NICHIA CORPORATION

SPECIFICATIONS FOR UV LED

NVMUR020A

- Built-in ESD Protection Device
- RoHS Compliant
## SPECIFICATIONS

### (1) Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Absolute Maximum Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward Current</td>
<td>$I_F$</td>
<td>24</td>
<td>A</td>
</tr>
<tr>
<td>Allowable Reverse Current</td>
<td>$I_R$</td>
<td>85</td>
<td>mA</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>$P_D$</td>
<td>105</td>
<td>W</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>$T_{opr}$</td>
<td>0~85</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>$T_{stg}$</td>
<td>-40~100</td>
<td>°C</td>
</tr>
<tr>
<td>Junction Temperature</td>
<td>$T_J$</td>
<td>130</td>
<td>°C</td>
</tr>
</tbody>
</table>

* Absolute Maximum Ratings at $T_{MP}=25°C$.
* The operating Temperature range is the range of measurement point temperatures ($T_{MP}$).
* Do not operate the LEDs in environments where temperature and humidity fluctuate greatly (i.e. causing condensation to form).

### (2) Initial Electrical/Optical Characteristics

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Condition</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward Voltage</td>
<td>$V_F$</td>
<td>$I_F=20A$</td>
<td>4.0</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>Radiant Flux</td>
<td>$\Phi_e$</td>
<td>$I_F=20A$</td>
<td>29</td>
<td>-</td>
<td>W</td>
</tr>
<tr>
<td>Peak Wavelength</td>
<td>$\lambda_p$</td>
<td>$I_F=20A$</td>
<td>365</td>
<td>-</td>
<td>nm</td>
</tr>
<tr>
<td>Spectrum Half Width</td>
<td>$\Delta \lambda$</td>
<td>$I_F=20A$</td>
<td>9.0</td>
<td>-</td>
<td>nm</td>
</tr>
<tr>
<td>Thermal Resistance</td>
<td>$R_{\theta JC}$</td>
<td>-</td>
<td>0.10</td>
<td>0.12</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

* Characteristics at $T_{MP}=25°C$.
* Radiant Flux value as per CIE 127:2007 standard.
* $R_{\theta JC}$ is the thermal resistance from the junction to the $T_C$ measurement point. (Heat sink used: Copper, $t=1.5\text{mm}$, Thermal grease used: 4.3W/m·K, $t=0.1\text{mm}$)
* It is recommended to operate the LEDs at a current greater than 10% of the sorting current to stabilize the LED characteristics.
## RANKS

<table>
<thead>
<tr>
<th>Item</th>
<th>Rank</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>H12b</td>
<td>4.15</td>
<td>4.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H12a</td>
<td>4.10</td>
<td>4.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H11b</td>
<td>4.05</td>
<td>4.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H11a</td>
<td>4.00</td>
<td>4.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M22b</td>
<td>3.95</td>
<td>4.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M22a</td>
<td>3.90</td>
<td>3.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M21b</td>
<td>3.85</td>
<td>3.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M21a</td>
<td>3.80</td>
<td>3.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M12b</td>
<td>3.75</td>
<td>3.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M12a</td>
<td>3.70</td>
<td>3.75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Radiant Flux

<table>
<thead>
<tr>
<th>Item</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>P15</td>
<td>35.2</td>
<td>38.7</td>
<td>W</td>
</tr>
<tr>
<td>P14</td>
<td>32.0</td>
<td>35.2</td>
<td>W</td>
</tr>
<tr>
<td>P13</td>
<td>29.1</td>
<td>32.0</td>
<td>W</td>
</tr>
<tr>
<td>P12</td>
<td>26.5</td>
<td>29.1</td>
<td>W</td>
</tr>
<tr>
<td>P11</td>
<td>24.1</td>
<td>26.5</td>
<td>W</td>
</tr>
</tbody>
</table>

### Peak Wavelength

<table>
<thead>
<tr>
<th>Item</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>U385</td>
<td>380</td>
<td>390</td>
<td>nm</td>
</tr>
<tr>
<td>U365</td>
<td>360</td>
<td>370</td>
<td>nm</td>
</tr>
</tbody>
</table>

* Ranking at $T_{MP}=25^\circ C$.
* Forward Voltage Tolerance: ±0.05V
* Radiant Flux Tolerance: ±6%
* Peak Wavelength Tolerance: ±3nm
* LEDs from the above ranks will be shipped. The rank combination ratio per shipment will be decided by Nichia.

