



# Assembly Precautions for the Nichia 123 Series LEDs

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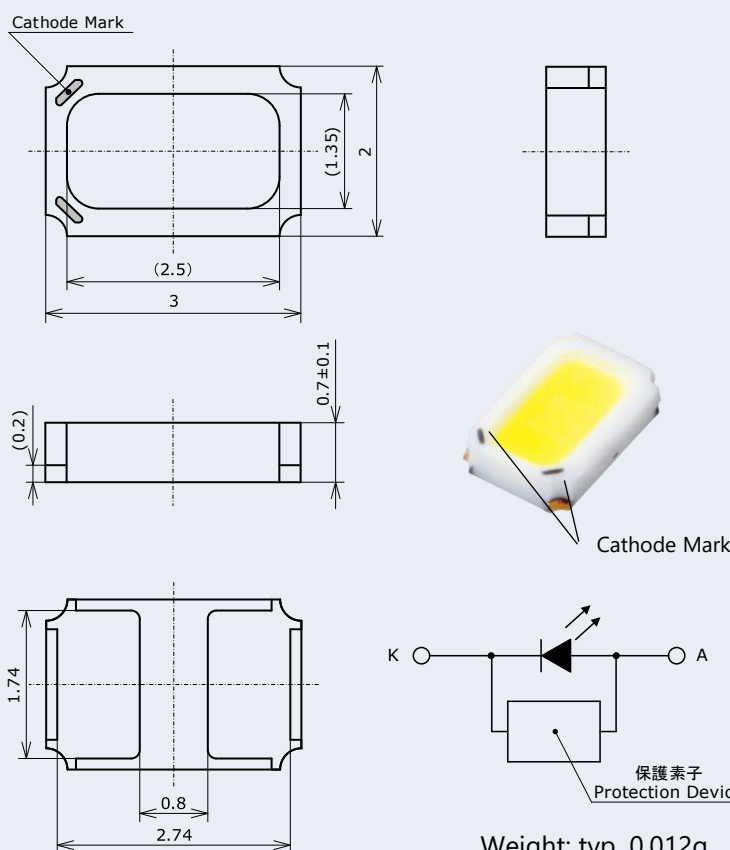
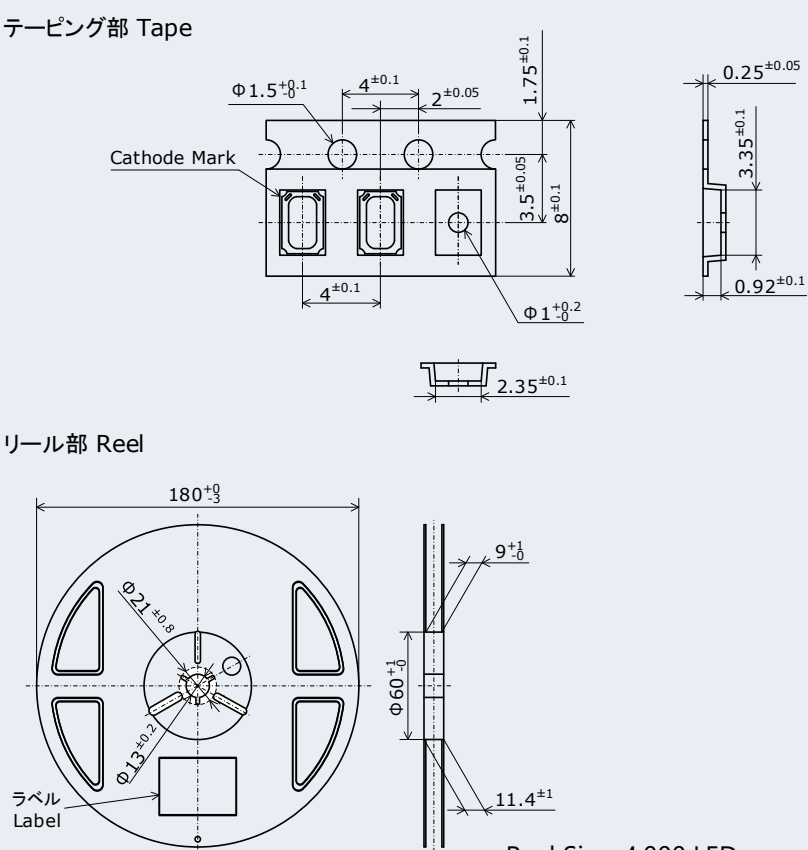
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NFSW123G , NFSx123D , NFSx123F and NxSx123x refer to Nichia part numbers. These Nichia part numbers within this document are merely Nichia’s part numbers for those Nichia products and are not related nor bear resemblance to any other company’s product that might bear a trademark.

