HOW TO SIZE A HEATSINK FOR INDUSTRIAL SOLID-STATE RELAYS

TECHNICAL PAPER

Littelfuse®

Expertise Applied | Answers Delivered

QUICK OVERVIEW

This guide helps you select the right heatsink for panel-mounted SSRs using practical, proven thermal methods.

WHAT'S COVERED:

- Method 1: Use datasheet derating curves (simple method)
- Method 2: Calculate thermal resistance manually (advanced method)
- Method 3: Use SSRs with built-in heatsinks (fast-track option)

WHO IT'S FOR:

- Panel builders
- OEMs
- Installers
- Technical sales & support reps

OUTCOME:

Be able to use SSRs at specified values, simplify system design, and ensure long-term SSR performance.

TECHNICAL GUIDE: SIZING A HEATSINK FOR INDUSTRIAL SOLID-STATE RELAYS

Introduction

In systems relying on solid-state relays (SSRs), managing heat is not optional—it's essential. Instead of using moving parts like traditional relays or contactors, SSRs work entirely with electronics. That means there's no mechanical click, no sparks — but every time they switch power they produce heat inside (see **Figure 1**). And if that heat isn't removed properly with a heatsink, the SSR can overheat and fail.

This white paper aims to demystify heatsink selection, making it accessible and straightforward for non-technical users. Here's what you'll learn:

- A simple step-by-step method to select a heatsink using only the derating curves in our datasheets—no formulas needed.
- How to read those curves clearly, so you can pick the correct heatsink every time.
- A pre-assembled DIN-rail option—if you want to skip this process entirely, our DIN-rail SSR solutions come with the right heatsink already included.

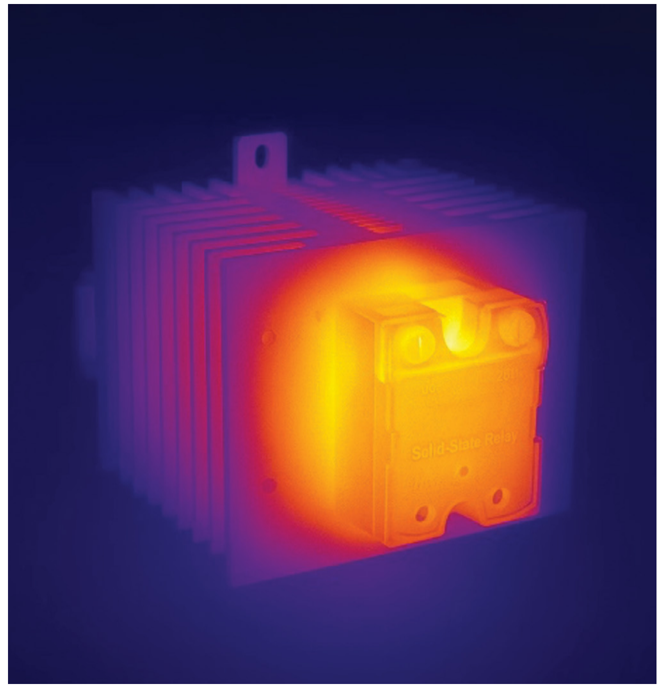


Figure 1. Thermal imaging representation

With this guide, you—and your team, engineers, or technicians—can confidently select the proper heatsink for SSR installations, avoiding the most frequent source of field failures. Let's get started with the basics!

At a Glance: Which method should I use?

Do you have a derating curve?	Do you need custom mechanical setup?	Do you want convenience or modularity?
↓	↓	↓
Use Method 1 Page 4	**Use Method 2** Page 6	**Use Method 3** Page 7

Method 1: Easy Selection Using The Derating Curves

Choosing the right heatsink depends mainly on two simple factors:

1. The current the SSR will handle continuously
2. The ambient temperature where the SSR will operate

The derating curves in the datasheet combine those two elements. They show how much current the SSR can safely handle at different temperatures—depending on the thermal resistance (°C/W) of the heatsink used. With just these two pieces of information, you can select a heatsink that will keep your SSR running cool and reliably. Let's walk through the steps.

Step 1: Open the datasheet and find the "Thermal derating curves" section

Locate the section labeled "derating curves" in the datasheet, and look for the diagram corresponding to your exact SSR model (e.g., SRP1-CE, 50 A Version) (see **Figure 2**).

