Light Emitting Diode

LED Mounting Process Techniques

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SP-QR-C2-210760-1
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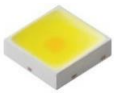
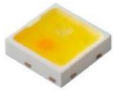
1. Overview

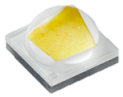
When manufacturing a luminaire using LEDs, the LED mounting technique is a critical aspect. Regardless of how good the LEDs' characteristics may be, improper mounting methods/conditions may significantly affect the LED's characteristics, and in some cases cause the LEDs not to illuminate.
This application note covers the importance of how the mounting process is performed and discusses precautions that customers should take into consideration for each stage of the mounting process.

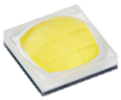
2. Applicable LED part/series numbers

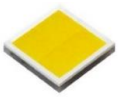
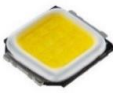
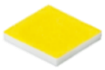
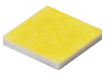
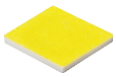
The contents described in this application note apply to the LEDs shown in Table 1, Nichia's LEDs for general lighting.

Table 1. Nichia LEDs for General Lighting

Category	Part Number [1]	Package Appearance (One example) (mm)
NICHIA 757 Series	NFSW757H-V1 NF2W757H-F1 NFSW757H	 3×3×0.80
	NF2W757GR-V4 NF2W757GR-V3P7 NF2W757GR-V3 NF2W757G-V3F1 NFSW757G-V3 NF2x757GR-V1U4 NF2x757GR-V1 NFSW757G-P5V1 NFSx757G-P5 NF2x757G-F1 NFSx757G	 3×3×0.65
	NE2B757G NF2E757GR NE2G757G NFSY757G NE2R757G-P6	 3×3×0.65
	NF2W757G-MT etc.	 3×3×0.75

Category	Part Number [1]	Package Appearance (One example) (mm)
NICHIA 119/219 Series	NVSW119F-V1 NVSW219F-V1 NVSW119F NVSW219F NVSW119D NVSW219D	 3.5×3.5×2.3
	NVSx119C NVSx219C	 3.5×3.5×2
	NCSC119B-V1 NCSC219B-V1 NCSB119B-V1 NCSB219B-V1 NCSE119B-V1 NCSE219B-V1 NCSG119B-V1 NCSG219B-V1 NCSA119B-V1 NCSA219B-V1 NCSR119B-V1 NCSR219B-V1 NVSA119B-V1 NVSA219B-V1 etc.	 3.5×3.5×2

Category	Part Number [1]	Package Appearance (One example) (mm)
NICHIA 229 Series	NWSx229A etc.	 4×4×2.3
NICHIA 309/319 Series	NVSW309B NVSW319B etc.	 3.5×3.5×2.35
NICHIA 385 Series	NF2W385AR-V2 etc.	 4×3.6×2.05
NICHIA 585 Series	NF3W585AR-V1 NF2W585AR-P8 NF3W585AR NF2W585AR etc.	 4×3.6×2.05
NICHIA 519 Series	NVSW519A etc.	 3.5×3.5×2.35
NICHIA 144 Series	NV4x144AR NV4x144AM etc.	 5×5×3.15
NICHIA 149 Series	NV9W149AM etc.	 7×7×3.1

Category	Part Number [1]	Package Appearance (One example) (mm)
NICHIA B35 Series	NV4WB35AR NV4WB35AM etc.	 3.65×3.65×0.73 3.65×3.65×0.76
NICHIA 481/484 486/488 Series	NFMW488AR-V1 NFMW481AR NFMW484AR NFMW486AR NFMW488AR etc.	 6.5×5.8×0.8
NICHIA E11 Series	NFSWE11A etc.	 1.1×1.1×0.27 1.1×1.1×0.30 1.1×1.1×0.35
NICHIA E17 Series	NCSxE17A	 1.7×1.7×0.27 1.7×1.7×0.30 1.7×1.7×0.35
	NCSCE17A NCSBE17A NCSGE17A NCSAE17A NCSRE17A etc.	 1.7×1.7×0.35
NICHIA E21 Series	NVSxE21A etc.	 2.1×2.1×0.27 2.1×2.1×0.30 2.1×2.1×0.35

Note:
[1] x = W (White) or L (Warm White)

3. Solder Printing Process

This section covers the first part of the LED mounting processes, the solder printing process for the solder paste. The other two parts of the process are the LED placement and reflow soldering. Solder printing refers to applying the solder paste to the soldering pad pattern on the PCB.
In this process, it is necessary to set the optimum soldering pad pattern and metal solder stencil aperture, prepare the solder paste, and adjust the printing conditions in order to obtain optimal solder printing conditions.

3.1 Recommended soldering pad pattern and metal solder stencil aperture

Nichia performed tests for mounting Nichia LEDs and provides customers with the recommended dimensions for the soldering pad pattern and metal solder stencil aperture. Refer to the "Soldering" section of the part specifications for these recommended dimensions. An example of these diagrams is shown in Figure 1 below for reference.

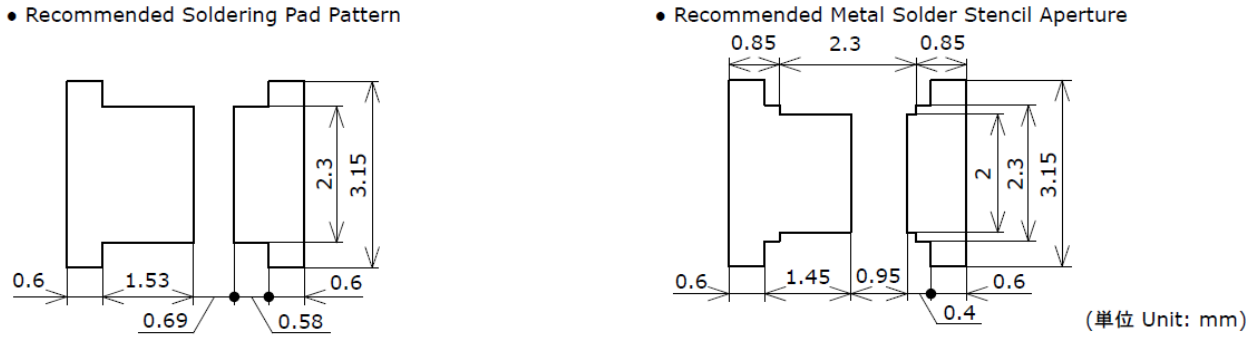


Figure 1. Recommended soldering pad pattern and recommended metal solder stencil aperture (example: part number NFSW757H-V1 Specification)

3.2 Adjusting the metal solder stencil aperture

Depending on the customer's mounting conditions/equipment, it may not be possible to use Nichia's recommended metal solder stencil aperture. In that case, customers will need to adjust the metal solder stencil aperture and perform mounting tests until the best design with that equipment can be verified.

