CrayoNano®

CrayoLED™
UV-C LED

UV-C LED PRODUCT INFORMAITON

www.crayonano.com
sales@crayonano.com
+47 72 58 00 50

CrayoNano AS
Sluppenvegen 6, 7037 Trondheim, Norway

CrayoLED™ UV-C LED

HE-SERIES Evolution 1 | CLH1-N3S

The CrayoLED™ H-series Evolution I (HE) UV-C LED (CLH1-N3S) is developed upon the feature of its predecessor, offering customers reliable and consistent quality for the applications - ideal for UV-C applications including surface disinfection and air and water purification.

FEATURES & BENEFITS

Package Size (L x W x H): 3.5 mm x 3.5 mm x 1.75 mm

Peak Wavelength (typ.): 275 nm

L70 Estimated Lifetime: 15,000 hours

Wall Plug Efficiency: 5.4 %

Built-in ESD Protection Zener Diode: 5 kV

RoHS, and IEC-62471 Compliant

APPLICATIONS

Water purification

Grey water reuse

Air purification

Surface disinfection

Food processing

Life sciences

Specifications may change without notice due to continuous improvements and innovations.

Electrical - Optical Characteristics at T_A= 25 °C[1] and I_F = 350 mA

Parameter (Typical)	Symbol	Min	Typ.	Max	Unit
Peak Wavelength	λ_P		275		nm
Forward Voltage	V_F		5.8		V
Spectrum Half-width	Δλ		11		nm
Viewing Angle	$2\Phi_{1/2}$		120		degrees
Thermal Resistance (junction – solder point)	$R_{\theta JS}$		6		°C/W

Note 1: T_A = Ambient temperature, °C
Equipment and processes:

- Measurement test setup were done using a LED mounted on a star MCPCB board, $R_{\theta JB}$ = 12 °C/W
- Variations of test conditions and utilization of other equipment may result in deviation of the specified values. All LEDs are tested by CrayoNano's industry approved measurement. Values are for reference only.

Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Forward Current T_A = 25°C	I_F	500	mA
Power Dissipation T_A = 25°C	P_D	3	W
Operating Temperature[1]	T_{opr}	-40~85	°C
Junction Temperature	T_J	110	°C
Storage Temperature	T_{stg}	-40~100	°C
ESD[2]	V_{ESD}	5	kV

Note 1: Operating Temperature (T_{opr}) represents the temperature of the surface onto which the package is mounted on
Note 2: ESD testing method : EIAJ4701/300 (304) Human Body Model (HBM) 1.5 kΩ,100 pF
Note 3: The LED is not designed for reverse operation.
Additional notes:

1. Tolerance is as follows:
   - Radiant Flux: ± 7 %
   - Peak Wavelength: ±3 nm
2. Equipment and processes.
   - Measurement test setup were done using a LED mounted on a star MCPCB board, $R_{\theta JB}$ = 12 °C/W
   - Variations of test conditions and utilization of other equipment may result in deviation of the specified values. All LEDs are tested by CrayoNano's industry approved measurement. Values are for reference only.
3. Operating the LED at or beyond the listed maximum ratings for prolonged periods of time may affect device reliability and cause permanent damage.

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Bin Code Structures at T_A = 25°C, I_f = 350 mA

Radiant Flux Bins (Φ [mW])[1]		
Group	Minimum Radiant Flux	Maximum Radiant Flux
AA	70	80
AB	80	90
AC	90	100
AD	100	110
BA	*110*	*120*

Wavelength (Peak λ [nm])[1]		
Group	Minimum Wavelength	Maximum Wavelength
1	270	280

Forward Voltage Groups (V_F [V])		
Group	Minimum Forward Voltage	Maximum Forward Voltage
1A	5.0	5.5
1B	5.5	6.0
1C	6.0	6.5
1D	6.5	7.0

Bin Code on Label

Example: AA – 1 – 1B

Radiant Flux	Peak Wavelength	Forward Voltage
AA	1	1B

Note 1: The primary bins available are in black font. The bin distribution per shipment will be decided by CrayoNano. Other wavelength bins may be available in the future. Please contact sales for further information.

