

MechaTronix in LED

Why Pin Fin LED coolers perform better under tilted position

Ever wondered what the effect would be of tilting you LED spot light design over a certain angle with respect to thermal behavior?

In this whitepaper we describe the effect of tilting spot light designs over an angle of 50 degrees and 90 degrees, and compare the thermal results from LED coolers made by extrusion and made by pin fin technology

For the experiment we compare the ModuLED 9980 with the LPF11180-ZHE

The ModuLED 9980 is a passive LED cooler from extruded aluminium with a diameter of 99mm and a height of 80 millimeter, thermal resistance under vertical position 1.02°C/W

The LPF11180-ZHE is a passive LED cooler with pin fin structure with a diameter of 111mm and a height of 80mm, thermal resistance under vertical position 1.07°C/W



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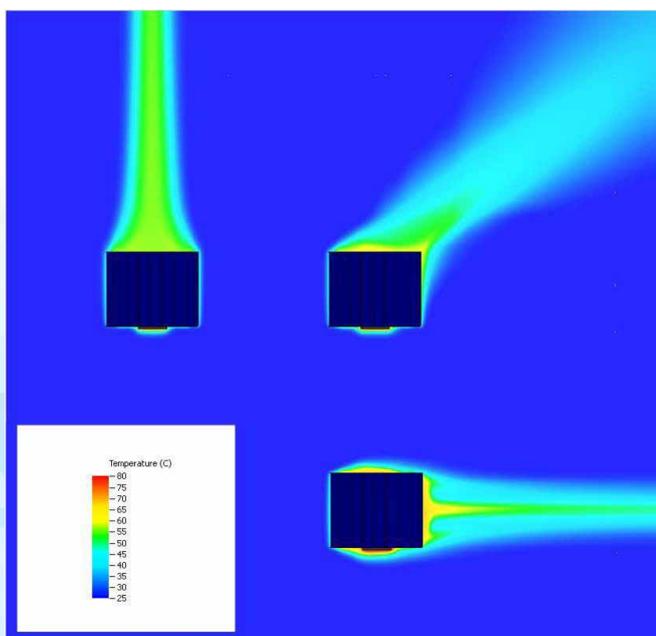
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So both LED coolers have a similar cooling performance under classic vertical position
In this experiment we mount the same LED module from Tridonic, the Talexx Stark spot light module STARK-SLE-G3-19-3000-830-CLA on both LED coolers with thermal grease as interface

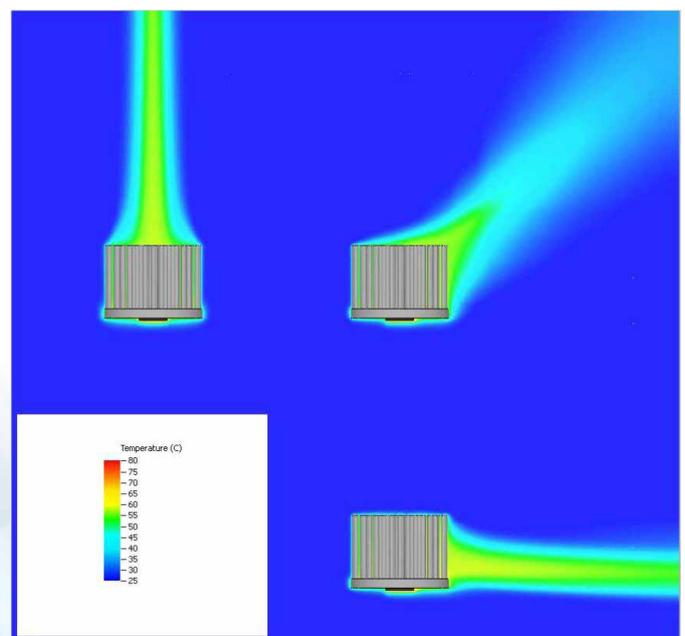
This Zhaga book 3 LED engine generates 30 watt of power

In CFD thermal simulation we change the gravity orientation to get a first impression of the expected results

The gravity simulated angles are 0°, 50° and 90°



CFD simulation ModuLED 9980 LED cooler



CFD simulation LPF 11180 LED cooler

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Under vertical position both coolers give a similar result, but the heat is more concentrated in the middle from the pin fin LED cooler compared with the extruded LED cooler

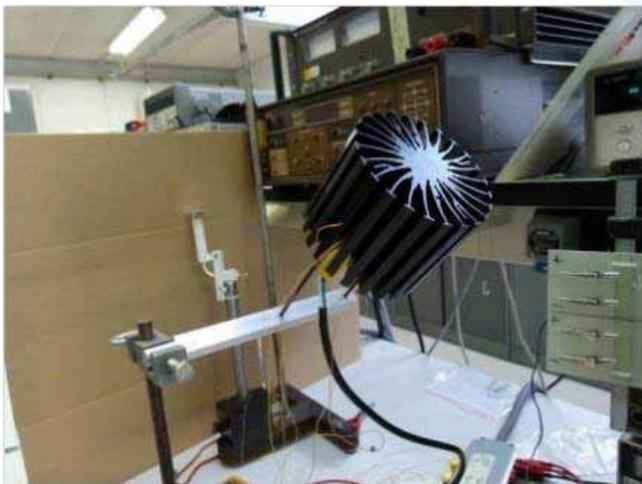
This effect is seen because of the massive aluminium in the center of the extrusion and the more spread out heat over the fins, while the pin fin LED cooler has a more open structure in the center of the design