### Forward Voltage Ranks by Peak Wavelength

```
Ranking by Forward Voltage
<table>
<thead>
<tr>
<th>Ranking by Peak Wavelength</th>
<th>M12a</th>
<th>M12b</th>
<th>M21a</th>
<th>M21b</th>
<th>M22a</th>
<th>M22b</th>
<th>H11a</th>
<th>H11b</th>
<th>H12a</th>
<th>H12b</th>
</tr>
</thead>
<tbody>
<tr>
<td>U365</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U385</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

### Radiant Flux Ranks by Peak Wavelength

```
Ranking by Radiant Flux
<table>
<thead>
<tr>
<th>Ranking by Peak Wavelength</th>
<th>P11</th>
<th>P12</th>
<th>P13</th>
<th>P14</th>
<th>P15</th>
</tr>
</thead>
<tbody>
<tr>
<td>U365</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U385</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```
OUTLINE DIMENSIONS

* This product complies with RoHS Directive.
* The dimension(s) in parentheses are for reference purposes.

---

<table>
<thead>
<tr>
<th>項目 Item</th>
<th>内容 Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>基板材質 Substrate Materials</td>
<td>窒化アルミニウム Aluminum Nitride</td>
</tr>
<tr>
<td>スペーサ材質 Spacer Materials</td>
<td>窒化アルミニウム Aluminum Nitride</td>
</tr>
<tr>
<td>カバー材質 Cover Materials</td>
<td>硬質ガラス Hard Glass</td>
</tr>
<tr>
<td>質量 Weight</td>
<td>0.66g(TYP)</td>
</tr>
</tbody>
</table>

* This product is non-soldering-compliant. Do not solder this product.

---

* 製品ははんだ付けに非対応です。はんだ付けでの使用をしないで下さい。This product is non-soldering-compliant. Do not solder this product.
* 製品と筐体間の接続には放熱グリスなど低熱抵抗の放熱材料を用いることを推奨します。When attaching the LEDs to the heat sink, etc., Nichia recommends using a thermal interface material that has a low thermal resistance (i.e. thermal grease).
数量は1トレイにつき20個入ります。
Tray Size: 20pcs
寸法は参考です。
All dimensions shown are for reference only and are not guaranteed.

* 数量は1トレイにつき20個入ります。
Tray Size: 20pcs
* 寸法は参考です。
All dimensions shown are for reference only and are not guaranteed.

N xxx R 020x
管理番号 No. STS-DA7-14631
(単位 Unit: mm)
シリカゲルともにトレイをアルミ防湿袋に入れて熱シールにより封をします。

Trays are shipped with desiccants in heat-sealed moisture-proof bags.

**印刷内容**

- 総合的にトレイをアルミ防湿袋に入れ、熱シールにより封をします。
- 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 LEDは紫外領域の光（UV光）を発します。UV光は直接目にあたらないと見えますが、UV光による目を傷める可能性があります。
- 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。
- 噴霧する状態では、製品を損傷させる原因になりますので注意して下さい。
- 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。

**ラベル**

- MODEL NO.: Nxxxxxxx
- QTY.: YMxxxx-RRR
- PCS

**警告ラベル**

- UV LEDは紫外領域の光（UV光）を発します。
- UV光は直接目にあたらないと見えますが、UV光を直接目に当てると目を傷める可能性があります。
- 噴霧する状態では、製品を損傷させる原因になりますので注意して下さい。
- 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。

