Light Emitting Diode

Thermal Design Considerations for the Nichia NCSxE17A or NVSxE21A LEDs

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The Nichia part numbers NCSxE17A and NVSxE21A 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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1. Overview

For any system/application that uses LEDs, the thermal design is a very important factor in determining the optical and electrical characteristics (e.g. luminous flux, forward voltage) and is directly related to the lifetime of the LED. In addition to the thermal evaluation of the LED, the junction temperature must be managed when the LEDs are used in the chosen applications.
The NCSxE17A/NVSxE21A LEDs have a more compact size when compared to other LEDs that produce the same wattage and have a high luminous flux density. The thermal design is especially important due to the higher input power in conjunction with the small package size of these LEDs.
This application note provides the information on the precautions and temperature evaluation techniques for thermal design.

2. LED Structure and Thermal Overview

To effectively transfer the heat generated in the internal emitting device (hereafter referred to as "LED chip"), the design of the NCSxE17A/NVSxE21A LEDs is to have the LED chip directly soldered onto a secondary substrate (e.g. a PCB). As shown in Figure 1, the heat generated in the LED chip is able to be conducted and dissipated:

LED chip → Electrode → Solder → Copper Layer → Insulation Layer → Aluminum Layer → Housing (Luminaire)

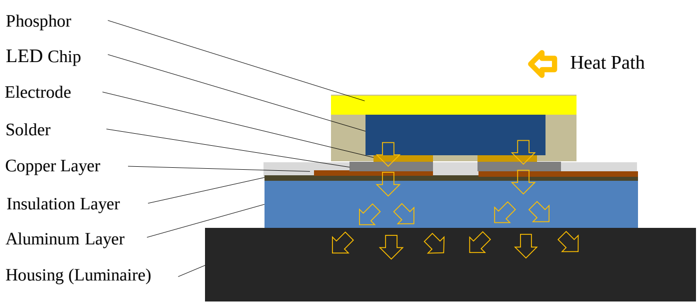
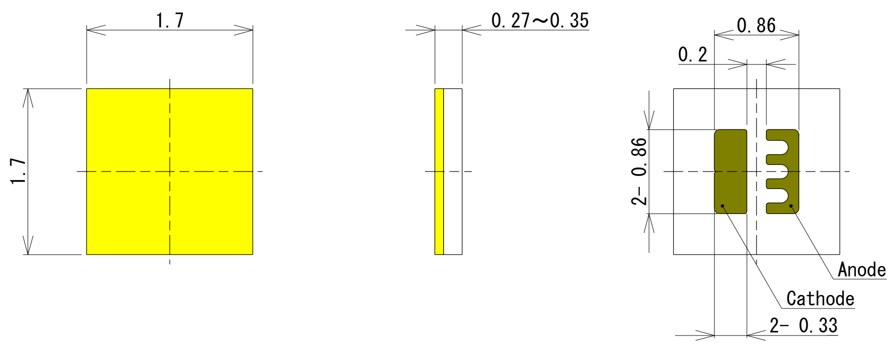


Figure 1. Internal Structure and Thermal Path of a NCSxE17A/NVSxE21A LED when connected to a PCB

The electrodes of NCSxE17A/NVSxE21A LEDs are small in proportion to the size of the package, it is important to use parts/materials with a sufficient heat dissipation capability for the heat dissipation path from the electrode to the housing. If a PCB with insufficient heat dissipation capability (e.g. glass-epoxy boards) is used, it may prevent heat from escaping and cause the junction temperature to extremely increase and/or the luminous flux to decrease.

For the dimensions of NCSxE17A/NVSxE21A's electrode pads, refer to Figures 2 and 3 below.



[Unit: mm]

Figure 2. Outline Dimensions of NCSxE17A

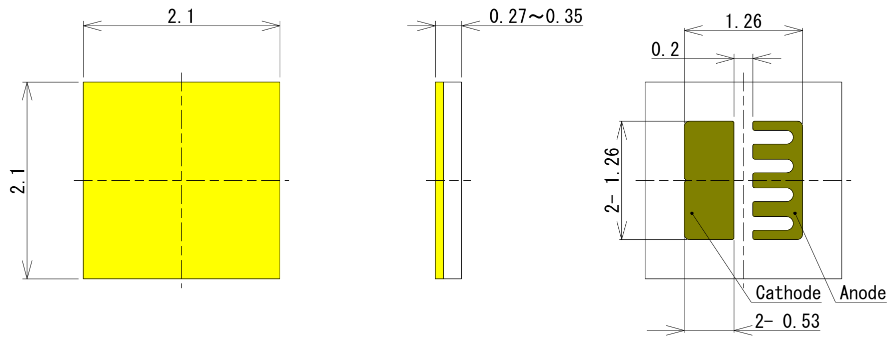


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Figure 3. Outline Dimensions of NVSxE21A

3. Thermal Design Considerations

3.1 A Thermal Resistance Model Example with Parameters

Refer to Figure 4 for an example of a cross section of an NCSxE17A/NVSxE21A LED soldered to an aluminum PCB when used with a heat sink to dissipate the heat and Figure 5 for a schematic diagram of the thermal resistance for this LED and PCB geometry. Refer to Table 1 for important technical terms used in this application note with descriptions and cautions/suggestions to consider.