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## 1. LED Outline Dimensions/Tape and Reel Dimensions

Table 1. NxSx123x Product Specifications

LED	Embossed Carrier Tape
 <p>                     Cathode Mark                      (1.35)                      2                      (2.5)                      3                      0.7±0.1                      (0.2)                      Cathode Mark                      1.74                      0.8                      2.74                      K      A                      保護素子                      Protection Device                      Weight: typ. 0.012g                      (Unit: mm, Tolerance: ±0.2mm)                 </p>	 <p>                     テーピング部 Tape                      Cathode Mark  <math>\Phi 1.5^{+0.1}</math>  <math>4^{\pm 0.1}</math>  <math>2^{\pm 0.05}</math>  <math>1.75^{\pm 0.1}</math>  <math>3.5^{\pm 0.05}</math>  <math>8^{\pm 0.1}</math>  <math>\Phi 1^{+0.2}</math>  <math>0.25^{\pm 0.05}</math>  <math>3.35^{\pm 0.1}</math>  <math>2.35^{\pm 0.1}</math>                      リール部 Reel  <math>180^{+0}_-3</math>  <math>\Phi 21^{\pm 0.8}</math>  <math>\Phi 13^{\pm 0.2}</math>                      ラベル                      Label  <math>9^{+0}_-0</math>  <math>\Phi 60^{+0}_-0</math>  <math>11.4^{\pm 1}</math>                      Reel Size: 4,000 LEDs                      (Unit: mm)                 </p>

The weight value provided in Table 1 is the weight for the NFSW123G LED.

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## 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),

### 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/or the wire to break causing a catastrophic failure.

### 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.

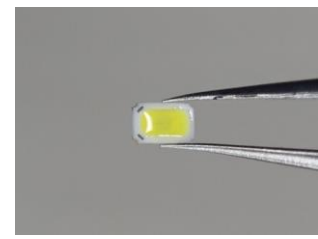
### 2-5. Baking

The NFSx123D and NFSx123F LEDs are comparable to JEDEC Moisture Sensitivity Level (MSL) 3 or equivalent and the NxSx123G LED is comparable to MSL2 or equivalent. Refer to IPC/JEDEC STD-020 for detailed information regarding the MSL. When baking the LEDs, remove the reel of the LEDs from the moisture-proof aluminum bag.

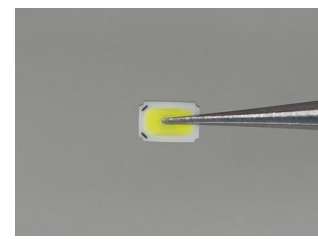
Table 2. Storage/Baking Conditions

	Conditions	Temperature	Humidity	Time
Storage	Before Opening the Moisture-proof Aluminum Bag	≤30°C	≤90%RH	Within 1 Year from Delivery Date
	After Opening the Moisture-proof Aluminum Bag	≤30°C	≤70%RH	MSL3: Within 168 Hours MSL2: Within 1 Year
	Baking	65±5°C	-	MSL3: ≥24 Hours

