Light Emitting Diode

Assembly and Handling Precautions for COB LEDs

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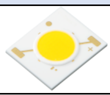
1. Overview

This application note provides general information on how to use/handle Nichia's Chip on Board (COB) LEDs.
Refer to the contents covered in this application note before using these LEDs in luminaires.

2. Applicable Part Numbers

The contents described in this application note apply to Nichia's Standard COB LEDs, High Luminous Density COB LEDs, and Color Tunable COB LEDs.

Table 1. Standard COB LEDs

Type	T Type	S Type	L Type			
Part Number	NTCWT012B-V3	NTCWS024B-V3	NFCWL036B-V3	NFCWL048B-V3	NFCWL060B-V3	NFCWL072B-V3
		NTCWS024B-V4	NFCWL036B-V4		NFCWL060B-V4	
		NFCWS024B-V5	NFCWL036B-V5		NFCWL060B-V5	
Appearance						
LES	⌀5.9mm	⌀6.7mm	⌀8.7mm	⌀11.5mm		
Package Size	15mm×12mm×2mm		19mm×16mm×2mm			

Type	D Type		J Type			H Type
Part Number	NFCWD084B-V3	NFCWD096B-V3	NFCWJ108B-V3	NFCWJ120B-V3	NFDWJ130B-V3	NFEWH306B-V2
			NFCWJ108B-V4		NFDWJ130B-V4	
			NFCWJ108B-V5		NFDWJ130B-V5	
Appearance						
LES	⌀13.4mm		⌀14.6mm			⌀23mm
Package Size	24mm×19mm×2mm					38mm×38mm×2mm

Table 2. High Luminous Density COB LEDs

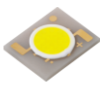
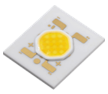
Type	S Type		L Type		J Type
Part Number	NVNWS007Z-V1	NJCWS024Z-V1	NVEWL016Z-V1	NVCWL024Z-V1	NVEWJ048Z-V1
Appearance					
LES	⌀5.9mm	⌀7mm	⌀8.9mm	⌀11mm	⌀14.6mm
Package Size	15mm×12mm×2mm		19mm×16mm×2mm		24mm×19mm×2mm

Table 3. Color Tunable COB LEDs

Type	S Type	L Type	J Type
Part Number	NJNWS012Z-V1MT	NJCWL024Z-V1MT	NVCWJ024Z-V1MT
Appearance			
LES	⌀5.9mm	7mm (octagonal)	11mm (octagonal)
Package Size	15mm×12mm×2mm	19mm×16mm×2mm	24mm×19mm×2mm

3. Structure of Nichia COB LEDs

The abbreviation COB refers to Chip On Board. COB LEDs have chips directly attached to the substrate. Figures 1, 2, and 3 show examples of the appearance and circuit configuration of each type of Nichia COB LED.

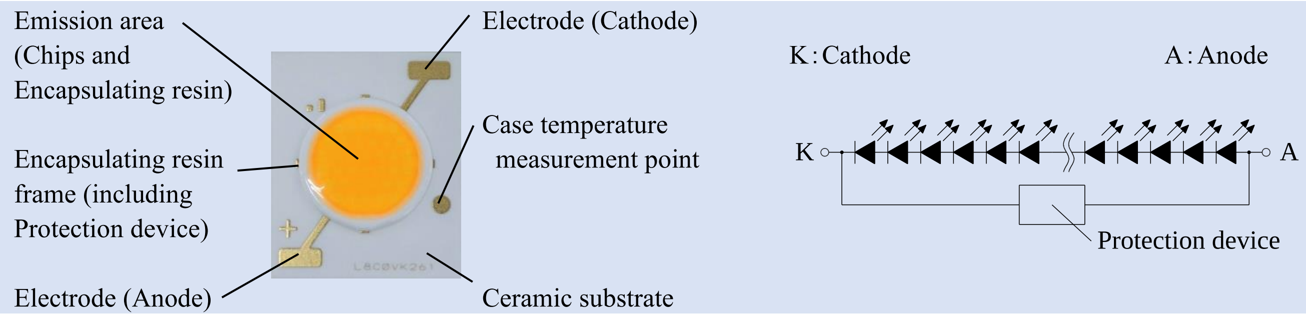


Figure 1. Example of the Appearance and Circuit Configuration of Nichia's standard COB LED

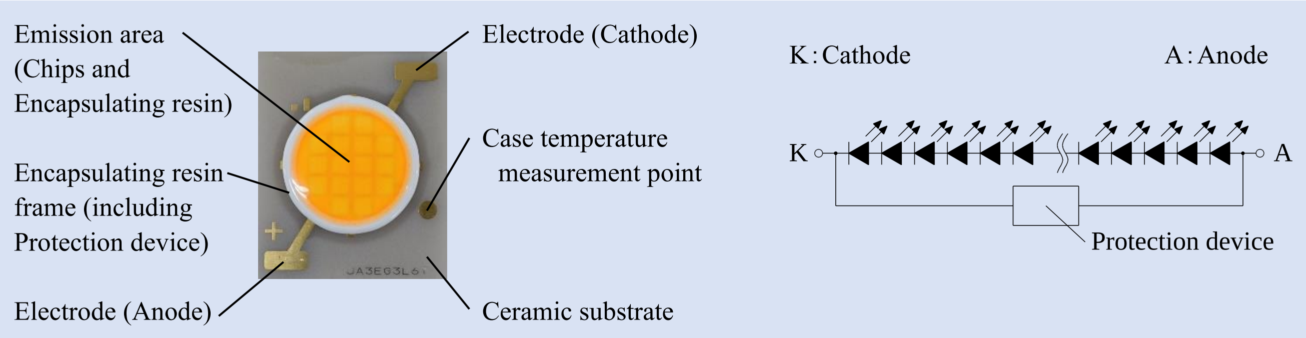


Figure 2. Example of the Appearance and Circuit Configuration of Nichia's High Luminous Density COB LED

