Assembly Precautions for the Nichia E13 Series LEDs

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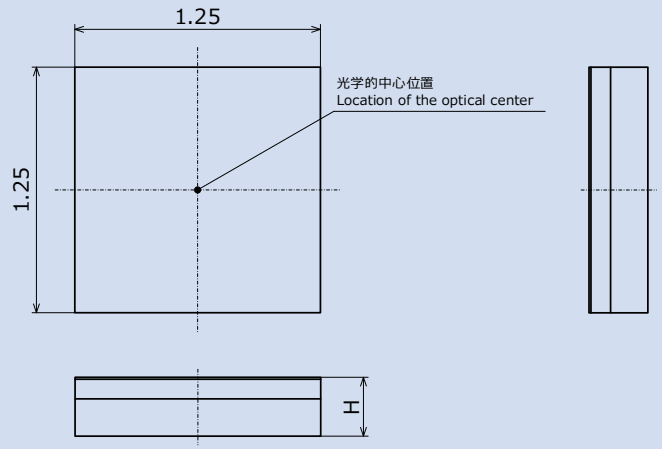
The Nichia part number NCSWE13A-V1 within this document is merely Nichia's part number for this Nichia product and is not related nor bears resemblance to any other company's product that might bear a trademark.

1. LED Outline Dimensions/Tape Dimensions

Table 1. Product Specifications

LED

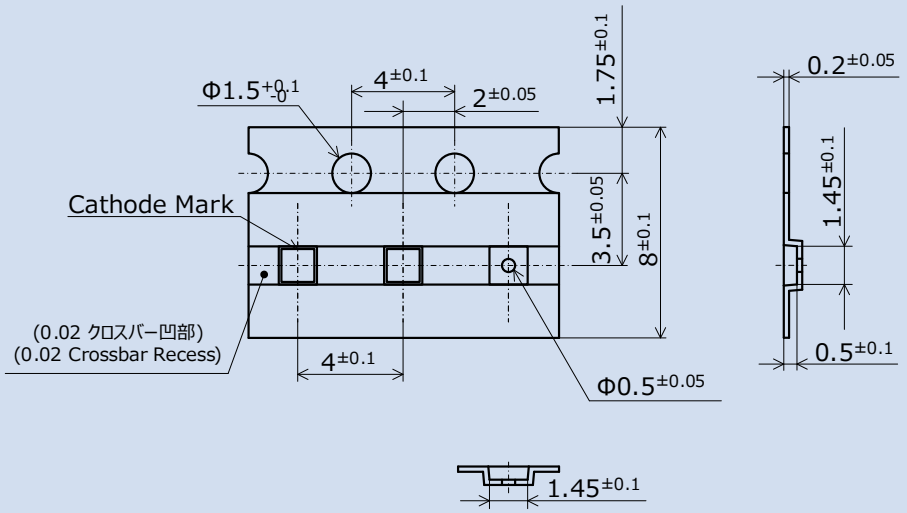


Color Temperature /Rank	CRI Rank	H (Height)
1800K-4000K	R9050	0.35
2700K-4000K	R8000	0.30
sm50x	R8000	0.27
5000K-6500K	R9050	0.30

Weight: typ. 0.0014g

(Unit: mm, Tolerance: ±0.5mm)

Embossed Carrier Tape



Reel Size: 6,000 LEDs

(Unit: mm)

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, and/or may cause the LEDs to deform and/or the wire to break causing a catastrophic failure (i.e. the LED not to illuminate).

2-2. Handling with tweezers

The encapsulating resin of these LEDs is very soft. Handling the LEDs with bare hands or with tweezers may also cause the LEDs to be damaged and/or fail to illuminate since it may apply force to the resin; do not handle the LEDs with bare hands or tweezers.

2-3. ESD Precautions

The E13 series LEDs are very sensitive to transient excessive voltages (e.g. ESD, lightning surge) since a protection device (e.g. Zener diode) is not incorporated in them. If this excessive voltage occurs, 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]). When handling the LEDs, ensure that necessary measures have been taken to protect them from transient excess voltages.

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

2-5. Storage

The storage/packaging requirements for this LED are comparable to JEDEC Moisture Sensitivity Level (MSL) 2a or equivalent. Nichia used IPC/JEDEC STD-020 as a reference to rate the MSL of this LED. Once the moisture-proof aluminum bag is opened, ensure that soldering is completed within the storage times detailed below. 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 aluminum bag used for shipment and reseal it.

