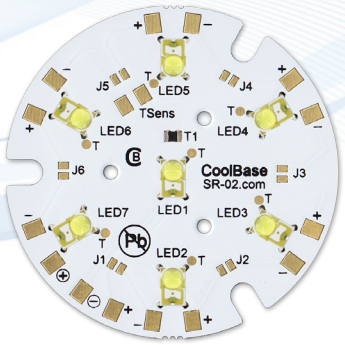
Overview:



The SR-02 high power LED lighting assembly is one of our highest lumen output products with some assemblies capable of generating over 2100 lumens of light. A by-product of light generation is heat. This heat is highly concentrated and must be removed from the assembly to ensure long life and reliability of the LEDs. This is normally accomplished by mounting the assembly onto a suitable heat sink and then confirming that the LEDs are being adequately cooled by monitoring the resistance of the Vishay NTC 10K NTHS0805N02N1002J thermistor that is mounted on every SR-02.

This application brief explains how to properly measure resistance values of the thermistor and then use those values to ensure that the LEDs are being adequately cooled during operation.

Scope:

The information in this document covers the SR-02 assembly with 7 LXML-PWN2 LEDs powered to a maximum of 1000mA with heatsink temperatures that do not exceed 70°C. All measurements are from the middle LED (LED1) only.

This document describes how to monitor the temperature of an SR-02 LED assembly for in situ monitoring and foldback temperature control circuits. It does not replace the need to confirm that individual LEDs are being adequately cooled by using the procedure described in the SR-02 datasheet.

Measuring LED Temperature:

To ensure long life and reliability it is important that the LED junction temperature is never allowed to exceed the maximum temperature rating specified in the LED datasheet.

As the LED junction is buried deep inside the LED body, it is not possible to directly measure the junction temperature unless you have access to some very specialized equipment. However you can calculate the junction temperature with a reasonable degree of accuracy by measuring the temperature close to the LED and then use this simple formula:

$$T_J = T_S + \Psi_{J\text{-}S} * PD$$

Where:

T_J = Junction Temperature of the LED

T_S = The measured temperature close to the LED

$\Psi_{J\text{-}S}$ = The total thermal resistance from the LED junction ($R\theta_{J\text{-}C}$) to the temperature measurement point ($R\theta_{C\text{-}S}$)

PD = The total power dissipation (in watts) of LED1 on the SR-02 assembly

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The latest version of this document can always be downloaded from our website at www.luxeonstar.com/sr-02-thermal.pdf

Document ID: SR-01-T
Revision: July 15, 2012

A schematic cross section showing the positioning of the thermistor and the thermal path is shown in Figure 1.

