Assembly Precautions for the Nichia 131G/131H Series LEDs

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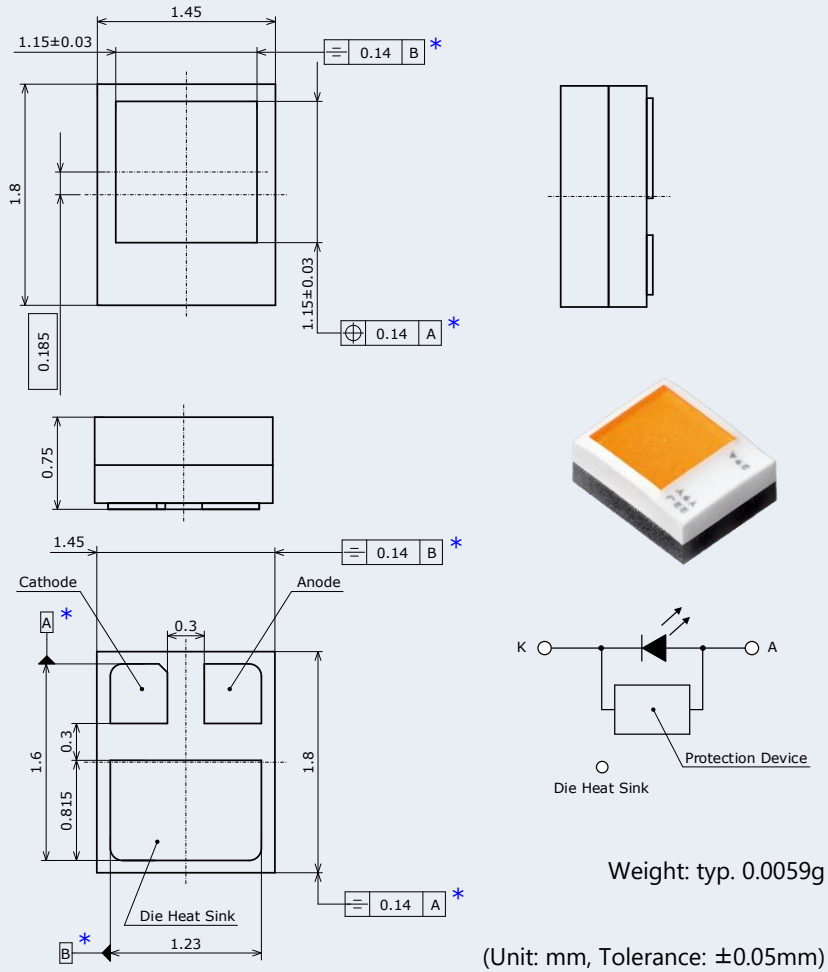
The Nichia part numbers NCSA131G, NCSA131H, NCSW131G, NCSW131H, NCSW131G-SA, NCSW131H-SA, NCSW131G-SB, and NCSW131H-SB within this document are merely Nichia's part numbers for those Nichia products and are not related nor bear resemblance to any other company's product that might bear a trademark.

1. LED Outline Dimensions/Tape Dimensions

Table 1. NCSA131G / NCSA131H Product Specifications

LED

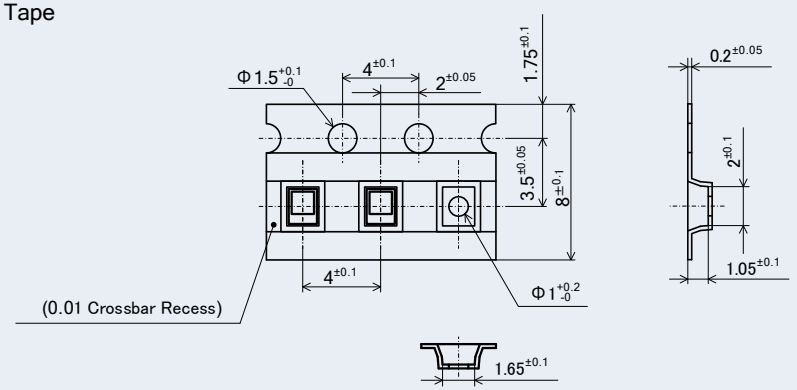


Weight: typ. 0.0059g

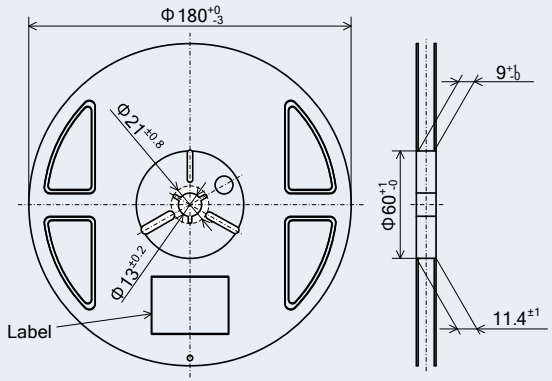
(Unit: mm, Tolerance: ±0.05mm)

Embossed Carrier Tape

Tape



Reel



Reel Size: 3,500 LEDs

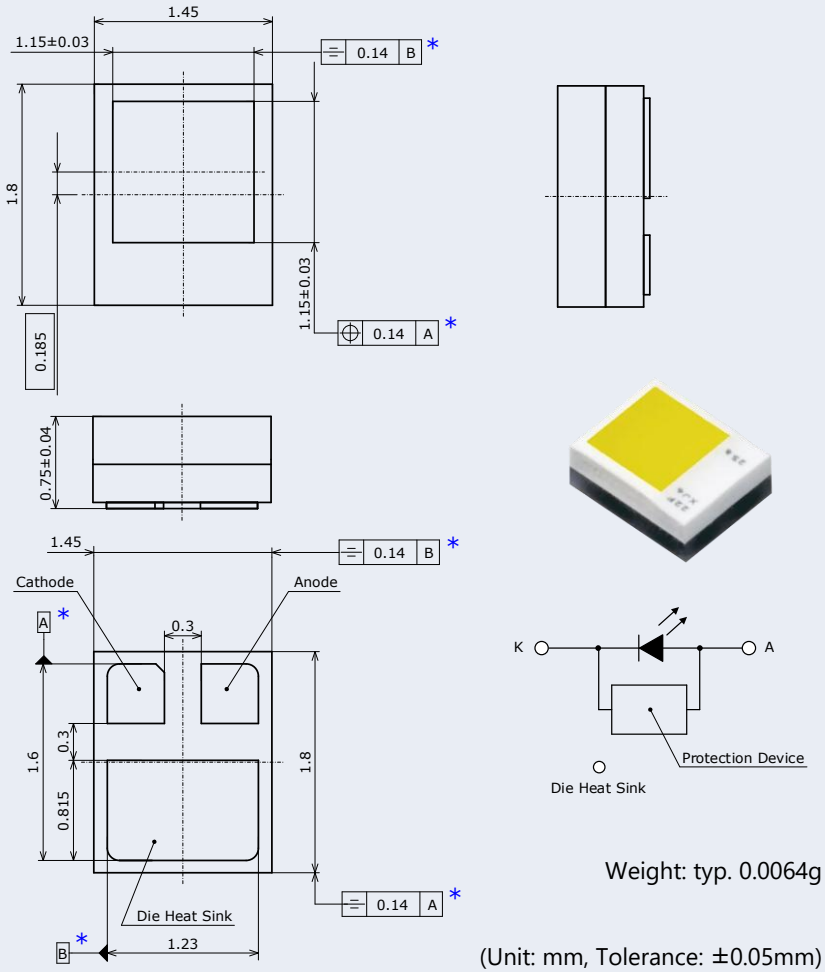
(Unit: mm)

* For the centerlines of the emitting area and of the LED package, the deviation from the centerlines of the electrodes and die heatsink (i.e. the baselines) is within ±0.07mm in both the lateral and longitudinal directions.

