



Assembly Precautions for LEDs with an Integrated Lens

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The part number NVSW_x19F_x, NVSW_x19D, NVS_{xx}19C, NxS_{xx}19B_x, NVSW3_x9B, NVSW3_x9A, NVSW519A, NV4_x144A_x, NV9W149AM, NF2W385AR_x, and NF_xW585AR_x in this document are the part number of our product, and do not have any relevance or similarity to other companies' products that may have trademark rights.

1. Overview

The industry has been making efforts to improve the performance of LEDs; miniaturization and high functionality of LEDs are two examples of these efforts; Surface Mount Device (SMD) LEDs acquired integrated lenses, which in combination with a compact package, made it more difficult to pick and place these high-performance LEDs due to the smaller pick-up area surface. As a result, the importance of pick-and-place technology is increasing year after year. Proper assembly of the LED is very important as its quality also affects the function and reliability of the end product (i.e. lamps, luminaires, and other types of fixtures/equipment).

This application note covers techniques on how to handle issues with picking and placing with automated systems for high power LEDs with lenses based on placement issues that have been identified in the past.

2. Applicable Part Numbers

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

Table 1. Applicable LED Part/Series Numbers

Category	NICHIA x19 Series				NICHIA 3x9 Series	
Part Number ¹	NVSWx19Fx	NVSWx19D	NVSxx19C	NxSxx19Bx	NVSW3x9B	NVSW3x9A
Package Appearance (One example)						
Package Size [Unit : mm]	3.5×3.5×2.3		3.5×3.5×2		3.5×3.5×2.35	3.5×3.5×2.1
Category	NICHIA 519 Series	NICHIA 144 Series	NICHIA 149 Series	NICHIA 385 Series	NICHIA 585 Series	
Part Number ¹	NVSW519A	NV4x144Ax	NV9W149AM	NF2W385ARx	NFxW585ARx	
Package Appearance (One example)						
Package Size [Unit : mm]	3.5×3.5×2.35	5×5×3.15	7×7×3.1	4×3.6×2.05		

Note:

¹ The x represents a letter that follows the alphanumeric code of the same LED type.
(Ex: NVSWx19Fx → NVSW119F, NVSW219F, NVSW119F-V1, NVSW219F-V1, etc.)

3. Potential placement issues for lensed LEDs

Since the integrated lenses for SMD LEDs are often made of resin materials, some are easily damaged by external pressure. Additionally, some of those LEDs have a wire inside the lens. As a result, it is necessary to avoid applying external stress to the lens, especially when the pick-and-place nozzle picks the LED.

The location of the lens also limits the points at which the nozzle can contact the LED during the pick-and-place process, this can sometimes cause an air leak to occur between the nozzle and the LED, and the LED may not be picked up properly out of the embossed carrier tape pocket (i.e. mis-pick). To prevent this type of mis-pick, it is necessary to be careful about the suction force of the nozzle.

Issue 1: Damage to the LED lens during the pick-and-place process

Issue 2: Mis-picks due to the suction force of the nozzle

The resin LED lenses can be tacky and stick to the embossed carrier top cover tape. If the LED lens is stuck to the top cover tape when the tape is pulled, it may cause the LED to be lifted up from the bottom of the embossed carrier tape pocket and become flipped/tilted and/or misaligned when it peels off and then return to a position inside the pocket.

Additionally, adding a lens onto a SMD LED increases its center of gravity; if a large vibration is applied to the embossed carrier tape, this may also lead to the LED being flipped/tilted and/or misaligned in the embossed carrier tape.

Issue 3: Flipping/tilting of the LED due to sticking to the top cover tape

Issue 4: Flipping/tilting of the LED due to vibration of the embossed carrier tape

The following sections will explain specific countermeasures for the four issues mentioned above.

4. Countermeasures

4.1 Damage to the LED lens during the pick-and-place process (Issue 1)

For lensed LEDs, Nichia determines the ideal nozzle design and pick-up method according to the design (e.g. shape, weight, etc.) of each LED, and takes this into consideration when designing the embossed carrier tape.

