Light Emitting Diode

How to Calculate the Junction Temperature for the Nichia 270 Series LEDs

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The Nichia part numbers NJ2W270A, NJ2W270A-Y7, NJ2W270B, NJ3W270B, NJ2W270B-PF and NJ3W270B-PF 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.

1. Overview

The thermal management for the LEDs is managed by Junction Temperature (T_J). If T_J value is out of spec. as overheated, it brings negative influence on reliability and might occur No-light mode at the worst case. This document introduces the method of T_J calculation by measuring the LED outline temperature with thermocouple.

2. Applicable Part Numbers

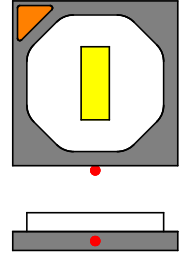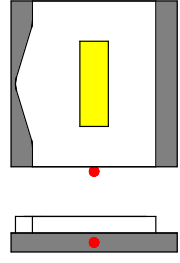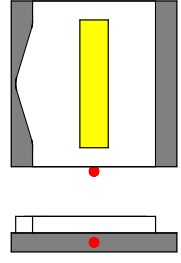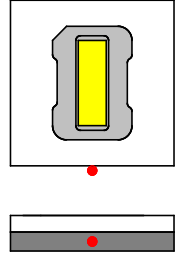This application note applies to the LEDs shown in Table 1.
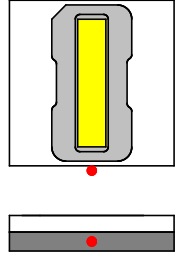
Table 1. Applicable LED Part Numbers

Part No.	NJ2W270A NJ2W270A-Y7 NJ2W270B NJ3W270B NJ2W270B-PF NJ3W270B-PF

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3. T$_{MP}$ Measurement

T$_J$ calculation is available by measuring the temperature of LED outline as T$_{MP}$. (See Table 2)

Table 2. T$_{MP}$ measuring point

• T$_{MP}$ measuring point

Part No.	NJ2W270A / NJ2W270A-Y7	NJ2W270B	NJ3W270B	NJ2W270B-PF	NJ3W270B-PF
T$_{MP}$ measuring point					

When measure the temperature of T$_{MP}$ with thermocouple, please attach the sensing point of thermocouple at the designated position of the ceramics part with fixing material such as a glue. (See Figure 1)
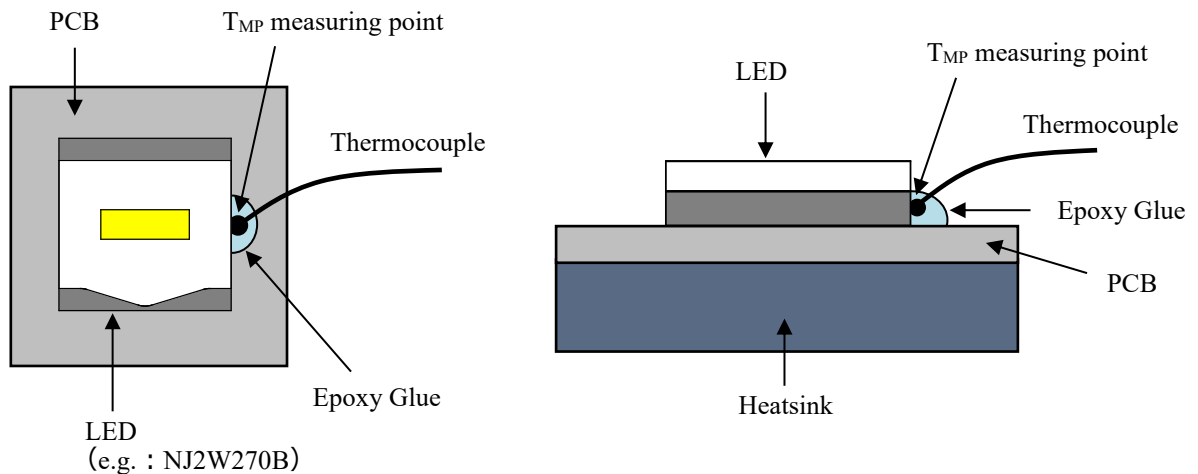

