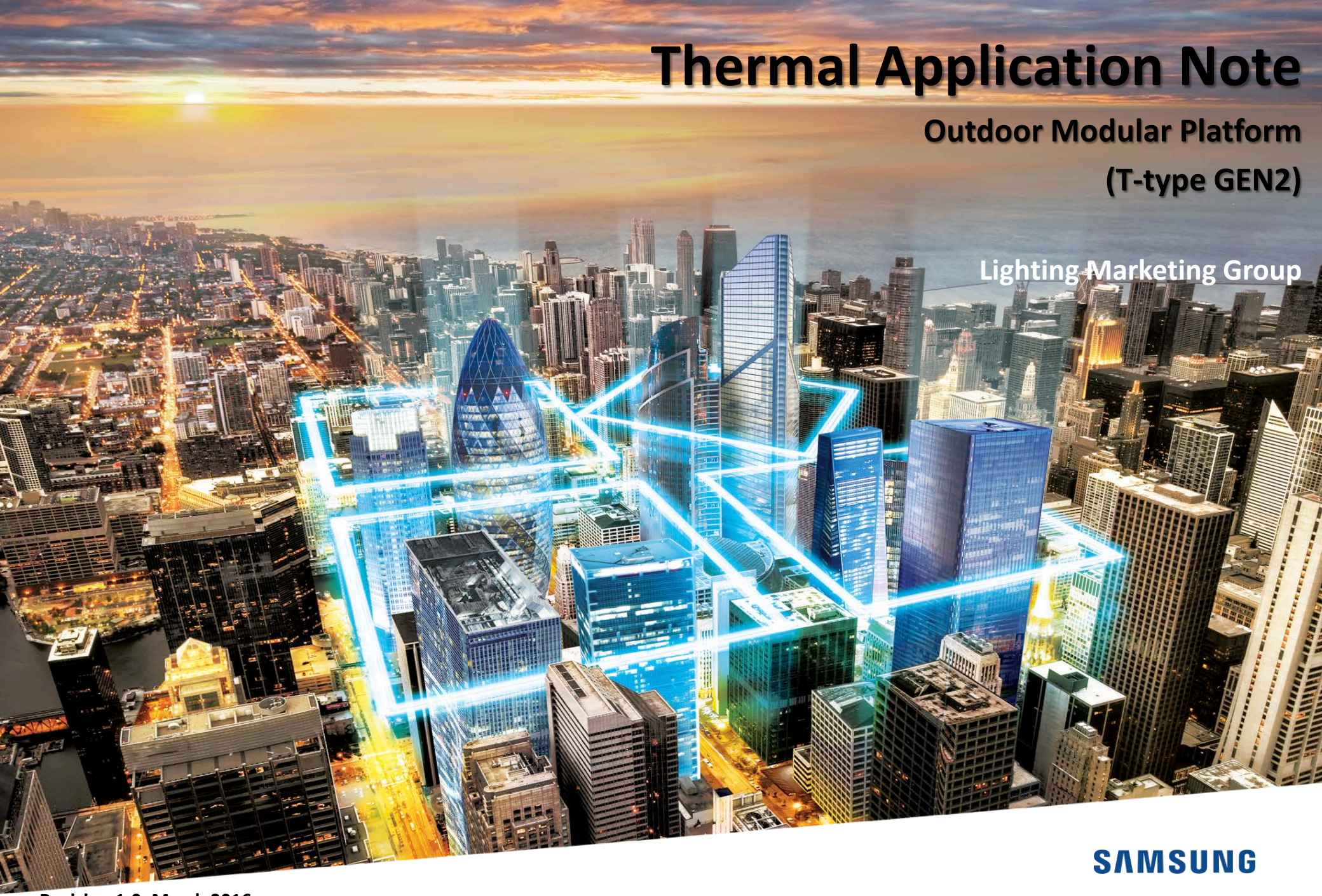
Thermal Application Note

Outdoor Modular Platform

(T-type GEN2)

Lighting Marketing Group



SAMSUNG

Revision 1.0_March 2016

Contents

1. Definition of Terms

1) Solder Point Temperature (Ts, ℃)

A solder point temperature is a temperature at the measurable point nearest toward the junction, generally the solder point of a light emitting diode on the printed circuit board(PCB).

Temperature can be recorded by using a thermocouple, which can be soldered at the metal (typically copper sheet on the PCB for LED module) directly.