1. LED Outline Dimensions/Tape Dimensions

Table 2. NCSW131G / NCSW131H Product Specifications

LED

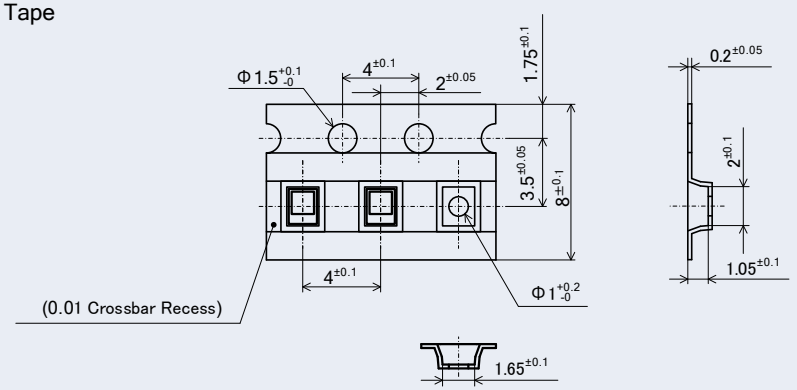


Weight: typ. 0.0064g

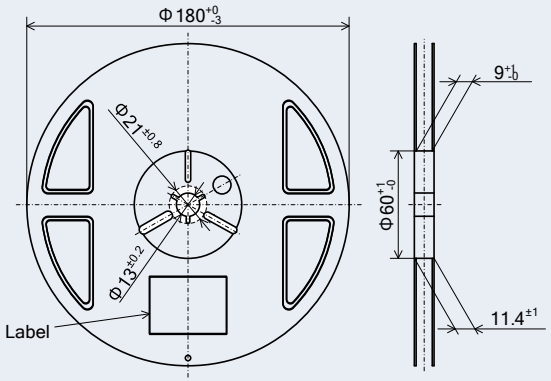
(Unit: mm, Tolerance: ±0.05mm)

Embossed Carrier Tape

Tape



Reel



Reel Size: 3,500 LEDs

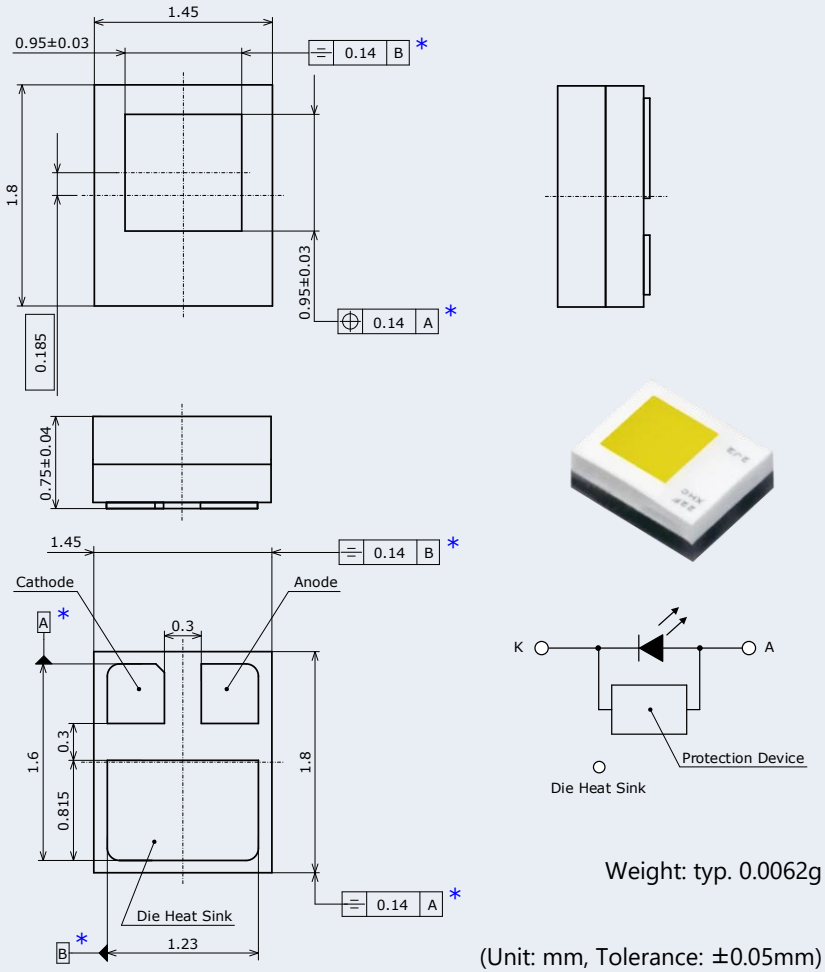
(Unit: mm)

* For the centerlines of the emitting area and of the LED package, the deviation from the centerlines of the electrodes and die heatsink (i.e. the baselines) is within ±0.07mm in both the lateral and longitudinal directions.

1. LED Outline Dimensions/Tape Dimensions

Table 3. NCSW131G-SA / NCSW131H-SA Product Specifications

LED

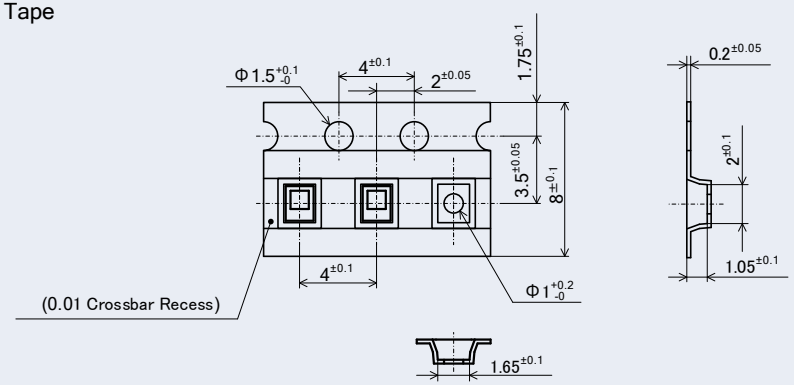


Weight: typ. 0.0062g

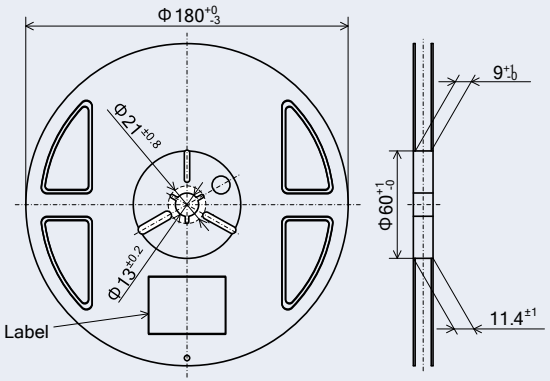
(Unit: mm, Tolerance: ±0.05mm)

