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Application Note – XTM & XIM Thermal Application Guide

Version 20141003

Background

The performance and life expectancy of Xicato modules are directly attributed to how well the LEDs and phosphors are thermally managed. When LED and phosphor temperatures rise beyond their designed temperature limit, module lifespan decreases and the color properties and luminous flux of the light may shift. Therefore, effective cooling is essential in luminaires designed to accommodate Xicato modules.

Xicato correlates the performance of its modules to the module case temperature (T_C), which must remain below 90°C at steady state under all conditions. There are countless luminaire design parameters that can affect module thermal performance and keep the Xicato modules below this limit. Some examples include:

- Heatsink size, material, coating, & fin structure
- Housing material and mechanical interfaces
- Luminaire style (track, recessed, pendant, etc.)
- Air flow conditions (ambient air temperature, forced or natural convection, venting ability, etc.)

The purpose of this document is to serve as a guide to initiate a design by matching Xicato LED modules with a variety of cooling solutions that will effectively limit the module case temperature to below 90°C in free air. The cooling solutions and methods in this document do not guarantee thermal performance and all products should be verified by testing in their luminaire.

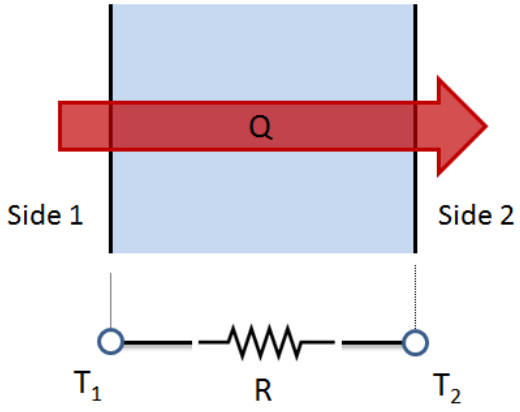
Analysis using Thermal Resistance Data

Thermal resistance is a property of heat and a measurement of a temperature difference by which an object or material resists a heat flow. Thermal resistance is measured in °C per watt and can be represented in the following equation:

$$R = \frac{T_1 - T_2}{Q}$$

Where:

R = thermal resistance of the material or object (°C/W)
Q = heat transfer rate (W)
$T_1 - T_2$ = temperature difference across the material or object (°C).



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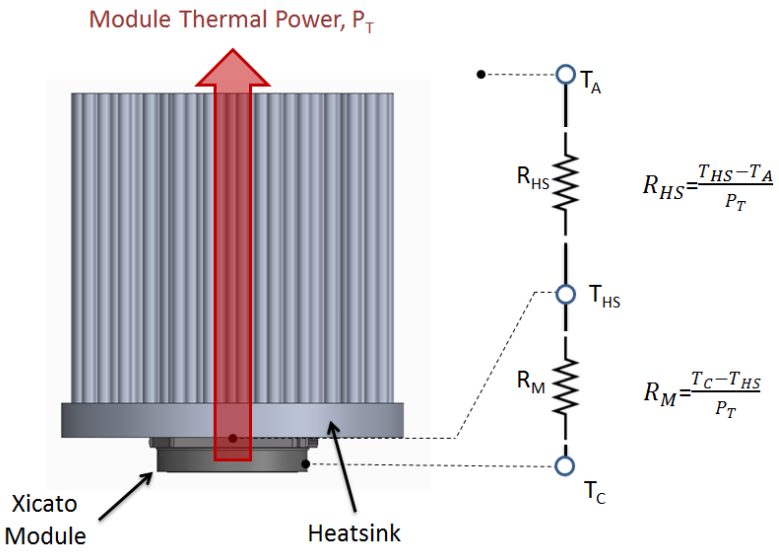
We can apply this thermal equation to modules and heatsinks by rewriting the equations as:



Where:

T_C = module case temperature (°C)

T_A = ambient temperature (°C)
(Defined as the average temperature that surrounds the luminaire)