2) Case Temperature (Tc, ℃)

A case temperature is a temperature at some specific point on either the engine or fixture to probe the solder point temperature instead of making the difficult preparation of the special sample, in many cases practically inappropriate for measurement during the thermal design and verification process. In general, Tc mark is available, printed in the product label on the aluminum case of a power supply unit.

3) Ambient Temperature (Ta, ℃)

An ambient temperature is a baseline temperature surrounding the devices such as a light emitting diode, module, engine, and luminaire under test. The ambient temperature is very much dependent on the weather and time of a day or night.

2. Thermal Characteristics

1) Define of Case Temperature(Tc) of LED Platform Module

A Tc point has been defined on the module to enable temperature measurement in a luminaire. This point can be found in the data sheet of the LED module.

The specified temperature of this point is related to the temperature of components and solder-joints inside the module and can estimate the lifetime based on the LM80 data.

Therefore, to measure the temperature at Tc point, good thermal contact between the heat sink and the thermocouple is required. The measurement result may be affected by the thermal resistance between the module and the luminaire and by the rotation angle of the module under test. To ensure that the lifetime of the product is reached, the thermal resistance between the bottom side of the module and the outside of the luminaire must be minimized.

The Solder Point temperature of the LED used is estimated to be higher by 5℃ above Tc, which is about 85℃ when the center of LED module is 80℃.

Fig. 1

2) Lumen Maintenance of LED (LH351B PKG)

The lumen output is estimated to be maintained 97.7% in average, relative to the initial value after 10,000 hours operation while the solder point temperature was set at 85℃, which means the expected life of the LED is longer than 50,000 hours according to the criteria using LM-80. The test summary in the table below shows good lumen maintenance for wide range of case temperature (in this case, Ts=Tc) and drive current.

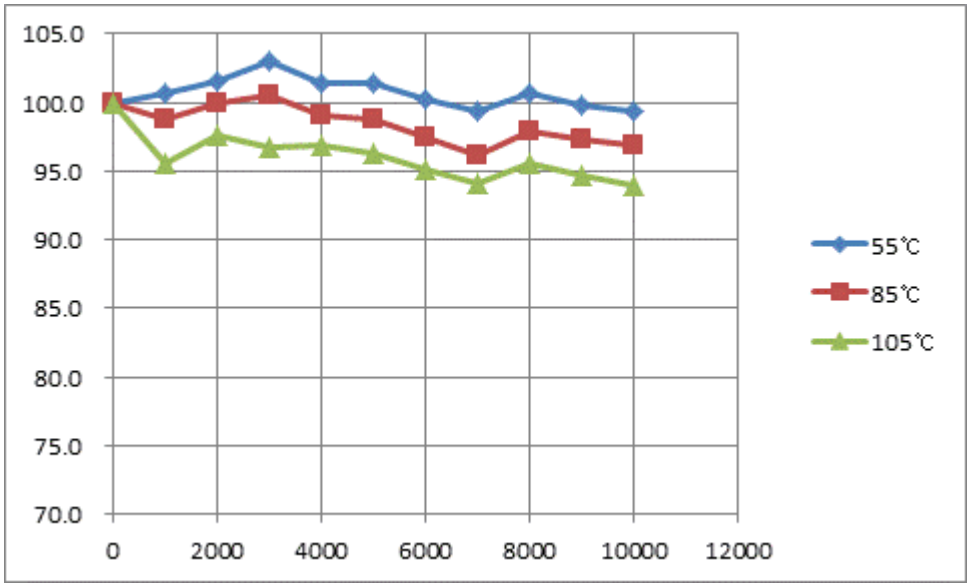
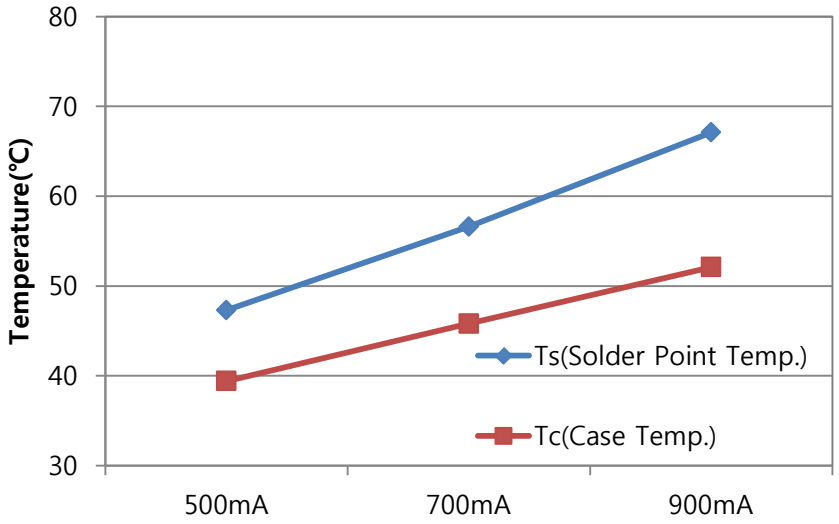