For example, if after mounting it was confirmed that the part floated, the metal solder stencil aperture would need to be adjusted. Figure 2 shows an example.

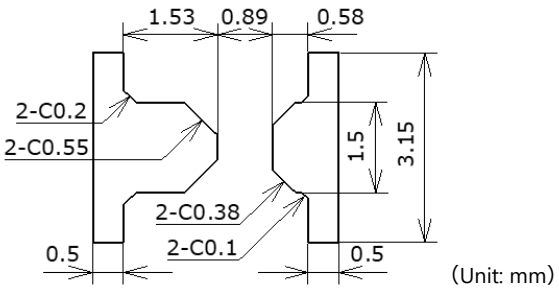


Figure 2. Example metal solder stencil aperture as a countermeasure against part floating

3.3 Solder Printing Conditions

In the solder printing process, it is important to print solder paste in the correct position on the PCB and with the correct amount and shape. To do this efficiently, it is necessary to prepare the solder paste and adjust the printing conditions as described below.

3.3.1 Preparing the Solder Paste

In most cases, solder paste stored in a refrigerator is not able to be used immediately. It is necessary to stir before use. The purpose of stirring the solder is to evenly distribute the solder particles and flux that may have become uneven while the solder was stored in the refrigerator. If the solder paste is uneven, it will not be possible to obtain good rollability.

Note that if the stirring time is too long, the solder temperature will rise, and the flux will deteriorate. Additionally, in order to avoid moisture absorption of the solder paste due to condensation, open the container after it has returned to room temperature.

3.3.2 Adjusting the Printing Conditions

In order to print the solder paste at the proper position on the PCB, the metal solder stencil aperture and PCB recognition data must be entered and set in the printing machine, and an alignment test must be performed.
Adjust the squeegee conditions and the solder stencil separation conditions to print with the correct amount and shape. The speed, pressing pressure and angle of the squeegee affect the amount and condition of the solder paste filling the metal solder stencil aperture. Additionally, the speed of the separation and the distance affects how smoothly the stencil separates from the solder paste as it is removed. These are also affected by the thickness of the metal solder stencil, the aperture pattern, and the surface roughness of the aperture wall.
In order to prevent the occurrence of solder bridges, etc. and maintain optimal printing conditions, adjust the cleaning method, conditions, and frequency of the metal solder stencil.
For reference, Table 2 on the following page shows an example of print condition settings for Panasonic screen printer SPG. The printing conditions change depending on the type of equipment, the length and rigidity of the squeegee, etc.

Table 2. Example of printing condition settings (Reference: Panasonic screen printer SPG)

Print Setting Items				Setting Conditions	Details
Printing Conditions	Action Mode			Single	The machine has a setting for either "Single" (one-way printing) or "Double" (two-way printing)
	Printing Speed		F→R	50mm/s	Squeegee travel speed (front→back)
			R→F	50mm/s	Squeegee travel speed (back→front)
	Pressing Pressure (Per Squeegee 1mm)		F→R	30.0×0.01N	Force that the squeegee applies to the metal solder stencil (front→back)
			R→F	30.0×0.01N	Force that the squeegee applies to the metal solder stencil (back→front)
	Downward Speed			7.0mm/s	Speed of separation required for stability
	Advanced Settings	Lift	Clearance	-0.20mm	Gap between metal solder stencil and PCB, typically "-0.3" to "-0.1" to improve adhesion
			Downward Stroke	3.0mm	The board separation distance required for a stable solder paste release: Consider deflection of metal solder stencil and extension of solder
		Squeegee Material [2]		Plastic	Select either metal, urethane, or plastic
		Squeegee Length		370.0mm	Length of the squeegee
		Squeegee Angle		60°	The angle of the squeegee

Operation		Interval (Frequency)	Process	Speed	Method [3]	Suction
Cleaning	1 round trip	Every 5 Sheets	Going	80mm/s	Dry	ON
			Returning	Operation: OFF		
	2 round trips	Every 20 Sheets	Going	80mm/s	Dry	ON
			Returning	80mm/s	Dry	OFF
			Going	40mm/s	Wet	OFF
			Returning	80mm/s	Dry	OFF

Note:

[2] Squeegee material: The materials for the squeegee are metal, urethane, and plastic. Select the squeegee suitable for the chosen application according to the following.

Metal squeegee: The material is hard, and it is easy to adjust the amount of solder uniformly; however, the metal solder stencil is easily damaged, and the life is short.

Urethane squeegee: Although the life of the metal mask is extended because the material is soft, the squeegee bends if the aperture size is large, the amount of solder is reduced (not uniform) in areas where the squeegee bends.

Plastic squeegee: It has the good properties of the metal and urethane options; however, regular replacement is necessary due to the occurrence of normal wear.

[3] Method of cleaning the metal solder stencil:

Dry: Removal of solder particles and flux attached to openings and back of metal solder stencil.

Wet: Removal of thin film of residual flux on the back of the metal mask (which causes solder particles to adhere more easily).

3.4 Visual inspection after solder printing

Nichia recommends performing a visual inspection after solder printing to confirm that the solder paste can be stably printed in the proper position and in the proper amount and shape.

Figure 3 shows an example of a visual inspection. Perform an image analysis to check the position, amount, and shape of the solder.