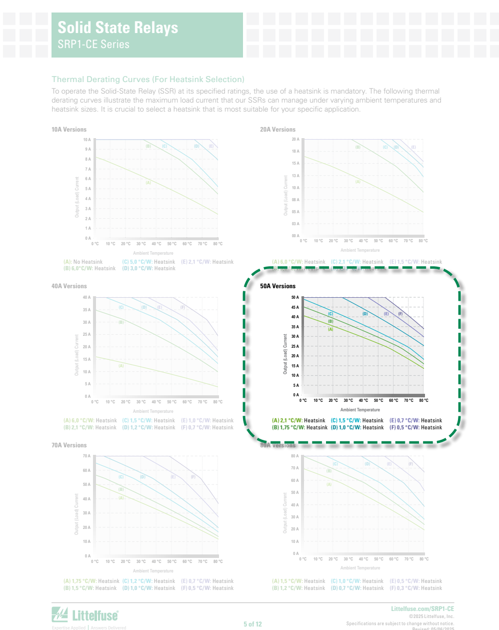


Figure 2. Thermal derating curves diagram in the SRP1-CE datasheet

COMMON MISTAKES TO AVOID

- Confusing ambient temperature with case temperature
- Overlooking airflow or spacing in dense panels
- Misinterpreting derating curves as linear

Step 2: Define your operating current (Y axis)

Locate the continuous current your SSR will handle. Example: 40 A (see **Figure 3**).

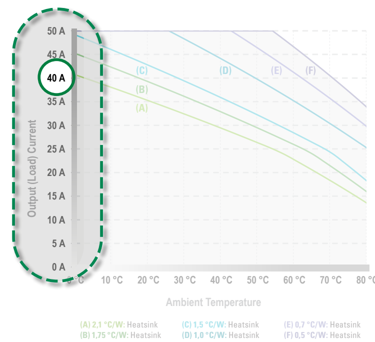


Figure 3. Operating current (Y axis)

COMMON MISTAKES TO AVOID

Make sure you consider inrush current.

Some applications will require more current at the beginning and then normalize later to the expected level.

Step 3: Estimate your ambient temperature (X axis)

Determine the temperature of the environment where the SSR is installed—for instance, inside a closed control panel near machinery. Example: 70 °C (see **Figure 4**).

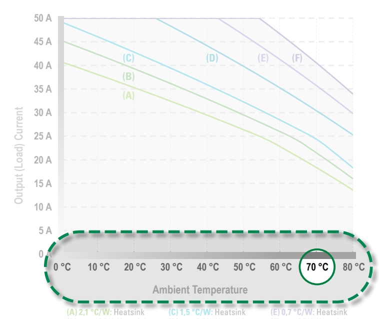


Figure 4. Ambient temperature (X axis)

COMMON MISTAKES TO AVOID

Make sure you consider the MAXIMUM ambient temperature and not the normal ambient temperature.

Sizing for worst-case conditions ensures the SSR will work reliably.

Step 4: Locate the intersection point on the curve

Using a preassembled SSR is ideal when:

- From your current value on the vertical (Y) axis, draw a horizontal line across the chart.
- From your ambient temperature on the horizontal (X) axis, draw a vertical line.
- The point where these lines cross (see Figure 5) falls on a derating curve—this is your intersection point.

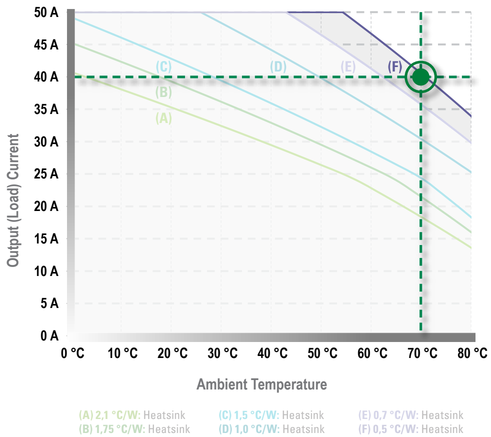


Figure 5. Intersection point on the curve

Step 5: Read the required thermal resistance value (°C/W)

From the intersection point, move toward the graph's right-hand scale. Match the letter of the scale to the list of values below the graph. That number, expressed in °C/W, represents the maximum thermal resistance your heatsink should have. Example: 0.5 °C/W (see **Figure 6**).

