Assembly Precautions for the Nichia 149 Series LEDs

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The part number NV9W149AM in this document is the part number of our product, and does not have any relevance or similarity to other companies' products that may have trademark rights.

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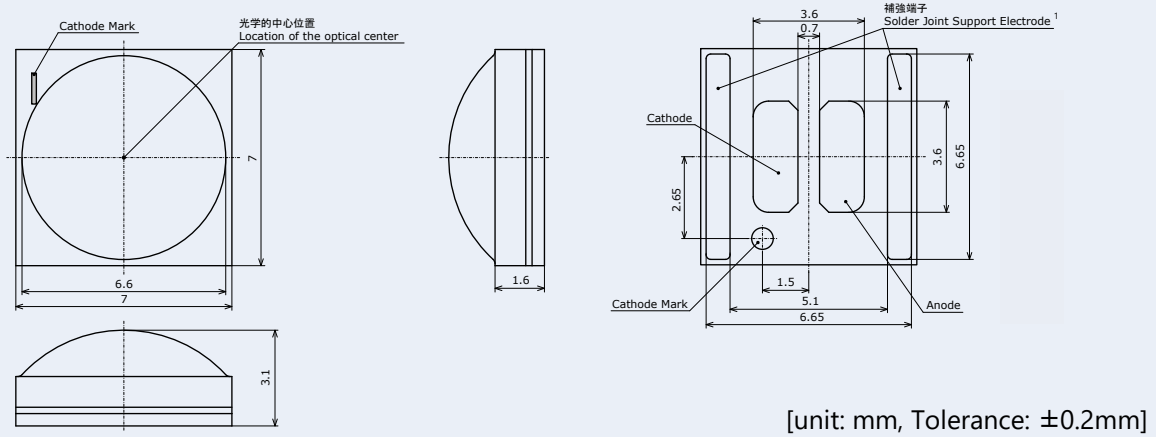
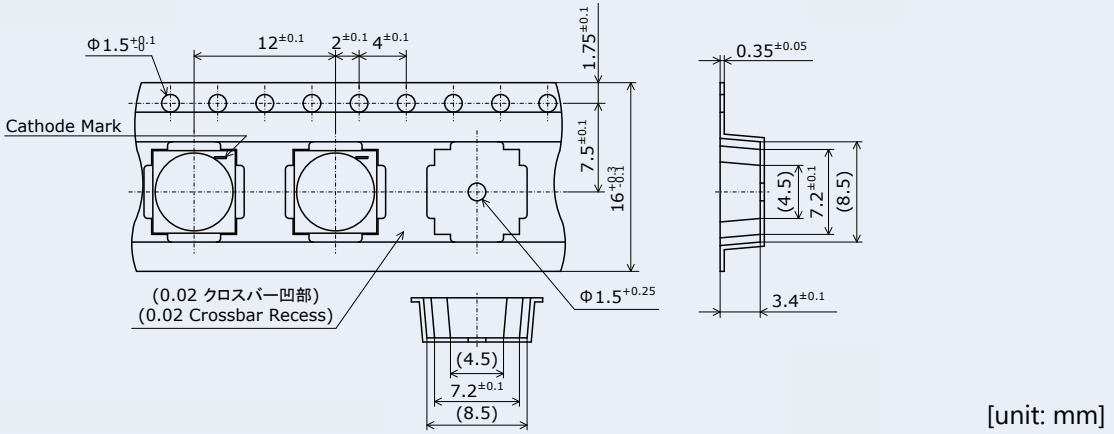
1. LED Outline Dimensions/Tape Dimensions

Table 1. Product Specifications

Part Number	NV9W149AM
LED[1]	 [unit: mm, Tolerance: ±0.2mm]
Embossed Carrier Tape	 [unit: mm]

Note:

[1] The NICHIA 149 Series LEDs have metal pads on the back surface to reinforce the solder joints (i.e. solder joint support electrodes) or for polarity recognition (i.e. cathode mark); these pads are electrically insulated from the anode/cathode electrodes which are on the same surface.

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2. Handling Precautions

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.

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 internal connection to fail causing a catastrophic failure (i.e. the LED not to illuminate).

ESD Precautions

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 have a reduction in the radiant flux 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.

