Light Emitting Diode

Assembly Precautions for the Nichia NCSxE17A or NVSxE21A Series LEDs

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The part number NCSxE17A, NVSxE21A 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.

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1. Overview

As a result of growing trends to reduce the size and increase the light energy of LED-based luminaries, the demand for compact, high luminous flux and high efficiency LEDs has been increasing. Nichia's NCSxE17A/NVSxE21A (hereinafter referred to as "E17/E21 Series") LEDs have a more compact size when compared to other LEDs that produce the same wattage, this allows for more flexibility for the LED luminaire design. On the other hand, E17/E21 Series requires more precision/technique regarding the mounting accuracy due to its smaller package size.
This application note provides the information on handling and processing, and the results of an assembly evaluation Nichia conducted.

2. Nichia E17/E21 Series

E17/E21 Series has a compact package and a structure that maximizes the luminous efficacy of the LED. The LED does not use a primary substrate (e.g. lead frame, etc.) for the electrical connection, so the LED is able to be soldered directly onto a secondary substrate (a print circuit board) and can have lower thermal resistance. As a result of this, the E17/E21 Series is suitable for luminaires that require high luminous flux and high density mounting.
This compact package has both drawbacks and advantages, especially in regards to the assembly difficulty. The small size of the electrical pads, the fact that the electrical pads are located around center of rear of the package which can cause not to create a solder fillet, and that electrical pads are closer in proximity to each other, make this LED more difficult to assemble than the conventional LED package sizes.

Figure 1. E17/E21 Series

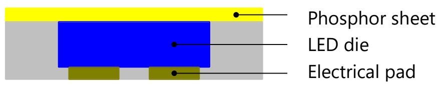
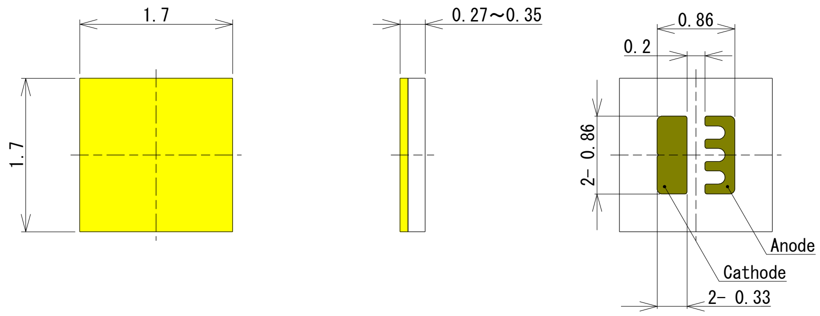
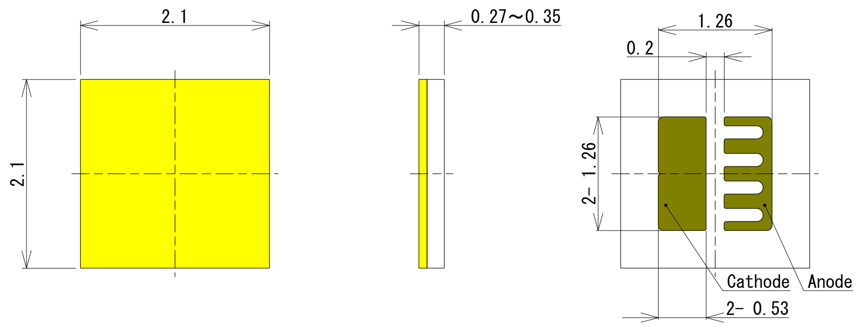


Figure 2. Structure



[Unit: mm]

Figure 3. Outline Dimensions of NCSxE17A



[Unit: mm]

Figure 4. Outline Dimensions of NVSxE21A

3. Handling Precautions

Since the E17/E21 Series is a thin package with no submount in its structure is more sensitive to external stress and force. The LED also is not equipped with an ESD protection device (e.g. zener diode). Additional care should be taken to avoid external stress/force and ESD damage.

3.1. Force (when loading)

When a nozzle is used during the assembly process, no more than 5N of force should be applied to the LED. Recommended conditions for a nozzle and force are provided in Section 6.

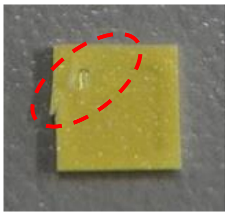


Figure 5. LED damaged by excessive press force

3.2. Bare hands

Handling the LED with bare hands will contaminate the LED surface and may affect the optical characteristics: it might cause the LED to be deformed and/or the bump to break, which will cause the LED not to illuminate.

ESD damage to the die may happen since no ESD protection device is included the LED. Do not handle the LED with bare hands.

3.3. Tweezers

The silicone resin used in the LED is soft. Applying force with tweezers may cause the resin to be damaged and the LED not to illuminate the same as if the LED has been handled with bare hands do. Do not use tweezers to handle the LED.

3.4. Electrostatic Discharge (ESD)

LED is not equipped with a protection device. When handling the LED, measures against electrostatic discharge such as using an ESD mat made of conductive materials and an ionizer are strongly recommended at every assembly process.

Mounting a protection device such as zener diode on the PCB is recommended to protect from ESD.

3.5. Stack assembled PCBs

Since the resin used in the LED is soft, do not stack assembled PCBs together. Failure to comply can cause the resin portion of the product to be cut, chipped, delaminated and/or deformed. This also applies to how the assembled PCBs are packed as the same failure may occur.

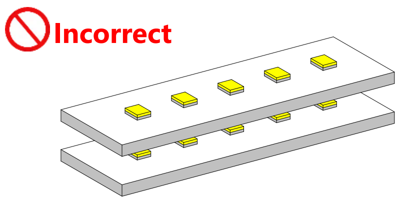


Figure 6. Improper storage of assembled PCBs

3.6. Hand soldering

The electrical pads are hidden on the back side of the LED, so hand soldering is not possible to perform. Using a hot plate is also not recommended as it would not be possible to confirm the position of the electrical pads and this may cause a short and/or open failure mode. These types of soldering are not recommended.