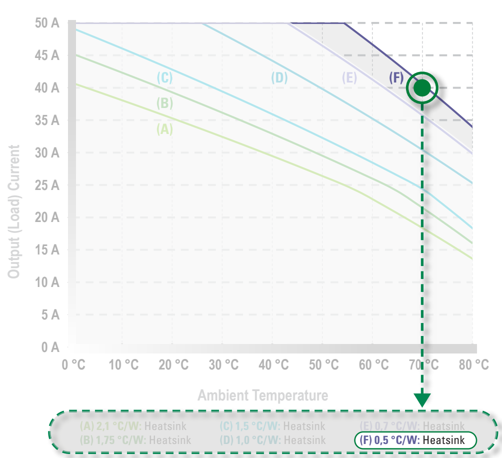
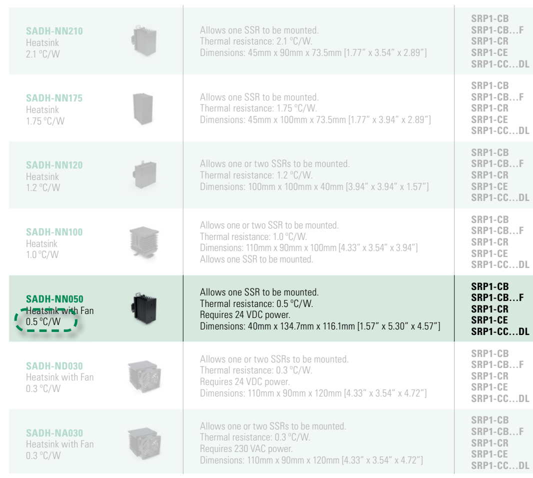


Figure 6. Thermal resistance value

Step 6: Select a heatsink with that value or better

Choose a heatsink whose thermal resistance is equal to or lower than the °C/W value.

Lower is better: it means more heat dissipation and a greater safety margin. Example: A 0.3 °C/W Heatsink provides better heat dissipation than a 0.5 °C/W Heatsink (see **Figure 7**).



SADH-NN210 Heatsink 2.1 °C/W	Allows one SSR to be mounted. Thermal resistance: 2.1 °C/W. Dimensions: 45mm x 90mm x 73.5mm [1.77" x 3.54" x 2.89"]	SRP1-CB SRP1-CB...F SRP1-CR SRP1-CE SRP1-CC...DL
SADH-NN175 Heatsink 1.75 °C/W	Allows one SSR to be mounted. Thermal resistance: 1.75 °C/W. Dimensions: 45mm x 100mm x 73.5mm [1.77" x 3.94" x 2.89"]	SRP1-CB SRP1-CB...F SRP1-CR SRP1-CE SRP1-CC...DL
SADH-NN120 Heatsink 1.2 °C/W	Allows one or two SSRs to be mounted. Thermal resistance: 1.2 °C/W. Dimensions: 100mm x 100mm x 40mm [3.94" x 3.94" x 1.57"]	SRP1-CB SRP1-CB...F SRP1-CR SRP1-CE SRP1-CC...DL
SADH-NN100 Heatsink 1.0 °C/W	Allows one or two SSR to be mounted. Thermal resistance: 1.0 °C/W. Dimensions: 110mm x 90mm x 100mm [4.33" x 3.54" x 3.94"] Allows one SSR to be mounted.	SRP1-CB SRP1-CB...F SRP1-CR SRP1-CE SRP1-CC...DL
SADH-NN050 Heatsink with Fan 0.5 °C/W	Allows one SSR to be mounted. Thermal resistance: 0.5 °C/W. Requires 24 VDC power. Dimensions: 40mm x 134.7mm x 116.1mm [1.57" x 5.30" x 4.57"]	**SRP1-CB SRP1-CB...F SRP1-CR SRP1-CE SRP1-CC...DL**
SADH-ND030 Heatsink with Fan 0.3 °C/W	Allows one or two SSRs to be mounted. Thermal resistance: 0.3 °C/W. Requires 24 VDC power. Dimensions: 110mm x 90mm x 120mm [4.33" x 3.54" x 4.72"]	SRP1-CB SRP1-CB...F SRP1-CR SRP1-CE SRP1-CC...DL
SADH-NA030 Heatsink with Fan 0.3 °C/W	Allows one or two SSRs to be mounted. Thermal resistance: 0.3 °C/W. Requires 230 VAC power. Dimensions: 110mm x 90mm x 120mm [4.33" x 3.54" x 4.72"]	SRP1-CB SRP1-CB...F SRP1-CR SRP1-CE SRP1-CC...DL

