Light Emitting Diode

LED Pitch and Heat Dissipation Performance

Table of contents

SP-QR-C2-210612-1
Jun. 14, 2021

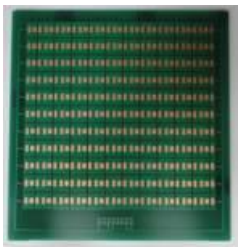
1. Objective

Multiple LEDs are generally mounted on a board for the desired light output, as panel light and illumination for facilities.
Operating a single LED generates high heat; all the more heat is generated when multiple LEDs are mounted on a board, leading to the decrease in their lifetimes. This is because the junction temperature (T_J) increases in each LED by mutual interaction.
Minimizing T_J equates to better thermal management, allowing for a longer lifetime.
Therefore, LEDs must be mounted with the optimal pitch among them.
This document shows the optimal pitch between LEDs by demonstrating some configurations.

2. Materials and Procedures

First, we prepared and used the PCBs as follows (Table 1 and 2).

Table 1. Circuit Board (FR-4)

Surface	Reverse Side
	

Board: FR-4 (Copper foil on both surfaces)
Board Thickness: 1.6mm
Copper Foil Thickness: 35μm
Reverse Side: Covered with copper foil

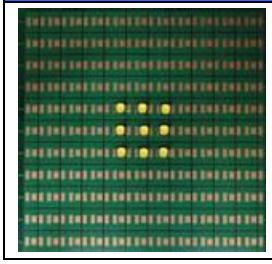
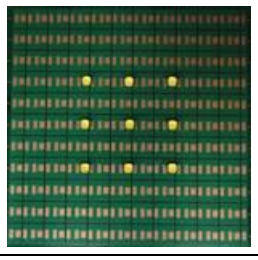
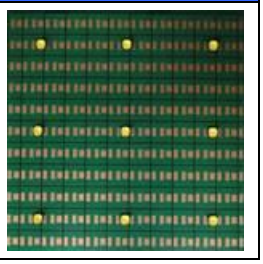
Table 2. Circuit Board (Aluminum)

Surface	Reverse Side
	

Board: Aluminum (Copper foil on one surface)
Board Thickness: 1.0mm
Copper Foil Thickness: 35μm
Insulating Layer Thickness: 120μm

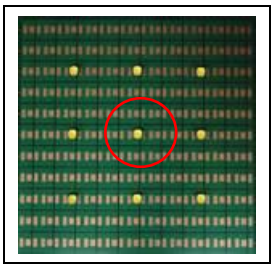
Second, we prepared the four configurations with LEDs (3 x 3 pcs.) at different pitches; 10, 20, 30, and 40 mm.

Table 3. Pitch Pattern

10mm Pitch	20mm Pitch	30mm Pitch	40mm Pitch
			

Then, the LEDs on each PCB were operated for 15 minutes. Finally, we measured T_J of the LED at the center (cf. Table 4).

Table 4. LED at the Center



3. LED Part No.

We demonstrated the configurations by using the five models below:

Part No. NVSxx19B	Part No. NS9x383	Part No. NF2x757AR-V1	Part No. NS2x757A-V1	Part No. NS2x157AR
				

4. Measurement Results of Junction Temperature at Each Pitch

4.1 Part No. NVSxx19B

Figure 1 shows the T_J measurement results at 1.0W (I_F=350 mA) and 2.0W (I_F=650 mA) with the specified pitches. When FR-4 is used, the junction temperature is less affected by the pitch at more than 20 mm at 1.0W, and at more than 30 mm at 2.0W. On the other hand, when the aluminum board is used, the junction temperature is less affected by the pitch at more than 20 mm.