There are two major methods for LED pick-up during placement:

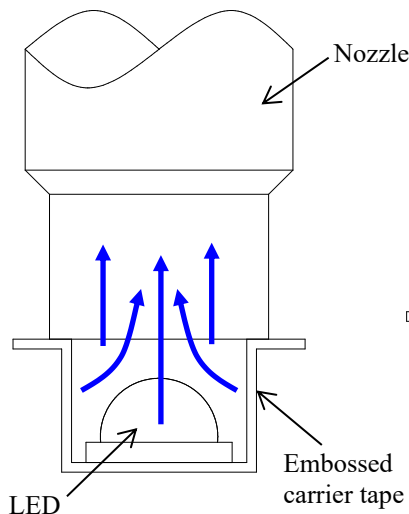
One method is to stop the pick-and-place nozzle on the top surface or the middle surface of the embossed carrier tape and pull air in from the top/middle surface to grab the LED in the air (i.e. aerial position pick-up). The other is a method in which a pick-and-place nozzle is inserted into the embossed carrier tape to apply suction at the closest possible point to the LED (i.e. typical position pick-up).

Method 1:

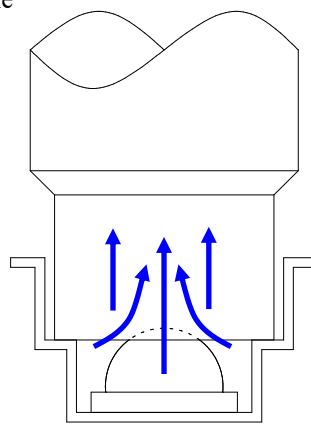
Aerial position pick-up: By suctioning air from the height at which the nozzle does not contact the LED, the only load that will be applied to the lens is the suction force at the time of suction.

Method 2:

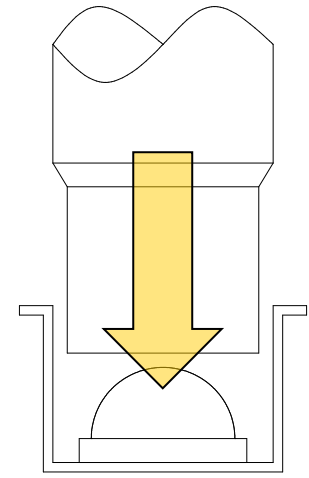
Typical position pick-up: Where aerial position pick-up is not possible or difficult, stable suction is made possible by bringing the nozzle closer to the LED and then applying suction.



Pulling air in from the top of the embossed carrier tape to pick up the LED



Pull air in from the middle of the embossed carrier tape to pick up the LED



Insert the nozzle inside of the embossed carrier tape and then apply suction to pick up the LED

Figure 1. Aerial position pick-up

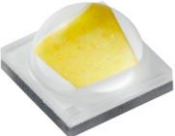
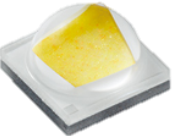
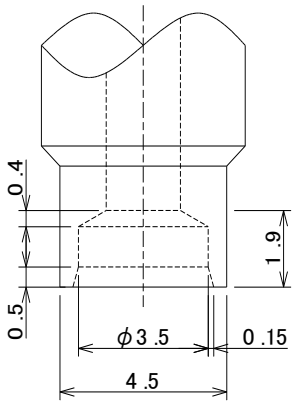
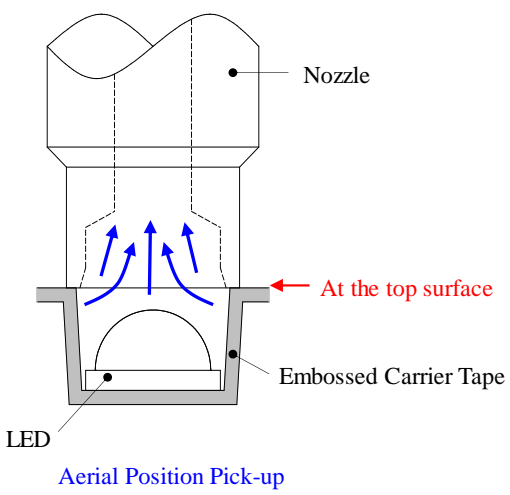
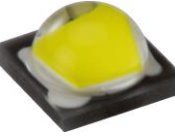