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 internal connection to fail causing a catastrophic failure (i.e. the LED not to illuminate).

Baking

The storage/packaging requirements for the NICHIA 149 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.

Incorrect

Caution: Do not grab/hold the LEDs with tweezers around the encapsulating resin.

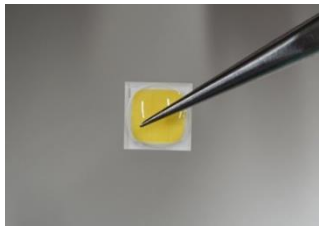

Figure 1. Example of an Improper Holding Position

Incorrect

Caution: Do not stack assembled PCBs on top of each other.

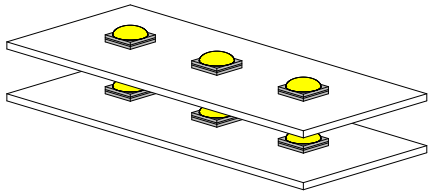

Figure 2. Example of Improper Stacking

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		65±5°C	-	≥24 hours

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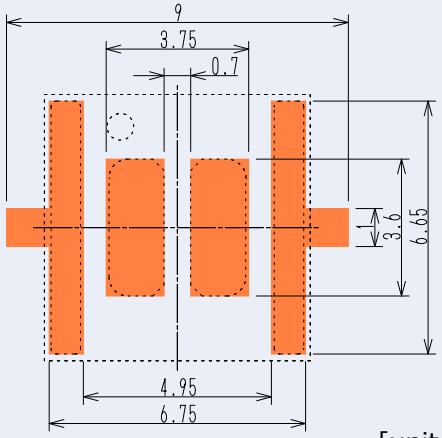
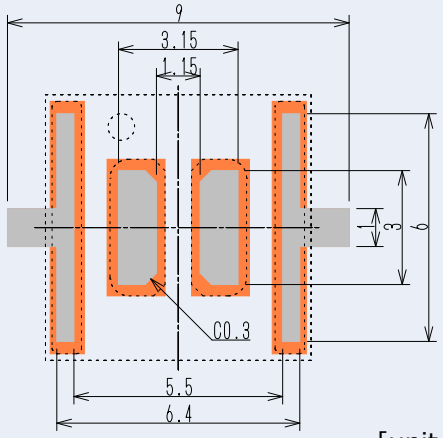
3. Design Recommendations for Optimal Amount of Solder

Soldering Pad Pattern/Metal Solder Stencil Aperture

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

Soldering Pad Pattern	Stencil Aperture
 [unit : mm]	 [unit : mm]

··· LED outline
■ Soldering Pad Pattern
■ Stencil Aperture

Table 4. Recommended Solder/Metal Solder Stencil Conditions

Item	Recommended Condition
Solder Stencil Thickness	120 [μm]
Solder Paste	Sn-3.0Ag-0.5Cu

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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[2]	Modular mounter	
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: 16mm Feed length: 12mm	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 1.8mm 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)	1.7mm 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:

[2] 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.)

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4-1. Pick-and-Place Nozzle

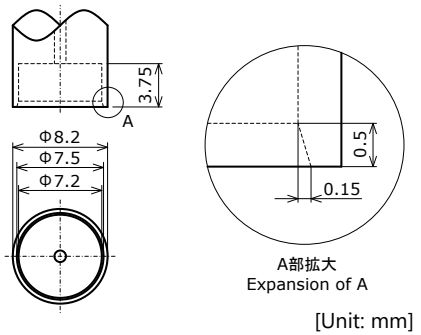

Figure 3. Recommended Nozzle Dimensions

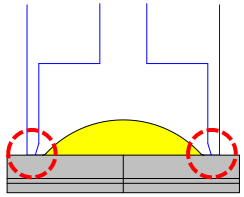

Figure 4. Cross-sectional view of a nozzle when transporting an NICHIA 149 Series LED to a PCB

- 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 internal connection to fail 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.