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3.7. Repairing

As explained in section 3.6, do not repair and/or rework the LED. Do not manually mount LED onto the PCB even if reflow soldering will be performed. This may cause the LED to have an open and/or short failure mode.

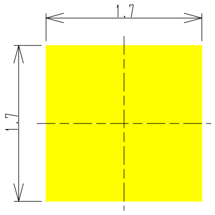
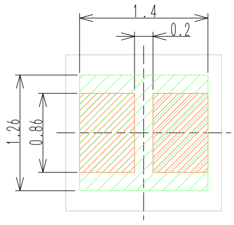
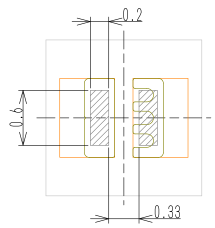
4. Designing a Board and Solder Stencil

Small electrical pads and the close proximity of the electrical pads on the LED affect the accuracy of the PCB design, creating the solder stencil design, and solder mask. Additionally, the PCB design and material selection are critical for thermal dissipation management.

This section provides tips for PCB design and results of an assembly evaluation.

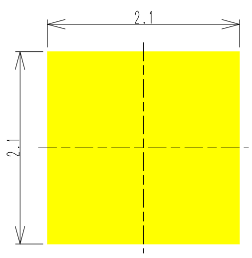
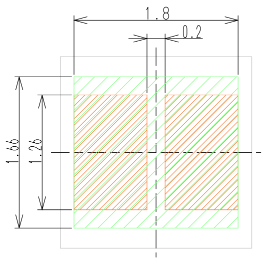
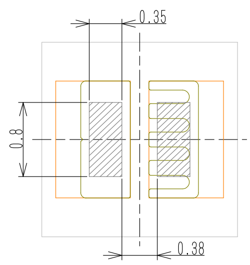
4.1. Conditions for the pad pattern and stencil

Table 1. NCSxE17A recommended soldering pad pattern and solder stencil

NCSxE17A		
LED	Soldering Pad Pattern Solder Mask	Stencil Aperture
		
Thickness of the stencil: 100 μm		

Solder pad pattern
Solder mask aperture
Solder stencil aperture

Table 2. NVSxE21A recommended soldering pad pattern and solder stencil

NVSxE21A		
LED	Soldering Pad Pattern Solder Mask	Stencil Aperture
		
Thickness of the stencil: 100 μm		

Solder pad pattern
Solder mask aperture
Solder stencil aperture

4.2. PCB materials

Composite epoxy materials (CEM-3), glass fiber epoxy laminate (FR-4), metal (e.g. aluminum) are commonly used as PCB materials. Metal-core PCBs have good thermal conductivity and heat dissipation, and are recommended if E17/E21 Series is used with high density mounting.
The application note "NxSxExxA Design Considerations for Direct Mountable Chip LEDs for High-Density Applications" provides details regarding the high density modules for E17/E21 Series.

4.3. Insulation layer

Heat dissipation for LEDs relies on the PCB material and the thickness of the insulation layer. Selecting the proper insulation layer for each luminaire is advised.
The application note "NxSxExxA Design Considerations for Direct Mountable Chip LEDs for High-Density Applications" describes the relationship between board thickness and thermal resistance.

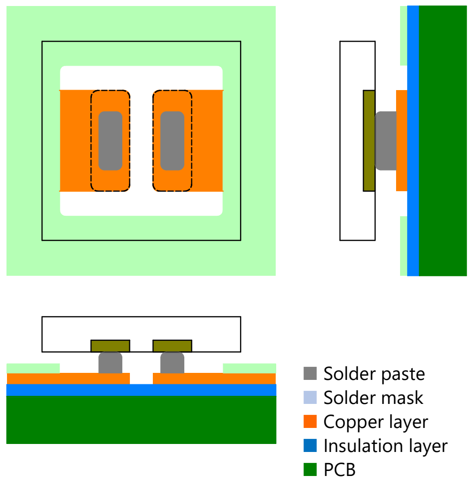
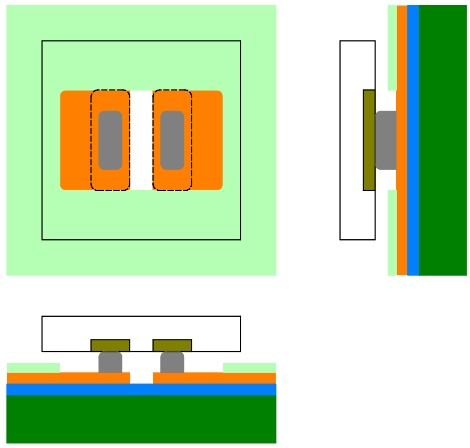
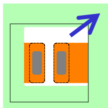
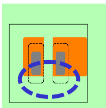
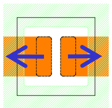
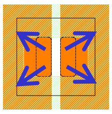
4.4. Copper layer

The recommended copper layer for the pad pattern is 35µm.
Etching is a common process to remove the unmasked area. Accuracy of etching is decreased if the copper layer is thick since the unmasked area is not completely removed by etching.
The small electrical pad area and the narrow space between the electrical pads (200µm) require a proper solder pad pattern for assembly. If the solder pads are not completely etched, it will cause the LED to have a short or open circuit.

4.5. Solder mask

In PCB design, the method for the solder mask is defined as either Solder Mask Defined (SMD) or Non-Solder Mask Defined (NSMD). Each type has pros and cons as shown in Table 3.
In general, using the copper etching solution (Copper defined pad) gives more precision than using the solder mask printing; therefore, NSMD formed with the copper etching solution is recommended for E17/E21 Series. SMD has better heat dissipation since SMD is able to provide a larger pad area; however it may result in a misaligned solder mask, leading to an inaccurate pad pattern, causing assembly failure.

Table 3. Solder mask design

	NSMD	SMD
		
Assembly Implementation	-Advantage- Reduce solder ball and void occurrence.	
Accuracy of Assembly	-Advantage- Misalignment of the solder mask can be absorbed. 	-Disadvantage- Solder mask may overlay the electrical pads due to misalignment of the solder mask. 
Heat Dissipation	-Disadvantage- Poor heat dissipation due to the small copper pad area. 	-Advantage- Better heat dissipation due to the large copper pad area. 