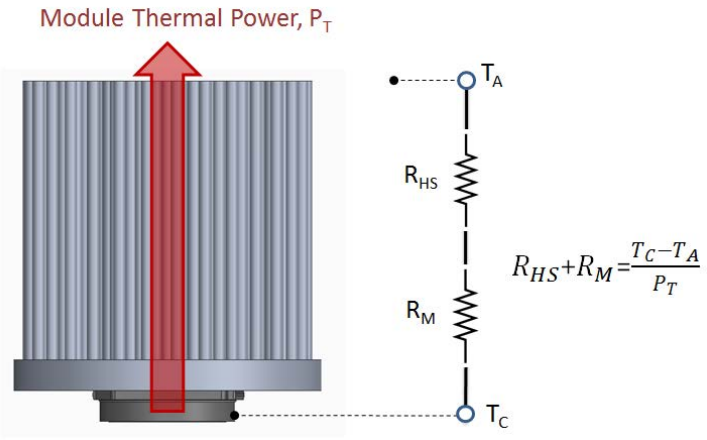
T_{HS}= heatsink temperature (°C)
(Defined as the temperature of the point on the surface of the heatsink directly underneath the module)

R_M = module thermal resistance (°C/W)

R_{HS} = heatsink thermal resistance (°C/W)

P_T = module thermal power (W)

Furthermore, combining the module and heatsink thermal resistance equations give the following:



$$T_C = P_T(R_M+R_{HS})+T_A$$

With this equation, the T_C temperature of any Xicato module can be predicted in a selected ambient temperature if the thermal resistances of the heatsink and module are known. Xicato provides information on the thermal resistance and thermal power of all its modules and these values can be found on each module's respective datasheet. Xicato also provides thermal resistance values of many Xicato compatible heatsinks that can be integrated into a luminaire design.

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Example 1

What is the predicted T_C temperature of an XTM 1300lm Standard Series module at 500mA, mounted on an XSA-60 heatsink, at 30°C ambient and a 0°C tilt in free air?

The thermal resistance and thermal power for this module can be found on the Xicato XTM Datasheet. For an XTM 1300lm Standard Series module at 500mA, the values are 0.46 °C/W and 5 W respectively. From the Xicato Heatsink Supplier Matrix, the thermal resistance of an XSA-60 is found to be 6.8°C/W.

$$T_C = P_T(R_M + R_{HS}) + T_A$$
$$T_C = (5W)(.46°C/W + 6.8°C/W) + 30°C$$
$$T_C = 66.3°C$$

The T_C of the XTM module under these conditions is expected to reach 66.3°C. This is under the maximum T_C limit of 90°C therefore the XSA-60 is an appropriate solution for cooling the module with sufficient margin in free air.

Example 2

Which heatsinks will keep the XTM 2000lm Artist Series module at 1050mA sufficiently cooled in a 40°C ambient?

According to the Xicato XTM Datasheet, the XTM 2000lm Artist Series module has a thermal resistance of 0.48 °C/W and a thermal power of 18.7 W. Since the module temperature must be less than or equal to 90°C, the equation becomes:

$$Max\ T_C \geq P_T(R_M + R_{HS}) + T_A$$
$$90°C \geq (18.7W)(.48°C/W + R_{HS}) + 40°C$$
$$R_{HS} \leq \frac{90°C - 40°C}{18.7W} - .48°C/W$$
$$R_{HS} \leq 2.2°C/W$$

Any heatsink with a thermal resistance of 2.2°C/W or less will be able to keep the T_C temperature of this module at or below 90°C. The Xicato Heatsink Supplier Matrix can be referenced to find a Xicato compatible thermal solution that meets this criterion.

All thermal resistance values in the Xicato Heatsink Supplier Matrix assume the heatsink and module are mounted at a 0° tilt in free air (i.e. straight down). Any modification to this setup such as tilting the luminaire to a different angle or restricting the airflow across the heatsink in any way can change the thermal resistance value of that thermal solution. Always make sure the conditions of a thermal resistance value of a heatsink are understood when choosing one.