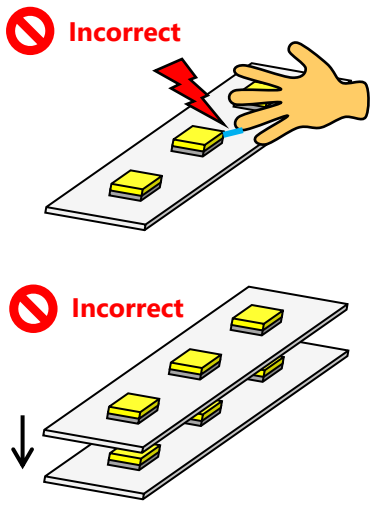


Figure 1. Incorrect Examples of Handling the LED

Table 2. Storage Conditions

Conditions		Temperature	Humidity	Time
Storage	Before Opening Aluminum Bag	≤30℃	≤90%RH	Within 1 Year from Delivery Date
	After Opening Aluminum Bag	≤30℃	≤70%RH	≤4 weeks

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

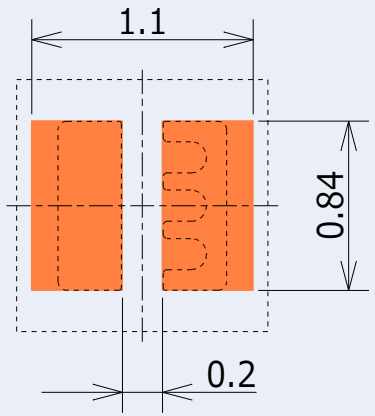
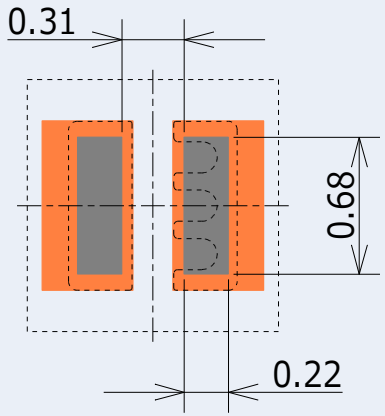
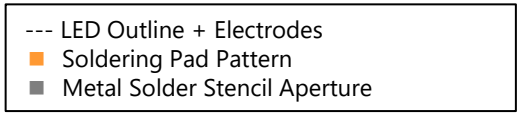
Recommended Soldering Pad Pattern	Recommended Metal Solder Stencil Aperture
 (Unit: mm)	 (Unit: mm)

Table 4. Recommended Solder/Metal Solder Stencil Conditions

Item	Recommended Conditions
Metal Solder Stencil (Thickness)	100 (μm)
Solder Paste (Composition)	Sn-3.0Ag-0.5Cu



1. Tables 3 and 4 shows the soldering pad pattern and the metal solder stencil aperture Nichia recommends.
2. If a soldering pad pattern that is different from Nichia's recommendation (see Table 3) is used, the distance between the anode and cathode should be as recommended (i.e. 0.2mm). Otherwise, it may cause a solder joint failure leading to emission failure and/or a performance/reliability degradation of the LEDs.
3. If high reliability solder paste is used to mount the LEDs onto a PCB and thermal stress occurs due to temperature fluctuation, the stress may be applied to the LED chips causing damage to them.
4. The recommended soldering pad pattern, metal solder stencil aperture, and thickness of the metal solder stencil provided in Tables 3 and 4 have been determined under Nichia's conditions; ensure that there are no issues with the chosen assembly conditions prior to 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	The recommended conditions/specifications herein have been determined using YS100 High-Speed General-Purpose Modular (manufactured by Yamaha Motor Co., Ltd.).
Pick-and-Place Nozzle	Use a nozzle that is smaller than the outline dimensions of the LEDs.	See “4.1 Pick-and-Place Nozzle” on Page 6 for details.
Tape-and-Reel Feeder	Electrical (motorized) feeder Tape width: 8mm Feeder pitch: 4mm	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 the height of 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” on Page 7 for the details.
Imaging-based Automatic Inspection	To locate the center of the LED, using the outline as a reference is recommended.	See "Imaging-based Automatic Inspection" on Page 8 for the details.