Embossed Carrier Tape

Tape



Reel



Reel Size: 3,500 LEDs

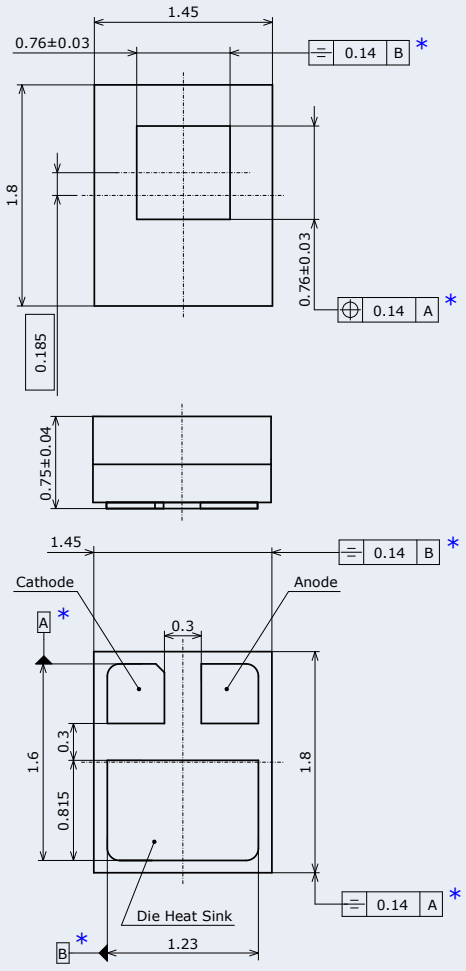
(Unit: mm)

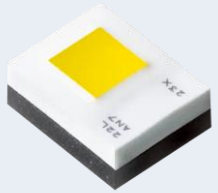
* For the centerlines of the emitting area and of the LED package, the deviation from the centerlines of the electrodes and die heatsink (i.e. the baselines) is within ±0.07mm in both the lateral and longitudinal directions.

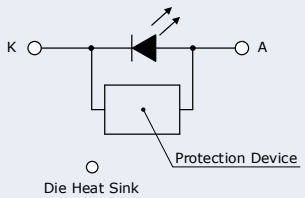
1. LED Outline Dimensions/Tape Dimensions

Table 4. NCSW131G-SB / NCSW131H-SB Product Specifications

LED





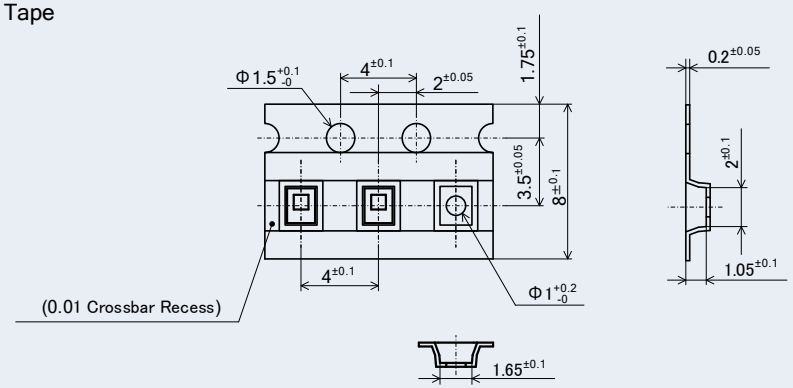


Weight: typ. 0.0061g

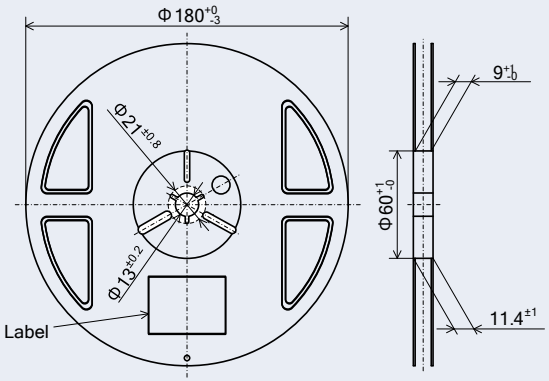
(Unit: mm, Tolerance: ±0.05mm)

Embossed Carrier Tape

Tape



Reel



Reel Size: 3,500 LEDs

(Unit: mm)

* For the centerlines of the emitting area and of the LED package, the deviation from the centerlines of the electrodes and die heatsink (i.e. the baselines) is within ±0.07mm in both the lateral and longitudinal directions.

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.

2.2 Handling with tweezers

Ensure that when handling the LEDs with tweezers, grab/hold the LEDs by the sides of the ceramic substrate and ensure that excessive force is not applied to the LEDs. Otherwise, it may cause damage to the light emitting area and/or the silicone resin (e.g. cut, scratch, chip, crack, etc.) and have an effect on the optical characteristics and/or the reliability.

2.3 Stacking assembled PCBs together

Do not stack assembled PCBs together. Otherwise, it may cause damage to the light emitting area (e.g. cut, scratch, chip, crack, etc.) and have an effect on the optical characteristics and/or the reliability.

2.4 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 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. Refer to the applicable specification for more details.

2.5 Storage Conditions

The storage/packaging requirements for the Nichia 131G/131H Series LEDs are comparable to JEDEC Moisture Sensitivity Level (MSL) 2 or equivalent. Nichia used IPC/JEDEC STD-020 as a reference to rate the MSL of the LEDs.

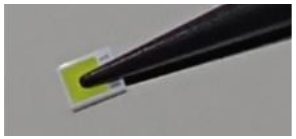
Table 5. Storage Conditions

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	≤ 1 Year

✔ Correct

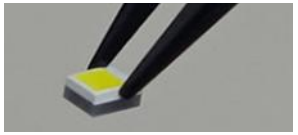
Suggestion: Grab/hold the LEDs with tweezers by the sides of the ceramic substrate.

⊘ Incorrect



Caution: Do not touch the emitting area.

⊘ Incorrect



Caution: Do not touch the silicone resin.

Figure 1. Correct/Incorrect Examples of Handling with Tweezers

Figure 2. Example of a Damaged Silicone Resin

3. Design Recommendations for Optimal Amount of Solder

Soldering Pad Pattern/Metal Solder Stencil Aperture

Table 6. Recommended Soldering Pad Pattern/Metal Solder Stencil Aperture

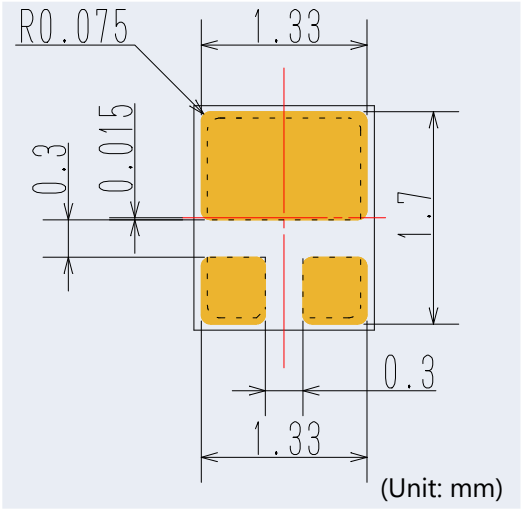
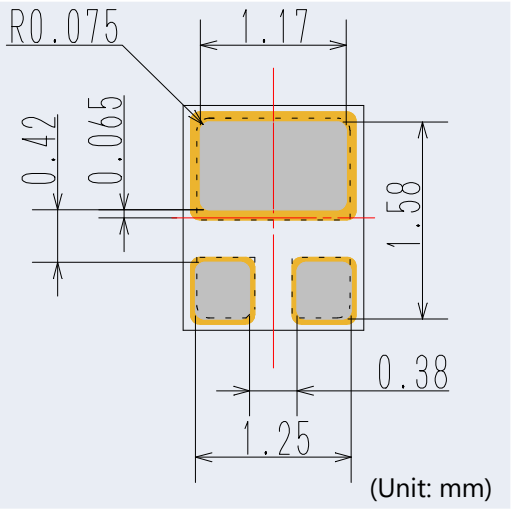
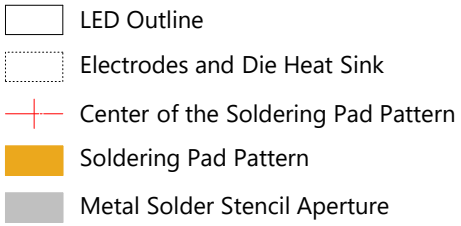
Recommended Soldering Pad Pattern	Recommended Metal Solder Stencil Aperture
	

Table 7. Recommended Solder/Metal Solder Stencil Conditions

Item	Recommended Conditions
Metal Solder Stencil (Thickness)	100 (μm)
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 6 and 7 have been determined under Nichia's conditions: ensure that there are no issues with the chosen assembly conditions prior to use.