**包装内容**

- シリカゲル
- UV LED
- 熱シール
- ラベル
- モデル番号

**注意事項**

- 本製品はトレイに入れたのち、輸送の衝撃から保護するためダンボールで梱包します。
- UV LEDは紫外領域の光（UV光）を発します。
- 取り扱いに際して、落下させたり、強い衝撃を与える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。
- ダンボールには防湿加工がされていませんので、湿気の多い場所に置かないでください。
- 特定の箱を並べて入れて、ダンボールで仕切ります。
- パッケージには、情報の収集が可能であることを示すためにリフィルも兼ねています。

**注意事項（英語）**

- Products shipped on trays are packed in a moisture-proof bag.
- Do not drop or expose the box to external forces as it may damage the products.
- Do not expose to water. The box is not water-resistant.
- For details, see "LOT NUMBERING CODE" in this document.
LOT NUMBERING CODE

Lot Number is presented by using the following alphanumeric code.

YMxxxx - RRR

Y - Year

<table>
<thead>
<tr>
<th>Year</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>I</td>
</tr>
<tr>
<td>2019</td>
<td>J</td>
</tr>
<tr>
<td>2020</td>
<td>K</td>
</tr>
<tr>
<td>2021</td>
<td>L</td>
</tr>
<tr>
<td>2022</td>
<td>M</td>
</tr>
<tr>
<td>2023</td>
<td>N</td>
</tr>
</tbody>
</table>

M - Month

<table>
<thead>
<tr>
<th>Month</th>
<th>M</th>
<th>Month</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>10</td>
<td>A</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>11</td>
<td>B</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>12</td>
<td>C</td>
</tr>
</tbody>
</table>

xxxx-Nichia’s Product Number

RRR-Ranking by Wavelength, Ranking by Radiant Flux, Ranking by Forward Voltage
* R_{θJM}の算出は注意事項熱の発生を参照して下さい。
For calculation of R_{θJM}, see the "Thermal Management" of this specification.
* All characteristics shown are for reference only and are not guaranteed.

The graphs above show the characteristics for U365x LEDs of this product.

* The graphs above show the characteristics for U365x LEDs of this product.
* 本特性は参考です。  
All characteristics shown are for reference only and are not guaranteed.

The graphs above show the characteristics for U385x LEDs of this product.
* All characteristics shown are for reference only and are not guaranteed.

The graphs above show the characteristics for U365x LEDs of this product. 

$T_A = 25^\circ C$
FORWARD CURRENT CHARACTERISTICS / TEMPERATURE CHARACTERISTICS

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

The graphs above show the characteristics for U385x LEDs of this product.

NVMUR020A
管理番号 No. STS-DA7-14636

* 本特性はピーク波長ランクU385xに対応しています。
The graphs above show the characteristics for U385x 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.

The graphs above show the characteristics for U365x LEDs of this product.

* 本特性はピーク波長ランクU365xに対応しています。

The characteristics shown are for reference only and are not guaranteed.

* 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

* All characteristics shown are for reference only and are not guaranteed.

* The graphs above show the characteristics for U385x LEDs of this product.
## RELIABILITY

### (1) Tests and Results

<table>
<thead>
<tr>
<th>Test</th>
<th>Reference Standard</th>
<th>Test Conditions</th>
<th>Test Duration</th>
<th>Failure Criteria</th>
<th>Units Failed/Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Shock (Air to Air)</td>
<td></td>
<td>-40°C to 100°C, 15min dwell</td>
<td>100cycles</td>
<td>#1</td>
<td>0/2</td>
</tr>
<tr>
<td>High Temperature Storage</td>
<td>JEITA ED-4701</td>
<td>Ta=100°C</td>
<td>1000hours</td>
<td>#1</td>
<td>0/2</td>
</tr>
<tr>
<td>Low Temperature Storage</td>
<td>JEITA ED-4701</td>
<td>Ta=-40°C</td>
<td>1000hours</td>
<td>#1</td>
<td>0/2</td>
</tr>
<tr>
<td>Room Temperature Operating Life</td>
<td>JEITA ED-4701</td>
<td>Ta=25°C, Tw=30°C, Ir=24A</td>
<td>1000hours</td>
<td>#1</td>
<td>0/2</td>
</tr>
<tr>
<td>Vibration</td>
<td>JEITA ED-4701</td>
<td>200m/s², 100<del>2000</del>100Hz, 4cycles, 4min, each X, Y, Z</td>
<td>48minutes</td>
<td>#1</td>
<td>0/2</td>
</tr>
<tr>
<td>Electrostatic Discharges</td>
<td>JEITA ED-4701</td>
<td>HBM, 2kV, 1.5kΩ, 100pF, 3pulses, alternately positive or negative</td>
<td>#1</td>
<td>#1</td>
<td>0/2</td>
</tr>
</tbody>
</table>