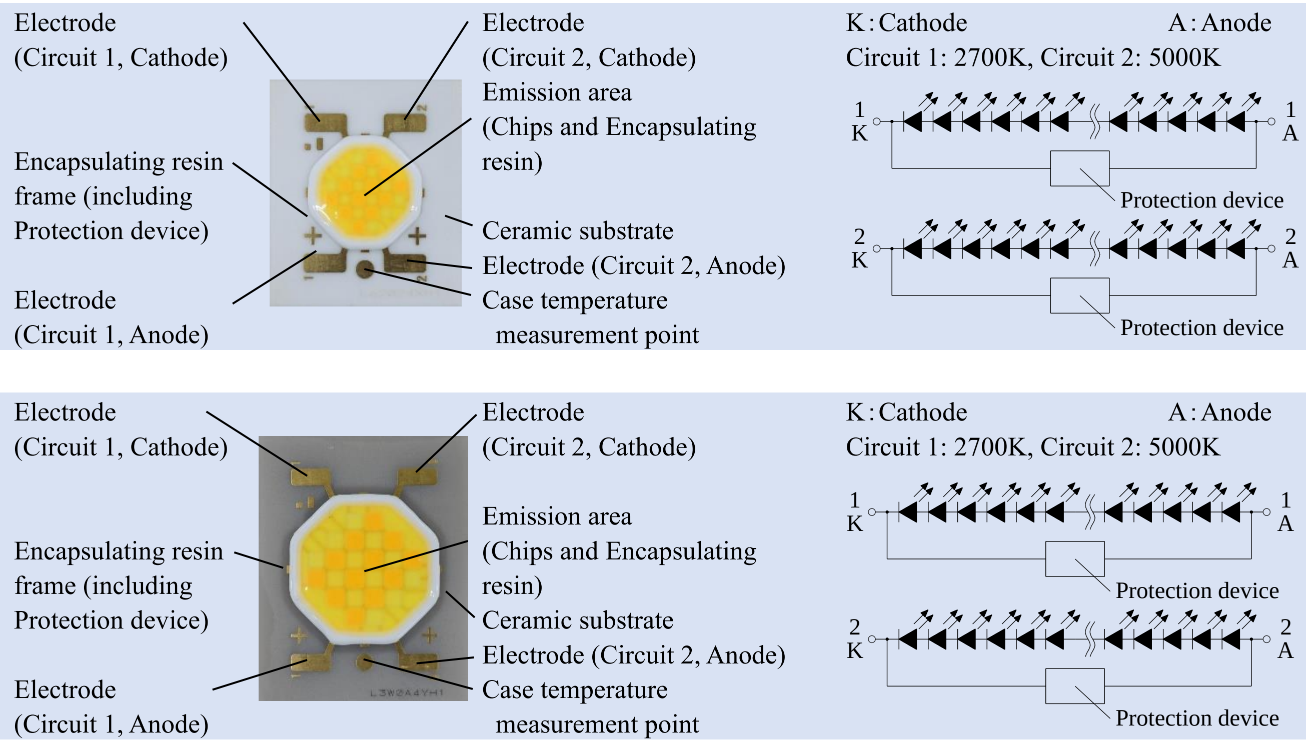


Figure 3. Examples of the Appearance and Circuit Configuration of Nichia's Color Tunable COB LED

4. Handling Precautions

4.1 Electrostatic Discharge (ESD)

These COB LEDs are sensitive to transient excessive voltages (e.g. ESD, lightning surge). If this excessive voltage occurs in the circuit, it may cause the LEDs to be damaged causing issues (e.g. the LEDs to become dimmer or not to illuminate [i.e. catastrophic failure]).
Ensure that when handling the COB LEDs, necessary measures are taken to protect them from an ESD discharge. The following examples are recommended measures to eliminate the charge:

- Grounded wrist strap, ESD footwear, clothes, and floors
- Grounded workstation equipment and tools
- ESD table/shelf mat made of conductive materials

Ensure that all necessary measures are taken to prevent the COB LEDs from being exposed to transient excessive voltages (e.g. ESD, lightning surge):

- tools, jigs, and machines that are used are properly grounded
- appropriate antistatic materials/equipment are used in the work area
- the system/assembly is designed to provide ESD protection for the COB LEDs against transient excessive voltages

Table 4 provides an example ESD checklist for reference purposes.

Table 4. ESD Checklist (Example)

Target	Check Item	Check Method Example
Operator	Is the operator wearing a grounded wrist strap?	Resistance Measurement
	Is the wrist strap properly in contact with the operator's skin?	Resistance Measurement
	Is the operator wearing antistatic clothes?	Resistance Measurement
	Is the operator wearing conductive footwear?	Resistance Measurement
Workbench	Is the workbench equipped with a conductive mat on the top surface?	Surface Potential Measurement
	Is the top surface of the workbench grounded with a resistance of approximately 1MΩ?	Resistance Measurement
	If a power supply will be used, is it properly insulated from the top surface of the workbench?	-
	Are there no tools, equipment, etc. that can become charged easily (e.g. a tool made of plastic) near the workbench?	-
Work Area	Are the machines/equipment that are installed in the work area properly grounded? Are the tools, cushion of the chair, etc. antistatic?	Resistance Measurement
	Are the insulated surfaces of the equipment, etc. uncharged in the area where high-pressure air is used?	Surface Potential Measurement
	Is the ionizer that is used to neutralize electrostatic charges properly inspected?	Surface Potential Measurement
	Are metal and/or charged objects kept away from the components that are sensitive to static electricity during all processes?	-
	Is the floor conductive? Is the floor properly maintained?	Resistance Measurement
	Are temperature and humidity controlled?	Temperature & Humidity Measurement
Packing Materials	Will static electricity not occur due to friction between the packing materials and the contents?	Surface Potential Measurement

	If an antistatic coated magazine rack is reused, will a coating be reapplied to it?	-
	Is the cushioning antistatic?	-

4.1.1 Measures for when the Tool/Equipment Used is an Insulator

If the tool/equipment used is an insulator (e.g. glass cover, plastic, etc.), ensure that necessary measures have been taken to protect the COB LEDs from transient excessive voltages (e.g. ESD). The following examples are recommended measures to eliminate the charge:
- Dissipating static charge with conductive materials
- Preventing charge generation with moisture
- Neutralizing the charge with ionizers

4.1.2 ESD Withstand Voltage for the COB LEDs

Table 5 shows the typical ESD withstand voltage for most of Nichia's COB LEDs

Table 5. Typical ESD Withstand Voltage for Most of Nichia's COB LEDs

Item	Symbol	Maximum Rating	Unit
ESD Withstand Voltage[1]	V_{ESD}	8	kV

[1] HBM ESD Component Classification Level of the LEDs: Class 3B
For more details, see ANSI/ESDA/JEDEC JS-001.

4.2 Handling the COB LEDs

The COB LEDs use a silicone resin for the encapsulating resin frame or resin area; the silicone resin is soft. If excess pressure is applied to the silicone resin, it may cause the resin to be damaged, chipped, cracked and/or deformed. If the encapsulating resin frame and/or resin area are damaged, chipped, cracked and/or deformed, it may cause the wire to break causing a catastrophic failure (i.e. the LEDs not to illuminate) and/or reliability issues (e.g. the LEDs to corrode and/or to become dimmer, the color directivity to change, etc.).
Nichia provides handling precautions for the COB LEDs in the following sections.

4.2.1 Handling with Bare Hands

Do not handle the COB LEDs with bare hands. Especially, do not touch the emitting surface:
- this may contaminate the LED surface and have an effect on the optical characteristics,
- this may cause the LEDs to deform and/or the wire to break causing a catastrophic failure (i.e. the LED not to illuminate). See Figure 4.