4-1. Pick-and-Place Nozzle

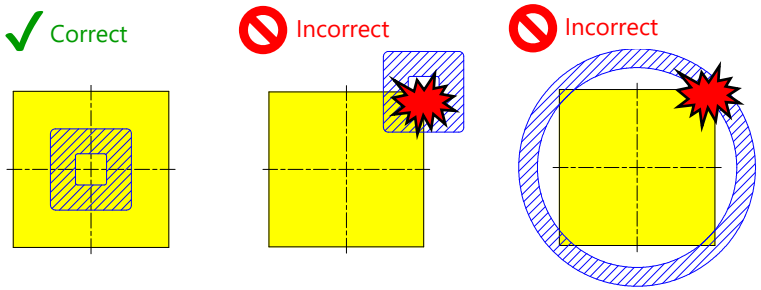


Figure 2. Correct/Incorrect Examples of LED Pick-up Positions

1. Use a pick-and-place nozzle that is smaller than the outline dimensions of the LEDs. Ensure that the LEDs are picked up at the center of the emitting surface.

   If the size and shape of the nozzle tip are not appropriate for the LEDs or if the nozzle does not pick up the LED at the center of the emitting surface, this may damage the LED (i.e. chipped, deformed, etc.) and/or lead to an incorrect pick up (i.e. the LEDs are picked up in a tilted position).

4-2. Tape-and-Reel Feeder

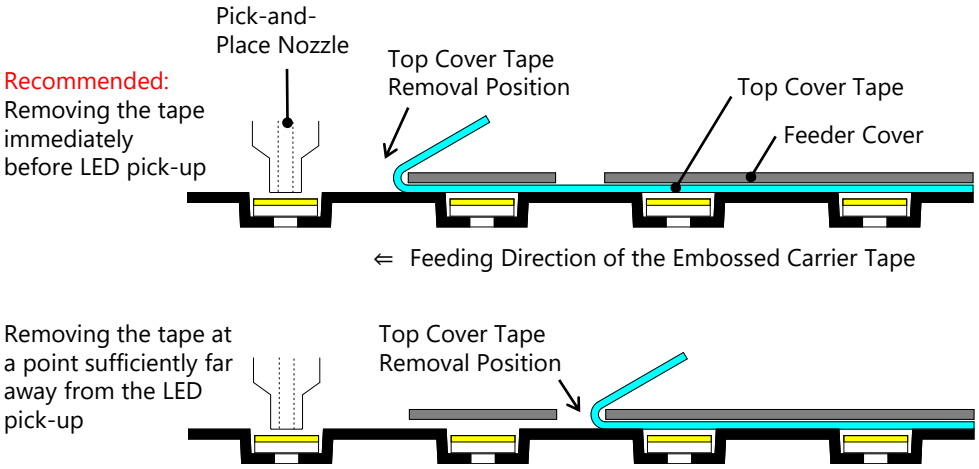


Figure 3. Top Cover Tape Removal Position

1. For the tape-and-reel feeder, the tape width is set to 8mm and the feeder pitch is set to 4mm.
2. Use a tape-and-reel feeder that ensures it does not create excessive vibrations causing assembly issues.
3. If LEDs in the embossed carrier tape pockets are not in the correct position when picked by the nozzle, reduce the feed speed.

   Example: Electrical (motorized) feeder
4. It is recommended to remove the top cover tape at the recommended position shown in Figure 3 (i.e. immediately before LED pick-up).
5. For some tape-and-reel feeders, removing the top cover tape at a point sufficiently far away from the LED pick-up position may reduce the possibility of picking failures. Verification should be performed before use to determine the optimal conditions for the tape-and-reel feeder being used.

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

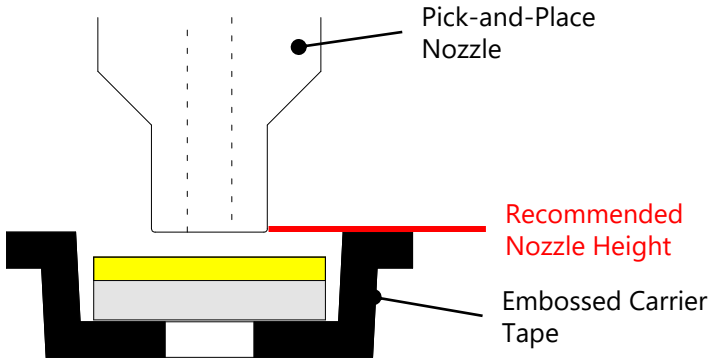


Figure 4. Recommended Nozzle Height for Pick-up Operations

1. Ensure that the nozzle goes down only to the height of the edge of the embossed carrier tape pocket.
2. The recommended nozzle height for pick-up operations has been determined by Nichia under the verification conditions 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.