If the solder paste and/or the PCB (e.g. base material, insulation material, soldering pad patterns, etc.) are not appropriate, it may cause thermal stress in the solder joints resulting in cracks. A thorough verification should be performed at the finished product level with the chosen solder paste and PCB prior to use to ensure there are no issues. In order to reduce the possibility of solder cracks, Nichia recommends using a copper-core PCB.

High Reliability Lead-free Solder Paste

Generally, the use of high reliability lead-free solder pastes can improve solder joint strength when compared with a standard lead-free solder paste. However, Nichia does not recommend using them as a measure to reduce solder cracks since it may cause stress to become concentrated onto the LEDs leading to cracks and/or breakage of the LED chip. When selecting a solder paste, perform sufficient verifications with the chosen PCB taking into consideration the conditions/environments in which the LEDs will actually be used to ensure there are no issues.

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

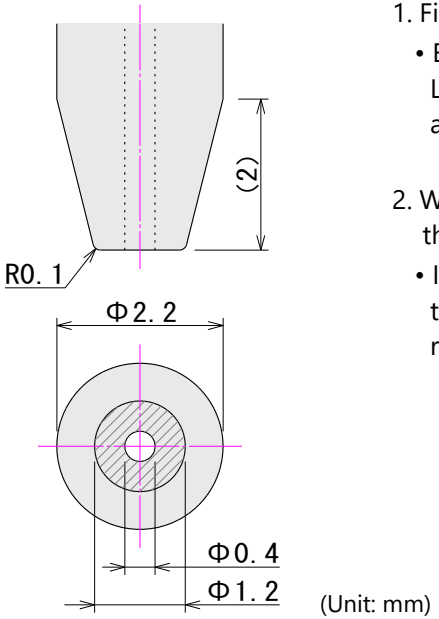
Table 8. Cautions/Suggestions for Setting Up Equipment

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 9 for the details.
Tape-and-reel feeder	Electrical (motorized) feeder Tape width: 8mm Feeder pitch: 4mm	See “Tape-and-Reel Feeder” on Page 10 for the details.
Top Cover Tape Removal Position	Immediately before pick-up	See “Tape-and-Reel Feeder” on Page 10 for the details.
Nozzle height for pick-up operations	The contact surface of the nozzle head for pick operations should be adjusted to 0.3mm below the edge of the embossed carrier tape pocket.	See “Recommended Nozzle Height for Pick-up Operations” on Page 11 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 11 for the details.
Imaging-based Automatic Inspection	Using the electrode as a reference is recommended to locate the center of the LEDs.	See "Imaging-based Automatic Inspection" on Page 12 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

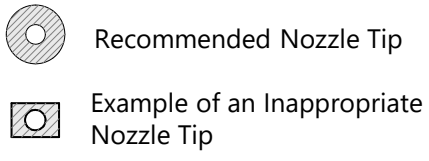


(Unit: mm)

Figure 3. Recommended Nozzle Dimensions

1. Figure 3 shows the recommended dimensions for the pick-and-place nozzle.
   - Ensure that the size and shape of the nozzle tip are appropriate for the LEDs. Otherwise, this may damage the LEDs (i.e. scratch, chip, crack, etc.), affecting the optical characteristics and/or the reliability. This may also lead to an incorrect pick up (i.e. the LEDs are picked up in a tilted position).

2. When setting the LED pick-up position, ensure that the center of the nozzle and the center of the emitting area of the LEDs are aligned (See Figure 3). Do not apply excessive force to the emitting area when picking up the LEDs.
   - If the nozzle does not pick up the LEDs at the center of the emitting area, and/or if excessive force is applied to the LEDs, this may damage the LEDs (i.e. scratch, chip, crack, etc.), affecting the optical characteristics and/or the reliability. This may also lead to an incorrect pick up (i.e. the LEDs are picked up in a tilted position).



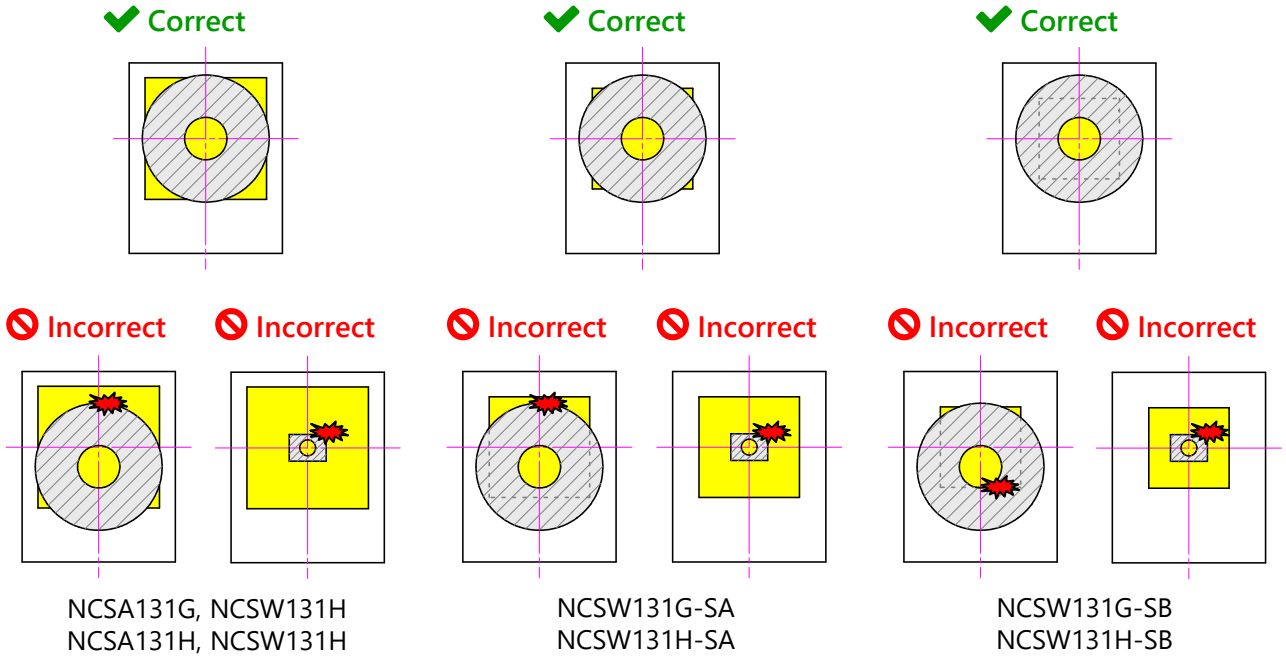
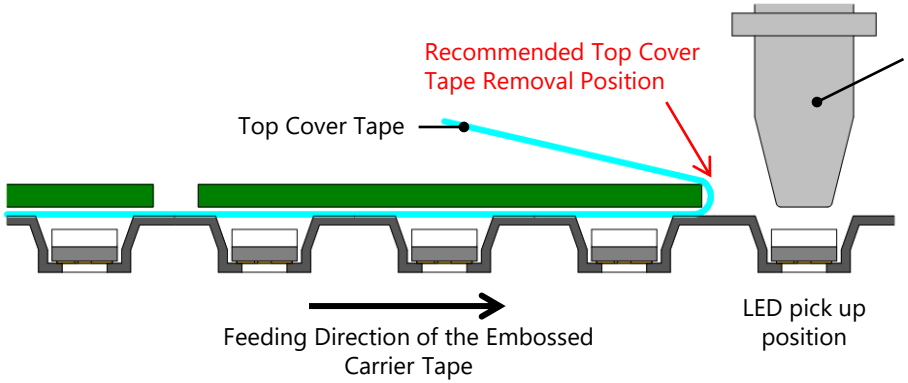


