

NICHIA CORPORATION

SPECIFICATIONS FOR UV LED

PART NO. NCSU276CT

- Pb-free Reflow Soldering Application
- Built-in ESD Protection Device
- RoHS Compliant



SPECIFICATIONS

(1) Absolute Maximum Ratings

Item	Symbol	Absolute Maximum Rating	Unit
Forward Current	I_F	700	mA
Pulse Forward Current	I_{FP}	1000	mA
Allowable Reverse Current	I_R	85	mA
Power Dissipation	P_D	3.25	W
Operating Temperature	T_{opr}	-10~85	°C
Storage Temperature	T_{stg}	-40~100	°C
Junction Temperature	T_J	90	°C

* Absolute Maximum Ratings at $T_S=25^\circ\text{C}$.

* I_{FP} conditions with pulse width $\leq 10\text{ms}$ and duty cycle $\leq 10\%$.

(2) Initial Electrical/Optical Characteristics

Item		Symbol	Condition	Typ	Max	Unit
U365	Forward Voltage	V_F	$I_F=500\text{mA}$	3.8	-	V
	Radiant Flux	Φ_e	$I_F=500\text{mA}$	1050	-	mW
	Peak Wavelength	λ_p	$I_F=500\text{mA}$	365	-	nm
Spectrum Half Width		$\Delta \lambda$	$I_F=500\text{mA}$	9.0	-	nm
Thermal Resistance		$R_{\theta JS}$	-	3.6	4.3	°C/W

* Characteristics at $T_S=25^\circ\text{C}$.

* Radiant Flux value as per CIE 127:2007 standard.

* $R_{\theta JS}$ is the thermal resistance from the junction to the T_S measurement point.

* It is recommended to operate the LEDs at a current greater than 10% of the sorting current to stabilize the LED characteristics.

RANKS

Item	Rank	Min	Max	Unit
Forward Voltage	H2	4.2	4.4	V
	H1	4.0	4.2	
	M2	3.8	4.0	
	M1	3.6	3.8	
	L2	3.4	3.6	
	L1	3.2	3.4	
Radiant Flux	P8d21	1130	1230	mW
	P7d22	1040	1130	
	P7d21	950	1040	
	P6d22	870	950	
Peak Wavelength	U365	360	370	nm

* Ranking at $T_s=25^{\circ}\text{C}$.

* Forward Voltage Tolerance: $\pm 0.05\text{V}$

* Radiant Flux Tolerance: $\pm 6\%$

* Peak Wavelength Tolerance: $\pm 3\text{nm}$

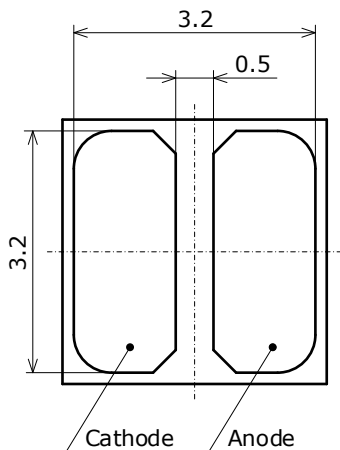
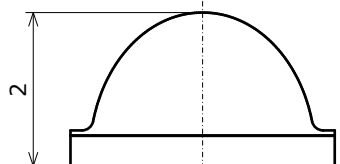
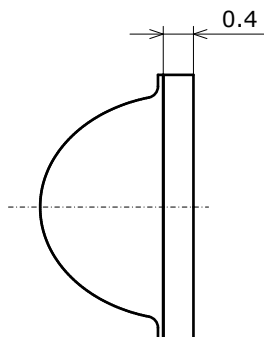
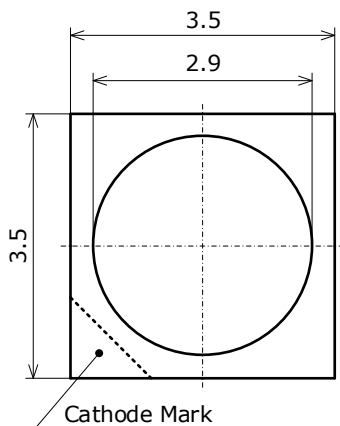
* LEDs from the above ranks will be shipped. The rank combination ratio per shipment will be decided by Nichia.

OUTLINE DIMENSIONS

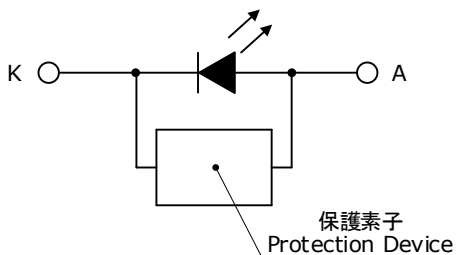
* 本製品はRoHS指令に適合しております。
This product complies with RoHS Directive.

NCSU276C
管理番号 No. STS-DA7-15246A

(単位 Unit: mm, 公差 Tolerance: ±0.2)

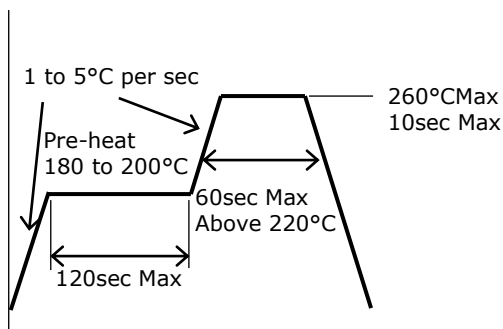


項目 Item	内容 Description
パッケージ材質 Package Materials	セラミックス Ceramics
レンズ材質 Lens Materials	シリコン樹脂 Silicone Resin
電極材質 Electrodes Materials	金メッキ Au-plated
質量 Weight	0.031g(TYP)

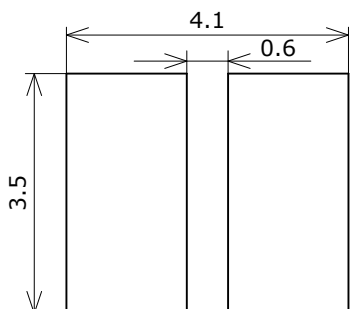


SOLDERING

• Recommended Reflow Soldering Condition(Lead-free Solder)



• Recommended Soldering Pad Pattern



(單位 Unit: mm)

- * This LED is designed to be reflow soldered to a PCB. If dip soldered or hand soldered, Nichia will not guarantee its reliability.
- * Reflow soldering must not be performed more than twice.
- * When cooling the LEDs from the peak temperature a gradual cooling slope is recommended; do not cool the LEDs rapidly.
- * 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.
- * This LED uses a silicone resin for the lens and internal pre-coating resin; the silicone resin is soft. If pressure is applied to the lens, it may cause the lens to be damaged, chipped, and/or delaminated. If the resin is damaged, chipped, delaminated and/or deformed, it may cause the wire to break causing a catastrophic failure (i.e. the LED not to illuminate) and/or reliability issues (e.g. the LED to corrode, the radiant flux to decrease, the color/directivity to change, etc.). Ensure that pressure is not applied to the lens.

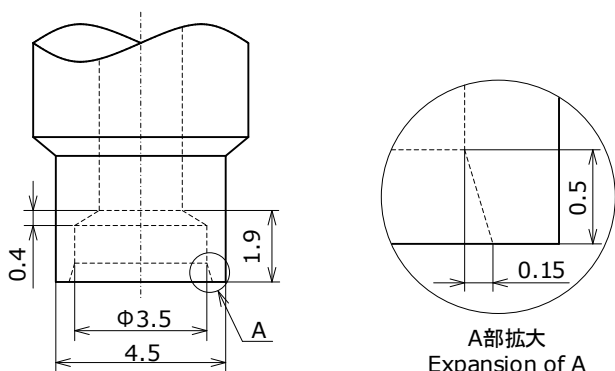
If an automatic pick and place machine is used for the LEDs, use a pick up nozzle that does not affect the lens.

Recommended conditions:

Using a nozzle specifically designed for the LEDs is recommended (See the nozzle drawing below).

- * Ensure that the nozzle does not come in contact with the lens when it picks up an LED.

If this occurs, it may cause internal disconnection causing the LED not to illuminate.



A部拡大
Expansion of A

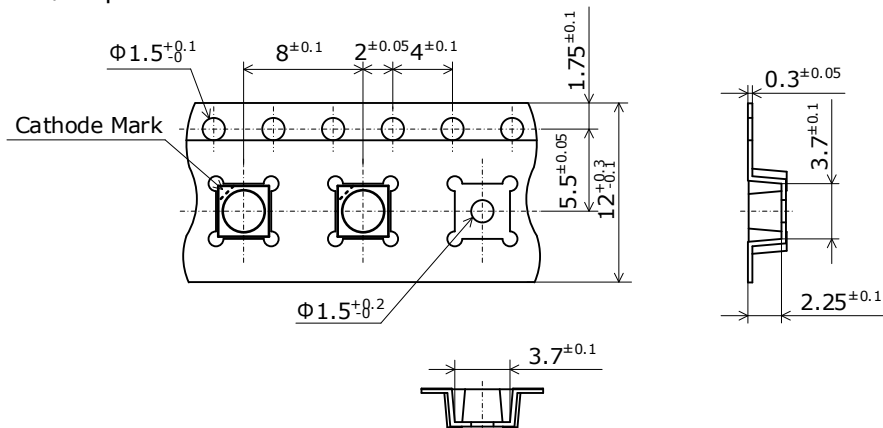
(單位 Unit: mm)

-
- * Repairing should not be done after the LEDs have been soldered. It should be confirmed beforehand whether the characteristics of the LEDs will or will not be damaged by repairing.
 - * When soldering, do not apply stress to the LED while the LED is hot.
 - * The soldering pad pattern above is a general recommendation for LEDs to be mounted without issues; if a high degree of precision is required for the chosen application (i.e. high-density mounting), ensure that the soldering pad pattern is optimized.
 - * When flux is used, it should be a halogen free flux. Ensure that the manufacturing process is not designed in a manner where the flux will come in contact with the LEDs.
 - * Ensure that there are no issues with the type and amount of solder that is being used.
 - * This LED has all the electrodes on the backside; solder connections will not be able to be seen nor confirmed by a normal visual inspection. Ensure that sufficient verification is performed on the soldering conditions prior to use to ensure that there are no issues.