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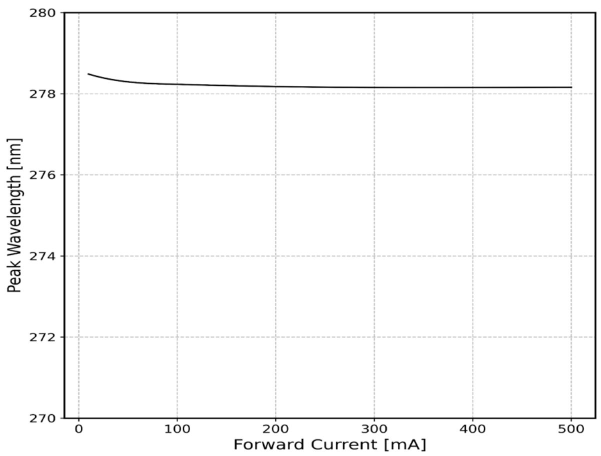
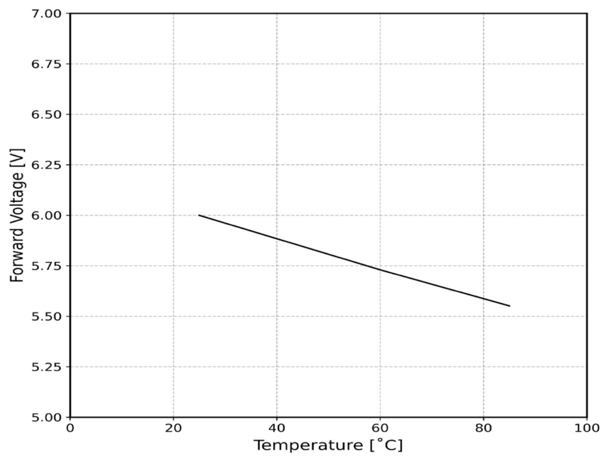
Typical Characteristic Curves

PEAK WAVELENGTH VS FORWARD CURRENT



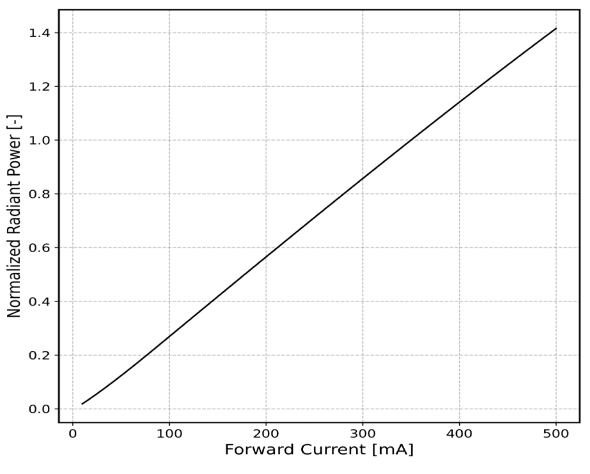
Test Conditions: T_A = 25 °C, I_{FP} = 350 mA

FORWARD VOLTAGE VS AMBIENT TEMPERATURE



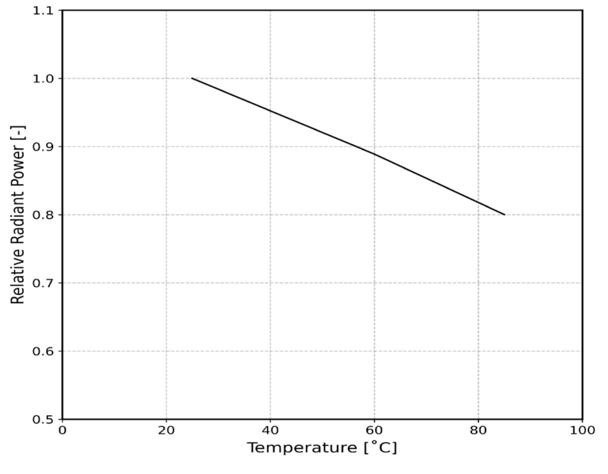
Test Conditions: I_{FP} = 350 mA

RELATIVE RADIANT FLUX VS FORWARD CURRENT



Test Conditions: T_A = 25 °C, I_{FP} = 350 mA

RELATIVE RADIANT FLUX VS AMBIENT TEMPERATURE



Test Conditions: I_{FP} = 350 mA

Note 1: All characteristics shown are for reference only and are not guaranteed.

