Assembly Precautions for the Nichia 585 Series LEDs

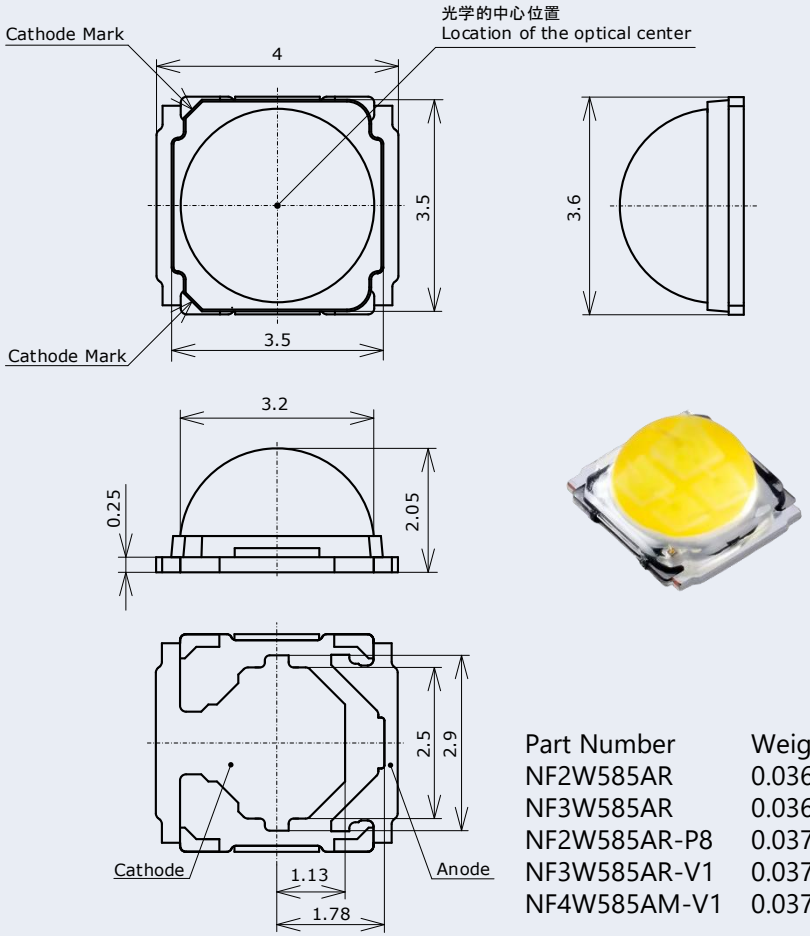
Table of contents

The part number NF2W585AR, NF2W585AR-P8, NF3W585AR, NF3W585AR-V1 and NF4W585AM-V1 in this document are the part number of our product, and do not have any relevance or similarity to other companies' products that may have trademark rights.

1. LED Outline Dimensions/Tape Dimensions

Table 1. NF2W585AR, NF2W585AR-P8, NF3W585AR, NF3W585AR-V1, NF4W585AM-V1 Product Specifications

LED Outline Dimensions

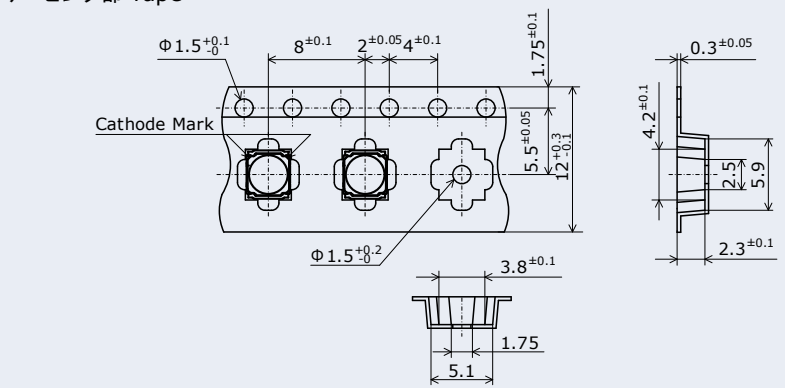


Part Number	Weight(typ.)
NF2W585AR	0.036g
NF3W585AR	0.036g
NF2W585AR-P8	0.037g
NF3W585AR-V1	0.037g
NF4W585AM-V1	0.037g