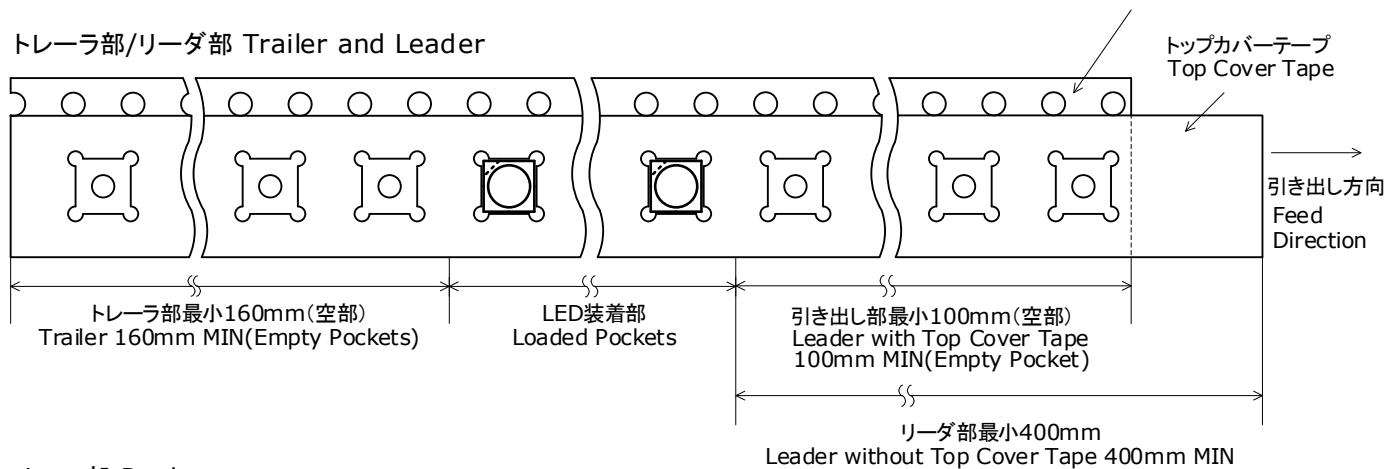
TAPE AND REEL DIMENSIONS

テーピング部 Tape

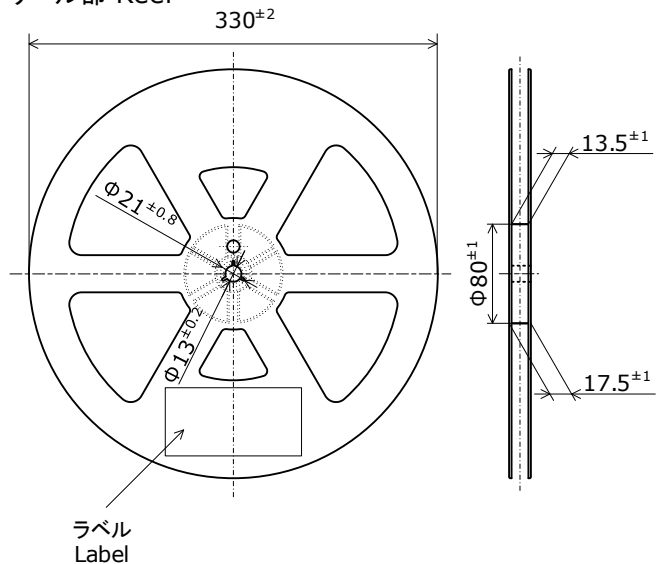
Nxxx276x
 管理番号 No. STS-DA7-15247A
 (単位 Unit: mm)



トレーラ部/リーダ部 Trailer and Leader



リール部 Reel

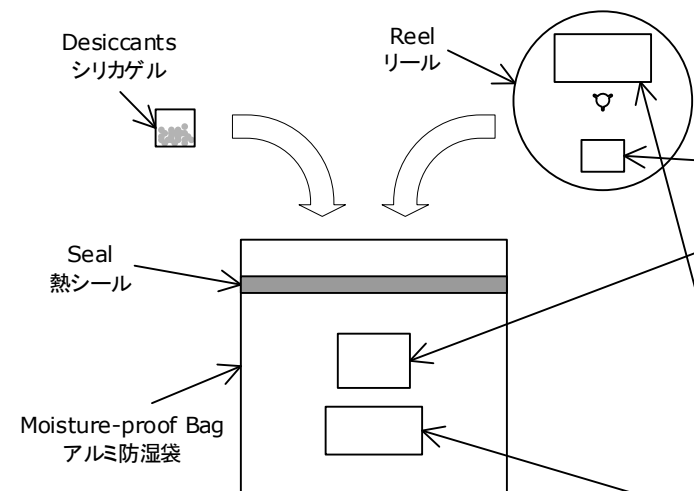


- * 数量は1リールにつき 3500個入りです。
 Reel Size: 3500pcs
- * 実装作業の中断などでエンボスキャリアテープをリールに巻き取る場合、エンボスキャリアテープを強く(10N以上)締めないで下さい。
 LEDがカバーテープに貼り付く可能性があります。
 When the tape is rewound due to work interruptions, no more than 10N should be applied to the embossed carrier tape.
 The LEDs may stick to the top cover tape.
- * JIS C 0806電子部品テーピングに準拠しています。
 The tape packing method complies with JIS C 0806 (Packaging of Electronic Components on Continuous Tapes).

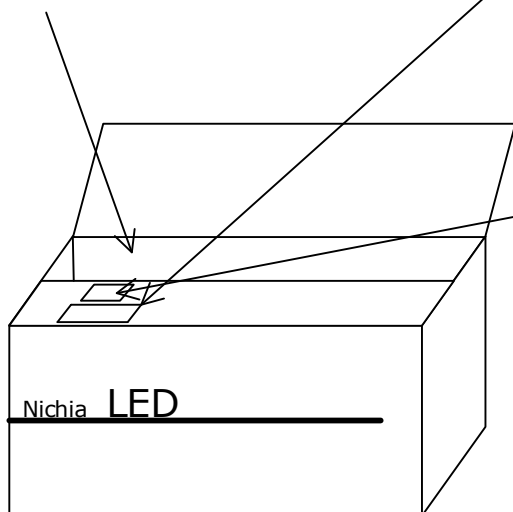
PACKAGING - TAPE & REEL

Reels are shipped with desiccants in heat-sealed moisture-proof bags. シリカゲルとともにリールをアルミ防湿袋に入れ、熱シールにより封をします。

Part No. Nxxxxxxx
No. STS-DA7-11776C



Moisture-proof bags are packed in cardboard boxes with corrugated partitions. アルミ防湿袋を並べて入れ、ダンボールで仕切ります。

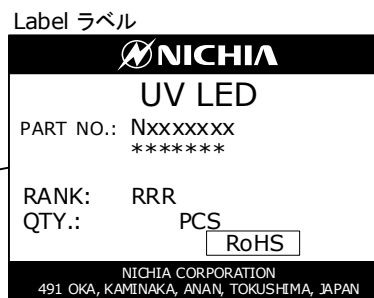


Warning and Explanatory Labels 警告ラベル

UV LED

- ・「UV LEDは紫外領域の光(UV光)を発します。」
- ・「UV光は人間の目には見えませんが、光が見えていなくてもUV光により目を傷める可能性があります。」
- ・「UV光を直接目にあてないでください。必ず適切な防護を着用してください。」
- ・「UV LEDを組み込んだ製品には、適切な警告表示をしてください。」

- ・ UV LEDs emit light in the ultraviolet region (UV light).
- ・ UV light is invisible and may be harmful to the human eye.
- ・ Do not expose the eyes directly to the UV light. Wear appropriate protective gear when handling.
- ・ Use appropriate warning signs/labels on devices using the UV LEDs.



- * ***** is the customer part number. If not provided, it will not be indicated on the label. 客先型名を*****で示します。客先型名が設定されていない場合は空白です。
- * For details, see "LOT NUMBERING CODE" in this document. ロット表記方法についてはロット番号の項を参照して下さい。

- * Products shipped on tape and reel are packed in a moisture-proof bag. They are shipped in cardboard boxes to protect them from external forces during transportation. 本製品はテーピングしたのち、輸送の衝撃から保護するためダンボールで梱包します。
- * Do not drop or expose the box to external forces as it may damage the products. 取り扱いに際して、落下させたり、強い衝撃を与えたりしますと、製品を損傷させる原因になりますので注意して下さい。
- * Do not expose to water. The box is not water-resistant. ダンボールには防水加工がされておきませんので、梱包箱が水に濡れないよう注意して下さい。
- * Using the original package material or equivalent in transit is recommended. 輸送、運搬に際して弊社よりの梱包状態あるいは同等の梱包を行って下さい。

LOT NUMBERING CODE

Lot Number is presented by using the following alphanumeric code.

