

Cree® XLamp® CXA3050 LED

Thermal Load

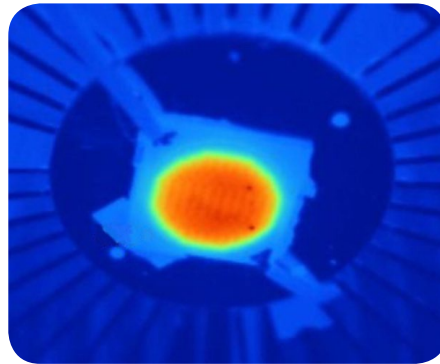


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INTRODUCTION

The Cree XLamp® CXA3050 LED integrated array delivers high lumen output and high efficacy in a single package that enables both directional and non-directional lighting applications and luminaire and lamp designs. But with the CXA3050's high lumen output comes a challenge to manage the thermal load.

This application note presents:

- Results of Cree's thermal load testing of the CXA3050 LED integrated array when attached to three different models of typical, commercially available heat sinks.
- Heat sink thermal resistance requirements when operating the CXA3050 LED integrated array at various current levels.

TEST RESULTS SUMMARY

Cree selected three heat sinks to test with the XLamp CXA3050 LED integrated array, as given in Table 1. Each heat sink is of a different shape and each was selected merely to test heat sinks of different architectures. These heat sinks were used to illustrate the case temperature (T_c) of the CXA3050 LED integrated array at various current/power levels and the presence of a heat sink in this document does not indicate a qualification or disqualification of the heat sink for its use in any specific application.

Table 1: Heat sinks

Company	Part Number	Web Link
Aavid Thermalloy, LLC	62725	www.aavidthermalloy.com/cgi-bin/process.php?pf=exdisp.pl&Pnum=62725&LengthUnits=in&ExLength=3&airflow=400&CType=&AirUnits=
Rocketfish	RF-UPCUWR	www.rocketfishproducts.com/products/computer-accessories/RF-UPCUWR.html
Wakefield Thermal Solutions	19754-M-AB	www.wakefield-vette.com/Portals/0/resources/datasheets/19754-Series.pdf

The following steps were performed to test each CXA3050 LED integrated array/heat sink combination.

1. Attach the LED to the heat sink using thermal grease¹ as the thermal interface material (TIM).
2. Mount a connector² to the CXA3050 LED integrated array.
3. Attach the LED input wires to the connector, shown in Figure 1.

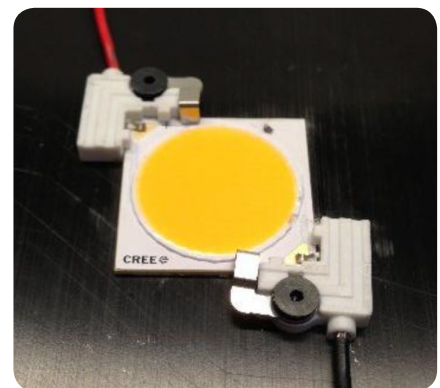


Figure 1: Connector attached to CXA3050 LED integrated array

4. Attach a thermocouple to the LED at the T_c measurement point shown in the [CXA3050 LED integrated array data sheet](#).
5. Orient the heat sink so the LED is facing down.
6. Operate the LED at 1.4 A, the binning current for the CXA3050 LED integrated array, and allow the LED T_c to stabilize.
7. Record the stabilized LED T_c .
8. Compare the measured T_c with the graph shown in Figure 2. The test is considered passed if the T_c at the test current level is less than the temperature on the graph. The measured maximum operating temperatures at the current levels in this test are shown in Figure 2.

¹ For this test, Silver Ice 710NS, [Timtronics](#)
Refer to Cree's [Chemical Compatibility application note](#) for compounds that are safe to use with Cree LEDs.
² For this test, part number 2-2154857-2, [TE Connectivity](#)