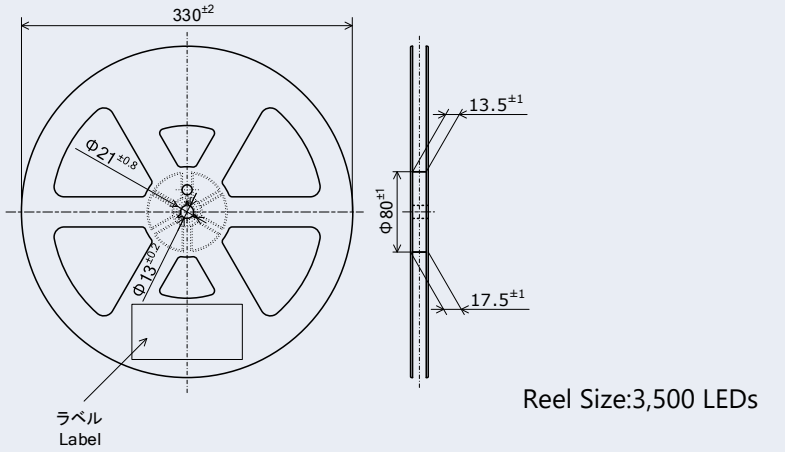
(Unit: mm, Tolerance: ±0.2mm)

Tape and Reel Dimensions

テーピング部 Tape



リール部 Reel



Reel Size:3,500 LEDs

(Unit: mm)

This document contains tentative information, Nichia may change the contents without notice.

2. Handling Precautions

2.1 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,
- this may cause the LED to deform and/or the wire to break causing a catastrophic failure (i.e. the LED not to illuminate),
- the lead frame may cause injuries when the LED is handled with bare hands.

2.2 Handling with tweezers

Ensure that when handling the LEDs with tweezers, excessive force is not applied to the LED. 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 LED not to illuminate).

2.3 ESD Precautions

The LEDs are sensitive to transient excessive voltages (e.g. ESD, lightning surge). If this excessive voltage occurs in the circuit, it may cause the LED to be damaged causing issues (e.g. the LED to become dimmer or not to illuminate [i.e. catastrophic failure]). When handling the LEDs, ensure that necessary measures have been taken to protect them from transient excess voltages. Refer to the applicable specification for more details.

2.4 Stacking assembled PCBs together

Do not stack assembled PCBs together. 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 LED not to illuminate).

2.5 Baking

The storage/packaging requirements for the NICHIA 585 Series LEDs are comparable to JEDEC Moisture Sensitivity Level (MSL) 3 or equivalent. Nichia used IPC/JEDEC STD-020 as a reference to rate the MSL of this LED. If the "After Opening" storage time has been exceeded or any pink silica gel beads are found, ensure that the LED are baked before use. Baking should only be done once.

Table 2. Storage/Baking Conditions

Conditions		Temperature	Humidity	Time
Storage	Before Opening Aluminum Bag	≤ 30° C	≤ 90%RH	Within 1 Year from Delivery Date
	After Opening Aluminum Bag	≤ 30° C	≤ 70%RH	≤ 168 hours
Baking (Reel is Removed from Aluminum Bag)		65±5° C	-	≥ 24 hours