4.6. Solder stencil

The solder stencil aperture of E17/E21 Series is small; as a result, depending on how the aperture is created there is a potential for clogging of the solder stencil aperture during the soldering printing process.

Special process for low roughness on surfaces such as electric polishing and fluorinating is needed for the solder stencil to improve the solder paste releasing property if clogging of the aperture during the solder printing process frequently occurs.

Figure 7. Clogged solder stencil aperture

4.7. LED mounting pitch

The LED mounting pitch for high-density modules should consider the accuracy of the assembly machine and the tolerance of the LED package dimensions and electrical pads.

$$\sqrt{0.1^2 \text{ (accuracy of assembly machine)} + 0.05^2 \text{ (tolerance of LED package dimensions)} + 0.05^2 \text{ (tolerance of electrical pads)}}$$

$$= 0.122 \text{ (tolerance in single side)} \Rightarrow 0.244 \text{ (tolerance in both side)} \cong 0.3\text{mm}$$

(Formula 1)

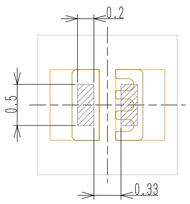
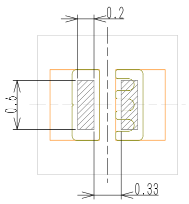
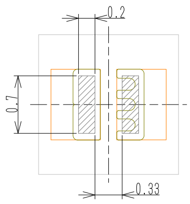
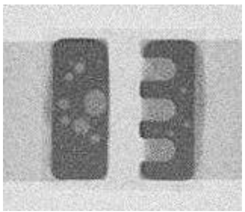
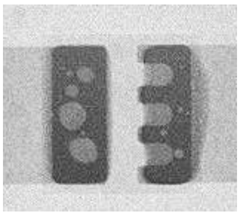
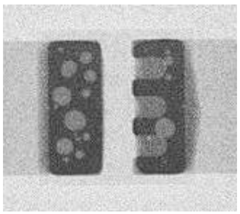
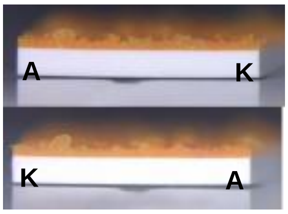
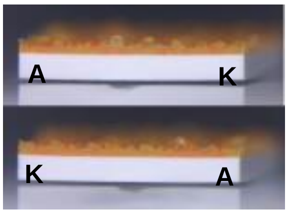
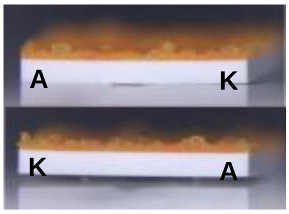
For example, assembly accuracy for an assembly machine such as solder printing and a chip mounter is 0.1mm, the minimum LED pitch will be 0.3mm according to the formula above. To take into consideration the LED alignment, a LED mounting pitch over 0.4mm is recommended.

4.8. Evaluation results for amount and position of solder paste

The area of the solder stencil aperture (amount of solder paste) was evaluated and compared with the recommended solder stencil aperture (specified in section 4.1). The solder mask was made with the NSMD method.
As shown in tables 4 and 5, both NCSxE17A and NVSxE21A did not have any assembly issue; however as the solder paste amount increases, the possibility that the LEDs will float on the solder also increases.

In addition, no assembly issues were found in any conditions in regards to the distance between the solder paste (See tables 6 and 7); however, there are possibilities for LED failure when the solder paste is mounted to the inward side of an electrical pad (distance of solder paste is short) or to the outward side of an electrical pad (distance of solder paste is long) from the recommended soldering position.
Solder paste reaches to the other side of the solder paste (electrical pad) when LED is pushed onto the solder paste if solder paste is mounted the inward side of an electrical pad. This may cause to the LED to short.
An open failure mode may occur if the LED is not mounted to the proper position if the solder paste is mounted to the outward side of an electrical pad.
The solder stencil aperture should be designed so the solder is printed at the center of each electrical pad.

Table 4. Solder Amount Evaluation (NCSxE17A)

	NCSxE17A		
	0.2mm×0.5mm (vs. Recommendation: -17%)	0.2mm×0.6mm (Recommendation)	0.2mm×0.7mm (vs. Recommendation: +17%)
Soldering Position			
Solder /Electrical Pad Pattern	K: 34.5% A: 50.8%	K: 41.5% A: 61.1%	K: 48.6% A: 71.5%
After Soldering			
Xray after Assembly			
LED Lifting			

Soldering Position

- Pad pattern
- Electrical pad
- Solder stencil aperture

Observation direction for LED Lifting

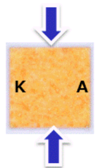
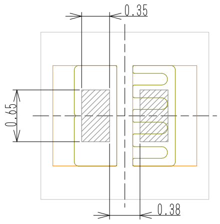
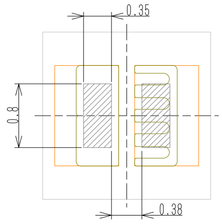
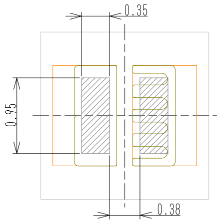
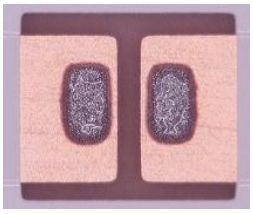
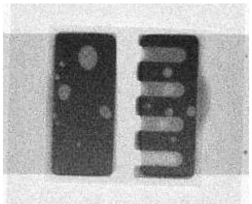
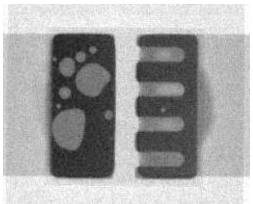
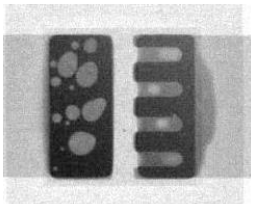
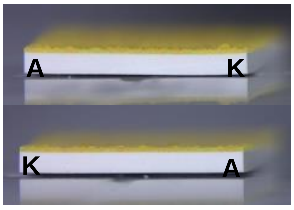
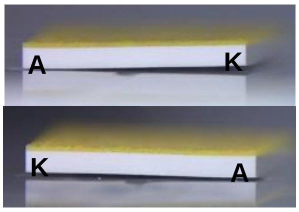
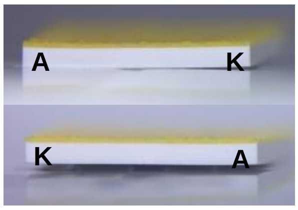


