How to verify the proper Heat Sink

For additional information:

AMERICAS

United States and Canada
2320 Paseo de las Americas,
Suite 201, San Diego, CA 92154
sales@crydom.com

Sales Support: (877) 502 5500
Technical Support: (877) 702 7700
Fax (619) 710 8540

Mexico
Tel: +52 (222) 409 7000
Fax: +52 (222) 409 7810

South America
Tel: +55 (11) 3026 9008
Fax: +55 (11) 3026 9009

EUROPE

United Kingdom
Tel: +44 (0) 1202 606030
Fax: +44 (0) 1202 606035

Germany
Tel: +49 (0) 180 3000 506

Italy
Tel: +39 02 66599260
Fax: +39 02 66599268

France
Tel: 0 810 123 963
Fax: 0 810 057 605

ASIA

China
Tel: +86 (21) 6249 0910
Fax: +86 (21) 6249 0701

Taiwan
Tel: +886 2 8751 6388 x130
Fax: +886 2 2657 8725

India
Tel: +91 (80) 329 02 245
Fax: +91 (80) 412 38 066

OTHER REGIONS

Tel: +44 (0) 1202 606030
Fax: +44 (0) 1202 606035

In certain instances, once the heat sink requirements for a SSR in a particular application have been determined and installed, (see the Crydom paper entitled ***SELECTING A SUITBLE HEATSINK***), it may be desirable to verify that the system does indeed provide adequate cooling to ensure reliable SSR operation.

The following is a relatively simple method to check this suitability, and essentially uses some of the calculations from ***SELECTING A SUITABLE HEAT SINK*** in a reverse manner. This technique may also be used on existing systems in the field that might have been more or less "empirically" designed, to gain information on their performance and potential reliabilty. This method involves determining the temperature of the internal power devices, (SCR's or Triac), within the SSR and then comparing that temperature with a "standard" absolute maximum temperature that the SSR power devices must never exceed. The maxium power device temperature is generally considered to be 125°C but for an added safety margin, 115°C should be used. (Of course for the truest indication, the **entire system** being evaluated should be stable and operating at its **maximum rated parameters** including load currents, ambient temperatures, and with doors and access panels in their normal operating positions.)

There are three additional pieces of data needed to perform this evaluation. They are the actual load current switched by the SSR, the specified "Thermal Resistance – Junction to Case" **-** Rθjc of the SSR, and the measured temperature of the SSR base plate. Ideally, the temperature measurement of the SSR base plate should be taken directly from the bottom center of the SSR. However, since in most installations this is not practical since the SSR is mounted to a heat sink surface, the next best accessible location is on the top surface of the base plate near the mounting screw holes at the junction of the plastic case to the base plate surface. (To compensate for this measurement location, it is a good practice to add 3 to 5 degrees to the actual measurement.)

Using the above data, and an estimated power drop of 1 Watt for every 1 Arms of load current, the total internal dissipation in Watts can be calculated. (e.g. 35 Arms load = 35 Watts of internal dissipation.) Next, multiply the internal dissipation in Watts by the Rθjc value, (in °C/W), to determine the internal temperature rise. This temperature value is added to the measured base plate temperature to arrive at the calculated temperature of the internal power devices. If this value is less than the 115°C *"standard maximum with safety margin"* value, then the heat sink is adequate.

In some cases, the heat sink information and derate curves provided within the SSR specification sheets may include expected base plate temperatures, but generally do not consider the safety margin values.

Selecting a Suitable Heatsink

other documents:

> Why Use Solid State Relays?
> SSRs - The Inside Story
> Selecting a Solid State Relay
> DC Output Solid State Relays
> SSR Overvoltage Protection

For additional information:

AMERICAS

United States and Canada
2320 Paseo de las Americas,
Suite 201, San Diego, CA 92154
sales@crydom.com

Sales Support: (877) 502 5500
Technical Support: (877) 702 7700
Fax (619) 710 8540

Mexico
Tel: +52 (222) 409 7000
Fax: +52 (222) 409 7810

South America
Tel: +55 (11) 3026 9008
Fax: +55 (11) 3026 9009

EUROPE

United Kingdom
Tel: +44 (0) 1202 606030
Fax: +44 (0) 1202 606035

Germany
Tel: +49 (0) 180 3000 506

Italy
Tel: +39 02 66599260
Fax: +39 02 66599268

France
Tel: 0 810 123 963
Fax: 0 810 057 605

ASIA

China
Tel: +86 (21) 6249 0910
Fax: +86 (21) 6249 0701

Taiwan
Tel: +886 2 8751 6388 x130
Fax: +886 2 2657 8725

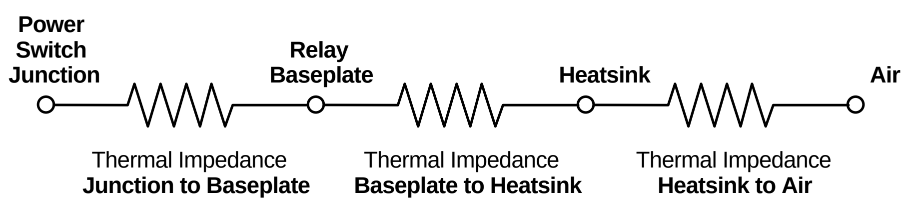
India
Tel: +91 (80) 329 02 245
Fax: +91 (80) 412 38 066