But cooling wise this gives exactly the same result, both coolers show a temperature on the Tc point of the Tridonic LED module of 57°C

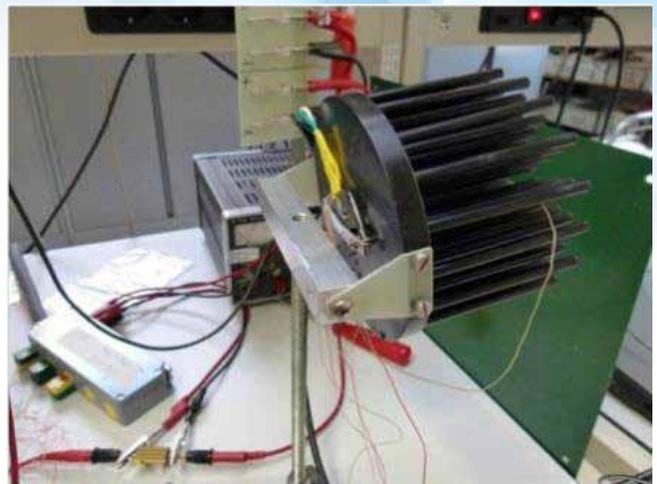
Once tilting the modules over an angle of more than 50 degrees, the pin fin LED coolers keeps on functioning while the extruded LED cooler loses more than 20% of the original cooling capacity

To verify the results of the CFD thermal simulation we made an experimental setup where the LED cooler with the LED module can be tilted from pure vertical position all the way up to a horizontal 90 degrees position

The temperature was measured by 2 calibrated thermocouples on the Tc point of the LED and in the center upper part of the LED heat sink



Lab setup with ModuLED 9980



Lab setup with LPF11180-ZHE

Up to a tilting angle of 50 degrees the results measured on both LED coolers stayed comparable

Once tilting over 50 degrees, the bottom side of the extruded LED cooler loses more and more cooling capacity

Since there is no forced air movement, the free air convection cooling is the main component of cooling in this way, and the radiation effect only counts for a few percent

While the hot air wants to rise vertically, the open structure of the LED pin fin cooler makes that the air can still move up without obstructions

Below table shows all the results both from CFD simulation and the experimental thermal measurements

Heat sink	Simulation results		Experimental results	
	LPF11180	ModuLED 9980	LPF11180	ModuLED 9980
Amb. [°C]	25	25	~23	~24
Pd [W]	30	30	~30	~30
Angle[°]	dHS-amb [°C]		dHSclose-amb [°C]	
0	31.1	32.5	34.0	34.0
5	31.1	32.5	-	-
15	30.8	32.7	-	-
30	30.3	33.3	-	-
45	30.4	34.7	-	-
50	30.7	35.3	33.5	36.3
75	32.7	40.7	-	-
90	32.6	43.1	35.8	46.2

As a conclusion you can see that pin fin LED coolers perform better under a tilted position of more than 50 degrees than an extruded LED cooler

Even under a 90 degree orientation the cooling capacity stays almost the same

That makes pin fin LED coolers ideal for spot lighting with tilting possibilities and track lighting designs

We would like to thank our partner Optimal Thermal Solutions for the test results of this experiment

When you experience challenges with regards to thermal results during your LED lighting design we are always at your service for consultancy or a full thermal verification of your LED fixture

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Model n°

ModuLED 9980

Dimension (mm)	ø99 x h80
Volume (mm ³)	219491
Thermal Resistance (°C/W)	1.02
Cooling Surface (mm ²)	164008
Power Pd (W)	48.9
Weight (gr)	573
Heat Sink Material	AL6063-T5



Model n°

LPF1180-ZHE

Dimension (mm)	ø111 x h80
Volume (mm ³)	211924
Thermal Resistance (°C/W)	1.07
Cooling Surface (mm ²)	116830
Power Pd (W)	48.2
Weight (gr)	572
Heat Sink Material	AL1070

About OTS

OTS offers several services in the field of thermal management with regards to training and development. All our services are aimed in solving your product specific cooling solution.

Whether it is an LED light you require assistance with or cooling an IGBT for a rail vehicle, OTS has the proper knowledge and experience.

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ABOUT MECHATRONIX

MechaTronix was founded as a creative designer & manufacturer of high end mechanical plastic & metal parts. With its Asia-based headquarters in Kaohsiung Taiwan, MechaTronix became a powerhouse at designing and manufacturing heat sinks and thermal solutions for OEM and LED lighting applications. Strategic partnerships with major LED manufacturers and sharing our thermal knowledge with their luminaire designers are our core missions. Simple passive cooling, advanced heat pipe technology or active cooling solutions? MechaTronix offers of the shelf and tailored solutions to its worldwide professional customer base. For more information about the company, please visit : www.mechatronix-asia.com