Equipment and processes:

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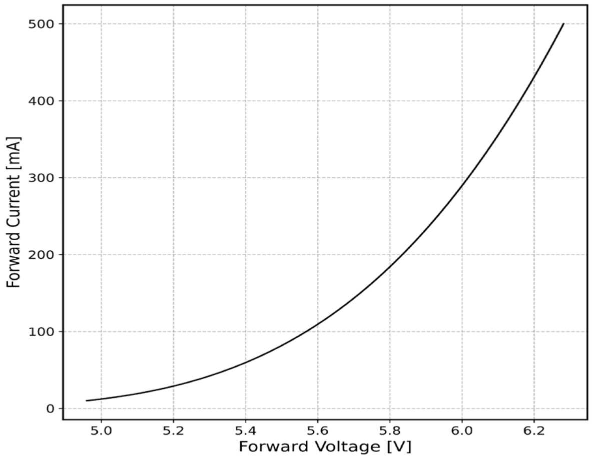
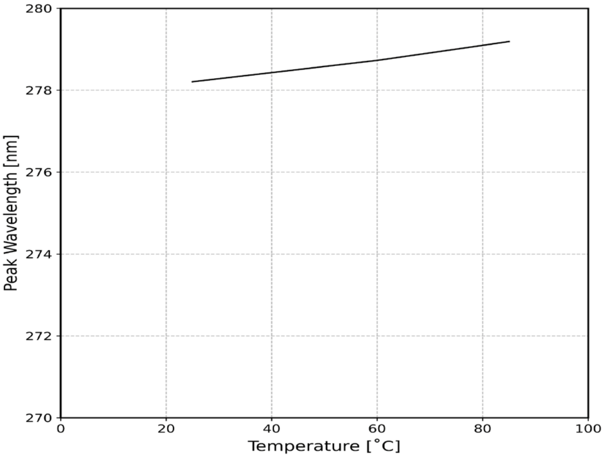
Typical Characteristic Curves

FORWARD CURRENT VS FORWARD VOLTAGE



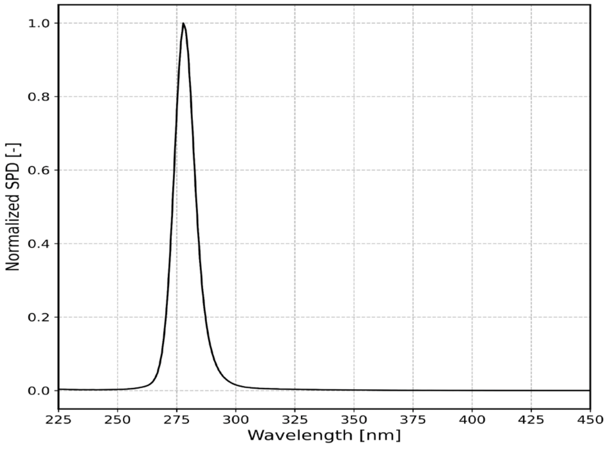
Test Conditions: T_A = 25 ℃, I_{FP} = 350 mA

PEAK WAVELENGTH VS AMBIENT TEMPERATURE



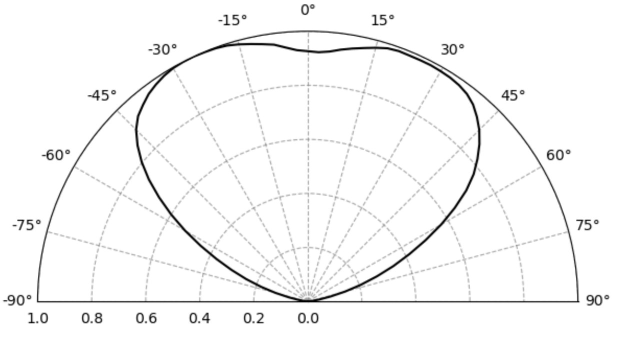
Test Conditions: I_{FP} = 350 mA

SPECTRUM



Test Conditions: T_A = 25 ℃, I_{FP} = 350 mA

RADIATION PATTERN



Test Conditions: T_A = 25 ℃, I_{FP} = 350 mA

Note 1: All characteristics shown are for reference only and are not guaranteed.

: Equipment and processes:

- Measurement test setup were done using a LED mounted on a star MCPCB board, RθJS = 12˚C/W
- Variations of test conditions and utilization of other equipment may result in deviation of the specified values. All LEDs are tested by CrayoNano's industry approved measurement. Values are for reference only.