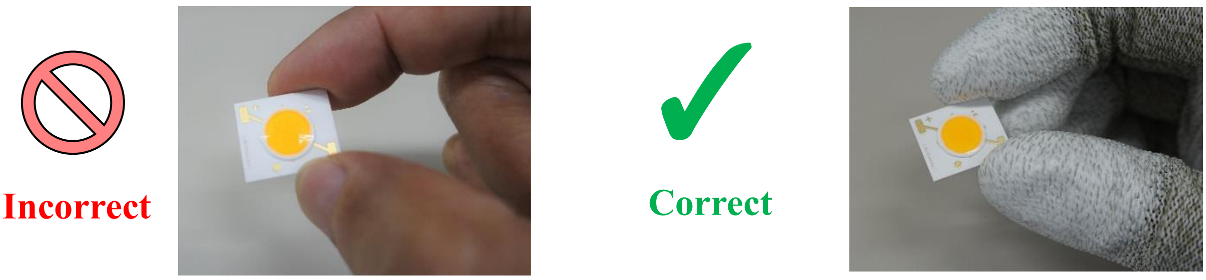


Figure 4. Handling the COB LED with Bare Hands

When picking up the COB LEDs, wear a glove (e.g. an ESD glove) and do not touch the emitting surface and/or the encapsulating resin frame. Figure 5 shows the prohibited area (i.e. the emitting surface and the encapsulating resin frame) of the COB LEDs.

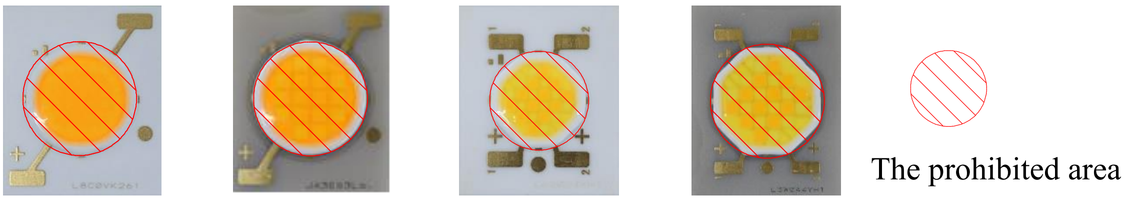


Figure 5. Prohibited Area of the COB LEDs

4.2.2 Handling with Tweezers

When handling the COB LEDs with tweezers, do not touch the emitting surface and/or the encapsulating resin frame; if excessive force is applied to the LEDs, it may cause damage to the resin (e.g. cut, scratch, chip, crack, delamination, and deformation) and the wire to break causing a catastrophic failure (i.e. the LEDs not to illuminate). See Figure 6.

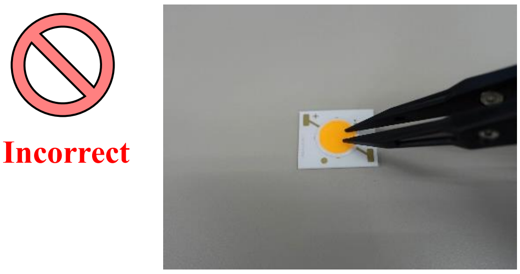


Figure 6. Handling with Tweezers

4.2.3 Do not Stack the COB LEDs

Do not stack the COB LEDs. Otherwise, it may cause damage to the resin (e.g. cut, scratch, chip, crack, delamination, and deformation) and the wire to break causing a catastrophic failure (i.e. the LEDs not to illuminate).

Incorrect

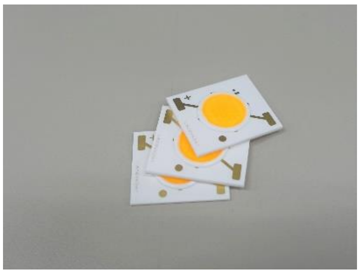


Figure 7. Do not Stack the COB LEDs

4.3 Removing the COB LEDs from the Tray

When removing the COB LEDs from Nichia's shipping tray, do not pick up the LEDs manually; if the emitting surface and/or the encapsulating resin frame is touched, it may cause damage to the resin e.g. cut, scratch, chip, crack, delamination, and deformation) and the wire to break causing a catastrophic failure (i.e. the LEDs not to illuminate). See Figure 8.

Incorrect

Figure 8. Removing the COB LEDs Manually

Using vacuum tweezers is the recommended handling method to remove the COB LEDs from the tray. Figure 9 shows how to pick up the LEDs with vacuum tweezers.

Correct

Incorrect

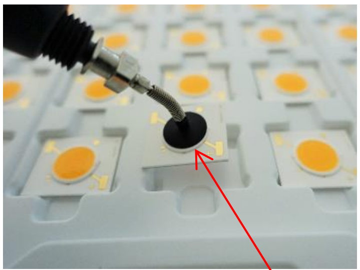


Figure 9. Removing the COB LEDs from the Tray with Vacuum Tweezers

When picking up the COB LEDs with vacuum tweezers, ensure that the suction is not applied to the emitting surface. Otherwise, it may cause the LEDs to deform and/or the wire to break causing a catastrophic failure (i.e. the LEDs not to illuminate).

4.4 Storage Environment

The parts/materials (e.g. housing, gasket/seal, secondary lens, lens cover, thermal grease, etc.) used with the COB LEDs in the same assembly/system may release corrosive gases containing sulfur, halogens, etc. A light-up test, sufficient verifications, etc. must be performed at the finished product level (i.e. luminaire, etc.) prior to use taking into consideration the conditions/environments in which the finished product will actually be used to ensure that the expected performance for the finished product is maintained.

Issues that may be caused by corrosive gases containing sulfur and/or halogens:
The COB LEDs have plated parts (e.g. lead frame, electrode, etc.). If the LEDs are exposed to corrosive gases containing sulfur and/or halogens, it may cause the plated surface to tarnish. If the gases penetrate the LEDs (e.g. emitting surface, package material, etc.), it may cause the surface of the plated parts inside the package to tarnish. In addition, it has been confirmed that if a silicone resin is used in the LEDs, the gases may accelerate degradation of the silicone resin. As a result, the optical characteristics may be adversely affected (i.e. significant reduction in the brightness, significant color shift, etc.); in the worst case, the circuit could become open causing a catastrophic failure (i.e. the LEDs not to illuminate). When determining the storage environment for the LEDs and/or selecting parts/materials that will be used with the LEDs in the finished product, it must be ensured prior to use that corrosive gases containing sulfur and/or halogens are not generated.

4.5 Storage Conditions

Once the moisture-proof aluminum bag is open, the remaining unused COB LEDs should be stored in a hermetically sealed container with silica gel desiccants. Nichia recommends placing them back to the original moisture-proof bag and reseal it if a hermetically sealed container with silica gel desiccants is not used.
Table 6 provides the required storage conditions before and after opening the moisture-proof aluminum bag.