✓ Correct



⊘ Incorrect



⊘ Incorrect

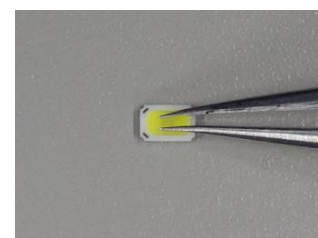


Figure 1. Correct/Incorrect Examples of Handling with Tweezers

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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

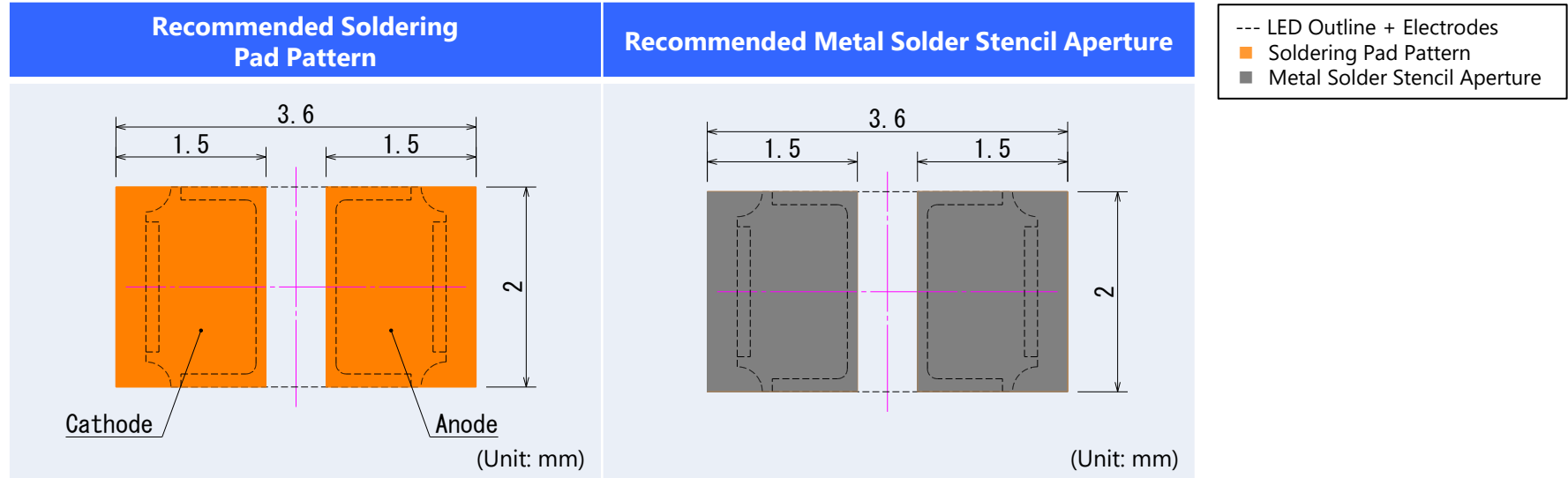


Table 4. Recommended Solder/Metal Solder Stencil Conditions

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

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.

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

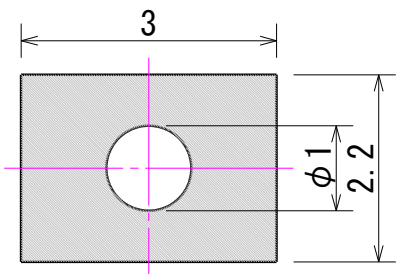
Table 5. Cautions/Suggestions for Setting Up Equipment

Item	Recommended Conditions/Specifications	Cautions/Suggestions
Pick-and-Place Machine	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 appropriate for the dimensions of the LED.	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 "4-2. Tape-and-Reel Feeder" on Page 7 for details.
Top Cover Tape Removal Position	Sufficiently far away from the LED pick-up position.	See "4-2. Tape-and-Reel Feeder" on Page 7 for details.
Nozzle Height for Pick-up Operations	The contact surface of the nozzle head for pick operations should be adjusted to 0.2mm below the edge of the embossed carrier tape pocket.	See "4-3. Recommended Nozzle Height for Pick-up Operations" on Page 8 for details.
Nozzle Height for Placement Operations (i.e. Placement Depth)	0.2mm for placement depth	See "4-4. Recommended Nozzle Height for Placement Operations (Placement Depth)" on Page 8 for details.
Imaging-based Automatic Inspection	Using the electrode as a reference is recommended to locate the center of the LED.	See "4-5. Imaging-based Automatic Inspection" on Page 9 for details.