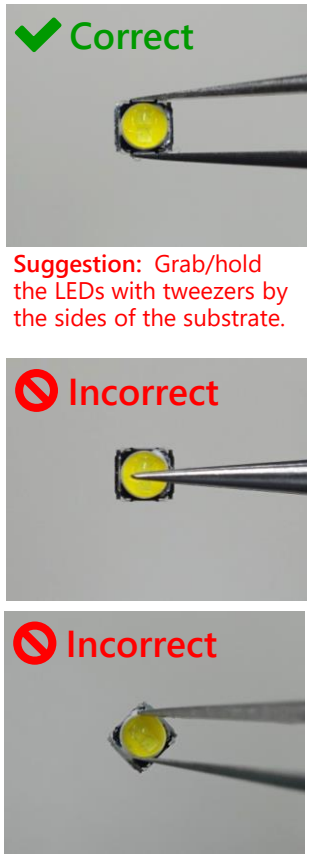
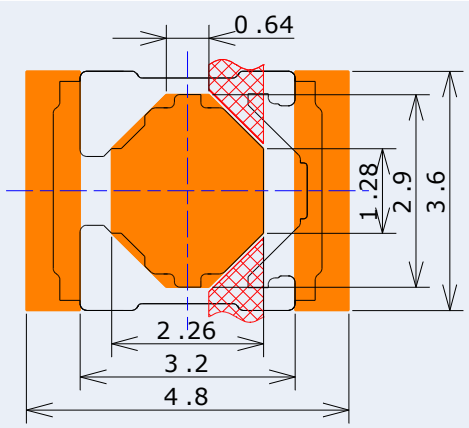
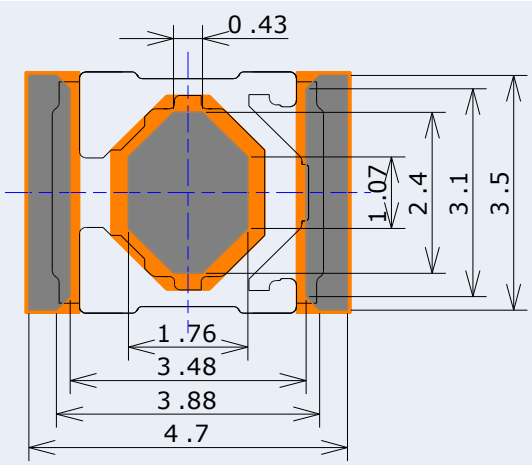


Figure 1. Examples of proper/improper handling with tweezers

3. Design Recommendations for Optimal Amount of Solder

Soldering Pad Pattern/Metal Solder Stencil Aperture

Table 3. Recommended Soldering Pad Pattern/Metal Solder Stencil Aperture

Recommended Soldering Pad Pattern	Recommended Metal Solder Stencil Aperture
	
▨: Do not have the solder pads in the area shaded with crossed diagonal lines. (Unit: mm)	(Unit: mm)

— LED Outline and Electrodes
■ Soldering Pad Pattern
■ Metal Solder Stencil Aperture

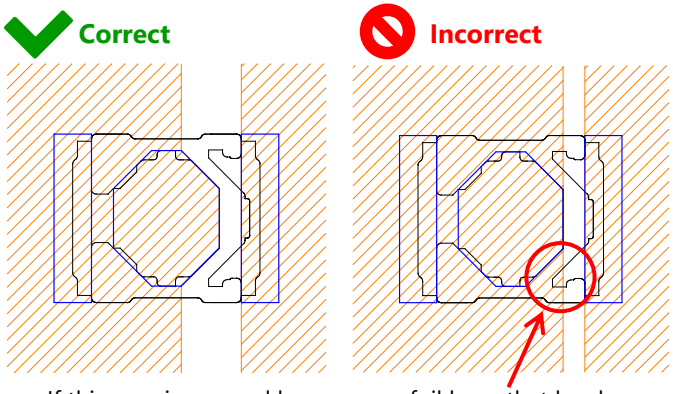


Figure 2. Prohibited Area for the Copper Layer

— LED Outline and Electrodes
▨ Copper Layer
□ Soldering Pad Pattern

Table 4. Recommended Solder/Metal Solder Stencil Conditions

Item	Recommended Conditions
Stencil Thickness	150μm
Solder Paste	Sn-3.0Ag-0.5Cu

The soldering pattern shapes, metal solder stencil aperture shapes, and metal stencil thicknesses shown in Tables 3 and 4 were selected based on Nichia's recommended placement conditions.
Customers should ensure that there are no issues with the chosen placement conditions before use.

4. Precautions for Setting Up a Pick-and-Place Machine/Nozzle

Table 5. Cautions/Suggestions for Setting Up Equipment

Item	Recommended Conditions/Specifications	Cautions/Suggestions
Pick-and-Place machine	Modular mounter	See the note below this table.
Pick-and-Place Nozzle	Specially designed nozzle (see Figure 3)	See “Pick-and-Place Nozzle” on Page 6 for the details.
Tape-and-reel feeder	Electrical (motorized) feeder Tape width: 12mm Feed length: 8mm	See “Tape-and-Reel Feeder” on Page 6 for the details.
Nozzle height for pick-up operations	The contact surface of the nozzle head for pick operations should be adjusted to 1.7mm below the edge of the embossed carrier tape pocket.	See “Recommended Nozzle Height for Pick-up Operations” on Page 7 for the details.
Nozzle height for placement operations (i.e. placement depth)	0.2mm for placement depth	See “Recommended Nozzle Height for Placement Operations (Placement Depth)” on Page 7 for the details.
Imaging-based Automatic Inspection	Using the electrode as a reference is recommended to locate the center of the LED.	See "Imaging-based Automatic Inspection" on Page 8 for the details.