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

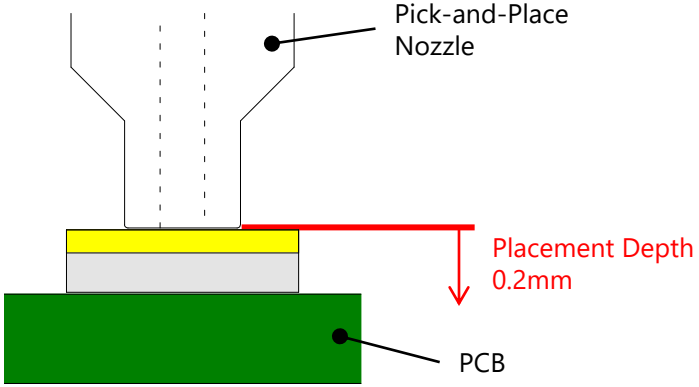


Figure 5. Recommended Nozzle Height for Placement (Placement Depth)

1. The nozzle should further press the LED 0.2mm onto the PCB from the height where the LED first touches solder paste.
   - 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 be mounted in an incorrect place/rotated position, 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

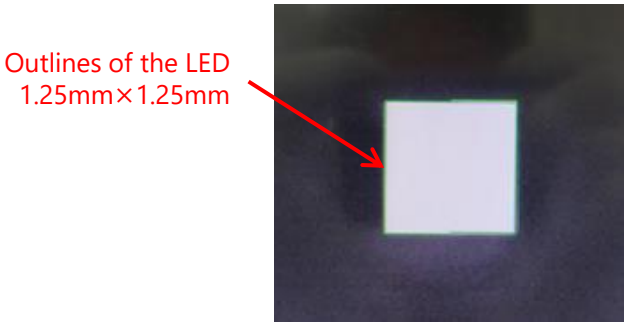


Figure 6. Example Image of the LED

1. Nichia recommends using the outlines of the LED as a reference to locate the center of the LED.
2. If the imaging device has trouble detecting/recognizing the LED, adjust the settings (i.e. the brightness of the light, etc.) of the pick-and-place machine.
3. For the E13 series LEDs, the center of the outlines may not match the center of the electrodes; there is a tolerance as provided in Table 1. If the electrodes are used as a reference to locate the center of the LED, the placement accuracy may be reduced. Misalignment of the LEDs may look especially obvious when multiple LEDs are mounted with a small pitch.

5. Precautions When Reflow Soldering

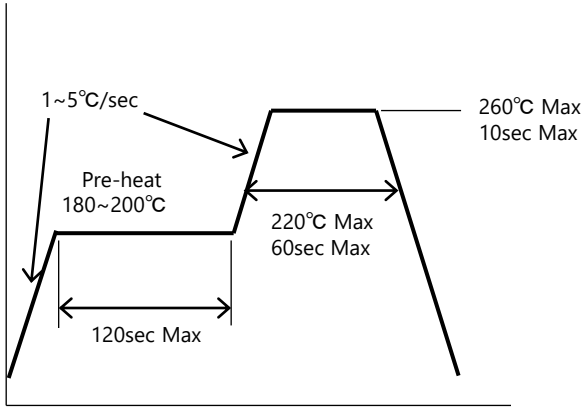


Figure 7. Recommended Reflow Soldering Condition (Lead-free Solder)

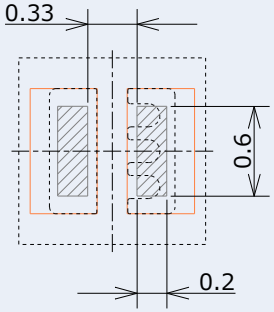
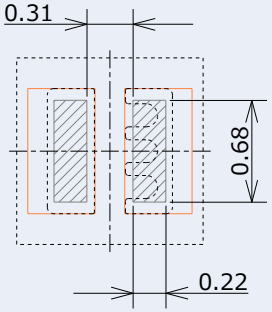
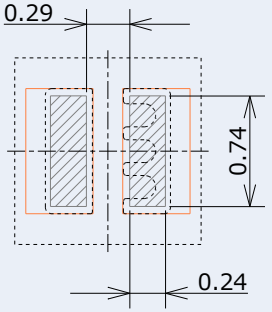
1. Reflow soldering must not be performed more than twice.
2. Nichia recommends using the reflow soldering conditions detailed in Figure 7 to the left; use the recommended reflow conditions specified by the manufacturer of the solder paste being used if it works better for the chosen application.

   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 Solder Volume

Nichia evaluated the effect of solder volume for reflow-soldering the LEDs using different solder volumes (i.e. three aperture ratios and three thicknesses for the metal solder stencil) including the recommended amount provided in Table 4 in Page 4. For details, see Table 6. The evaluation results provided herein were obtained under Nichia's evaluation conditions/environments; Nichia makes no guarantee that customers will see the same results for their chosen application. Perform a sufficient verification to ensure that there are no issues with the chosen conditions/environments.