Figure 7. Solid-state relays accessories sheet

Quick-reference summary

Step	What to do	Outcome
1	Open SSR datasheet and find derating curves	You have the right graph
2	Note your desired continuous load current	Set your Y axis value
3	Estimate panel or ambient temperature	Set your X axis value
4	Find where the current and temperature meet	Identifies your intersection point
5	Read °C/W value	Defines maximum thermal resistance needed
6	Choose heatsink with ≤ °C/W	Ensures SSR operates safely and reliably

Method 2: Advanced Selection Using Formulas

If you're designing your own heatsink or mounting the SSR directly onto a surface like an enclosure wall, you'll need to calculate whether your setup can keep the SSR cool under load. This method helps you do that by calculating how much thermal resistance your heatsink must provide using just a few values from the datasheet and your application.

Step 1: Estimate how much power the SSR will dissipate

Every SSR generates some heat when conducting. The amount depends on the load current and the on-state voltage drop, which is the voltage "lost" across the SSR while it's on.

You'll calculate voltage drop using V_{to}, and r_t listed in the datasheet (see **Figure 8**). For example, let's switch 40A with the Littelfuse SSR SRP1-CEDZH-050NC-N:

$$V_{to} = 0.85\ \mathrm{V}\ \mid\ r_t = 7.5\ m\Omega = 0.0075\ \Omega\ \mid\ I_e = 40\ \mathrm{A}$$

Given that the dissipation formula is:

$$V_F = V_{to} + (r_t \times I_e)$$

If we substitue the values we have:

$$V_F = 0.85 + (0.0075 \times 40) = 1.15\ \mathrm{V}$$

Now in order to determine what this means in Power (W), we have:

$$\mathrm{Power} = 1.15\ \mathrm{V} \times 40\ \mathrm{A} = 46\ \mathrm{W}$$

SYMBOL	PARAMETER	CONDITION	RANGE	VALUE FOR 50A VERSIONS	VALUE FOR 70A VERSIONS	VALUE FOR 80A VERSIONS	UNIT
-	Output Configuration	-	-	SPST-NO	SPST-NO	SPST-NO	-
f	Operating Frequency	-	Minimum	0,1	0,1	0,1	Hz
			Nominal	50-60	50-60	50-60	
			Maximum	800	800	800	
Ue	Operating Voltage	47-63Hz	Minimum	24	24	24	Vrms
			Nominal	400	400	400	
			Maximum	600	600	600	
Usync	Zero Cross Level (Zero Voltage Turn-on)	-	Maximum	35	35	35	V
Ua	Latching Voltage	At Ue Nominal	Minimum	10	10	10	V
V	On-State Voltage Drop	At Rated Current	Maximum	0,85 + 0,0075 x Ie	1 + 0,0045 x Ie	0,8 + 0,003 x Ie	Vrms
Vto	Threshold Voltage (Power Loss Calculations only)	Tvj = 150 °C	Maximum	0,85	1,00	0,80	V
rt	On state dynamic resistance (Power Loss Calculations only)	Tvj = 150 °C	Maximum	7,5	4,5	3,0	mΩ
Up	Transient Over-Voltage* (Peak/Blocking/Non-Repetitive Voltage)	-	Maximum	1200	1200	1200	Vpk

Figure 8. Output/load specifications in the SRP1-CE datasheet

Step 2: Find the maximum temperature the SSR can tolerate internally

All SSRs have a maximum internal (junction) temperature. If that limit is exceeded, the relay may fail. Datasheets typically specify this value. If the datasheet doesn't specify it, a safe and commonly accepted value for AC SSRs is:

$$T_{j\,max} = 125\ ^\circ\mathrm{C}$$

Step 3: Estimate the ambient temperature around the SSR

This is the temperature inside the cabinet or panel where the SSR is mounted. If the environment is hot or poorly ventilated, this number will be higher. In this example:

$$T_{ambient} = 70\ ^\circ\mathrm{C}$$

Step 4: Calculate how much "temperature rise" is available

This is the difference between the SSR's max allowed temperature and the temperature around it. That margin is all you have for heat to escape through the thermal path.