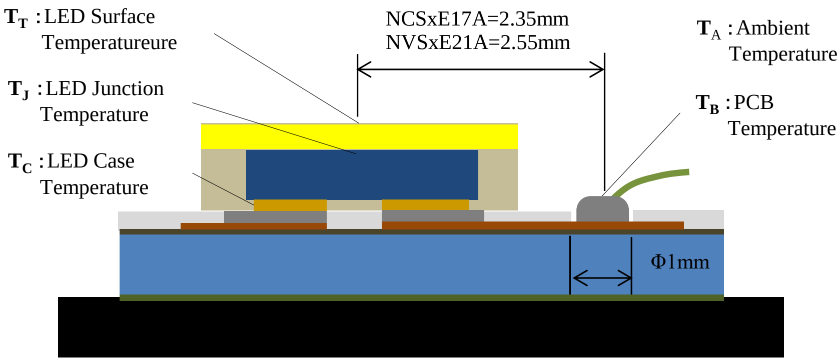


Figure 4. Cross Sectional Diagram of an NCSxE17A/NVSxE21A LED

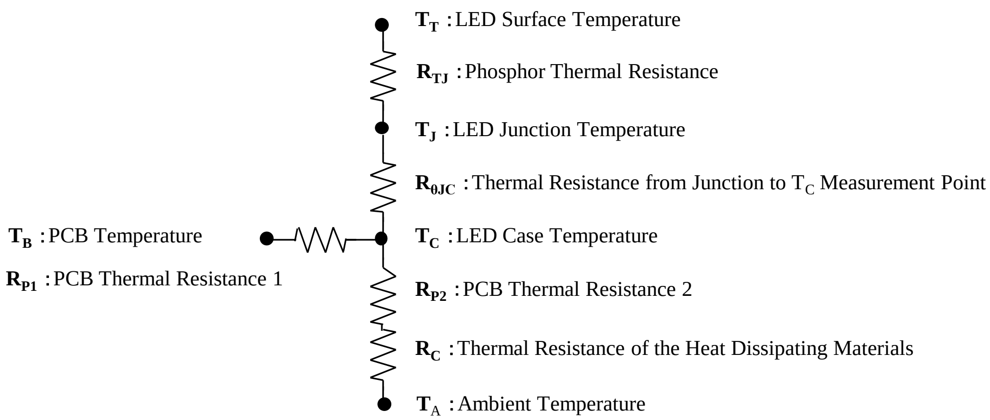


Figure 5. Schematic diagram of the thermal resistance of a NCSxE17A/NVSxE21A when soldered to a PCB

Table 1. Important Technical Terms/Descriptions and Cautions/Suggestions

Term	Symbol	Descriptions and Cautions/Suggestions
LED Surface Temperature	T_T	The temperature at the center on the surface of the emission area of the LED.
LED Junction Temperature	T_J	The temperature of the LED chip. The maximum junction temperature of NCSxE17A/NVSxE21A is 135°C; ensure that the junction temperature does not exceed this temperature during operation.
Thermal Resistance from Junction to T_C Measurement Point	$R_{\theta JC}$	The thermal resistance from the LED chip (i.e. junction) to the electrode (i.e. case). Nichia determines thermal resistances according to the measurement/calculation methods detailed in JESD 51. The maximum thermal resistance values of NCSxE17A/NVSxE21A are very small: 1°C/W (max.) for NCSxE17A and 0.6 °C/W (max.) for NVSxE21A.
LED Case Temperature	T_C	The temperature at the electrodes. In the case of the NCSxE17A/NVSxE21A LEDs, once the LED has been soldered to a PCB it is difficult to determine the T_C due to the location of the T_C measurement point.
PCB Temperature	T_B	The PCB surface temperature measured at a point that is close to the LED. In the case of the NCSxE17A/NVSxE21A LEDs, no solder fillets will be formed between the LED electrode and the PCB and it is difficult to determine the temperature at the solder connection. The T_B should be measured at the T_B measurement point as shown in Figure 4.
PCB Thermal Resistance 1	R_{P1}	The thermal resistance from the LED electrode to the T_B measuring point. The R_{P1} can vary depending on the aluminum PCB (e.g. the land pattern design soldering pad pattern and its size [copper layer], heat dissipation performance, etc.), the heat sink, and operating conditions (i.e. LED temperature during operation, etc.) used for the LEDs.
Thermal Resistance from junction to T_B measuring point	$R_{\theta JB}$	The thermal resistance from the LED chip (i.e. junction) to the surface of the PCB (T_B measurement point). This thermal resistance ($R_{\theta JB}$) is represented by the following equation. LED Thermal Resistance ($R_{\theta JB}$) = LED Thermal Resistance ($R_{\theta JC}$) + PCB Thermal Resistance 1 (R_{P1}) $R_{\theta JC}$ = Thermal resistance from junction to T_C measurement point
PCB Thermal Resistance 2	R_{P2}	The thermal resistance of the aluminum PCB from the contact surface with the LED to the heat sink (in the Z direction). The thermal resistance of an aluminum PCB can vary greatly depending on the insulation layer specifications (i.e. thermal conductivity, thickness); ensure that sufficient verification is performed when selecting the material. The R_{P2} is characterized by the following equation: PCB Thermal Resistance 2 (R_{P2}) [°C/W] = Insulation Layer Thickness [m] / (Insulation Layer's Thermal Conductivity [W/m·K] x Insulation Layer's Area [m^2])
Thermal Resistance of the Heat Dissipating Materials	R_C	The thermal resistance obtained by combining the thermal resistances of the heat dissipating materials (e.g. heat dissipating film, heat dissipating grease, heat sink, etc.).
Ambient Temperature	T_A	The temperature of the environment surrounding the LED light module.

