

**Solid Statements:  
Printed Circuit Board Mount  
(PCB) Solid-State Relays:**



An ever increasing trend over the past decades with most all manufacturers of electronic devices is “smaller is better”. Design engineers for anything from mobile phones, personal computers, to larger residential appliances and audio / video systems continuously struggle with the market-driven requirement for smaller packages with “new and improved” features above and beyond that of their predecessors. This demand not only tests the mechanical design capabilities of the engineer, but creates a requirement for smaller and often more “power-dense” electronic components, as well.

Accordingly, manufacturers of equipment used in commercial and industrial applications are also subjected to the same trend. Reductions in the size of control panels directly equates to a reduction in the real-estate requirements on the factory floor or storage facility, less metal used in the panel, and a decrease in the overall

weight of the equipment, amongst other things. All of which directly relates to either an increase in efficiency, a reduction in cost, or in most cases, both.

Unfortunately, in most commercial and industrial applications the power requirements are not reduced in direct proportion to the reduction in panel space. Therefore, smaller and more power-dense electronic components are necessary in order to perform the same systemic function within a smaller footprint. This requires a more intimate familiarity with the components in question to ensure that the “compressed” design and assembly process does not infringe upon their mechanical and electrical limits.

**Crydom PCB Mount Solid State Relays:**

Solid state relays are commonly used in many commercial and industrial applications, including plastics and packaging machines, professional food equipment, laboratory ovens, theatrical lighting systems, medical equipment, renewable energy systems, HVAC&R equipment, etc. They are therefore “prime targets” for engineers that are trying to reduce the size of their overall system. This makes the Crydom PCB mount single-in-line packaged (or SIP) solid state relays an ideal alternative to discrete or panel mount solutions.

The primary advantage of using a SIP PCB mount solid state relay is, appropriately enough, space savings. The package is quite small compared to other SSR packages, which allows for

the use of many relays on a single PCB. Medical equipment, such as a portable dialysis machine, is one example of a perfect candidate for a PCB mount solid state relay. As the demand for home-care services increases, so does the demand for lighter and more portable medical equipment.

However, as mentioned previously, engineers must be sensitive to the mechanical and electrical limitations of the solid state relay when redesigning their system(s). If the overall power requirements of the “new and improved” design is not decreased in proportion to the reduction in overall system size, then the SSRs may be subjected to more strenuous operating conditions.



Crydom Panel Mount and CX Packaged SIP PCB Mount Solid State Relays

### Power Dissipation and Solid State Relays

As we've discussed in a few previous editions, all solid state relays generate heat in direct proportion to the load current of the application. A PCB mount solid state relay carrying 5 amps of load current will dissipate approximately 5 Watts of power in the form of heat. The SSR must dissipate this heat into the ambient air surrounding the housing in order for it to stay below its maximum operational ratings. Therefore, when multiple PCB SSRs are used on a single PCB, adequate spacing must be given to each relay. Otherwise, the heat dissipated by one relay will directly affect the performance of the SSRs next to it on the board.

While this is all fairly straight forward information, the actual determination of the spacing required between each relay is not. Each application is different and conditions such as load current, ambient temperature, surge currents, airflow, etc., all impact the minimum allowable spacing between each SSR. However, as a general “rule of thumb”, the spacing between each relay should be no less than the width of the relays themselves. Therefore, the minimum spacing between CX series solid state relays should be no less than 8mm, while the spacing between SPF series SSRs should be no less than 23mm.

Regardless of this, a more important factor in determining the spacing between each relay is the maximum allowable case temperature of the individual SSR. Powder coated SSRs,

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such as the CX and ASO series relays, have a maximum allowable case temperature of 100°C. SIP SSRs in a plastic housing, such as the MP and MCX series, have a maximum allowable case temperature of 90°C. If the actual case temperature in the application encroaches upon these maximums, then either the spacing between each relay must be increased, or airflow must be introduced into the system in order to cool the housing.

**A word of caution;** we highly recommend the placement of a “hot” warning label on the printed circuit board next to the location of any solid state relay(s). We’re quite sure that any technician sticking his fingers into a circuit would appreciate it as well, lest he leave for the day with a permanent reminder that SSRs can function at a fairly high temperature!

### **PCB SSRs and Heat Sinks**

In the December 2008 and January 2009 editions we discussed methods for calculating base plate and SCR die temperatures inside panel mount SSRs when using heat sinks. As with the panel mount SSRs, a few Crydom PCB mount solid state relays can also be used with a heat sink to increase its load-current rating. Some versions, such as the PF and SPF series, have an integral heat sink, which allows for load current ratings up to 25 amps with forced airflow. Other versions, such as the LS and LR series solid state relays, have an exposed substrate or base plate that allows them to be mounted to

an external heat sink to increase their ratings.