Note:

- The recommended conditions/specifications above have been determined under the following verification conditions:
  Pick-and-Place machine (modular mounter):
  - YS100 High-Speed General-Purpose Modular (manufactured by Yamaha Motor Co., Ltd.)

4.1 Pick-and-Place Nozzle

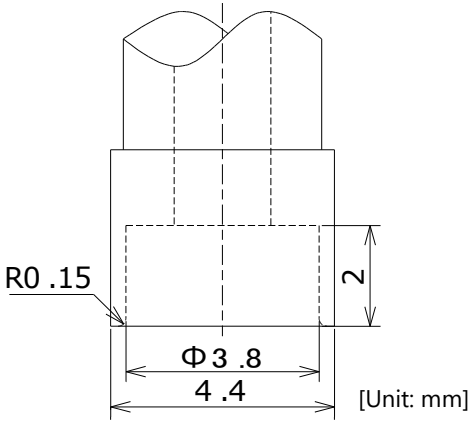


Figure 3. Recommended Nozzle Dimensions

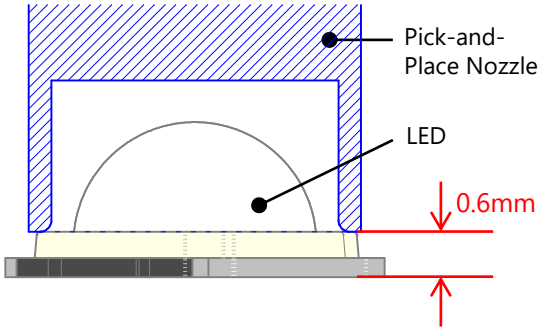


Figure 4. Cross-sectional view of a nozzle when transporting a NICHIA 585 Series LED to a PCB

1. As shown in Figure 4, the nozzle tip should only touch the flat corners of the LED's top surface to hold the LEDs. Ensure that it does not come in contact with the lens. The LEDs uses a silicone resin for the lens and internal pre-coating resin; the silicone resin is soft. If pressure is applied to the lens, it may cause the lens to be damaged, chipped and/or delaminated. If the lens is damaged, chipped, delaminated and/or deformed, it may cause the wire to break causing a catastrophic failure (i.e. the LED not to illuminate) and/or reliability issues (e.g. the LED to corrode and/or to become dimmer, the color/directivity to change, etc.) Ensure that no amount of pressure is applied to the lens.
2. Part height for the nozzle to pick up the LEDs: 0.6mm