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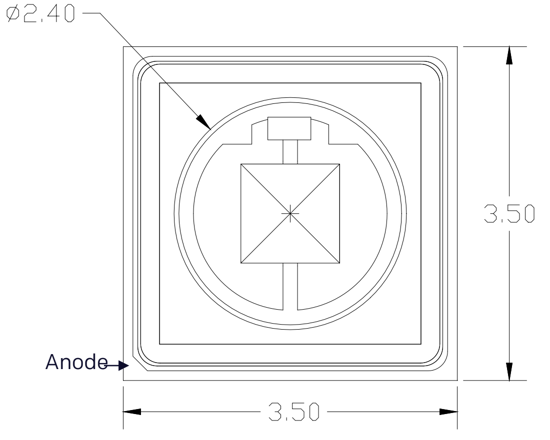
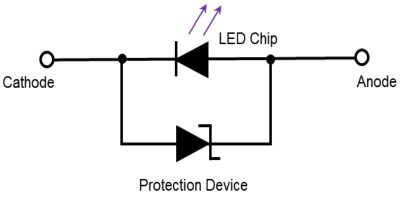
Mechanical dimensions (Unit: mm, Tolerance: ±0.2)

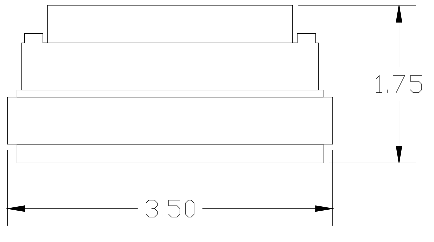
TOP VIEW



Packaged LED Circuit



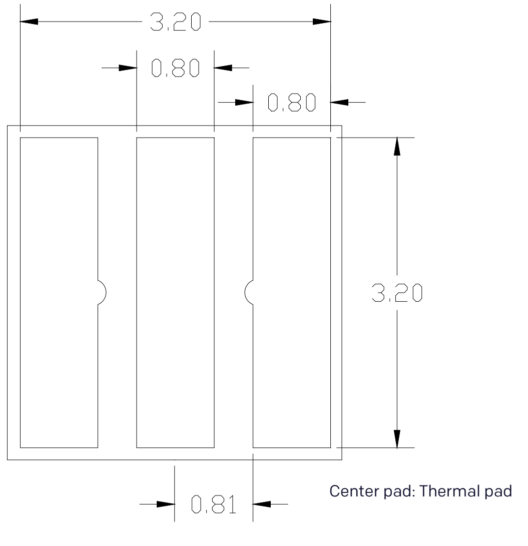
SIDE VIEW



DETAILS:

- Substrate Material: AlN
- Glass Window Material: Quartz
- Electrodes Material: Au

BOTTOM VIEW



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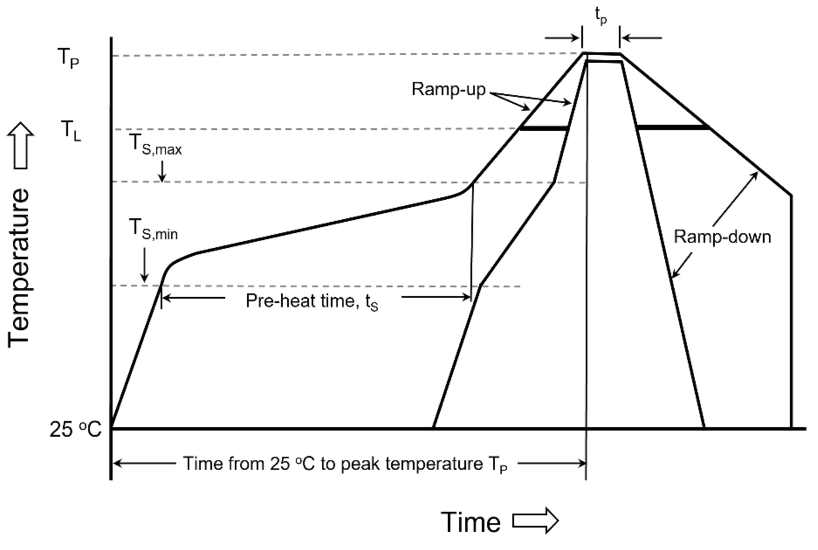
Recommended Soldering Guidelines

Recommended Reflow Soldering Conditions	Solder Pattern



Profile Feature	**Pb-Free Assembly** (SnAgCu)
Ramp-up rate (from $T_{S,max}$ to T_P)	1 °C/second max.
Minimum pre-heat temperature ($T_{S,min}$)	100 °C - 150 °C
Maximum pre-heat temperature ($T_{S,max}$)	180 °C - 200 °C
Pre-heat time (from $T_{S,min}$ to $T_{S,max}$)	60 – 120 seconds
Liquid phase temperature (T_L)	217 °C
Time to maintain temperature above T_L	50 – 80 seconds
Peak temperature of the package (T_P)	260 °C
Time to develop within 5 °C of peak temperature (t_p)	20 – 40 seconds
Ramp-down rate (from T_P to T_L)	3 °C/second max.
Time from 5 °C to peak temperature	maximum 4 minutes