YMxxxx - RRR

Y - Year

Year	Y
2020	K
2021	L
2022	M
2023	N
2024	O
2025	P

M - Month

Month	M	Month	M
1	1	7	7
2	2	8	8
3	3	9	9
4	4	10	A
5	5	11	B
6	6	12	C

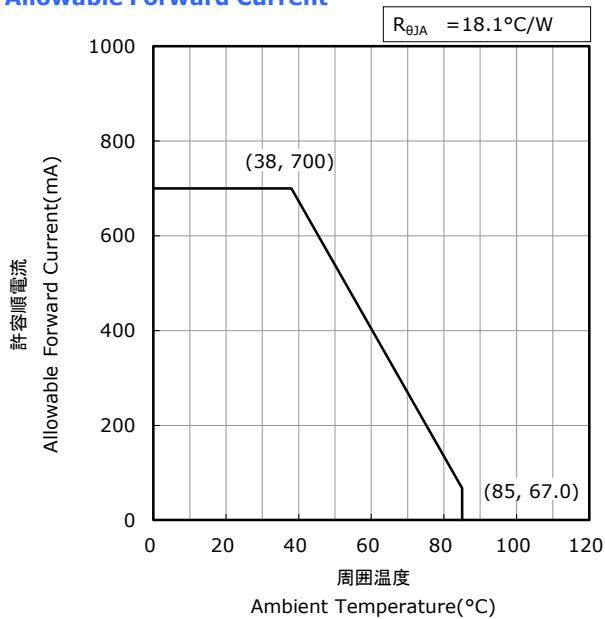
xxxx-Nichia's Product Number

RRR-Ranking by Wavelength, Ranking by Radiant Flux, Ranking by Forward Voltage

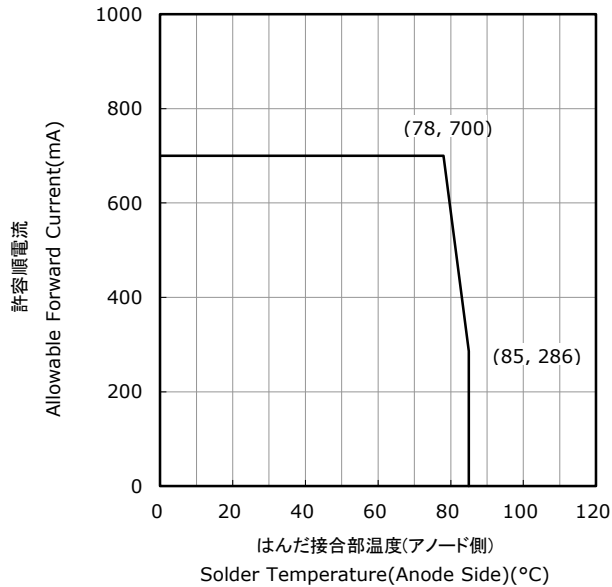
DERATING CHARACTERISTICS

NCSU276C
管理番号 No. STS-DA7-15248

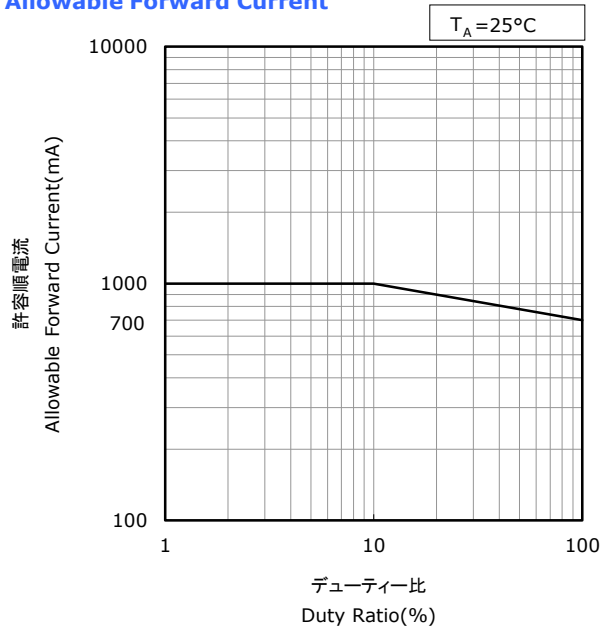
周囲温度-許容順電流特性
Ambient Temperature vs
Allowable Forward Current



はんだ接合部温度(アノード側)-許容順電流特性
Solder Temperature(Anode Side) vs
Allowable Forward Current



デューティー比-許容順電流特性
Duty Ratio vs
Allowable Forward Current

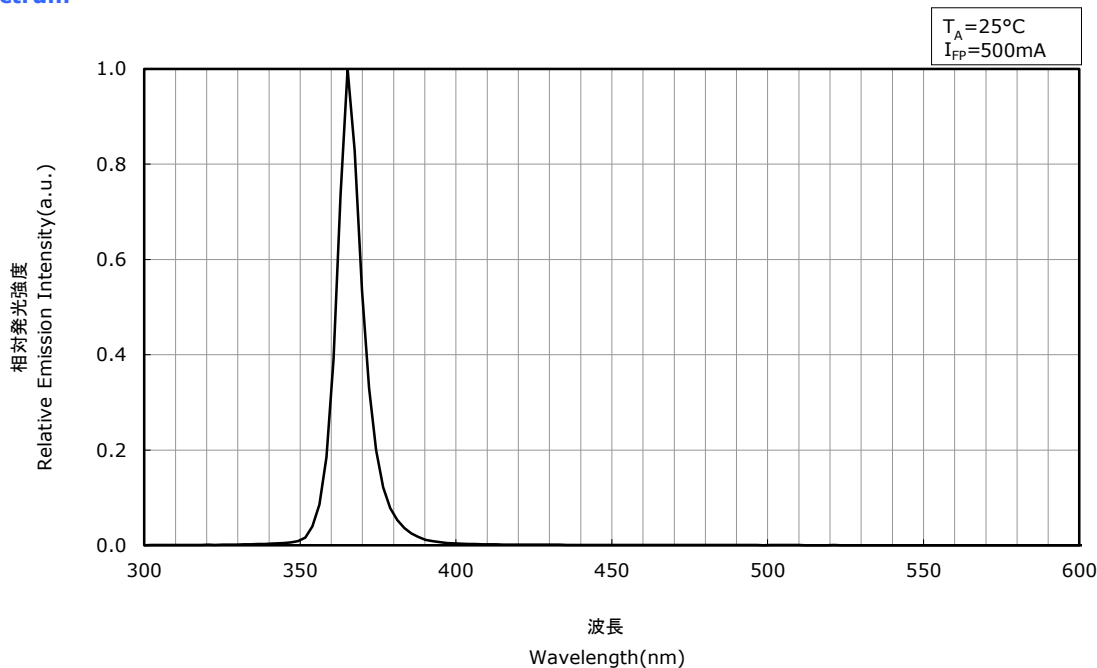


OPTICAL CHARACTERISTICS

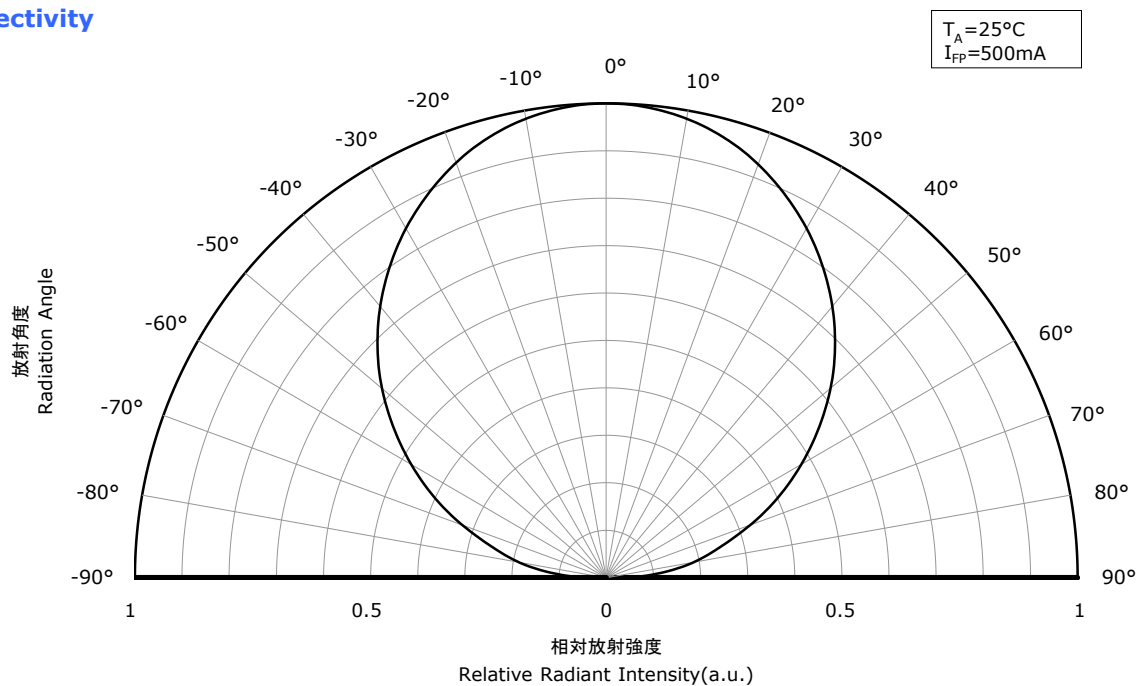
* 本特性は参考です。
All characteristics shown are for reference only and are not guaranteed.

NCSU276C
管理番号 No. STS-DA7-15199

発光スペクトル Spectrum



指向特性 Directivity



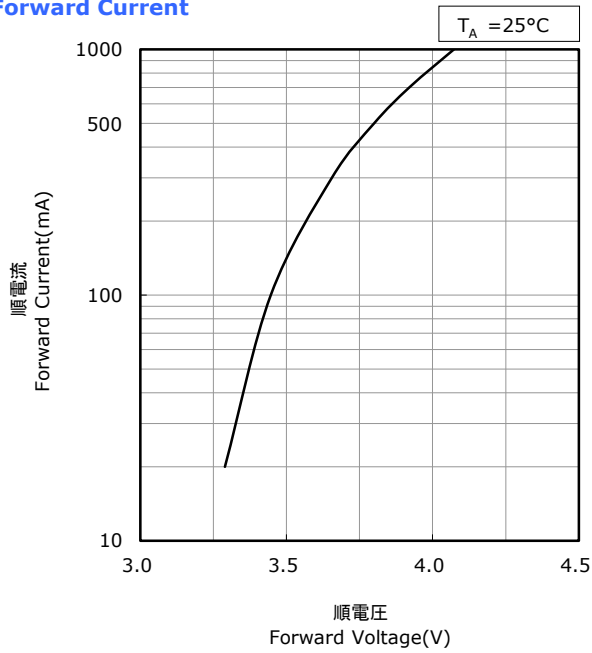
* 本特性はピーク波長ランクU365xに対応しています。
The graphs above show the characteristics for U365x LEDs of this product.

FORWARD CURRENT CHARACTERISTICS / TEMPERATURE CHARACTERISTICS

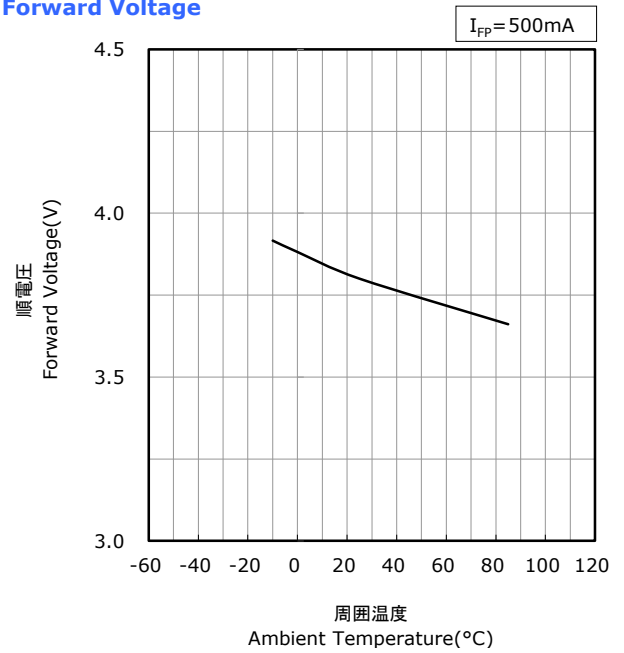
* 本特性は参考です。
All characteristics shown are for reference only and are not guaranteed.