**NOTES:**
1) $R_{θJMP} ≈ 0.572°C/W$
2) $T_W$ = Cooling Water Temperature: °C
3) Measurements are performed after allowing the LEDs to return to room temperature.

### (2) Failure Criteria

<table>
<thead>
<tr>
<th>Criteria #</th>
<th>Items</th>
<th>Conditions</th>
<th>Failure Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Forward Voltage($V_F$)</td>
<td>$I_r=20A$</td>
<td>$vInitial value \times 1.1$</td>
</tr>
<tr>
<td></td>
<td>Radiant Flux($Φ_E$)</td>
<td>$I_r=20A$</td>
<td>$vInitial value \times 0.7$</td>
</tr>
</tbody>
</table>
CAUTIONS

(1) Storage

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Temperature</th>
<th>Humidity</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Opening Aluminum Bag</td>
<td>≤30°C</td>
<td>≤90%RH</td>
<td>Within 1 Year from Delivery Date</td>
</tr>
<tr>
<td>After Opening Aluminum Bag</td>
<td>≤30°C</td>
<td>≤70%RH</td>
<td>≤168 hours</td>
</tr>
</tbody>
</table>

- After opening the moisture-proof aluminum bag, the LEDs should be installed into an end product immediately. If a PCB is used to mount the LEDs before installing into an end product, these processes must be completed within the range of the conditions stated above. Unused remaining LEDs should be stored with silica gel desiccants in a hermetically sealed container, preferably the original moisture-proof bags for storage and resealing this bag.
- This LED has gold-plated parts; if the LEDs are exposed to a corrosive environment, it may cause the plated surface to tarnish causing issues. 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

- Nichia recommends designing the circuit to ensure that each LED is driven by a separate power supply.
- If two or more LEDs are connected in parallel, the current will be split between them (i.e. current division); this 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, and in some cases, excessive current (i.e. exceeding the Absolute Maximum Rating). 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 issues (i.e. a variation in the current flowing through the LEDs).

![Circuit A](image)

![Circuit B](image)

- 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 ≥ 10% of the sorting current.
- Ensure that transient excessive voltages (e.g. lighting 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.
- If this product is stored and/or used constantly under 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 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).
(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 lens and/or the substrate (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 the LEDs on top of one another, regardless of whether the LEDs are attached to heat sinks or not. Otherwise, it may cause damage to the lens and the substrate (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

- Volatile organic compounds that have been released from materials present around the LEDs (e.g. housing, gasket/seal, adhesive, secondary lens, lens cover, thermal grease, etc.) may adhere to the LED glass cover and other areas (e.g. package). 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. In this case, ventilating the environment may improve the reduction in light output. Perform a light-up test of the chosen application for optical evaluation to ensure that there are no issues.
- When attaching the LEDs to the heat sink, etc., Nichia recommends using a thermal interface material that has a low thermal resistance (i.e. thermal grease).

(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 (≤20mA).
  - Failure Criteria: \( V_F < 2.0 \text{V at } I_F = 10.0 \text{mA} \)
  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

- When designing, the derating characteristics (i.e. Thermistor Temperature vs. Allowable Forward Current) must be considered. The increase in the temperature of an LED while in operation may vary depending on the heat sink’s thermal resistance and the density of LEDs in the system/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 to ensure the derating characteristics during actual use.

- Use the Measurement Point Temperature (T_{MP}) to determine the operating current for the chosen application and optimize the thermal design (e.g. selecting a proper heat sink, thermal interface material, etc.) accordingly.