Fig. 2

3) Thermal Characteristics of a Unit Module as a Function of Driving Current

The solder point temperature and case temperature have been measured as a function of driving current from 500mA to 900mA at ambient temperature of 25℃. The solder point temperature was 56.6℃ at 700mA and 67.1℃ at 900mA below 80℃.



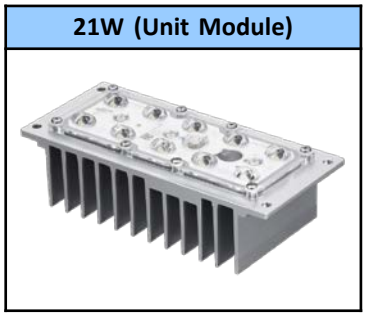


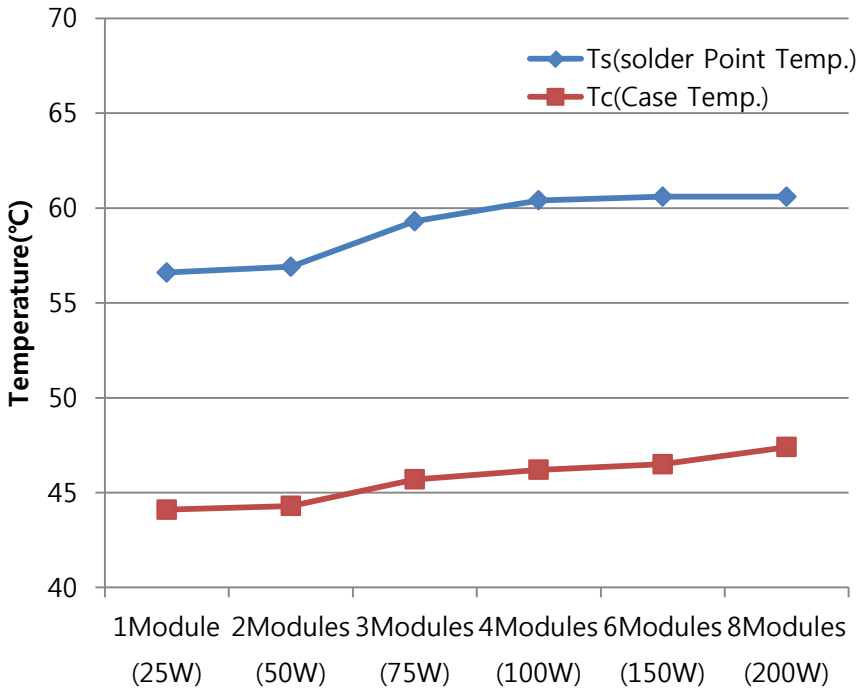
Fig. 3

2. Thermal Characteristics

4) Thermal Characteristics of Module Array with Aluminum Adaptor

The case temperature of various module arrays with aluminum adaptor has been measured as shown in the figure below. The adaptor can minimize the case temperature difference across the modules in the array to some extent.

The maximum solder point temperature and the case temperature increase as the total power dissipation increases. The solder point temperature show the difference of maximum 14 ℃ than the case temperature.