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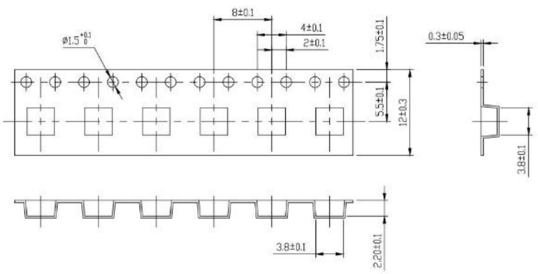
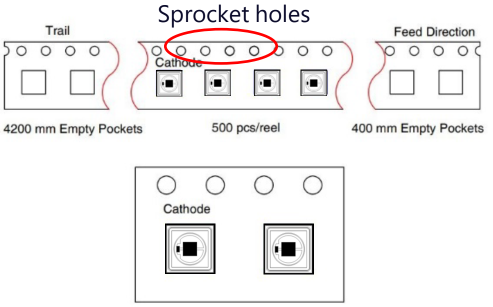
Packing Structure

Reeled moisture sensitive products (qty : 500 pcs) are packed in a dry bag containing desiccant and a humidity card per JEDEC-STD-033.

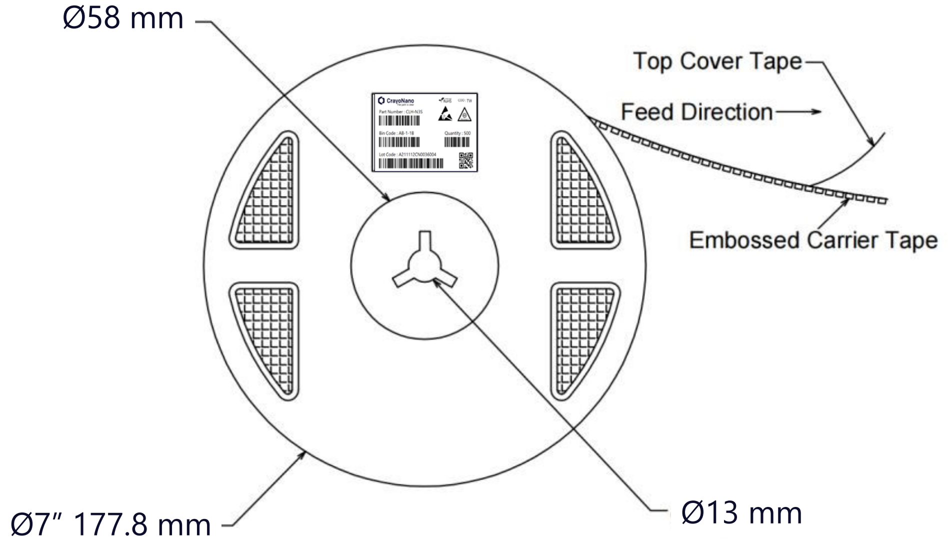
One reel shipped per cardboard carton (L x W x H dimensions: 225 x 205 x 40 mm).

Taping





Tape and Reel



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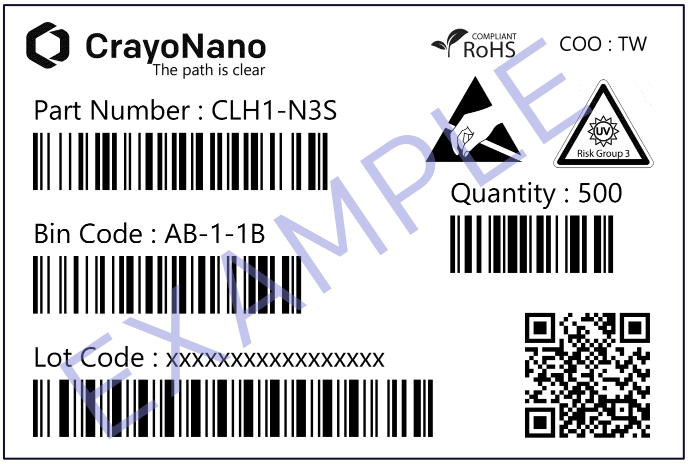
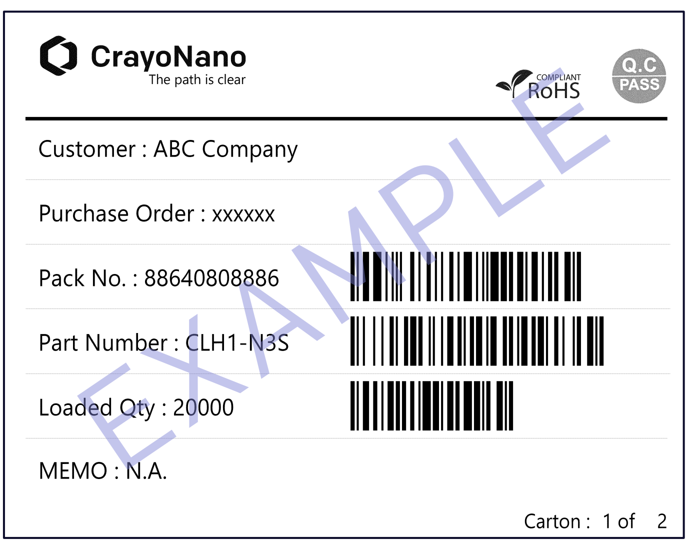
Product Label