4-2. Tape-and-Reel Feeder

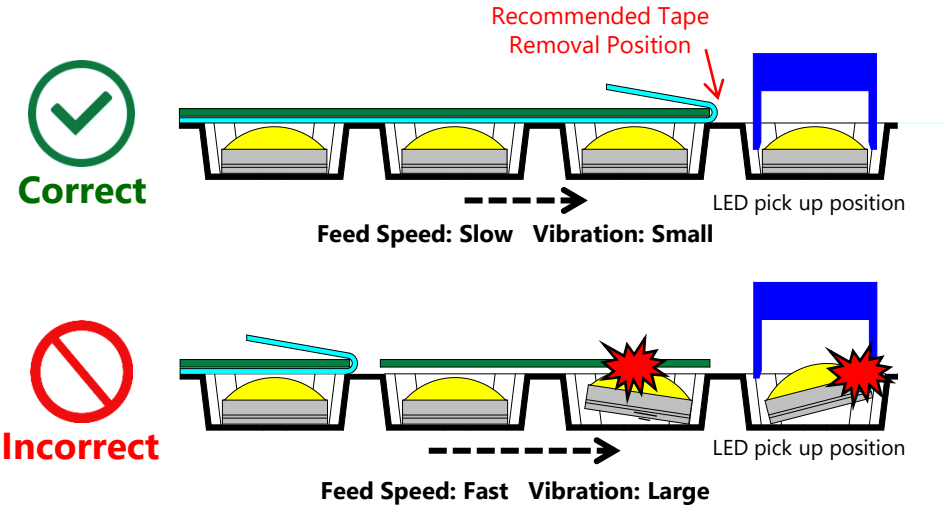

Figure 5. Examples of Correct/Incorrect Top Cover Tape Removal Positions

- Recommended setting for the tape-and-reel feeder.

  Tape width: 16mm
  Feed length: 12mm

- Use a tape-and-reel feeder that ensures it does not create excessive vibrations causing assembly issues.

  Example: Electrical (motorized) feeder

- 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.

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4-3. Recommended Nozzle Height for Pick-up Operations

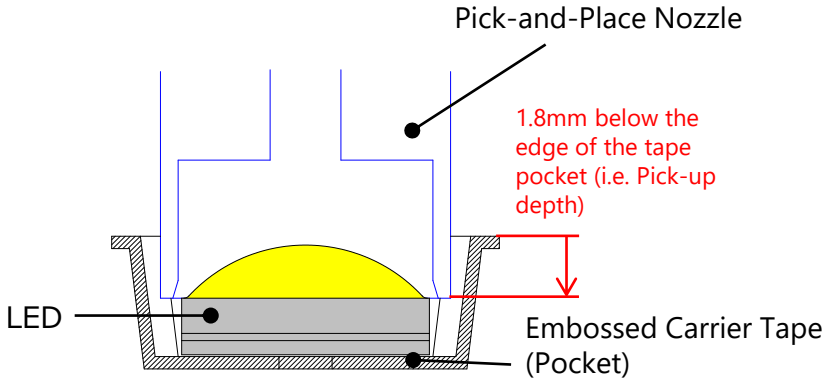

Figure 6. Recommended Nozzle Height for Pick-up Operations

4-4. Recommended Nozzle Height for Placement Operations (Placement Depth)

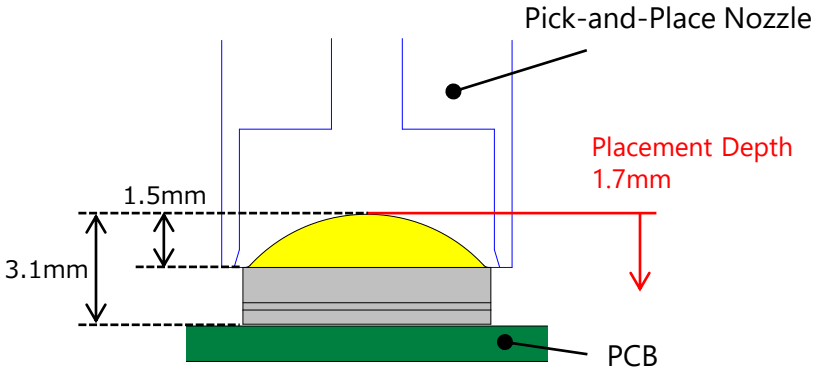

Figure 7. Recommended Nozzle Height for Placement (Placement Depth)

- 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: 1.8mm[3]
- The recommended nozzle height for pick-up operations has been determined by Nichia under the verification conditions (See Table 5 Note) 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 failures.

