Thermal Design of NVSU333A (U405) LEDs with Water Cooling System

1. Objective
   The LEDs’ light output can be affected by the heat generated from the LEDs/LED-assembled products. Also, the reliability performance can be seriously degraded, if the LEDs are operated over the absolute maximum rated junction temperature (Tj). It is critical to design the heat dissipation performance not to exceed the Tjmax for NVSU333A, to deliver high reliability/performance. This document shows the Tj evaluation results by demonstrating two heat dissipation conditions with a water cooling system. Please use the data for reference to your thermal design.

2. Tj Calculation
   Tj can be calculated by the following formula:
   \[ T_j = T_s + R_{thj-s} \times P_D \]
   \( T_j \): Junction Temperature
   \( T_s \): Soldering Temperature (°C)
   \( R_{thj-s} \): Thermal resistance (°C/W) from the die to the Ts measuring point
   * \( R_{thj-s} \) (NVSU333A): 2.08°C/W
   \( P_D \): Input Power (W)

3. Ts Measuring Point
   ![Diagram of Ts Measuring Point]
   The thermocouple was solder-attached to the Ts measuring point for the evaluation. (Board Size: 60mm \( \times \) 60 mm \( \times \) 1mm)

4. Tj Evaluation Result
<table>
<thead>
<tr>
<th>Type of Board</th>
<th>( I_r ) (A)</th>
<th>Thermistor (°C)</th>
<th>( T_s ) (°C)</th>
<th>( V_F ) (V)</th>
<th>( T_j ) (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu</td>
<td>3.5</td>
<td>25</td>
<td>34</td>
<td>3.85</td>
<td>62</td>
</tr>
</tbody>
</table>

5. PCB Specifications
<table>
<thead>
<tr>
<th>Type of Board</th>
<th>Land Pattern (µm)</th>
<th>Insulating Layer (µm)</th>
<th>Heat Conductivity (W/(m·K))</th>
<th>Board Thickness (mm)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu</td>
<td>35</td>
<td>120</td>
<td>10</td>
<td>1</td>
<td>The thermal pad is not in contact with the copper base.</td>
</tr>
</tbody>
</table>

This sheet contains tentative information; we may change the contents without notice.

(SP-QR-C-4619B)  
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6. Heat Dissipating Conditions

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>18</td>
<td>2.5</td>
<td>Oxygen-free copper 60mm×60mm×10mm</td>
<td>8.2</td>
<td>9 LEDs connected in series</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Note
We specified the absolute maximum ratings for NVSU333A; IF=4.5A and $T_{j\text{max}} = 100°C$.
We cannot guarantee the usage over these ratings.
We appreciate your understanding and cooperation.