



# Assembly Precautions for the Nichia 144 Series LEDs

## Table of contents

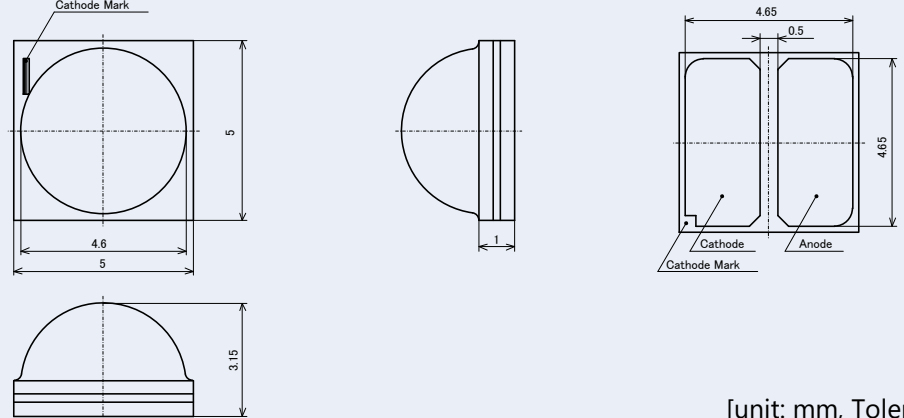
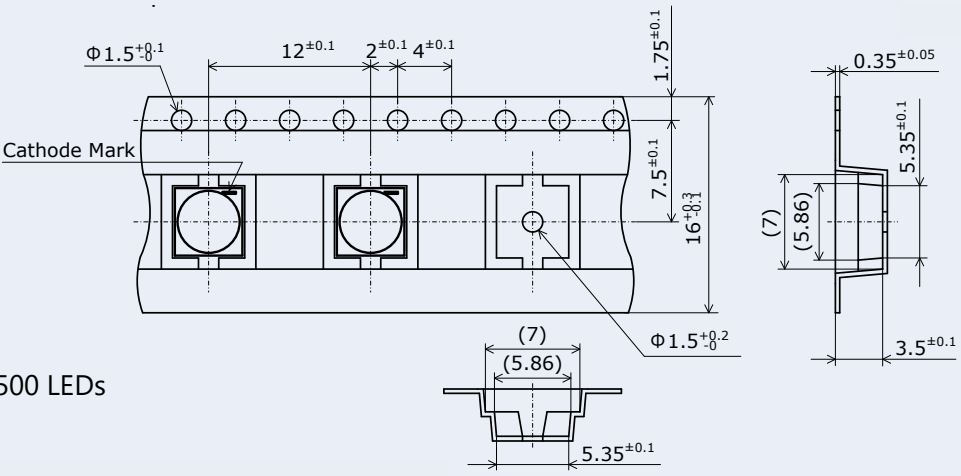
<u>1. LED Outline Dimensions/Tape Dimensions</u>	· · · · ·	2
<u>2. Handling Precautions</u>	· · · · ·	3
<u>3. Design Recommendations for Optimal Amount of Solder</u>	· · · ·	4
<u>4. Precautions for Setting Up a Pick-and-Place Machine/Nozzle</u>	· ·	5-8
<u>5. Precautions When Reflow Soldering</u>	· · · · ·	8
<u>6. Evaluation of the Effect of Solder Volume</u>	· · · · ·	9-10
<u>7. Evaluation of Self-Alignment Performance</u>	· · · · ·	10-11

The part number NV4L144AR,NV4W144AR,NV4L144AM,NV4W144AM in this document are the part number of our products, and do not have any relevance or similarity to other companies' products that may have trademark rights.