NCSU276C
管理番号 No. STS-DA7-15200

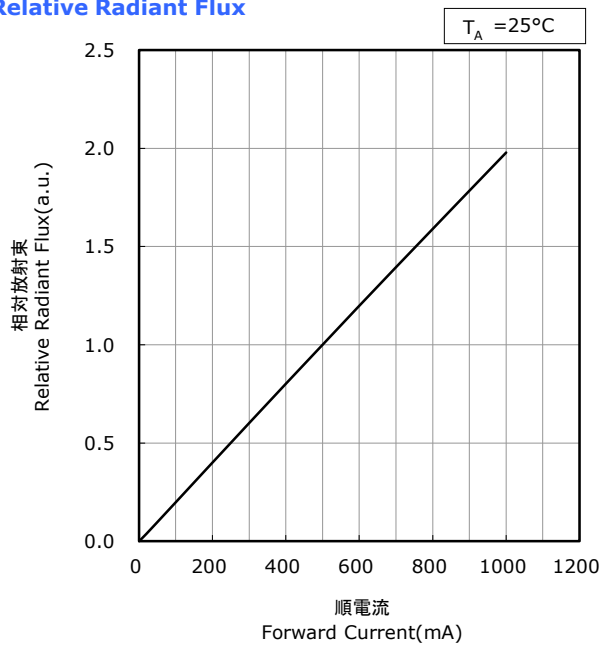
順電圧-順電流特性
Forward Voltage vs
Forward Current



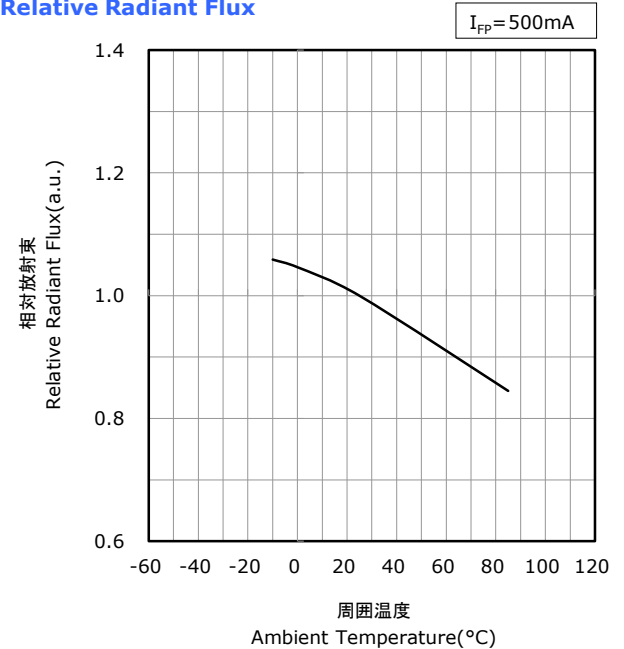
周囲温度-順電圧特性
Ambient Temperature vs
Forward Voltage



順電流-相対放射束特性
Forward Current vs
Relative Radiant Flux



周囲温度-相対放射束特性
Ambient Temperature vs
Relative Radiant Flux



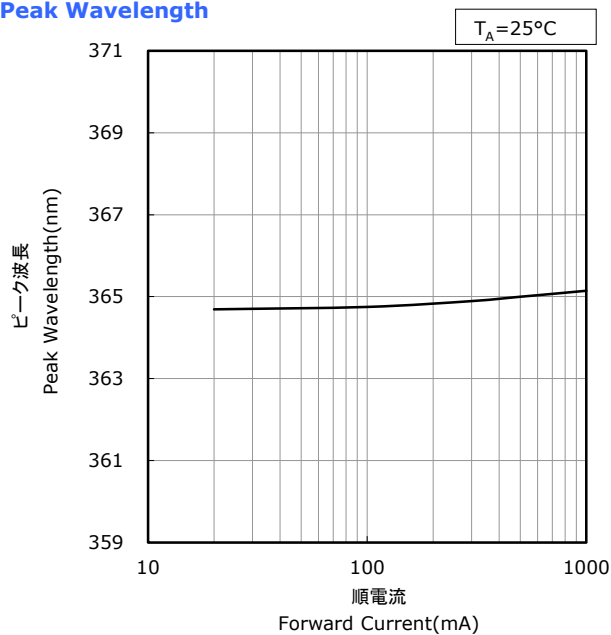
* 本特性はピーク波長ランクU365xに対応しています。
The graphs above show the characteristics for U365x LEDs of this product.

FORWARD CURRENT CHARACTERISTICS / TEMPERATURE CHARACTERISTICS

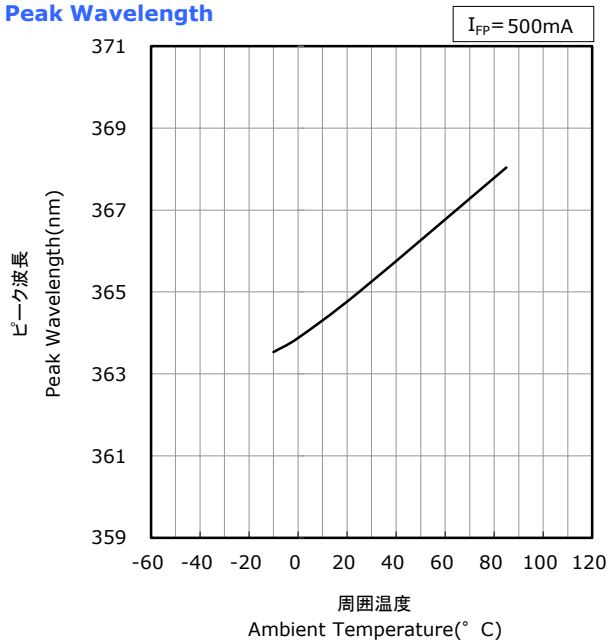
* 本特性は参考です。
All characteristics shown are for reference only and are not guaranteed.

NCSU276C
管理番号 No. STS-DA7-15201

順電流-ピーク波長特性
Forward Current vs
Peak Wavelength



周囲温度-ピーク波長特性
Ambient Temperature vs
Peak Wavelength



* 本特性はピーク波長ランクU365xに対応しています。
The graphs above show the characteristics for U365x LEDs of this product.

RELIABILITY

(1) Tests and Results

Test	Reference Standard	Test Conditions	Test Duration	Failure Criteria #	Units Failed/Tested
Resistance to Soldering Heat (Reflow Soldering)	JEITA ED-4701 300 301	$T_{sld}=260^{\circ}\text{C}$, 10sec, 2reflows, Precondition: 30°C , 70%RH, 168hr		#1	0/10
Thermal Shock(Air to Air)		-40°C to 100°C , 15min dwell	100cycles	#1	0/10
High Temperature Storage	JEITA ED-4701 200 201	$T_A=100^{\circ}\text{C}$	1000hours	#1	0/10
Low Temperature Storage	JEITA ED-4701 200 202	$T_A=-40^{\circ}\text{C}$	1000hours	#1	0/10
Room Temperature Operating Life		$T_A=25^{\circ}\text{C}$, $I_F=700\text{mA}$	1000hours	#1	0/10
High Temperature Operating Life		$T_A=85^{\circ}\text{C}$, $I_F=60\text{mA}$	1000hours	#1	0/10
Temperature Humidity Operating Life		60°C , RH=90%, $I_F=350\text{mA}$	500hours	#1	0/10
Low Temperature Operating Life		$T_A=-10^{\circ}\text{C}$, $I_F=500\text{mA}$	1000hours	#1	0/10
Vibration	JEITA ED-4701 400 403	200m/s^2 , 100~2000~100Hz, 4cycles, 4min, each X, Y, Z	48minutes	#1	0/10
Electrostatic Discharges	JEITA ED-4701 300 304	HBM, 2kV, 1.5k Ω , 100pF, 3pulses, alternately positive or negative		#1	0/10

NOTES:

- 1) $R_{\theta JA} \approx 18.1^{\circ}\text{C/W}$
- 2) Measurements are performed after allowing the LEDs to return to room temperature.

(2) Failure Criteria

Criteria #	Items	Conditions	Failure Criteria
#1	Forward Voltage(V_F)	$I_F=500\text{mA}$	>Initial value $\times 1.1$
	Radiant Flux(Φ_E)	$I_F=500\text{mA}$	<Initial value $\times 0.7$

CAUTIONS

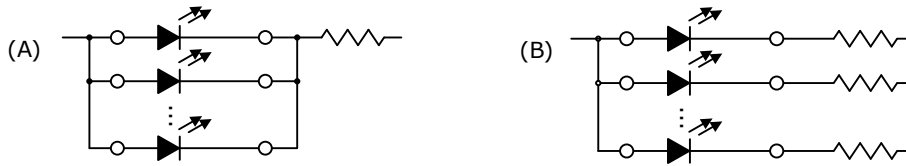
(1) Storage

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

- The storage/packaging requirements for this LED are comparable to JEDEC Moisture Sensitivity Level (MSL) 3 or equivalent. Nichia used IPC/JEDEC STD-020 as a reference to rate the MSL of this LED.
- This LED uses a package that could absorb moisture; if the package absorbs moisture and is exposed to heat during soldering, it may cause the moisture to vaporize and the package to expand and the resulting pressure may cause internal delamination. This may cause the optical characteristics to degrade. To minimize moisture absorption in storage/transit, moisture-proof aluminum bags are used for the LEDs with a silica gel packet to absorb any air moisture in the bag. The silica gel beads turn blue to red as they absorb moisture.
- Once the moisture-proof aluminum bag is open, ensure that the LED is soldered to a PCB within the range of the conditions above. To store any remaining unused LEDs, use a hermetically sealed container with silica gel desiccants. Nichia recommends placing them back to the original moisture-proof bag and reseal it.
- If the "After Opening" storage time has been exceeded or any pink silica gel beads are found, ensure that the LED are baked before use. Baking should only be done once.
- This LED has gold-plated electrodes. If the LEDs are exposed to a corrosive environment, it may cause the plated surface to tarnish causing issues (i.e. solderability). Ensure that when storing LEDs, a hermetically sealed container is used. Nichia recommends placing them back to the original moisture-proof bag and reseal it.
- To prevent substances/gases from affecting the plated surface, ensure that the parts/materials used with the LEDs in the same assembly/system do not contain sulfur (e.g. gasket/seal, adhesive, etc.). If the plating is contaminated, it may cause issues (e.g. electric connection failures). If a gasket/seal is used, silicone rubber gaskets/seals are recommended; ensure that this use of silicone does not result in issues (e.g. electrical connection failures) caused by low molecular weight volatile siloxane.
- To avoid condensation, the LEDs must not be stored in areas where temperature and humidity fluctuate greatly.
- Do not store the LEDs in a dusty environment.
- Do not expose the LEDs to direct sunlight and/or an environment over a long period of time where the temperature is higher than normal room temperature.

(2) Directions for Use

- The circuit must be designed to ensure that the Absolute Maximum Ratings are not exceeded for each LED. The LEDs should be operated at a constant current per LED. In the case of operating at a constant voltage, Circuit B is recommended. If Circuit A is used, it may cause the currents flowing through the LEDs to vary due to the variation in the forward voltage characteristics of the LEDs on the circuit.