Tape/Reel Label: Specifying Part Number, Bin Code, Lot Code and Quantity



Shipping box label: Specifying Customer, Purchase Order, Pack Number, Part Number, Quantity and Outbox ID



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Cautions on Use

Moisture Barrier Bags

- Product complies with JEDEC MSL 3 or equivalent and is shipped in moisture barrier bags (with silica desiccant).
- Absorbed moisture in the LED package may vaporize and expand during soldering, which can damage the optical characteristics of the LEDs.

Storage

- Always store packaged LEDs inside the moisture barrier bags (with desiccant) when not being used in order to minimize moisture absorption.
- Any unused LEDs should be stored in moisture barrier bags with absorbent material or desiccants.
- If LEDs have exceeded the storage time or the desiccants have faded or expired, we recommend baking the LEDs at 60 deg. C for at least 24 hours.
- LEDs should be kept away from volatile organic compounds as well as hazardous, acidic, and corrosive substances such as sulfur, chlorine, hydrofluoric acid, etc. Failure to do so may result in mechanical degradation of the LED package and/or decrease in electrical and optical performance.
- Avoid exposure to sudden temperature changes or high humidity levels.
- Avoid condensation.

	Conditions	Temperature	Humidity	Time
Transportation Storage	Before Opening Aluminum Bag	18 ℃ ~ 30 ℃	30-60 % RH	Within 15 months from Delivery Date
Baking	LED has been left outside of Aluminuim bag for an extended time	60 ℃ ± 5 ℃	< 10 % RH	At least 24 hours

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Cautions on Use

Cleaning

- Do not clean the LEDs without testing the cleaning process. Improper cleaning may damage the LED.
- Pretests should be conducted with the actual cleaning process and cleaning agents to validate that the process will not damage the LEDs.
- Do not clean LEDs using excessive mechanical force.
- Refer to application notes for recommended cleaning methods.

Thermal Management

- Thermal management and proper heat dissipation is extremely important for the design and the use of the LED. It will greatly affect the performance and reliability of the UV-C LED package and must be seriously considered throughout the lifetime of the LED.
- The Absolute Maximum Junction Temperature (T_J) as specified in the Product Specification (page 3) must not be exceeded under any circumstances.
- The LED's junction temperature may vary while in operation and is dependent on the module/system design, including but not limited to: PCB thermal resistance, the LED's density on the PCB assembly, thermal interface material specification, circuit material, PCB structure, ambient temperature and condition, etc.
- Ensure that when using the LEDs for the chosen application, heat is not concentrated in any particular area and is 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.
- To calculate the LED's junction temperature, the following two formulas can be used:

1) $T_J = T_A + R_{\theta JA} \times W$

2) $T_J = T_s + R_{\theta JS} \times W$

T_J = LED Junction Temperature: °C

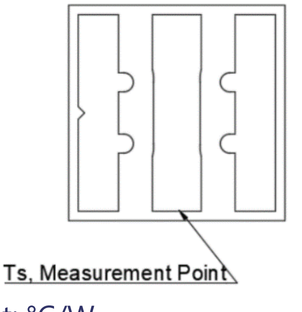
T_A = Ambient Temperature: °C

T_s = Soldering Point Temperature (Die Heat Sink): °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



