

## Layout design of LED

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## 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 (Figure 1 and 2).

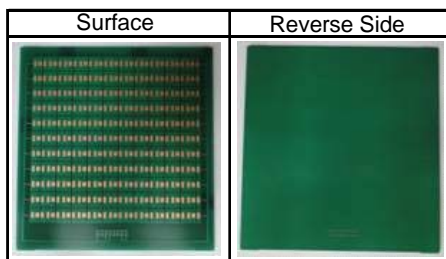


Figure 1 Circuit Board (FR-4)

Board: FR-4 (Copper foil on both surfaces)

Board Thickness: 1.6mm

Copper Foil Thickness: 35 $\mu$ m

Reverse Side: Covered with copper foil

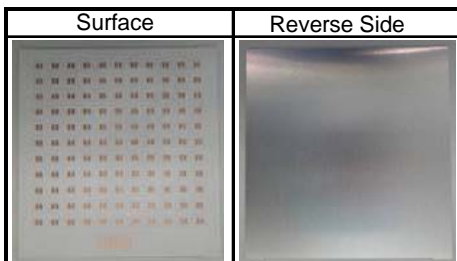


Figure 2 Circuit Board (Aluminum)

Board: Aluminum (Copper foil on one surface)

Board Thickness: 1.0mm

Copper Foil Thickness: 35 $\mu$ m

Insulating Layer Thickness: 120 $\mu$ m

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

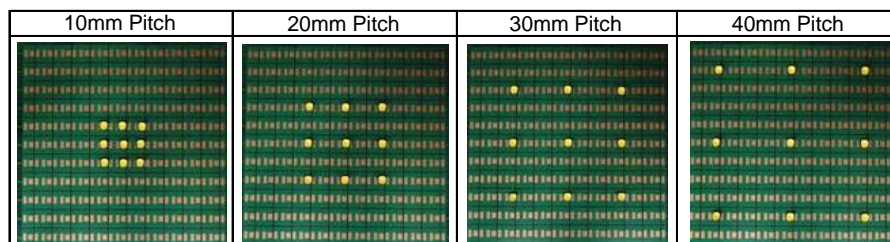


Figure 3 Pitch Pattern

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

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

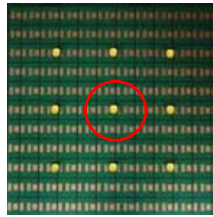


Figure 4 LED at the Center

### 3. LED Model

We demonstrated the configurations by using the five models below:

NVSx(W/L)x19B	NS9x(W/L)383	NF2x(W/L)757AR-V1	NS2x(W/L)757A-V1	NS2x(W/L)157AR

### 4. Measurement Results of Junction Temperature at Each Pitch

#### 4-1. NVSxx19B

Figure 5 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.

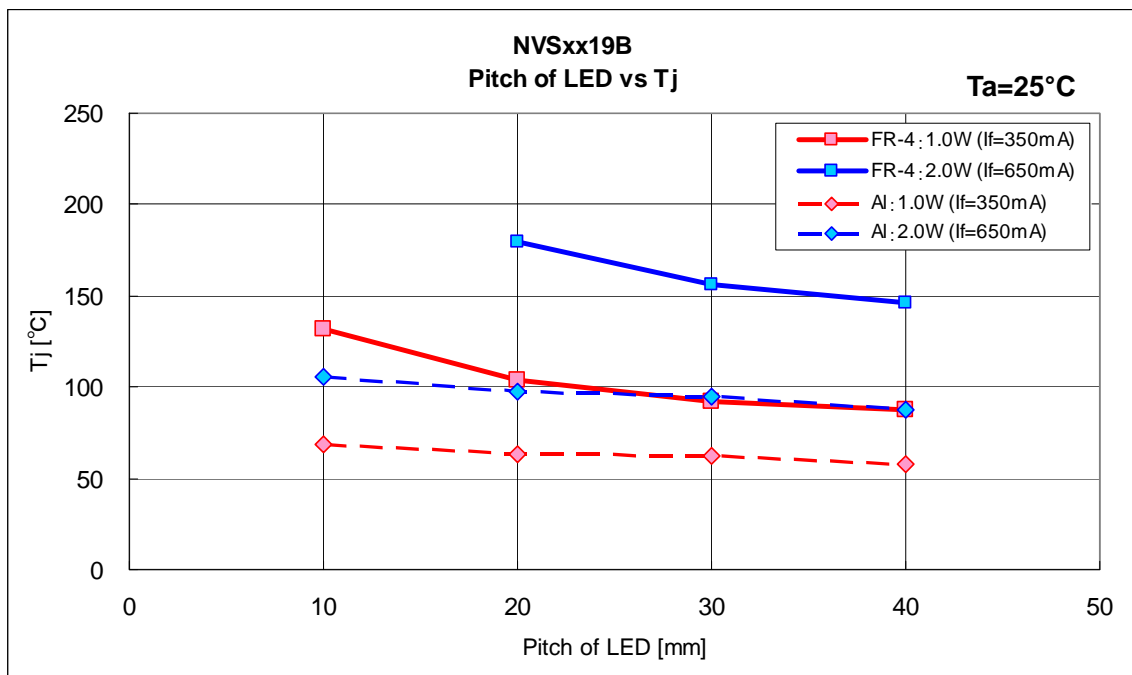


Figure 5 Junction Temperature at Each Pitch (NVSxx19B)