Table 6. Storage Conditions

Conditions		Temperature	Humidity	Time
Storage[2]	Before Opening Aluminum Bag	≤30ºC	≤90%RH	Within 1 Year from Delivery Date
	After Opening Aluminum Bag	≤30ºC	≤70%RH	≤168 hours

[2] Storage precautions:
- These COB LEDs have gold-plated electrodes. However, if the LEDs are exposed to a corrosive environment, it may cause the plated surface to tarnish causing issues (i.e. electric connection failures).
- To avoid condensation, the COB LEDs must not be stored in areas where temperature and humidity fluctuate greatly.
- Do not store the COB LEDs in a dusty environment. Do not expose the COB LEDs to direct sunlight and/or an environment over a long period of time where the temperature is higher than normal room temperature.

5. Assembly Precautions

5.1 An Example of the Structure of a Typical Luminaire Using COB LEDs

Nichia's COB LEDs are mainly used for applications such as floodlights, PAR lamps, spotlights, down lights, high ceiling lights, and streetlights.

This section describes precautions for selecting components and for assembly when assembling the COB LEDs into a luminaire. Figure 10 shows an example luminaire using a COB LED.

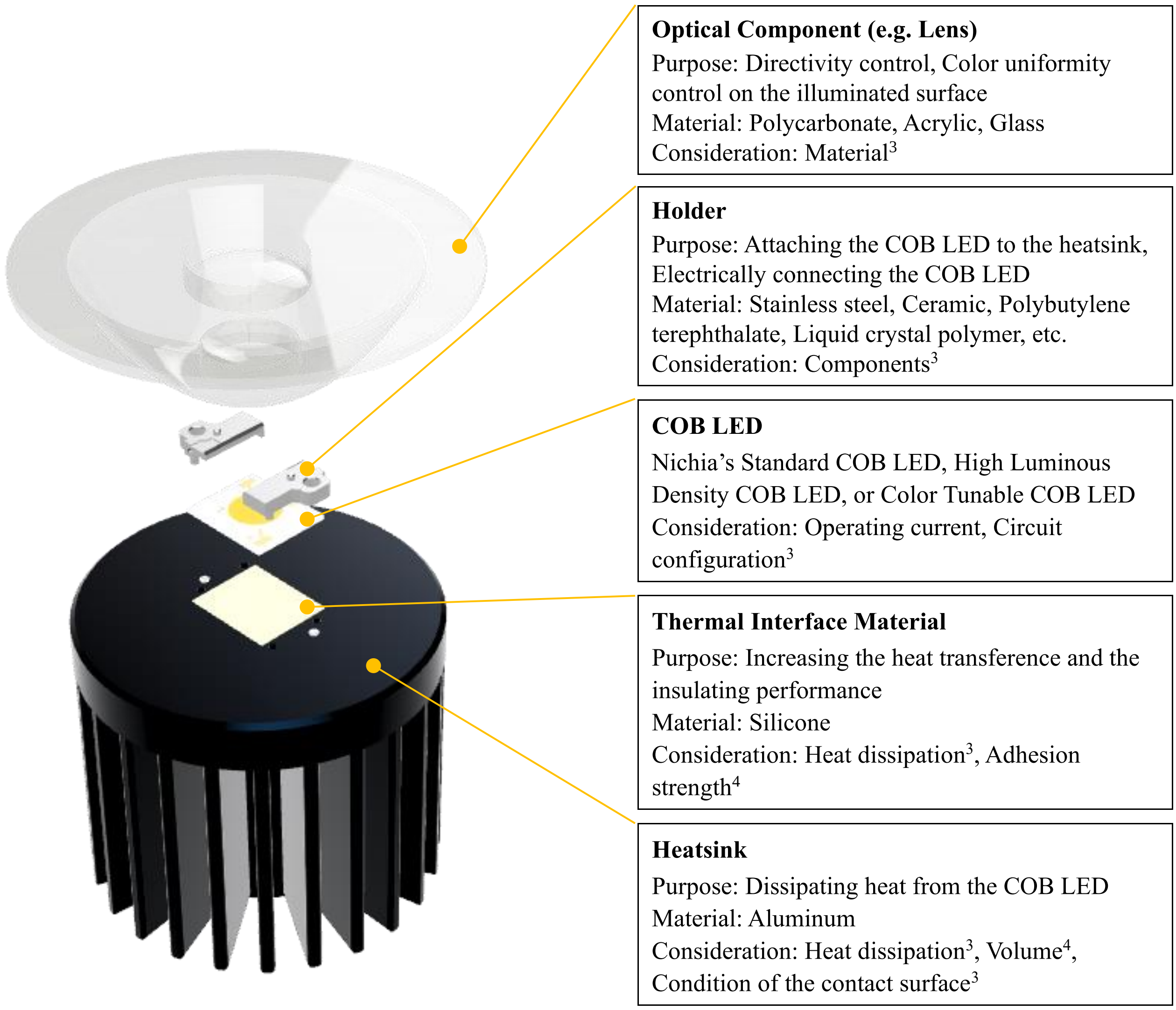


Figure 10. Example of a Luminaire Using a COB LED

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[3] These topics are discussed within this section of the application note.

[4] For more information on these topics, refer to the proper application note as indicated below:

- Electrical connection of the COB LED, refer to the application note: How to Hand Solder an Electric Wire to a COB LED
- Adhesion strength of the thermal interface material, refer to the application note: Heat dissipation performance according to the adhesion strength of COB and housing
- Heat dissipation of the heatsink, refer to one of the following application notes depending on the COB type:

- Nichia Standard COBs: Thermal Design Guide for COB LEDs How to Select an Appropriate Heat Sink
- Nichia COB-Z series LEDs: Thermal Design Guide for the COB-Z Series LEDs How to Select an Appropriate Heat Sink

5.2 Contact Surface of the Heatsink

The surface of the heatsink to attach the COB LEDs should be smooth and even (i.e. no hole/recess, burr/flash, etc.); ensure that the surface is leveled by machining and cleaned to remove any liquid, grease, contamination, etc. just before attaching a COB LED to the heatsink. If the heatsink has holes/recesses on the contact surface with the COB LED or the COB LED is tilted because of burrs/flashes on the contact surface, it may cause the heat from the LED not to sufficiently transfer to the heatsink causing the junction temperature of the LED to significantly increase.
Figure 11 shows correct/incorrect examples of attaching a COB LED to the heatsink.