Table 6. Solder Volumes and Soldering Pad Patterns

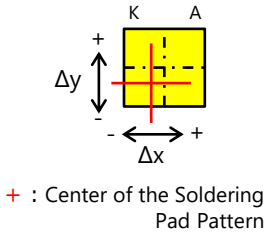
Thickness \ Aperture Ratio[1]	45%	56% (Nichia's Recommendation)	67%
80µm			
100µm (Nichia's Recommendation)			
120µm			

--- LED Outline + Electrodes
■ Soldering Pad Pattern
■ Metal Solder Stencil Aperture

[1] Aperture Ratio = Area of Aperture/Areas of Electrodes

6-1. Placement Accuracy in x and y Directions

Nichia evaluated the placement accuracy of the reflow-soldered LEDs in the x and y directions from the center of the soldering pad pattern using different solder volumes (i.e. three aperture ratios and three thicknesses for the metal solder stencil).
There was no significant difference seen per condition in either the x or y directions.



+ : Center of the Soldering Pad Pattern

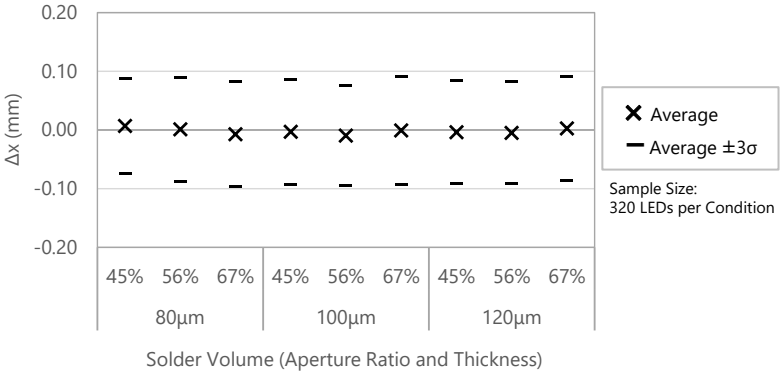


Figure 8. Placement Accuracy in the x Direction

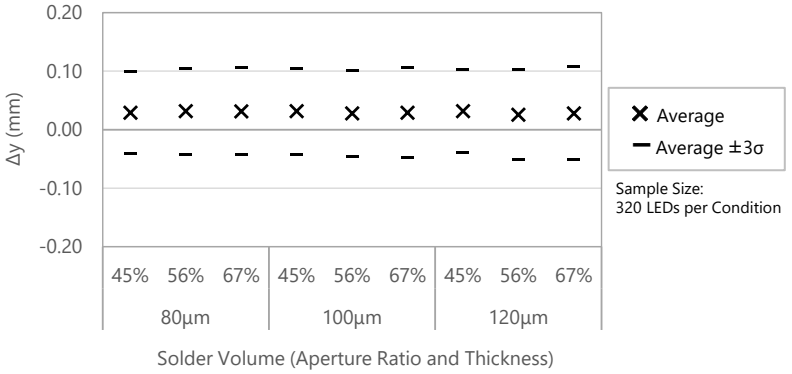
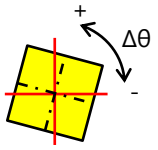


Figure 9. Placement Accuracy in the y Direction

6-2. Placement Accuracy in the Angular Direction

Nichia evaluated the placement accuracy of the reflow-soldered LEDs in the angular direction from the reference axis of the soldering pad pattern using different solder volumes (i.e. three aperture ratios and three thicknesses for the metal solder stencil).
The deviation became smaller as the solder volume increased.



+ : Center of the Soldering Pad Pattern

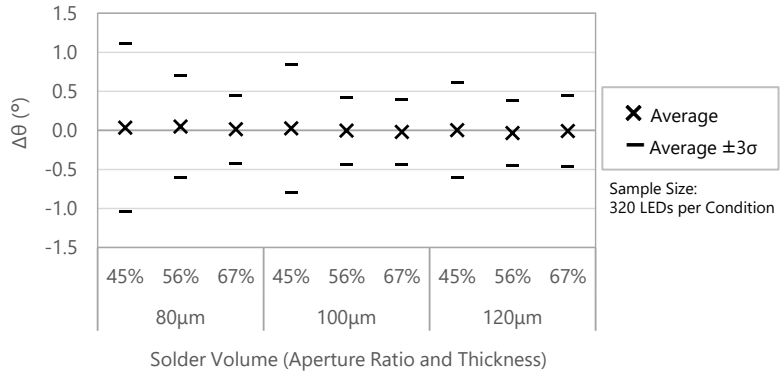


Figure 10. Placement Accuracy in the Angular Direction

6-3. Placement Accuracy in the z Direction (Tilt)