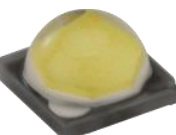
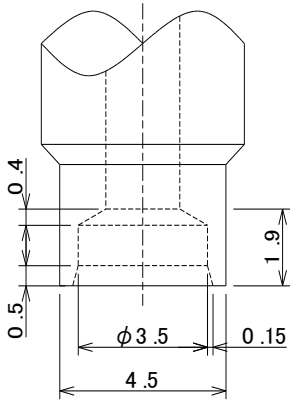
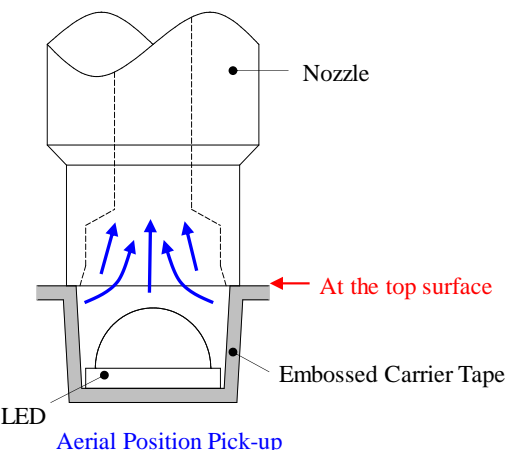
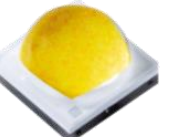

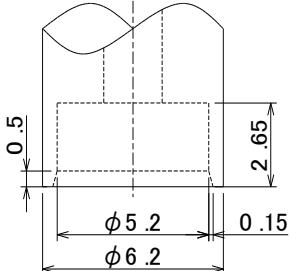
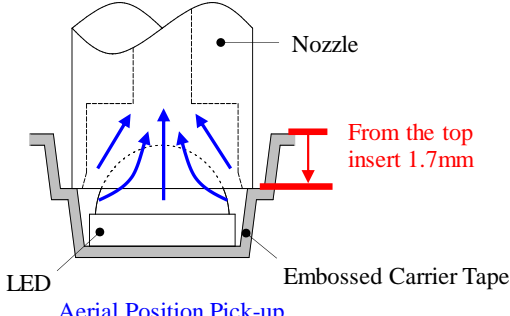
Figure 2. Typical position pick-up

When designing a nozzle for a lensed LED, it is necessary to provide a clearance that takes into consideration the tolerances of the dimensions for both the lens and the nozzle in order to completely avoid contact between the lens and the nozzle. When designing or choosing the nozzle shape, having the inner surfaces with C or R corners enables the nozzle to hold the LED flat to the nozzle leading to a reduction in mis-pick rates and a smoother operation for the pick-up.

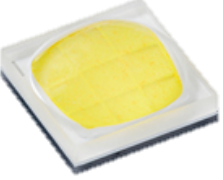
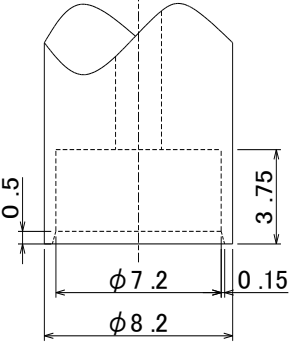
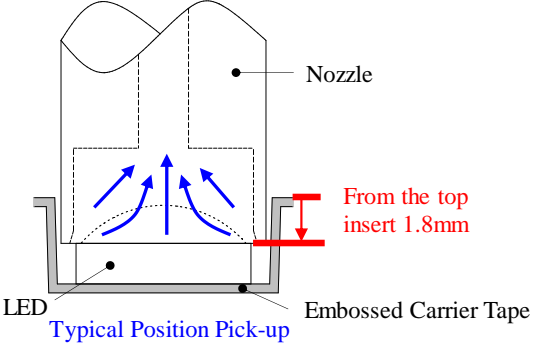


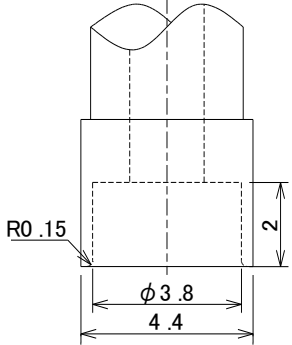
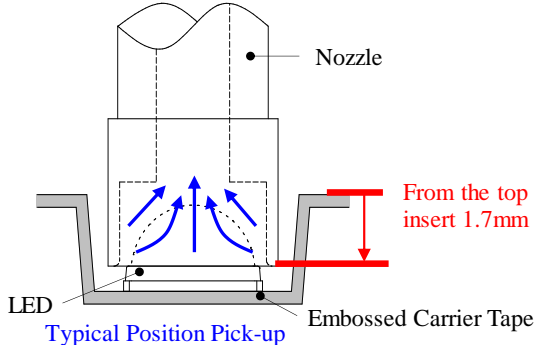
Refer to Table 2 below and on the following page for the recommended nozzle dimensions, pick-up method, and nozzle insertion amount for each lensed LED. Be careful not to insert the nozzle excessively.