- This LED is designed to be operated at a forward current. Ensure that no voltage is applied to the LED in the forward/reverse direction while the LED is off. If the LEDs are used in an environment where reverse voltages are applied to the LED continuously, it may cause electrochemical migration to occur causing the LED to be damaged. When not in use for a long period of time, the system's power should be turned off to ensure that there are no issues/damage.
- To stabilize the LED characteristics while in use, Nichia recommends that the LEDs are operated at currents $\geq 10\%$ of the sorting current.
- Ensure that transient excessive voltages (e.g. lightning surge) are not applied to the LEDs.
- If the LEDs are used for outdoor applications, ensure that necessary measures are taken (e.g. protecting the LEDs from water/salt damage and high humidity).
- Although this LED is specifically designed to emit invisible light, a small amount of light in the visible region exists in the emission spectrum. Ensure that when using the LEDs for sensors, verification is performed to ensure that the emission spectrum is fit for the intended use.
- Exposure to the UV radiation from this LED could cause health risks and the degree of hazard may vary depending on the wavelength, irradiance, and exposure time. When necessary, safety and other information/precautions should be provided to the end users. For more details, see Handling Precautions for Ultraviolet Light (UV LEDs). To access the application notes, go to the Technical Suggestions And Recommendations section of Nichia's website.
- The UV light may accelerate the degradation/aging processes of the components used in the chosen system. When selecting a part/material, perform sufficient verification prior to use to ensure that there are no issues, this verification should be performed taking into consideration the conditions/environments in which the end-product containing these LEDs will actually be used. When necessary, safety and other information/precautions should be provided to the end users.
- This LED may cause fluorescence to occur resulting in certain devices (e.g. sensors, etc.) failing to function as intended. Taking into consideration the conditions/environments in which the end-product containing these LEDs will actually be used, safety and other information/precautions should be provided to the end users.
- If the UV LEDs are used with LEDs containing a phosphor in the same application, the UV light may cause the phosphor to emit light. The design of the chosen application should ensure that those LEDs are not exposed to the UV light.
- If this LED is stored and/or used constantly under high temperature and high humidity conditions, it may accelerate the deterioration of the die; this may cause the radiant flux to decrease. If the LEDs are stored and/or used under these conditions, sufficient verification must be done prior to use to ensure that there are no issues for the chosen application.
- Do not design this LED into applications where condensation may occur. If the LEDs are stored/operated in these environments, it may cause issues (e.g. current leaks that cause the radiant flux to decrease).
- This LED uses a silicone resin for the lens. Depending on the operating/environmental conditions the silicone lens may have issues (e.g. cracks) due to deterioration resulting from being exposed to the UV light; this may have an adverse effect on the optical characteristics; ensure that sufficient verification is performed to ensure that there are no issues for the chosen application.

(3) Handling Precautions

- Do not handle the LEDs with bare hands:
 - this may contaminate the LED surface and have an effect on the optical characteristics,
 - this may cause the LED to deform and/or the wire to break causing a catastrophic failure (i.e. the LED not to illuminate).
- Ensure that when handling the LEDs with tweezers, excessive force is not applied to the LED. Otherwise, it may cause damage to the resin (e.g. cut, scratch, chip, crack, delamination and deformation) and the wire to break causing a catastrophic failure (i.e. the LED not to illuminate).
- Dropping may cause damage to the LED (e.g. deformation).
- Do not stack assembled PCBs together. Otherwise, it may cause damage to the resin (e.g. cut, scratch, chip, crack, delamination and deformation) and the wire to break causing a catastrophic failure (i.e. the LED not to illuminate).

(4) Design Consideration

- If the LEDs are soldered to a PCB and the PCB assembly is bent (e.g. PCB depaneling process), it may cause the LED package to break. The PCB layout should be designed to minimize the mechanical stress on the LEDs when the PCB assembly is bent/warped.
- The amount of mechanical stress exerted on the LED from depaneling may vary depending on the LED position/orientation on the PCB assembly (e.g. especially in areas near V-groove scores). The PCB layout should be designed to minimize the mechanical stress on the LEDs when the PCB is separated into individual PCB assemblies.
- To separate a PCB populated with the LEDs, use a specially designed tool. Do not break the PCB by hand.
- If an aluminum-core PCB is used to operate the LEDs, it may cause thermal stress during operation causing damage to the solder joints (e.g. crack). Ensure that sufficient verification is performed prior to use.
- Volatile organic compounds that have been released from materials present around the LEDs (e.g. housing, packing, adhesive, secondary lens, lens cover, etc.) may penetrate LED lens and/or internal pre-coating resin. If the LEDs are being used in a hermetically sealed environment, these volatile compounds can discolor after being exposed to heat and/or photon energy and it may greatly reduce the LED light output and/or cause a color shift. In this case, ventilating the environment may improve the reduction in light output and/or color shift. Perform a light-up test of the chosen application for optical evaluation to ensure that there are no issues, especially if the LEDs are planned to be used in a hermetically sealed environment.
- When substances commonly found in ink adhere to the resin of this LED, it may change the material properties of the resin causing the radiant flux to decrease. Materials (e.g. dustproof glass cover) should be used to protect the LEDs.

(5) Electrostatic Discharge (ESD)

- This LED is sensitive to transient excessive voltages (e.g. ESD, lightning surge). If this excessive voltage occurs in the circuit, it may cause the LED to be damaged causing issues (e.g. the LED to have a reduction in the radiant flux or not to illuminate [i.e. catastrophic failure]).

Ensure that when handling the LEDs, necessary measures are taken to protect them from an ESD discharge. The following examples are recommended measures to eliminate the charge:

- Grounded wrist strap, ESD footwear, clothes, and floors
- Grounded workstation equipment and tools
- ESD table/shelf mat made of conductive materials
- Ensure that all necessary measures are taken to prevent the LEDs from being exposed to transient excessive voltages (e.g. ESD, lightning surge):
 - tools, jigs, and machines that are used are properly grounded
 - appropriate ESD materials/equipment are used in the work area
 - the system/assembly is designed to provide ESD protection for the LEDs
- If the tool/equipment used is an insulator (e.g. glass cover, plastic, etc.), ensure that necessary measures have been taken to protect the LED from transient excessive voltages (e.g. ESD). The following examples are recommended measures to eliminate the charge:
 - Dissipating static charge with conductive materials
 - Preventing charge generation with moisture
 - Neutralizing the charge with ionizers
- To detect if an LED was damaged by transient excess voltages (i.e. an ESD event during the system's assembly process), perform a characteristics inspection (e.g. forward voltage measurement) at low current ($\leq 1\text{mA}$).
- Failure Criteria: $V_F < 2.0\text{V}$ at $I_F = 0.5\text{mA}$
If the LED is damaged by transient excess voltages (e.g. ESD), it will cause the Forward Voltage (V_F) to decrease.

(6) Thermal Management

- The Absolute Maximum Junction Temperature (T_J) must not be exceeded under any circumstances. The increase in the temperature of an LED while in operation may vary depending on the PCB thermal resistance and the density of LEDs on the PCB assembly. Ensure that when using the LEDs for the chosen application, heat is not concentrated in an area and properly managed in the system/assembly.
- The operating current should be determined by considering the temperature conditions surrounding the LED (i.e. T_A). Ensure that when operating the LED, proper measures are taken to dissipate the heat.
- The following two equations can be used to calculate the LED junction temperature:

$$1) T_J = T_A + R_{\theta JA} \cdot W \quad 2) T_J = T_S + R_{\theta JS} \cdot W$$

* T_J =LED Junction Temperature: °C

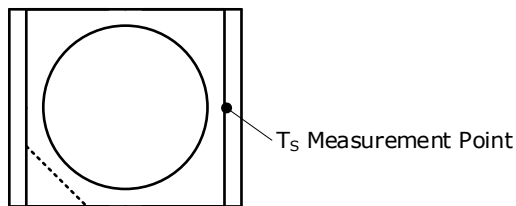
T_A =Ambient Temperature: °C

T_S =Soldering Temperature (Anode Side): °C

$R_{\theta JA}$ =Thermal Resistance from Junction to Ambient: °C/W

$R_{\theta JS}$ =Thermal Resistance from Junction to T_S Measurement Point: °C/W

W =Input Power($I_F \times V_F$): W



(7) Cleaning

- Do not clean the LEDs with water, benzine and/or thinner.
- To clean the LEDs, use isopropyl alcohol (IPA). If another solvent is used, it may cause the LED package/resin to be damaged causing issues; ensure that sufficient verification is performed prior to use. Additionally, ensure that the solvent being used does not cause any other issues (e.g. CFC-based solvents are heavily regulated).
- If an LED is contaminated (e.g. dust/dirt), use a cloth soaked with isopropyl alcohol (IPA). Ensure that the cloth is firmly squeezed before wiping the LED.
- Do not clean the LEDs with an ultrasonic cleaner. If cleaning must be done, ensure that sufficient verification is performed by using a finished assembly with LEDs to determine cleaning conditions (e.g. ultrasonic power, LED position on the PCB assembly) that do not cause an issue.

(8) Eye Safety

- There may be two important international specifications that should be noted for safe use of the LEDs: IEC 62471:2006 Photobiological safety of lamps and lamp systems and IEC 60825-1:2001 (i.e. Edition 1.2) Safety of Laser Products - Part 1: Equipment Classification and Requirements. Ensure that when using the LEDs, there are no issues with the following points:
 - LEDs have been removed from the scope of IEC 60825-1 since IEC 60825-1:2007 (i.e. Edition 2.0) was published. However, depending on the country/region, there are cases where the requirements of the IEC 60825-1:2001 specifications or equivalent must be adhered to.
 - LEDs have been included in the scope of IEC 62471:2006 since the release of the specification in 2006.
 - Most Nichia LEDs will be classified as the Exempt Group or Risk Group 1 according to IEC 62471:2006. However, in the case of high-power LEDs containing blue wavelengths in the emission spectrum, there are LEDs that will be classified as Risk Group 2 depending on the characteristics (e.g. radiation flux, emission spectrum, directivity, etc.)
 - If the LED is used in a manner that produces an increased output or with an optic to collimate the light from the LED, it may cause damage to the human eye.
- If an LED is operated in a manner that emits a flashing light, it may cause health issues (e.g. visual stimuli causing eye discomfort). The system should be designed to ensure that there are no harmful effects on the human body.
- This LED emits light in the ultraviolet (UV) region. The UV light from an LED while in operation is intense and harmful; if human eyes are exposed to this light, it may cause damage to them. Do not look directly or indirectly (e.g. through an optic) at the UV light. Ensure that if there is a possibility that the UV light reflects off objects and enters the eyes, appropriate protection gear (e.g. goggles) is used to prevent the eyes from being exposed to the light.
- Ensure that appropriate warning signs/labels are provided both on each of the systems/applications using the UV LEDs, in all necessary documents (e.g. specification, manual, catalogs, etc.), and on the packaging materials.