Figure 4. Examples of LED pick-up positions for the Nichia 131G/131H Series LEDs

4.2 Tape-and-Reel Feeder

• It is recommended to remove the top cover tape immediately before LED pick-up.



• It is NOT recommended to remove the top cover tape at a point significantly far away from the LED pick-up position.

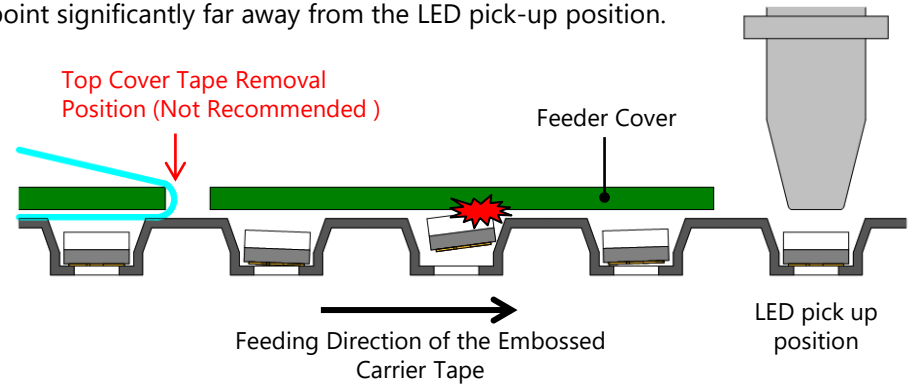


Figure 5. Top Cover Tape Removal Position

1. Recommended setting for the tape-and-reel feeder.
   Tape width: 8mm
   Feeder pitch: 4mm
2. Use a tape-and-reel feeder that ensures it does not create excessive vibrations causing assembly issues.
   Example: 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.
3. It is recommended to remove the top cover tape immediately before the LED pick-up position.
   - If the tape is removed at a point significantly far away from the LED pick-up position, the LED may contact the feeder cover causing damage to the emitting surface.

4.3 Recommended Nozzle Height for Pick-up Operations

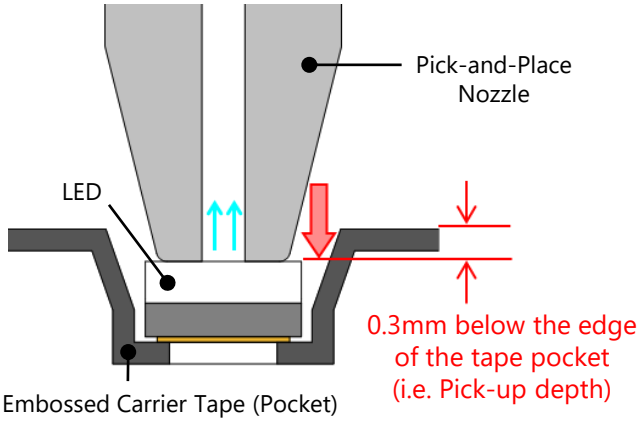


Figure 6. Recommended Nozzle Height for Pick-up Operations

1. Ensure that the nozzle goes down onto the LEDs in the tape pocket until the tip touches LEDs.

   Pick-up depth: 0.3mm

   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 8) 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 LEDs into the air, incorrect picking causing the LEDs 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)

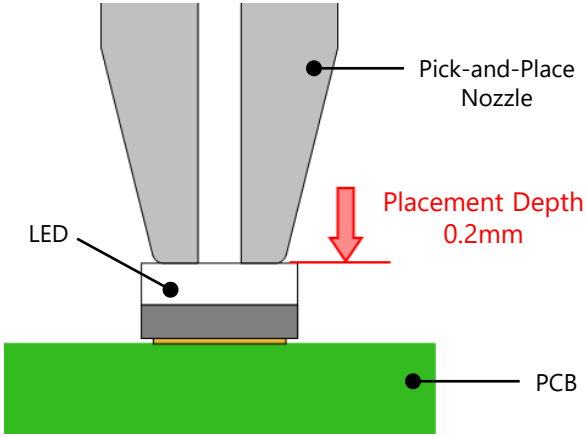


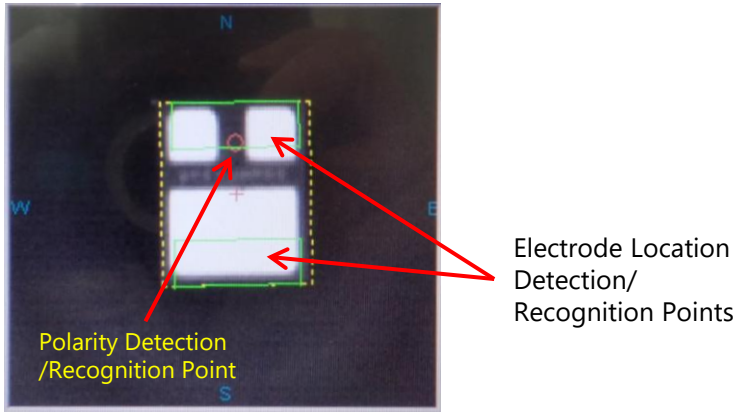
Figure 7. Recommended Nozzle Height for Placement (Placement Depth)

1. The nozzle should further press the LEDs 0.2mm onto the PCB from the height where the LEDs first touch solder paste.

   If the release point of the nozzle is too high,
   - it may cause placement issues (e.g. the LEDs to stick to the nozzle after placement, the LEDs to be mounted in an incorrect place/rotated position, the LEDs 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 LEDs during placement and it may cause the LEDs to become damaged.

4.5 Imaging-based Automatic Inspection



1. Nichia recommends using the electrodes as a reference to locate the center of the LEDs.
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.

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

5. Precautions When Reflow Soldering

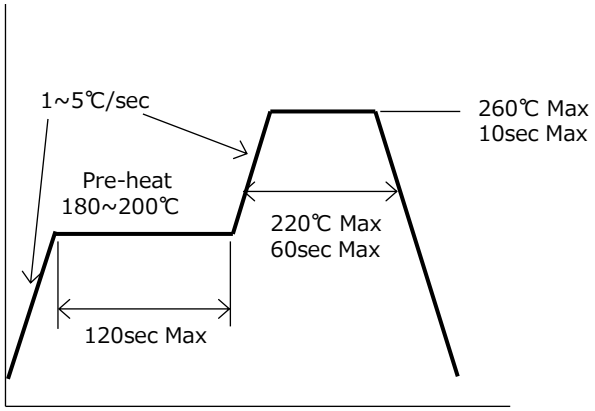


Figure 8. Recommended Reflow Soldering Condition (Lead-free Solder)

1. Reflow soldering must not be performed more than twice.
2. Nichia recommends using the reflow soldering conditions detailed in Figure 8 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.