Table 5. Solder Amount Evaluation (NVSxE21A)

	NVSxE21A		
	0.35mm×0.65mm (vs. Recommendation: -17%)	0.35mm×0.80mm (Recommendation)	0.35mm×0.95mm (vs. Recommendation: +17%)
Soldering Position			
Solder /Electrical Pad Pattern	K: 33.6% A: 52.9%	K: 41.6% A: 65.4%	K: 49.3% A: 77.6%
After Soldering			
Xray after Assembly			
LED Lifting			

Soldering Position

- Pad pattern
- Electrical pad
- Solder stencil aperture

Observation direction for LED Lifting

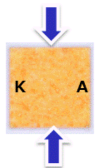
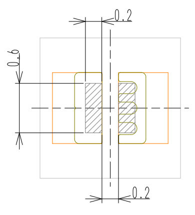
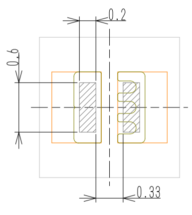
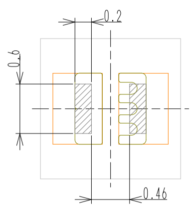
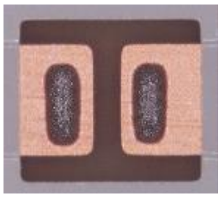
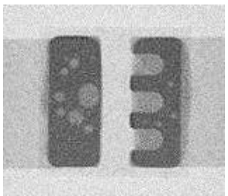
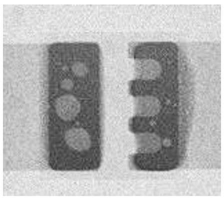
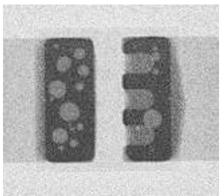
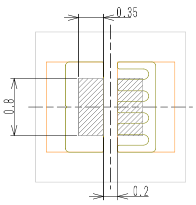
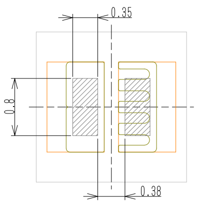
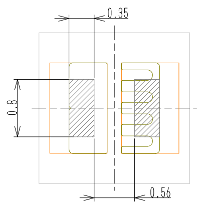
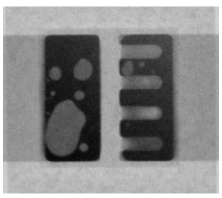
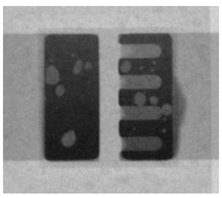
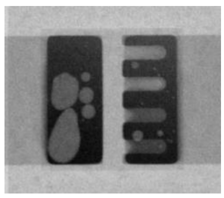


Table 6. Soldering Distance Evaluation (NCSxE17A)

	NCSxE17A		
	Inward from the electrical pads	Center from the electrical pads (Recommendation)	Outward from the electrical pads
Soldering Position			
			
X-ray after Assembly			
Lighting	Light	Light	Light
Solder Ball	No	No	No

Pad pattern
Electrical pad
Solder stencil aperture

Table 7. Soldering Distance Evaluation (NVSxE21A)

	NVSxE21A		
	Inward from the electrical pads	Center from the electrical pads (Recommendation)	Outward from the electrical pads
Soldering Position			
			
X-ray after Assembly			
Lighting	Light	Light	Light
Solder Ball	No	No	No

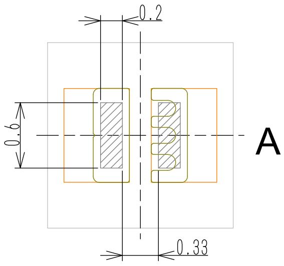
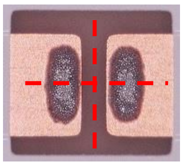
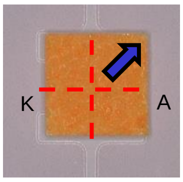
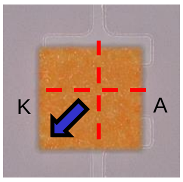
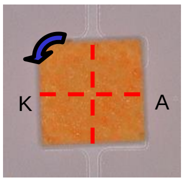
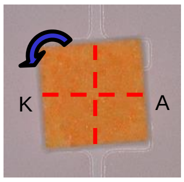
Pad pattern
Electrical pad
Solder stencil aperture

4.9. Evaluation results for self-alignment

Self-alignment was evaluated under the condition shown in section 4.8. The solder mask was made with the NSMD method.

As shown below in Figures 8 to 15, the self-alignment effects more when the amount of solder paste is increased. At the same time, a larger solder paste volume increases the possibility of the LED floating. As a result, the self-alignment and the LED float will be a trade-off at a certain amount of solder paste.