(9) Miscellaneous

- Nichia warrants that the discrete LEDs will meet the requirements/criteria as detailed in the Reliability section within this specification. If the LEDs are used under conditions/environments deviating from or inconsistent with those described in this specification, the resulting damage and/or injuries will not be covered by this warranty.
- Nichia warrants that the discrete LEDs manufactured and/or supplied by Nichia will meet the requirements/criteria as detailed in the Reliability section within this specification; it is the customer's responsibility to perform sufficient verification prior to use to ensure that the lifetime and other quality characteristics required for the intended use are met.
- The applicable warranty period is one year from the date that the LED is delivered. In the case of any incident that appears to be in breach of this warranty, the local Nichia sales representative should be notified to discuss instructions on how to proceed while ensuring that the LED in question is not disassembled or removed from the PCB if it has been attached to the PCB. If a breach of this warranty is proved, Nichia will provide the replacement for the non-conforming LED or an equivalent item at Nichia's discretion. **FOREGOING ARE THE EXCLUSIVE REMEDIES AVAILABLE TO THE CUSTOMER IN RESPECT OF THE BREACH OF THE WARRANTY CONTAINED HEREIN, AND IN NO EVENT SHALL NICHIA BE RESPONSIBLE FOR ANY INDIRECT, INCIDENTAL OR CONSEQUENTIAL LOSSES AND/OR EXPENSES (INCLUDING LOSS OF PROFIT) THAT MAY BE SUFFERED BY THE CUSTOMER ARISING OUT OF A BREACH OF THE WARRANTY.**
- **NICHIA DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.**
- This LED is intended to be used for general lighting, household appliances, electronic devices (e.g. mobile communication devices); it is not designed or manufactured for use in applications that require safety critical functions (e.g. aircraft, automobiles, combustion equipment, life support systems, nuclear reactor control system, safety devices, spacecraft, submarine repeaters, traffic control equipment, trains, vessels, etc.). If the LEDs are planned to be used for these applications, unless otherwise detailed in the specification, Nichia will neither guarantee that the LED is fit for that purpose nor be responsible for any resulting property damage, injuries and/or loss of life/health. This LED does not comply with IATF 16949 and is not intended for automotive applications.
- The customer will not reverse engineer, disassemble or otherwise attempt to extract knowledge/design information from the LED.
- All copyrights and other intellectual property rights in this specification in any form are reserved by Nichia or the right holders who have granted Nichia permission to use the content. Without prior written permission from Nichia, no part of this specification may be reproduced in any form or by any means.
- Both the customer and Nichia will agree on the official specifications for the supplied LEDs before any programs are officially launched. Without this agreement in writing (i.e. Customer Specific Specification), changes to the content of this specification may occur without notice (e.g. changes to the foregoing specifications and appearance, discontinuation of the LEDs, etc.).

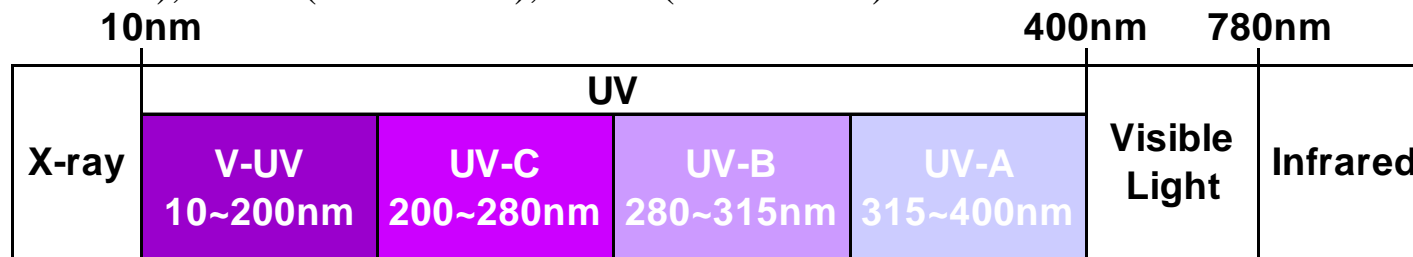
Handling Precautions for Ultraviolet Light (UV-LEDs)

● About Ultraviolet Light:

Ultraviolet rays have shorter wavelengths than visible light, generally in the 100-400nm range.

There are three categories depending on the wavelength:

UV-C (200-280nm), UV-B (280-315nm), UV-A (315-400nm)



The key features of UV-C, UV-B, and UV-A are summarized below.

UV-C (200 to 280nm):

It is absorbed by the atmospheric layer (the ozone layer) and therefore does not normally reach the earth's surface. Due to its strong disinfectant properties, it is highly dangerous to living organisms.

UV-B (280-315nm):

Most of this is absorbed by the atmospheric layer (99.5%) though some reaches the surface and is harmful to skin and eyes. This can cause sunburns and skin cancer.

UV-A (315-400nm):

Approximately 5.6% passes through the atmospheric layer without being absorbed and reaches the surface. Although it is not as harmful as UV-B, prolonged exposure may affect health.

Handling Precautions for Ultraviolet Light (UV-LEDs)

● Dangers of ultraviolet rays (eye damage)

Intense ultraviolet is dangerous to the eyes and can cause snow blindness (photokeratitis), ultraviolet eye infections (electro-optic ophthalmitis), cataracts, pterygium, and pinguecula. For environments where workers are exposed to ultraviolet light, protective eyewear is an effective way to protect the eyes from exposure. To prevent UV rays from entering the eyes from the sides, it is better to use protective glasses that can cover the whole eye (i.e. goggles). Then the exposure risk is reduced.

For reference, the following is a list of the protective glasses that Nichia uses.

No.	Part Number	Lens Color	Visible Light Transmittance [%]	Wavelength [nm]	Optical Density [OD]
1	YL-335-EX/He-Cd	Yellow	75%	193-442	>10
2	YL-717-EX	Clear	85%	190-380	>10

● Dangers of ultraviolet rays (skin damage)

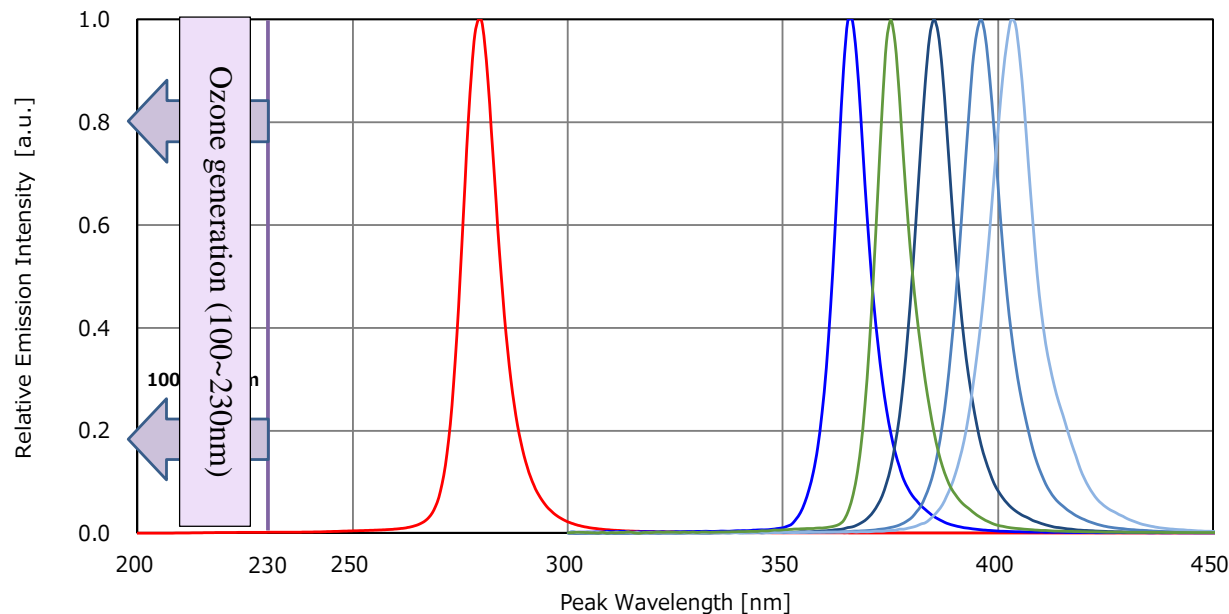
Proteins are one of the most important components of living organisms. Ultraviolet rays can denature proteins. When the skin is exposed to UV light, it damages collagen fibers and elastic fibers. This results in aging of the skin, damage to DNA, and risk of skin cancer. Avoid exposure of the skin to UV rays (e.g. gloves, thick long sleeves, wear a mask, etc.).

Handling Precautions for Ultraviolet Light (UV-LEDs)

● Ozone generation from UV rays

At wavelengths of 100-230nm, it can react with oxygen in the air to produce ozone. Ozone is a powerful oxidizing agent (several times more powerful than chlorine). Due to its powerful oxidizing properties, ozone can deteriorate rubber and plastics and may affect the human body depending on the concentration.

The figure below shows examples of the spectrums for Nichia's UV products. It shows that Nichia's UV products do not pose a risk for ozone generation.



Handling Precautions for Ultraviolet Light (UV-LEDs)

● Summary

When working in an environment that has the potential to expose workers to ultraviolet radiation, the workers should cover their skin and eyes with protective equipment (e.g. wearing protective glasses, arm covers, thick long sleeves, protective head gear, and a mask) to avoid ultraviolet radiation exposure during work. Wearing the proper protective equipment is an effective measure against exposure.

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Assembly Precautions for LEDs with an Integrated Lens

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The series names of the lensed LEDs described in this application note (e.g. x19C series) is a number common to multiple part numbers which is used only to help customers easily identify the group of part numbers that is discussed, it is not a trademark.

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.



Figure 1: Examples of the appearance of SMD LEDs with various lenses

2. 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.

3. Countermeasures

3.1 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:

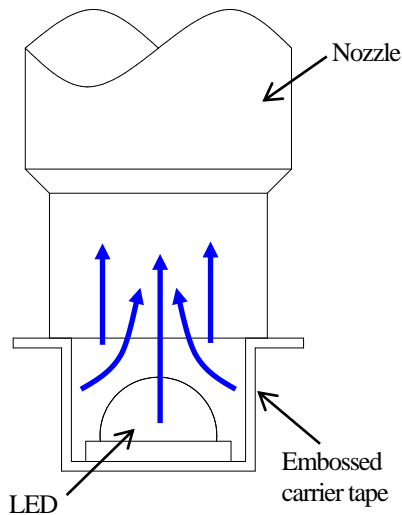
One method is to stop the pick-and-place nozzle on the top surface or the middle surface of the embossed carrier tape and pull air in from the top/middle surface to grab the LED in the air (i.e. aerial position pick-up). The other is a method in which a pick-and-place nozzle is inserted into the embossed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

Method 1:

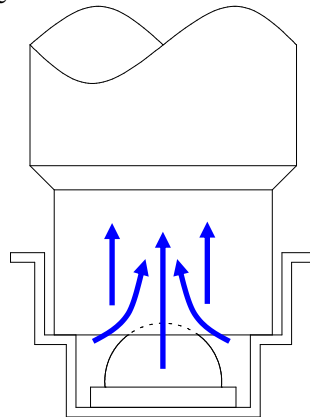
Aerial position pick-up: By suctioning air from the height at which the nozzle does not contact the LED, the only load that will be applied to the lens is the suction force at the time of suction.