$$\Delta T = T_{j\,max} - T_{ambient} = 125\ ^\circ\mathrm{C} - 70\ ^\circ\mathrm{C} = 55\ ^\circ\mathrm{C}$$

Step 5: Identify what parts of the system add thermal resistance

The total resistance to heat flow comes from several layers:

1. Inside the SSR (junction to its metal base):

$$R_{jc} = 0.6\ ^\circ\mathrm{C/W}\ \text{(from datasheet)}$$

2. The thermal interface material (pad or paste):

$$R_{\theta\,tp} \approx 0.2\ ^\circ\mathrm{C/W}\ \text{(typical value)}$$

These two are fixed. What's left must be handled by the heatsink.

Step 6: Calculate the maximum thermal resistance your heatsink can have

Now use the formula:

$$R_{\theta heatsink} = \frac{\Delta T}{\mathrm{Power}} - R_{jc} - R_{\theta\,tp}$$

Let's plug in the numbers:

$$R_{\theta heatsink} = \frac{55\ ^\circ\mathrm{C}}{46\ \mathrm{W}} - 0.6\ ^\circ\mathrm{C/W} - 0.2\ ^\circ\mathrm{C/W}$$

$$R_{\theta heatsink} \approx 1.20 - 0.8 = 0.40\ ^\circ\mathrm{C/W}$$

Final Result

To keep the SRP1-CEDZH-050NC-N operating safely at 40 A in a 70 °C environment, the heatsink must have a thermal resistance of 0.40 °C/W or lower. If your heatsink has a higher value, the SSR will likely overheat under continuous load.

Method 3: Pre-Assembled SSRs With Built-In Heatsinks

The simplest approach: when the heatsink comes pre-installed. For many users, the easiest way to ensure proper thermal performance is to use a solid-state relay or contactor that already includes a factory-integrated heatsink (see **Figure 9**). These preassembled devices are designed and validated by the manufacturer to operate safely within their rated current across standard temperature ranges, with no additional thermal design effort required.

This method eliminates the need for:

1. Heatsink selection or sizing
2. Power dissipation calculations
3. Interface material application (e.g. thermal grease or pad)
4. Manual mounting and torque validation

Instead, the user installs the relay as a complete unit, typically on a DIN rail or panel, and operates it within the current and temperature limits indicated in the datasheet.

Figure 9. Pre-assembled solid-state relay with built-in heatsink

Derating Still Applies

Even when the heatsink is already included, the datasheet will still show thermal derating curves (see **Figure 10**). These indicate how much current the device can safely switch as the ambient temperature increases.

For example:

- At 20–40 °C ambient, the relay may support its full rated current
- At 60–70 °C, the available current may drop by 40–50%

These curves are especially important in closed panels or high-temperature applications, and users should still consult them to ensure long-term reliability.

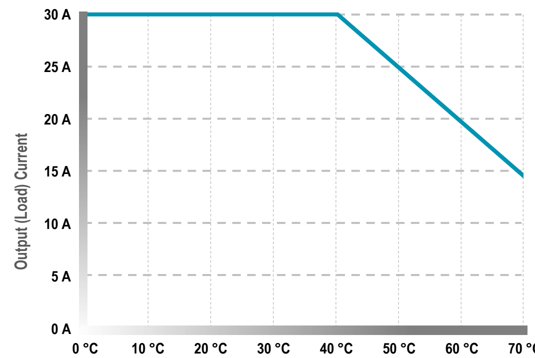


Figure 10. Thermal derating curve

When This Method Makes Sense

Using a preassembled SSR is ideal when:

- You want to avoid thermal sizing altogether
- You are working in DIN-rail-based industrial control panels
- The application involves resistive loads like heating elements
- You are operating in environments with moderate ambient temperatures

Summary

Using an SSR with a built-in heatsink is the fastest and most reliable way to ensure proper thermal management — particularly in standard, repetitive-use applications like heating. While it doesn't eliminate the need to read the datasheet, it does remove the complexity of heatsink selection and installation, making it ideal for panel builders, OEMs, and installers working under time or resource constraints.

For more information, visit
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