Table 8. Test conditions for self-alignment test (NCSxE17A)

Solder Printing Conditions	 			
LED Mounting Position	x: +0.1mm y: +0.1mm	x: -0.1mm y: -0.1mm	θ: +2°	θ: +5°
				

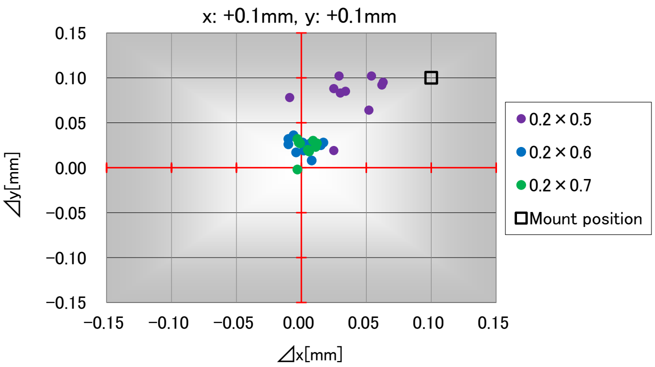


Figure 8. NCSxE17A Test Result (xy+0.1mm)

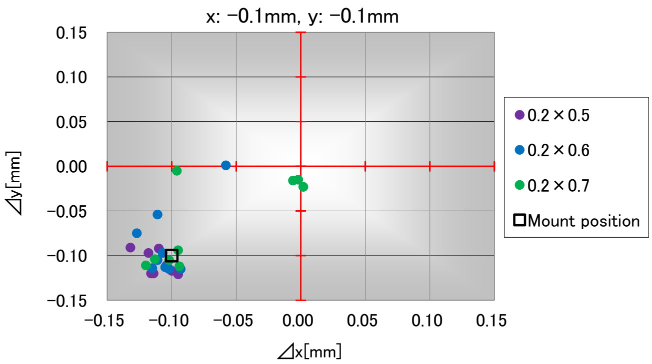


Figure 9. NCSxE17A Test Result (xy-0.1mm)

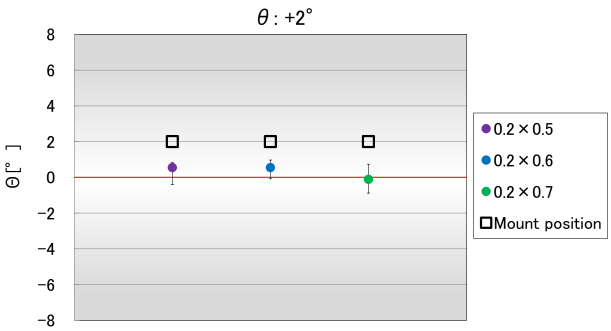


Figure 10. NCSxE17A Test Result (θ+2°)

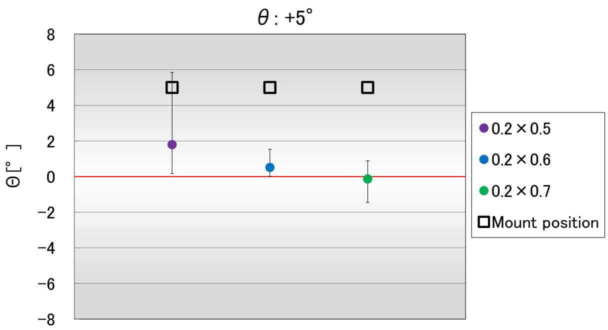
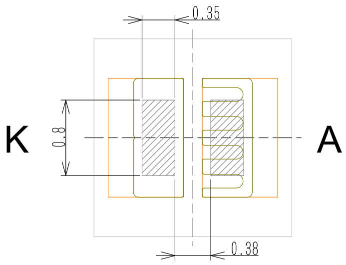
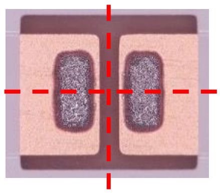
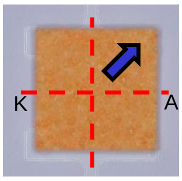
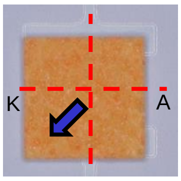
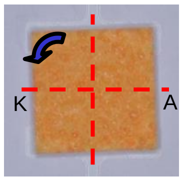
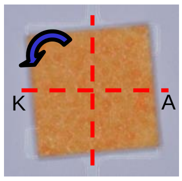


Figure 11. NCSxE17A Test Result (θ+5°)

Table 9. Test conditions for self-alignment test (NVSxE21A)

Solder Printing Conditions				
LED Mounting Position	x: +0.1mm y: +0.1mm	x: -0.1mm y: -0.1mm	θ: +2°	θ: +5°
				

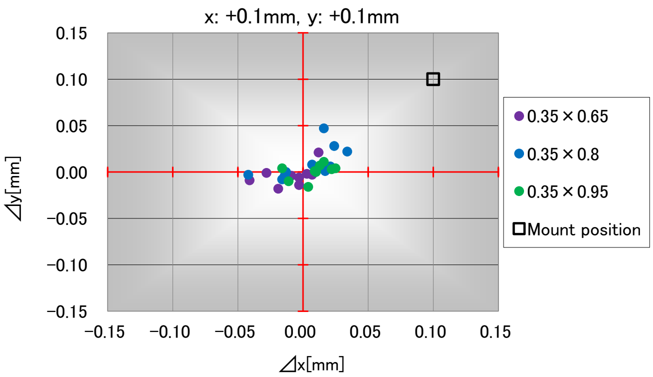


Figure 12. NVSxE21A Test Result (xy+0.1mm)

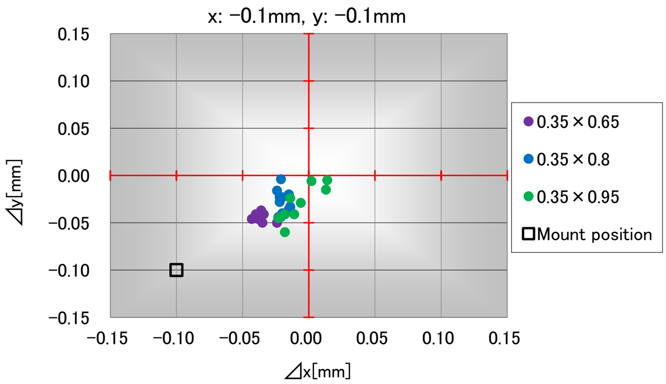


Figure 13. NVSxE21A Test Result (xy-0.1mm)