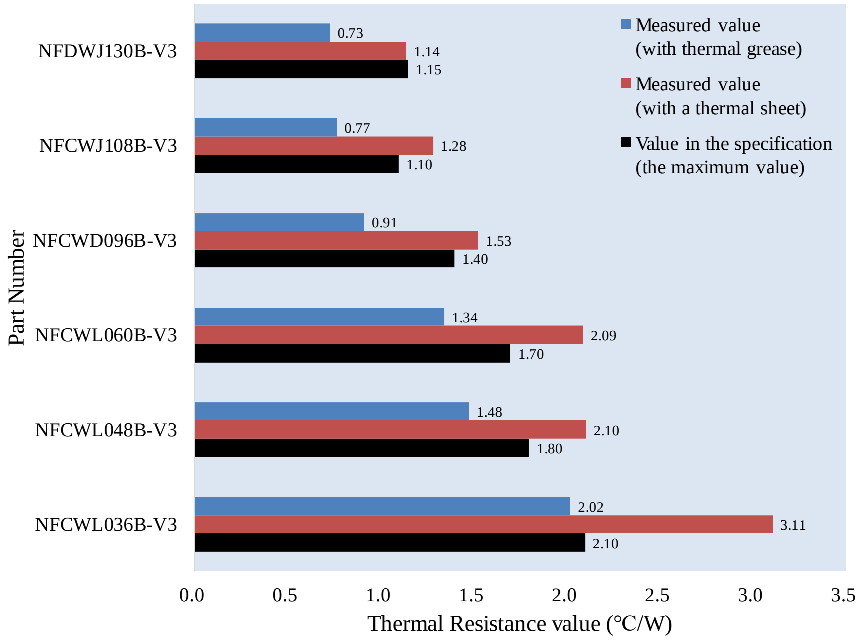
Note: TIM stands for "thermal interface material."

Figure 11. Correct/Incorrect Examples of Attaching a COB LED to a Heatsink

5.3 Thermal Interface Materials (TIMs)

To increase the heat dissipation performance, use a thermal interface material (TIM) (i.e. thermal grease, thermal sheets, etc.) between the COB LEDs and heatsink. Nichia recommends using thermal grease for better heat dissipation. Note that the thermal resistance values provided in the specifications of Nichia COB LEDs are the values when thermal grease is used.
For reference, Figure 12 shows the thermal resistance values measured using thermal grease or a thermal sheet for Nichia Standard COB LEDs (i.e. COB-B-V3 Series LEDs) and High Luminous Density COB LEDs (i.e. COB-Z-V1 Series LEDs).

Thermal Resistance of Nichia COB-B-V3 Series LEDs (Junction Temperature: 140°C)



Thermal Resistance of Nichia COB-Z-V1 Series LEDs (Junction Temperature: 150°C)

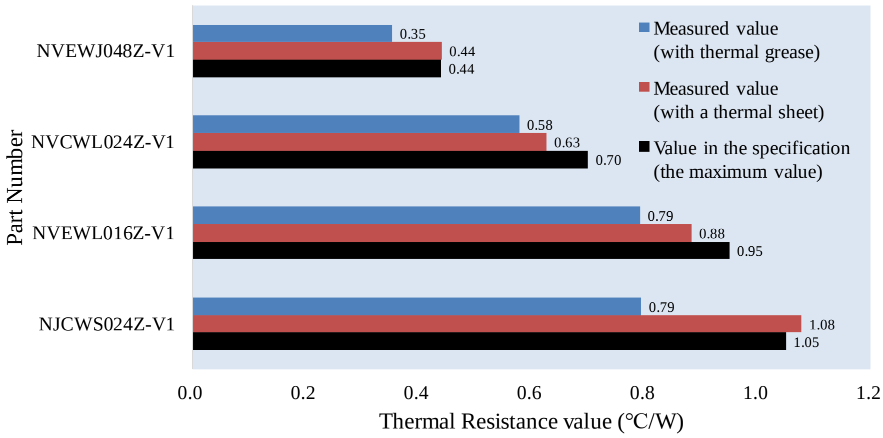


Figure 12. Thermal Resistance of Nichia COB LEDs[5]

[5] The thermal resistance values were measured using the Dynamic mode detailed in JESD51-1.
TIM used: Thermal grease: SCH-20 manufactured by Sunhayato Corp. (Thermal conductivity: 0.84W/m·K)
Thermal sheet: 30Y-c manufactured by Fuji Polymer Industries Co., Ltd. (Thermal conductivity: 4.0W/m·K, Thickness: 0.3mm)

The measurement results in Figure 12 indicate that the thermal resistance of the COB LEDs is greater when a thermal sheet is used than when thermal grease is used. This is because the thermal resistance of a thermal sheet is greater than that of thermal grease. Figure 13 shows rough thermal resistance models for the COB LEDs. These models indicate that the thermal resistance of the COB LED is greater when a thermal sheet is used.