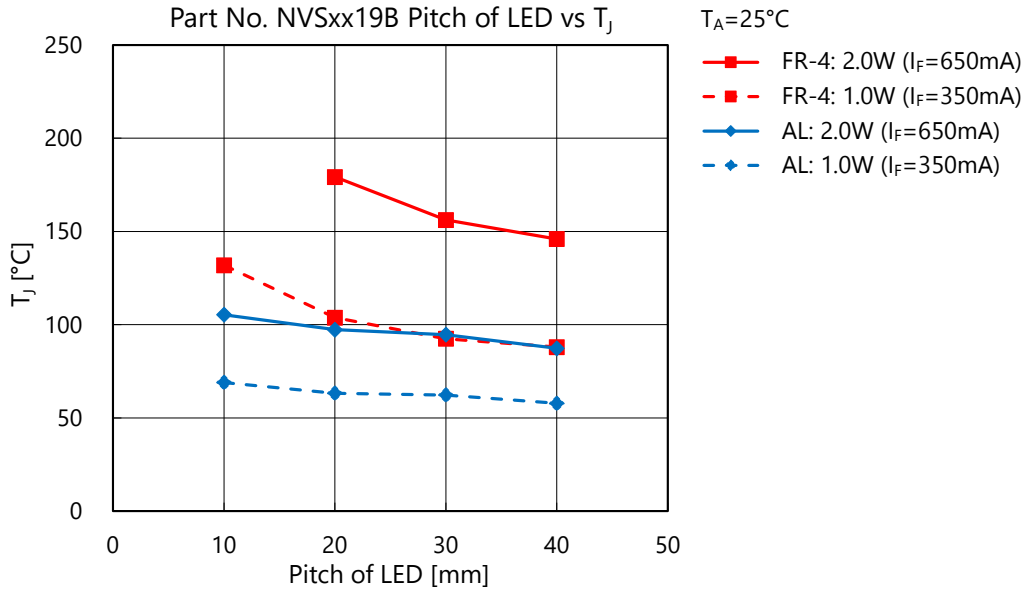


Figure 1. Junction Temperature at Each Pitch (Part No. NVSxx19B)

4.2 Part No. NS9x383

Figure 2 shows the T_J measurement results at 0.6W (I_F=200 mA) and 1.0W (I_F=350 mA) with the specified pitches. When FR-4 is used, the junction temperature has less interaction at more than 20 mm both at 0.6W and 1.0W. On the other hand, when the aluminum board is used, the junction temperature is less affected even by the pitch at 10 mm, enabling LEDs to be mounted by the narrow pitch.

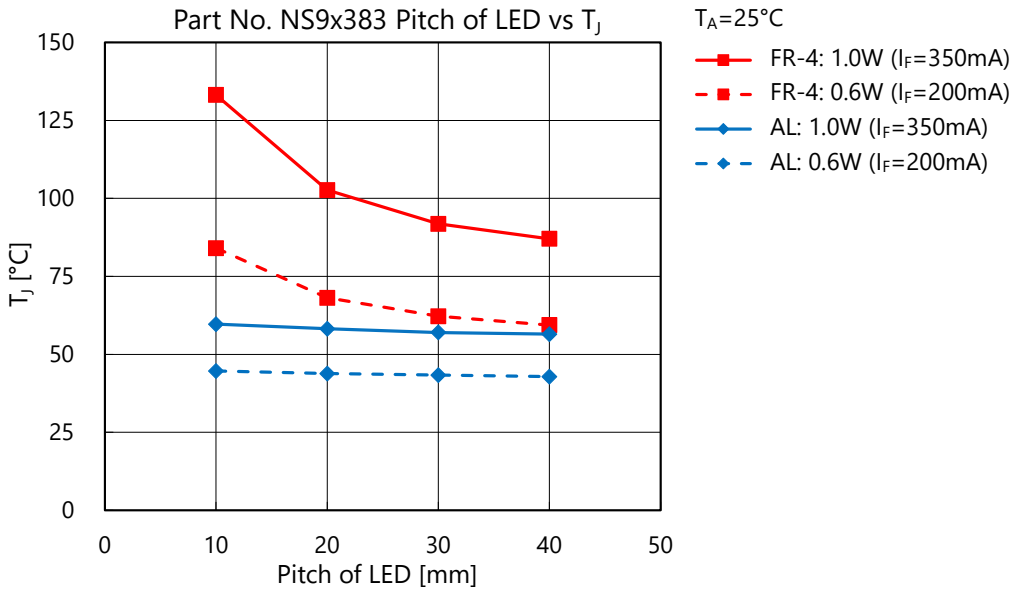


Figure 2. Junction Temperature at Each Pitch (Part No. NS9x383)

4.3 Part No. NF2x757AR-V1

Figure 3 shows the T_J measurement results at 0.6W (I_F=100 mA) and 0.9W (I_F=150 mA) with the specified pitches. When FR-4 is used, the junction temperature has less interaction at more than 20 mm both at 0.6W and 0.9W. On the other hand, when the aluminum board is used, the junction temperature is less affected even by the pitch at 10 mm, enabling LEDs to be mounted by the narrow pitch.

