Light Emitting Diode

Precautions for the Nichia LEDs for General Lighting

Table of contents

SP-QR-C2-210506-3
Aug 19, 2024

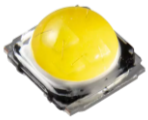
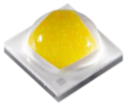
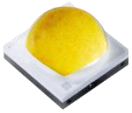
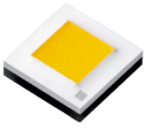
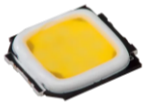
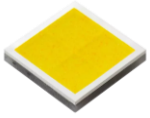
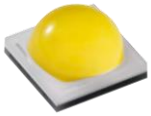
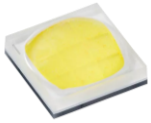
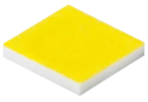
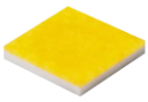
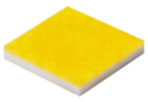
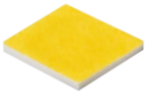
1. Introduction

When using LEDs, care should be taken to ensure that they are used in a proper manner; if LEDs are used improperly, it may cause damage to the LEDs and/or an adverse effect on their performance. This application note provides the precautions for Nichia's LEDs for general lighting.

2. Applicable Part Numbers

This application note applies to the LEDs shown in Table 1.

Table 1. Applicable LED Part/Series Numbers

Middle Power				
Series Name	Nichia757 Series	Nichia 385 Series	Nichia 585 Series	Nichia T02 Series
Part Number	NFxx757x	NF2W385x	NFxW585x	NSSxT02x
Appearance				
Outline Dimensions	3.0mm×3.0mm	4.0mm×3.6mm	4.0mm×3.6mm	1.2mm×0.7mm
High Power				
Series Name	Nichia x19 Series	Nichia 519 Series	Nichia 719 Series	Nichia 48 Series
Part Number	NxSx119x /NxSx219x	NVSW519x	NVSW719x	NFMW48xx
Appearance				
Outline Dimensions	3.5mm×3.5mm	3.5mm×3.5mm	3.5mm×3.5mm	6.5mm×5.8mm
Super High Power				
Series Name	Nichia B35 Series	Nichia 144 Series	Nichia 149 Series	
Part Number	NV4WB35x	NV4x144x	NV9W149x	
Appearance				
Outline Dimensions	3.5mm×3.5mm	5.0mm×5.0mm	7.0mm×7.0mm	
Direct Mountable Chip				
Series Name	Nichia E11 Series	Nichia E13 Series	Nichia E17 Series	Nichia E21 Series
Part Number	NFSWE11x	NCSWE13x	NCSxE17x	NVSxE21x
Appearance				
Outline Dimensions	1.1mm×1.1mm	1.25mm×1.25mm	1.7mm×1.7mm	2.1mm×2.1mm

3. Storage

3.1 Storage Conditions

When moisture absorbed in the LED package vaporizes and expands due to the heat generated during the soldering process, the encapsulating resin can be detached from the LED package, resulting in degradation of the optical characteristics. See Figure 1.

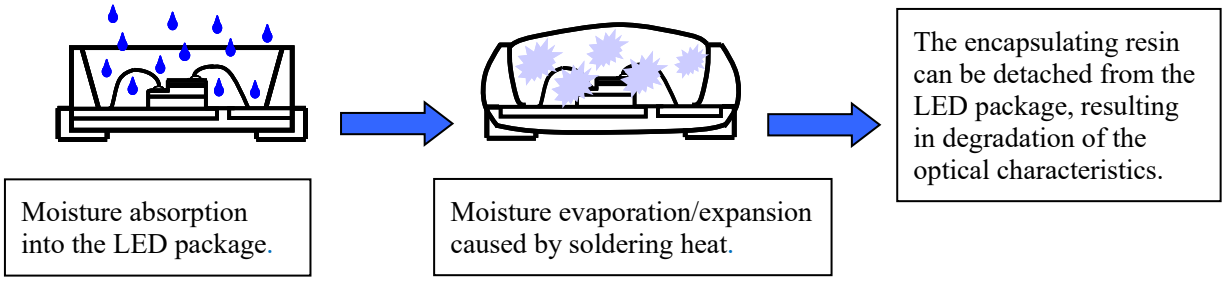


Figure 1. How the Soldering Heat Causes Moisture Evaporation and Expansion

To minimize moisture absorption in storage/transit, moisture-proof aluminum bags are used for the LEDs with a silica gel packet to absorb any air moisture in the bag.
Table 2 provides the required storage conditions before and after opening the moisture-proof aluminum bag.