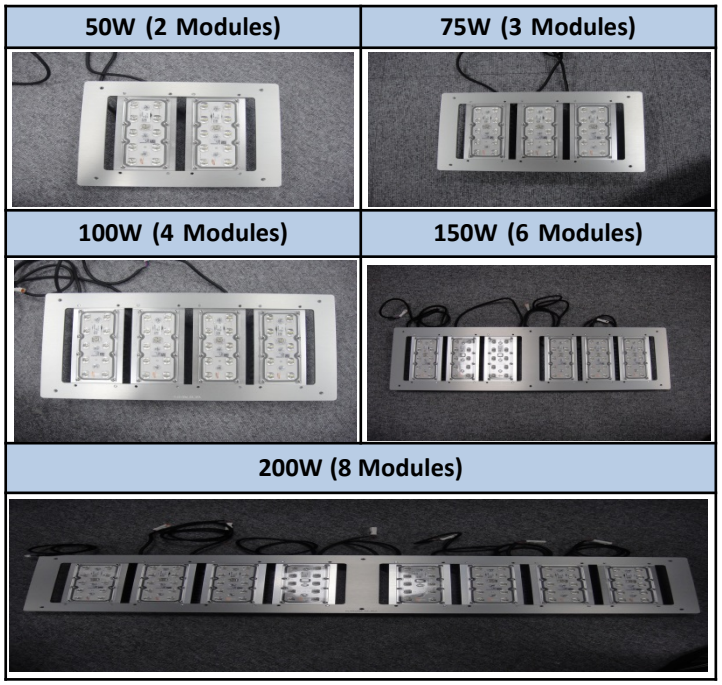


Fig. 4

5) Thermal Characteristics of Module Array as a Function of Module Spacing

The solder point temperature is very much dependent on the module spacing in the array.

The simulation results from 4 modules array with the aluminum adaptor show a dramatic change of Ts as a function of module spacing(see picture below).

If you want to use modules over 4 series, spacing more than 10mm at middle is recommended for stable thermal management.

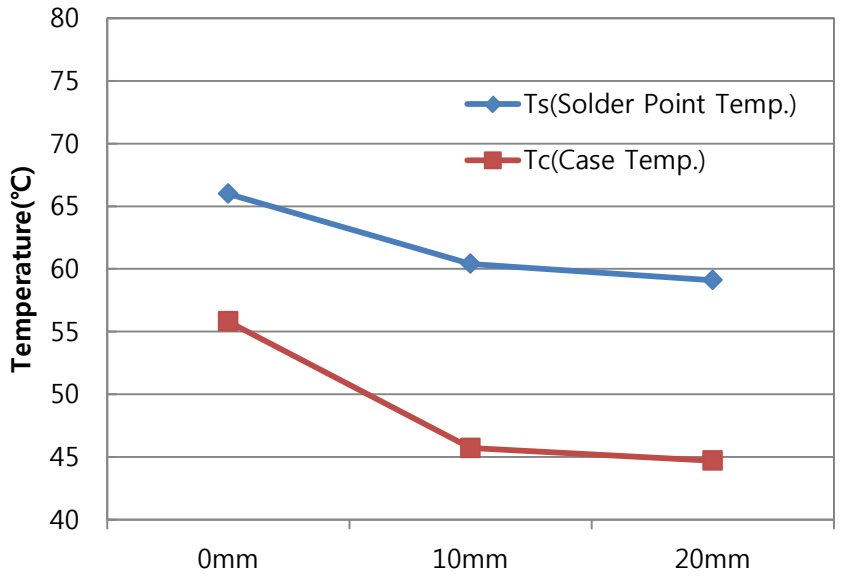


Fig. 5

6) Thermal Characteristics of Module Array as a Function of Ambient Temperature

The luminous intensity from the module array is dependent on the ambient temperature as shown in the figure below. The relative decrease of the luminous intensity

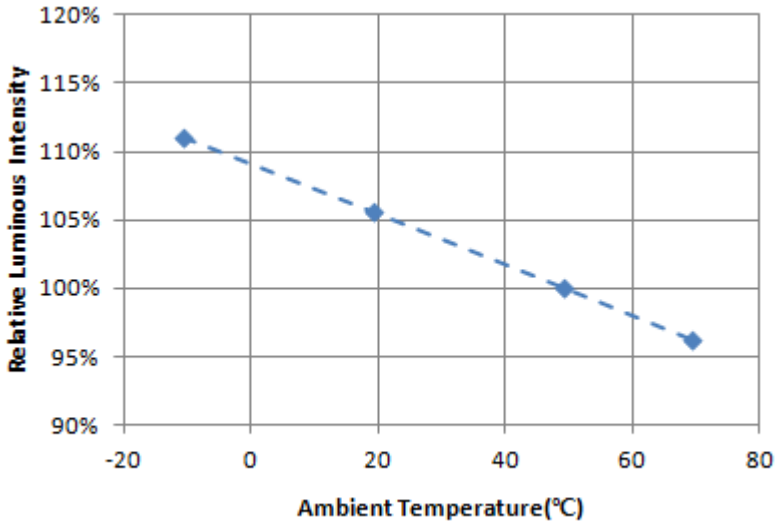


Fig. 6

1) Junction Temperature Design Guide based on Electro-Thermal Sensitivity

The junction temperature should be designed by choosing the operating current and voltage to make sure that the case temperature not exceed the highest value of 80℃at ambient temperature of 25℃.