4.2 Tape-and-Reel Feeder

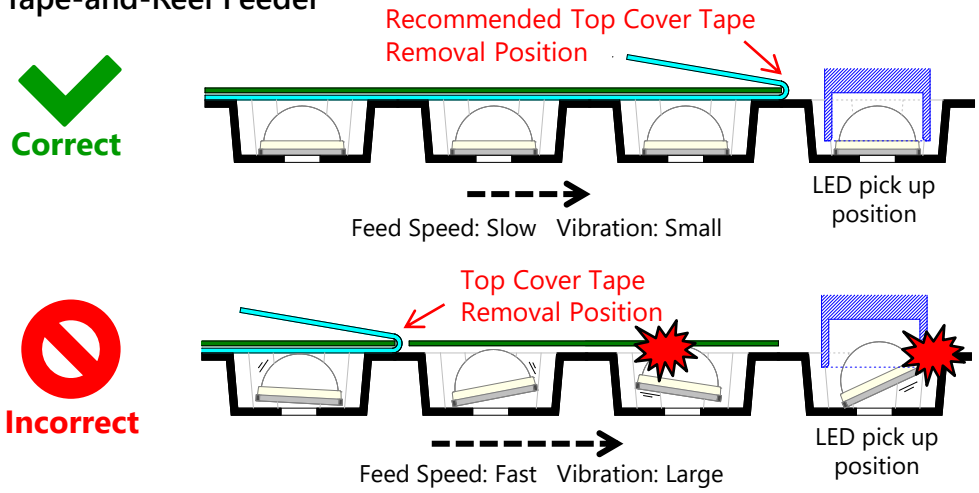


Figure 5. Examples of Correct/Incorrect Top Cover Tape Removal Positions

1. Recommended setting for the tape-and-reel feeder.
   Tape width: 12mm
   Feed length: 8mm
2. Use a tape-and-reel feeder that ensures it does not create excessive vibrations causing assembly issues.
   Example: Electrical (motorized) feeder
3. When removing the top cover tape, it should be done adjacent to the target LED (See Figure 5). Otherwise, it may shake the embossed carrier tape and cause the LED to move within the tape pocket. This may cause
   - the nozzle to fail to pick up the LED or not to pick it up properly and shift while on the nozzle during the transport to the PCB (i.e. pick-up/placement failure)
   - the LED to hit the feeder cover and become damaged.

4.3 Recommended Nozzle Height for Pick-up Operations

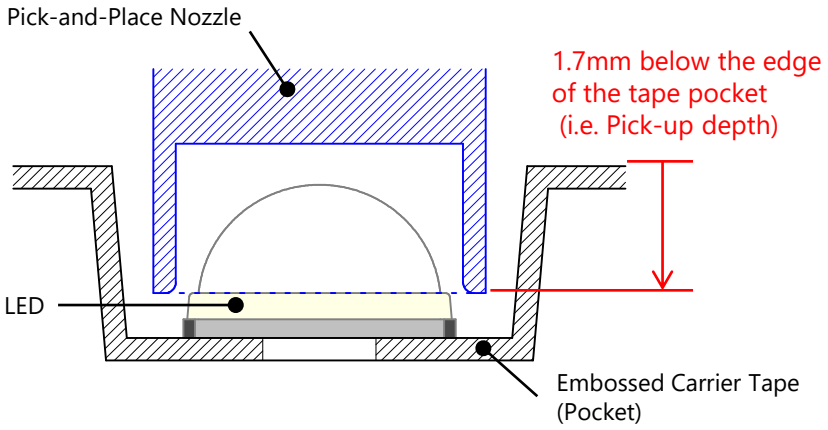


Figure 6. Recommended Nozzle Height for Pick-up Operations

1. Ensure that the nozzle goes down onto the LED in the tape pocket until the tip touches the flat surface around the lens.

   Pick-up depth: 1.7mm

   Note: If the reference level for the nozzle setting is at the edge of the tape pocket.

2. The recommended nozzle height for pick-up operations has been determined by Nichia under the verification conditions (See Table 5) and may not function as expected with some other pick-and-place machines. If the pick-up operations are unstable even with using the recommended nozzle height, adjust the nozzle height appropriate for the pick-and-place machine being used.

   If the pick point of the nozzle is too high,
   - it may cause insufficient suction power leading to picking errors (e.g. the nozzle's failure to pick/lift the LED into the air, incorrect picking causing the LED to tilt when in the air).

   If the pick point of the nozzle is too low,
   - it may cause issues (e.g. causing the embossed carrier tape to shake, causing the tape pocket to deform) leading to picking failure and/or damage to the LED.

4.4 Recommended Nozzle Height for Placement Operations (Placement Depth)

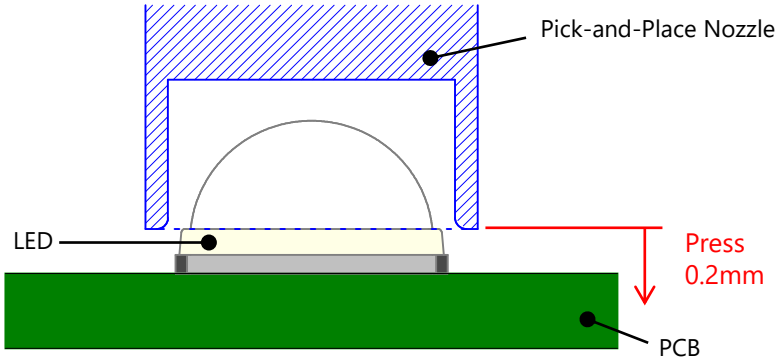


Figure 7. Recommended Nozzle Height for Placement (Placement Depth)

1. After the LED is placed onto the solder paste on the PCB, the nozzle should further press the LED 0.2mm into the PCB.

   If the release point of the nozzle is too high,
   - it may cause placement issues (e.g. the LED to stick to the nozzle after placement, the LED to become soldered to the PCB in a tilted position, etc.).

