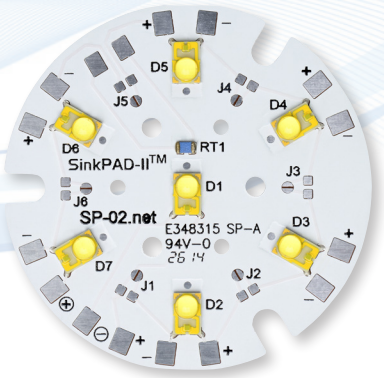
SP-02 SinkPAD-II™ 7 Rebel LED 40mm Round Module

lead-free RoHS compliant

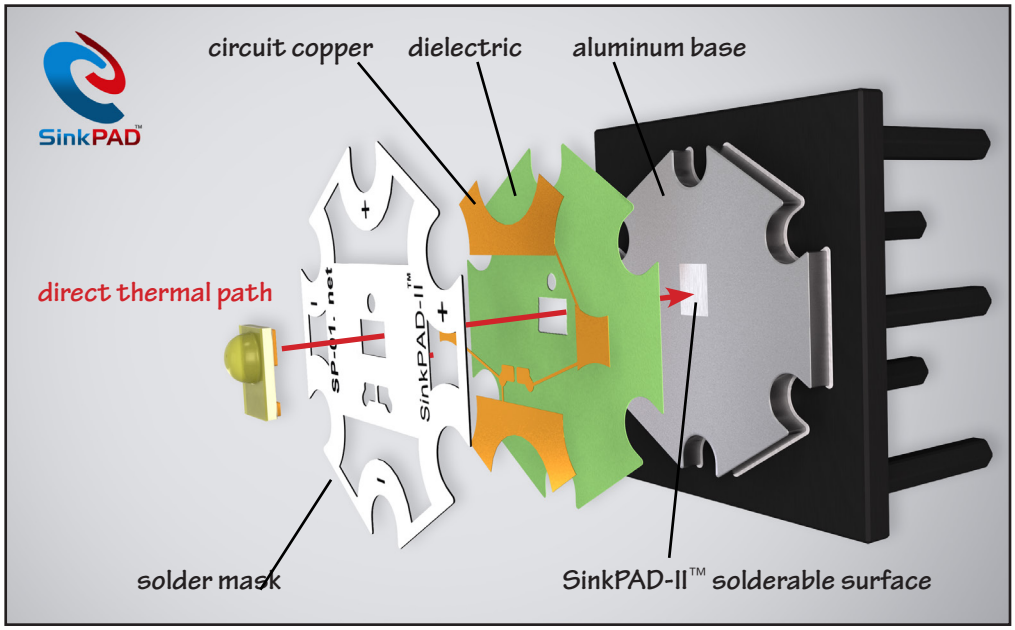
The SP-02 series of high brightness (HB) LED modules includes seven Rebel LEDs soldered to a 40mm round SinkPAD-II™ board. The SinkPAD-II™ features second-generation technology that minimizes thermal resistance by **eliminating the dielectric layer so that the LED thermal pad is soldered directly to the aluminum base**. This ensures the lowest possible LED junction temperature, resulting in increased LED life, lumens output and overall reliability.



The LEDs can be connected in series or singly for full control of each LED making this module ideally suited for:

- **Flashlights**
- **Bicycle Lights**
- **Dive Lights**
- **Color tuned lighting**
- **Lightsabers**
- **Spot lighting**
- **Task Lamps**
- **Fiber optic illuminators**

SinkPAD-II™ Technology



Features

- **Direct Thermal Path** technology for ultimate cooling efficiency.
- Extremely low thermal resistance of **0.7 °C/W** from the LED thermal pad to the bottom of the aluminum base.
- Reduced LED junction temperature
- Available with all currently produced Rebel LEDs
- Modules can be ordered with any color combination of mounted LEDs. No minimums or additional charges
- Multiple wire connection points
- LEDs can be configured for series or parallel operation
- Can be mounted with thermal tape, epoxy or mechanical fasteners
- **RoHS compliant**
- **Pb free** reflow soldered
- **UL Approved** MCPCB

Benefits

- Maximum LED life
- Maximum lumens output
- Improved color rendering and stability
- Reduced cooling requirements means a smaller heat sink
- Create more densely packed LED designs
- Same light output with fewer LEDs means reduced cost
- Wide selection of compatible optics

lead-free RoHS compliant

Module Specifications

Parameter	Value
Base Type	1.6mm SinkPAD-II™ Aluminum
Thermal Performance $R\theta_{C-B}$ From the LED thermal pad to the bottom of the SinkPAD-II base	0.7 °C/W
Pad Finish	Lead Free HASL
Solder Mask Color	White
Solder Paste	AIM NC-258 No-Clean, Lead-Free
Max Operating Temperature (Aluminum Base)[1]	120°C
Overall Dimensions (mm)	40D x 3.68H
Weight	6.4g

1. For maximum life, the aluminum board temperature must be kept below this value.
For LED specifications, please refer to the Philips Lumileds Rebel LED datasheet.