Table 2. Examples of nozzle shape and pick-up method

Unit: mm

LED		Recommended Nozzle	Pick-up Method (Pick-up Position)
Part No. NVSWx19Fx  3.5×3.5×2.3mm 0.03g (TYP)	Part No. NVSWx19D  3.5×3.5×2.3mm 0.03g (TYP)		
Part No. NVSxx19C  3.5×3.5×2mm 0.03g (TYP)	Part No. NxSxx19Bx  3.5×3.5×2mm 0.03g (TYP)		
Part No. NVSW3x9B  3.5×3.5×2.35mm 0.04g (TYP)	Part No. NVSW3x9A  3.5×3.5×2.1mm 0.03g (TYP)		
Part No. NVSW519A  3.5×3.5×2.35mm 0.04g (TYP)			
Part No. NV4x144Ax  5×5×3.15mm 0.09g (TYP)			

Unit: mm

LED		Recommended Nozzle	Pick-up Method (Pick-up Position)
Part No. NV9W149AM  7×7×3.1mm 0.19g (TYP)		 Dimensions: 0.5, 3.75, 0.15, $\phi 7.2$, $\phi 8.2$	 Labels: Nozzle, LED, Embossed Carrier Tape, Typical Position Pick-up From the top insert 1.8mm
Part No. NF2W385ARx  4×3.6×2.05mm 0.04g (TYP)	Part No. NFxW585ARx  4×3.6×2.05mm 0.04g (TYP)	 Dimensions: R0.15, 2, $\phi 3.8$, 4.4	 Labels: Nozzle, LED, Embossed Carrier Tape, Typical Position Pick-up From the top insert 1.7mm

Supplemental Note: Adjusting the pick-up position

Ensure that the pick-up position is corrected before operating the pick-and-place machine (also called "mounter") using the hole in the center of the embossed carrier tape.

Example: The screen of the Yamaha YS mounter for adjusting the pick-up position is shown for reference in Figure 3. The setting screen for fine positioning of the pickup nozzle displays the pocket hole on the top left side.



Figure 3. Yamaha YS mounter's pick-up nozzle positioning screen (Reference)

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

4.2 Mis-picks due to the suction force of the nozzle (Issue 2)

Since the lensed LEDs have limited contact points with the nozzle during the pick-and-place process, 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 tolerances for the dimensions to ensure the nozzle does not touch the LED lens.

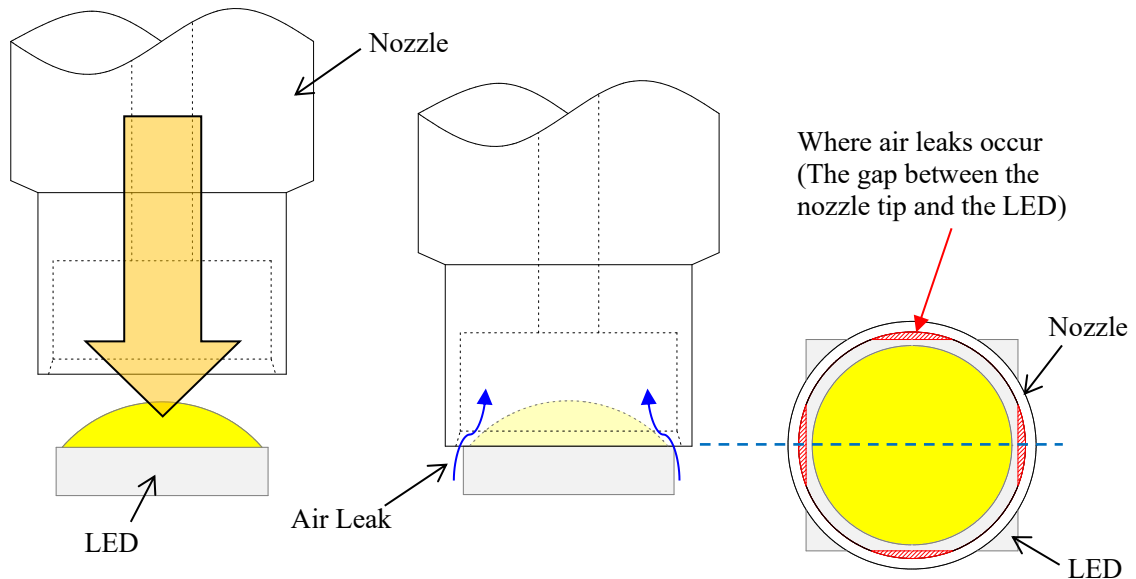


Figure 4. Air leak at the time of LED pick-up (example: part number NV9W149AM)