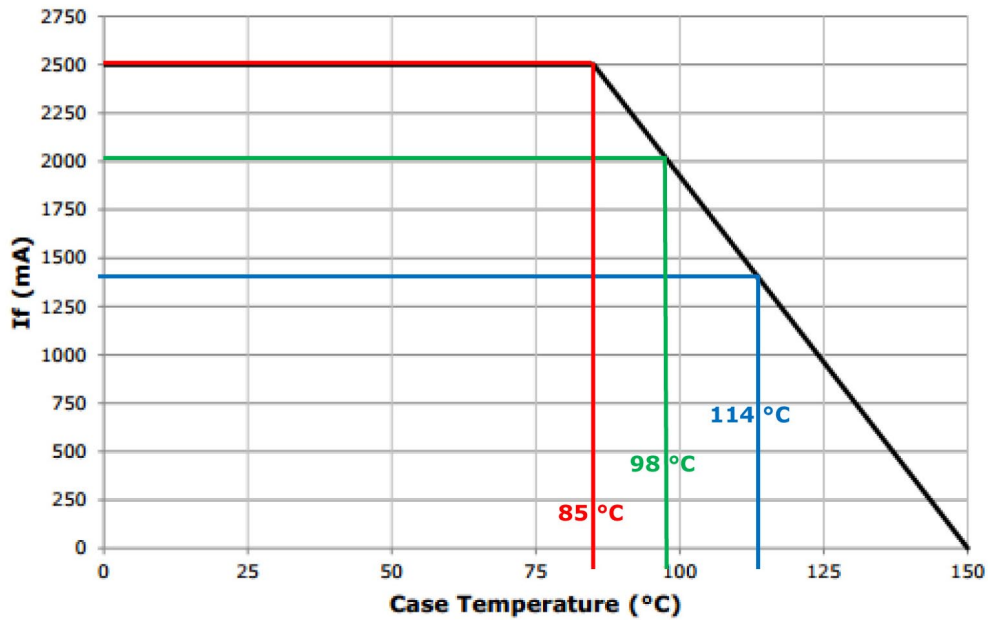


Figure 2: CXA3050 operating limits

- If the thermal results at this current level are satisfactory, increase the current level to 2.0 A and then 2.5 A, the maximum current level for the CXA3050 LED integrated array, using the CXA3050’s operating limits graph to verify the thermal performance.

Table 2 shows the measured CXA3050 LED integrated array Tc with each heat sink operated at the current and power levels tested.

Table 2: Summary results

Heat Sink	Tc at Current and Power Level (°C)		
	1.4 A/53 W	2.0 A/80 W	2.5 A/103 W
Aavid	47	58	68
Rocketfish	100	125	Not Tested
Wakefield	52	63	74

In this test, the Aavid and Wakefield heat sinks satisfied the CXA3050 LED integrated array thermal dissipation requirements, i.e., the CXA3050 LED integrated array remained within its operating limits, over the current/power range tested. The Rocketfish heat sink satisfied the requirements at the 1.4 A/53 W level, but not at the other two levels.

TEST RESULTS

Figure 3 shows the CXA3050 LED integrated array mounted on the Aavid heat sink. The heat sink is 6 in (15.24 cm) X 9.75 in (24.77 cm) X 2.28 in (5.79 cm). Figure 4 shows the CXA3050 LED integrated array thermal performance over time with the Aavid heat sink. The horizontal lines labeled with current levels identify the thermal performance at each level. The temperature at each current level was within the CXA3050’s operating limits.