Eliminating the dielectric layer between the LED thermal pad and the aluminum base means that the SinkPAD-II™ can easily outperform even the best MCPCB boards available.

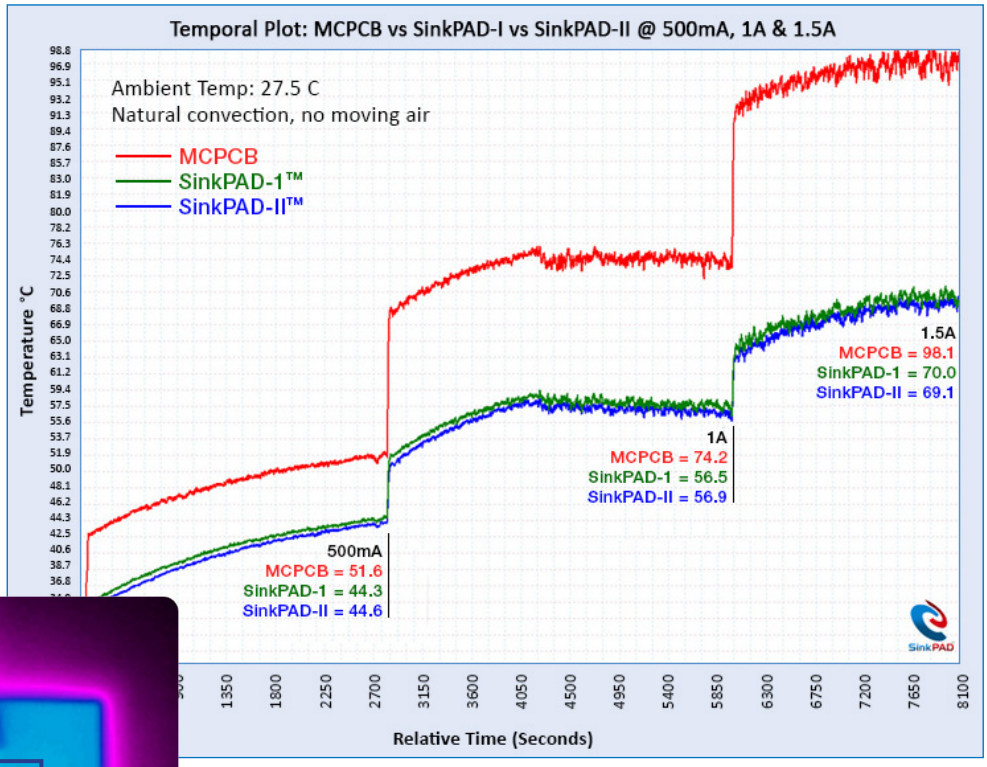


Image 1

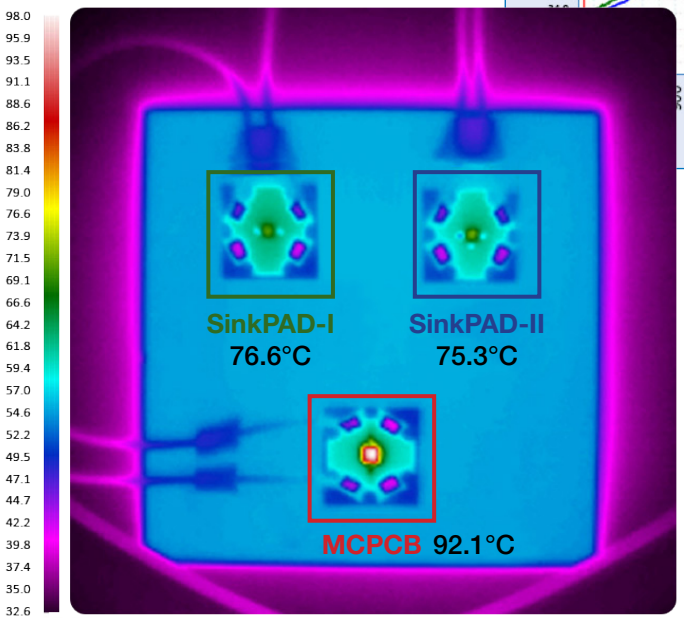


Image 2

HB LEDs radiate minimal heat around the LED. Instead, all generated heat must be conducted away from the LED through the thermal pad on the bottom. By soldering the LED thermal pad directly to the aluminum base, a **Direct Thermal Path** is established that efficiently conducts the heat to the cooling surface.