4.3 Flipping/tilting of the LED due to sticking to the top cover tape (Issue 3)

The resin LED lenses can be tacky and stick to the embossed carrier top cover tape. If the LED lens is stuck to the top cover tape when the tape is pulled, it may cause the LED to be lifted up from the bottom of the embossed carrier tape pocket and become flipped/tilted and/or misaligned when it peels off and then return to a position inside the pocket. If the LED becomes misaligned within the pocket, it may cause a mis-pick. Since it is not possible to completely reduce the tackiness, this section covers some examples of countermeasures by adjusting the tape feeder unit settings when LED sticking occurs.

4.3.1 Slow down the feed speed of the tape feeder

If the feed speed of the tape feeder is too fast, the nozzle tries to pick up the LED before the LED peels off from the top cover tape and returns to a position inside the embossed carrier tape.

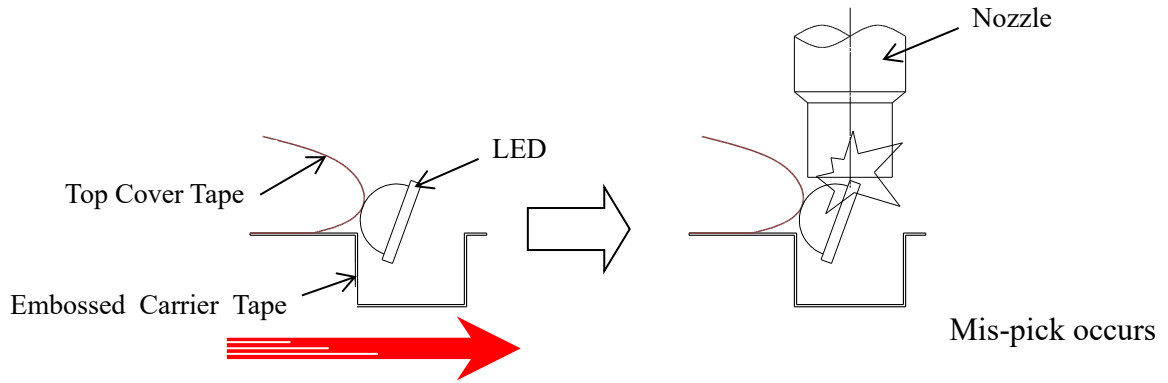


Figure 5. Tape feeder feed rate (fast)

Even when the LED sticks to the top cover tape, if the feed speed is slower, it allows for more time for the LED to return to the proper position and the mis-pick rate is reduced.

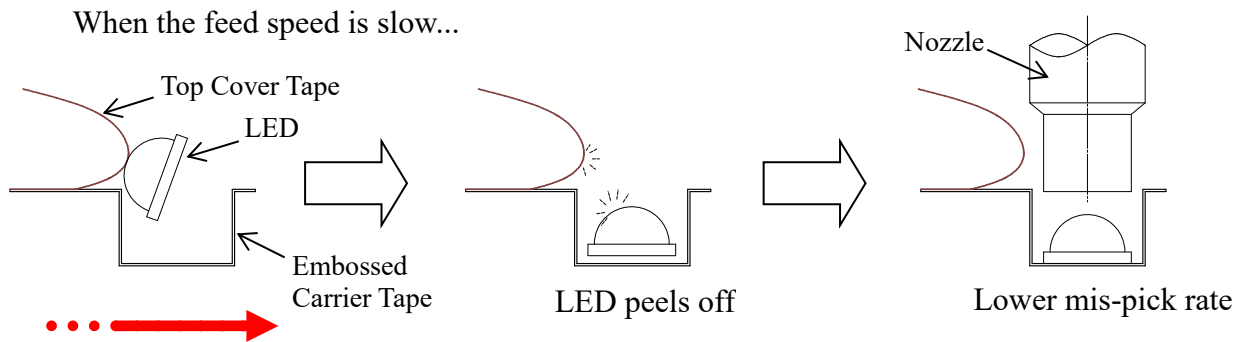


Figure 6. Tape feeder feed rate (slow)

Example: The screen of the Yamaha YS mouter for adjusting the feed rate is shown for reference in Figure 7 (in the red box). This pick-and-place machine has several options for the feed rate (e.g. “Normal”, “90%”, “80%”, “70%”, etc.).