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

## 1. LED Outline Dimensions/Tape Dimensions

Table 1. Product Specifications

Part Number	NV4L144AR, NV4W144AR, NV4L144AM, NV4W144AM
LED	 <p>[unit: mm, Tolerance: ±0.2mm]</p>
Embossed Carrier Tape	 <p>Reel Size: 1,500 LEDs</p> <p>[unit: mm]</p>

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

## 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/package requirements for the Nichia 144 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		65±5°C	-	≥24 hours

### Incorrect

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

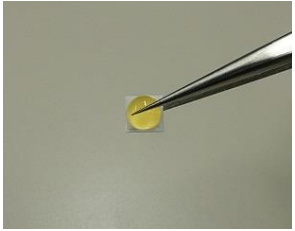


Figure 1. Example of an Improper Holding Position

### Incorrect

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

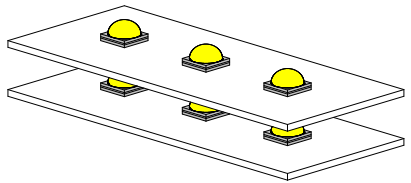


Figure 2. Example of Improper Stacking

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

## 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

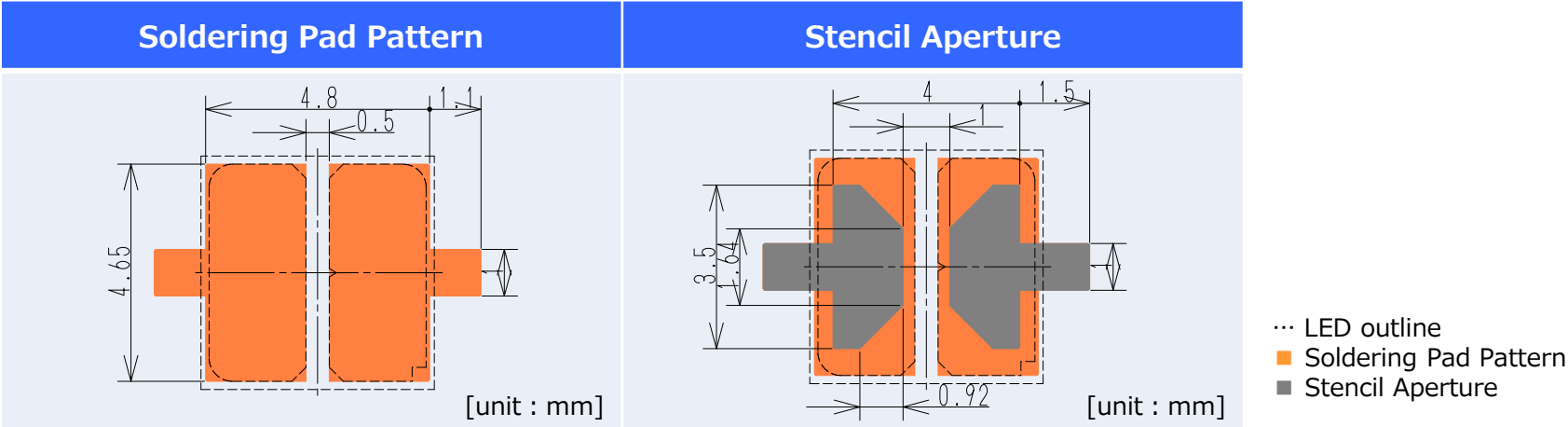


Table 4. Recommended Solder/Metal Solder Stencil Conditions

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

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

## 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 <sup>1</sup>	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 1.7mm 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:  
<sup>1</sup> 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

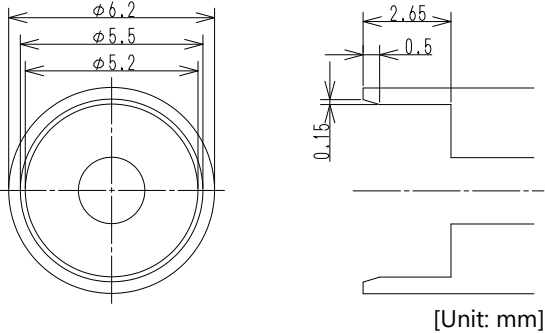


Figure 3. Recommended Nozzle Dimensions

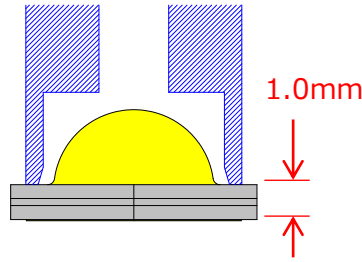


Figure 4. part Height

- The nozzle must not have any direct contact with the encapsulating resin.
- The nozzle touches on the top of LED substrate. (see Fig. 4)  
Therefore input value of the Part Height should be 1.0mm.