Table 2. Storage Conditions

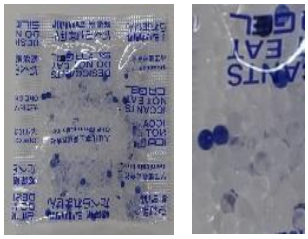
Moisture-proof Aluminum Bag	Temperature	Humidity	Storage Time	
Before Opening	≤30°C	≤90%RH	Within 1 year from Delivery Date	
After Opening	≤30°C	≤70%RH	MSL2a	≤4 weeks
			MSL3	≤168 hours

The “After Opening” storage time is different depending on the Moisture Sensitivity Level (MSL) of the LED. Refer to the specification for each LED part number for the MSL to ensure that soldering is completed within the specified storage time.
To store any remaining unused LEDs, use a hermetically-sealed container with silica gel desiccants. Nichia recommends placing them back to the original moisture-proof bag used for shipment and reseal it.

The storage times after opening the moisture-proof aluminum bag provided in Table 2 are for when the LEDs are stored under the required conditions (i.e. a temperature of ≤30°C and humidity of ≤70%RH). If the LEDs are stored at a higher temperature/humidity, allowable storage times will be shorter.
If the LEDs are stored in a dry environment where the humidity is ≤10%RH, the time duration under the condition will not be added to the cumulative count for the storage time. Refer to IPC/JEDEC STD-033 for details. Note that in that case, the warranty period for the LEDs will not be extended; the applicable warranty period will remain one year from the date that the LEDs are delivered.

3.2 If the Storage Time has been Exceeded

For the LEDs that are comparable to JEDEC Moisture Sensitivity Level (MSL) 3 or equivalent, ensure that they are baked for ≥24 hours at a temperature of 65±5ºC before use if the "After Opening storage" time (i.e. 168 hours) has been exceeded. If any pink silica gel beads are found within the storage times, ensure that the LEDs are baked in the same manner. See Figure 2 and Table 3.



A. When packed for shipment

B. After being left for 168 hours at 30ºC and 70%RH

The blue silica gel beads absorbed moisture and turned pink.

Figure 2. Appearance of Silica Gel Desiccants

Table 3. Baking Conditions

Series Name	Storage Time	Baking Conditions
Nichia T02 Series, Nichia E11 Series, Nichia E13 Series, Nichia E17 Series, Nichia E21 Series	MSL2a: ≤4 weeks	Baking is not guaranteed; once the moisture-proof aluminum bag is opened, ensure that soldering is completed within the specified storage time.
Nichia 757 Series, Nichia 385 Series, Nichia 585 Series, Nichia x19 Series, Nichia 519 Series, Nichia 719 Series, Nichia 48 Series, Nichia B35 Series, Nichia 144 Series, Nichia 149 Series	MSL3: ≤168 hours	For ≥24 hours, at a temperature of 65±5ºC. Baking should only be done once.

For LEDs that allow baking per the specifications, remove the reel of the LEDs from the storage container (e.g. a moisture-proof aluminum bag). See Figure 3.
If the baking temperature specified in the applicable specification is exceeded, it may cause the LEDs to degrade in performance and/or the embossed carrier tape to deform causing pick-up errors during the mounting process.

Figure 3. Example for Baking the LEDs

3.3 Deformation of the Embossed Carrier Tape

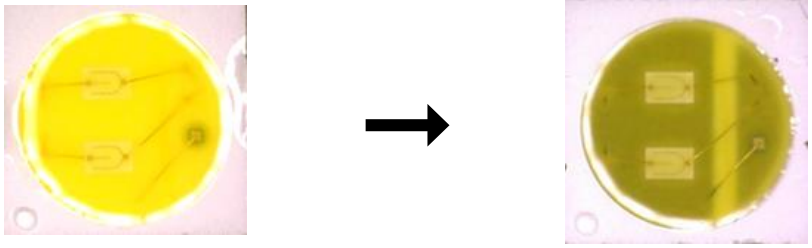
Do not store the LEDs in a manner where excessive external force may be applied to the reel (e.g. the reel is stored using a vacuum seal in a manner where there is too little air left in the storage bag, heavy objects are stacked onto the reel, etc.) since it may cause the embossed carrier tape to deform; see Figure 4. If the embossed carrier tape deforms, the LEDs inside the pockets of the embossed carrier tape may tilt, causing damage to the LEDs and/or pick-up errors.

Figure 4. Correct/Incorrect Examples for Embossed Carrier Tape after Vacuum Sealing

3.4 Storage Environment

The parts/materials (e.g. housing, gasket/seal, secondary lens, lens cover, thermal grease, etc.) used with the 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 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; see Figure 5. 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.



No tarnish or discoloration

Tarnish and discoloration after an LED is stored in a corrosive atmosphere containing sulfur

Figure 5. Example of Tarnish and Discoloration of an LED Due to Sulfur

For reference purposes, Table 4 shows materials/components that are generally used for/with luminaires using LEDs and the corrosive gas(es) they may contain (i.e. sulfur and/or halogen).