   If the release point of the nozzle is too low,
   - excessive forces may be applied to the LED during placement and it may cause the LED to become damaged.

4.5 Imaging-based Automatic Inspection

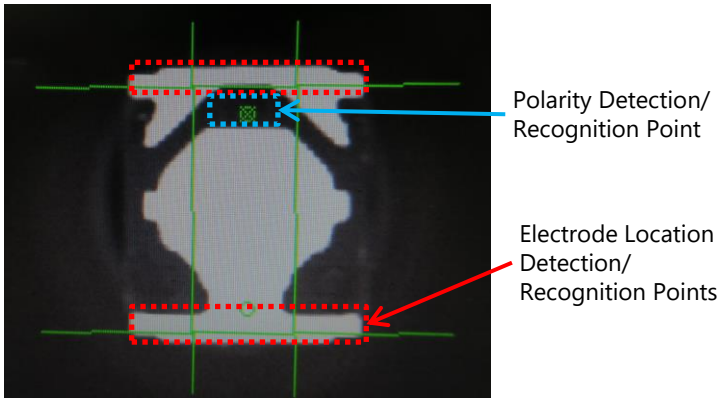


Figure 8. Recommended reference points to detect, recognize, or locate the polarity/electrodes

1. Nichia recommends using the electrodes as a reference to locate the center of the LED.
2. If the imaging device has trouble detecting/recognizing the electrodes due to the uniqueness of the electrode pattern, adjust it to detect/recognize the outer portions of the electrodes (i.e. the areas circled in red in Figure 8 to the left).
3. If an automatic polarity detector is used for the LEDs, set up the imaging device to detect the empty space between the anode and cathode electrodes (i.e. Polarity Detection/Recognition Point in Figure 8 to the left). In the example in Figure 8, the equipment measures the brightness of the empty space against the threshold to locate the electrodes and/or determine the polarity.

5. Precautions When Reflow Soldering

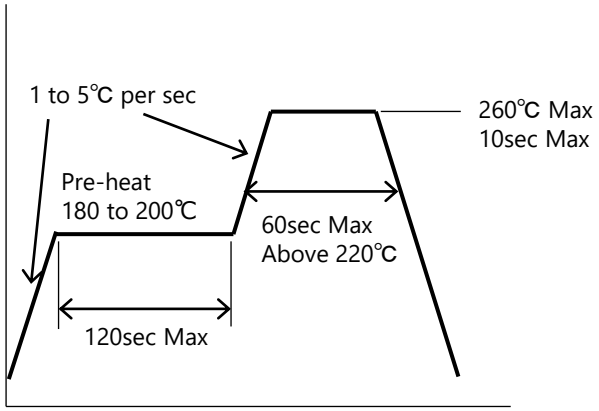


Figure 9. Recommended Reflow Soldering Condition (Lead-free Solder)

1. Reflow soldering must not be performed more than twice.
2. Using the recommended reflow soldering conditions (See Figure 9 to the left) as a reference, modify if necessary, the recommended reflow conditions specified by the manufacturer of the solder paste being used.

   Note: To ensure that these reflow conditions have no negative effect on the LEDs, perform sufficient verification prior to use.
3. When cooling the LEDs from the peak temperature a gradual cooling slope is recommended; do not cool the LEDs rapidly.
4. 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.

6. Evaluation of the Effect of Soldering Volume

6.1 Method/Conditions

Nichia has evaluated the effect of solder volume on the workmanship of the reflow-soldered in terms of LED emission, solder wettability (i.e. solder void percentage), number of solder ball, LED parallel/angular misalignment, and LED tilt. To control the amount of solder, three different metal solder stencil thicknesses were used.

Metal Solder Stencil Thickness:

120µm, 150µm (Nichia's recommendation), 180µm

6.2 Results

LED emission, solder balls, LED parallel/angular placement deviations, LED delamination, and LED tilt

- There were no issues with the evaluated amounts of solder used.

Solder wettability/void percentage,

- The solder spread was sufficient; the average solder void percentage of the cathode electrode area in the middle was approx. 6-10%.