- The following two equations can be used to calculate the LED junction temperature:

  \[ T_J = T_{MP} + R_{\theta_{JMP}} \times W \]
  \[ T_J = T_C + R_{\theta_{JC}} \times W \]

  *T_{J} = LED Junction Temperature: °C
  *T_{MP} = Measurement Point Temperature: °C
  *T_{C} = Case Temperature (back surface of LED): °C
  *R_{\theta_{JMP}} = Thermal Resistance from Junction to T_{MP} Measurement Point: °C/W
  *R_{\theta_{JC}} = Thermal Resistance from Junction to T_{C} Measurement Point: °C/W
  *W = Input Power (I_F \times V_F): W

- Once the LEDs have been attached to a heat sink, it is difficult to measure T_{C} due to the location of the T_{C} measurement point. Refer to the relevant application notes for a method of determining the T_{J} by measuring T_{MP}. To access the application notes, go to the Technical Suggestions And Recommendations section of Nichia’s website.

- Refer to the relevant application notes for detailed information (e.g. how to handle the COB LEDs, the effect of adhesion strength between the COB and the heat sink, thermal design considerations, etc.). To access the application notes, go to the Technical Suggestions And Recommendations section of Nichia’s website. Note that the application notes may be updated, revised, modified and supplemented without notice.

- To determine the thermal resistance (R_{\theta_{JMP}}), use the following data/equation.

\[ y = 0.19 e^{3.18x} \]
(7) Cleaning

- Do not wipe/clean the LEDs with any type of material (e.g. dry/wet cloth) or solvent (e.g. benzene, thinner, etc.). Cleaning can cause pressure leading to damage to the top surface (e.g. lens, electrode, connecting device, etc.) that may cause issues (e.g. the LED not to illuminate [i.e. catastrophic failure]).
- 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.

(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.).
Assembly and Handling Precautions for the NVMUR020A UV LEDs

First Edition
February 7, 2019

UV LED Development Group, UV Project
Optoelectronic Products BU.
Nichia Corporation

The Nichia part number NVMUR020A within this document are merely Nichia’s part numbers for those Nichia products and are not related nor bear resemblance to any other company’s product that might bear a trademark.
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## Revision History

<table>
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<th>Revision</th>
<th>Date</th>
<th>Description</th>
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<tr>
<td>1</td>
<td>Feb. 7, 2019</td>
<td>First edition (i.e. SP-QR-C-16816)</td>
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Key Features

Overview
This LED uses a newer LED package technology that integrates multiple bare LED die in a single package. For most conventional LEDs, it is necessary to solder LEDs to PCBs before attaching LED assemblies to heat sinks. However, since these LEDs are designed to be directly attached to heat sinks, neither soldering nor PCBs are required. Additionally, light sources using these LEDs require fewer LEDs to produce the same amount of output as those using conventional LEDs due to the mechanical feature of these LEDs (i.e. being multi-chip packaged). This enables the light source size to be reduced.

This application note provides general technical information on how to use/handle the UV LEDs.

Basic structure
Refer to Figure 1 below for the basic structure of the UV LEDs.

Figure 1. Basic structure of a NVMUR020A UV LED
**Thermal Management**

- Since the absolute maximum junction temperature must not be exceeded under any circumstances, consider the operating conditions/environment that both the system/assembly and the UV LEDs are exposed to when calculating the junction temperature ($T_J$) for the chosen application.

- The following two methods can be used to calculate the $T_J$:
  1. Calculating the $T_J$ using the thermal resistance from junction to $T_C$ measurement point\(^1\) (i.e. $R_{\theta JC}$)
  2. Calculating the $T_J$ using the thermal resistance from junction to $T_{MP}$ measurement point (i.e. $R_{\theta JMP}$)

  For the position of the $T_{MP}$ measurement point, see Figure 2 below. For more details on these $T_J$ calculation methods, refer to page 6 and page 7.