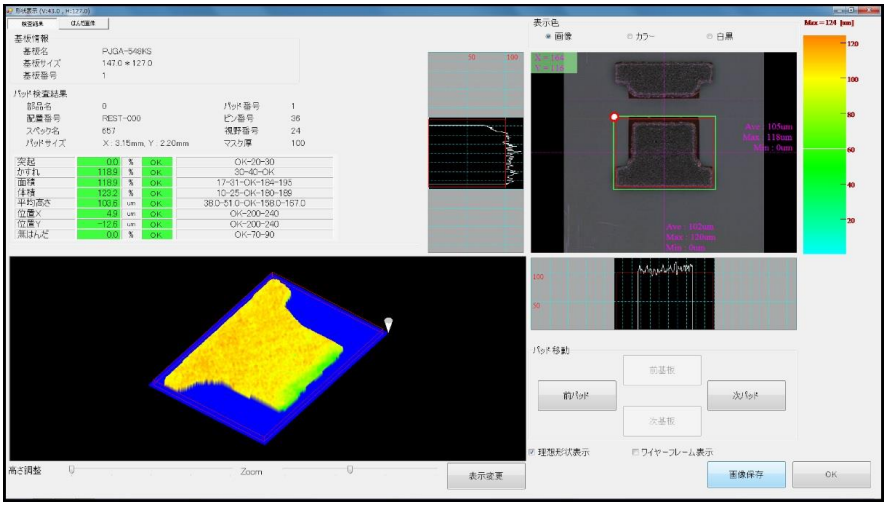


Figure 3. Example of the data for a visual inspection after solder printing (Reference: CKD VP6000M-V)

4. LED Placement

This section covers the second part of the LED mounting processes, the LED placement. LED placement refers to mounting the LED on a soldering pad pattern to which solder paste has been applied.
In this process, it is necessary to set the optimum nozzle shape and suction method and adjust the suction and mounting conditions in order to obtain optimal conditions for LED placement. During this process, care must be taken to avoid applying any excessive force to the light emitting surface or the lens part of the LED. Excessive force may affect the reliability and optical characteristics.

4.1 Recommended Nozzle Shape

Nichia performed tests to provide customers with a recommended nozzle configuration. Refer to the "Soldering" section of the specifications which may contain a diagram like the one shown in Figure 4.
For products that do not have the recommended nozzle shape described in the specification, contact Nichia directly to discuss this further.

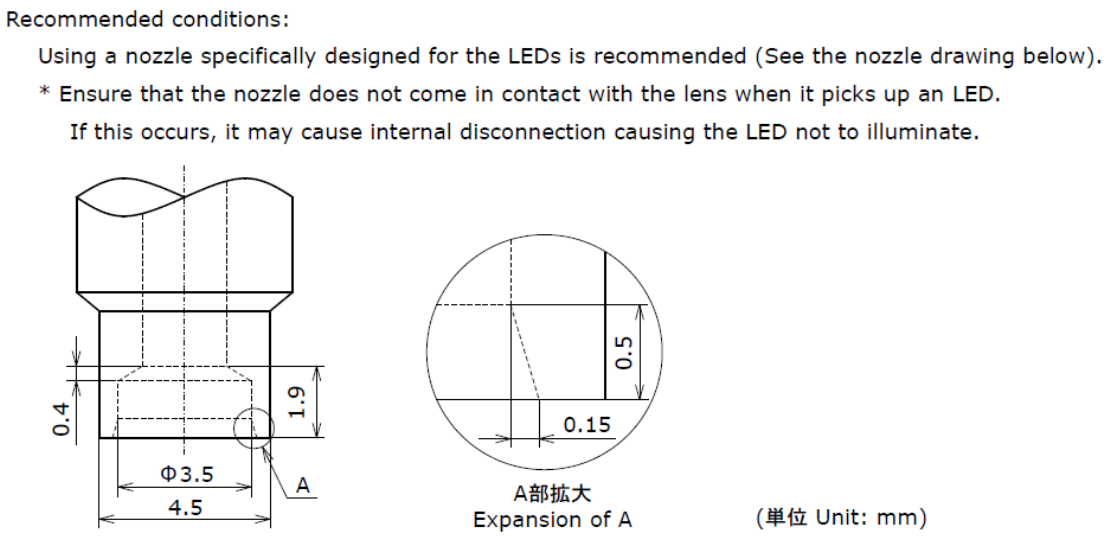


Figure 4. Recommended nozzle shape (example: part number NVSW119F-V1 Specification)

For nozzle shapes for LEDs with an integrated lens, when designing or choosing the nozzle shape, having the inner surfaces with C or R corners enables a smoother operation for the suction pick-up and reduces the possibility of pick-up errors.

4.2 Nozzle Suction Method

Nichia determines the ideal nozzle shape and suction method that is optimal according to the shape and weight of each Nichia LED and takes this into consideration when preparing the embossed carrier tape.
There are two major methods for LED suction during mounting:
One method is to stop the suction nozzle on the top surface or the middle surface of the embossed carrier tape and suck the LED (i.e. vacuum suction). The other is a method in which a suction nozzle is inserted into the embossed carrier tape until it reaches the LED as close as possible (i.e. normal suction).

① Vacuum suction: By suctioning air from the height at which the nozzle does not contact the LED, the only load that may be applied to the lens is the suction pressure at the time of suction.

② Normal suction: Where vacuum suction is not possible or difficult, stable suction is made possible by bringing the nozzle closer to the LED and then applying suction.

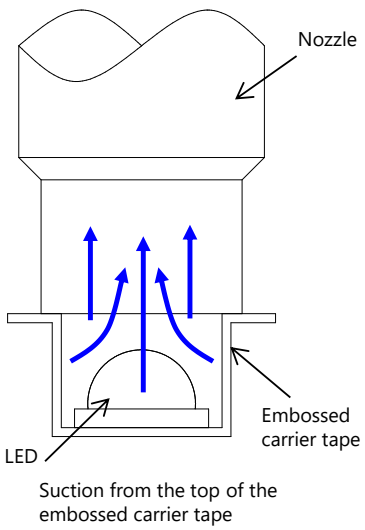


Figure 5. Vacuum suction

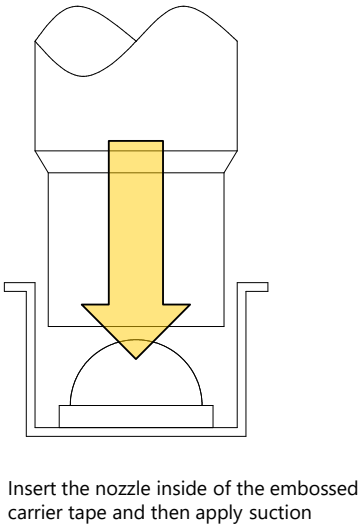


Figure 6. Normal suction

Refer to the drawing shown in Figure 7 in the "Recommended nozzle height" section of the assembly precaution application note for each LED part number for the LED suction method and nozzle suction/insertion position.
For products that do not have the recommended suction/insertion height described in the application notes, contact Nichia directly to discuss this further.