## 4-2. Tape-and-Reel Feeder

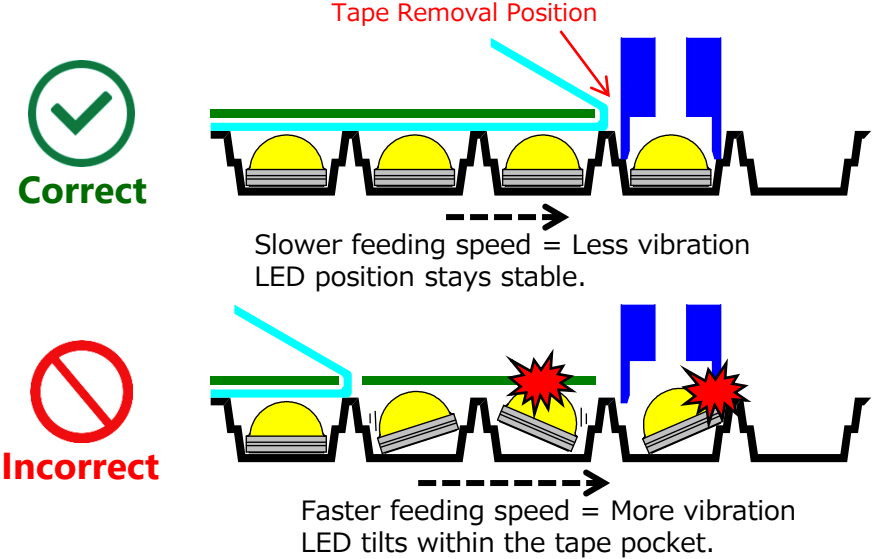


Figure 5. Examples of Correct/Incorrect Top Cover Tape Removal Positions

- Tape width:16mm / Feed length:12mm
- The chosen tape feeder should be one that has a slower feeding speed (e.g. electrical feeders).
- The recommended tape removal position is right next to where the pick-and-place nozzle picks up the LEDs to prevent the LEDs from tilting within the tape pocket and becoming damaged by the feeder shutter and/or nozzle.

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

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

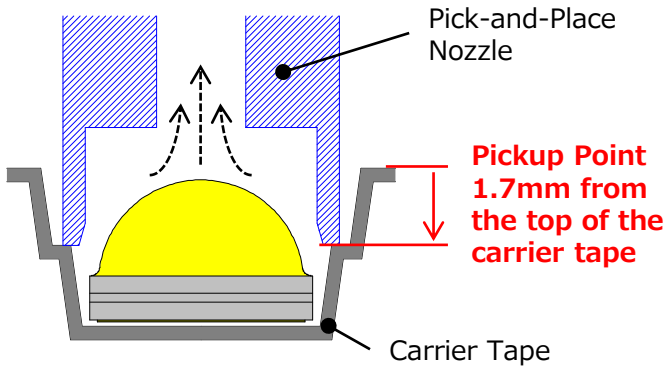


Figure 6. Recommended Nozzle Height for Pick-up Operations

- Pick-and-place nozzle should be 1.7mm inside from the top of carrier tape to pick up the LED. (see Fig. 6)
- Some LED mounters may not be stabilize the operation. In that case, adjusting the height for LED pickup is needed until the operation is stabilized.
  - ☞ If the pickup point is higher than the recommended point, the LED may tilt, and poor suction may occur which will cause a suction error.(e.g. diagonal positioning within the nozzle)
  - ☞ If the pickup point is lower than the recommended point, poor suction may occur due to carrier tape deformation.