The following section provides the results of Nichia's thermal simulations to outline the importance of the printed circuit board assembly.

3.2 Thermal Simulations with Aluminum PCBs

When using the NCSxE17A/NVSxE21A LEDs, the heat dissipation capability of the PCB is very important. Refer to Figure 6 and Figure 7 to compare the results of thermal simulations using an aluminum PCB with low thermal conductivity and with high thermal conductivity.

Heat from the LED is not sufficiently dissipated causing the T_J to become high.

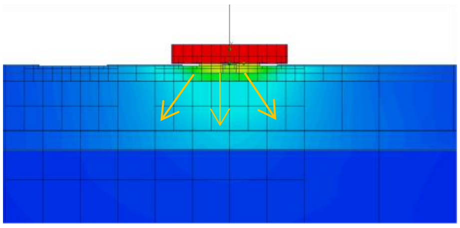


Figure 6. Aluminum PCB with low thermal conductivity

Heat from the LED is sufficiently dissipated causing the T_J to become low.

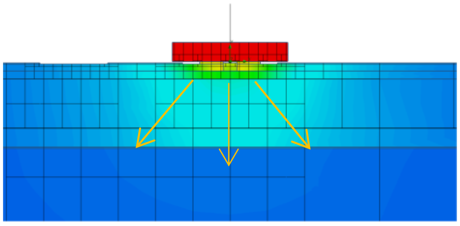


Figure 7. Aluminum PCB with high thermal conductivity

When the NCSxE17A/NVSxE21A LEDs are soldered to an aluminum PCB with low thermal conductivity, the heat from the LED is not sufficiently dissipated and it causes the LED junction temperature to increase. If they are soldered to an aluminum PCB with high thermal conductivity, the heat from the LED is sufficiently dissipated to the aluminum PCB via the insulation layer (that also has high thermal conductivity) and it causes the LED junction temperature to be low. When using NCSxE17A/NVSxE21A LEDs for the chosen application, the PCB should be carefully selected. If the input power to the LED is large, using a PCB with poor thermal conductivity (e.g. glass epoxy resin PCBs [FR4], glass composite PCBs [CEM3] and aluminum PCBs with low thermal conductivity) are not recommended; instead, Nichia recommends using aluminum PCBs with high thermal conductivity.

3.3 Types of Soldering Pad Patterns and the Heat Dissipation Capabilities

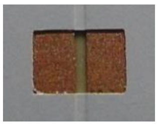
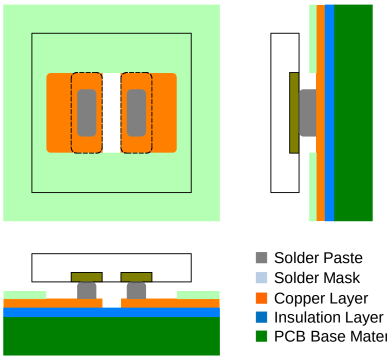
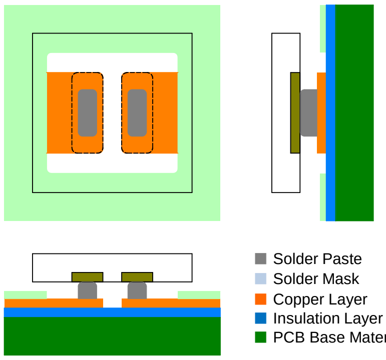
There are two different types of soldering pad patterns: solder mask defined (SMD) pads and non-solder mask defined (NSMD) pads.

SMD pads: Solder masks (i.e. solder stencil aperture) are used to define the land (i.e. area/position of the land on the PCB)

NSMD pads: A copper etching solution (Copper defined pad) is used to define the land (i.e. area/position of the land on the PCB)

Refer to Table 2 for the advantages/disadvantages of these types of pads.

Table 2. Comparison of SMD and NSMD Land Patterns

Soldering Pad Pattern Type	SMD	NSMD
Appearance		
Structural Diagrams		
Ease/Precision of Assembly	[Disadvantage] The quality of the assembly depends on how precisely the solder mask is applied. △	[Advantage] The quality of the assembly does not critically depend on how precisely the solder mask is applied. ○
Heat Dissipation Performance	[Advantage] SMD designs have a copper layer that is greater in area than the land and that causes better heat dissipation. ○	[Disadvantage] NSMD designs have a copper layer that is smaller in area than the land and that causes poor heat dissipation. △

• <u>Ease of Assembly for LEDs</u>

The NCSxE17A/NVSxE21A LEDs have very small electrodes with a little clearance (0.2mm) between the anode and cathode electrodes; these features require the PCB to be manufactured with precision. In the case of SMD pads, the land size/position are defined by the aperture of the solder mask (i.e. SMD pads); if the quality of solder mask application is poor, it will cause a position error (i.e. difference between the intended position and actual position where the LED is soldered) and the resulting difference in size between the lands for the anode electrode and cathode electrode. These differences can cause LED-related failures/defects during the assembly of the chosen application (e.g. open circuit, short circuit, misalignments, lifts/delamination, solder balls, etc.); when using SMD pads for the chosen application, ensure that the PCBs are manufactured with precision through sufficient verification.

In the case of NSMD pads, a copper etching solution is used to define the size and position of the land; if the solder mask is not applied correctly and/or not in the correct position, it will not have a significant effect on the land. As a result, NSMD pads have an advantage for the ease of assembly over SMD pads.