Table 4. Examples of Materials/Components that may be Used for/with Luminaires and the Corrosive Gas(es) they may Contain

Material/Component	Sulfur	Halogen	Recommended Measures for the End Products Using the LEDs
Cardboard	Yes	No	Moisture-proof aluminum bags should be used for shipment.
PCB	Yes	Yes	Halogen-free PCBs should be used.
Solder Paste	No	Yes	Halogen-free solder paste should be used.
Housing	Yes	Yes	Perform verifications at the end product level to ensure that the corrosive gases will not adversely affect the LEDs.
Gasket/Seal	Yes	No	Silicone[1] gaskets/seals should be used.
Adhesive	Yes	No	Silicone[1] adhesive should be used.
Lens	Yes	No	Perform verifications at the end product level to ensure that the corrosive gases will not adversely affect the LEDs.
Lens Cover	Yes	No	Perform verifications at the end product level to ensure that the corrosive gases will not adversely affect the LEDs.
Grease	Yes	No	Silicone[1] grease should be used.

To avoid condensation, the LEDs must not be stored in areas where temperature and humidity fluctuate greatly. Also, ensure that the LEDs are not exposed to direct sunlight and/or an environment over a long period of time where the temperature is higher than normal room temperature. Do not store the LEDs in a dusty environment.

[1] If a silicone material/component is used, ensure that this use of silicone does not result in issues (e.g. electrical connection failures) caused by low molecular weight volatile siloxane.

4. Handling Precautions

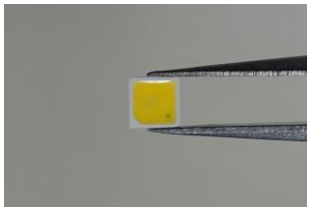
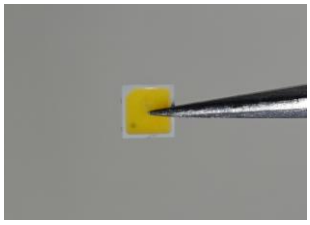
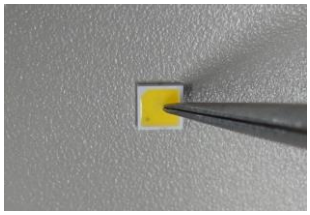
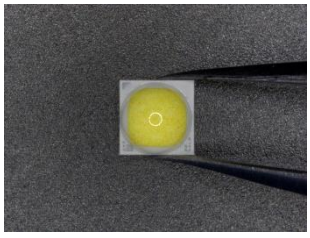
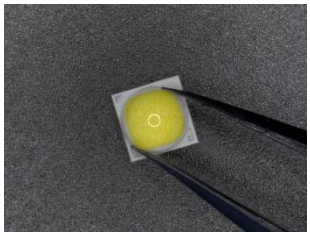
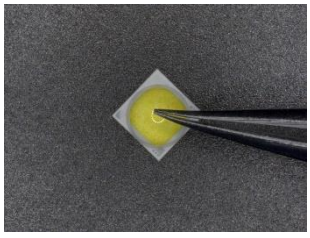
4.1 Handling with Bare Hands

Do not handle the LEDs with bare hands. This may contaminate the LED surface and have an effect on the optical characteristics. Also, the lead frame may cause injuries when the LED is handled with bare hands.

4.2 Handling with Tweezers

Ensure that when handling the LEDs with tweezers, excessive force is not applied to the LEDs. Otherwise, it may cause damage to the light emitting area and/or the silicone resin (e.g. cut, scratch, chip, crack, etc.) and have an effect on the optical characteristics and/or the reliability. Also, ensure that the LEDs are grabbed/held by the sides. Do not apply excessive force to the emitting area and/or the silicone resin; see Table 5.

Table 5. Correct/Incorrect Examples of Handling the LEDs with Tweezers

Correct	Incorrect	
Correct	Incorrect	Incorrect
Nichia 757 Series		
		
Nichia x19 Series		
		

The resin of the Nichia E11, E13, E17, and E21 series LEDs is very soft; do not handle these LEDs with tweezers.

4.3 Other Precautions

Do not drop the LEDs; this may cause issues (e.g. crack, chip, and/or deformation of the LEDs, and/or cut, scratch, etc. on the emitting area) causing the optical characteristics and/or the reliability to be adversely affected.

5. Precautions for the Mounting Process

5.1 Pick-and-Place Nozzle

Some of the applicable LEDs use silicone resin for the encapsulating resin; the silicone resin is soft. If force is applied to the encapsulating resin, it may cause the resin to be damaged (i.e. scratch, chip, crack, delamination, etc.) causing the LEDs to be deformed, the wires to break, and/or the reliability to be affected. Ensure that the pick-and-place nozzle being used will not come in contact with the encapsulating resin when it picks up the LEDs. Note that using a nozzle with a smaller diameter than the size of the LED's emitting surface will cause damage to the emitting surface causing a catastrophic failure (i.e. the LEDs not to illuminate); see Figure 6.