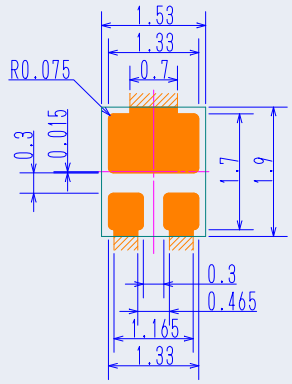
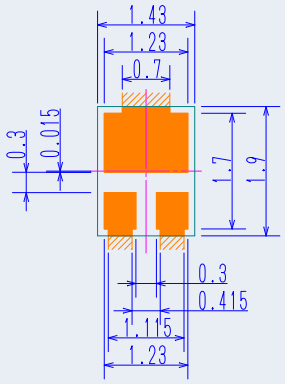
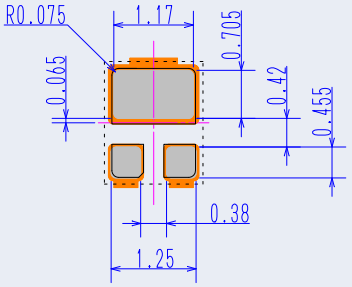
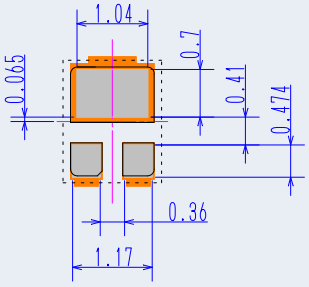
   Note: To ensure that these reflow conditions have no negative effect on the LEDs, perform sufficient verification prior to use.
3. When cooling the LEDs from the peak temperature a gradual cooling slope is recommended; do not cool the LEDs rapidly.
4. During reflow soldering, the heat and atmosphere 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.
5. If the amount of solder voids in the solder joint is large, solder cracks may be likely to occur, etc. causing an effect on the reliability of the end-product. If the amount of solder voids is large, adjust the reflow conditions to reduce the amount of solder voids.

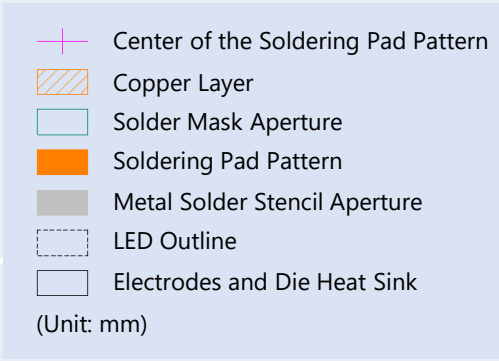
6. Evaluation of the Effect of Solder Conditions

Nichia evaluated the effect of solder volume for reflow-soldering the LEDs (i.e. the parallel/angular deviations and self-alignment performance) using different solder conditions including the recommended conditions as shown in Section 3.

- PCB and LEDs Used for the Evaluation
  FR4, copper layer thickness of 70µm, substrate thickness of 1.6mm, LED Part No.: NCSW131G, Sample Size: 250 LEDs per condition for the placement accuracy, 15 LEDs per condition for the self-alignment performance
- Evaluated Items
  Placement accuracy (x and y directions, angular direction, and tilt) and self-alignment performance (x and y directions and rotation)

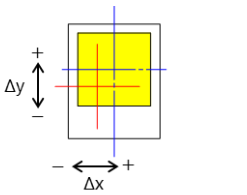
Table 9. Soldering Pad Patterns, Metal Solder Stencil Apertures, and Solder Volumes

	Recommended Condition	Different Conditions		
Thickness	100µm	80µm	100µm	120µm
Soldering Pad Pattern (NSMD)				
Metal Solder Stencil Aperture				



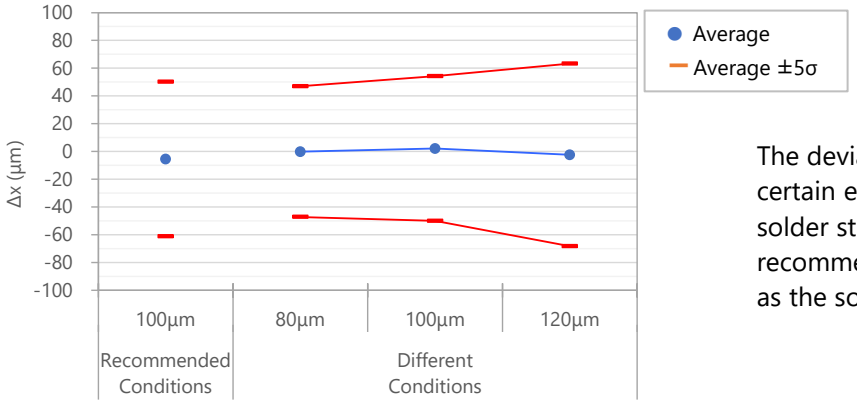
6.1 Placement Accuracy in x and y Directions

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 conditions. The amount of the deviation from the center of the soldering pad pattern in the x and y directions are described as Δx and Δy respectively. Sample size: 250 LEDs per condition

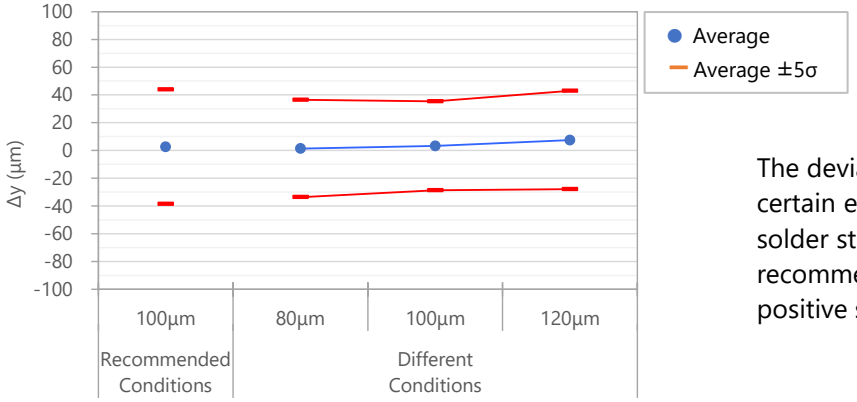


＋ : Centerline of the emission area

＋ : Target LED Position



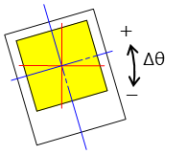
The deviation of Δx of the evaluated LEDs was improved to a certain extent when the soldering pad pattern and the metal solder stencil aperture used were different from the recommended conditions. The deviation tended to be smaller as the solder volume decreased.



The deviation of Δy of the evaluated LEDs was improved to a certain extent when the soldering pad pattern and the metal solder stencil aperture used were different from the recommended conditions. The LEDs tended to shift toward the positive side a little as the solder volume increased.