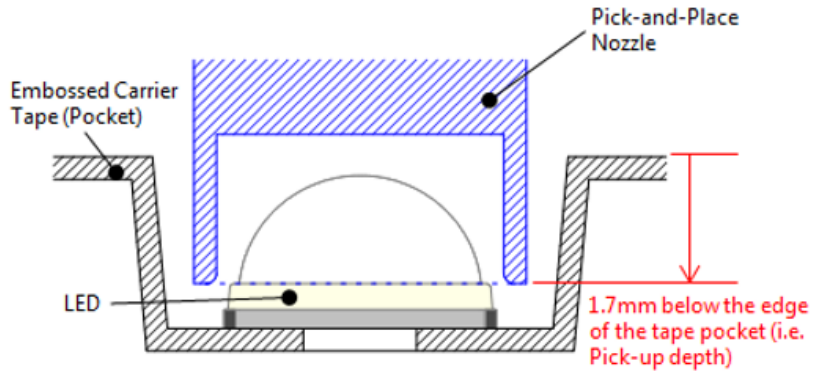


Figure 7. Recommended nozzle height (example: part number NFxW585AR Assembly Precaution application note)

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 and/or damage to the LED.

4.3 Optimizing the Nozzle Suction Force

Adjust the nozzle suction force to the optimal condition. In a non-optimized state, depending on the shape and material of the LED, it may not be picked up, or the LED may adhere to the nozzle during the mounting process.
For LEDs with an integrated lens, air leaks may occur between the nozzle and the LED, which may cause the LED to not be picked up properly. If this occurs, adjust the nozzle to a more appropriate suction by increasing the nozzle suction force and/or reducing the nozzle inner diameter to reduce the potential for air leaks. When reducing the inner diameter of the nozzle, ensure that the clearance takes into consideration the dimensional tolerances to ensure there is no contact with the LED lens.

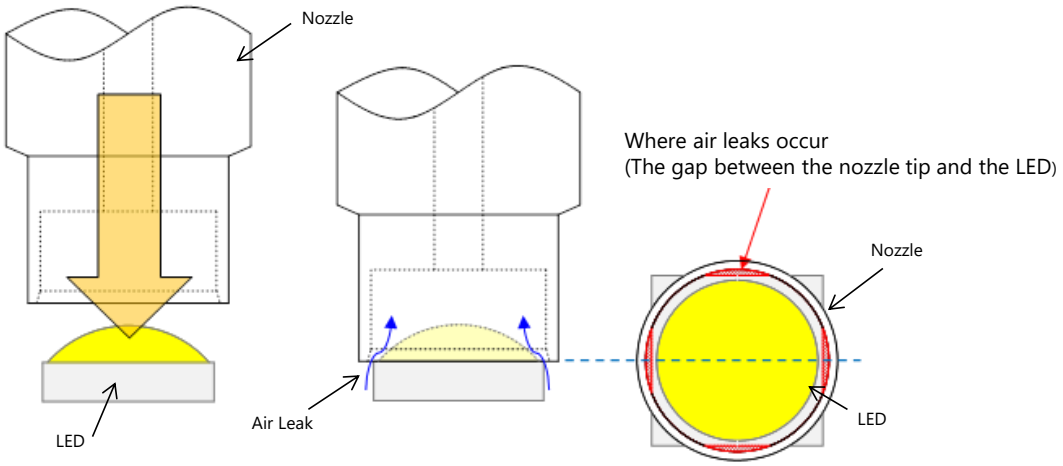


Figure 8. Air leak at the time of LED suction (example: part number NV9W149AM)

4.4 Tape Feeder Types

Nichia recommends the use of a motorized tape feeder with a low feed vibration. For example, in air-type tape feeders, where the feed vibration is larger than that of motorized tape feeders, suction failure may occur (e.g. LEDs move within emboss carrier tape, or a tilted suction.)

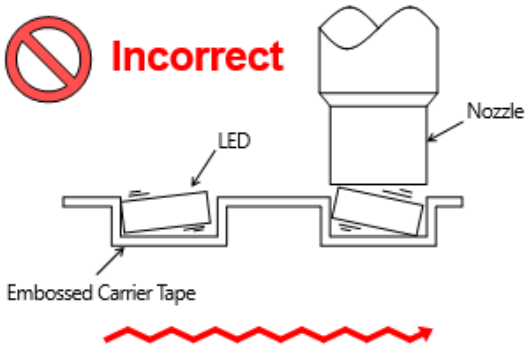


Figure 9. Tape feeder with large vibration

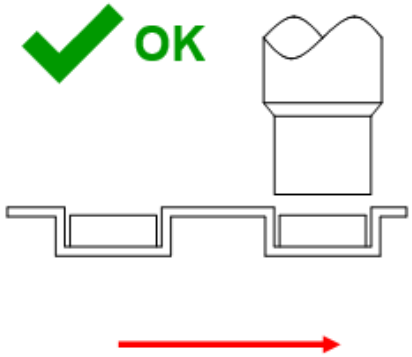


Figure 10. Tape feeder with small vibration

4.5 Feeding Speed of the Tape Feeder

The feed speed of the tape feeder needs to be adjusted to the optimum speed according to the shape of the mounted LED. For example, a simple square-shaped LED can be picked-up and placed at a high speed; however if it is an LED with an integrated lens, it will be difficult to pick-up and place at that same high speed. Since LEDs with integrated lenses tend to have a high center of gravity, if the feed rate is too high, suction failure is likely to occur due to rolling or tilting of the LED due to vibration.

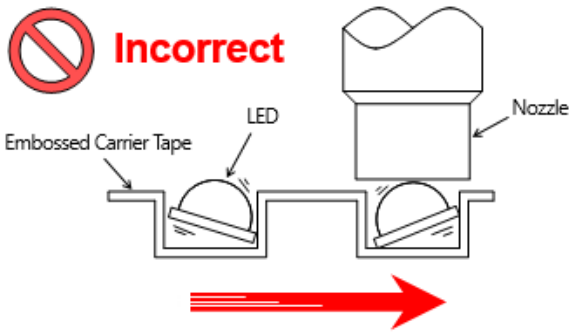


Figure 11. Tape feeder feed rate (fast)

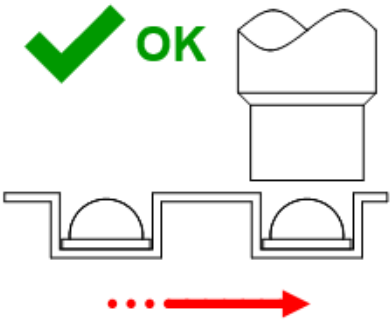


Figure 12. Tape feeder feed rate (slow)

Additionally, since the LED lens is a resin material, it is tacky and the LED lens may stick to the embossed carrier top cover tape; if the tape feeder speed is too high, the suction occurs before the LED peels off from the top cover tape, which causes suction failure.