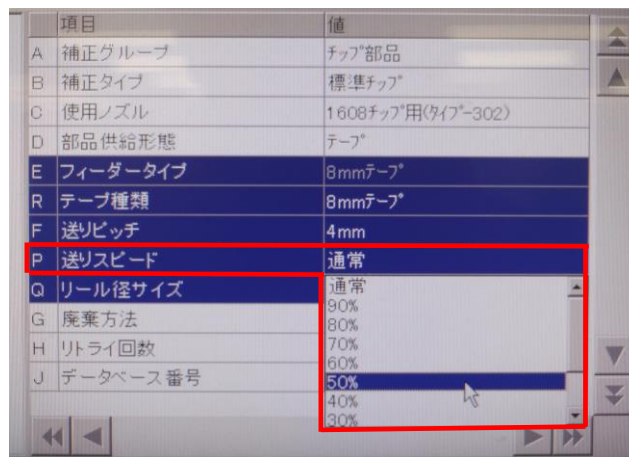


Figure 7. Yamaha YS mouter screen (Reference)

4.3.2 Adjust the peel angle of the top cover tape

This is another countermeasure for when the lensed LED is sticking to the top cover tape. As shown in the figure below, by making the peeling angle of the top cover tape acute, the LED lens peels off from the top cover tape in a lower position than when the top cover tape is removed at a higher angle, right after lifting from the pocket. This adjustment can reduce the chance of the LED flipping/tilting, and/or that the LED becomes misaligned within the pocket. Depending on the structure of the tape feeder, some are pre-adjusted in the factory to the optimum peeling angle.

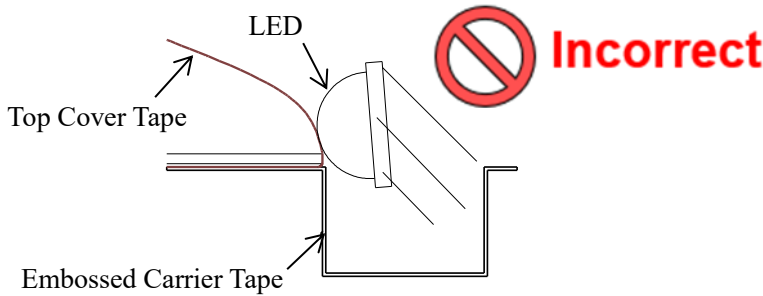


Figure 8. Peeling off the top cover tape at an obtuse angle

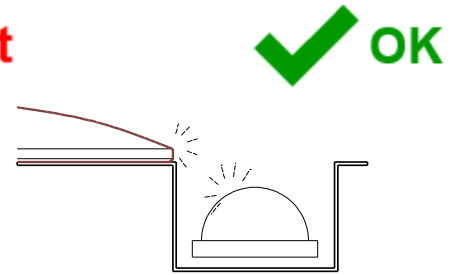


Figure 9. Removing the top cover tape at an acute angle

4.4 Flipping/tilting of the LED due to vibration of the embossed carrier tape (Issue 4)

During the pick-and-place process, when the embossed carrier tape is subjected to a large vibration, LEDs can flip/tilt and/or become misaligned in the embossed carrier tape. Since the lensed LEDs have a higher center of gravity than other LEDs, the vibration is more likely to cause LED flipping/tilting and/or misalignment.

4.4.1 Slow down the feed speed of the tape feeder

The higher the feed speed of the tape feeder, the greater the vibration of the embossed carrier tape. If the LED is flipping/tilting and/or misaligned, it is necessary to reduce the feed speed to reduce the vibration.

Additionally, pneumatic tape feeders have greater feed vibration than motorized tape feeders. Selecting a tape feeder suitable for the parts is also important for stable placement.

