8, Solutions” of this application note. Please follow the specification of each maker’s connector.
4-2. Precaution for assembly

i) Please be aware to contact the resin area of the COB LED package during assembly. Please do not use sharp objects especially finger, screw, screw driver, pen to catch and hold of LED package. The wire inside of the resin area may be disconnection and affect the light breakdown. (Figure15)

   Figure15 Prohibit using sharp objects

ii) In the case of assembling, please be aware to use the correct way which is followed by the specification of each products. Besides please do not fix the product by over torque and put huge stress into the product. (Figure16)

   Figure16 Prohibit huge stress and over torque

iii) Please assemble the correct way and not to push the resin area with any other parts during assembling the product. (Figure17)

   Figure17 Prohibit incorrect assembly
5, Thermal Design

5-1, Significance of the heat dissipation structure

An LED package radiates light and heat according to the input power. However, the surface area of an LED package is quite small, and the package itself is expected to release little heat into the atmosphere. An external radiator such as a heatsink is thus required. The heat dissipation structure up to the connection portion of the external radiator uses mainly heat conduction. Regarding LED packages, to control the junction temperature of the LED dice Tj is important. The Tj must be kept from exceeding the absolute maximum rating in the specifications under any conditions. As direct measurement of the junction temperature of a LED dice inside a package is difficult, the temperature of a particular part on the external package (the case temperature) Tc [°C] is normally measured. Tj [°C] is calculated using the thermal resistance between the junction and the case Rj-c [°C/W], and the input power Pi [W] considered as the emitted heat amount. The heat generated at the LED dice can be conducted to the external radiator efficiently because the package structure for the COB LED package minimizes the thermal resistance Rj-c.

This document describes the detailed heat dissipation structure of the COB LED package and provides data necessary for thermal design of the lighting apparatus to maximize performance.

5-2, Package structure and thermal resistance

The cross-sectional structure example, where the COB LED package is connected to an external heatsink, is shown in Figure 18. The package has a laminated structure of an aluminum substrate, insulating layers and conductive cooper foil pad. A distinctive point is that the LED dice is mounted directly on the well conductive aluminum substrate not on the insulating layer, which has low thermal conductivity. Thus, the heat generated at the LED dice can be efficiently conducted to the outside of the package. The aluminum substrate side of the package outer shell is thermally connected to the heatsink via TIM. As described above, the heat generated in the junction section of the LED dice is transferred mainly to the heatsink using heat conduction, through the LED dice to the adhesive for diemounting to the aluminum substrate to the TIM. The thermal resistance between the junction section of the LED dice and the aluminum substrate side of the package outer shell is Rj-c, and the specific thermal resistance value of the package. Therefore, the following formula is used:

\[ T_j = R_{j-c} \cdot P_i + T_c \]

In addition, the thermal resistance of the TIM outside the package is R-TIM [°C/W], the thermal resistance with the heatsink is Rh [°C/W], and the ambient temperature is Ta [°C]. Figure 19 indicates the equivalent thermal resistance along the cross-sectional diagram in Figure 18. As indicated, the thermal resistances Rj-c, R-TIM, and Rh are connected in series between the junction temperature Tj and the ambient temperature Ta. The thermal resistances outside the package R-TIM and Rh can be integrated into the thermal resistance Re-a at this point. Thus, the following formula is also used:

\[ T_j = ( R_{j-c} + R_{e-a} ) \cdot P_i + T_a \]
6, Electrical Connection

6-1, Introduction

Prior to driving an LED package, which is a kind of semiconductor, it is necessary to thoroughly comprehend its characteristics because it has various elements. For example, the forward current ‘If’ varies widely with fluctuation in the forward voltage ‘Vf’. In the case of Figure 20, a 10% rise in Vf results in an increase of If by more than 40% under constant temperature conditions. The fluctuations in If have a significant influence on light emission and heat generation of LED packages. Especially, strict control of If is required for high-power LED packages used for lighting because they are driven by large current. In addition, the measures taken against heat release by an LED package are a crucial factor as Vf varies with temperature. When driving our LED packages, please be sure to read the relevant specifications and application notes and take appropriate measures according to their characteristics.

6-2, Constant current drive system (recommended)

The system that continues to supply a certain current to an LED package even under the conditions that Vf varies with heat generation or other factors is said to be a ‘constant current drive system’. This system allows relatively stable driving of LED packages even under changing environmental conditions or other parameters. In general, an LED package has a tendency for Vf, which applies a certain current to an LED package, to decrease as the temperature increases. (Figure 21) Citizen Electronics recommends the constant current drive system to ensure stable light emitting output and reliability.