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## 4-1. Pick-and-Place Nozzle

1. Figure 2 shows a recommended nozzle tip.



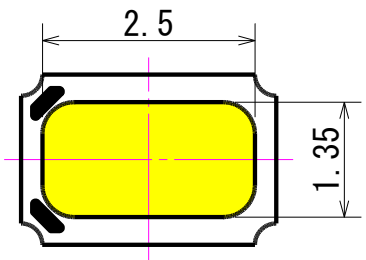
(Unit: mm)

Figure 2. Recommended Nozzle Tip

2. Use a nozzle that is appropriate for the LED (i.e. the nozzle dimensions are appropriate for the dimensions of the recommended pick-up position for the LED).

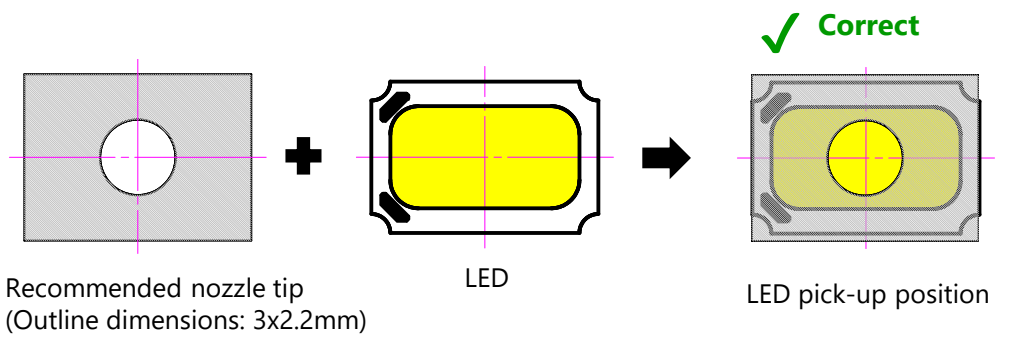
Do not use a nozzle that is smaller than the emitting area of the LED (i.e. 2.5mm x 1.35mm); otherwise, it may damage the emitting surface causing the LED not to illuminate.

Figure 4 shows correct/incorrect examples for shapes of the nozzle and LED pick-up positions for reference purposes.



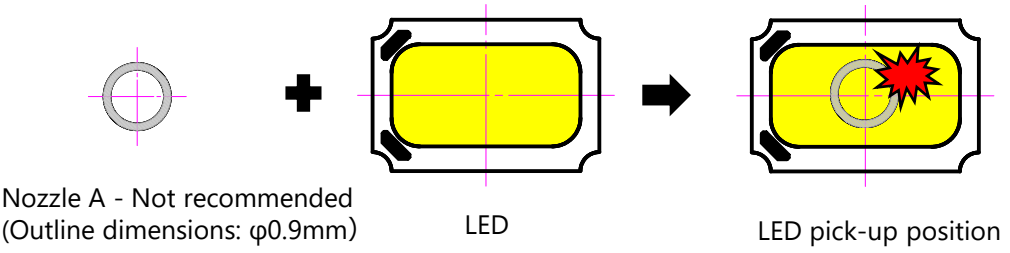
(Unit: mm)