Method 2:

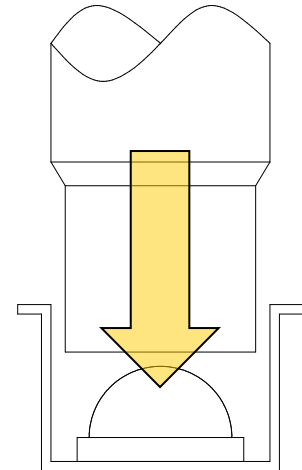
Typical position pick-up: Where aerial position pick-up is not possible or difficult, stable suction is made possible by bringing the nozzle closer to the LED and then applying suction.



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 2: Aerial position pick-up


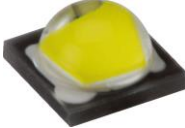
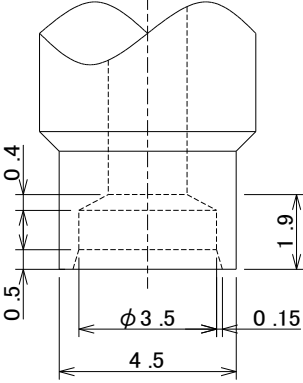
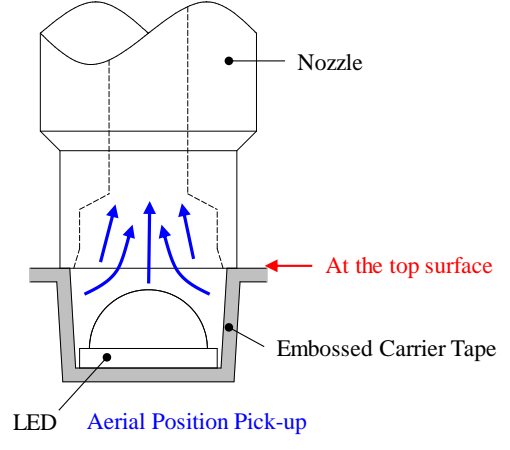
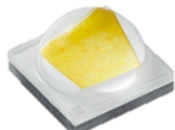
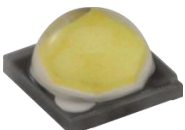
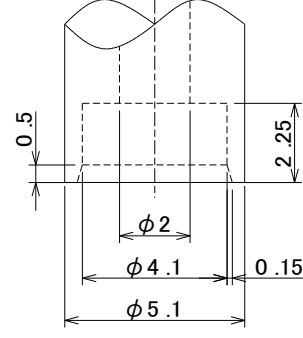
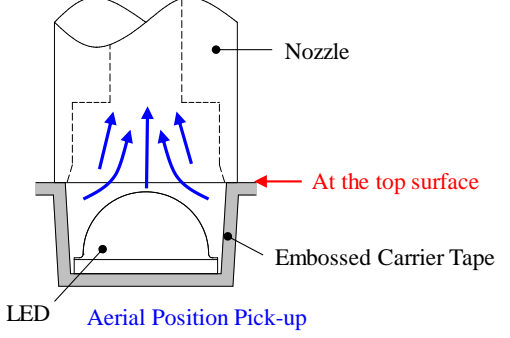


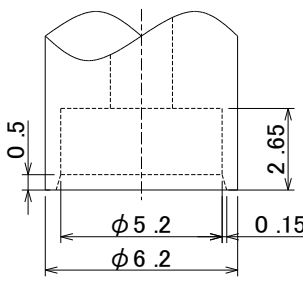
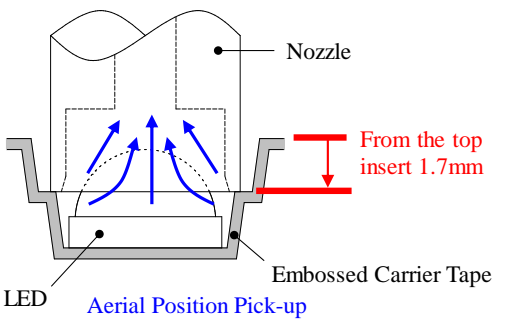
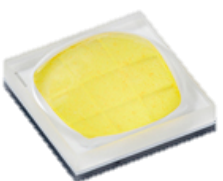
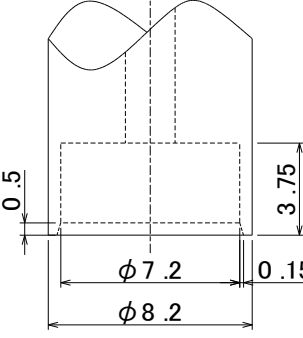
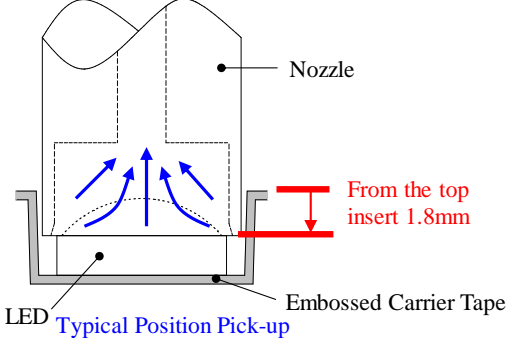
Figure 3: Typical position pick-up

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 1 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 1: Examples of nozzle shape and pick-up method

Unit: mm

LED		Recommended Nozzle	Pick-up Method (Pick-up Position)
<p>x19B series</p>  <p>3.5×3.5×2mm 0.03g (TYP)</p>	<p>x19C series</p>  <p>3.5×3.5×2mm 0.03g (TYP)</p>	 <p>0.4 0.5 1.9 φ 3.5 4.5 0.15</p>	 <p>Nozzle</p> <p>At the top surface</p> <p>Embossed Carrier Tape</p> <p>LED Aerial Position Pick-up</p>
<p>x19D series</p>  <p>3.5×3.5×2.3mm 0.03g (TYP)</p>	<p>3x9A series</p>  <p>3.5×3.5×2.1mm 0.03g (TYP)</p>	 <p>0.5 2.25 φ 2 φ 4.1 φ 5.1 0.15</p>	 <p>Nozzle</p> <p>At the top surface</p> <p>Embossed Carrier Tape</p> <p>LED Aerial Position Pick-up</p>
<p>229A series</p>  <p>4.0×4.0×2.3mm 0.05g (TYP)</p>	<p>144A series</p>  <p>5×5×3.15mm 0.09g (TYP)</p>	 <p>0.5 2.65 φ 5.2 φ 6.2 0.15</p>	 <p>Nozzle</p> <p>From the top insert 1.7mm</p> <p>Embossed Carrier Tape</p> <p>LED Aerial Position Pick-up</p>
<p>149A series</p>  <p>7×7×3.1mm 0.19g (TYP)</p>	<p>Recommended Nozzle</p>  <p>0.5 3.75 φ 7.2 φ 8.2 0.15</p>	<p>Pick-up Method (Pick-up Position)</p>  <p>Nozzle</p> <p>From the top insert 1.8mm</p> <p>Embossed Carrier Tape</p> <p>LED Typical Position Pick-up</p>	

Light Emitting Diode

LED		Recommended Nozzle	Pick-up Method (Pick-up Position)
385A series	585A series		
 4×3.6×2.05mm 0.04g (TYP)	 4×3.6×2.05mm 0.04g (TYP)		

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 4. The setting screen for fine positioning of the pickup nozzle displays the pocket hole on the top left side.



Figure 4: Yamaha YS mounter's pick-up nozzle positioning screen (Reference)

3.2 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.

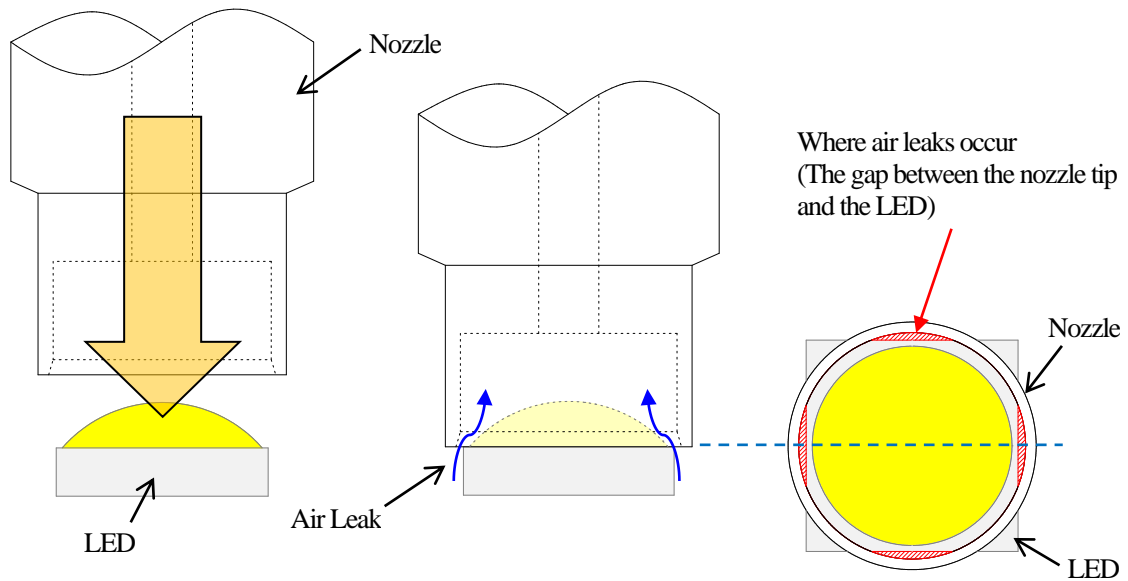


Figure 5: Air leak at the time of LED pick-up (example: part number NV9W149AM)

3.3 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.

3.3.1 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.

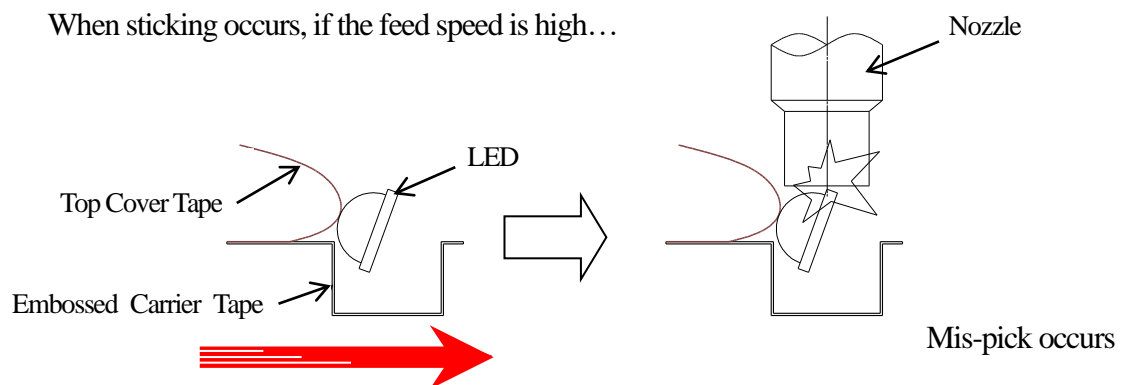


Figure 6: Tape feeder feed rate (fast)

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.