OTHER REGIONS

Tel: +44 (0) 1202 606030
Fax: +44 (0) 1202 606035

Due to the forward voltage drop of the output SCRs, solid state relays generate an internal power loss. The amount of power generated is afunction of the load current. The manufacturer provides power loss curves, as shown in Fig 1. At normal load currents the power loss can be estimated at 1 Watt for every 1 Arms of load current.

Obviously the junction temperature Tj can be calculated if the power dissipation is known. The normal maximum allowable junction temperature is 125 degrees Centigrade. Most designs are based on providing a 10 degree Centigrade safety margin and use a heat sink to keep the junction temperature to 115 degrees Centigrade.



In order to maintain an acceptable power switch junction temperature, some form of heatsink must dissipate the heat generated by the power loss. For most printed circuit board types, the relay current rating is established by measuring the thermal impedance, from the dissipating elements to air, using the relay package as the heat sink. Some printed circuit board types are available with an integral heatsink; their ratings reflect the additional effects of the integral heatsink.

Panel mount relays usually require an external heatsink. The electrical analogy shown below identifies the primary thermal impedances in the path from junction to ambient air:

Tj = Power x (sum of thermal impedances)
The relay manufacturer provides the thermal impedance junction to baseplate, and the heatsink manufacturer provides the thermal impedance heatsink to air. However, the thermal impedance from baseplate to heatsink is determined by the assembly procedure used. It is important that the surface to which the relay is being assembled is clean, flat, bare metal (NOT PAINTED). If an anodized aluminum heatsink is used, the thermal impedance of the anodized surface may be acceptable, depending on the thickness of the anodize.

A thermal compound (or thermal pad)is needed to minimize the baseplate-to-heatsink thermal impedance. In

a company of Schneider Electric

general a thermal compound will give the lowest thermal impedance, but it is very important to use a minimum of thermal compound – too much is almost as bad as none at all. One widely used technique ch is to apply a thin layer of compound and then apply pressure to the relay while rotating it back and forth to squeeze any excess compound out before attaching the relay to the mounting surface.

In some applications the relay will be mounted directly to a panel. This technique will work up to load currents of 7 to 8 Arms depending on the panel material, ambient temperature, etc. In these cases it is absolutely essential to mount the relay to an un painted surface and use a good thermal compound. As a rule, the minimum per-relay panel area should be 25 square inches.

Above these current levels some form of heatsink will be required. Determine heatsink thermal impedance using rating curves like those shown in Fig 1.

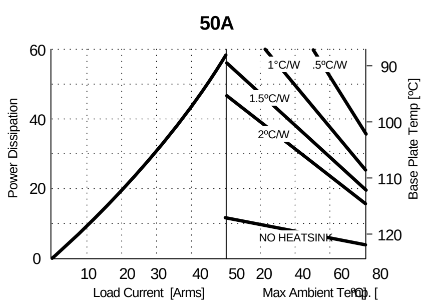


Fig 1

The figure shown is for a 50 Arms rated relay. Assume the load current is 30Arms, then in the left hand side of the curve the power dissipated is seen to be 31 Watts. Reading across to the heatsink versus ambient temperature curves shows that an ambient of 40 degrees Centigrade requires a heatsink with a thermal impedance of 2 degrees Centigrade per Watt. However, toreduce the junction temperature to approximately 115 degrees Centigrade, a heatsink of about 1.5 degrees Centigrade would be more suitable. If the point of 31 Watts dissipation is read all the way to the right, then them aximum allowable base-plate temperature is shown for a junction temperature of 125 degrees Centigrade. In the example discussed, this is 106 degrees Centigrade. However, to allow for the 10 degrees Centigrade safety factor, the baseplate temperature should not exceed 96 degrees Centigrade.

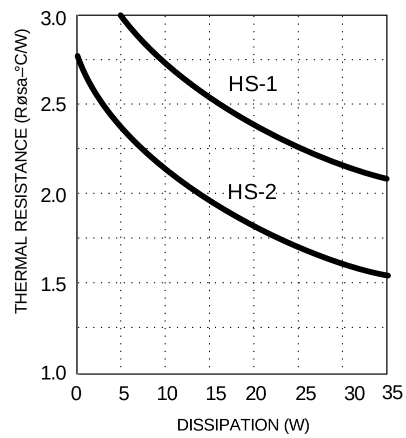


Fig 2

As shown by the thermal impedance curves for HS-1 and HS-2 heat sinks in Fig 2, not only is the surface area of the heatsink a factor but also the power being dissipated. There are many sources for heat sinks, enabling designers to select one most suitable thermally and mechanically for the application.