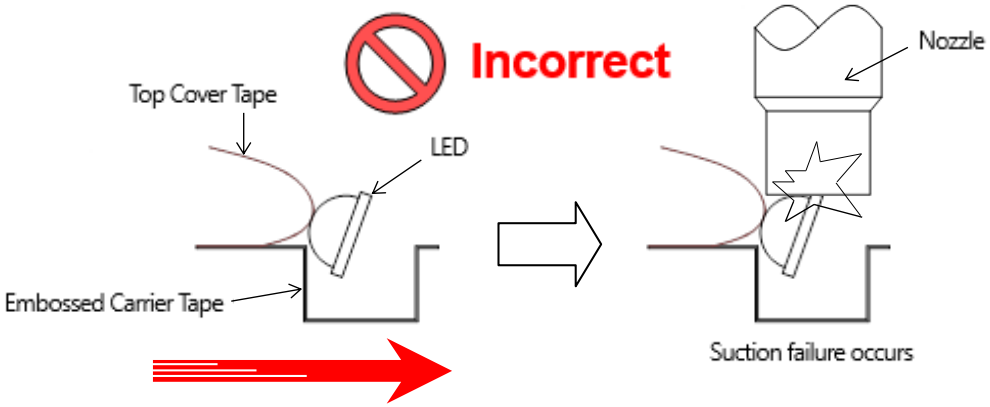


Figure 13. When the tape feeder feed rate is fast and the LED sticks to top cover tape

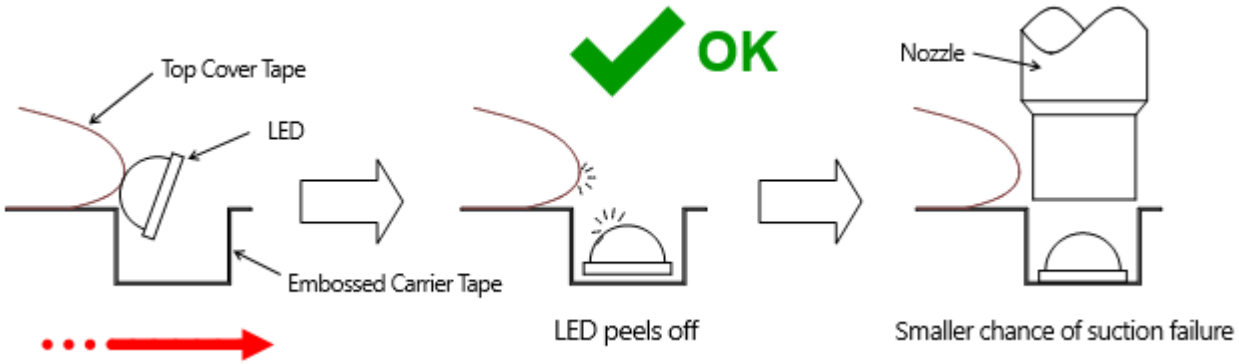


Figure 14. When the tape feeder feed rate is slow and the LED sticks to top cover tape

4.6 Peeling Position of the Top Cover Tape

As mentioned previously, depending on the type of pick-and-place machine used and the shape of the LED, the LED may move within the embossed carrier tape. When this occurs, if the top cover tape peels off early before suction, extra space is created above the top of the LED. This extra space makes it easy for the LED when affected by vibration to move up and down, leading to tilting of the LED.

As a countermeasure, make adjustments to the tape feeder to ensure the top cover tape is peeled off immediately before suction. This regulates the vertical movement of the LED and reduces the tilting of the LED.