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

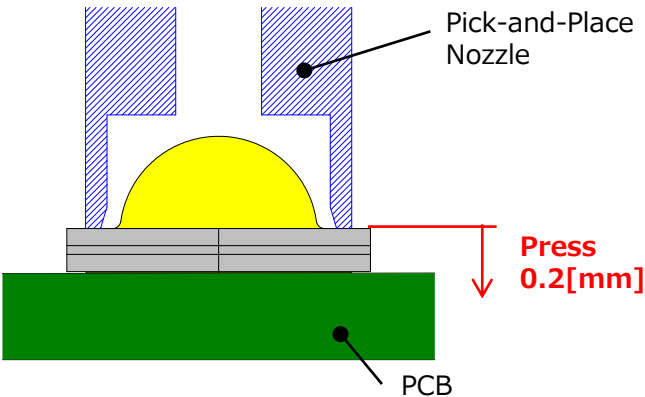


Figure 7. Recommended Nozzle Height for Placement (Placement Depth)

- After the LED is mounted onto solder paste on the PCB, the nozzle should further press the LED 0.2mm into the PCB.
  - ☞ If the press force is too weak, assembly failure may occur since the LED may float on top of the PCB or it may not separate from the nozzle.
  - ☞ If press force is too strong, LED may receive excessive stress which may cause the LED to be damaged.

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

## 4-5. Imaging-based Automatic Inspection

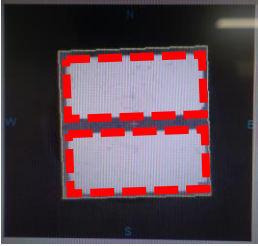


Figure 8. Electrical Pads  
(Recommended)

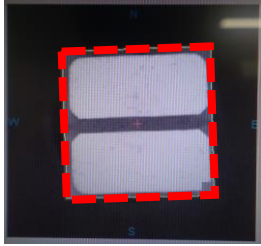


Figure 9. Outline

- Using image recognition and adjusting the pickup position for each LED should be implemented to maintain assembly accuracy. It is recommended to have the adjustment based on the position of the electrical pads for higher assembly accuracy.

## 5. Precautions When Reflow Soldering

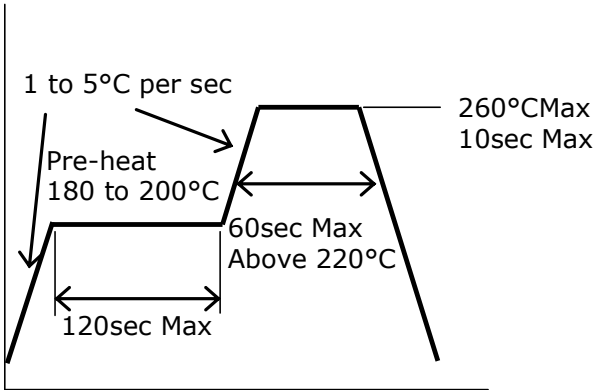


Figure 10. Recommended Reflow Soldering Condition (Lead-free Solder)

- Reflow soldering must not be performed more than twice.
- Using the recommended reflow soldering conditions (See Figure 10 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.

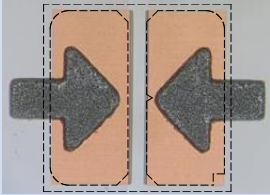
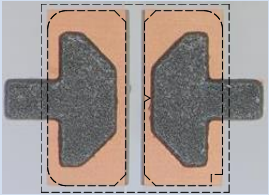
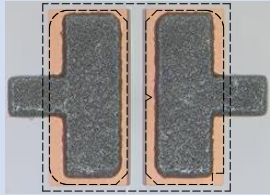
This document contains tentative information, Nichia may change the contents without notice.



## 6. Evaluation of the Effect of Solder Volume

The amount of solder paste was evaluated and compared with the recommended solder stencil conditions (section3). Lighting, wettability, solder ball and floating were inspected after the reflow process.