The user of 25W Platform LED Module should choose the fixture design appropriately to allow the module function as designed for sufficient thermal management by the engine itself. To fulfill this requirement, the user should consult the following diagram to check and see if his or her design is in compliance with this thermal design guide.

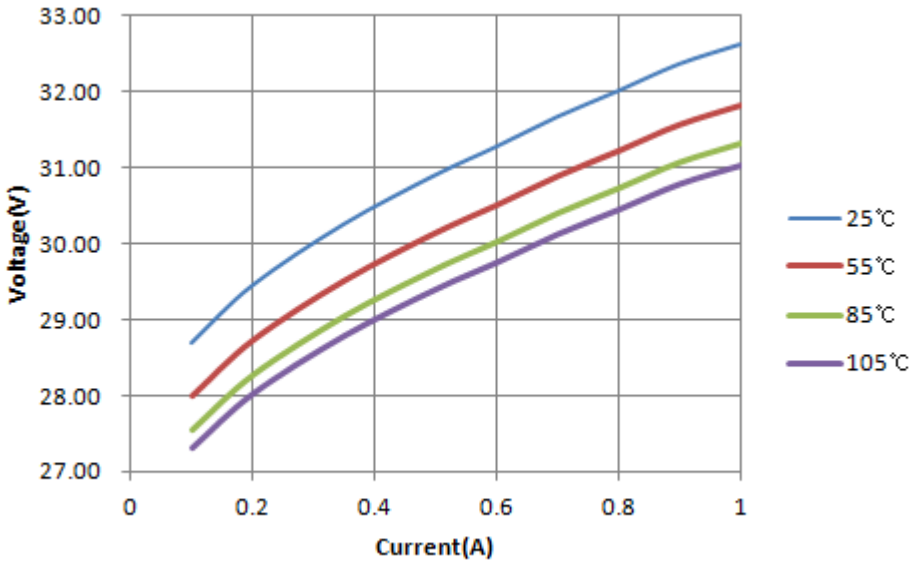


Fig. 7

2) Case Temperature by Dust

A thermal performance of heatsink may be affected by thermal conductive ratio from air.

Therefore, a dust from outside interference can disturb the convection between heatsink and air and the Tc increases when a dust are accumulated in the platform module.

In experiments, the Ts is increased by about 4 ℃ and Tc is increased by about 2 ℃ when dust of full is filled in the platform.

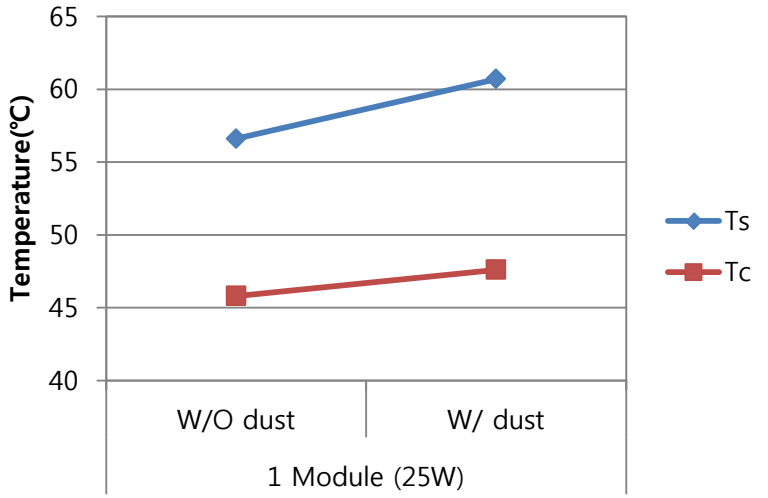
Module	Ts(Solder Point Temp.) and Tc (Case Temp.)
	

Fig. 8

2) Case Temperature by Dust(Continue)

In 75W module, the center module is only filled with dust. Then, the case temperatures are increased proportionally by amount of dust as shown in the figure below.