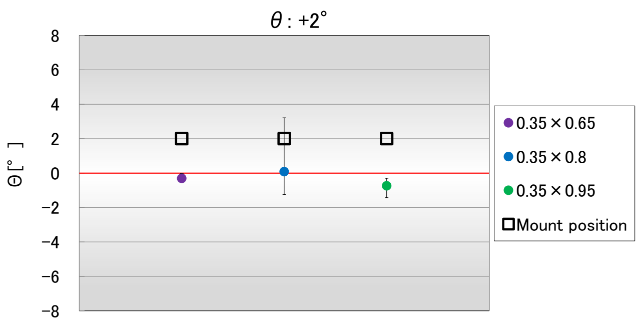


Figure 14. NVSxE21A Test Result (θ+2°)

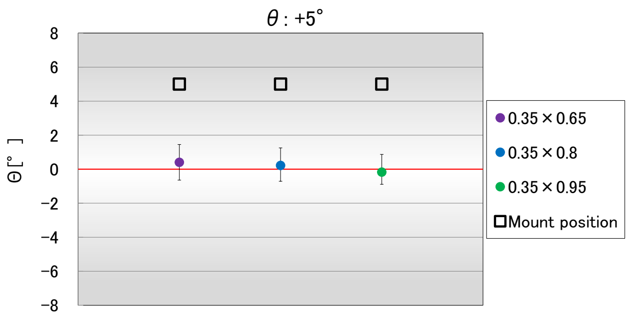
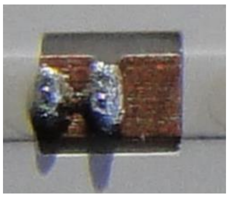


Figure 15. NVSxE21A Test Result (θ+5°)

5. Solder Printing Process

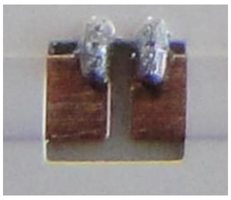
Small electrical pads (or solder joint pads) and the close proximity of the electrical pads could lead to a misalignment of the solder paste and may cause the LED to have an open or short failure. The solder position for the solder printing process is key to prevent this type of failure.

Incorrect



Possible to be short

Incorrect



Possible to be open

Figure 16. Example of improper soldering

5.1. Soldering

The recommended particle size for solder powder is less than 30µm taking into consideration the printing properties of the solder: The particle size is commonly around 1/5 size of the solder stencil aperture and less than 1/3 of the solder stencil thickness.

If the particle size is large, the particle density will be low and may increase the gap between the solder particles as there may be a larger amount scraped off when using a squeegee; additionally, the amount of the solder paste will be insufficient. If the particle size is small, the relative solder surface area will increase due to oxidization and this may result in the decrease of the solder ball and the wettability performance. This can increase the occurrence of an LED failure.

The recommended composition for the solder paste is SAC based (Sn-3.0Ag-0.5Cu) and silver-free (manufacturer: NIHON SUPERIOR, product type: SN100C).

The solder paste enhanced solder joint strength may fail due to the coefficient of the thermal expansion difference between the solder and the circuit board. This leads to stress to the LED and may cause it to crack or break.

The solder type and composition of the solder may impact the reliability. An evaluation of both the solderability and reliability should be performed prior to use to ensure there is no issue with the reliability for the chosen application.

5.2. Squeegee

Polyurethane rubber or metal are commonly used materials for a squeegee.

If the squeegee's material is soft (e.g. polyurethane rubber), the tip of the squeegee may deform when excess pressure is applied and more solder paste will be scraped off by the deformed squeegee. As the result, the remaining amount of solder paste may be insufficient.

The metal squeegee is recommended when LEDs require high accuracy of assembly, such as the E17/E21 Series models. However, using a metal squeegee increases the wear on the solder stencil more than a polyurethane rubber squeegee.

To prevent misalignment of the LEDs during the solder printing process, the solder stencil needs to be designed taking into consideration the printing direction as shown in Figure 17. The solder stencil design must have the electrical pads (anode and cathode) aligned so the long side of the pads are parallel to the printing direction.

If the printing direction and the long side of the electrical pads are placed perpendicular to each other, the LEDs may have an open or short since the solder stencil is positioned onto the circuit board inappropriately.

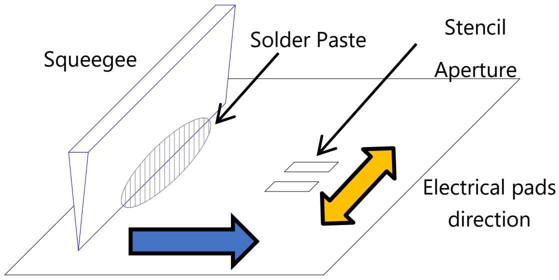


Figure 17. Solder printing direction

5.3. Printing speed

As Figure 18 shows, the printing speed of most solder printing machines can be adjusted to take into consideration the solder printing conditions in the print settings.

The solder paste is not able to get into the solder stencil apertures if the speed is too high. This may cause solder misalignment and/or an insufficient solder volume.

The printing speed should be adjusted so that it is slow enough to allow the solder paste to roll over the surface of the solder stencil efficiently.

Figure 18. Image of the print setting

5.4. Printing pressure

The printing pressure can also be adjusted in the print settings.

Excessive solder volume will occur if the printing pressure is too low. Alternately if the pressure is too high, then the solder volume will be insufficient and the wear on the solder stencil and the squeegee is accelerated which reduces their product lifetime.

The printing pressure should be adjusted to the lowest required level for quality printing performance and continual printing.

The pressure should also be adjusted as needed for each kind of solder paste, squeegee, and their conditions since printing conditions will vary.

5.5. Inspection of the solder printing process

A 3D solder paste inspection machine should be installed for solder paste inspection and since the solder area is small a high resolution camera is also required to ensure measurement accuracy.

There are other failures that were not indicate in the previous sections that may occur during the soldering process. For these other failures, see Table 10 and Figure 19.