Table 6. Evaluation Result (Lighting Check, Solder Wettability, Solder Ball)

Stencil Aperture Rate <small>※Stencil Aperture Area / Electrode Area</small>		30%	50% (Recommend)	70%
				
Stencil Thickness	100μm	Lighting check OK	Lighting check OK	Lighting check OK
		Solder Ball 0/24 pcs	Solder Ball 0/24 pcs	Solder Ball 0/24 pcs
	<b>120μm (Recommend)</b>	Lighting check OK	Lighting check OK	Lighting check OK
		Solder Ball 0/24 pcs	Solder Ball 0/24 pcs	Solder Ball 2/24 pcs
	150μm	Lighting check OK	Lighting check OK	Lighting check OK
		Solder Ball 0/24 pcs	Solder Ball 2/24 pcs	Solder Ball 6/24 pcs

- Solder wettability performance was good enough to light the LED in all conditions. However, solder ball occurrence was increased if solder paste volume (area, thickness) is increased.

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

# Assembly Precautions for the Nichia 144 Series LEDs

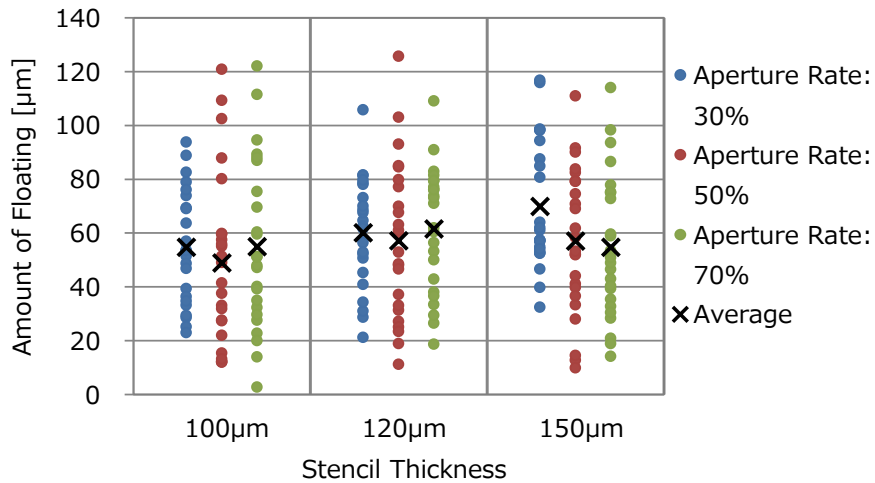


Figure 11. Evaluation Result (LED Lifting)  
 ※n=24pcs/each condition

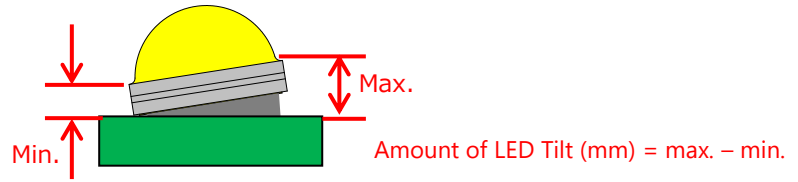


Figure 12. How to Measure the Amount of LED Tilt

- Amount of tilt (avg.): 60μm
- Angle of incline: around 0.7 degree
- Solder volume does not affect to the amount of tilt and angle of incline.

## 7. Evaluation of Self-Alignment Performance

Self-alignment was evaluated under the condition shown in table 7 with the solder conditions shown in section 6.

Amount of self-alignment was confirmed from center of the land pattern.