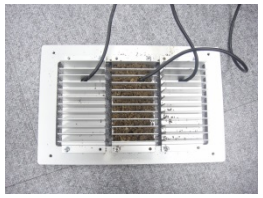
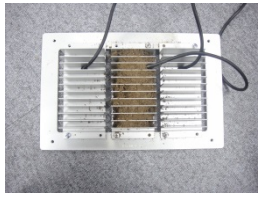
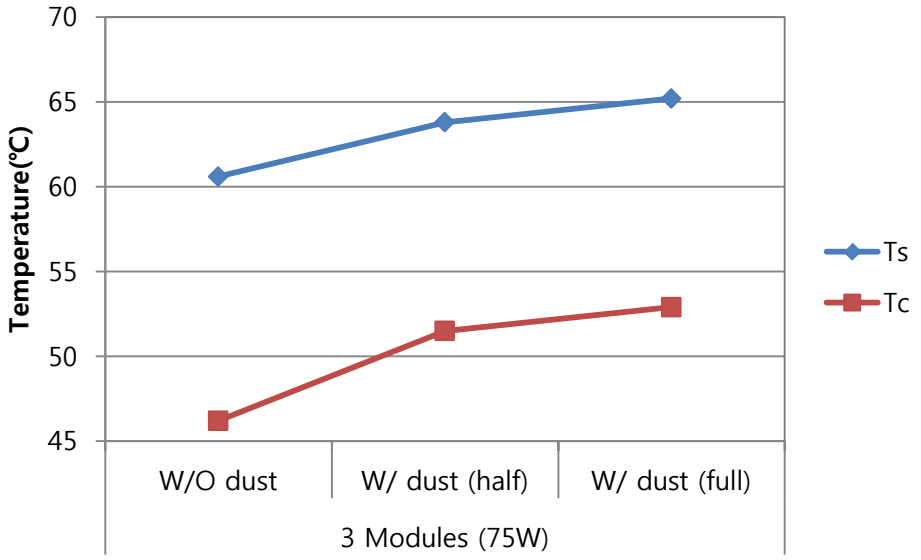
Module	Ts(Solder Point Temp.) and Tc (Case Temp.)
 W/O dust  W/ dust (half)  W/ dust (full)	

Fig. 9

3) Thermal Management Guide

a. When LED modules are installed more than two, it is recommended to space at least 1.5 mm apart to lower the module temperature. And when LED modules are installed more than four, it is recommended to space min 10 mm apart at more than one place(See fig.5).

b. When it comes to install Luminaire as open type , it is needed to have space for Air Flow underneath to enhance convective heat transfer. When it comes to design Luminaire, over 20% of top is required to open for Air Flow. But straight up side should not be opened cause debris can accumulate on the top of module.

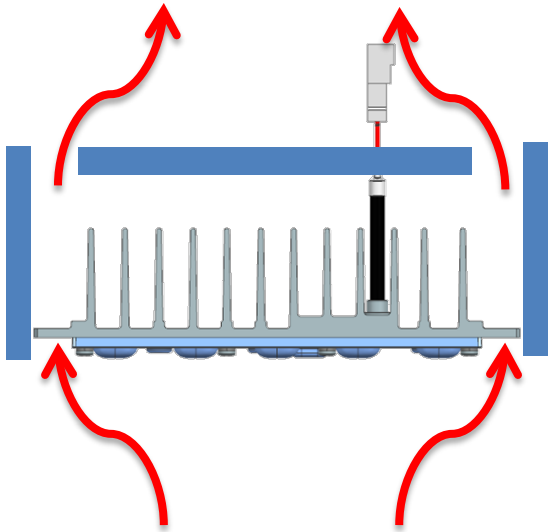


Fig. 10

3) Thermal Management Guide

c. When the Luminaire be installed at totally clean place, full open type design can be adopted to cool down the module.