IMPORTANT NOTE: Once an NCSxE17A/NVSxE21A LED is soldered to a PCB, do not repair and/or rework the LEDs. For more details, refer to the application note "Assembly Techniques for NCSxE17A/NVSxE21A" and ensure that sufficient verification is performed prior to use.

• Effects of SMD/NSMD pads on the Heat Dissipation Performance

In order to ensure that heat from an LED is effectively conducted to the aluminum PCB, the area of the copper layer should be as large as possible. The maximum size of the copper layer of an SMD design is virtually unlimited if the design of the PCB allows, while that of a NSMD design is limited to the solder pad pattern size for the LED. As a result, SMD pads have an advantage in heat dissipation over NSMD pads. The thickness of the copper also influences the heat dissipation and the greater the thickness the better the heat dissipation performance. However, since the electrode-to-electrode clearance is only 0.2mm, the recommended thickness of a copper layer is 35µm considering possible etching failures/defects during manufacturing of the PCB.

3.4 Recommended Soldering Pad Pattern

Refer to Figure 8 and Figure 9 for the recommended soldering pad patterns for the NCSxE17A/NVSxE21A LEDs when NSMD pads are used for the PCB.

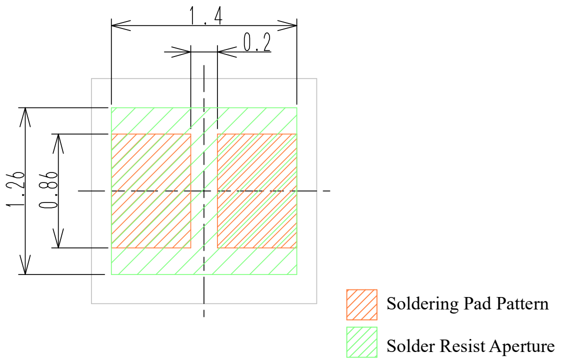


Figure 8. NCSxE17A Recommended Soldering Pad Pattern

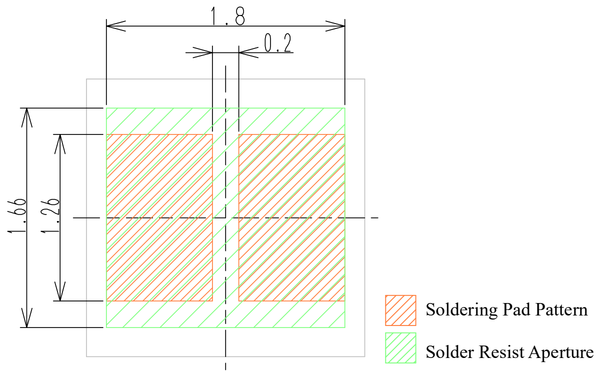


Figure 9. NVSxE21A Recommended Soldering Pad Pattern

For the NCSxE17A LEDs, the recommended solder pad pattern size is 0.86mm in width and the solder mask aperture size for this is 1.26mm in width; this difference in size is designed to account for a solder mask position deviation of less than 0.2mm. Both soldering pad designs (i.e. SMD/NSMD) have advantages/disadvantages; ensure that the cautions/suggestions detailed in section 3.3 are read and understood and the appropriate soldering pad design is used for the chosen application.

Nichia has performed an evaluation of how the soldering pad design and/or the PCB's heat dissipation performance affect the thermal resistance from junction to solder ($R_{\theta JB}$). Refer to Section 4 below for these $R_{\theta JB}$ values and the details of the evaluation.

4. Evaluation of the Thermal Resistance from the LED chip to the T_B Measurement Point ($R_{\theta JB}$)

Nichia has calculated the thermal resistance ($R_{\theta JB}$) of NCSxE17A/NVSxE21A LEDs with various types of aluminum PCBs (e.g. type/size of soldering pad pattern, thermal conductivity of the insulation layer). The measurement methods used comply with JESD 51.

4.1 Specifications for the PCBs used in the Evaluation

For the thermal conductivity of the insulation layer of the aluminum PCB, six different types ranging from 1.8W/m·K to 11.1W/m·K were used. Details for the specifications of these PCBs are shown in Table 3 below.

Table 3. Specifications for the Aluminum PCBs

PCB Specifications*[1]	Unit	NRA-ES1	NRA-8	NRA-E(3.0)	NRA-E(6.5)	NRA-H6	NRA-H10
Insulation Layer Thermal Conductivity*[2]	W/m·K	1.8	2.1	2.7	4.5	5.7	11.1
Insulation Layer Thickness	μm	120	120	120	120	120	120
Copper Layer Thickness	μm	35	35	35	35	35	35
Aluminum Layer Thickness	mm	1	1	1	1	1	1

*[1] The PCBs are manufactured by Nippon Rika Kogyosho Co., Ltd.

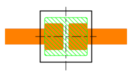
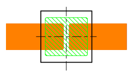
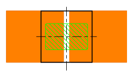
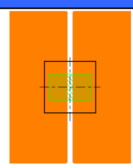
*[2] The values for the thermal conductivity of the insulation layer are from Nippon Rika Kogyosho Co., Ltd. catalogs and are not guaranteed.

4.2 Soldering Pad Patterns and PCB Designs (i.e. shapes/size of the copper layer) used in the Evaluation

• NCSxE17A

Two different types of soldering pad patterns (i.e. SMD and NSMD) with copper layers ranging in size were used: 0.5mm (min.), 0.86mm (same size as the electrodes), 1.7mm (same size as the package) and 5mm (max.).