Nichia evaluated the placement accuracy of the reflow-soldered LEDs in the z direction (i.e. tilt in the height direction) from the PCB surface (i.e. reference plane) using different solder volumes (i.e. three aperture ratios and three thicknesses for the metal solder stencil).
There was no significant difference seen in the average and the deviation of Δz of the evaluated LEDs per condition in the x direction; the deviation of Δz of the evaluated LEDs became larger in the y direction as the solder volume increased.

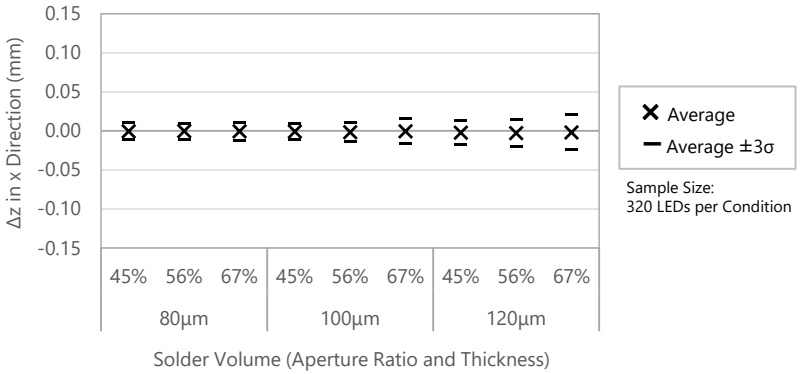


Figure 11. Placement Accuracy in the z-x Direction

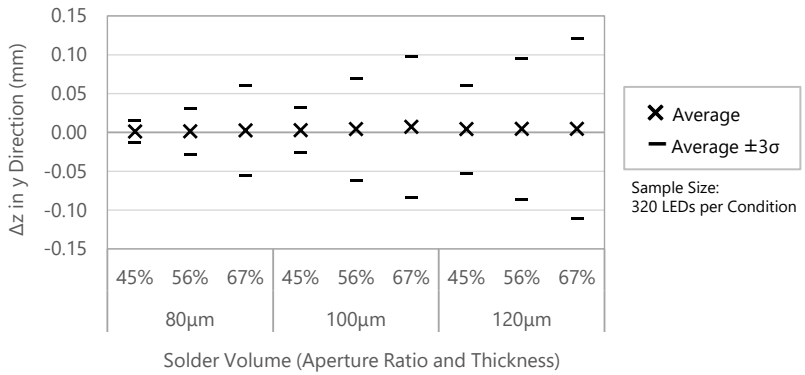
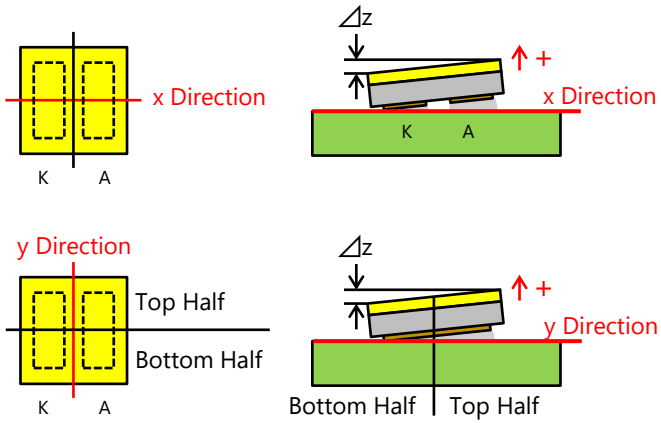


Figure 12. Placement Accuracy in the z-y Direction



In the z-x direction, if the anode side of the LED is higher, the LED is regarded as being tilted in the plus direction; if the cathode side is higher, the LED is regarded as being tilted in the minus direction.

In the z-y direction, if the top half of the LED is higher, the LED is regarded as being tilted in the plus direction; if the bottom half is higher, the LED is regarded as being tilted in the minus direction.