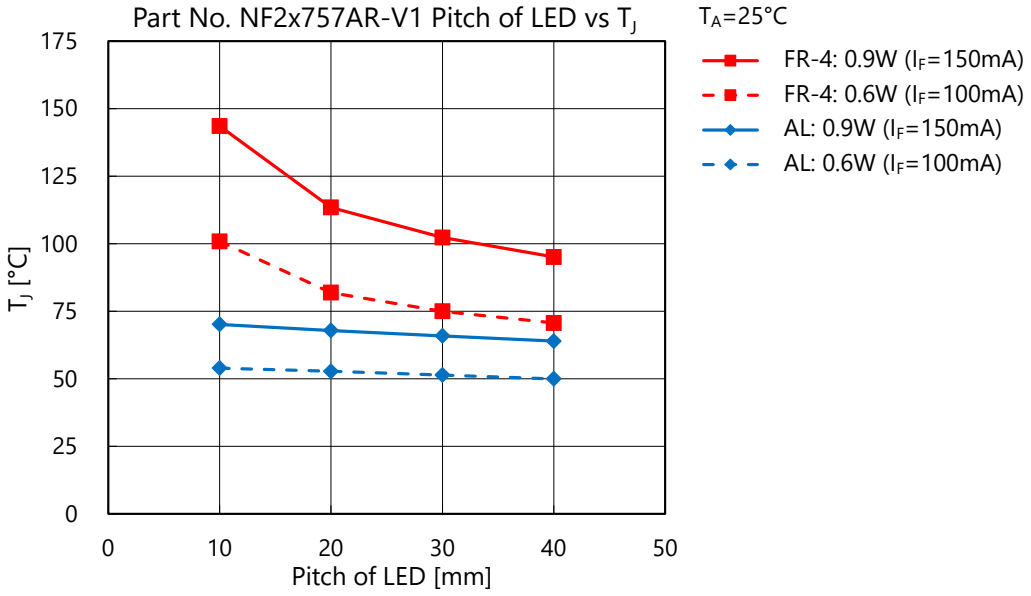


Figure 3. Junction Temperature at Each Pitch (Part No. NF2x757AR-V1)

4.4 Part No. NS2x757A-V1

Figure 4 shows the T_J measurement results at 0.2W (I_F=65 mA) and 0.45W (I_F=150 mA) with the specified pitches. When FR-4 is used, the junction temperature has less interaction at more than 10 mm at 0.2W and at more than 20 mm at 0.45W. On the other hand, when the aluminum board is used, the junction temperature is less affected even by the pitch at 10 mm , enabling LEDs to be mounted by the narrow pitch.

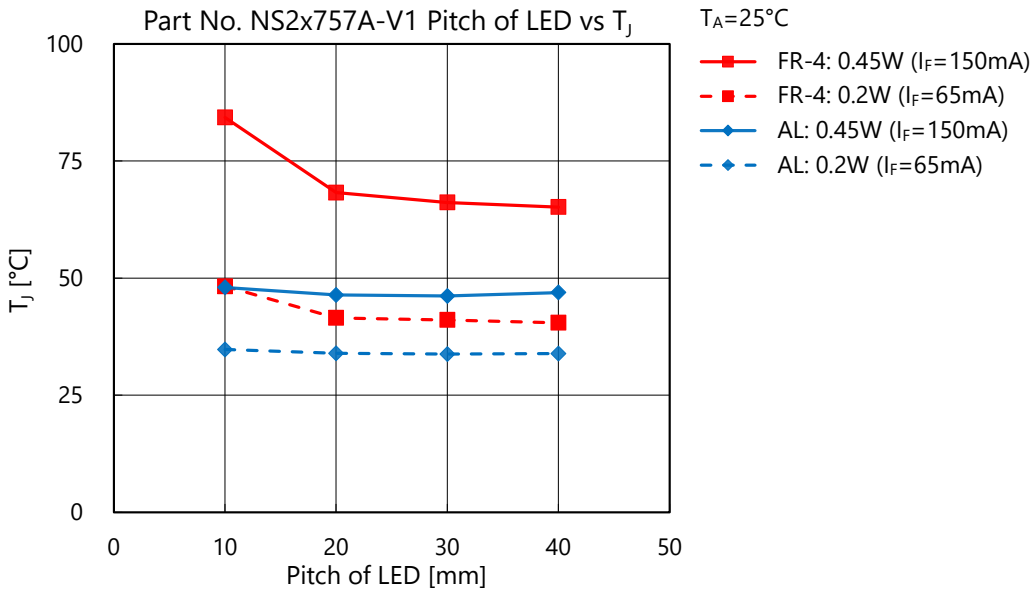


Figure 4. Junction Temperature at Each Pitch (Part No. NF2x757A-V1)

4.5 Part No. NS2x157AR

Figure 5 shows the T_J measurement results at 0.2W (I_F=40 mA) and 0.4W (I_F=75 mA) with the specified pitches. When FR-4 is used, the junction temperature has less interaction at more than 10 mm at 0.2W and at more than 20 mm at 0.4W. On the other hand, when the aluminum board is used, the junction temperature is less affected even by the pitch at 10 mm, enabling LEDs to be mounted by the narrow pitch.