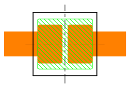
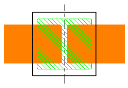
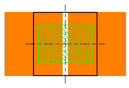
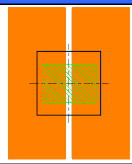
Table 4. Soldering Pad Patterns and PCB Design used for the Thermal Resistance Evaluation for NCSxE17A

Type	A	B	C	D
Solder Pad Pattern	NSMD	NSMD	SMD	SMD
Pattern Width	0.5mm	0.86mm	1.7mm	5mm
Soldering Pad Pattern and PCB Design Outline				
Typical Application	Not recommended	High-density assembly	High-density assembly	Single LED assembly, etc.

• NVSxE21A

Two different types of soldering pad patterns (i.e. SMD and NSMD) with copper layers ranging in size were used: 0.8mm (min.), 1.26mm (same size as the electrodes), 2.1mm (same size as the package) and 5mm (max.).

Table 5. Soldering Pad Patterns and PCB Design used for the Thermal Resistance Evaluation for NVSxE21A

Type	A	B	C	D
Solder Pad Pattern	NSMD	NSMD	SMD	SMD
Pattern Width	0.8mm	1.26mm	2.1mm	5mm
Soldering Pad Pattern and PCB Design Outline				
Typical Application	Not recommended	High-density assembly	High-density assembly	Single LED assembly, etc.

4.3 Measurement Results for the Transient Thermal Resistance

• Refer to Figure 10 for the thermal resistance from the LED chip to the T_B measurement point ($R_{\theta JB}$) when operating NCSLE17A LEDs (Color Rank: sm27, Color Rendering Index Rank: R8000) at I_F=700 mA.

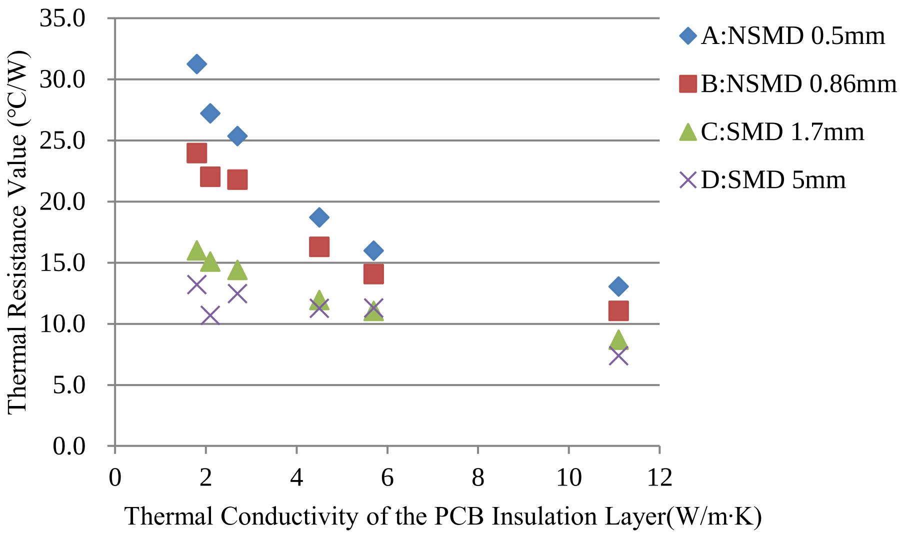


Figure10. NCSLE17A's Thermal Resistance Values ($R_{\theta JB}$)

• Refer to Figure 11 for the thermal resistance from the LED chip to the T_B measurement point ($R_{\theta JB}$) when operating NVSLE21A LEDs (Color Rank: sm27, Color Rendering Index Rank: R8000) at I_F=1400 mA.

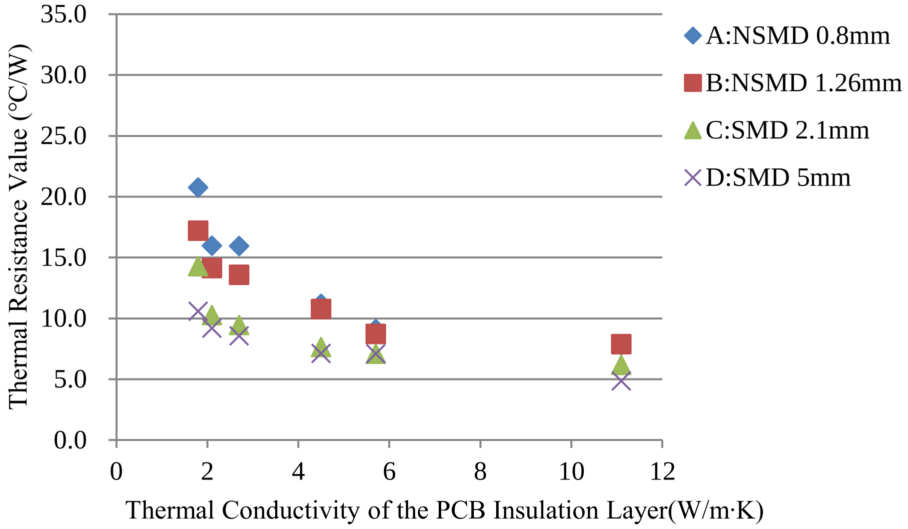


Figure11. NVSLE21A's Thermal Resistance Values ($R_{\theta JB}$)