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

### 4-2. NS9x383

Figure 6 shows the  $T_j$  measurement results at 0.6W ( $I_f=200\text{ mA}$ ) and 1.0W ( $I_f=350\text{ mA}$ ) with the specified pitches. When FR-4 is used, the junction temperature has less interaction at more than 20 mm both at 0.6 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.

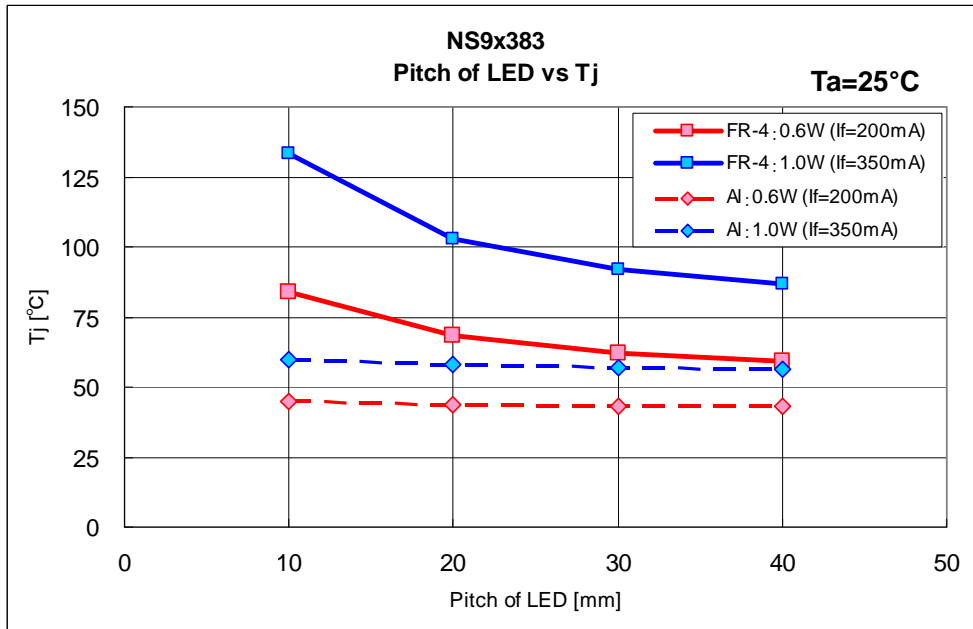


Figure 6 Junction Temperature at Each Pitch (NS9x383)

### 4-3. NF2x757AR-V1

Figure 7 shows the  $T_j$  measurement results at 0.6W ( $I_f=100\text{ mA}$ ) and 0.9W ( $I_f=150\text{ mA}$ ) with the specified pitches. When FR-4 is used, the junction temperature has less interaction at more than 20 mm both at 0.6 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.

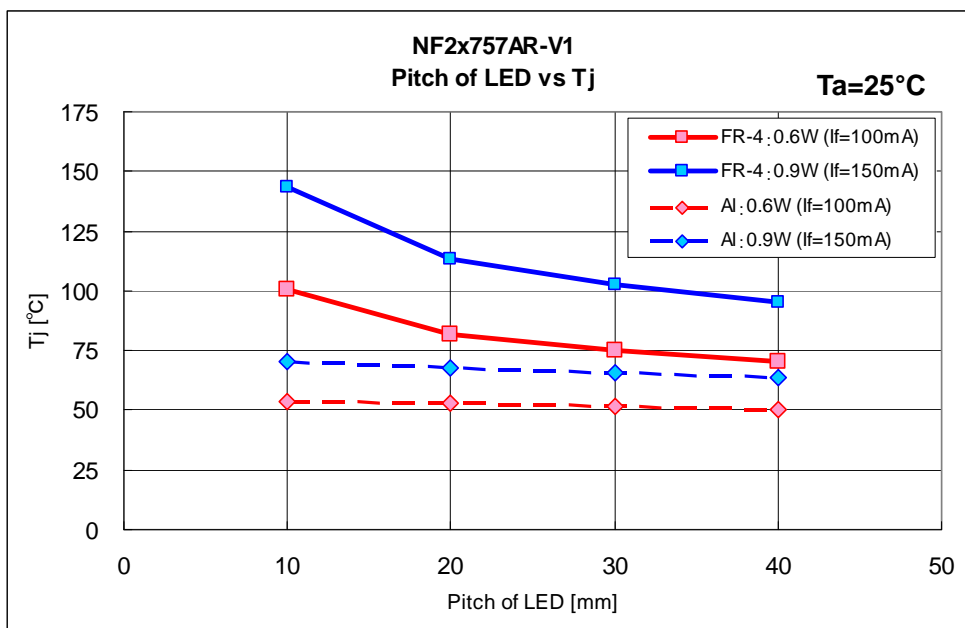


Figure 7 Junction Temperature at Each Pitch (NF2x757AR-V1)

### 4-4. NS2x757A-V1

Figure 8 shows the  $T_j$  measurement results at 0.2W ( $I_f=65\text{ mA}$ ) and 0.45W ( $I_f=150\text{ mA}$ ) 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.