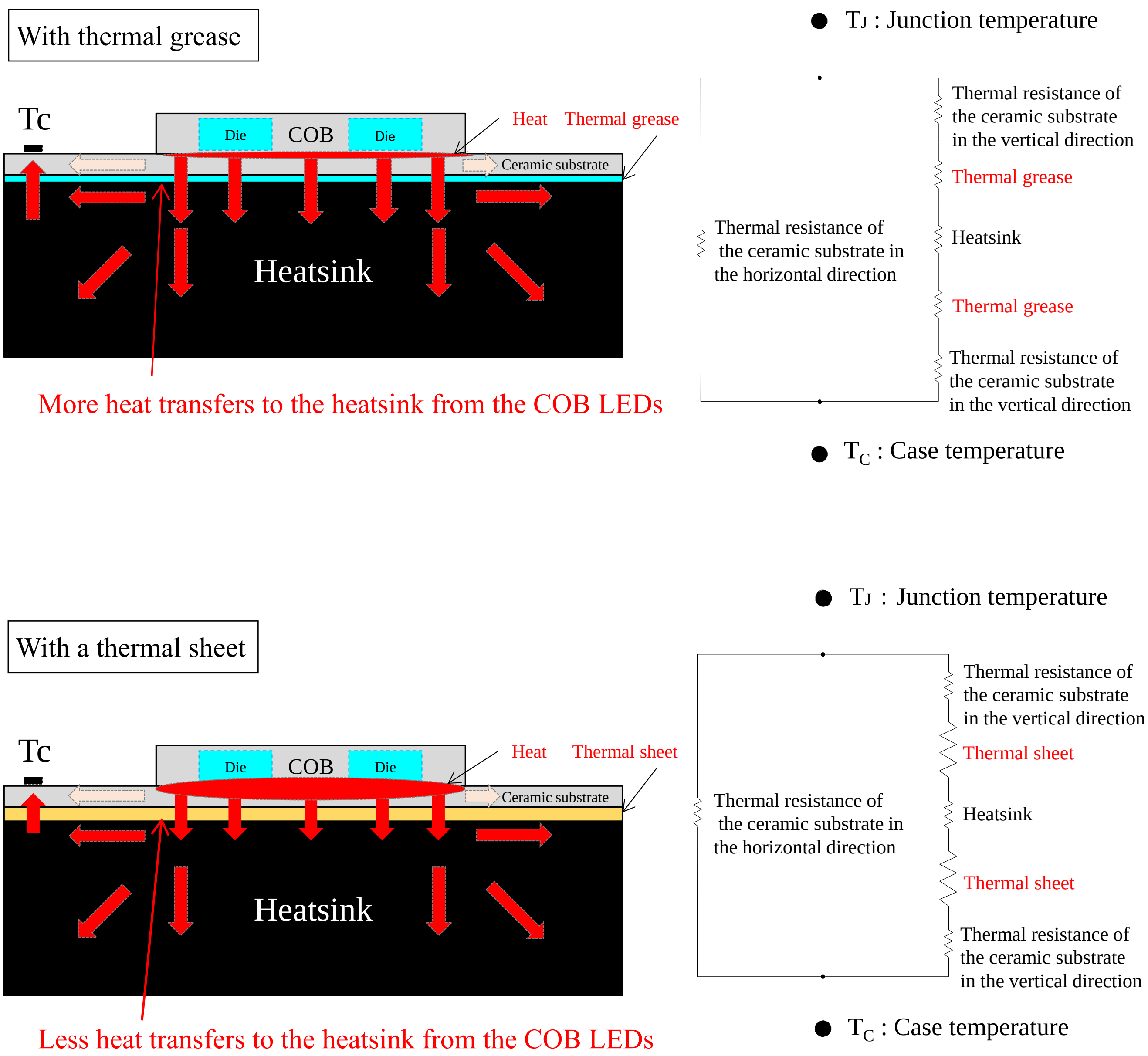


Figure 13. Rough Thermal Resistance Models for the COB LEDs

5.3.1 Thermal Grease

When selecting thermal grease, consider its characteristics (i.e. thermal conductivity, operating temperature range, etc.) and the components it is made of to ensure that the chosen thermal grease is suitable for the chosen luminaire. An adequate amount of thermal grease should be applied to the heatsink. Otherwise, excessive thermal grease may contact the electrode of the COB LEDs causing electrical connection failures resulting in a catastrophic failure (i.e. the LEDs not to illuminate) or causing the electrode to become burnt. See Figure 14.
For reference, Table 7 shows the thermal grease Nichia used for the heat dissipation performance evaluations.

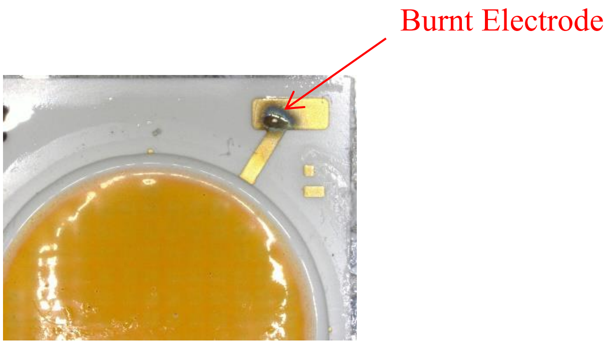


Figure 14. Example of a Burnt Electrode on a COB LED

Table 7. Thermal Grease Nichia Used for the Evaluations

Manufacturer	P/N	Thermal Conductivity	Operating Temperature Range
Sunhayato Corp.	SCH-20	0.84W/m·K	-50°C～200°C
Fuji Polymer Industries Co., Ltd.	SPG-30B	3.1W/m·K	-40°C～150°C
Shin-Etsu Chemical Co., Ltd.	G-777	3.3W/m·K	-40°C～200°C
	G-779	3.0W/m·K	-40°C～200°C

5.3.2 Thermal Sheet

When a thermal sheet is used to increase the withstand voltage performance of the luminaire, ensure that the chosen thermal design has sufficient margins/tolerances since the junction temperature of the COB LEDs will become higher. In this case, the thermal resistance value of the COB LEDs varies depending on the chosen thermal sheet and therefore the junction temperature of the COB LEDs cannot be calculated using the equation provided in Section 6 in this application note. The junction temperature can be estimated using a thermal imaging camera; for the exact value, contact a local Nichia sales representative. Nichia can provide the measurement of the thermal resistance of the COB LEDs and the calculation of the junction temperature of the COB LEDs in a luminaire when a thermal sheet is used.

5.4 Maximum current and circuit configuration for Nichia COB LEDs

5.4.1 Maximum Current for Nichia COB LEDs

The maximum current that is allowed to be applied to Nichia's COB LEDs is specified in the specifications as the absolute maximum rating current. The absolute maximum rating current is the current that must not be exceeded even for a short period of time; ensure that the COB LEDs are operated at a current lower than that. In addition, an inrush current or a ripple current may flow through the COB LEDs when the luminaire containing a COB LED is turned on; ensure that such current will not exceed the absolute maximum rating current specified.

5.4.2 Circuit Configuration for Nichia COB LEDs

In an array of multiple COB LEDs, Nichia recommends that the COB LEDs are connected in series with each other or that each is operated at a constant current.
If the COB LEDs are connected in parallel with each other, the current flow to each one can vary depending on the forward voltage (V_F) variation among them. See Figure 15 (A).

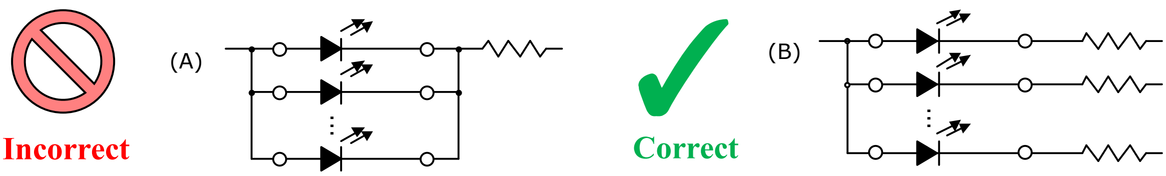


Figure 15. Circuit Configuration for the COB LEDs

5.5 Attaching a COB LED to a Heatsink

Ensure that excessive force is not applied to the COB LEDs when attaching the COB LEDs to a heatsink. Otherwise, it may cause the ceramic substrate of the COB LEDs to be damaged. The COB LEDs have no screw holes; it must not be attached to a heatsink with screws (see Figure 16). Nichia recommends attaching it to a heatsink using a specially designed holder for efficient heat dissipation and easy assembly.

Figure 16. Do Not Attach the COB LEDs with Screws

5.5.1 COB LED Holders

The required specifications for the COB LED holders (e.g. structure, heat dissipation performance, operating current, maximum allowable ambient temperature, etc.) are different depending on the chosen luminaire; Nichia does not recommend any specific holders. Contact manufacturers of connectors, etc. for detailed information to select a suitable holder for the chosen luminaire. The local Nichia sales representatives will provide information regarding the manufacturers if requested.