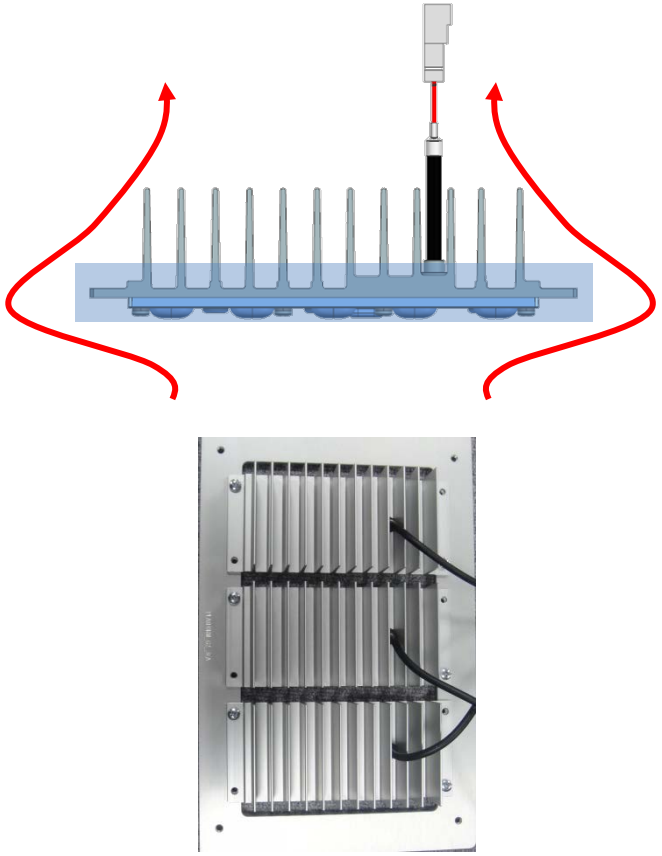


Fig. 11

3) Thermal Management Guide

d. When it comes to install Luminaire as close type , it is needed to have space over 10mm between modules more than one place to enhance radiative heat transfer. And as the heat transfer by convection is very low it is recommended to use more heavier heat sink that has enough heat capacity.

e. As waterproof performance of LED module is IP66, it is necessary to equip drainage channel for not collecting water inside of Luminaire.

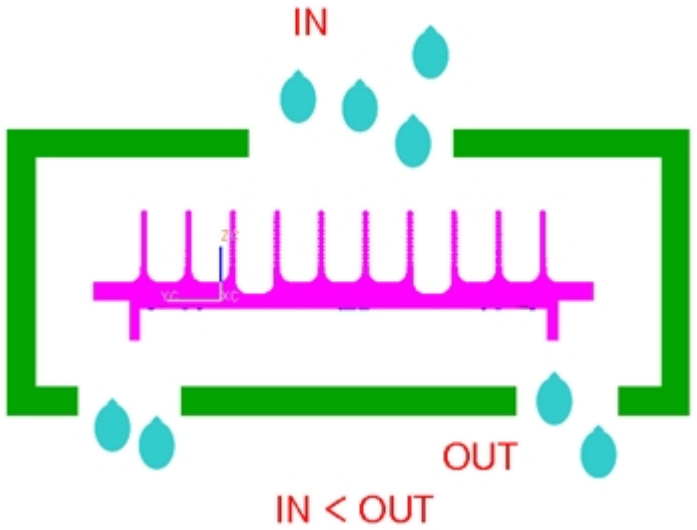


Fig. 12

3) Thermal Management Guide

f. In any condition, PSU installed in 'Luminaire' must be derived under 70℃.

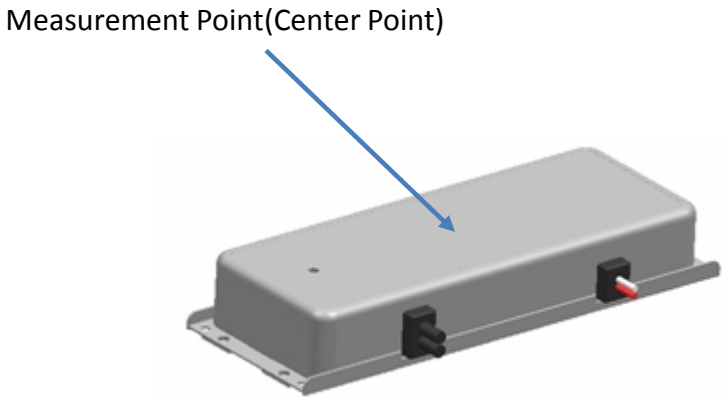


Fig. 13

4. Limitations in Application

1) Validity of the Numerical Values Quoted in this Application Note

A lifetime of platform may be affected by case temperature. To ensure that the lifetime of the product is reached, the thermal resistance between the bottom side of the module and the outside of the luminaire must be minimized.

However, the heat deflection temperature of lens is about 95℃ as the material of Lens is polycabonate.

Therefore, the Tc also should not exceed 95 ℃ with respect to the lens temperature.

Thank you

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