Power Drivers

FlexBlock Wide Range DC Driver - Ideally suited for powering all 7 LEDs connected in series from voltages a low as 10VDC.

BuckPuck/PowerPuck Drivers - Offers a variety of options for powering the SP-02 LEDs in parallel, series or parallel/series configurations.

For help with selecting and using LED power drivers, visit our online support center at www.luxeonstar.com/support.

Secondary Optics

The SP-02 module has been specifically designed to accommodate all of the Polymer and Khatod 7 cell LED optics including:

- Polymer 7 cell optic series
- Polymer 7 cell fiber concentrator optic
- Khatod PL121 7 cell optic series

More information about all of these optics is available on our website at: www.luxeonstar.com/sp-02-optics.

Mounting & Cooling

Use of this module requires careful attention to mounting and cooling to ensure that the junction temperature of the LED is kept well below the maximum rating as specified in the LED documentation published by Philips Lumileds.

For optimal cooling, we recommend that the module be mounted to a suitable finned heat sink (aluminum or copper) that is exposed to open air. The module can be mounted to the heat sink in one of three ways:

- through pressure sensitive, thermally conductive tape
- by a termally conductive adhesive
- with mechanical fasteners (not recommended)

The bottom of the LED module is electrically neutral, so it is not necessary to electrically isolate the LED base from the cooling surface.

Once mounted, you need to confirm that the module is being adequately cooled by testing the temperature of the LED as described in the Measuring LED Junction Temperature section of this document.

Bottom View

LED Mounting Using Pressure Sensitive Thermal Tape

Pressure sensitive thermal tape such as our pre-cut Bond-Ply© 100 tape makes it easy to fasten the base directly to a heat sink without the need for screws, clip mounts, or fasteners. However in order to ensure a sound thermal bond, it is very important that the tape be used correctly. This includes:

- Ensuring that all mating surfaces are clean, totally flat and free of voids
- Sizing and positioning the tape so that all mating surfaces are covered
- Applying a minimum of 10 PSI of even pressure between the LED and heat sink for at least 30 seconds

Applying even pressure to bond the LED module to the heat sink can be difficult due to the small size of the module and the need to avoid touching or applying any pressure to the LED optic. To overcome this problem, we include a thermal press with our pre-cut thermal tape. This press has been specifically designed to allow you to apply even, constant pressure to the module and heat sink, without touching the LED itself. A video that demonstrates how to properly apply pressure sensitive thermal tape and use a thermal press is available at www.luxeonstar.com/using-thermal-tape.

If pressure sensitive thermal tape is used correctly, there is no need to use any additional mechanical fasteners.

LED Mounting Using Thermally Conductive Adhesive

Thermally conductive adhesive such as Arctic Silver™ Thermal Adhesive requires a bit more effort to use than thermal tape, but offers a permanent bond, wider operating temperature range, and higher reliability, especially in environments where the module will be subjected to mechanical shock and vibration.

To create a thermally efficient and reliable bond:

- Ensure that all mating surfaces are clean and free of any grease or oil
- Use just enough epoxy to create as thin a bond line as possible
- Apply as much pressure as possible between the LED and heat sink for at least 30 seconds, and then maintain pressure using a clamp or weight until the epoxy has set