The evaluation results confirm that the thermal resistance value of NCSLE17A/NVSLE21A LEDs decreases when:

1) the thermal conductivity of the insulation layer is larger,
2) an SMD design is used instead of a NSMD design,
3) the width of the copper layer is larger

4.4 Recommended Aluminum PCB Materials

When the LEDs are used with an aluminum PCB with a high thermal conductivity, the thermal resistance from junction to solder ($R_{\theta JB}$) is less likely to be affected by the soldering pad pattern and/or PCB design (i.e. size/shape of the copper layers on the PCB). Since the thermal resistance in this case would have a lower value, Nichia recommends using an aluminum PCB with an insulation layer that has a thermal conductivity ≥ 5.7W/m·K for the NCSxE17A/NVSxE21A LEDs.

5. How to Determine the Junction Temperature (T_J)

There are two different types of methods to determine the LED junction temperature:
- Calculating T_J from the PCB temperature (T_B) and the input power for the LED (see section 5.1)
- Calculating T_J using the ΔV_F method (see section 5.2)

Refer to the following sections for details on these calculation methods.

5.1 Calculating LED Junction Temperature (T_J) from the PCB temperature (T_B) and the Input Power for the LED

T_J is represented by Equation 1 below. It is possible to estimate the T_J by using this equation.

Equation 1 : $T_J = T_B + R_{\theta JB} \cdot W$

T_J = Junction Temperature [°C]
T_B = PCB Temperature [°C]
$R_{\theta JB}$=Thermal Resistance from LED chip to T_B Measurement Point [°C/W]
W = Input Power ($I_F \times V_F$) [W]

Table 6. Thermal Resistance for NCSxE17A/ NVSxE21A

Part Number	Symbol	Unit	PCB*1	PCB*2
NCSxE17A	$R_{\theta JB}$	°C/W	16	31
NVSxE21A	$R_{\theta JB}$	°C/W	9	21

Aluminum PCBs used:
*1Insulation layer thermal conductivity; 5.7W/m·K, Thickness: 120μm
*2Insulation layer thermal conductivity; 1.8W/m·K, Thickness: 120μm

For the thermal resistance values ($R_{\theta JB}$) of NCSxE17A/NVSxE21A, refer to Table 6 above. As discussed in Section 4, the $R_{\theta JB}$ varies greatly depending on the PCB and the $R_{\theta JB}$ listed in Table 6 were determined by using PCBs with two different insulation layer thermal conductivities (see the note under the table) and the smallest discussed soldering pad designs (i.e. Soldering Pad Design A: NSMD [see Tables 4 & 5 in Section 4]). Additionally, the $R_{\theta JB}$ may vary depending on the chosen operating conditions/environment; use these values for reference purposes only.

• <u>How to Measure the PCB Temperature (T_B) for the NCSxE17A/NVSxE21A LEDs</u>

For thermal measurement, attach a thermocouple in a position closest to the LED while ensuring that the LED is not adversely affected by the heat when the thermocouple's wires are soldered to the PCB. It is recommended to set the temperature measurement point 2.35mm away from the LED center for an NCSxE17A LED, 2.55mm away from the LED center for an NVSxE21A LED. For both LED models, the size of temperature measurement point should be φ1.0mm.

Refer to Figure 12 for an example of a thermocouple used by Nichia and Figure 13 for an example showing how to attach a thermocouple to a PCB.

Figure 12. Example of a Thermocouples used by Nichia

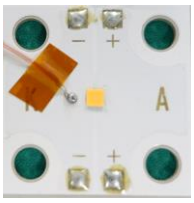


Figure 13. Example of a PCB attached with a Thermocouple

5.2 Calculating the LED Junction Temperature (T_J) using the ΔV_F method

The forward voltage (V_F) of LEDs varies as the ambient temperature (T_A) changes. It is possible to use this characteristic to calculate the T_J of a LED in a light module.

<u>• How to Determine the Temperature Coefficient of an LED soldered to a PCB</u>

Place the LED light module in a temperature/humidity chamber. Measure the V_F at T_A ranging from 25°C to 135°C to determine the LED temperature function using Equation 2 below.

Equation 2: Temperature Coefficient $K = V_{F@25°C} – V_{F@135°C} / (135\text{-}25)$

For the measurement, use a pulse current (I_P=1mA) and it will not cause the LED to generate excessive heat causing no effect on the measurement, and achieve good reproducibility. For the measurement circuit, refer to Figure 14 and for the relationship between T_A and V_F, refer to Figure 15.

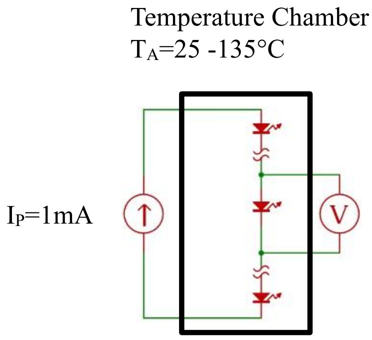


Figure 14. V_F Measurement Circuit

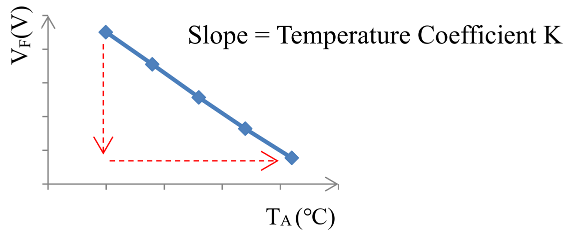


Figure 15. T_A VS. V_F

<u>• How to Calculate the Junction Temperature</u>

First measure the V_F immediately after the LED light module is turned on using the pulse current (I_P= 1mA) (V_{F1}). Then proceed to operate the LED light module using the chosen operating current for the application until the thermal saturation point is reached. At that point, then measure the VF again using the pulse current (I_P = 1mA) (V_{F2}). These steps ensure that the ΔV_F is measured in a method that ensures these measurements are not affected by the heat from the LED during operation and is reproducible; Then determine the $\Delta V_F = V_{F1} – V_{F2}$. For the relationship between the T_J and ΔV_F, refer to Equation 3. Use this equation to estimate the T_J.