Figure 1. T$_{MP}$ measuring method

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4. T_J Calculation Method

T_J can be calculated with the below formula, combining each necessary parameter including the measured T_{MP} and others under driven.

$$T_J = T_{MP} + R_{\theta JMP} \times W \qquad \text{……… (1)}$$

    T_J = LED junction temperature (℃)

    T_{MP} = Temperature of measuring point (℃)

    $R_{\theta JMP}$ = Thermal resistance from LED junction to T_{MP} measuring point (℃/W)

    W = Input power ($I_F \times V_F$) (W)

$R_{\theta JMP}$ values are introduced in the below table for each LED type. (See Table 3)

Table 3. $R_{\theta JMP}$ values

Part No.	$R_{\theta JMP}$ (℃/W)
NJ2W270A	6.0
NJ2W270A-Y7	6.0
NJ2W270B	5.0
NJ3W270B	4.3
NJ2W270B-PF	5.0
NJ3W270B-PF	4.3

5. T_J Calculation Example

It is introduced the T_J calculated result with the T_{MP} measured result based on T_{MP} measuring method. (See Figure 1)

【Example LED: NJ2W270B】

The T_J value is calculated 120℃ as below with the parameters: T_{MP}=70℃ and Input Power=10W. (T_{MP}: See Table 3)

    $T_J = T_{MP} + R_{\theta JMP} \times W$

    $T_J = 70(℃) + 5.0(℃/W) \times 10(W) = 120(℃)$

6. Cautions of Attaching Thermocouple

When there is a gap from ceramics to thermocouple, or when the thermocouple contacts to other than LED ceramics part, the measurement values might have the problem of accuracy with miss measuring.

The temperature sensing point of thermocouple is the 1st contact point of two wire from root. When the thermocouple has twisting tip (Figure 2-b), the temperature is measured by 1st contact point of wires, the tip is not sensing point. Even if the tip of thermocouple contacts to LED, if the temperature sensing point does not contact that the measurement value might be lower.
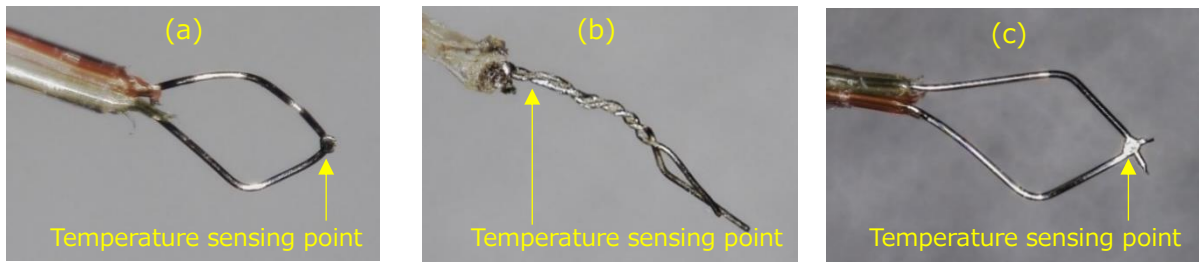

Figure 2. Temperature sensing point of thermocouple

It needs to care that the glue for fixing thermocouple is not too much. if the glue covered LED emitting surface, the measurement values might have the problem of measurement accuracy with miss measurement.

7. Summary

This document introduces the T_J calculation method based on the actual measuring with thermocouple for the mock-up LED module/unit evaluation. The influential parameter as T_{MP} is changeable depending on thermocouple set-up and PCB conditions as material kind etc. for example. Please make the precise measuring procedure as much as possible referring the introduced method in this document. Please ensure to make the proper thermal design to control T_J value within the specified maximum value in datasheet.

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