![Figure 2. Position of the $T_{MP}$ measurement point](image)

**Note:**

\(^1\) The $T_C$ measurement point is on the back of the ceramic substrate. For more information, see Figure 3 or the specification for the UV LEDs.
How to Calculate the Junction Temperature ($T_J$) Using the $R_{\theta JC}$

Once the UV LEDs have been attached to a heat sink, it is difficult to measure $T_C$ due to the location of the $T_C$ measurement point. When calculating the junction temperature ($T_J$) using the $R_{\theta JC}$, the temperature of the heat sink ($T_{HS}$) should be used. Note that this $T_J$ calculation method may require simulation runs using material properties (e.g. thermal conductivity, etc.) of components being used with the UV LEDs in addition to the $R_{\theta JC}$ values shown below. If this method is not convenient for the chosen application, refer to the method on the next page.

$$T_J = \text{LED Junction Temperature: } ^\circ C$$

$$R_{\theta JC} = \text{Thermal resistance from junction to } T_C \text{ measurement point: } ^\circ C/W$$

$$T_C = \text{Case temperature: } ^\circ C$$

$$R_{\theta CHS} = \text{Thermal Resistance from } T_C \text{ measurement point to } T_{HS} \text{ measurement point: } ^\circ C/W$$

$$T_{MP} = \text{Temperature of the Heat Sink}^2$$

Figure 3. Cross-sectional diagram of the UV LEDs attached on a heat sink

Figure 4. Schematic diagram of the thermal resistance of the UV LEDs when attached to a heat sink

Table 2. $R_{\theta JC}$ value of the UV LEDs

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Thermal Resistance</th>
<th>Typical</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>NVMUR020A</td>
<td>$R_{\theta JC}$</td>
<td>0.10</td>
<td>0.12</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

Equation (1)$^{4,5}$:  

$$T_J \,(^\circ C) = T_{HS} \,(^\circ C) + R_{\theta JHS} \,(^\circ C/W) \times \text{Input Power} \,(W)$$

Note:

2. For water cooling, use the set temperature of the cooling water (i.e. $T_W$) as the $T_{HS}$; for air cooling, measure the temperature of the heat sink and use that measurement as the $T_{HS}$. For information on how to measure the heat sink, consult appropriate literature (e.g. manufacturer’s technical document) or contact the manufacturer directly.

3. If the actual $R_{\theta CHS}$ in the chosen system/assembly is not available, consult appropriate literature (e.g. manufacturer’s technical document) or contact the manufacturer directly.

4. $R_{\theta JHS} = R_{\theta JC} + R_{\theta CHS}$

5. Input Power: $W = V_F + I_F$
The UV LEDs have a \( T_{MP} \) measurement point that allows \( T_J \) calculation by measuring at that specific point. To determine the \( T_J \) of the UV LEDs, first measure the \( T_{MP} \) and it will be possible to calculate the \( R_{\theta JMP} \) with the following data/equations shown in Figure 5. Then, use all these values (i.e. \( T_{MP} \) and \( R_{\theta JMP} \)), the input power (\( W \))^\text{5}, and equation (2) below to calculate the \( T_J \).

Equation (3): \[ T_J (\degree C) = T_{MP} (\degree C) + R_{\theta JMP} (\degree C/W) \times \text{Input Power (W)} \]

Note:
^6 Change in the \( T_{MP} \): \( \Delta T_{MP} = \) The change in \( T_{MP} \) once the \( T_{MP} \) has stabilized.
Derating Characteristics

When designing, the derating characteristics (i.e. $T_{MP}$ vs. Allowable Forward Current [$I_F$]) must be considered. The increase in the temperature of an LED while in operation may vary depending on the heat sink’s thermal resistance and the density of LEDs in the system/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 to ensure the derating characteristics during actual use.

**Figure 6. Derating characteristics (i.e. $T_{MP}$ vs. allowable $I_F$)**

<table>
<thead>
<tr>
<th>Measurement Point Temperature (°C)</th>
<th>Allowable Forward Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.24°C/W</td>
<td>20</td>
</tr>
<tr>
<td>0.36°C/W</td>
<td>15</td>
</tr>
<tr>
<td>0.5°C/W</td>
<td>10</td>
</tr>
<tr>
<td>0.7°C/W</td>
<td>5</td>
</tr>
</tbody>
</table>

$R_{JMP}$ = 0.24°C/W
$R_{JMP}$ = 0.36°C/W
$R_{JMP}$ = 0.5°C/W
$R_{JMP}$ = 0.7°C/W
Precautions Against Condensation

• When using the UV LEDs, do not design them into applications where condensation may occur. If the UV LEDs are stored/operated in these environments, it may cause issues (e.g. current leaks that cause the radiant flux to decrease).