- If the pick-and-place machine uses the part height as a reference, then the recommended placement depth (i.e. nozzle's release point) is 1.7mm[4] (i.e. 1.7mm below the reference point).

  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.

Note:

[3] If the reference level for the nozzle setting is at the edge of the tape pocket

[4] The part height of the NICHIA 149 Series LEDs (i.e. 3.1mm) include the height of the lens protruding out on the package (i.e. 1.5mm). Since the nozzle tip should travel down to the package surface to hold the LED, the lens height needs to be considered when setting the placement depth. To ensure a better spread of solder paste and prevent issues after reflow soldering, an additional force (i.e. approx. a depth of 0.2mm) should be included in the placement depth settings.

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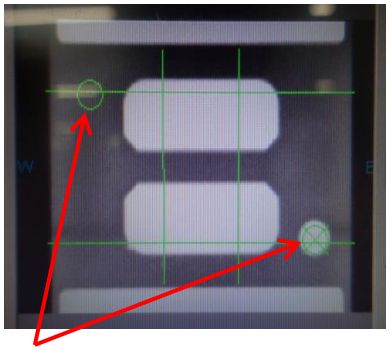
4-5. Imaging-based Automatic Inspection



Polarity Detection/Recognition Points

Figure 8. Example of automatic polarity detection/recognition from an image: the machine extracts information from the image and determines the polarity (i.e. Anode or Cathode)

- If a high level of accuracy is required for positioning the LEDs at the time of placement, Nichia recommends using the electrodes as a reference to locate the center of the LED. Since the electrode position against the outline may vary depending on the LED (i.e. manufacturing variation) the LED outline should not be used for location/positioning purposes.
- If an automatic polarity detector is used for the LEDs, set up the imaging device to detect the mark adjacent to the cathode electrode (i.e. cathode mark). In the example in Figure 8, the equipment measures the difference in brightness between the two points on the screen (i.e. green circles in the upper-left and lower right corners in Figure 11) and determines the polarity. Adjust the equipment settings to ensure that the cathode mark is in the correct position on the screen during the imaging-based automatic inspection.

5. Precautions When Reflow Soldering

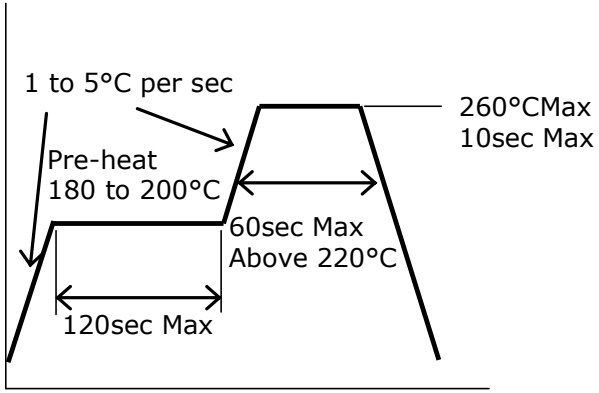


Figure 9. Recommended Reflow Soldering Condition (Lead-free Solder)

- Reflow soldering must not be performed more than twice.
- 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.
- 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.

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6. Evaluation of the Effect of Solder Volume

6-1. Evaluation Method/Conditions

The effect of solder volume on the workmanship of the reflow-soldered LEDs (i.e. LED emission failure, number of solder balls and amount of LED tilt) was evaluated using nine different evaluation configurations (i.e. three aperture ratios, three stencil thicknesses) to control the amount of solder paste.

Metal Solder Stencil Aperture Ratio[5]:

31%, 56% (Nichia's recommendation), 77%

Metal Solder Stencil Thickness:

100µm, 120µm (Nichia's recommendation), 150µm

6-2. Evaluation Results

Emission failure, and solder wettability/void percentage

- There were no issues with the evaluation conditions (i.e. volume of the solder paste) used.

For more details, refer to Table 6 on the next page.

LED tilt

- The amount of LED tilt became larger as the aperture size and thickness of the stencil increased.
- The average amount of LED tilt with the recommended conditions (i.e. 120µm for the stencil thickness, 56% for the aperture ratio) was 0.052mm.