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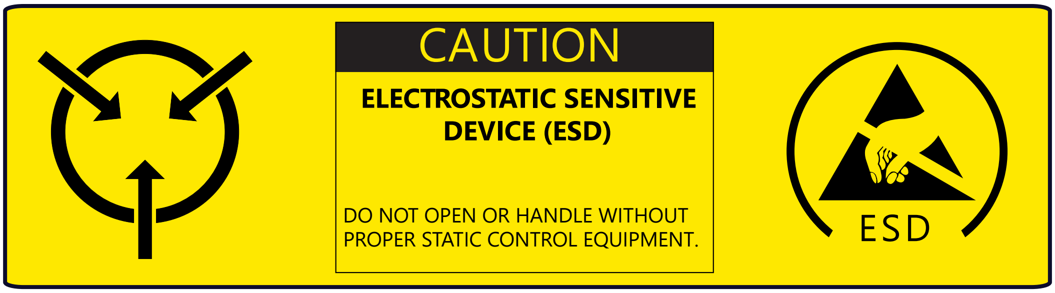
Cautions on Use

Electrostatic Discharge (ESD)

- The LEDs are sensitive to static electricity or surge voltage.
- If excessive current or voltage occurs in the circuit , it may damage the LED.
- When handling LEDs, the following measures against ESD are actively recommended:
  - grounded wrist strap, ESD footwear, clothes and floor
  - grounded workstation equipment and tools
  - ESD table/shelf mat made of conductive materials
- Ensure that LEDs are not exposed to transient excessive voltage (e.g., ESD, lightning surge):
  - tools, jigs and machines are properly grounded
  - appropriate ESD materials and equipment are used in the work area
  - the system/assembly is designed to provide ESD protection for the LED
- To avoid electrostatic discharge when using tools or equipment with glass or plastic insulation:
  - dissipate static charge with conductive materials
  - prevent charge generation with moisture
  - neutralize the charge with ionizers



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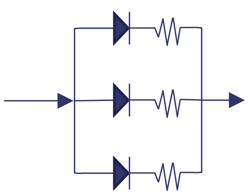
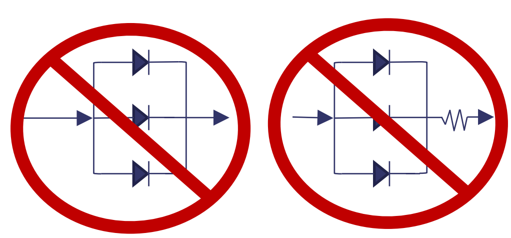
Cautions on Use

Recommended Circuit

- The circuit must be designed to ensure that the Absolute Maximum Ratings are not exceeded for each LED.
- Each LEDs must be operated at a constant current condition, preferably using a driver IC controller.
- The LED is designed to operate at a forward current. Operating LEDs using reverse current or reverse voltage can damage the Zener diode and potentially cause device failures and strongly not recommended. If the LEDs are used in an environment where reverse voltages are applied continuously, electrochemical migration may damage the LED.
- Ensure that no voltage is applied in the forward/reverse direction while the LED is OFF. When not in use for a long period of time, the system's power should be turned OFF to avoid electrical surge that can damage the LEDs.
- LEDs are sensitive to driving current surge. It is strongly recommended to integrate protection circuitry. Slight voltage shifts may cause a forward current change leading to LED burn out. Ensure that transient excessive voltage (e.g., lightning surge) is not applied to the LEDs.
- In general, individual LEDs may have a varying forward voltage. Different forward voltages in parallel connections via a single resistor can result different forward currents to each LED, which can output different radiant flux values.
- Matrix circuits with a single resistor for each LED are recommended to avoid radiant flux fluctuations.
- LEDs may be operated in a series connection with a single constant current source. Please note that one LED failure can affect the system.
- If the LEDs are used for outdoor application, ensure that necessary measures are taken (e.g., protecting the LED from water, salt and high humidity).



Recommended circuit in series connection



Circuits without individual resistors for each LED, have potential exposure to current surges.

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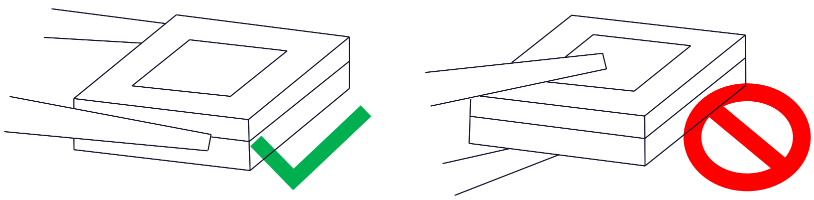
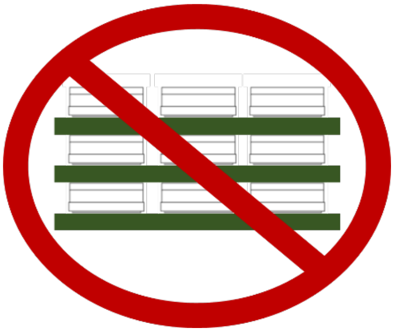
Cautions on Use

Handling Precautions

- **Refer to CrayoNano's Application Note: Handling, Processing and Usage document**
- Do not handle the LEDs with bare hands
- Avoid contaminating the LED's surface, which may affect the optical characteristics
- CrayoNano recommends the use of vacuum tweezers, plastic tweezers, or Teflon coated tweezers when handling the LED package manually
  - When manually handling the product with tweezers, only contact the side of the package and be careful not to apply excessive force to the glass. The glass can be cut, deformed, and/or chipped, potentially causing mechanical damage and catastrophic failures.