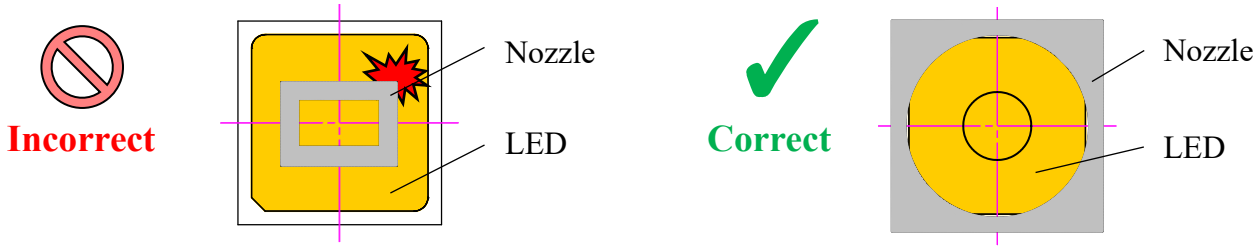


Figure 6. Correct/Incorrect Examples for Shapes of the Nozzle and LED Pick-up Positions for the Nichia 757 Series LEDs.

For the LEDs with an integrated lens, ensure that force will not be applied to the lens when the nozzle picks up the LEDs. If force is applied to the lens, it may cause the reliability of the LEDs to be affected and in the worst case, the LEDs not to illuminate.

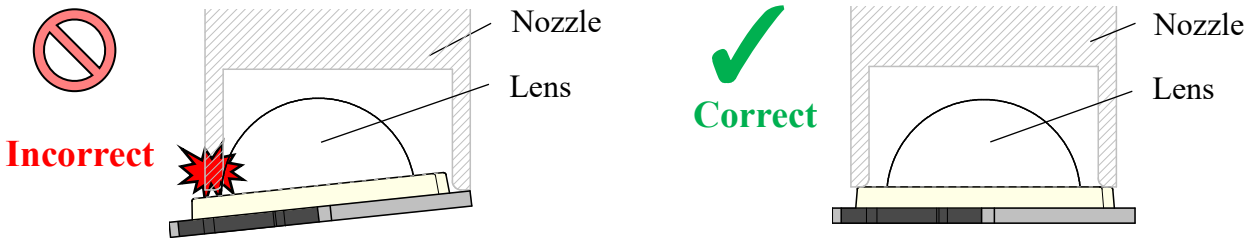


Figure 7. Correct/Incorrect Examples for LED Pick-up for the Nichia 585 Series LEDs.

For the recommended nozzle dimensions for each LED part number, refer to the applicable specification or the applicable application note regarding the mounting process. For LEDs that do not have the recommended nozzle dimensions described in the specification/application note, contact a local Nichia sales representative.

5.2 Precautions When Soldering

When soldering, do not apply stress to the LEDs while the LEDs are hot. When flux is used, it should be a halogen free flux. Ensure that the manufacturing process is not designed in a manner where the flux will come in contact with the LEDs.

5.3 Recommended Reflow Conditions

The LEDs are designed to be reflow soldered to a PCB. Reflow soldering must not be performed more than twice.

Using the recommended reflow soldering conditions (See Figure 8) as a reference, modify if necessary, the recommended reflow conditions specified by the manufacturer of the solder paste being used. When cooling the LEDs from the peak temperature a gradual cooling slope is recommended; do not cool the LEDs rapidly.

During reflow soldering, the heat and atmosphere in the reflow oven may cause the optical characteristics to degrade. In particular, reflow soldering performed with an air atmosphere may have a greater negative effect on the optical characteristics than if a nitrogen atmosphere is used; Nichia recommends using a nitrogen reflow atmosphere.

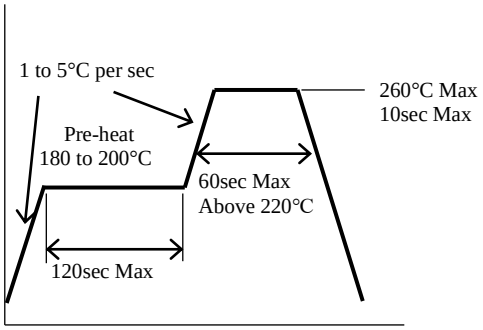


Figure 8. Recommended Reflow Soldering Condition

For reference purposes, Figure 9 shows an example of a reflow profile for the LEDs; this profile was created based on the recommended conditions specified by the manufacturer of the evaluated solder paste (Sn-3.0Ag-0.5Cu).