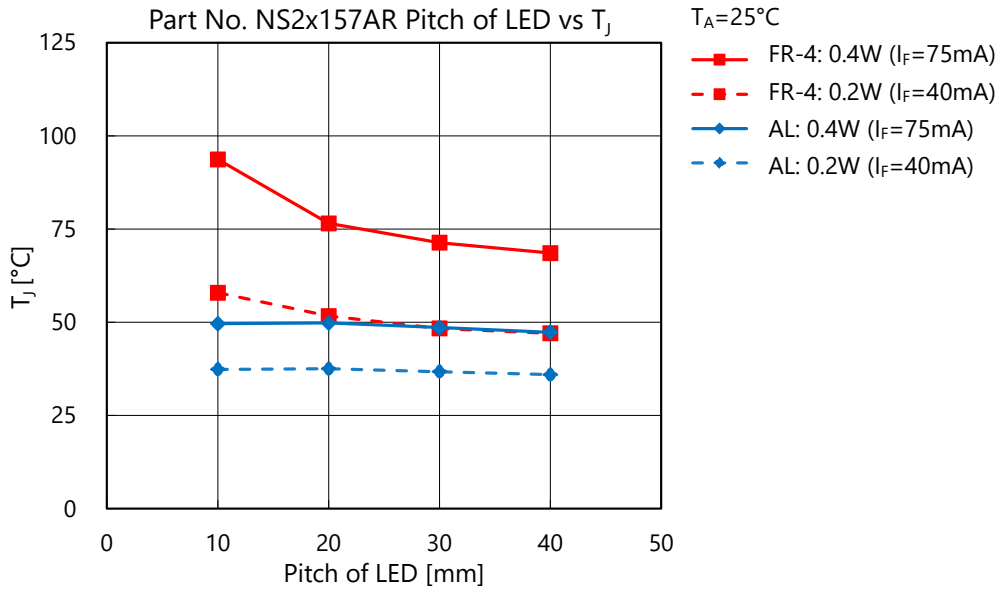


Figure 5. Junction Temperature at Each Pitch (Part No. NS2x157AR)

5. Conclusion

As shown in the measurement data, the optimal pitch and T_J depend on the output current (W). Therefore, the optimal pitch between LEDs needs to be designed at every output current (W).

To achieve high quality performance, it is necessary to package LEDs based on the verification results of the optimal pitch and T_J.

Please use this document as reference, since the measurement data varies depending on LED model and usage conditions/environment at customer sites.

Disclaimer

This application note is a controlled document of Nichia Corporation (Nichia) published to provide technical information/data for reference purposes only. By using this application note, the user agrees to the following:

- This application note has been prepared solely for reference on the subject matters incorporated within it and Nichia makes no guarantee that customers will see the same results for their chosen application.
- The information/data contained herein are only typical examples of performances and/or applications for the product. Nichia does not provide any guarantees or grant any license under or immunity from any intellectual property rights or other rights held by Nichia or third parties.
- Nichia makes no representation or warranty, express or implied, as to the accuracy, completeness or usefulness of any information contained herein. In addition, Nichia shall not be liable for any damages or losses arising out of exploiting, using, or downloading or otherwise this document, or any other acts associated with this document.
- The content of this application note may be changed without any prior or subsequent notice.
- Copyrights and all other rights regarding the content of this document are reserved by Nichia or the right holders who have permitted Nichia to use the content. Without prior written consent of Nichia, republication, reproduction, and/or redistribution of the content of this document in any form or by any means, whether in whole or in part, including modifications or derivative works hereof, is strictly prohibited.

NICHIA CORPORATION
491 Oka, Kaminaka-Cho, Anan-Shi,
TOKUSHIMA 774-8601, JAPAN
http://www.nichia.co.jp
Phone: +81-884-22-2311 Fax: +81-884-21-0148