5.5.2 Materials of COB LED Holders

Table 8 provides notes regarding different materials often used for COB holders; this information can be used for reference purposes when considering what holder to select for the luminaire.

Table 8. Materials of COB LED Holders

Material	Notes
Metal	When using a holder made of metal, note that the ceramic substrate of the COB LEDs may be chipped/cracked if excessive force is applied to the ceramic substrate. Nichia recommends a holder with a structure that will reduce the force applied to the COB LEDs.
Resin	When using a holder made of resin, it should be noted that there may be issues depending on the ingredients contained within the resin. The light emitted on the resin of the holder from the COB LEDs may cause issues (i.e. the holder to discolor, deform, and/or reduction in the mechanical strength, etc.) since the COB LEDs have a high luminous flux density (see Figure 17). In addition, note that the ingredients contained within the resin may adversely affect the emitting area (i.e. encapsulating resin), the encapsulating resin frame, etc. of the COB LEDs.[6] Ensure that the resin of the chosen holder causes no issues if the chosen luminaire is too airtight.
Ceramic	When using a holder made of ceramic, note that the holder may be chipped/cracked if excessive force is applied. Ensure that the tightening torque is not excessive when the holder is attached directly to a heatsink with screws. Nichia recommends a holder that is not attached directly to a heatsink (i.e. the holder is attached to a heatsink with adaptors).

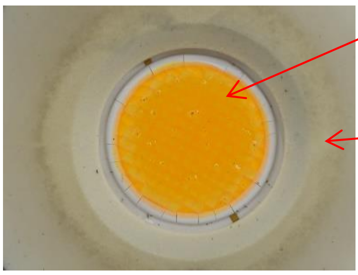


Figure 17. An example Example Appearance of a COB LED and a Holder After a Continuous Operation of 1000 Hours

[6] If high power light is emitted from the COB LEDs on the resin of the holder, halogen contained in the resin may be released when the temperature of the resin increases. If the halogen is released inside a luminaire that is too airtight, it may cause issues to the encapsulating resin of the COB LEDs.

Relationship between the materials of the resin in a holder and the frequency of issues occurring:

No issue = Resin containing no halogen < Halogen-free resin (that includes a phosphorus compound as a flame retardant) < Halogen resin (that includes a halogen compound as a flame retardant) = High possibility of issues

5.5.3 Heat Resistance Temperature of the Holder

When selecting a holder, the absolute maximum temperature of the COB LEDs (i.e. 105°C) should be taken into consideration to ensure that the chosen holder can withstand the temperature in the conditions/environments in which the luminaire containing the holder will actually be used. The temperatures of the encapsulating resin surface and frame of the COB LEDs will be higher than that of the ceramic substrate; attach the COB LEDs to a holder in a manner where the holder will not contact the encapsulating resin surface and frame of the COB LEDs.
The temperature of the ceramic substrate of a COB LED can be measured using a thermocouple attached to the measurement point of the case temperature; it is recommended to use a thermal imaging camera to measure the temperature of a holder.

5.6 Optical Components (e.g. Lens)

COB LEDs have a very high light output. The heat and light emitted from the COB LEDs will cause adverse effects to the adjacent components (e.g. lens, reflector, etc.) of the COB LEDs. Especially, the components that are directly exposed to the emitted light may have issues with their resin (e.g. decomposition, reduction in the mechanical strength, etc.).
When selecting optical components to be used with a COB LED, ensure that the materials of the chosen components will not have issues in the conditions/environments in which the luminaire containing the components will actually be used.

5.7 Hermetically Sealed Environment

The parts/materials (e.g. housing, gasket/seal, secondary lens, lens cover, thermal grease, etc.) used with the COB LEDs in the same assembly/system may release corrosive gases containing sulfur, halogens, etc., and/or volatile organic compounds (VOCs). A light-up test, sufficient verifications, etc. must be performed at the finished product level (i.e. luminaire, etc.) prior to use taking into consideration the conditions/environments in which the finished product will actually be used to ensure that the expected performance for the finished product is maintained. See below for the detailed information.

Issues that may be caused by corrosive gases containing sulfur and/or halogens:
The COB LEDs have plated parts (e.g. lead frame, electrode, etc.). If the LEDs are exposed to corrosive gases containing sulfur and/or halogens, it may cause the plated surface to tarnish. If the gases penetrate the LEDs (e.g. emitting surface, package material, etc.), it may cause the surface of the plated parts inside the package to tarnish. In addition, it has been confirmed that if a silicone resin is used in the LEDs, the gases may accelerate degradation of the silicone resin. As a result, the optical characteristics may be adversely affected (i.e. significant reduction in the brightness, significant color shift, etc.); in the worst case, the circuit could become open causing a catastrophic failure (i.e. the LEDs not to illuminate). When determining the storage environment for the LEDs and/or selecting parts/materials that will be used with the LEDs in the finished product, it must be ensured prior to use that corrosive gases containing sulfur and/or halogens are not generated.

Issues that may be caused by VOCs:
If VOCs that have been released from the parts/materials and/or organic additives used with the COB LEDs in the finished product penetrate into the LEDs and remain inside the LEDs, the VOCs can discolor after being exposed to heat and/or photon energy. This may cause the optical characteristics to be adversely affected (i.e. significant reduction in the brightness, significant color shift, etc.). This adverse effect may be improved by ventilating the environment (i.e. the LEDs are not used in a hermetically sealed environment) to prevent the VOCs from remaining inside the LEDs. When selecting parts/materials that will be used with the LEDs in the finished product, it must be ensured prior to use that there are no issues with the substances found in those parts/materials and/or that the expected performance for the finished product is maintained by performing a light-up test, sufficient verifications etc. taking into consideration the conditions/environments in which the finished product will actually be used.

6. Thermal Evaluation

6.1 How to Determine the Junction Temperature

When using the COB LEDs, ensure that proper thermal management is provided and the die temperature does not exceed the maximum junction temperature (T_{Jmax}).
The junction temperature (T_J) can be calculated using the following equation:

$$T_J = T_C + R_{\theta JC} \times W$$

T_J: COB LED junction temperature
T_C: Case temperature
$R_{\theta JC}$: Thermal resistance from the die to Tc measuring point[7]
W: Input power ($I_F \times V_F$): W
(I_F: Forward Current, V_F: Forward Voltage)

Figure 18 provides the T_C measurement point.