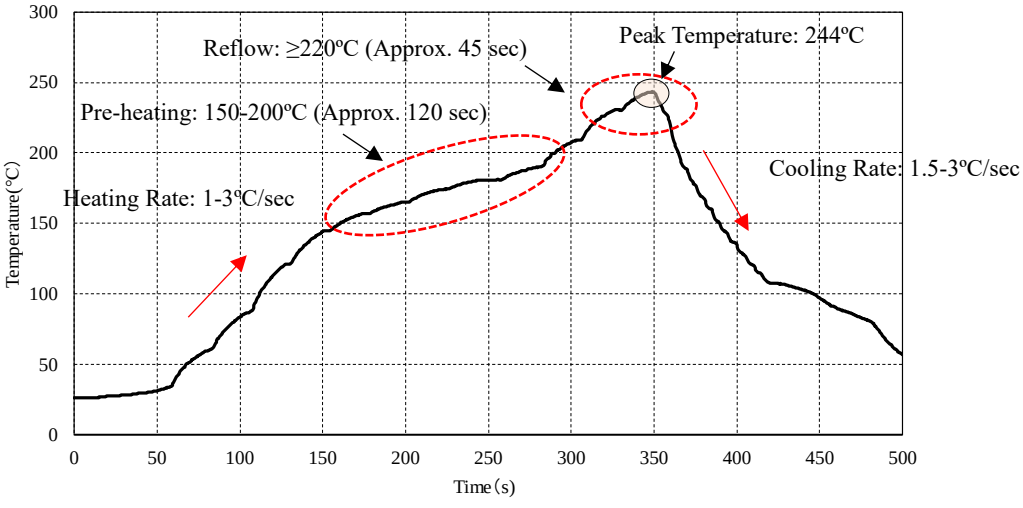


Figure 9. Example of a Reflow Profile

5.4 Precautions for Assembled PCBs

Do not stack assembled PCBs together. Otherwise, it may cause damage to the emitting area and/or the resin (e.g. cut, scratch, chip, crack, etc.) and have an effect on the optical characteristics and/or the reliability.

6. Directions for Use

6.1 Absolute Maximum Ratings

Absolute maximum ratings of the LEDs are the maximum values that must not be exceeded even for a short period of time. It must be ensured that the absolute maximum ratings are taken into consideration when designing an end product using the LEDs and will not be exceeded in the conditions/environments in which the LEDs will actually be used even for a short period of time. For the absolute maximum rating values for the LEDs, refer to the applicable specification.

6.2 Circuit Design Considerations

The circuit must be designed to ensure that the absolute maximum ratings are not exceeded for each LED. The LEDs should be operated at a constant current per LED. In the case of operating at a constant voltage, Circuit B in Figure 10 is recommended. If Circuit A is used, it may cause the currents flowing through the LEDs to vary due to the variation in the forward voltage characteristics of the LEDs on the circuit.

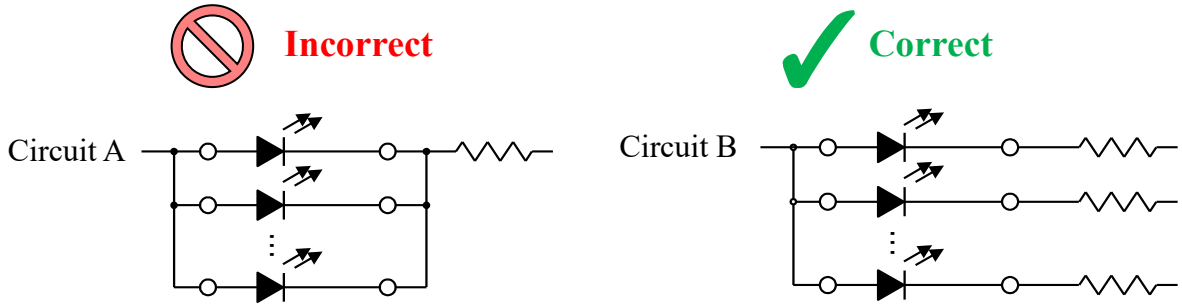


Figure 10. Correct/Incorrect Examples for the Circuit Design

6.3 Operating Current

These LEDs are designed to be operated at a forward current. To stabilize the LED characteristics while in use, Nichia recommends that the LEDs are operated at currents ≥10% of the sorting current. For the sorting current for each LED part number, refer to the applicable specification.

If the LEDs are incorporated in a dimmable and/or color tunable luminaire and operated at a low current (i.e. lower than 10% of the applicable sorting current), the brightness may vary among individual LEDs.
To reduce the difference in brightness for the chosen luminaires, Nichia may be able to sort the LEDs by forward voltage at a low current. For more information, contact a local Nichia sales representative.