Figure 3. Emitting Area of the LED



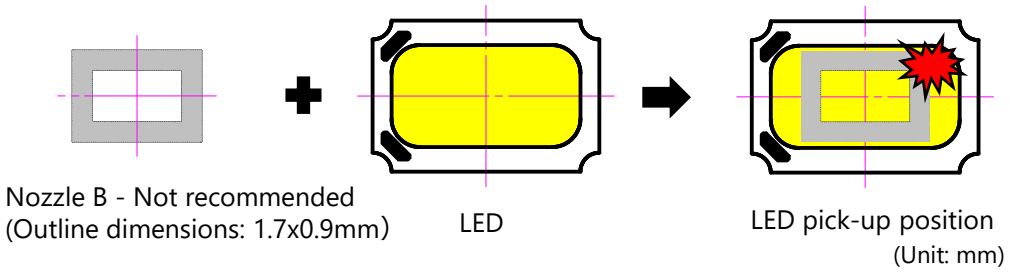
Recommended nozzle tip  
(Outline dimensions: 3x2.2mm)

**Incorrect**



Nozzle A - Not recommended  
(Outline dimensions: φ0.9mm)

**Incorrect**



Nozzle B - Not recommended  
(Outline dimensions: 1.7x0.9mm)

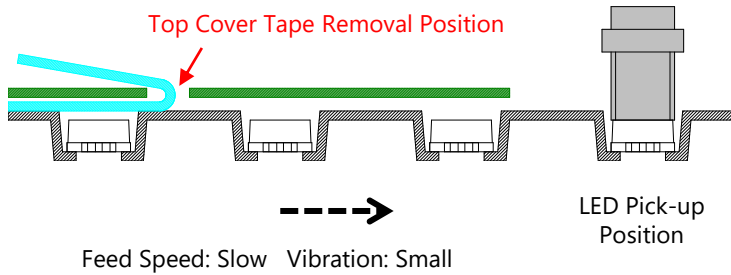
LED pick-up position  
(Unit: mm)

Figure 4. Correct/Incorrect Examples for Shapes of the Nozzle and LED Pick-up Positions

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

- It is **recommended** to remove the top cover tape at a point sufficiently far away from the LED pick-up position.



- It is **not recommended** to remove the top cover tape immediately before LED pick-up.

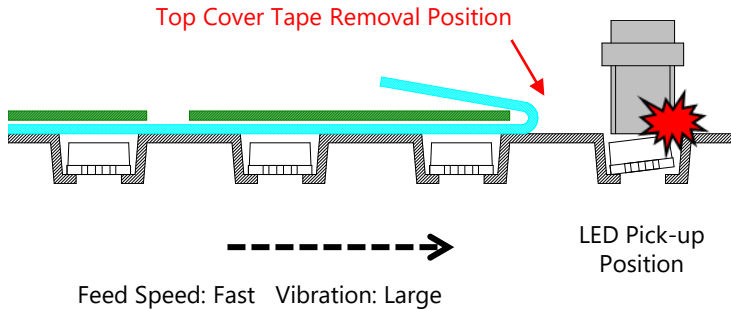


Figure 5. Examples of Recommended/Not Recommended Top Cover Tape Removal Positions

- For the tape-and-reel feeder, the tape width is set to 8mm and the feeder pitch is set to 4mm.

- Use a tape-and-reel feeder that ensures it does not create excessive vibrations causing assembly issues (e.g. an electrical [motorized] feeder).

- When the tape feeder feed rate is fast, the LEDs in the embossed carrier tape pockets may not be in the correct position when picked by the nozzle; it may be improved by reducing the tape feeder feed rate.

- It is recommended to remove the top cover tape at a point sufficiently far away from the LED pick-up position.

- If the top cover tape is removed right next to where the nozzle picks up the LEDs, regardless of whether the LEDs have been baked or not, it may cause the LED to be picked up incorrectly; it is recommended to remove the top cover tape further from where the nozzle picks up the LEDs.