Table 7. Evaluate Conditions

① x : +0.2mm y : +0.2mm	② θ : +10°

+ Pad pattern Position  
 + Mounted Position

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

# Assembly Precautions for the Nichia 144 Series LEDs

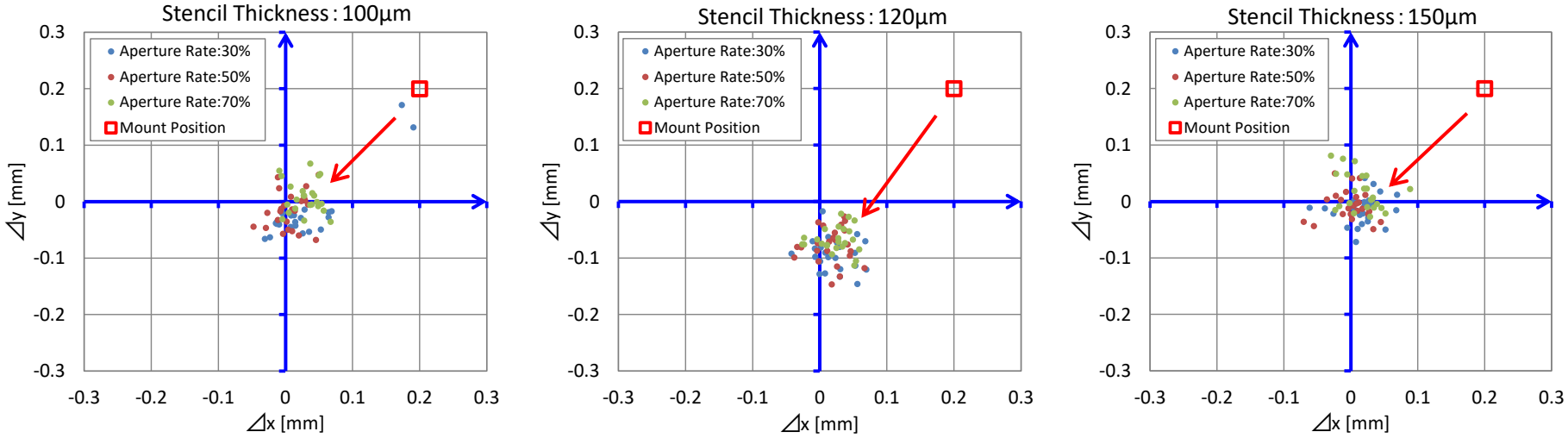


Figure 13. Evaluation Result (① x:+0.2mm,y:+0.2mm)  
※n=24pcs/condition

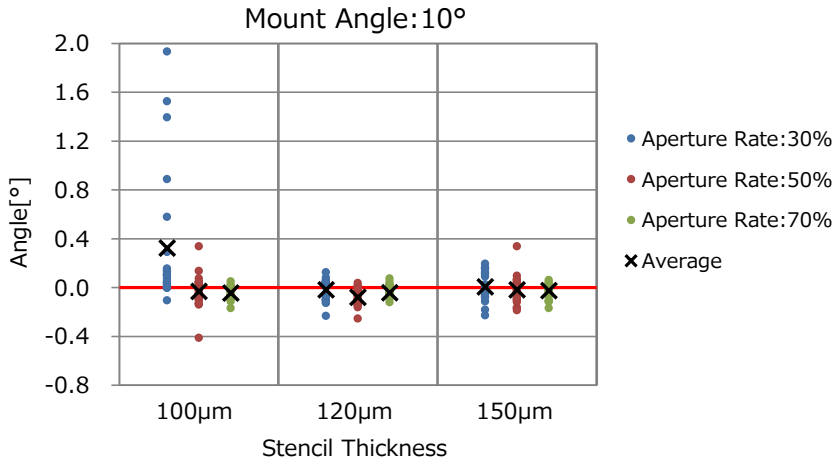


Figure 14. Evaluation Result (② θ:+10°)  
※n=24pcs/each condition

- Aperture ratio: 50%, stencil thickness: 120µm (Recommended conditions)
  - No abnormality in the self-alignment
  - Self-alignment could be acceptable if the mounting accuracy are x,y <200µm and θ<10°.
- Aperture ratio: 30%, stencil thickness: 100µm
  - Some LEDs have issue for the self-alignment.
  - If the solder volume is poor, LED may not be mounted to the proper position that causes misalignment of LED.

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

## 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.