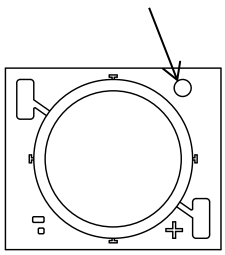


Figure 18. T_C Measurement Point

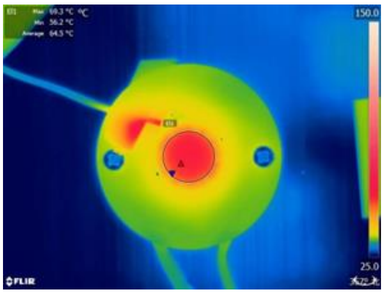
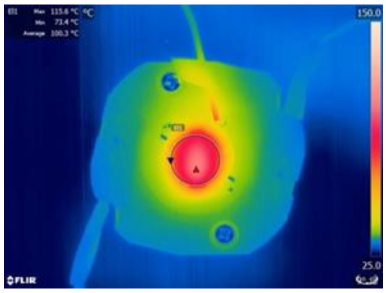
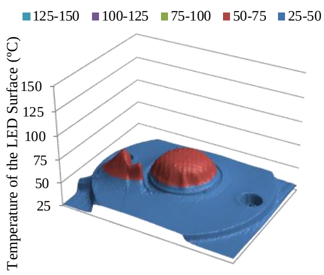
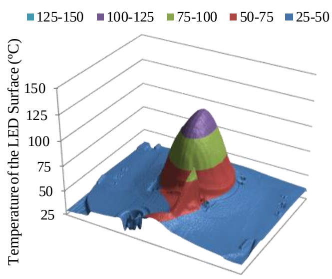
[7] The thermal resistance from the die to the T_C measurement point ($R_{\theta JC}$) provided in the specifications of Nichia COB LEDs is the value when thermal grease is used. If a thermal sheet is used, the $R_{\theta JC}$ value can be higher.
$R_{\theta JC}$ may change depending on the material properties for both the interface materials (e.g. TIM) and the housing and the surface state of the housing; the following must be considered:

- TIMs with a low thermal resistance should be used for the interface between the COB LEDs and heatsink/housing.
- The surface of the heat sink where the COB LEDs are attached must not have any small recesses, cavities, or holes to ensure that the COB LEDs are attached firmly.
- If a holder is used to attach the COB LEDs, ensure that the heat is effectively dissipated.
- During use if the heat dissipating material deteriorates due to heat (i.e. the dimensions change and/or the properties degrade), it may cause the adhesion strength of the COB LEDs and heatsink to be reduced resulting in a decrease in heat dissipation; this may cause the COB LEDs to be damaged. Ensure that reliability verification is performed for the chosen luminaire.

6.2 Thermal Evaluations Using a Thermal Imaging Camera

When measuring the surface temperature of the COB LED emission area, the temperature distribution (i.e. the evenness of the distribution) on the surface can be evaluated if a thermal imaging camera is used. When evaluating the heat dissipation performance of the chosen luminaire, it is recommended to perform an evaluation using a thermal imaging camera in addition to the temperature measurement/calculation described in Section 6.1.
Table 9 shows an example of thermal evaluation results using a thermal imaging camera.

Table 9. Example of Thermal Evaluation Results Using a Thermal Imaging Camera

Evaluated Item	Thermal Interface Material (TIM)	
	With Thermal Grease[8]	With a Thermal Sheet[9]
Input Current (mA)[10]	1150	1150
Case Temperature (ºC)	44.0	52.9
Maximum Surface Temperature of the LED (ºC)	69.3	115.6
Thermal Image		
Temperature Distribution		

Ensure that the surface temperature of the COB LED emission area will not exceed 150ºC with the thermal design of the chosen luminaire. If the surface temperature of the COB LEDs becomes too high (i.e. >150ºC) during operation, that indicates that the LEDs are being subjected to significant thermal stress; check if there are any issues with the heat dissipation performance of the heatsink and if the operating current is not excessive. If a thermal sheet is used, note that the temperature difference between the emission area and the case temperature of the COB LEDs will be significant.

[8] Thermal grease: Thermal conductivity: 0.84W/m·K
[9] Thermal sheet: Thermal conductivity: 3.3W/m·K, Thickness: 0.45mm
[10] Evaluated COB LED: NFDLJ130B LEDs

7. Cleaning

Do not clean and/or wipe the emitting surface of the COB LEDs. If an area of the LEDs other than the emitting surface is contaminated (e.g. dust/dirt), use a cloth, swab, etc. soaked with a small amount of isopropyl alcohol (IPA) and wipe the LEDs with it in a manner that does not touch the emitting surface. If another solvent is used, it may cause the LED package/resin to be damaged causing the optical characteristics and/or the reliability to be affected; ensure that sufficient verification is performed prior to use.

Do not clean the COB LEDs with an ultrasonic cleaner. This may cause the optical characteristics and/or the reliability to be affected.

8. Eye Safety

There may be two important international specifications that should be noted for safe use of the LEDs: IEC 62471:2006 Photobiological safety of lamps and lamp systems and IEC 60825-1:2001 (i.e. Edition 1.2) Safety of Laser Products - Part 1: Equipment Classification and Requirements. Ensure that when using the LEDs, there are no issues with the following points:

- LEDs have been removed from the scope of IEC 60825-1 since IEC 60825-1:2007 (i.e. Edition 2.0) was published. However, depending on the country/region, there are cases where the requirements of the IEC 60825-1:2001 specifications or equivalent must be adhered to.
- LEDs have been included in the scope of IEC 62471:2006 since the release of the specification in 2006.
- Most Nichia LEDs will be classified as the Exempt Group or Risk Group 1 according to IEC 62471:2006. However, in the case of high-power LEDs containing blue wavelengths in the emission spectrum, there are LEDs that will be classified as Risk Group 2 depending on the characteristics (e.g. radiation flux, emission spectrum, directivity, etc.)
- If the LED is used in a manner that produces an increased output or with an optic to collimate the light from the LED, it may cause damage to the human eye.

If an LED is operated in a manner that emits a flashing light, it may cause health issues (e.g. visual stimuli causing eye discomfort). The system should be designed to ensure that there are no harmful effects on the human body.

9. Summary

Nichia COB LEDs have both high luminance and high heat dissipation. Unlike surface mount device LEDs, there is no mounting process with the COB LEDs and therefore there will be less processes when assembling luminaires containing the COB LEDs. However, there are more chances to handle the LEDs manually during the assembly process. If the COB LEDs are properly handled, emission failure of the COB LEDs can be mostly avoided; Nichia focuses on the handling precautions for the LEDs in this application note.

Since the thermal resistance values provided in the specifications of Nichia COB LEDs are only the values when thermal grease is used, Nichia provides the thermal resistance values when a thermal sheet is used in this application note. Ensure that the content herein is taken into consideration for the thermal design of the chosen luminaire containing the COB LED.

Perform sufficient verifications before use with the conditions/environments in which the luminaires containing the COB LEDs will actually be used to ensure that the characteristics and/or the reliability for the LEDs are not adversely affected.

Light Emitting Diode

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