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

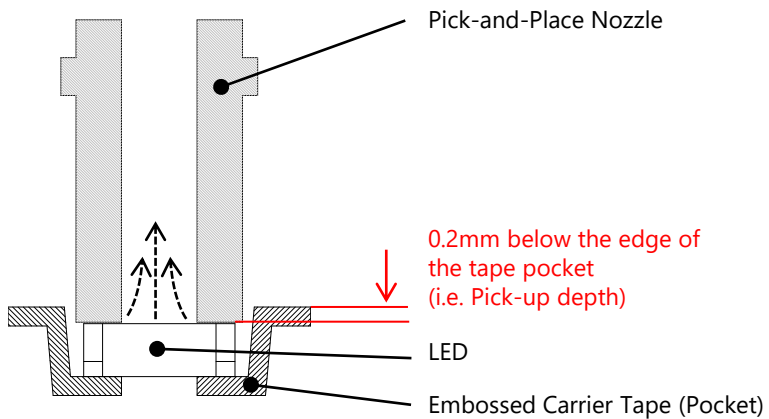


Figure 6. Recommended Nozzle Height for Pick-up Operations

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

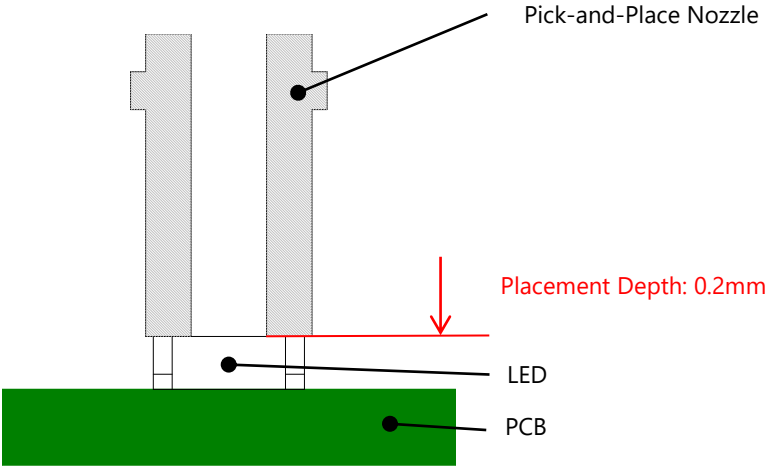


Figure 7. Recommended Nozzle Height for Placement Operations (Placement Depth)

1. Ensure that the nozzle goes down onto the LED in the tape pocket until the tip touches the flat surface of the LED.  
Pick-up depth: 0.2mm  
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 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.
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.

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## 4-5. Imaging-based Automatic Inspection

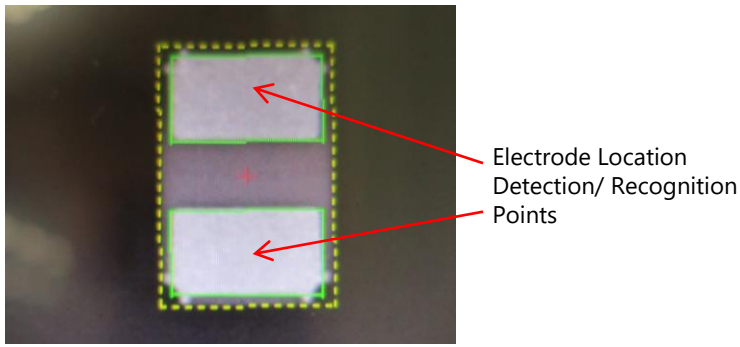


Figure 8. Recommended Reference Points to Detect, Recognize, or Locate the Electrodes

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, adjust the settings (i.e. the brightness of the light, etc.) of the pick-and-place machine.