For more details, refer to Figures 10 and 11 on the next page.

Note:

[5] Aperture ratio [%]: Ratio of the metal stencil aperture size to the soldering pad size

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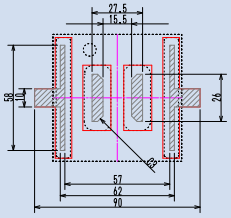
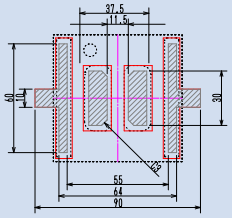
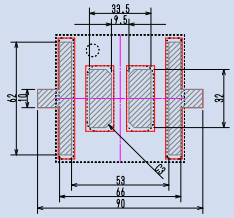
6-2. Evaluation Results (continued)

Table 6. Evaluation Results (LED Emission/Solder Ball)

Sample size: 60 LEDs per condition

Metal Solder Stencil Aperture Ratio[5]		31%	**56% (Recommend)**	77%
				
Stencil Thickness	100µm	LED emitted	LED emitted	LED emitted
		No solder balls were formed	No solder balls were formed	No solder balls were formed
	120µm (recommend)	LED emitted	LED emitted	LED emitted
		No solder balls were formed	No solder balls were formed	No solder balls were formed
	150µm	LED emitted	LED emitted	LED emitted
		No solder balls were formed	No solder balls were formed	No solder balls were formed

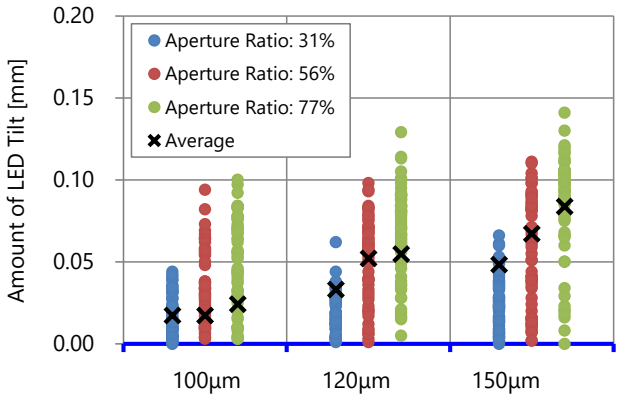


Figure 10. Evaluation Results (LED Tilt)
Sample size: 60 LEDs per condition (i.e. stencil thickness)

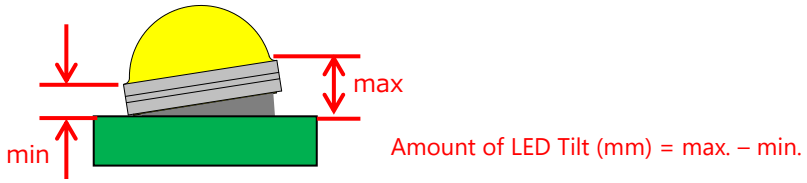


Figure 11. How to Measure the Amount of LED Tilt

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7. Evaluation of Self-Alignment Performance

7-1. Evaluation Method/Conditions

The self-alignment performance of the reflow-soldered LEDs was evaluated using the following evaluation method/conditions:

- Nine different evaluation configurations (i.e. three aperture ratios, three stencil thicknesses) to control the amount of solder paste
- Evaluation LEDs were placed on a specified point (i.e. $\Delta x,y = 0.2mm$) and then intentionally rotated (i.e. $\Delta\theta = 5°$)
- The amounts of parallel/angular deviation from the center of the soldering pad pattern were measured for each stencil thickness/aperture ratio (i.e. solder volume).

Metal Solder Stencil Aperture Ratio[5]:

31%, 56% (Nichia's recommendation), 77%

Metal Solder Stencil Thickness:

100µm, 120µm (Nichia's recommendation), 150µm

LED Parallel/Angular Misalignment:

See Figure 7 on the next page.

7-2. Evaluation Results

The LEDs with the deviations above moved to positions that were sufficiently close to the correct one (i.e. the center of the soldering pad pattern) by themselves during reflow soldering (i.e. surface tension-driven self-alignment) and no issues (e.g. causing the LED not to illuminate) were observed. For more details, refer to Tables 12 and 13 on the next page.