Table 10. Examples of other failure modes during the soldering process

Mode	Cause	Countermeasure
Spreading (Excessive solder volume)	Wider clearance between PCB and the solder stencil	Adjust the height of the stencil Adjust the support device under the PCB
Blurring (Insufficient solder volume)	Clogged solder stencil aperture	Clean the solder stencil aperture area Use a solder stencil that can release the paste properly
	Dried up solder paste	Check the solder stirring conditions Control the solder time and frequency of soldering

Spread Blur

Figure 19. Examples of Soldering Failures

6. LED Assembly Process

Handling precaution at the LED assembly process is described in Section 6. Mounting accuracy is required for LEDs with small package as the soldering printing process does.

6.1. Tape feeder

There are two drive types of tape feeders: electrical (motorized) feeders and mechanical (pneumatic) feeders.

In general, the motorized feeder has less vibration when the top cover tape is removed, so the LED is picked up more accurately. If the LED is inclined or popped out so that the pick-and-place nozzle is not able to pick up the LED, the feeder speed should be adjusted to be slower or a motorized feeder with a smaller motor should be used.

If the vibrations are large during operation of the feeder, the LED surface may touch the feeder shutter and may cause the LED to become damaged, especially when the top cover tape is removed further from where the nozzle picks up the LED (see Figure 20). Reducing the vibrations or changing the tape removal position to right next to the pick-and-place nozzle may improve the situation.

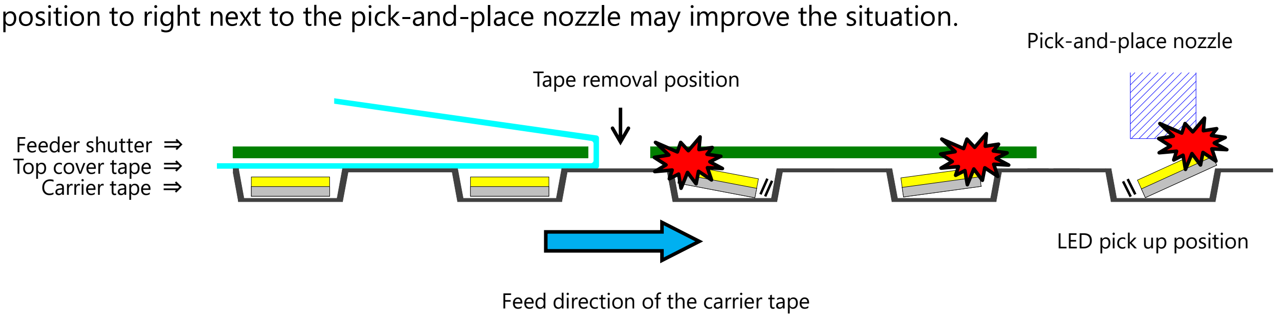


Figure 20. Example of failure during the tape feeding process

6.2. Pick-and-place nozzle

Ensure a proper the pick-and-place nozzle should be chosen. If a nozzle that is an improper size and/or shape is used, a pickup failure may occur (e.g. air leakage from the nozzle causes the LED to tilt during pick-up and the LED surface becomes scratched). This may affect the LED characteristics (e.g. LED might dim, have a color shift, etc.).

The shape of generic nozzles may be different depending on the machine manufacturer. The suitable size for the pick-up-place nozzle for the E17/E21 Series is 1005/1608.

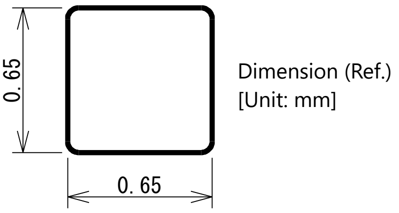


Figure 21. Example of pick-and-place

6.3. Image recognition and adjustment

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.

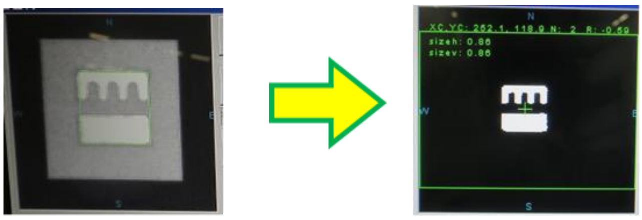


Figure 22. Image recognition and adjustment during the pick-up-place process

6.4. Height for LED pickup

Recommended height for LED pickup is the same height as top of the carrier tape.

Nozzle may not be able to pick up the LED or LED may be picked up incorrectly if pickup height is too high. If the nozzle suction is too close to the LED surface, LED may get stuck in the carrier tape when the nozzle touches and pushes the LED, and/or the LED surface may become damaged.

Recommended height for LED pickup varies by LED mounters. Evaluating the nozzle setup prior assembly should be performed.

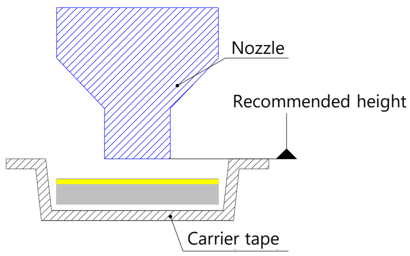


Figure 23. Recommended pickup height

6.5. Pressure during LED mounting

When mounting the LED onto a PCB the recommended height for the press force is 0.2mm from top of the LED. If the press force is too weak, the LED may not come in contact with the solder paste or the LED may lift after the soldering process.

If press force is too strong, LED surface may damage or solder ball may appear.

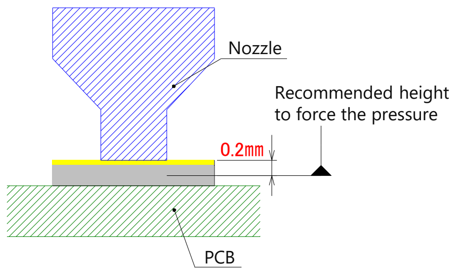


Figure 24. Recommended height to force the pressure

6.6. Inspection after the LED mounted

To confirm that the LEDs are mounted in the proper position, it is recommended that right before the solder process (after the LEDs and surrounding components are mounted onto the PCB) a visual inspection by eyes or by using an image inspection machine is performed.