- When populating boards in SMT production avoid excessive mechanical pressure on the product.
- Test and verify materials in the system or assembly (for example: the PCB) before use.
- Do not stack boards, assemblies with LEDs mounted on them. When boards are stack on top of another, the glass may get damaged, resulting in a scratch , chip or detachment of the glass, leading to defect and potential performance degradation.



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Cautions on Use

Eye Safety

- The evaluation of eye safety occurs according to the standard IEC 62471:2006 (Photo biological safety of lamps and lamp systems). CrayoNano's UV-C LED is classified as Risk Group 3 according to IEC 62471:2006. when operating at nominal operating conditions.
    - When operating conditions are below or above the recommended nominal current (for example: with an optic or higher driving current) the risk group classification will be out of the scope of CrayoNano's test classification and will need to be tested by customer.
- During operation, the LED emits high intensity ultraviolet (UV) light, which is intense, hazardous and harmful to skin and eyes. UV Light is also a known potential carcinogen. If human eyes or skin are exposed to this light, it may cause damage to them.
    - Avoid direct or indirect exposure to UV light when LED is operational (i.e.: through an optical device or microscope.
    - Precautions must be taken with the use of UV light protective glasses and proper skin protection.
- Attach warning labels on products/systems that use UV LEDs and in all necessary documents (e.g., specification, manual, catalogues) and on packaging materials.

CAUTION: UV RISK GROUP 3

RoHS/REACH Compliance

Our products are RoHS and RoHS 3 compliant, which took effect 2019 July 22, and Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) directive 1907/2006 EC as related to the restriction of the use of certain hazardous substances in electrical and electronic equipment.

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- Each user must identify and perform all tests and analyses necessary to ensure that it's finished application incorporating CrayoNano products will be safe and suitable for use under end-use conditions.
- Each user of devices assumes full responsibility to become educated in and to protect from harmful irradiation.
- CrayoNano specifically disclaims all liability for harm arising from buyer's use or misuse of UV-C devices either in development or end-use.
- The customer will not reverse engineer , disassemble or otherwise attempt to extract knowledge /design information from the LED.
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Glossary

1) **LED**: A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The wavelength of the emitted light is determined by the energy gap of the semiconductor.
2) **Forward Voltage**: The forward voltage is measured during a current pulse of typically 25 ms, with an internal reproducibility of ±0.05 V and an expanded uncertainty of ±0.1 V (acc. to GUM with a coverage factor of k = 3).
3) **Thermal Resistance**: Rth max is based on statistic values (6 σ).
4) **Typical Values**: Due to the special conditions of the manufacturing processes of semiconductor devices, the typical data or calculated correlations of technical parameters can only reflect statistical figures. These do not necessarily correspond to the actual parameters of each single product, which could differ from the typical data and calculated correlations or the typical characteristic line.
5) **Characteristic curve**: In the range where the line of the graph is broken, you must expect higher differences between single devices within one packing unit.
6) **Operating Temperature** (T_{opr}) represents the temperature of the surface onto which the package is mounted on.
7) **Ambient Temperature** (T_a) represents the temperature of the surrounding environment where the UV-C LED operates. It directly impacts the performance, efficiency, and lifespan of the LED. Proper thermal management is essential to maintain optimal functionality and achieve the specified product lifetime.
8) **Tolerance of Measure**: Unless otherwise noted in drawing, tolerances are specified with ±0.2 and dimensions are specified in mm.
9) **Spectral Power Distribution, SPD:** A representation of the power output of a light source across different wavelengths, showing its intensity at each wavelength and defining its color and energy characteristics.
10) **Tape and Reel**: LED shipping and package materials. All dimensions and tolerances are specified acc. IEC 60286-3 and specified in mm.
11) **Wavelength**: Wavelengths are tested at a current pulse duration of 25 ms and a tolerance of ±3 nm.
12) **Pulsed forward current, I_{FP}:** Non-continuous wave forward current applied to the LEDs to obtain the characteristic curves.