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7-2. Evaluation Results (continued)

Placement with a Misalignment of Δx,y = 0.2mm

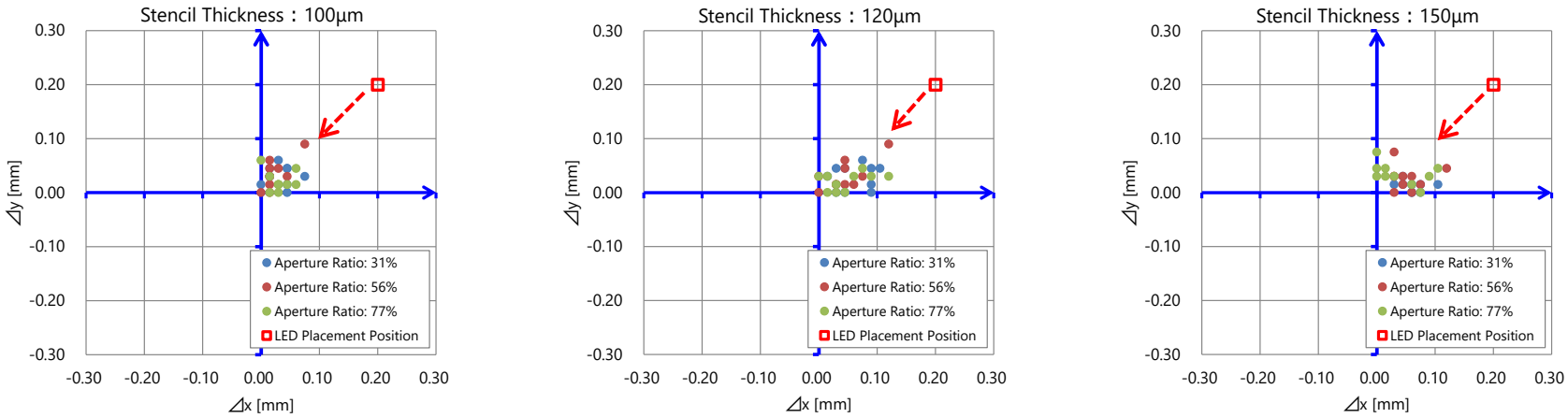


Figure 12. Evaluation Results (Parallel misalignment)
Sample size: 10 LEDs for each condition

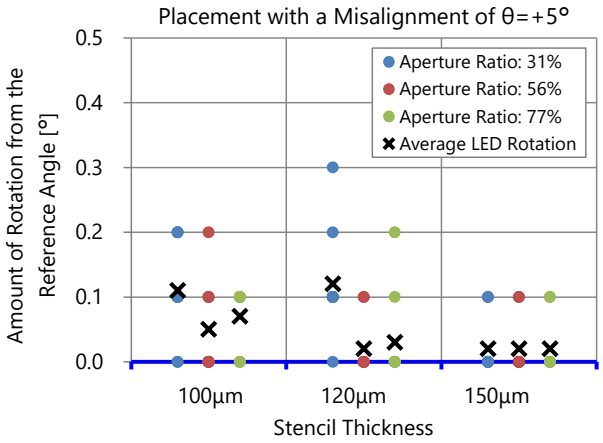
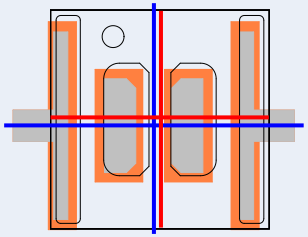
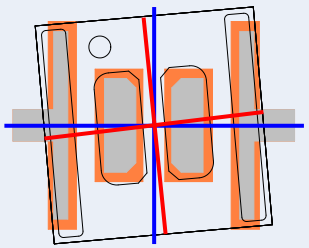


Figure 13. Evaluation Results (Angular misalignment)
Sample size: 10 LEDs for each condition

Table 7. LED Misalignment Conditions

Parallel (LED Placement Position) Δx,y = 0.2mm	Angular (LED Rotation) Δθ = 5°
	

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

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