6-4. Self-alignment Performance in the x and y Directions

Nichia evaluated the self-alignment performance of the reflow-soldered LEDs; the evaluation LEDs were placed on specified points (i.e. x=-0.1mm and y=+0.1mm/x=-0.2mm and y=+0.2mm from the center of the soldering pad pattern).
The higher the aperture ratio was, the better the self-alignment performance was.

【Placement Deviation: ±0.1mm】

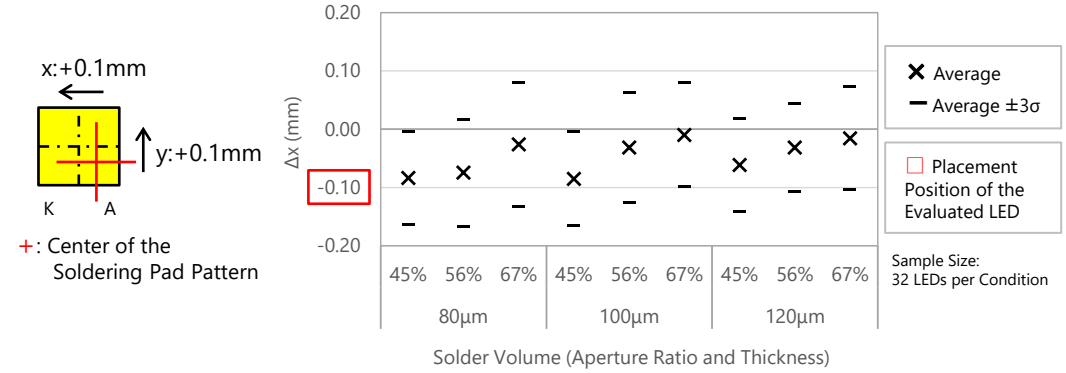


Figure 13. Self-alignment Performance in the x Direction for a Deviation of ±0.1mm

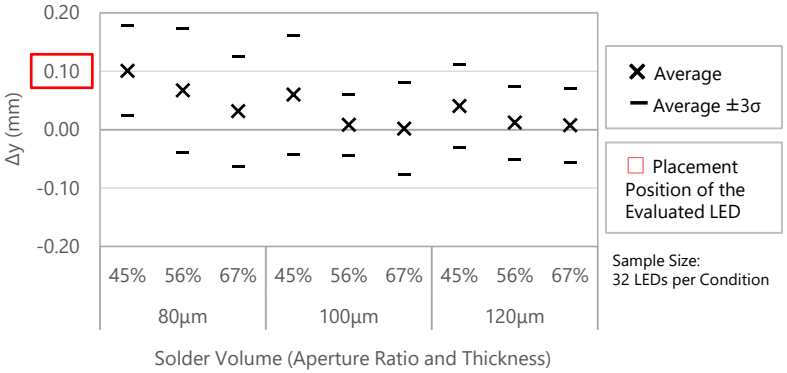


Figure 14. Self-alignment Performance in the y Direction for a Deviation of ±0.1mm

【Placement Deviation: ±0.2mm】

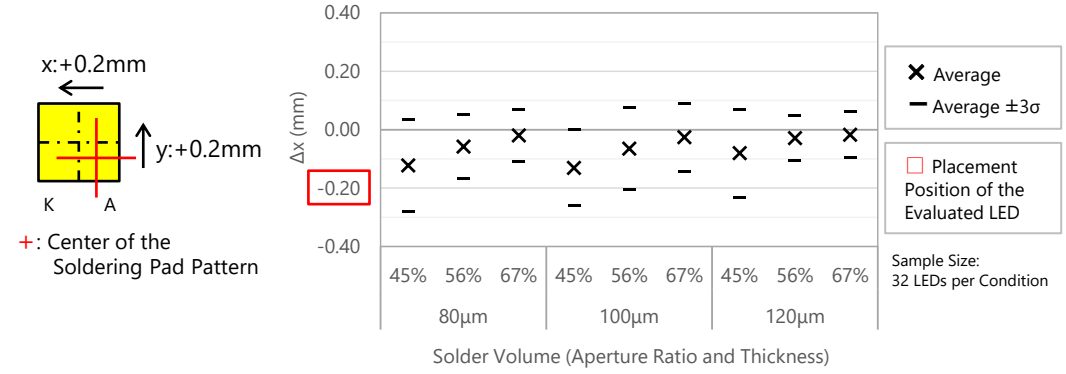


Figure 15. Self-alignment Performance in the x Direction for a Deviation of ±0.2mm