## 5. Precautions When Reflow Soldering

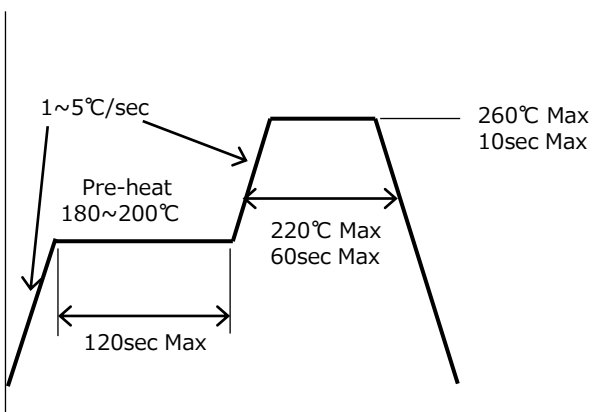


Figure 9. Recommended Reflow Soldering Condition (Lead-free Solder)

1. Reflow soldering must not be performed more than twice.
2. Nichia recommends using the reflow soldering conditions detailed in Figure 9 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.

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## 6. Evaluation of the Effect of Solder Volume

### 6-1. Evaluation Method/Conditions

Nichia evaluated the effect of solder volume for reflow-soldering the LEDs using different solder volumes including the recommended amount provided in Table 3 in Section 3. For details, see Table 6.

#### 1. PCB and LEDs Used for the Evaluation

PCB: FR4, copper layer thickness of 35 $\mu$ m, substrate thickness of 1.6mm, metal solder stencil thickness of 100 $\mu$ m

LED Part No.: NFSW123F

Sample Size: 1000 LEDs per condition

#### 2. Evaluated Items

Appearance of the reflow-soldered LEDs and placement accuracy (x and y directions, angular direction, and tilt).

## 6-2. Evaluation for the Appearance of the Reflow-soldered LEDs

Table 6. Evaluation Result for the Appearance of the Reflow-soldered LEDs for Different Metal Solder Stencil Aperture Condition

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

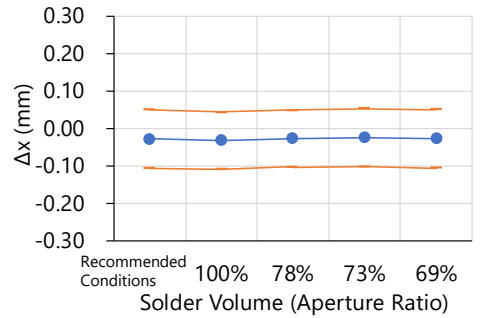
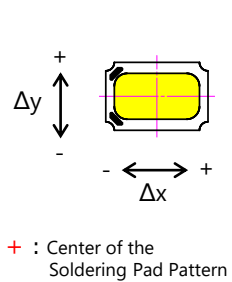
(Unit: mm)

	Recommended Conditions	Metal Solder Stencil Aperture Ratio			
		100%	78%	73%	69%
Soldering Pad Pattern					
Metal Solder Stencil Aperture					
Appearance of the Reflow-soldered LED					
Evaluation Result	The soldering conditions were good.				

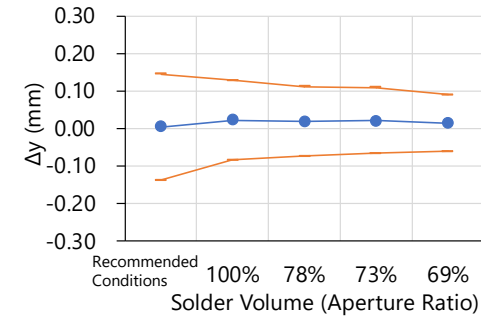
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## 6-3. Placement Accuracy in x and y Directions

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. The amount of the deviation from the center of the soldering pad pattern in the x and y directions are described as  $\Delta x$  and  $\Delta y$  respectively.



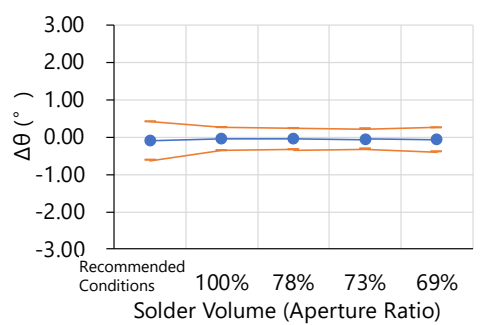
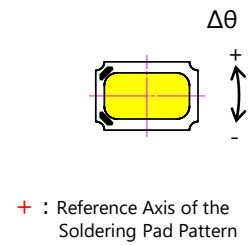
- There was no significant difference seen in the average and the deviation of  $\Delta x$  of the evaluated LEDs per condition.