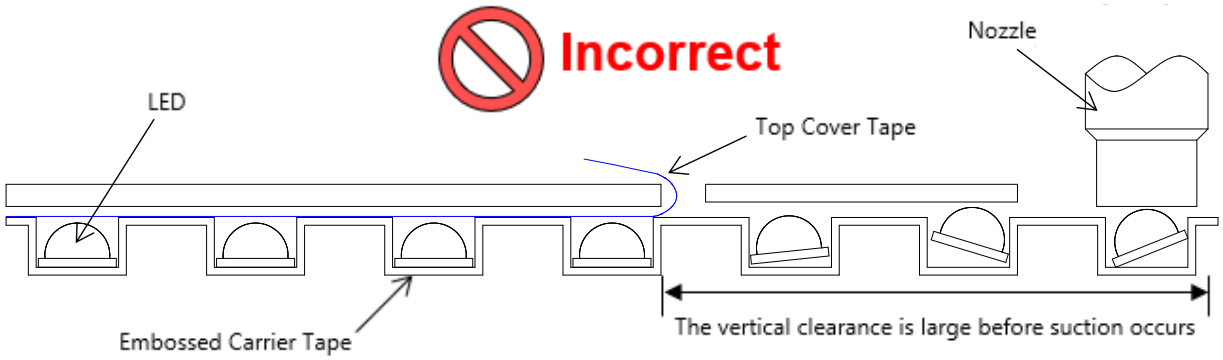


Figure 15. Removing the top cover tape in the normal position

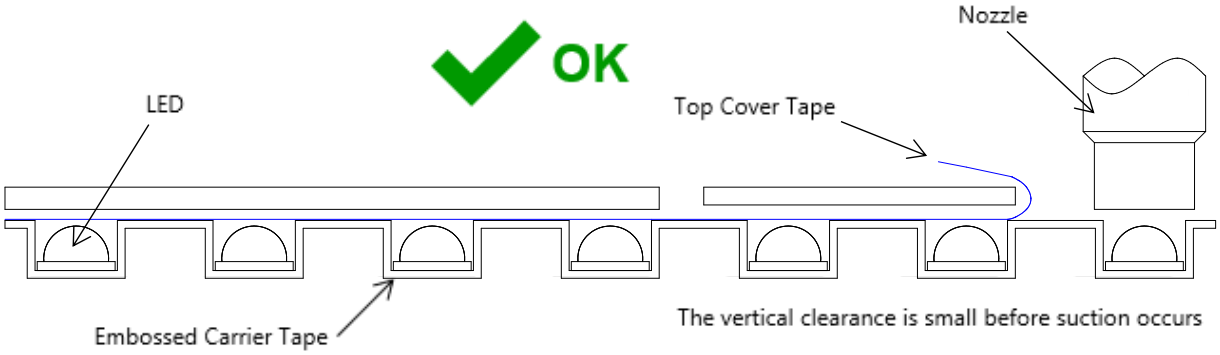


Figure 16. Removing the top cover tape just before suction

4.7 Nozzle placement pressure when placing the LED

When placing the LEDs on the PCB, pay attention to the amount of nozzle placement pressure against the PCB surface. If the placement depth of the nozzle is insufficient, the LEDs may float or shift after reflow. If the placement depth is too much, the LEDs will be over stressed and solder balls may occur. Nichia recommends a placement depth of 0.2 mm.
As shown in Fig. 17, the relationship between the placement depth and the placement speed determines the size of the nozzle's placement pressure on the LED. A large placement pressure leads to LED defects (e.g. package cracks, disconnections, etc.). If the placement pressure of the nozzle is within 3N, there should be no problem with the LEDs. However, the PCB could warp and/or other factors may affect the placement pressure. Perform a verification test using the actual process and placement conditions to ensure that the LEDs do not have a defect after placement. If there is a problem with the LEDs due to the placement pressure of the nozzle, take countermeasures to reduce the placement speed.
For LEDs with an integrated lens, avoid applying any nozzle placement pressure to the lens. Excessive pressure on the lens may cause scratches, chipping, peeling, deformation of the LED, internal disconnections, and/or reliability issues.

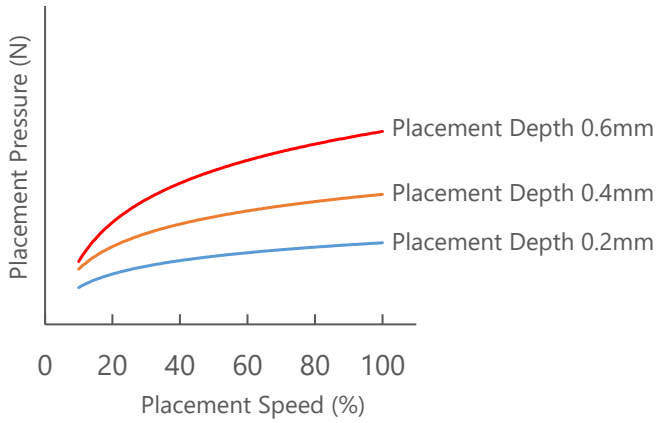


Figure 17. Placement pressure due to placement depth

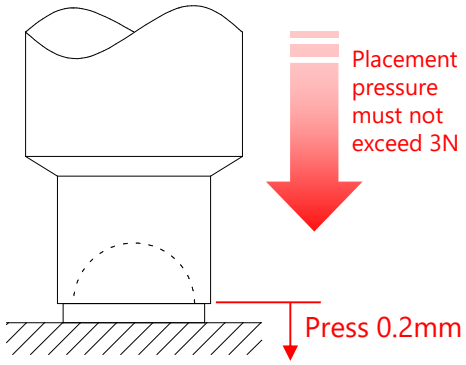


Figure 18. Nozzle Placement Depth

5. Reflow Soldering

This section covers the third part of the LED mounting processes, the reflow soldering. Reflow is the process of placing the components that have been mounted on the solder paste into a high-temperature reflow oven to melt and bond the solder.
In this process, it is necessary to set the optimum reflow conditions in order to obtain a good solder joint condition.

5.1 Recommended Reflow Conditions

Nichia performed mounting tests to provide customers with recommendations for the reflow soldering conditions (i.e. reflow profile). Refer to the “Soldering” section of the specifications which details the reflow soldering conditions like the one shown in Figure 19.

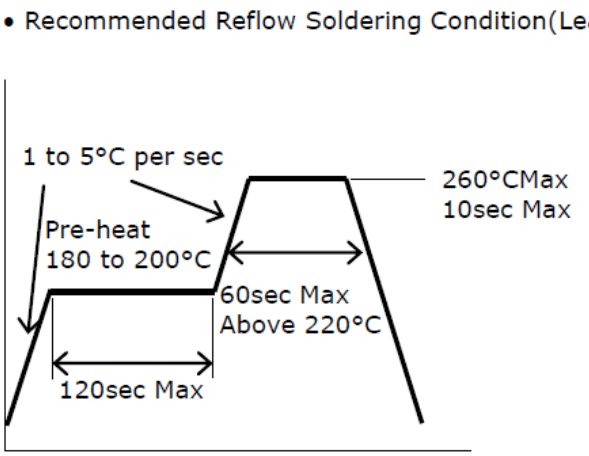


Figure 19. Recommended Reflow Soldering Condition
(example: part number NFSW757H-V1 Specification)

5.2 Details of the Reflow Soldering Profile

The reflow soldering profile has three zones: Pre-heat, Reflow, and Cooling. The following shows the role of each zone.

Pre-heat zone:
The flux contained in the solder is activated to remove the oxide film on the PCB surface.

Reflow zone:
The heat melts the solder to form an alloy.

Cooling zone:
The alloy is completed by the cooling temperatures.

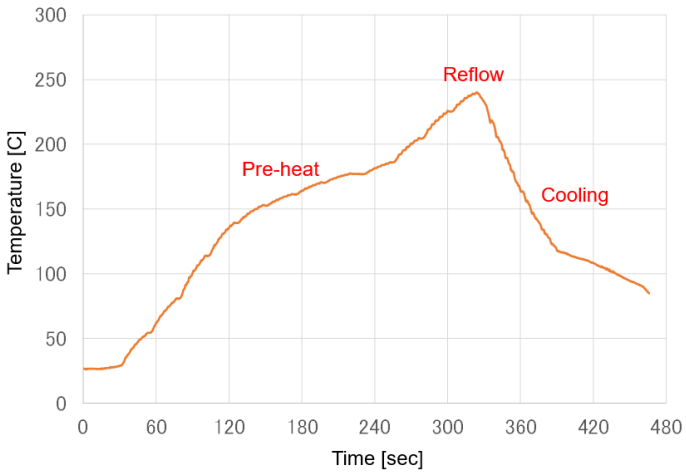


Figure 20. Example of a Reflow Profile

5.3 Adjusting the Reflow Soldering Profile

The following describes how to adjust the reflow profile. Refer to Figure 21.