Crydom LS (top) and PF (bottom) series SIP PCB Mount Solid State Relays

As with any Crydom panel mount solid state relay, a derate curve is provided in the datasheet of both the LS and LR series PCB SSR. This allows for engineers to quickly determine the required heat sink rating necessary for

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their application, given the load current and ambient temperature inside their panel. For those that really enjoy the math, the SCR die temperature can also be calculated as with any other SSR. The internal thermal impedance for the LS and 25A LR series is 1.15°C/W, while the internal impedance of the 40A LR is 0.73°C/W (the 0.10°C/W impedance of the thermal pad or paste is already considered in these specifications). If we all remember the formulas from previous editions (which I'm sure everyone does!), then we can estimate die temperature and heat sink requirements as follows, using a 40A LR at max load current as an example:

- 1) LR 40A Rjb = **0.73°C/W** (with thermal pad)
- 2) LR 40A Vf – Assume **1.2V max**, worst case
- 3) Max SCR die Temp = **125°C** (as with all Crydom SCR output SSRs)

$$\begin{aligned}BP_{max} &= 125^{\circ}\text{C} - (40\text{A} \times 1.2\text{V} \times .73^{\circ}\text{C/W}) \\BP_{max} &= 125^{\circ}\text{C} - 35^{\circ}\text{C} \\BP_{max} &= 90^{\circ}\text{C}\end{aligned}$$

To carry it one step further, we can calculate the heat sink required @ a 40°C ambient in order to maintain a 90°C maximum base plate temperature:

$$\begin{aligned}R_{s-a} &= (BP_{max} - T_{amb}) / \text{Power} \\R_{s-a} &= 90^{\circ}\text{C} - 40^{\circ}\text{C} / (40\text{A} \times 1.2\text{V}) \\R_{s-a} &= 50^{\circ}\text{C} / 48 \text{ Watts} \\R_{s-a} &= \sim 1.0^{\circ}\text{C/W Heat Sink}\end{aligned}$$

### Installation of PCB Mount SSRs

A few additional points that engineers must consider when selecting PCB solid state relays revolve around the mechanical aspects of the product. Unlike traditional panel and DIN mount solid state relays, PCB mount SSRs are typically soldered into a circuit board, which will have lower load-current capabilities and an assembly process often designed around smaller components with less mass. In order to ensure the reliability of the assembly, consideration must be given to issues such as the soldering and forming of the SSR, as well as the design of the PCB itself

- 1) Soldering: Solder profiles vary from application to application, based on the design of the board. For boards with PCB mount SSRs, the profile must be sufficient to provide adequate solder coverage on all of the pins but not in excess of maximum capabilities of the SSR. For most Crydom PCB mount SSRs, this is 260°C for 10 seconds (wave solder) or 400°C for 3 to 5 seconds (hand solder). The PCB mount SSRs are not suitable for reflow.
- 2) PCB Traces: Most of Crydom's PCB mount solid state relays utilize SCR die in the output capable of withstanding high surge currents. In many applications this rating will exceed the capabilities of the traces on the PCB itself. The characteristics of the load must be considered when the engineers design the PCB
- 3) Pin Forming: In some cases it is desirable to bend the pins on a PCB

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mount SSR in order to better adapt it to the PCB. This is not recommended as it could stress the relay's internal components. Please contact Crydom directly if this is a requirement and we can discuss options for providing you with a relay that has pre-formed pins.

- 4) **Fusing:** As with any application, suitable fusing of the relay is highly recommended to avoid damage to the relay and / or load in an over current situation.



Popular Crydom PCB Mount Solid State Relays

### **In Conclusion**

Crydom's PCB mount solid state relays offer the same technical advantages that a panel or DIN mount SSR have over electromechanical relays, including: significantly enhanced life expectancy, no contact bounce or arcing, silent operation, zero-crossing capability, low power input, and high resistance to shock and vibration.

However, they do so in a package that allows for smaller and more flexible system designs. Given the proper consideration we've outlined here, a Crydom PCB solid state relay will far outlive the equipment in which it is used, as well as the engineer that designed the system!

- **Ratings up to 25A (forced air) @ 660V AC**
- **SCR output (AC versions) for heavy industrial or commercial loads (most versions)**
- **Low-impedance MOSFET (DC versions) rated up to 20A @ 60Vdc**
- **Available in standard SIP, mini-SIP, or DIP packages**
- **Life expectancy in excess of 50x typical electro-mechanical relays at full-load current**
- **No moving parts eliminates all acoustical noise**
- **Not sensitive to magnetic fields**
- **Custom models available upon request**
- **RoHS Compliant**

### Reference Links:

[AC Output SIP Solid State Relays](#)

[AC Output Mini-SIP Solid State Relays](#)

[DC Output SIP Solid State Relays](#)

[DC output Mini-SIP Solid State Relays](#)

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### **CMX100D10**

- ⇒ **Low-impedance MOSFET output**
- ⇒ **Ratings up to 10A @ 100Vdc**
- ⇒ **Low current DC control suitable for interfacing with most PLC or control boards**
- ⇒ **Industry-standard SIP package**
- ⇒ **UL / cUL Recognized**
- ⇒ **CE & RoHS Compliant**

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