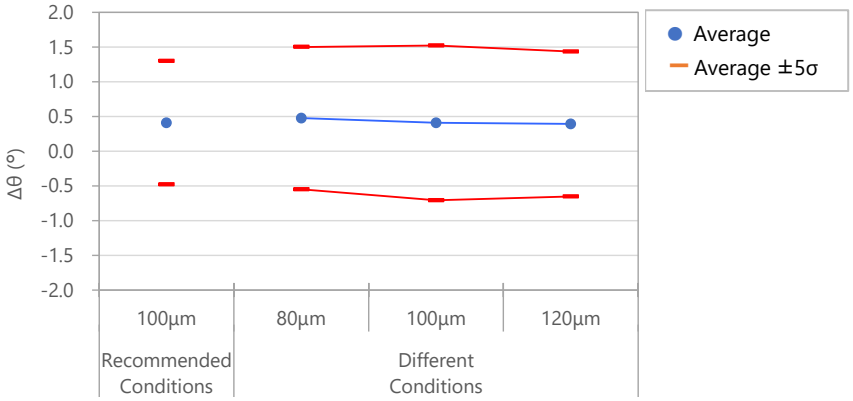
6.2 Placement Accuracy in the Angular Direction

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 conditions. The amount of the deviation from the reference axis in the angular direction is described as Δθ. Sample size: 250 LEDs per condition



＋ : Centerline of the emission area

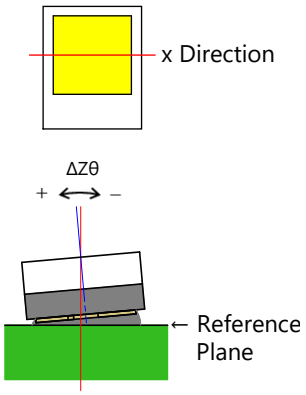
＋ : Reference Axis

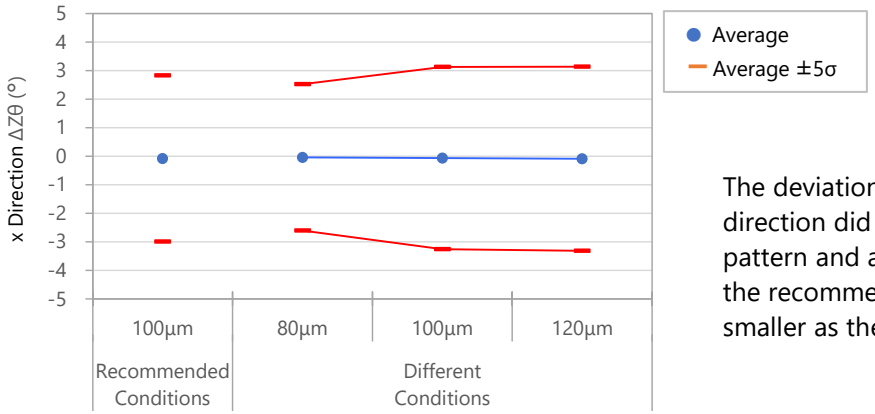


The deviation of Δθ of the evaluated LEDs became slightly larger when the soldering pad pattern and the metal solder stencil aperture used were different from the recommended conditions. There was no significant difference seen when the solder volumes were changed from the recommended conditions by changing the thickness of the metal solder stencil.

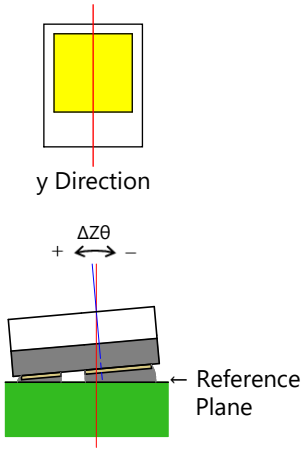
6.3 Placement Accuracy in the Angular Direction (ΔZθ)

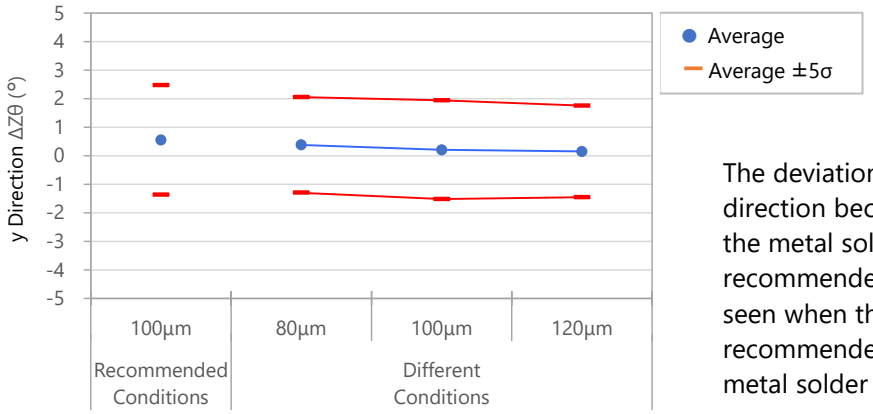
Nichia evaluated the placement accuracy of the reflow-soldered LEDs in the z direction (i.e. tilt in the height direction) from the center of the soldering pad pattern using different solder conditions. The amount of the deviation from the center of the soldering pad pattern in the z-x and z-y directions are described as ΔZθ. Sample size: 250 LEDs per condition





The deviation of ΔZθ of the evaluated LEDs in the z-x direction did not become smaller by using a soldering pad pattern and a metal solder stencil aperture that differed from the recommended conditions. The deviation tended to be smaller as the solder volume decreased.



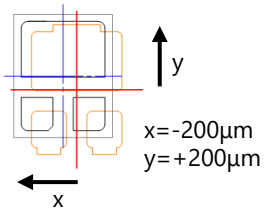


The deviation of ΔZθ of the evaluated LEDs in the z-y direction became smaller when the soldering pad pattern and the metal solder stencil aperture used were different from the recommended conditions. There was no significant difference seen when the solder volumes were changed from the recommended conditions by changing the thickness of the metal solder stencil.

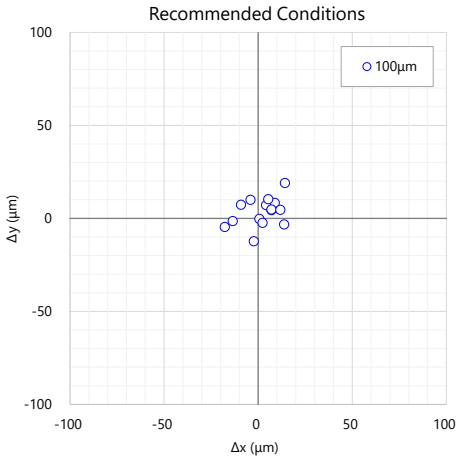
6.4 Self-alignment Performance in the x and y Directions

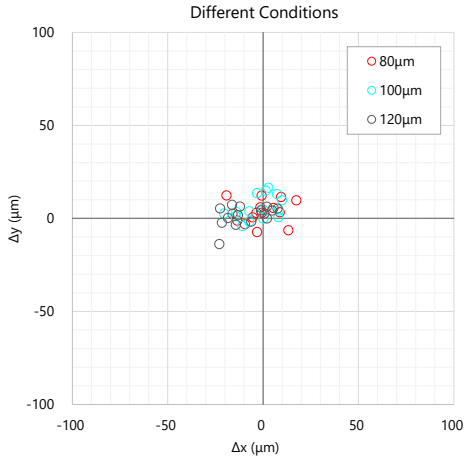
Nichia evaluated the self-alignment performance of the reflow-soldered LEDs using different solder conditions: the evaluation LEDs were placed on specified points (i.e. x = -200µm and y = +200µm/x = -200µm and y = -200µm from the center of the soldering pad pattern). Sample Size: 15 LEDs per condition