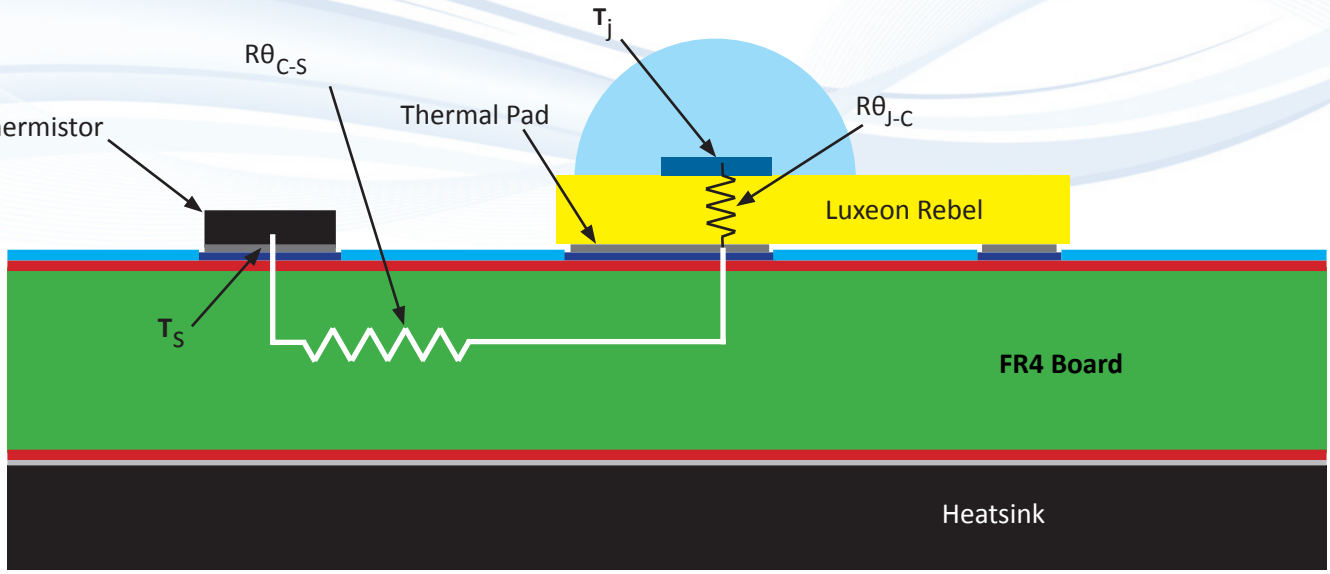

Figure 1. Cross section of a Luxeon Rebel on FR4 board showing the thermal resistances from the LED junction on the thermistor.

- $R\theta_{J-C}$ is the thermal resistance from the LED junction (T_j) to the thermal pad.
- $R\theta_{C-S}$ is the thermal resistance from the LED thermal pad to the thermistor measurement point (T_S).
- The Ψ_{J-S} is the sum of $R\theta_{J-C}$ and $R\theta_{C-S}$.

Determining the T_S temperature is a simple matter of measuring the resistance of the thermistor that is mounted to the SR-02 board using a DMM (Fig 2) and then using table 2 on pages 5 & 6 of this document to determine the actual temperature in °C.

Measure thermistor resistance using these two pads

Vishay NTC 10K Thermistor

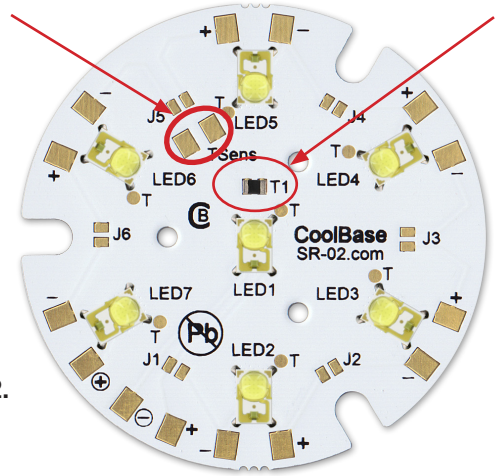

Figure 2.

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The $R\theta_{J-C}$ value can be found in the datasheet for each LED. It will usually be listed as the *Typical Thermal Resistance Junction To Thermal Pad (°C/W)* $R\theta_{J-C}$

The $R\theta_{C-S}$ value for all SR-02 assemblies is: **4°C/W**

The PD can be calculated by multiplying the LED drive current by the forward voltage (Vf). The forward voltage should be measured at the LED after the LED has reached it's stabilized operating temperature. (Fig 3.)

Measure the voltage drop across LED1 while the LEDs are powered and operating at their stabilized temperature.