① Pre-heating speed (Reference: 1 to 5°C/sec)
 When it is large: Solder balls are created [4], possibility of voids increases [5]
② Pre-heat temperature
 If it is high: The solder wettability declines [6]
③ Pre-heat time
 If it is long: The solder wettability declines
④ Reflow heating speed (Reference: 1 to 5°C/sec)
 If it is small: The solder wettability declines [6]
 When it is large: Solder balls are created [4], possibility of voids increases [5]
⑤ Reflow peak temperature
 If it is too low: The solder wettability declines, possibility of voids increases [5]
 If it is too high: Solder balls are created [4], the solder wettability declines
⑥ Reflow time
 If it is short: possibility of voids increases [5]
⑦ Cooling speed (Reference: 1.5 to 2°C/sec)
 If it is large: The cause of component damage due to thermal shock
 If it is small: The cause of the decrease in solder joint strength and positional deviations
⑧ Cooling temperature
 When the temperature at the time of PCB discharge is high: Warpage occurs within the PCB

Note:

[4] If solder balls are created, it will lead to a cause of a short circuit and insulation failure.

[5] An increase in voids leads to a decrease in bonding reliability and heat dissipation.

[6] If the solder wettability decreases, the bonding area decreases, which leads to the decrease in bonding reliability.

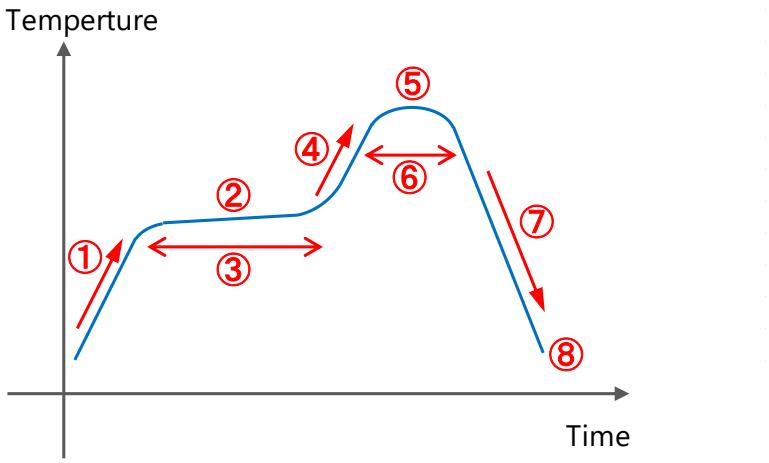


Figure 21. Description of where the reflow conditions are adjusted

5.4 The differences between an air reflow atmosphere and a nitrogen reflow atmosphere

Nichia recommends nitrogen reflow atmosphere, and the specifications contain the following statement.

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.

5.4.1 Pros of a nitrogen reflow atmosphere

Optical degradation due to reflow is mainly caused by discoloration of the package resin. Discoloration of package resin is caused by deterioration and oxidation of resin by heat of reflow. By using nitrogen reflow, discoloration of the resin due to oxidation is suppressed, and the decrease in luminous flux is improved accordingly.
Nitrogen reflow also has the advantage of preventing solder oxidation, leading to improved solder wettability.

5.4.2 Nitrogen reflow concentration settings

In order to obtain the improvement effect by nitrogen reflow, it is necessary to increase the nitrogen concentration to about 500 ppm of oxygen concentration.

5.4.3 The luminous flux reduction rate for an air reflow atmosphere

For LEDs with ceramic packages, the luminous flux loss is approx. 1% even in an air reflow atmosphere. Also, as shown in Figure 22, some resin packaged LEDs are not affected as much depending on the material and the conditions of the air reflow atmosphere.

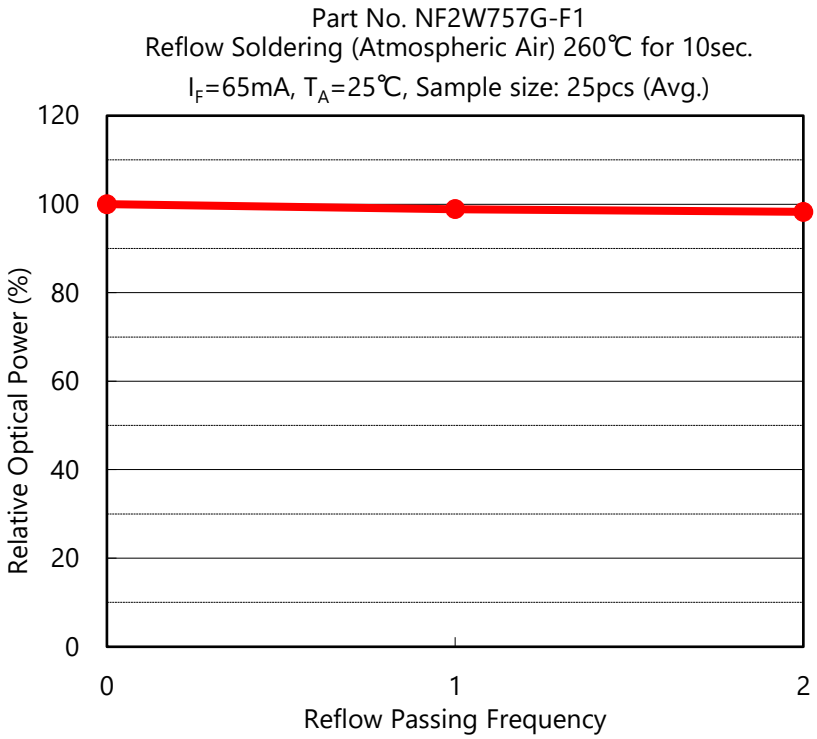


Figure 22. Luminous flux reduction rate confirmation data in air reflow (example: part number NF2W757G-F1)

6. Verification of LED Mounting Performance

After completing necessary adjustments for the mounting process, conduct inspections/tests to check if there are any abnormalities in the soldering conditions or LEDs. Table 3 shows an example of items to verify.