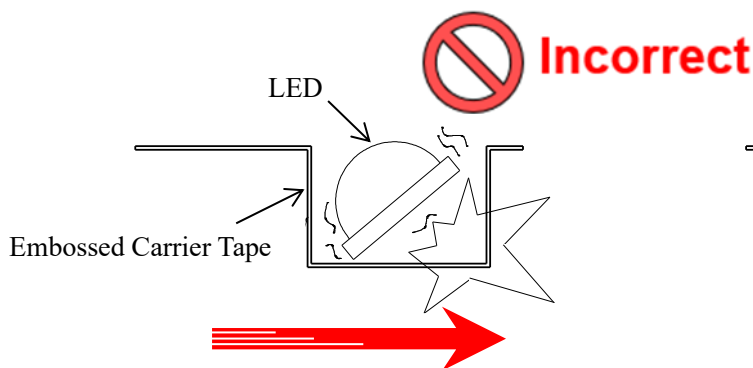


Figure 10. When the speed is fast

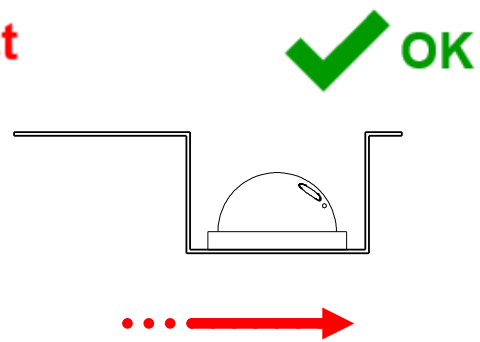


Figure 11. When the speed is slow

4.4.2 Change the peeling position of the top cover tape

Once the top cover tape peels off, more clearance is created above the top of the LED that may allow the LED to move up and down due to vibration from the tape feeder. If the tape removal position is too far away from the pick-up position and there are multiple pockets in the queue without the top cover tape sealing them, as shown in Figure 12 below, it may lead to the LEDs in those pockets being flipped/tilted and/or misaligned.

As a countermeasure, make adjustments so the top cover tape is peeled off immediately before pick-up. This regulates the vertical movement of the LED and reduces the occurrence of LED flipping/tilting and/or misalignment.