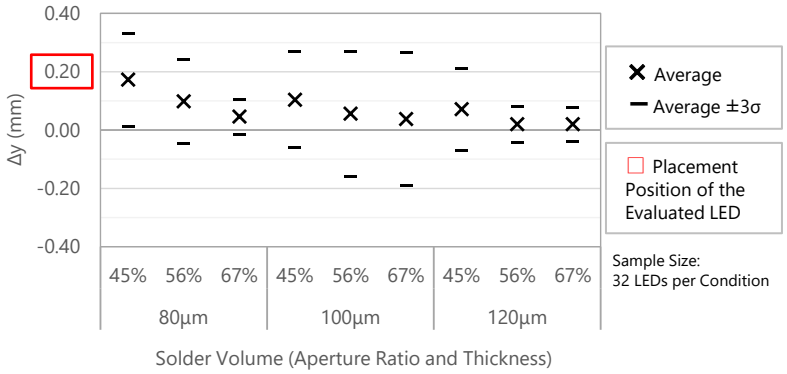
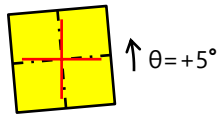


Figure 16. Self-alignment Performance in the y Direction for a Deviation of ±0.2mm

6-5. Self-alignment Performance in the Angular Direction

Nichia evaluated the self-alignment performance of the reflow-soldered LEDs; the evaluation LEDs were intentionally rotated (i.e. Δθ=+5/10/30°
from the reference axis whose origin was the center of the soldering pad pattern).
The larger the solder volume was, the better the self-alignment performance was.

【Placement Deviation: +5°】



+: Reference Axis of the Soldering Pad Pattern

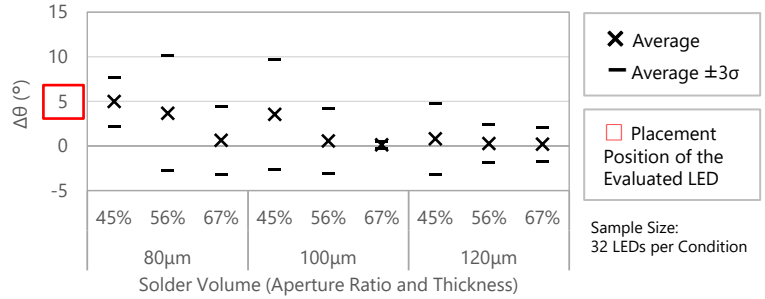
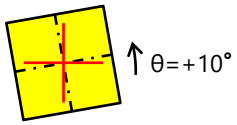


Figure 17. Self-alignment Performance in the Angular Direction for a Deviation of +5°

【Placement Deviation: +10°】



+: Reference Axis of the Soldering Pad Pattern

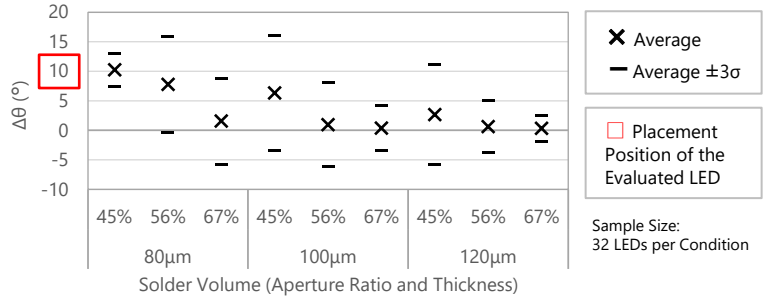
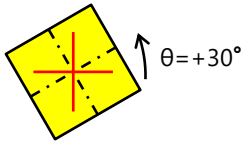


Figure 18. Self-alignment Performance in the Angular Direction for a Deviation of +10°

【Placement Deviation: +30°】



+: Reference Axis of the Soldering Pad Pattern

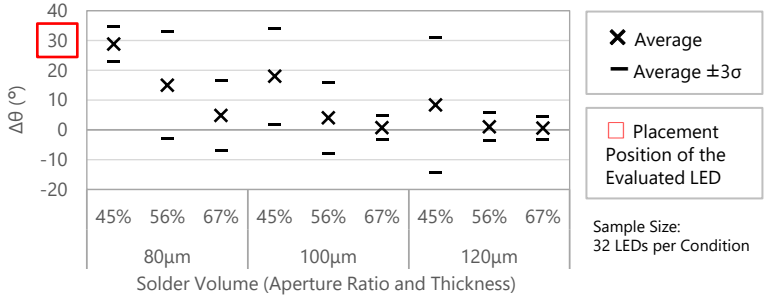


Figure 19. Self-alignment Performance in the Angular Direction for a Deviation of +30°

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