Table 3: Example of inspection/tests to verify the mounting processes

Item to verify		Verification Checklist	Probable cause(s) when there is an abnormality/failure
1	Visual Inspection (Visual, Image)	Are there any scratches, chips, or peeling/delamination?	The nozzle placement pressure is large.
		Is the LED unevenly soldered to the PCB? Or only soldered on one side?	Insufficient amount of solder, improper soldering pad pattern, improper metal solder stencil aperture.
		Are there any solder balls?	Excessive amount of solder, improper reflow profile.
		Is there a good solder fillet shape?	Insufficient amount of solder, improper soldering pad pattern, improper metal solder stencil aperture, improper reflow profile.
		Is there any floating, tilting, misalignment. Does the solder not fully cover the solder pad?	Insufficient amount of solder, improper soldering pad pattern, improper metal solder stencil aperture, improper reflow profile.
2	Lighting Inspection	Is there an emission failure?	Open circuit due to insufficient amount of solder. Short circuit due to excessive amount of solder (e.g. a solder bridge). Disconnection due to excessive nozzle placement pressure. (Identify the cause using the X-ray examination)
3	X-ray Inspection	Are there any voids?	Improper reflow profile.
		Are there any solder balls?	Excessive amount of solder, improper reflow profile.
4	Shear Strength Test	Is there sufficient resistance to shearing stress?	Insufficient amount of solder, improper soldering pad pattern, improper metal solder stencil aperture, improper reflow profile.

After confirming with inspections/tests that there are no abnormalities/failures, the verified mounting processes can begin to be used for the chosen application.

Since the mounting status changes due to slight differences in setting conditions, as well as differences in the solder paste, PCB, and mounting equipment/parts, etc.: always check and control the soldering status after mounting. By using an automatic solder visual inspection system (i.e. one that can provide an image where it is easy to judge if the image is good or if there is a defect), it is possible to improve the efficiency of work and reduce the dependence on the operator's skill compared to visual inspection.

Even if customers apply Nichia's recommended conditions, the mounting processes may not be successful. It is best for customers to understand the trends for the processes chosen for the applications, accumulate actual test data, and be able to respond daily to any necessary changes/adjustments to the processes.

7. Other Considerations

This section describes the notes and other details regarding the jigs and operations related to mounting LEDs.

7.1 Cautions about the transfer board

When using a transfer board for machine mounting, the PCB is placed on the transfer board (transfer jig) to move throughout the mounting process; however, if the transfer board is warped, mounting defects will occur. In addition, even if there is no warpage in the transfer board in the early stages of production, warpage may occur if the same transfer board is used for the reflow process a few dozen times. It is recommended to make sure that warping does not occur by passing the material that would be used for the transfer board through the reflow process a few dozen times before using it during actual production use. For reference, materials typically used for transfer boards include Bakelite, glass epoxy, etc.

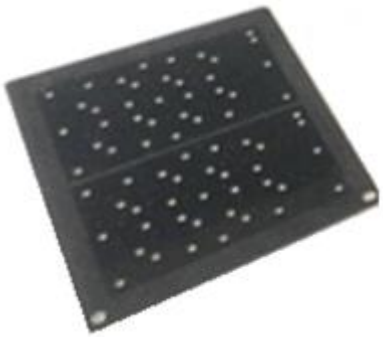


Figure 23: Transfer board appearance

7.2 Precautions for handling the mounted PCB

The most common failures for LEDs are wire breakage and package cracks due to external stress/pressure applied to the LED. Special care should be taken when handling the LED after mounting it on the PCB.
Customers should take careful note of the following examples of situations that cause these failures:

- Stress/pressure is applied to the PCBs when bending or twisting occurs during the PCB separation process.

- Stress/pressure is applied to the LED when LED-mounted PCBs are stacked on top of each other.

7.3 Cautions for the lighting inspection of the mounted PCB

As mentioned in section 7.2, there are many cases for LED failure (i.e. overcurrent or reverse current which can often occur during the lighting inspection after the mounting process, during/after product assembly, etc.).
Customers should take careful note of the following examples of situations that cause these failures:

- When a test voltage is applied to the PCB during the lighting inspection, a large current exceeding the maximum rating temporarily flows through the LED due to the inrush current. (See Figure 24)

- When a test voltage is applied to the circuit of the PCB (hot-wire connection) by a probe while the power is on (i.e. during lighting inspection), a large current exceeding the maximum rating flows through the LED.

- The reverse current from the power supply during the lighting inspection will cause the Zener diode to short circuit and cause the LED not to illuminate.

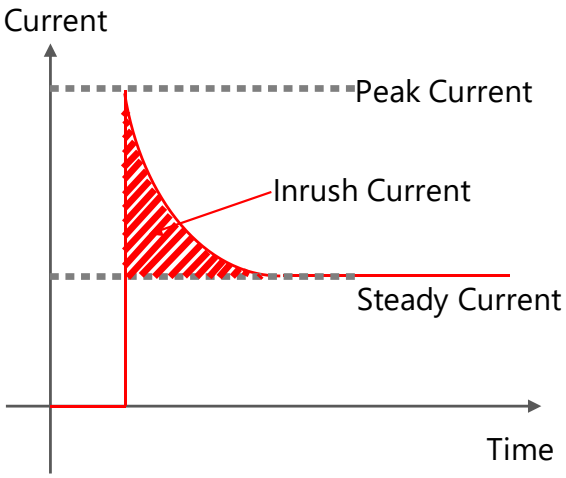


Figure 24. Example of an inrush current waveform

8. Summary

As detailed within this application note, the mounting process for LEDs has many details that need to be verified or noted for each process stage: solder printing, LED placement, reflow soldering. Achieving optimal mounting conditions is a very important factor in producing good LED lighting. Customers should refer to the contents covered in this application note and establish conditions and methods suitable for the mounting process for the chosen application.

In this application note, Nichia has provided an example of how to adjust the basic mounting processes and how to handle mounting defects; however, the method described here may not be the best solution. Depending on the specific product or mounting equipment that is being used it may be optimal to adjust the mounting processes according to instructions/methods detailed by the product/equipment which may be different than those described here. Nichia will continue to accumulate data on LED mounting technology and provide useful feedback to customers on this topic. If any other issues other than those described in this application note should occur during the mounting process for the chosen application, customers should contact Nichia to discuss the details.

The designations within this document to indicate a certain LED series are merely used to make it easier to grasp the product specifications at a glance for the Nichia part numbers listed in Table 1: Nichia LEDs for General Lighting. These series numbers, along with Nichia's part numbers in Table 1, are not related nor bear resemblance to any other company's product that might bear a trademark.

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