There are other failures that were not indicate in the previous sections that may occur during the LED mounting process. For these other failures, see Table 11.

Table 11. Examples of other failure modes during the LED mounting process

Mode	Cause	Countermeasure
Suction error	LED is not mounted in the proper position	Set the pickup position to the center of the LED.
Misplacement (LED is not mounted on the PCB)	Insufficient solder paste volume	Check the soldering process
	PCB warpage Improper PCB thickness	Use backside support for PCB Check the PCB thickness
Misalignment	Incorrect parameter for the mounting position	Adjust the parameters for the mounting program
	Poor assembly accuracy	Check PCB design (e.g. pad pattern, solder mask, etc.)

Light Emitting Diode

7. Reflow Process

The recommended reflow soldering conditions are shown in Table 12.

If conditions other than those noted in Table 12 would be applied, then it should be based on the recommended conditions of the chosen solder paste. Air flow soldering conditions can cause optical degradation, caused by heat and/or atmosphere. Nitrogen reflow soldering is recommended.

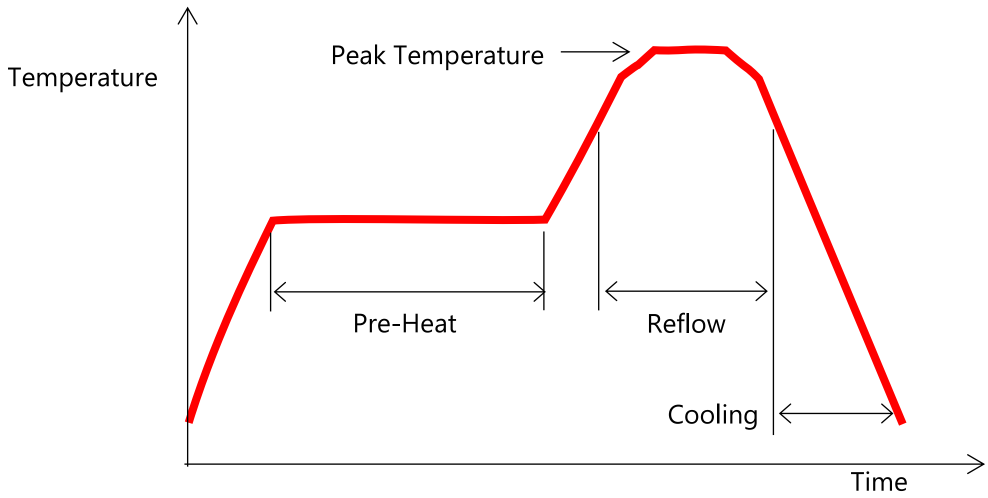


Figure 25. Reflow profile

Table 12. Reflow profile for E17/E21 Series

Process	Recommended	Note
Ramp-up rate Start – Pre-heat Pre-heat - Reflow	Speed: 1～5℃/sec	A faster ramp-up rate increases the potential occurrence of solder balls and/or the solder paste to slump (e.g. too much heat and the solder paste is too thin [low viscosity]).
Pre-heat	Temp: 180～200℃ Time: 90[1]～120sec	The solvent in the paste begins to evaporate. If the rise rate (temperature level) is too low, it increases the potential occurrence of poor solder wettability and void. If the pre-heat time is too long, the activation period of the flux decreases and unmelted solder is more likely to occur.
Reflow	Temp: 220～260℃ Time: 30[1]～60sec	The temperature is kept above the melting point of the solder. If the temperature is not high enough, it may lead to a melting failure (e.g. unmelted solder).
Peak temperature	Temp: <260℃ Time: <10sec	The temperature is kept above the melting point of the solder. If the temperature is not high enough, it may lead to a melting failure (e.g. unmelted solder).
Cooling rate	-[1]	If the cooling rate is slow, it may cause a decrease in the strength of the solder joint.

[1]: Recommended condition determined by solder type.

8. Inspection after Reflow

Since the E17/E21 Series is a small package and the electrical pads are hidden on the back side of the LED, the accuracy of the soldering conditions is not able to be confirmed during the reflow process, so an inspection after the reflow process is important.
The inspection criteria needs to be determined depending on the user's chosen assembly process and application.
The inspection process below describes what items need to be checked for solderability. Evaluation tests such as reliability tests are needed to ensure the reliability of LED mounted boards or fixtures.

8.1. Lighting inspection
Visual inspection by eyes or using an image inspection machine to verify if the LEDs are lit normally.

8.2. Electrical characteristics inspection
Inspection of the electrical characteristics to determine if the forward current is being applied as designed and whether the forward voltage value is reasonable in relation to the applied forward current.

8.3. Visual inspection
A visual inspection by eyes or using an image inspection machine to inspect that the LEDs are mounted properly (e.g. no misalignment, lifting, solder ball, LED damage).
E17/E21 Series is a small package and the electrical pads are hidden on the back side of the LED; so a visual inspection may not be able to detect soldering failures.

8.4. X ray inspection
An X-ray inspection is used for inspecting the solder wettability, for solder voids, and for solder balls.

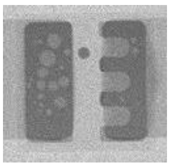


Figure 26. Solder ball

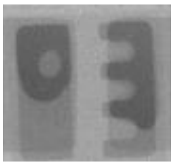


Figure 27. Poor wettability

9. Summary

E17/E21 Series requires more caution regarding the assembly techniques than conventional LED packages due to its package size and structure. As a result, the PCB design for E17/E21 Series is important.
If the accuracy of the PCB design is poor, assembly failures may continue to occur even if the assembly process is reviewed and improved. A receiving inspection of the PCB should be performed to ensure that PCBs are made as designed.
Although this application note explains precautions and failure modes during the assembly process, the user is still responsible for evaluating the chosen assembly process and reliability.

Light Emitting Diode

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NICHIA CORPORATION 491 Oka, Kaminaka-Cho, Anan-Shi, TOKUSHIMA 774-8601, JAPAN
http://www.nichia.co.jp Phone: +81-884-22-2311 Fax: +81-884-21-0148