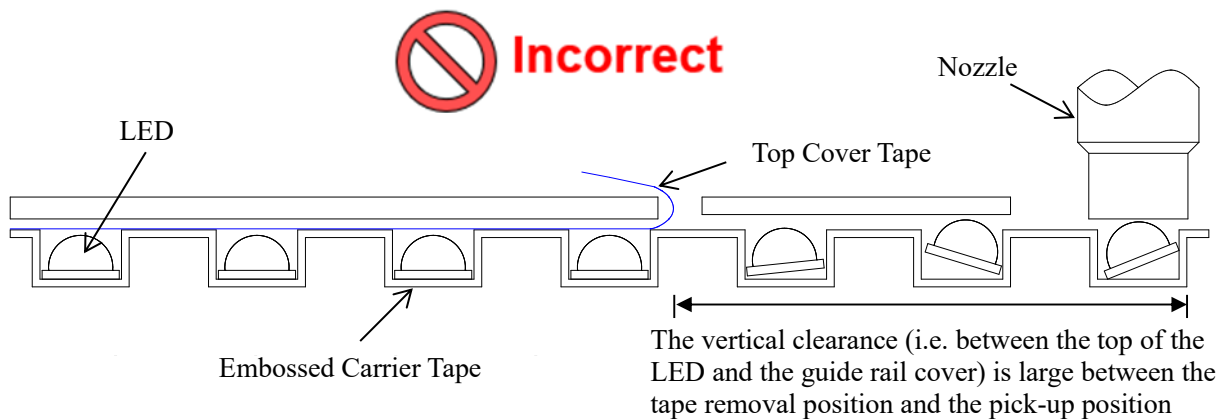


Figure 12. Removing the top cover tape at the typical position

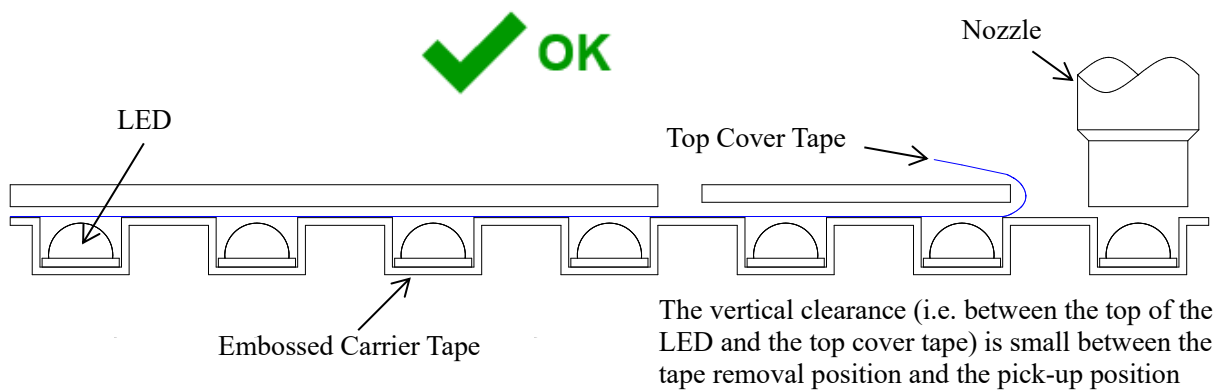
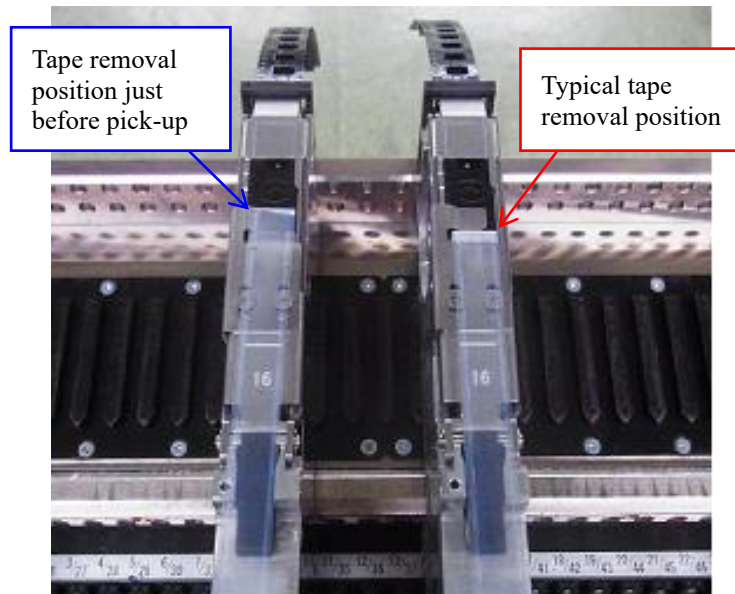


Figure 13. Removing the top cover tape just before pick-up

Example: The top cover tape removal position of the Yamaha YS mounter is shown for reference in Figure 14.



Yamaha YS Mounter (Reference)

Figure 14. Top cover tape removal position

Cautions/Suggestions: Tape feeders with a shutter

There are tape feeders that are designed so that the tape is peeled at the typical tape removal position and the shutter is provided to prevent the LED from being ejected from the pocket in the pick-up position. Depending on the tape feeder, it is impossible to remove the shutter and change the tape removal position to be adjacent to the pick-up position.

5. Other Cautions/Suggestions

Splicing (tape joint) work is not recommended.

The work of cutting and connecting the tape of the front reel and the new reel is called splicing (tape joint). This is done during assembly using an automated pick-and-place machine when replacing the reels without shutting down the pick-and-place machine and removing the tape feeder from the machine in order to improve the machine utilization by eliminating the machine downtime due to component shortage.

If two pieces of embossed carrier tape are joined to make one long piece by splicing, it may cause them to be deformed or distorted leading to LED flipping/tilting and/or misalignment and resulting in a placement failure. Therefore, Nichia does not recommend splicing.

6. Summary

To pick up lensed LEDs without damage and reduce the mis-pick rate, it is very important to ensure that the pick-up method of the LED, the design and suction force of the nozzle, the feed speed of the tape feeder, the tape removal angle, and the tape removal position are appropriate.

In this application note, examples of how to handle placement issues for lensed LEDs are mentioned; however, the handling methods described here may not be the best for all situations, and the handling method will vary depending on the chosen application and the pick-and-place equipment used. Nichia hopes to collect data on LED placement technology from multiples sources, including customer feedback, to provide useful information. Contact Nichia if something that is not described in this application note that is noticed while picking and placing the LEDs with automated systems.

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