- The deviation of  $\Delta y$  of the evaluated LEDs tended to be reduced when the outline dimensions of the soldering pad pattern used were different from the recommended soldering pad pattern.

## 6-4. Placement Accuracy in the Angular Direction

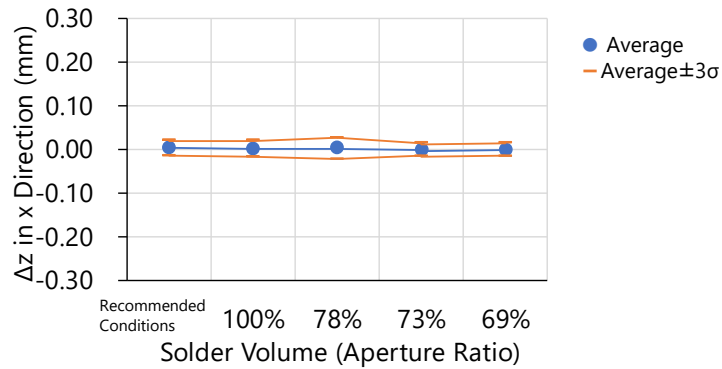
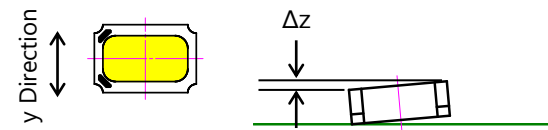
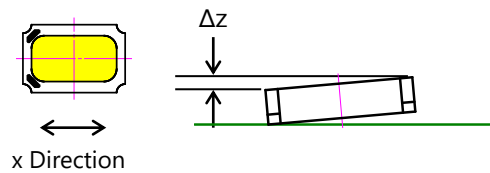
Nichia evaluated the placement accuracy of the reflow-soldered LEDs in the angular direction from the reference axis of the soldering pad pattern using different solder. The amount of the deviation from the reference axis in the angular direction is described as  $\Delta\theta$ .



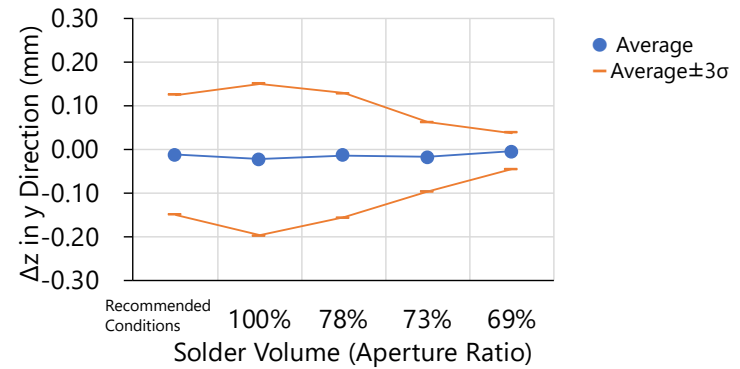
- There was no significant difference seen in the average and the deviation of  $\Delta\theta$  of the evaluated LEDs per condition.

## 6-5. Placement Accuracy in the z Direction (Tilt)

Nichia evaluated the placement accuracy of the reflow-soldered LEDs in the z-x and z-y directions; the amount of the deviation is described as  $\Delta z$ .



There was no significant difference seen in the average and the deviation of  $\Delta z$  of the evaluated LEDs per condition in the x direction.



The deviation of  $\Delta z$  of the evaluated LEDs in the y direction was reduced by using a different soldering pad pattern from the recommended one and optimizing the volume of the solder paste (or the aperture ratio).

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.

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