For luminaires that operate at tilt angles other than straight down, refer to Xicato's Heatsink Compatibility Matrix which matches Xicato modules to selected cooling solutions based on ambient environment and covers all tilt angles up to 60° in free air.

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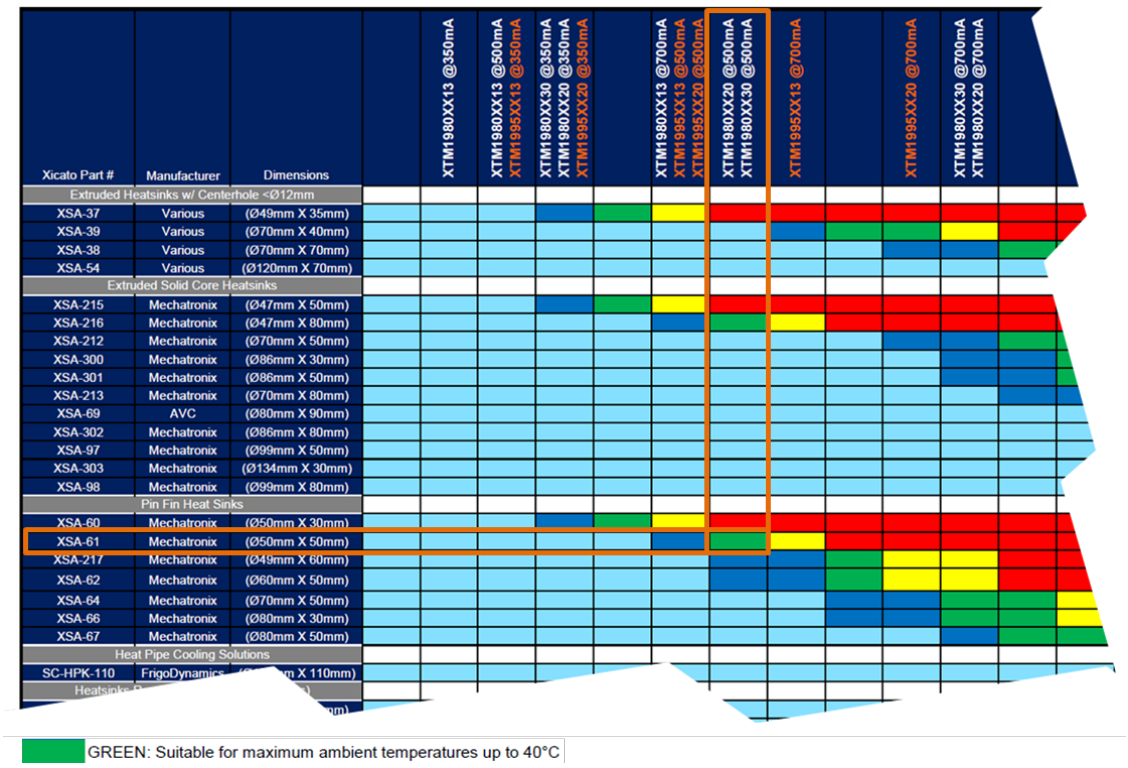
Heatsink Compatibility Matrixes

A resource Xicato offers to help designers quickly identify cooling solutions for Xicato modules is the Heatsink Compatibility Matrix. To use this tool, simply find the column of the desired module at the top of the matrix and choose a row that represents a Xicato compatible heatsink. Where the column and row intersect is a color coded box that indicates the maximum ambient temperature that the module and heatsink combination is rated to. The data in these matrixes apply to heatsinks in free air and cover all tilt angles up to 60°.

Heatsink compatibility matrixes for both XTM and XIM modules are available online from the Xicato website or by contacting your Xicato account manager or technical representative.



In the example above, the XTM Heatsink Compatibility Matrix indicates that both 2000lm and 3000lm XTM Standard Series modules, at 500mA, at up to a 60° tilt in free air can be cooled sufficiently with an XSA-61 heatsink in a 40°C ambient. Please note that this example is for reference only. Contact Xicato for latest versions of the Heatsink Compatibility Matrixes as the color grid is subject to change at any time.