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Figure 20: Vf-If characteristic

Figure 21: Te-Vf characteristic
6-3, Constant voltage drive system

Whereas the constant current drive system continues to supply a certain current to an LED package, the system that continues supplying a certain voltage to an LED package is said to be a ‘constant voltage drive system’. As described above, an LED package has a tendency for $V_f$, which applies a certain current to an LED package, to decrease as the temperature increases. In the case of Figure 18, when the case temperature $T_c$ is 90°C, the same amount of current is achieved by approximately 5% lower $V_f$ than that of the condition in which $T_c$ is 25°C. From another perspective, when an LED package is operated with a certain voltage, the more the temperature increases, the larger the current that flows through the LED package. In cases of driving with a constant voltage, as shown in Figure 22, temperature changes lead to changes in $V_f$ and current as the temperature of an LED package is unstable due to variance in environmental temperature or other factors. Accordingly, the brightness of an LED package can be unstable as it depends on current. Thus, when driving with a constant voltage is employed, an appropriate measure such as the connection of current control resistance needs to be implemented based on an assumption of the temperature in actual use.

6-4, Precautions for inrush current

When an LED package is connected to capacitive load such as a capacitor, instantaneous inrush current may occur during on/off operations. For instance, this includes the case where the second side of energized power circuit is turned on/off. Citizen Electronics recommends usage that avoids the occurrence of inrush current as much as possible. In cases where the occurrence of inrush current is unavoidable, please be sure to take measures to prevent exceeding the absolute maximum rating of the relevant LED package.

6-5, Connection between multiple LED packages

When connecting multiple identical LED package products, the series connection makes current flowing through LED packages uniform. Citizen Electronics recommends series connection to ensure stable light-emitting output and reliability. On the other hand, a parallel connection should be considered for $V_f$ variation between LED packages. Some measures, such as the appropriate current regulation resistor being connected to each LED package in series based on the temperature conditions in actual use, are required to apply even current to each LED package with different $V_f$ characteristics.
6-6, A parallel connection of LED packages

There is the way below for using n LED packages as the parallel connection.

6-6-1, The case of using constant current drive system

The way to prepare the Constant current circuit for each LED package line.(Figure23)

6-6-2, The case of using current-limiting resistor

The equivalence circuit in the case setting current-limiting resistor for each LED package line.(Figure24)
7. Chemical Incompatibility

The LED package contains a silicone to protect the LED dies and the silicone is gas permeable. Some VOCs (volatile organic compounds) and chemicals will cause discoloration, surface damage, crack, erosion. Table 1 is showing the list of harmful materials will damage the silicone. Please do not use them together with the LED package. If it is necessary to use them together, please consider and test them before use.

<table>
<thead>
<tr>
<th>Chemical Name</th>
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<tbody>
<tr>
<td>hydrochloric acid</td>
</tr>
<tr>
<td>sulfuric acid</td>
</tr>
<tr>
<td>nitric acid</td>
</tr>
<tr>
<td>acetic acid</td>
</tr>
<tr>
<td>sodium hydroxide</td>
</tr>
<tr>
<td>potassium hydroxide</td>
</tr>
<tr>
<td>ammonia</td>
</tr>
<tr>
<td>MEK (Methyl Ethyl Ketone)</td>
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<tr>
<td>MIBK (Methyl Isobutyl Ketone)</td>
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<tr>
<td>Toluene</td>
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<tr>
<td>Xylene</td>
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<tr>
<td>Benzene</td>
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<tr>
<td>Gasoline</td>
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<tr>
<td>Mineral spirits</td>
</tr>
<tr>
<td>dichloromethane</td>
</tr>
<tr>
<td>tetrachloromethane</td>
</tr>
<tr>
<td>Castor oil</td>
</tr>
<tr>
<td>lard</td>
</tr>
<tr>
<td>linseed oil</td>
</tr>
<tr>
<td>petroleum</td>
</tr>
<tr>
<td>silicone oil</td>
</tr>
<tr>
<td>halogenated hydrocarbons (containing F, Cl, Br elements)</td>
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<tr>
<td>rosin flux</td>
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Table 1 List of harmful materials that will damage the silicone.
8. Solutions

The short list below shows some commercially available design resources. Citizen Electronics introduce a variety of solutions (Optical solutions, Thermal solutions, Electrical solutions, Electrical devices, Connectors, Sockets) that may be used to handle and assemble Citizen Electronics LED package approved or qualified suppliers for customers convenience. It is the responsibility of the customer to fully qualify and validate luminaire design components and assembly processes to meet all code and regulatory requirement. Please check the detail at the URL site below. This information contained in URL may be changed without notice.

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<th>Top page of solution information</th>
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<td><a href="http://ce.citizen.co.jp/lighting_led/en/technology/solutions/index.html">Link</a></td>
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<th>Optical solutions</th>
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<td><a href="http://ce.citizen.co.jp/lighting_led/en/technology/solutions/lens.html">Link</a></td>
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<th>Thermal solutions</th>
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<td>Introducing manufacturers who provide heatsink, thermal interface materials for our LED packages.</td>
<td><a href="http://ce.citizen.co.jp/lighting_led/en/technology/solutions/heat.html">Link</a></td>
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<td>Introducing manufacturers who provide power supplies, drivers for our LED packages.</td>
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