6.4 Precautions for when the LEDs are Off

Ensure that no voltage is applied to the LEDs in the forward/reverse direction while the LEDs are off. If the LEDs are used in an environment where reverse voltages are applied to the LEDs continuously, it may cause electrochemical migration to occur causing the LEDs to be damaged. When not in use for a long period of time, the system's power should be turned off to ensure that there are no issues/damage.

6.5 Precautions for Environmental Conditions

Ensure that transient excessive voltages (e.g. lightning surge) are not applied to the LEDs. If the LEDs are used for outdoor applications, ensure that necessary measures are taken (e.g. protecting the LEDs from water/salt damage and high humidity).

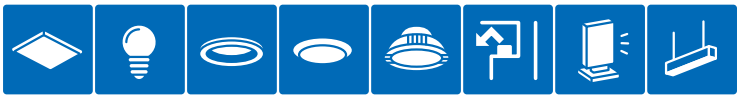
6.6 Secondary Lens

If a secondary lens is used to collimate or diffuse the light, evaluation must be performed for color uniformity, the temperature of the lens, etc. before use. Especially for the Nichia 757 series LEDs, the color uniformity on the illuminated surface is more likely to be lower when a secondary lens is used; perform sufficient verifications.

6.7 Applications for Each LED Series

Regardless of the applications, the chosen conditions/environment in which the LEDs will actually be used must be as specified in the applicable specification.
Especially when the LEDs are used for outdoor applications (e.g. streetlight, floodlight, etc.), ensure that necessary measures are taken to protect the LEDs from high temperature and high humidity conditions, ultraviolet rays, etc. and perform sufficient verifications at the end product level. For reference purposes, Table 6 shows example applications for each series LEDs.

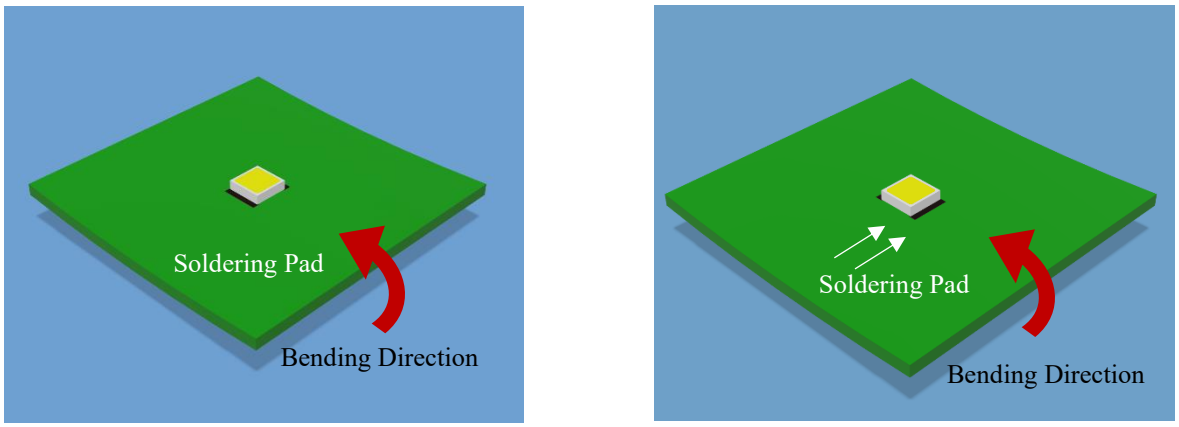
Table 6. Example Applications for Each Series LEDs

Series Name	Suitable Location for Installation/Use	Example Applications
Nichia 757 Series	Indoor & Outdoor	
Nichia 385 Series Nichia 585 Series	Indoor & Outdoor	
Nichia T02 Series	Indoor & Outdoor	
Nichia x19 Series Nichia 519 Series	Indoor & Outdoor	
Nichia 719 Series	Indoor & Outdoor	
Nichia 48 Series	Indoor & Outdoor	
Nichia B35 Series	Indoor & Outdoor	
Nichia 144 Series	Indoor & Outdoor	
Nichia 149 Series	Indoor & Outdoor	
Nichia E11 Series	Indoor & Outdoor	
Nichia E13 Series Nichia E17 Series	Indoor & Outdoor	
Nichia E21 Series	Indoor & Outdoor	

7. Design Precautions

7.1 LED Position/Orientation on the PCB Assembly

If the LEDs are soldered to a PCB and the PCB assembly is bent (e.g. PCB depaneling process), it may cause the LED package to break. The PCB layout should be designed to minimize the mechanical stress on the LEDs when the PCB assembly is bent/warped; see Figure 11.