For more details, refer to Table 6 on Page 10.

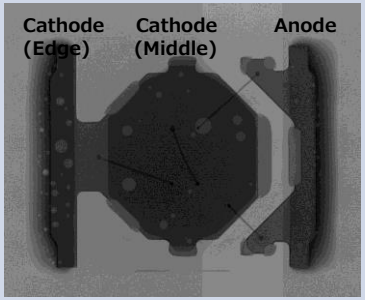
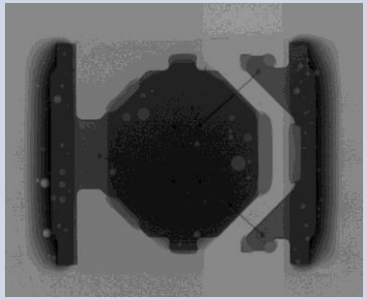
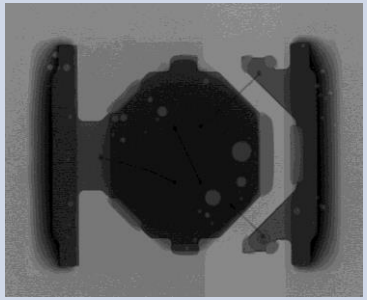
6.2 Recommendations

If solder balls appear in the chosen application, review the reflow profile and/or reduce the size of the metal solder stencil aperture for the cathode electrode in the middle.

6. Evaluation of the Effect of Soldering Volume (Continued)

Table 6. Evaluation Results for Each Stencil Thickness

Sample size: 102 LEDs per condition (i.e. stencil thickness)

Stencil Thickness	120µm	150µm (Nichia's Recommendation)	180µm
X-Ray Image[1]			
Emission Inspection	LED emitted	LED emitted	LED emitted
Solder Ball	No solder balls were formed	No solder balls were formed	No solder balls were formed
Solder Void Percentage[2]	Cathode (Edge): 5.9 % Cathode (Middle): 10.1 % Anode: 5.2 %	Cathode (Edge): 5.0 % Cathode (Middle): 6.9 % Anode: 4.5 %	Cathode (Edge): 4.2 % Cathode (Middle): 6.2 % Anode: 3.6 %
LED Parallel/Angular Misalignment, and LED Tilt	No issue	No issue	No issue

Note:

1 Example of LEDs with average void percentages under the same evaluation conditions (i.e. amount of solder).

2 Solder void percentage [%]: Area of a space within the solder joint that lacks solder paste/area of the electrode.

7. Verification of the Self-Alignment Capability

7.1 Method/Conditions

Nichia has verified the self-alignment capability of the LEDs using three different solder stencil thicknesses to control the amount of solder. Evaluation LEDs were placed on specified points or intentionally rotated to create a parallel/angular misalignment from the center of the soldering pad pattern (see Figure 10 below). After reflow soldering, LED positions and angles were measured for each stencil thickness (i.e. solder volume) to determine the amount of misalignment.

Metal Solder Stencil Thickness: 120µm, 150µm (Nichia's recommendation), 180µm

Parallel Deviation Condition: Δx,y = 0.1mm, 0.2mm **Angular Deviation Condition:** Δθ = 10°, 5°

+ Center of the soldering pad pattern
+ LED center for placement (i.e. center determined based on the electrodes' position)