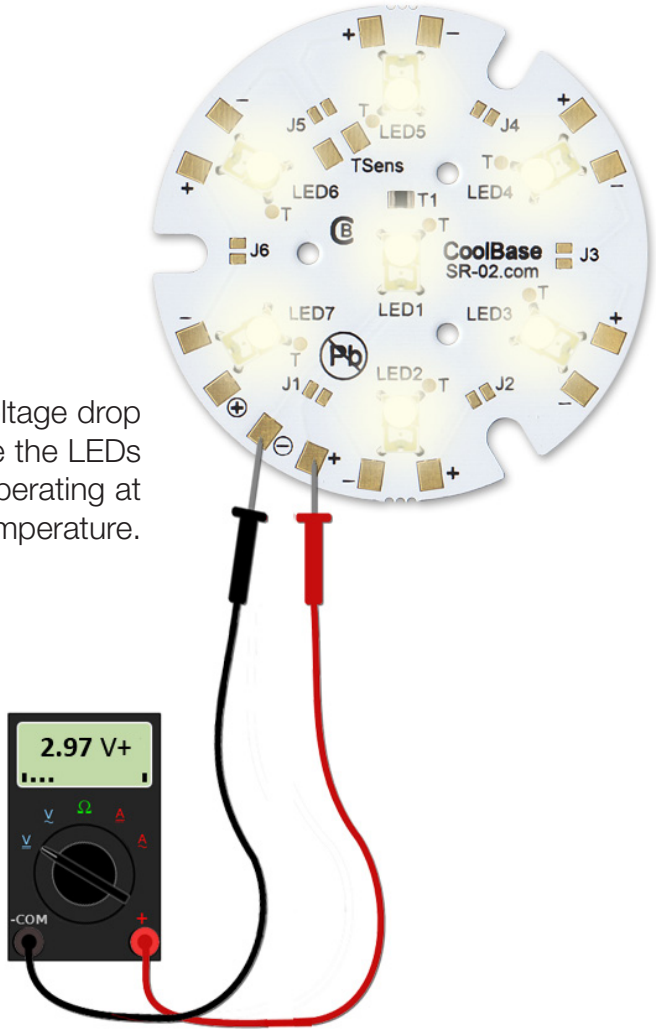

Figure 3.

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An Example:

Lets assume you are powering a SR-02-WN300 (Neutral White LXML-PWN2 LEDs) at 700mA.

According to the datasheet, these LEDs have a $R\theta_{J-S}$ of 6°C/W. After allowing the assembly to stabilize to its normal operating temperature you measure the resistance of the thermistor and find it to be 2950R. The voltage drop across the LED is measured at 2.98Vf.

With this information we can then determine that the actual LED junction temperature is about **80.8°C**.

$$60 + 10 * 2.079 = 80.8°C$$

Where:

T_S = 60 (2950R = 60°C - always select the next highest value from the table)

$R\theta_{J-C}$ = 6

$R\theta_{C-S}$ = 4

Ψ_{J-S} = 10 (6 + 4)

PD = 2.079 (0.7 x 2.97)

Recommendations:

While it is safe to operate the SR-02 assemblies up to the maximum junction temperature ratings provided in the datasheets for all Rebel LEDs, we recommend that you not exceed the LED junction temperatures as published on pages 9 and 10 of the SR-02 datasheet.

You will find more information about LED lifespans vs. junction temperature in the Lumileds Reliability Data (RD07) document available for download from our website.

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Vishay NTC 10K Thermistor (NTHS0805N02N1002J) Resistance/Temperature Conversion

Resistance Ω	Temp °C	Resistance Ω	Temp °C	Resistance Ω	Temp °C
33,740	-4	4,370	48	969	99
32,230	-3	4,225	49	945	100
30,810	-2	4,086	50	921	101
29,450	-1	3,953	51	898	102
28,160	0	3,824	52	875	103
26,920	1	3,700	53	853	104
25,760	2	3,581	54	832	105
24,650	3	3,467	55	811	106
23,600	4	3,356	56	792	107
22,600	5	3,250	57	772	108
20,740	7	3,147	58	753	109
19,870	8	3,049	59	735	110
19,050	9	2,954	60	717	111
18,270	10	2,862	61	700	112
17,510	11	2,774	62	683	113
16,800	12	2,689	63	667	114
16,120	13	2,607	64	651	115
15,470	14	2,528	65	636	116
14,850	15	2,451	66	621	117
14,260	16	2,378	67	607	118
13,700	17	2,306	68	593	119
13,160	18	2,238	69	579	120
12,640	19	2,172	70	566	121
12,160	20	2,108	71	553	122
11,680	21	2,046	72	540	123
11,230	22	1,986	73	528	124
10,800	23	1,929	74	516	125
10,390	24	1,873	75	504	126
10,000	25	1,820	76	493	127
9,624	26	1,768	77	482	128
9,265	27	1,717	78	471	129
8,921	28	1,669	79	461	130
8,591	29	1,622	80	451	131
8,276	30	1,577	81	441	132
7,973	31	1,533	82	431	133
7,684	32	1,490	83	422	134
7,406	33	1,449	84	413	135
7,140	34	1,410	85	404	136
6,885	35	1,371	86	395	137
6,641	36	1,334	87	387	138
6,406	37	1,298	88	379	139

Continued ...

Table 2.

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... Table 2 Continued

Resistance Ω	Temp °C	Resistance Ω	Temp °C	Resistance Ω	Temp °C
6,181	38	1,263	89	371	140
5,965	39	1,229	90	363	141
5,758	40	1,197	91	355	142
5,559	41	1,165	92	348	143
5,368	42	1,134	93	341	144
5,185	43	1,105	94	334	145
5,008	44	1,076	95	327	146
4,839	45	1,048	96	320	147
4,676	46	1,021	97	314	148
4,520	47	995	98	307	149
				301	150

Safety:

The LEDs mounted onto this assembly produce highly intense points of light. Do not stare directly at the LEDs for any length of time.

Restricted Use:

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