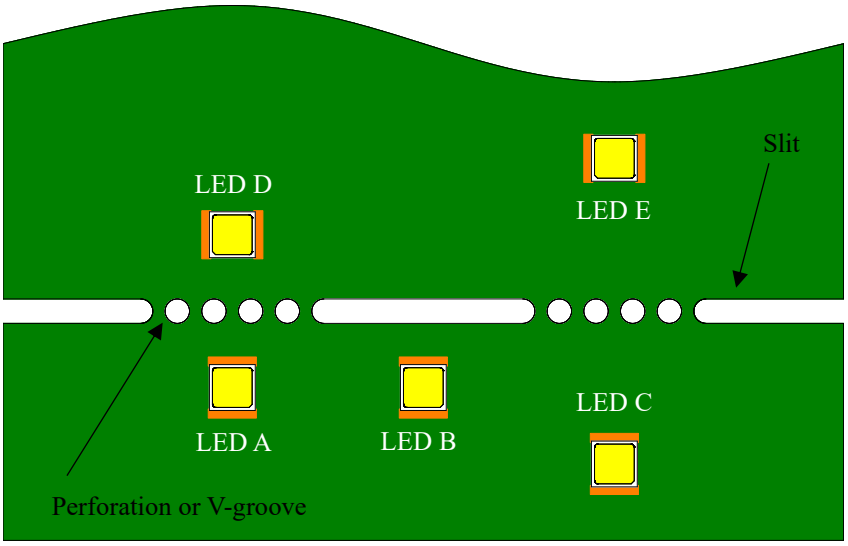


A. Recommended Direction

B. Not Recommended Direction (Excessive force may be applied to the LED)

Figure 11. Examples of the LED Orientation for the PCB Bending Direction for the Nichia 757 Series LEDs

The amount of mechanical stress exerted on the LED from depaneling may vary depending on the LED position/orientation on the PCB assembly (e.g. especially in areas near the slits and/or perforations). The PCB layout should be designed to minimize the mechanical stress on the LEDs when the PCB is separated into individual PCB assemblies. For example, in Figure 12 the amount of stress on the LED from depaneling would be smallest for LED E.
To separate a PCB populated with the LEDs, use a specially designed tool. Do not break the PCB by hand; this may cause excessive stress to be applied to the LEDs.



Amount of Stress on the LED:
A > B > C > D > E

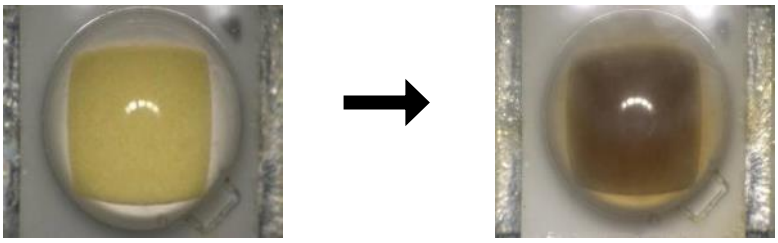
Figure 12. Examples of the LED Position/Orientation near the Slits and Perforations/V-groove on a PCB for the Nichia 757 Series LEDs

5.7 Hermetically Sealed Environment

The parts/materials (e.g. housing, gasket/seal, secondary lens, lens cover, thermal grease, etc.) used with the 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 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 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.



No tarnish or discoloration　　Tarnish and discoloration have occurred.

Figure 13. Example of Tarnish and Discoloration of an LED Due to VOCs

7.3 How to Select an Appropriate PCB

Note that solder cracks are more likely to occur when a ceramic material is used for the substrates of the LEDs (see Table 7) and a metal-core PCB (especially an aluminum PCB) is selected to mount the LEDs on.

Table 7. LEDs with Ceramic Substrates

Series Name
Nichia x19 Series, Nichia 144 Series, Nichia 149 Series, Nichia 519 Series, Nichia B35 Series

Solder cracks are more likely to occur when the difference in the coefficient of thermal expansion (CTE) between the LED and the PCB is large due to the thermal stress generated during operation. For example, the magnitude of the CTE values for aluminum, glass epoxy, and ceramic can be described as aluminum>glass epoxy>ceramic; using a glass epoxy PCB for the LEDs with a ceramic substrate is a better option than using an aluminum substrate to prevent solder cracks.
Nichia recommends that a metal-core PCB with an insulting layer with a low elastic modulus (i.e. low modulus elasticity insulating layer) is used to reduce the possibility of solder cracks.
The solder crack resistance varies depending on the types of solder paste (i.e. composition) as well as the specifications of the PCBs. Ensure that sufficient verification is performed to determine the appropriate PCB and solder paste for the chosen application.

8. Electrostatic Discharge (ESD)

8.1 Electrostatic Discharge (ESD)

These 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 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 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 LEDs against transient excessive voltages

Table 8 provides an example ESD checklist for reference purposes.