Equation 3: $T_J=\Delta VF/K+T_A$

Refer to Figure 16 for the measurement circuit, Figure 17 for an example of the measured waveform of input current to operate an LED light module and Figure 18 for an example of the measured waveform of voltage in the same module.

I_P=1mA (for V_{F1} and V_{F2} Measurements)

I_F= Chosen Current (to achieve the saturation temperature for the chosen LED light module)

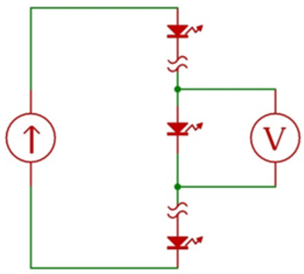


Figure 16. Measurement Circuit

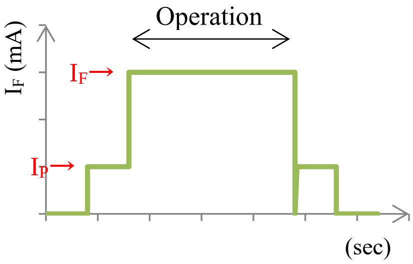


Figure 17. Measured Input Current Waveform (Example)

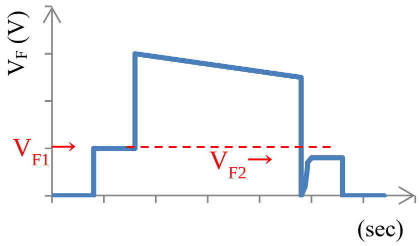


Figure 18. Measured Voltage Waveform (Example)

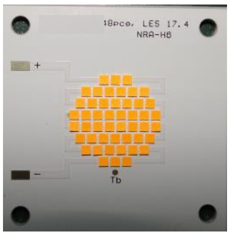
When determining T_J, the ΔV_F method has an advantage in measurement precision over the other method in Section 5.1. The disadvantaged are that it requires special equipment/instruments (e.g. temperature chamber, power supply for operation, measuring instruments) and a high level of measurement precision (i.e. temperature coefficient K and ΔV_F). Refer to the next section for a simpler temperature evaluation method using a thermal imaging camera.

6. Temperature Evaluation

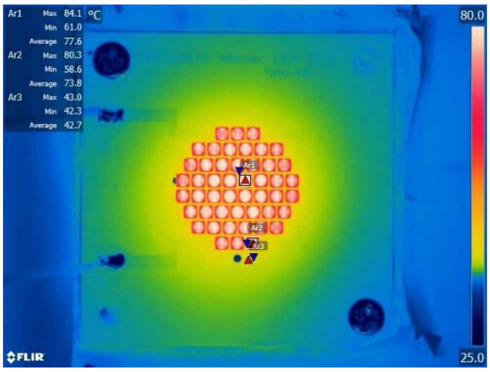
For LED module temperature evaluations, verification with an infrared thermal imaging camera is effective. With this method, it is impossible to measure LED junction temperatures and it is a practical method for checking LED surface temperatures and the temperature distributions of LED modules. An example of Nichia's evaluation using this method is shown in Figure 19 below.

6.1 Example of a Temperature Evaluation for an LED Light Module

[Light Module Used]



PCB Outline Dimensions: 40mm
Light Emitting Surface (LES):
Dimension: φ17.4mm
PN: NCSLE17A (sm27 R8000)
Number of Units: 48 LEDs
I_F=350mA
Input Power: 48W
Aluminum PCB's Insulation Layer:
Thermal Conductivity:
5.7W/m·K
Thickness: 120µm
Soldering Pad Design: NSMD
Heat Sink: 0.5°C/W



Measurements		°C
Ar1 *1	Max	84.1
	Min	61.0
	Average	77.6
Ar2 *1	Max	80.3
	Min	58.6
	Average	73.8
Ar3 *1	Max	43.0
	Min	42.3
	Average	42.7

Parameters	
Emissivity	0.95
Refl. temp.	25 °C

*1 Ar1: LED Surface Temperature (center), Ar2: LED Surface Temperature (edge), Ar3: PCB Temperature

*2 Measuring Instrument: T620 Thermal Imaging IR Camera (640 x 480) manufactured by FLIR Systems, Inc.

Figure 19. Temperature Evaluation with a Thermal Imaging Camera

6.2 Surface Temperature of an LED

For the NCSxE17A/NVSxE21A LEDs, the surface temperature is more likely to be higher than the junction temperature. The heat of an LED is mostly generated in its junction area; however, it is also generated in the phosphor layer as a result of the wavelength conversion within that layer (i.e. Stokes loss). The NCSxE17A/NVSxE21A LEDs have thin phosphor layers designed to be far from the heat dissipation path of the LED chip; this causes the surface temperature to increase since the heat in the phosphor layer is not able to dissipate easily. Refer to Figure 20 for a schematic diagram of how the heat generated in the phosphor layer flows in a NCSxE17A/NVSxE21A LED.