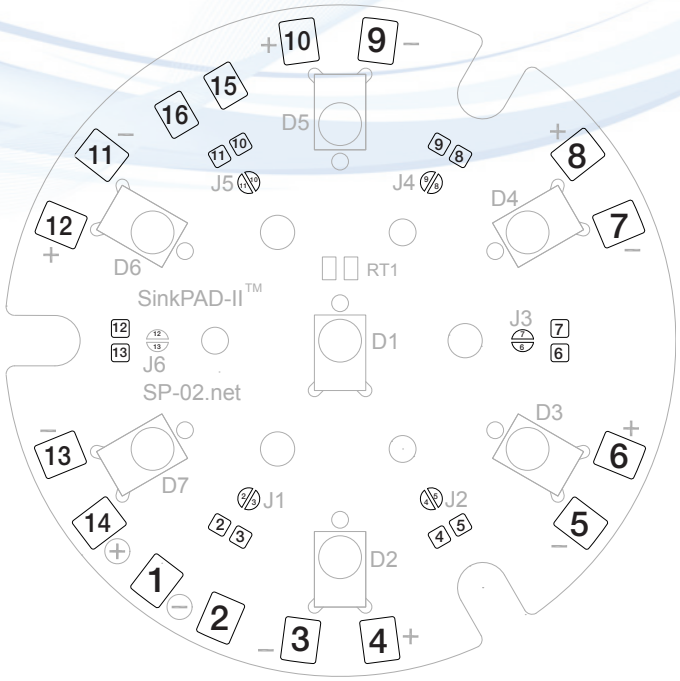
Like our thermal tape, we include a thermal press with every order of Arctic Silver Thermal Adhesive to make it easier to create a sound bond. A video that demonstrates how to properly use the Arctic Silver Thermal Adhesive and a thermal press is available at www.luxeonstar.com/using-arctic-silver.

LED Mounting Using Mechanical Fasteners (Not Recommended)

While the SP-02 includes three slots that can be used to fasten the LED module to a heat sink using screws, we generally **do not recommend** this fastening method. As the LED is directly soldered to the aluminum base, it is very easy to weaken or fracture the solder joint if the screws are unevenly or overtightened. If your specific application requires that you fasten the LED using screws, take extra care to ensure that the screws are carefully and evenly tightened, and that you only use just enough thermal grease to fill any small voids.

Connections

PAD No	Connection
1	LED1 - Cathode (-)
2	LED1 - Anode (+)
3	LED2 - Cathode
4	LED2 - Anode
5	LED3 - Cathode
6	LED3 - Anode
7	LED4 - Anode
8	LED4 - Cathode
9	LED5 - Cathode
10	LED5 - Anode
11	LED6 - Cathode
12	LED6 - Anode
13	LED7 - Cathode
14	LED7 - Anode
15	TSens
16	TSens



Series Operation

To power all of the LEDs simultaneously (series operation), apply 6 solder dots to the series configuration pads J1 to J6 and connect a suitable current regulating driver to the + and - pads as shown in Image 3.

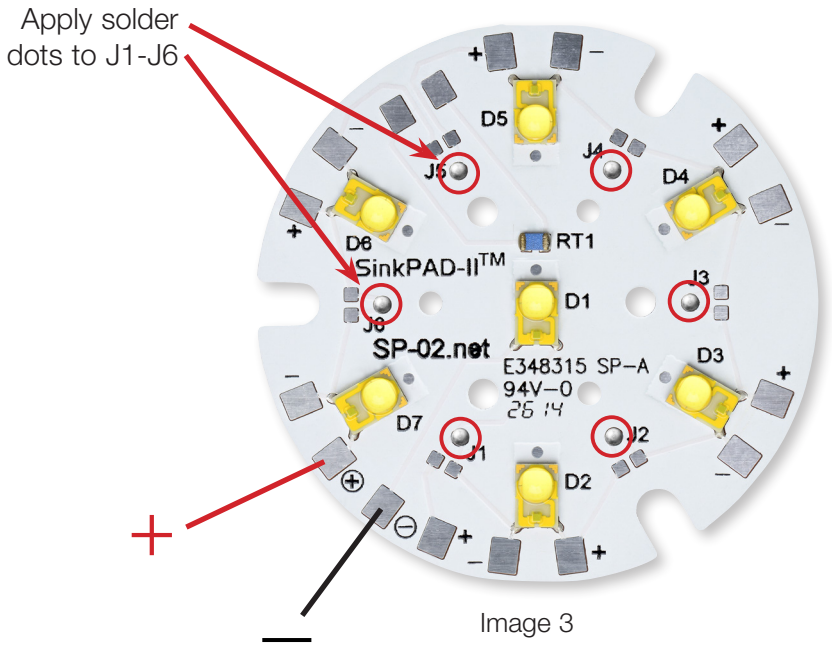


Image 3

Parallel (Single) Operation

To power and control each LED separately, simply connect a suitable current regulating driver to each pad as shown in Image 4.