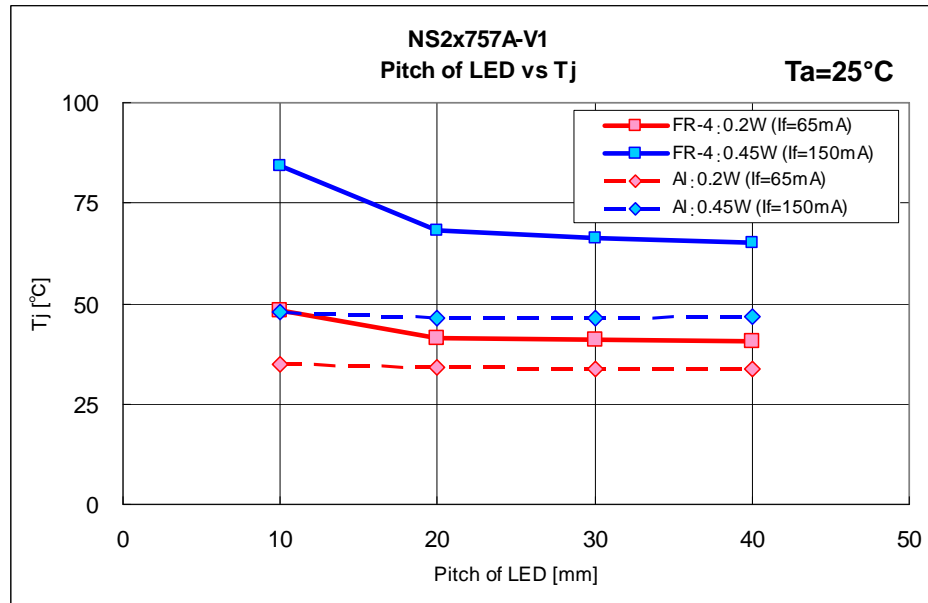


Figure 8 Junction Temperature at Each Pitch (NF2x757A-V1)

### 4-5. NS2x157AR

Figure 9 shows the  $T_j$  measurement results at 0.2W ( $I_f=40\text{ mA}$ ) and 0.4W ( $I_f=75\text{ mA}$ ) 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.

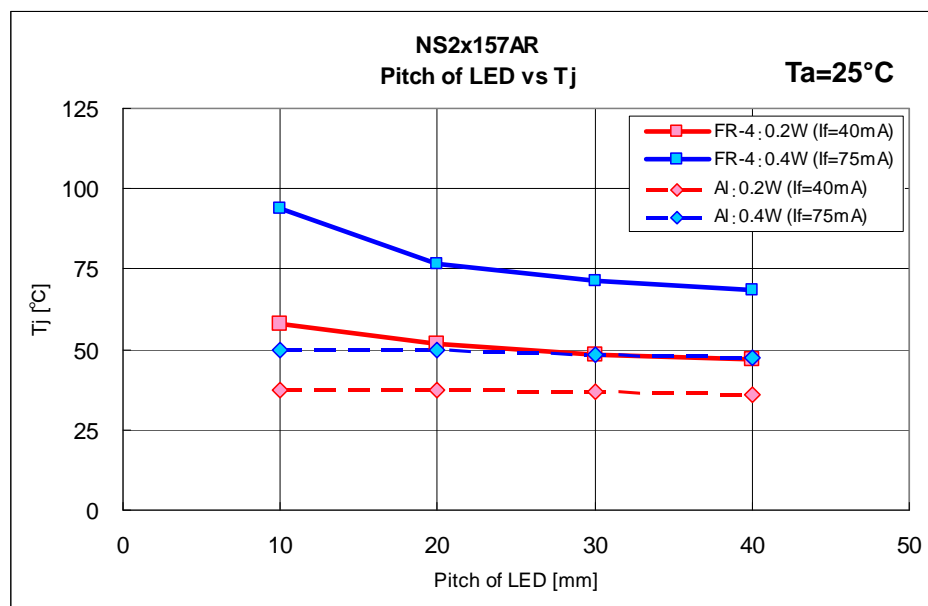


Figure 9 Junction Temperature at Each Pitch (NS2x157AR)

## 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.