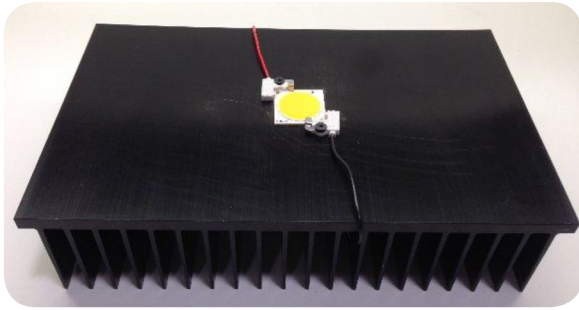


Figure 3: CXA3050 LED integrated array on Aavid heat sink

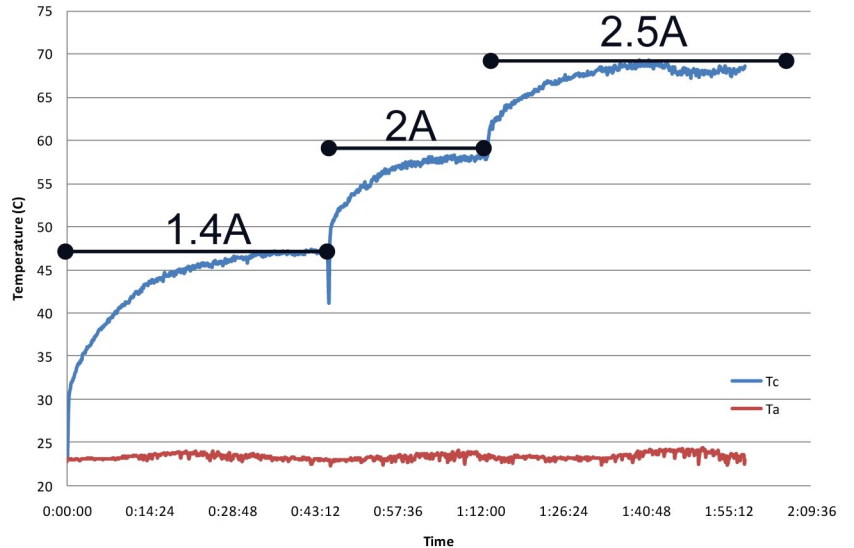


Figure 4: CXA3050 thermal performance with Aavid heat sink

Figure 5 shows the CXA3050 LED integrated array mounted on the Rocketfish heat sink. The heat sink is 5.25 in (13.34 cm) X 3.5 in (8.9 cm) X 2 in (5.08 cm). We removed the fan that provides active cooling to this heat sink. Figure 6 shows the CXA3050 LED integrated array thermal performance over time with the Rocketfish heat sink. The horizontal lines labeled with current levels identify the thermal performance at each level. The 2 A measurement was above the CXA3050's operating limits and we did not measure at 2.5 A.