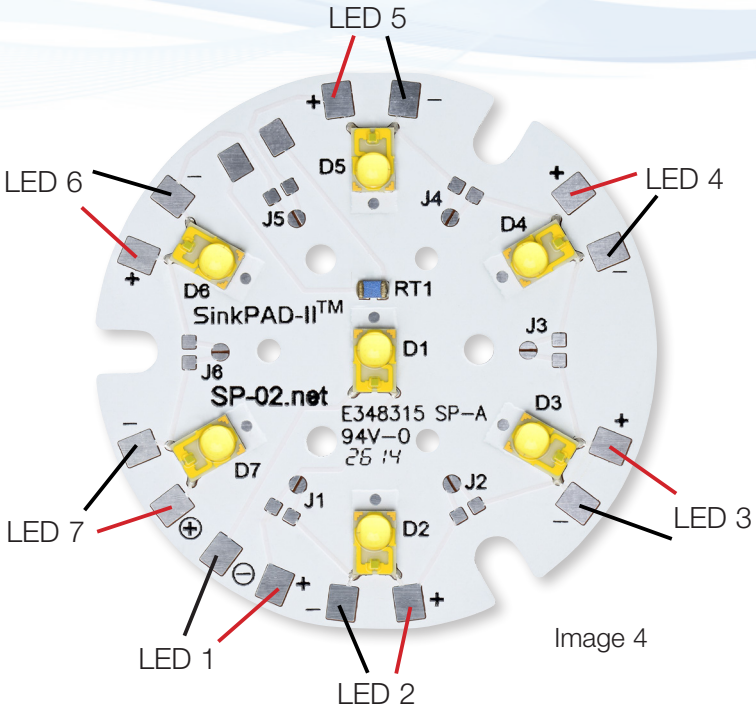


Image 4

Custom Colors

The SP-02 module can be supplied with any color combination of Rebel LEDs mounted to the base. There is no minimum order requirement or additional fees for this service. To order a customized 7 LED round module, visit our website at www.luxeonstar.com/sp-02-custom.

Measuring LED Junction Temperature

The junction temperature of the LED must be tested to ensure that it is being adequately cooled.

To make testing easy, the SP-02 module includes a temperature test point that can be used to determine the LED junction temperature using the following procedure.

For more details, refer to the Thermal Model on page 10 of this document.

Required Tools

- Digital Multimeter
- Temperature measurement meter
- Thermocouple or thermistor with Kapton tape and/or thermal adhesive epoxy

- or -

- Hand held temperature measurement probe with a small tip.

Test Procedure

1. Enter the LED Typical Thermal Resistance Junction to Thermal Pad (°C/W) $R\theta_{J\text{-}C}$ value from the Rebel LED datasheet into box **B** in the formula on page 9 of this document.
2. Ideally, the temperature should be tested with the LED module mounted in the location where it will be operated.

   If the module's location will be difficult to reach, then you will need to attach a thermocouple or thermistor to the module using Kapton tape or Arctic Silver™ Thermal Adhesive epoxy so that the tip of the sensor is in direct contact with the temperature measurement point as shown in Images 5 & 6. Be sure to allow the adhesive to fully cure before testing.

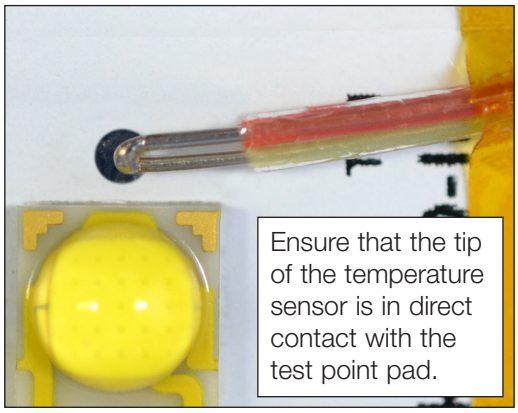


Image 5

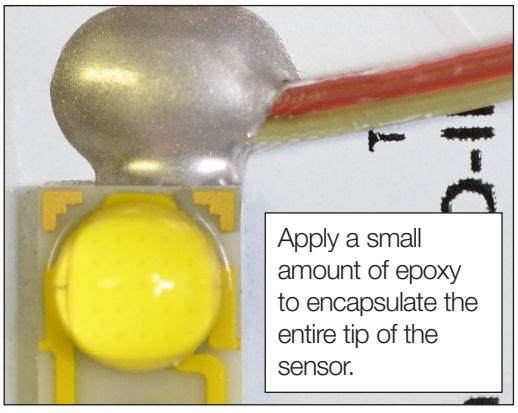


Image 6

3. If the LED module is easily accessible, you can use a hand held temperature probe such as our TP-01 Thermistor Tipped Probe to determine the LED junction temperature.