• Cautions for use with a water cooling system:
If the water temperature is lower than the ambient temperature, it may cause condensation on both the outer and inner surfaces of the UV LED and its surrounding surfaces. Adjust the water temperature to suit the operating environment (i.e. temperature and humidity) to prevent condensation from occurring.

• Example:
The water jacket surrounding the assembly/system may be covered with dew when used under the following conditions:

Water temperature: \( \leq 26^\circ C \)
Ambient temperature \( (T_A) \): 30°C\(^7\)
Relative humidity (RH): 80%\(^7\)

---

Figure 7. Saturated vapor density

Note:

7 The actual amount of water vapor in the air (i.e. absolute humidity) can be calculated to be 24g/m\(^3\) with the \( T_A \) and RH values.
Example of How to Design the UV LEDs into an Assembly/System

Refer to Figure 8 below for an example of an assembly using 11 NVMUR020A UV LEDs. For the parts/components used in the assembly, refer to Figures 9 through 11.

Figure 8. Overview of an example of a NVMUR020A assembly

Figure 10. PCB with metal terminals

Figure 11. Metal terminal specially designed for the UV LEDs

Cautions/Suggestions:
1. Since the UV LEDs are not designed to be soldered, the assembly above uses a metal terminal to exert a downward force on the UV LED to prevent the UV LED from moving. This is only an example for how to use the UV LEDs.
2. If two or more UV LEDs are connected in parallel, refer to “Precautions When Using UV LEDs in a Parallel Circuit” in Nichia’s application note: Assembly and Handling Precautions for UV LEDs.
How to Apply Thermal Grease

• Ensure that thermal grease is applied evenly and in an adequate amount (see Correct example in Figure 13 below).
  ◦ If the amount is too low – especially if it does not fully cover the back side of the emission area of the UV LEDs (see Incorrect example in Figure 14 below), heat from the UV LED die may not be efficiently dissipated.
  ◦ If the amount is too high, the excess thermal grease may contaminate the UV LED’s top surface causing the output power to decrease.

Thermal grease: TC-5622 manufactured by Dow Corning Toray Co., Ltd.
Stencil thickness: \( t = 0.1 \text{mm} \)

Figure 13. Thermal grease applied to the back of the UV LEDs

• To determine the procedure/conditions for applying the thermal grease (e.g. stencil design, volume, etc.), perform sufficient verification on the chosen system fully assembled with all parts/materials properly in place. If the thermal grease has been applied incorrectly, it may significantly affect the heat dissipation. To ensure that there are no issues with the application, use the \( T_J \) calculation method on page 7 to determine the actual \( T_J \) and verify it against the designed/intended \( T_J \).

Note:
8 The thermal grease stencil mask is designed and used only for Nichia’s evaluation of the NVMUR020A UV LEDs. The specifications for the thermal grease/stencil mask are provided for reference purposes only.
Cautions/Suggestions for Attaching the UV LEDs to a Heat Sink

- If there are issues with the contact surface of the heat sink (i.e., uneven surface, hole/recess, burr/flash, etc.), it may significantly reduce the thermal conductivity.

- If there are issues with the thermal interface material (e.g., insufficient coverage, excessive thickness, etc.), it may cause heat not to sufficiently transfer to the heat sink and in some cases, damage to the UV LEDs. Additionally, excessively thick thermal films/sheets are more likely to lead to assembly issues (e.g., damage to the ceramic substrate) when excessive pressure is applied to the UV LEDs. Nichia recommends using thermal grease.