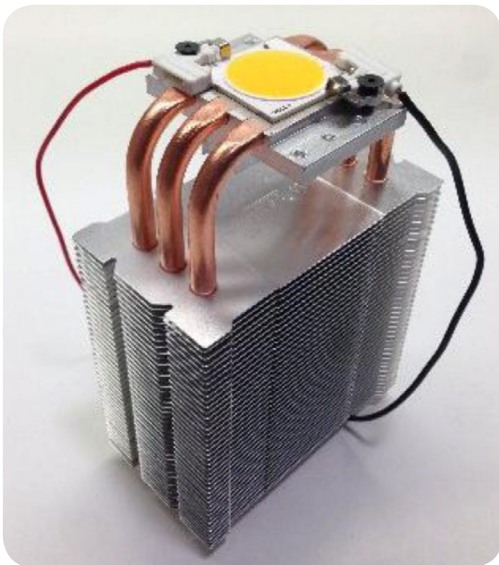


Figure 5: CXA3050 LED integrated array on Rocketfish heat sink

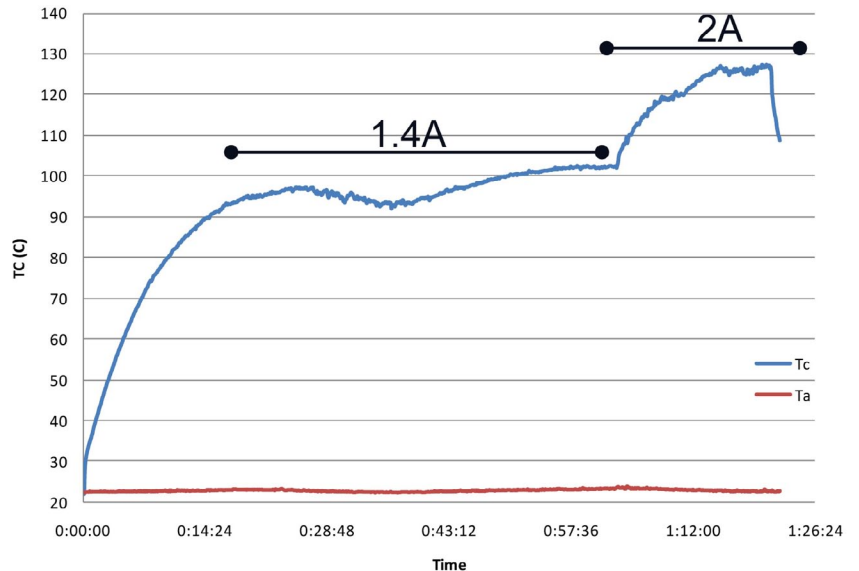


Figure 6: CXA3050 thermal performance with Rocketfish heat sink

Figure 7 shows the CXA3050 LED integrated array mounted on the Wakefield heat sink. The heat sink is 7.5 in (19.05 cm) X 4.5 in (11.43 cm). The diameter of its inner core is 1.374 in (3.49 cm). Figure 8 shows the CXA3050 LED integrated array thermal performance over time with the Wakefield heat sink. The horizontal lines labeled with current levels identify the thermal performance at each level. The temperature at each current level was within the CXA3050's operating limits.

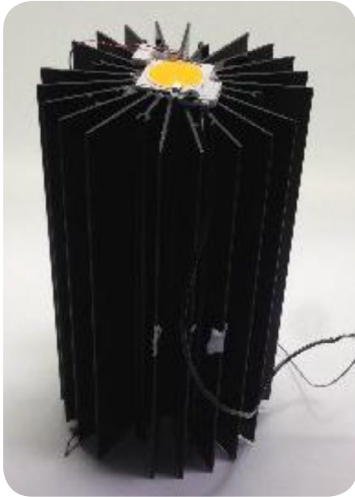


Figure 7: CXA3050 LED integrated array on Wakefield heat sink

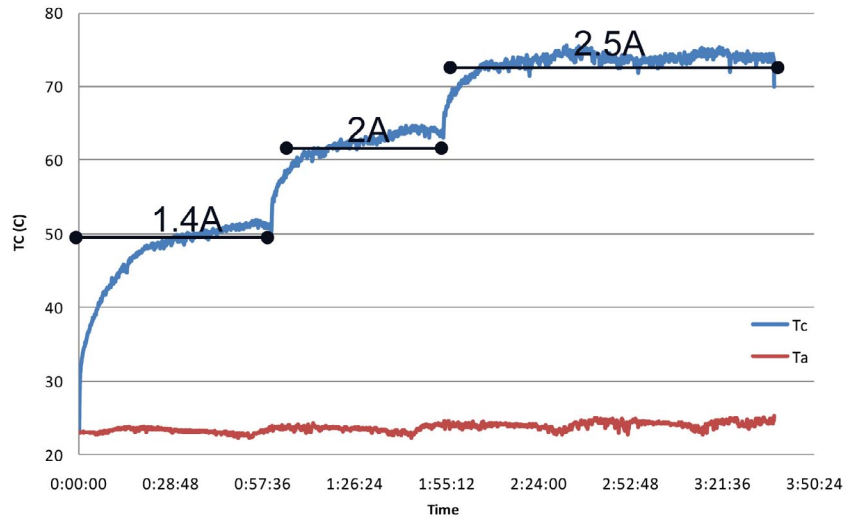


Figure 8: CXA3050 thermal performance with Wakefield heat sink

THERMAL RESISTANCE

Table 3 shows the thermal resistance (Rth) a heat sink must provide to operate the XLamp CXA3050 LED integrated array within its operating limits at various current/power levels and case to ambient temperature (Ta) differences.

Table 3: Heat sink thermal resistance values needed for optimal CXA3050 LED integrated array performance

Temperature $\Delta T_c - T_a$ (°C)	Thermal Resistance (Rth)					
	1.0 A/36 W	1.4 A/52 W	1.7 A/64 W	2.0 A/77 W	2.2 A/86 W	2.5 A/100 W
10	0.28	0.19	0.15	0.13	0.11	0.1
20	0.55	0.38	0.31	0.25	0.23	0.2
30	0.83	0.57	0.46	0.38	0.34	0.3
40	1.12	0.77	0.62	0.51	0.46	0.4
50	1.4	0.96	0.78	0.64	0.58	0.5
60	1.69	1.16	0.93	0.78	0.7	0.6
70	1.98	1.36	1.09	0.91	0.82	0.71
80	2.27	1.56	1.26	1.04	0.94	0.81
90	2.57	1.77	1.42	1.18	1.06	0.91
100	2.87	1.97	1.58	1.32	1.18	1.02
110	3.17	2.18	1.75	1.46	1.31	1.13
120	3.48	2.39	1.92	1.59	1.43	1.24