Table 8. 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?	-

8.2 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 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

8.3 Identifying ESD Damaged LEDs

To identify if an LED was damaged by transient excess voltages (i.e. an ESD event during the system's assembly process), perform a characteristics inspection (e.g. forward voltage measurement, light-up test) at low current (≤1mA). If the LED was damaged by transient excess voltages (e.g. ESD), it would cause the Forward Voltage (V_F) to decrease, the LED not to illuminate at a low current, etc.
For the failure criteria for the LEDs, refer to the applicable specification; the failure criteria for the V_F at the forward current of 0.5mA is specified.

8.4 ESD Withstand Voltage for the LEDs

Table 9 shows the typical ESD withstand voltage for the LEDs with a protection device: 8kV. For the LEDs without a protection device, the values would be less than several hundred volts.
The electrostatic voltage generated in work environments can be higher than the ESD withstand voltages of the LEDs; it must be ensured that the measures against ESD detailed in section 8.1 are taken.

Table 9. ESD Withstand Voltage for the LEDs

Series Name	Protection Device	ESD Withstand Voltage (HBM)[2]
Nichia x19 Series, Nichia 144 Series, Nichia 149 Series, Nichia 48 Series, Nichia 519 Series, Nichia 585 Series, Nichia 719 Series, Nichia 757 Series	Incorporated	8kV
Nichia B35 Series, Nichia E11 Series, Nichia E13 Series, Nichia E17 Series, Nichia E21 Series, Nichia T02 Series	Not Incorporated	-

For the LEDs that do not have an incorporated protection device, ensure that ESD protection is provided, as necessary. To protect PCB assemblies with the LEDs from ESD, mounting Zener diode(s) on the PCB will be effective. For reference purposes, Nichia provides precautions/considerations for selecting/mounting Zener diode(s):
- Ensure that the voltage of the Zener diode(s) is higher than the V_F of the LEDs in the whole operating temperature range for the LEDs. When selecting Zener diode(s), especially take variations in the voltage and/or the temperature characteristics of each individual Zener diode into consideration.
- Ensure that the Zener diode(s) are mounted sufficiently close to the LEDs. Note that the distance between the LEDs and Zener diode(s) are not shown in a circuit diagram; ensure that the actual distance is appropriate.
- Ensure that ESD current will be bypassed through the Zener diode(s); when selecting the location(s) to mount the Zener diode(s), it is necessary to identify the areas on the PCB where static charges are likely to occur (e.g. the areas where an operator may touch) in order to create an effective flow path for the ESD current.

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

9. Thermal Management

Maximum Junction Temperature (T_J) must not be exceeded under any circumstances. The increase in the temperature of an LED while in operation may vary depending on the PCB thermal resistance and the density of LEDs on the PCB assembly. Ensure that when using the LEDs for the chosen application, heat is not concentrated in an area and properly managed in the system/assembly.
The operating current should be determined by considering the temperature conditions surrounding the LEDs (i.e. T_A). Ensure that when operating the LEDs, proper measures are taken to dissipate the heat.

10. Cleaning

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

11. 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.

12. Summary

The LEDs need to be handled and assembled in a proper manner to obtain the required characteristics and the reliability. Follow the cautions/suggestions detailed in this application note and the applicable specification for each LED part number to ensure that the LEDs are used properly. In addition, perform sufficient verification at the end product level with the conditions/environments in which the end product containing the LEDs will actually be used to ensure that the characteristics and/or the reliability for the LEDs are not adversely affected.

Disclaimer

This application note is a controlled document of Nichia Corporation (Nichia) published to provide technical information/data for reference purposes only. By using this application note, the user agrees to the following:

- This application note has been prepared solely for reference on the subject matters incorporated within it and Nichia makes no guarantee that customers will see the same results for their chosen application.
- The information/data contained herein are only typical examples of performances and/or applications for the product. Nichia does not provide any guarantees or grant any license under or immunity from any intellectual property rights or other rights held by Nichia or third parties.
- Nichia makes no representation or warranty, express or implied, as to the accuracy, completeness or usefulness of any information contained herein. In addition, Nichia shall not be liable for any damages or losses arising out of exploiting, using, or downloading or otherwise this document, or any other acts associated with this document.
- The content of this application note may be changed without any prior or subsequent notice.
- Copyrights and all other rights regarding the content of this document are reserved by Nichia or the right holders who have permitted Nichia to use the content. Without prior written consent of Nichia, republication, reproduction, and/or redistribution of the content of this document in any form or by any means, whether in whole or in part, including modifications or derivative works hereof, is strictly prohibited.

NICHIA CORPORATION 491 Oka, Kaminaka-Cho, Anan-Shi, TOKUSHIMA 774-8601, JAPAN
http://www.nichia.co.jp Phone: +81-884-22-2311 Fax: +81-884-21-0148