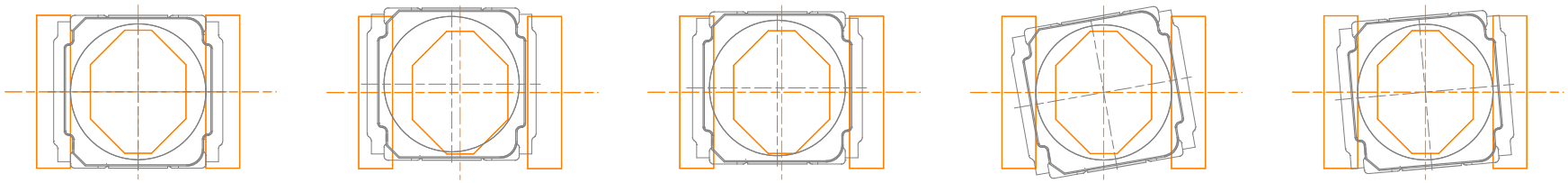


Figure 10. LED misalignment Conditions

7.2 Conclusions

LED Parallel Misalignment

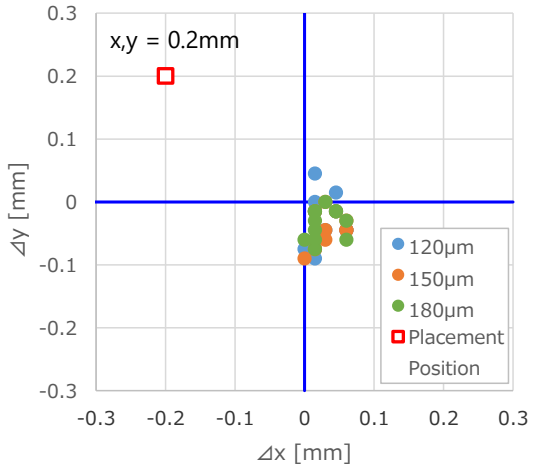
- If the misalignment is within 0.2mm in both the x and y coordinates, it will not have an effect on the self-alignment capability.

LED Angular Misalignment

- Since all the rotated LEDs moved back to the correction position (i.e. the center of the soldering pad pattern) by themselves during reflow soldering, there are no issues with the self-alignment capability against the evaluated angular deviation.

For more details, refer to Figures 11 and 12 on Page 12.

7. Verification of the Self-Alignment Capability (Continued)



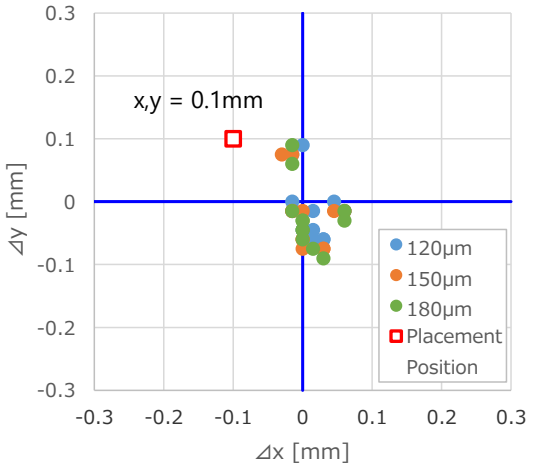


Figure 11. Evaluation Results (Parallel misalignment)

Sample size: 12 LEDs for each condition

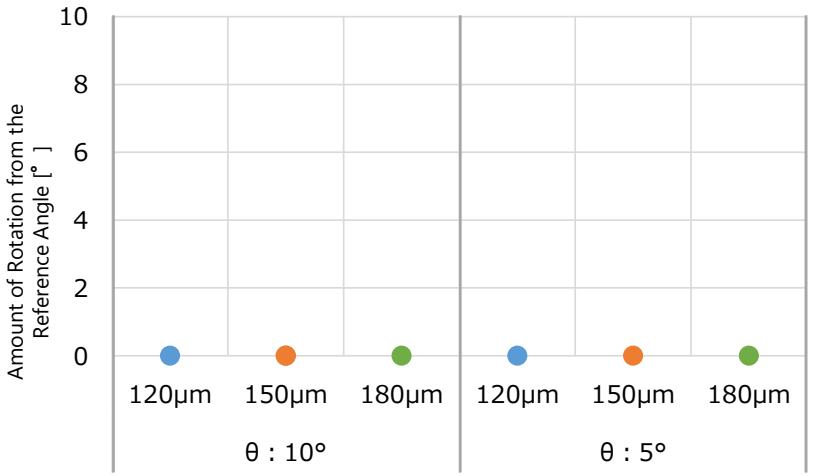
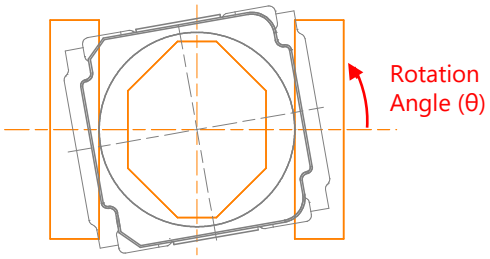


Figure 12. Evaluation Results (Angular misalignment)

Sample size: 12 LEDs for each condition



+ Center of the soldering pad pattern
+ LED center for placement (i.e. center determined based on the electrodes' position)

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