Evaluated LED Placement Position 1



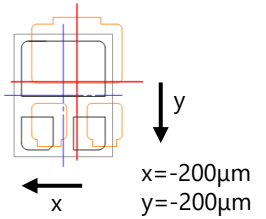
□ : Soldering Pad Pattern
+ : Center of the Soldering Pad Pattern
+ : Center of the Evaluated LED Placement Position



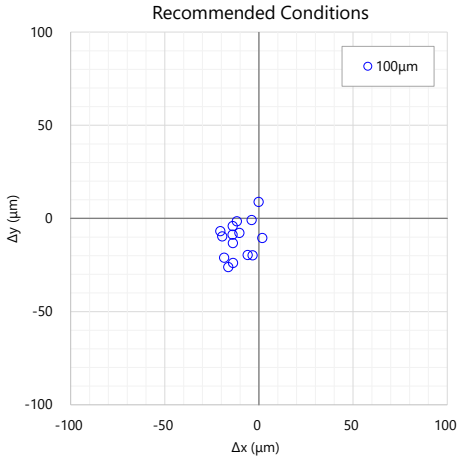


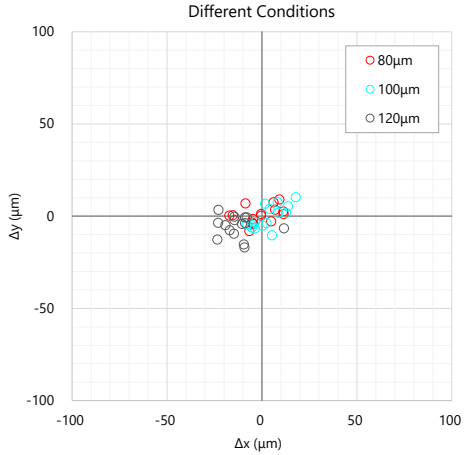
With all the evaluation conditions used, the LEDs moved to positions that were sufficiently close to the correct one (i.e. the amount of the deviation was almost the same as the evaluation results shown in 6-1); there were no issues.

Evaluated LED Placement Position 2



□ : Soldering Pad Pattern
+ : Center of the Soldering Pad Pattern
+ : Center of the Evaluated LED Placement Position



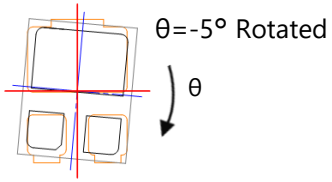


With all the evaluation conditions used, the LEDs moved to positions that were sufficiently close to the correct one (i.e. the amount of the deviation was almost the same as the evaluation results shown in 6-1); there were no issues.

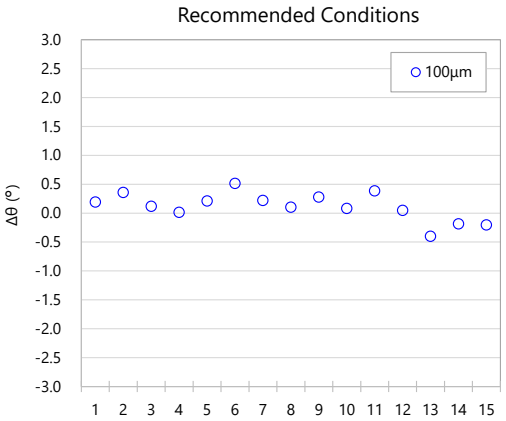
6.5 Self-alignment Performance in the Angular Direction

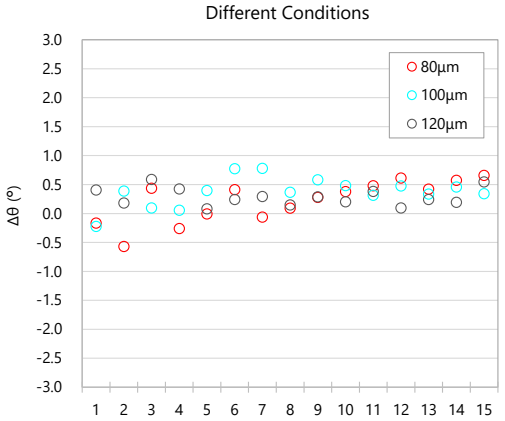
Nichia evaluated the self-alignment performance of the reflow-soldered LEDs using different solder conditions: the evaluation LEDs were intentionally rotated (i.e. Δθ = -5/10° from the reference axis whose origin was the center of the soldering pad pattern). Sample Size: 15 LEDs per condition

Evaluated LED Placement Position 3



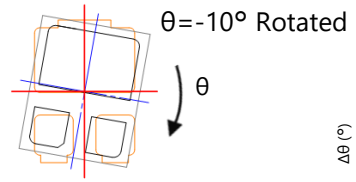
□ : Soldering Pad Pattern
+ : Reference Axis of the Soldering pad pattern
+ : Reference Axis of the Evaluated LED Placement Position



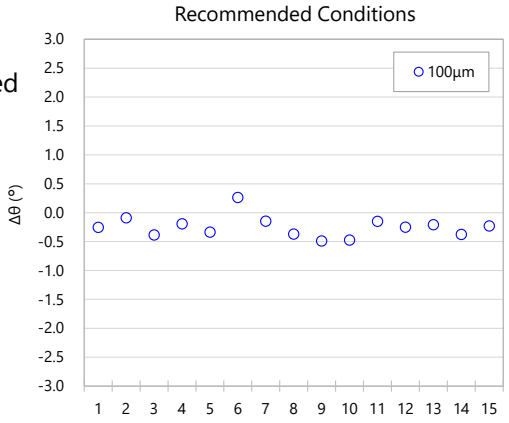


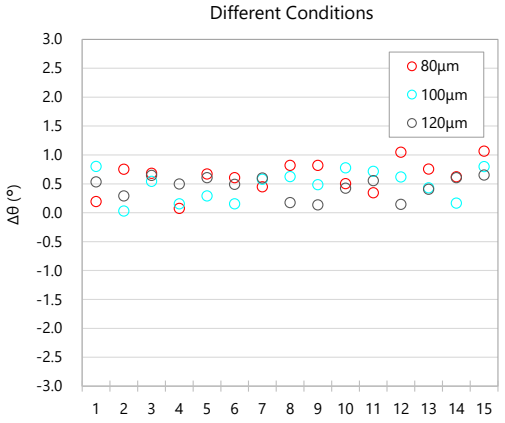
With all the evaluation conditions used, the LEDs moved to positions that were sufficiently close to the correct one (i.e. the amount of the deviation was almost the same as the evaluation results shown in 6-2); there were no issues.

Evaluated LED Placement Position 4



□ : Soldering Pad Pattern
+ : Reference Axis of the Soldering pad pattern
+ : Reference Axis of the Evaluated LED Placement Position





With all the evaluation conditions used, the LEDs moved to positions that were sufficiently close to the correct one (i.e. the amount of the deviation was almost the same as the evaluation results shown in 6-2); there were no issues.

6.6 Summary

- The evaluation results show that overall, the placement accuracy tends to be better when the solder volume is smaller. However, if the solder volume is insufficient, it may cause a decrease in solder joint strength.
- The evaluation results provided herein were affected by the manufacturing accuracy of the PCB, the precision of the measurement instruments, etc.; these results should be used for reference purposes only.
- 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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