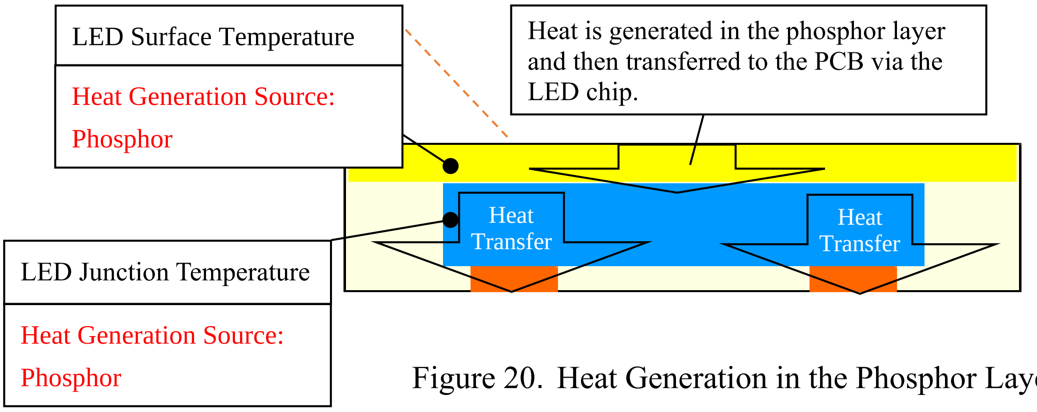


Figure 20. Heat Generation in the Phosphor Layer

The amount of the heat generated in the phosphor layer may vary depending on the color temperature, color rendering index and light output. Refer to Figure 21 and Figure 22 for the details on how the difference between the junction and surface temperatures changes as the operating current increases.

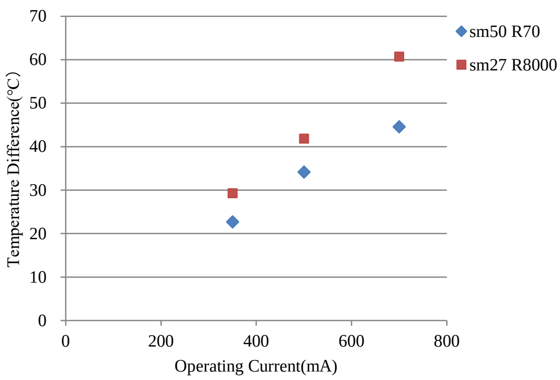


Figure 21. Example of the Surface and Junction Temperature Differences for NCSxE17A LEDs

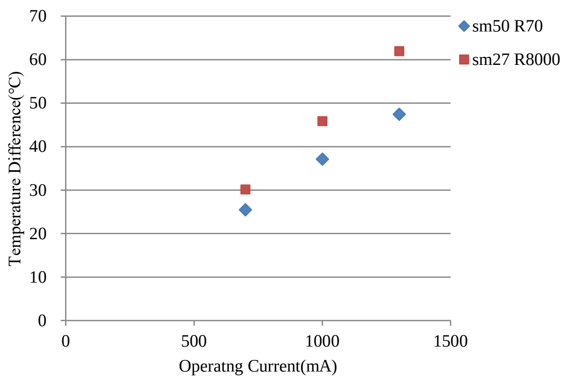


Figure 22. Example of the Surface and Junction Temperature Differences for NVSxE21A LEDs

Based on Figure 21, when the NCSLE17A LEDs (Color Rank: sm27, Color Rendering Index Rank: R8000) are operated at I_F=350mA, the surface temperature is higher than the junction temperature by approximately 30°C. It is possible to use this result to estimate the junction temperature:

Example: NCSLE17A LED (Color Rank: sm27, Color Rendering Index Rank: R8000) at I_F=350mA

[Estimated LED Junction Temperature]	･･･[Measured LED Surface Temperature (by thermal imaging)] –	[30°C (based on Figure 21)]

6.3 Cautions/Suggestions for Temperature Evaluation with a Thermal Imaging Camera

- The measurement result may vary depending on the measuring instrument and the measurement conditions/environment and may contain measurement errors. To use this measurement result for the thermal management design of the chosen application, ensure that the design has sufficient tolerances.
- The surface temperature an NCSxE17A/NVSxE21A LED will be higher than the junction temperature of the LED. If using the LEDs with optical parts with low heat resistance (e.g. secondary lens, reflector) in the same luminaire, ensure that necessary precautions are taken. Additionally, ensure that a necessary clearance distance is taken between the LED and an optical part and it is verified for the chosen application prior to use.
- The LED surface temperature should be lower than 150°C. If the LED surface temperature is high, the operating/environmental conditions are too severe for the LEDs. Ensure that there are no issues with the chosen operating/environmental conditions (e.g. the PCB, soldering pad design, heat sink to dissipate the heat from the LED, and operating current used).

7. Summary

This application note describes important items for system/luminaire designers to consider when using NCSxE17A/NVSxE21A LEDs and optimizing the thermal design of the chosen application. Ensure that when designing an LED luminaire, appropriate parts/materials are selected for the light module (e.g. PCB, heat dissipating materials) and sufficient temperature evaluations are conducted.

Disclaimer

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