   To measure the test point temperature with a hand held probe, allow the temperature of the LED module to stabilize and then hold the tip of the probe onto the temperature test point for at least one minute. Move the tip of the probe around a bit to be sure you are measuring the point with the highest temperature reading. (Images 7 & 8)

   You will find more details about how to use the TP-01 probe (and other hand held temperature probes) at TP-01.com.

4. After the temperature measurement has stabilized, note the test point temperature and enter it in box **A** on page 9.

Firmly hold the test probe directly onto the thermal test point.

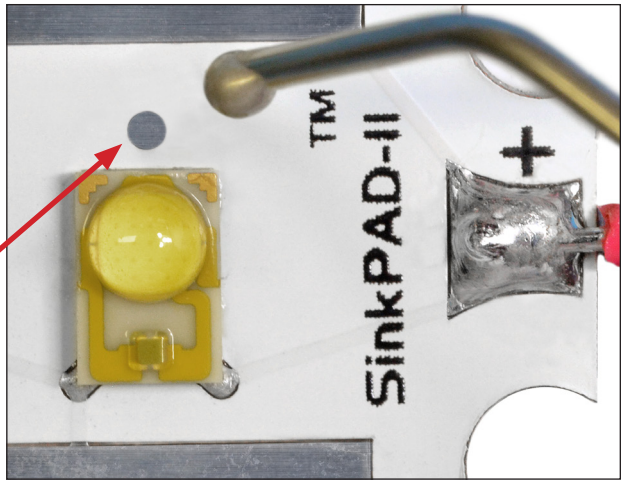


Image 7

Move the tip of the probe around to be sure that you are measuring the highest temperature you can find.

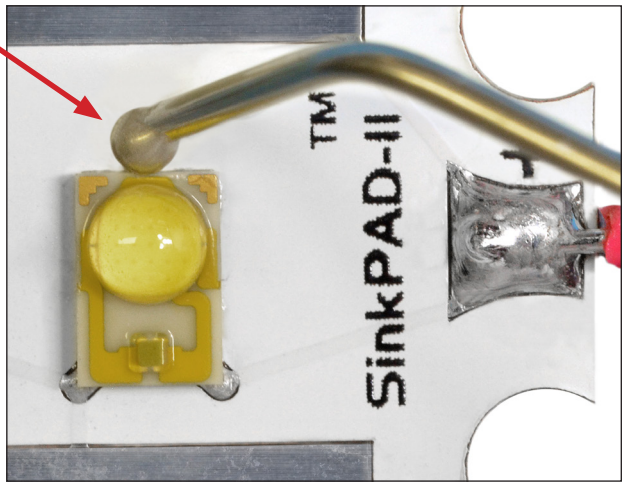
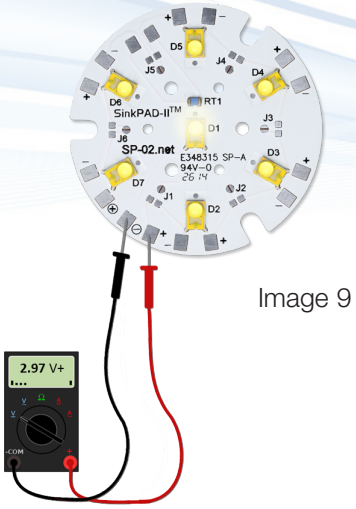


Image 8

5. Measure the forward voltage of the LED while at the stabilized temperature (Image 9) and note it in box **C**.



Only measure the voltage across the LED you are testing.

Image 9

6. Enter the current, which you are using to power the LED, in box **D**.
7. Evaluate the completed formula to determine the junction temperature of the LED.

$$\boxed{A} + (0.5 + \boxed{B}) \times (\boxed{C} \times \boxed{D}) = \boxed{}^{*}$$

A		B		C		D		
Test Point T_S Temperature °C	+	$R\theta_{C\text{-}S}$	$R\theta_{J\text{-}C}$	LED Forward Voltage V_f	×	LED Forward Current I_f	=	LED Junction Temperature °C

* For maximum LED life, color stability and reliability, the calculated junction temperature must always be below the maximum LED junction temperature published in the Philips Lumileds datasheet for Rebel LEDs.