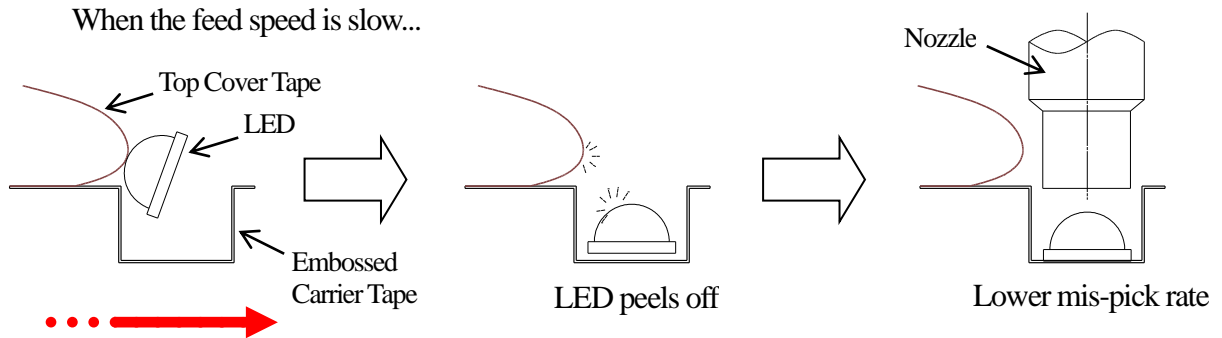


Figure 7: Tape feeder feed rate (slow)

Example: The screen of the Yamaha YS mounter for adjusting the feed rate is shown for reference in Figure 8 (in the red box). This pick-and-place machine has several options for the feed rate (e.g. “Normal”, “90%”, “80%”, “70%”, etc.).

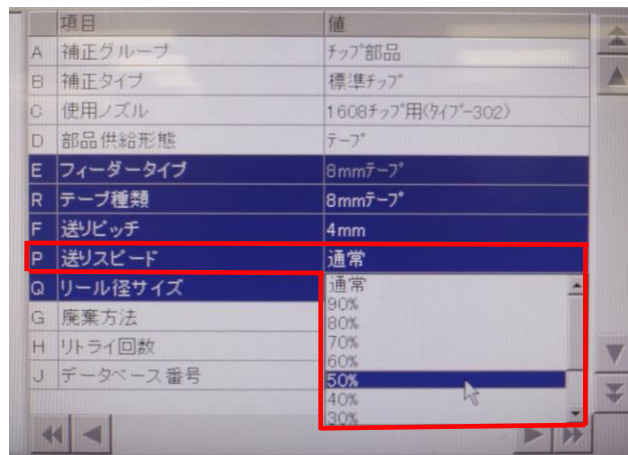


Figure 8: Yamaha YS mounter screen (Reference)

3.3.2 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.

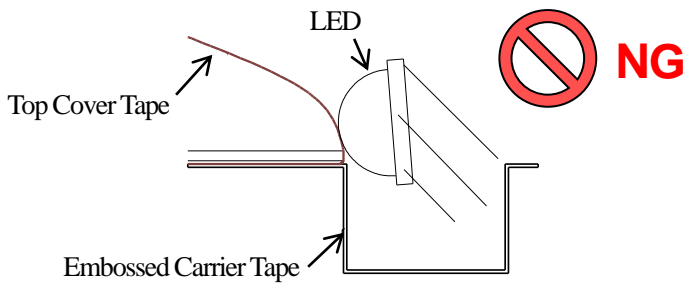


Figure 9: Peeling off the top cover tape at an obtuse angle

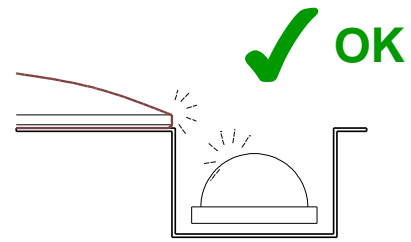


Figure 10: Removing the top cover tape at an acute angle

3.4 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.

3.4.1 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.

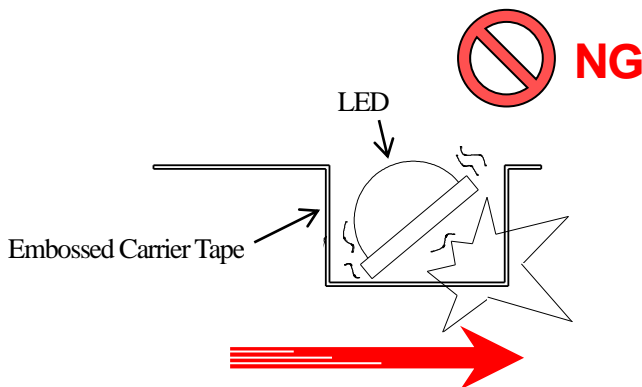


Figure 11: When the speed is fast

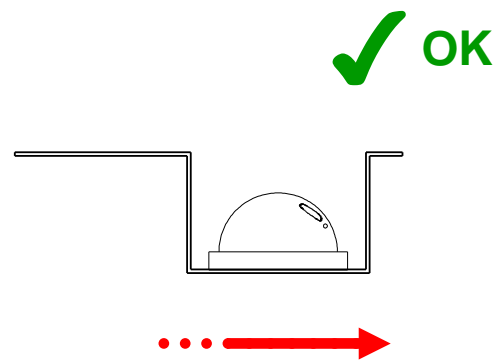


Figure 12: When the speed is slow

3.4.2 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 13 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.

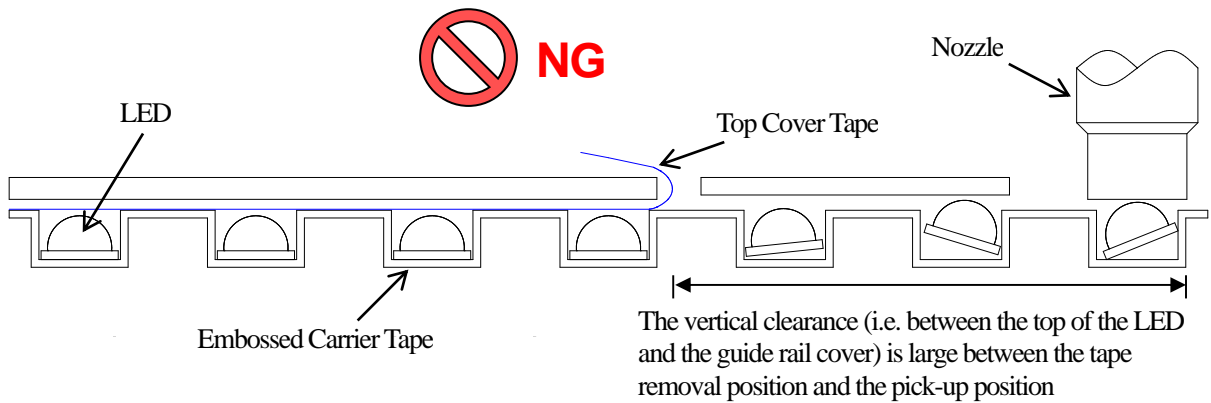


Figure 13: Removing the top cover tape at the typical position

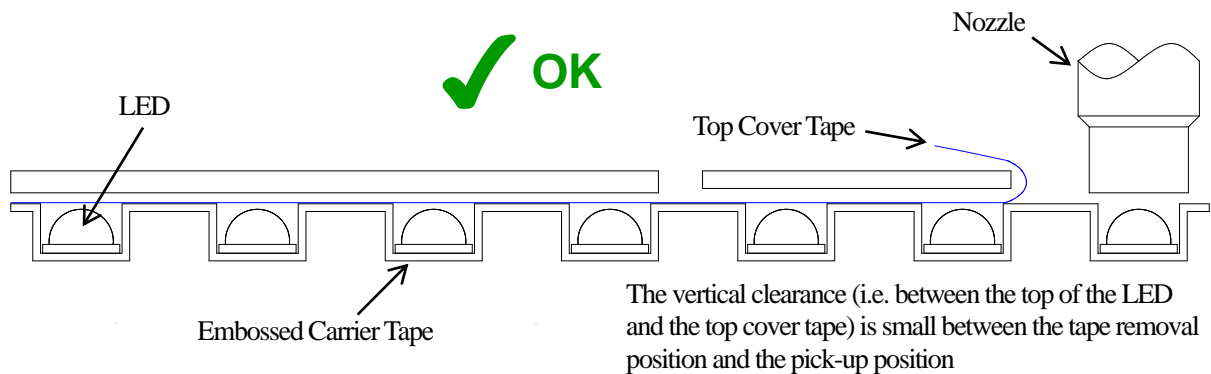
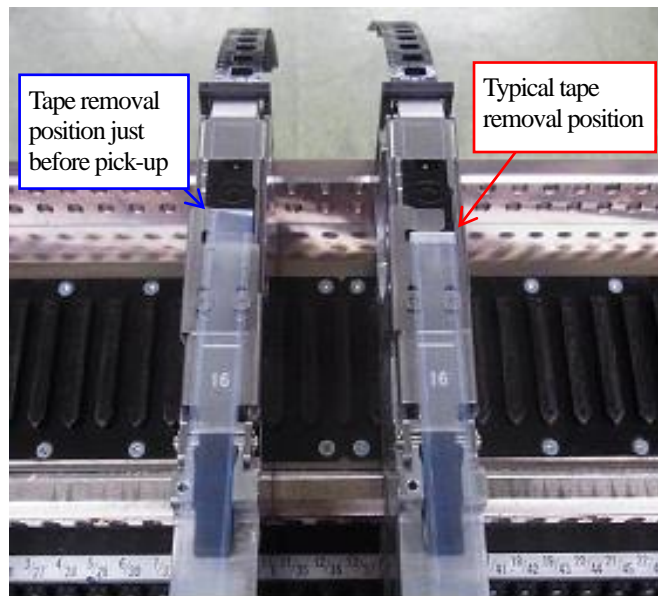


Figure 14: Removing the top cover tape just before pick-up

Example: The top cover tape removal position of the Yamaha YS mounter is shown for reference in Figure 15.



Yamaha YS Mounter (Reference)

Figure 15: 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.

4. 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.

5. 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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