- If the heat sink has a foreign material and/or burr/flash on the contact surface as indicated in Figure 14-I and Figure 14-J, there is a possibility that the UV LED may be damaged when a metal terminal is attached to the PCB to supply power to the UV LED since it exerts a downward force on the UV LED to prevent the UV LED from moving.

- For more issues with the heat sink/thermal interface material, refer to Figures 14-A through 14-J below.

Figure 14. Correct/incorrect application of thermal grease between the UV LED and heat sink
How to Supply Power to the UV LEDs

The NVMUR020A UV LEDs are designed to be used with a metal terminal for electrical connection. Nichia uses a metal terminal specially designed for the UV LEDs and provides the details of this metal terminal as follows for reference purposes only.

- **Material:**
  Phosphor bronze (C5210R-H)

- **Surface finish:**
  - Nickel plating (t ≥ 1μm), gold plating (t ≥ 0.05μm)

- **Bending height:**
  ≥ 0.4mm

![Metal terminal specially designed for the UV LEDs](image)

Figure 15. Drawings and specifications for a metal terminal (for reference only)

![Bending height of the area that contacts the UV LED.](image)

≥ 0.4mm

Figure 16. Example of the placement of the metal terminal with the UV LEDs
Nichia has observed a UV LED failure during a developmental reliability test caused by improper use/attachment of the metal terminal.

**Test Conditions:**
UV LED P/N: NVMUR020A  
Wavelength Rank: U365  
Operating Conditions:  
\[ T_A = 25°C, T_W = 30°C, I_F = 24A \] (i.e. Absolute maximum rating current)

**Failure Description/Findings:**
During the test, a UV LED failed to meet the criteria for the power output at 2,500 hours. On a close examination, one of the metal terminals used with this UV LED was discolored (see Figure 17 and Figure 18 below for the appearances of the discolored metal terminal and a normal metal terminal). Since no other anomalies were observed in the UV LED, a lighting check was performed after replacing the metal terminal with a new one; Nichia confirmed that the UV LED emitted normally and met the criteria.

**Conclusion/Recommendations:**
The UV LED failure was caused by poor electrical connection between the metal terminal and the electrode of the UV LED. This caused the metal terminal to become excessively hot leading to the discoloration. To avoid the issue, select/design a proper metal terminal for the chosen application and use/attach it correctly. Additionally, ensure that there are no foreign materials on the contact surface that may affect the electrical connection.

---

**Figure 17. Appearance of the metal terminal for the failed UV LED**  
**Figure 18. Appearance of a normal metal terminal**
Assembly/Handling Precautions for the NVMUR020A UV LEDs

Assembly Precautions
- Ensure that the nozzle does not come in contact with the lens when it picks up the UV LED. If this occurs, it may cause damage to the lens (e.g. cuts, scratches, chips, cracks, delamination, and deformation) and the wire to break causing a catastrophic failure (i.e. the UV LED not to illuminate).
- The nozzle should only touch the ceramic substrate to hold the UV LED.

Handling Precautions with Tweezers
- Nichia recommends using special tweezers (e.g. vacuum tweezers) to handle the UV LEDs. However, use care to ensure:
  - the tweezers do not touch the lens,
  - excessive force is not applied to the UV LED.
Otherwise, it may cause damage to the lens and/or the ceramic substrate (e.g. cuts, scratches, chips, cracks, delamination, and deformation) and the wire to break causing a catastrophic failure (i.e. the UV LED not to illuminate).

Handling Precautions with Bare hands
- Do not handle the UV LEDs with bare hands:
  - this may contaminate the UV LED surface and have an effect on the optical characteristics,
  - the lens may cause injuries since the edges are sharp.
- Dropping may cause damage to the lens, ceramic substrate, and in some cases the internal wires causing a catastrophic failure (i.e. the UV LED not to illuminate).

Miscellaneous
- Do not stack the UV LEDs on top of one another, regardless of whether the UV LEDs are attached to heat sinks or not. Otherwise, it may cause damage to the lens and the ceramic substrate (e.g. cuts, scratches, chips, cracks, delamination, and deformation) and the wire to break causing a catastrophic failure (i.e. the UV LED not to illuminate).