8. If you are powering all of the LEDs in series and the module is mounted to the center of a symmetrically shaped heat sink in open air, then it is typically only necessary to test a single LED to determine the junction temperature of all the LEDs.

   If you are powering the LEDs singly, or if the module is mounted to an unusually shaped heat sink, or will be used in an unusual operating environment, then you will need to test each LED to ensure that the junction temperature is below it's safe operating point.

More information about this junction measurement technique can be found in the LUXEON LED Thermal Measurement Application Brief (AB33) published by Philips Lumileds.

Failure to ensure that the LED junction temperature is kept below it's maximum temperature rating will result in poor color rendering, early degradation of light output, and premature LED failure!

Thermal Model

Image 10 is a cross-section of a typical SinkPAD-II™ LED module that illustrates how the LED is attached to the SinkPAD-II™ base and shows the thermal paths between the LED junction, temperature test point and bottom of the LED module.

- $R\theta_{J-C}$ is the thermal resistance from the LED junction (T_j) to the LED thermal pad
- $R\theta_{C-S}$ is the thermal resistance from the LED thermal pad to the temperature test point (T_S)
- $R\theta_{C-B}$ is the thermal resistance from the LED thermal pad to the bottom of the SinkPAD-II™ module

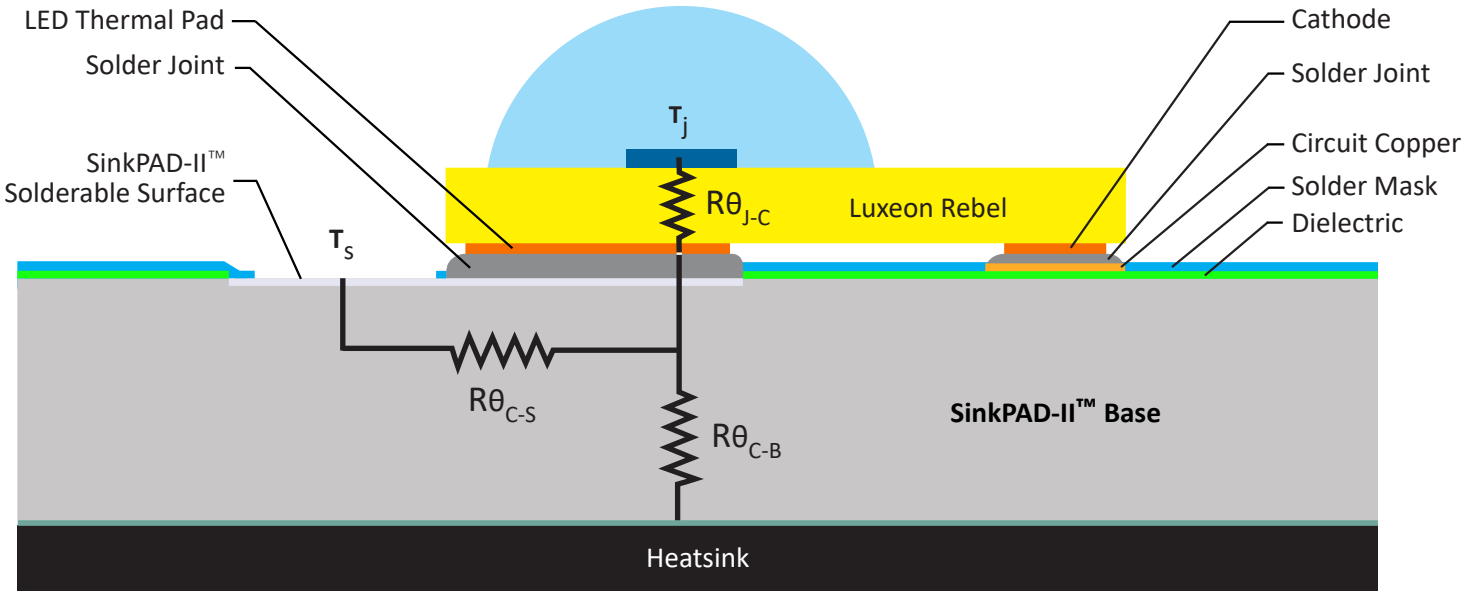


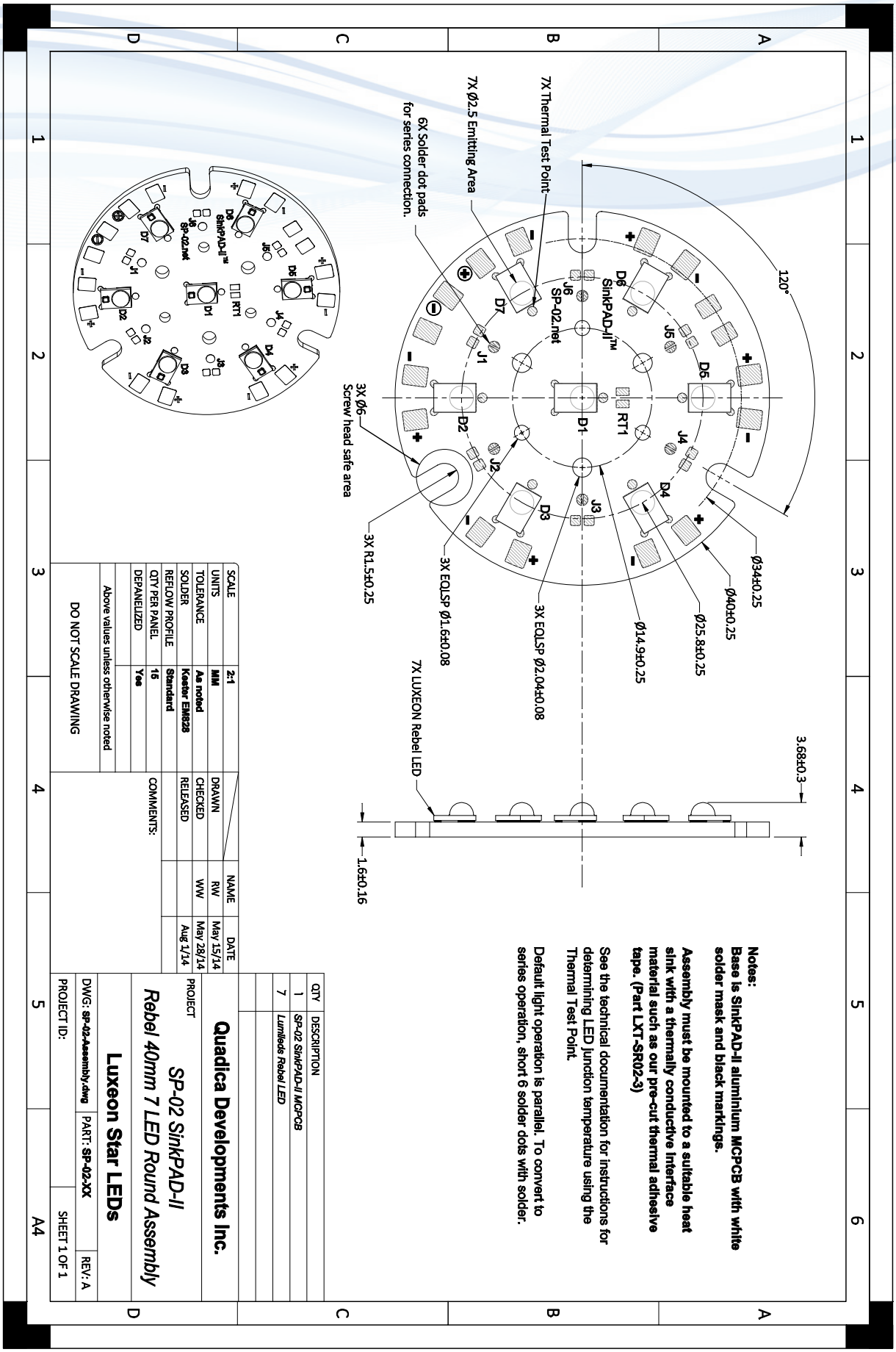
Image 10

Onboard Thermistor Temperature Measurement

Every SP-02 module includes a single Vishay NTC 10K Thermistor (NTHS0805N02N1002J) mounted near the center of the board. This thermistor is intended for continuous monitoring of the module during operation and can be used as part of a foldback temperature control circuit to ensure that the module does not overheat.

The thermistor does not replace the need to ensure that each LED is being adequately cooled by using the previously described test procedure. It is only intended to be used for in situ monitoring of the entire LED module.

For details on how to measure the LED junction temperature using the thermistor, please refer to the Determining LED Junction Temperature Using the Onboard Thermistor document.



You can download the full sized drawing from www.luxeonstar.com/sp-02-assembly.pdf

Safety:

The LED mounted onto this module will produce a highly intense point of light. Do not stare directly at the LED for any length of time.

Restricted Use:

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