SOLID STATE RELAY

Solid State Relays are high speed state-of-the-art *semiconductor* load switching relays, that when used with "PID" or proportional output temperature controllers, will give you much improved accuracy in controlling your temperature.

When using a solid state relay, the "cycle time" of a controller can be reduced from 15 seconds (typical for contactor control) to 1 second for the SSR.   This allows the temperature controller to switch much smaller bursts of power to your elements, thereby delivering smaller amounts of power to the elements, *reducing overshoot and improving accuracy of control!*

1   Our SSR's are avaliable in three sizes 10 amps, 25 amps and 40 amps.

2   Our SSR's will handle either 90Vac~250Vac or 90Vac~480Vac load voltages.

3   Our SSR's have *three control options*

   3.1 DC 4~32 volts, meaning that any voltage between 4 and 32 volts DC will switch them on.

   3.2 AC 90~280 volts, meaning that any voltage between 90 and 280 volts will switch them on.

   3.3 Potentiometer control, meaning that there is a potentiometer that when turned will regulate the power much like a domestic light dimmer.

4   Our SSR's have a "red" LED to indicate control signal status.

5   Our SSR's have *"Zero Voltage Turn-on".*   Because the SSR is turned on when the voltage is passing though the "zero point", it reduces the inrush current to the load and also reduces the electromagnetic noise that may otherwise be generated.

6   Our SSR's have *"Zero Current Turn-off".* Because the SSR is turned off when the current is at it's lowest, when switching inductive loads the back EMF is considerably reduced, thus increasing the life of the SSR.

7   Our SSR's have a *built in "Snubber Circuit"*. This acts as a noise filter and prevents spurious signal noise from inadvertently switching the SSR on.   It also helps with the switching of inductive loads that generate large inrush or switch-off spikes.

8   We recommend that our SSR's be protected *by "Ultra High Speed Fuses".*   These fuses are rated by the I^2t value.   The fuse must have a rating of less than the SSR I^2t value specified below.

INPUT SPECIFICATIONS

	DC INPUT	AC INPUT	Potentiometer INPUT
Input Range	4 ~32 Vdc	90~280 Vrms	200 K ohms
Max. Turn-On Voltage	4.0 Vdc	80 Vrms	-*
Min. Turn-Off Voltage	3.5 Vdc	60 Vrms	-*
Input Current	7 mA @32Vdc, 5 mA @24Vdc	0.6 mA @240 Vrms	-*

OUTPUT SPECIFICATIONS

MODEL NUMBERS	D2410, (D4810) A2410, (A4810) V2410, (V4810)	D2425, (D4825) A2425, (A4825) V2425, (V4825)	D2440, (D4840) A2440, (A4840) V2440, (V4840)
Operating Voltage (50/60 Hz)	90~280 (90~530) $V_{(rms)}$	90~280 (90~530) $V_{(rms)}$	90~280 (90~530) $V_{(rms)}$
Max. Load Current @ 25℃ Ambient Temperature	10 $A_{(rms)}$	25 $A_{(rms)}$	40 $A_{(rms)}$
Min. Load Current	0.1 $A_{(rms)}$	0.1 $A_{(rms)}$	0.1 $A_{(rms)}$
Max. Surge Peak On-State Current (16.7ms)	105 A	260 A	420 A
Max. On-State Voltage Drop @ Rated Current	1.6 $V_{(rms)}$	1.6 $V_{(rms)}$	1.6 $V_{(rms)}$
Max. Off-State Leakage Current @ Rated Voltage	1 $mA_{(rms)}$	1 $mA_{(rms)}$	1 $mA_{(rms)}$
Min. Off-State dv/dt @ Max. Rated Voltage	1000 V/μsec	1000 V/μsec	500 V/μsec
Transient Over voltage	800 V	800 V	800 V
I^2 t for Fusing	55 A^2 s	340 A^2 s	880 A^2 s
Max. Turn-On Time	1/2 Cycle*	1/2 Cycle*	1/2 Cycle*
Max. Turn-Off Time	1/2 Cycle*	1/2 Cycle*	1/2 Cycle*

* Not available for potentiometer input type.

GENERAL SPECIFICATIONS

Isolation Voltage (AC, 1 minute)	5000 $V_{(rms)}$
Insulation Resistance (Min.) @500VDC	10^{12} Ω
Max. Capacitance Input/Output	0.8 pF
Ambient Operating Temperature Range	-40 ~ 80 ℃
Ambient Storage Temperature Range	-40 ~ 125 ℃
Status Indicating Display	Red LED Indicator

MECHANICAL SPECIFICATIONS

Weight	110 g
Encapsulation	Thermally Conductive Epoxy

All Dimensions Are In Millimeter
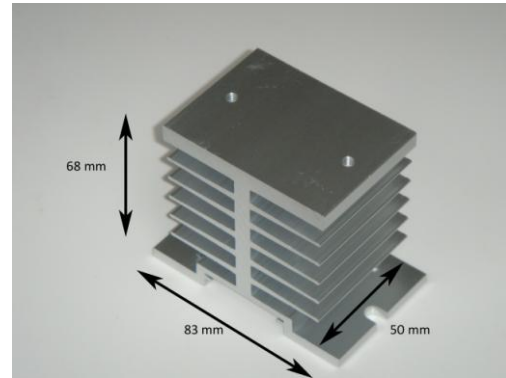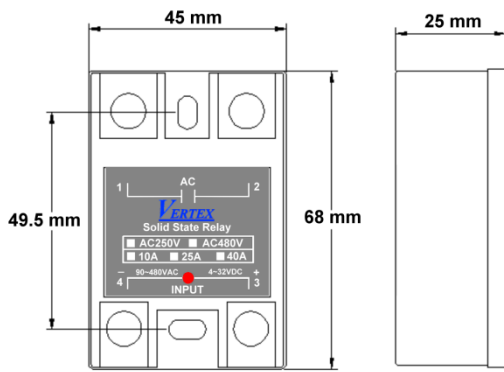
Accessory Options

Heat Sink: Vertex Heat Sinks offer thermal management and are matched to the load current ratings of Vertex's solid state relay.

Din Rail Brackets used with Vertex heat sinks make it possible to convert panel mount type to din rail mount.

Ordering Code

VT – 1 – 2 – 3

1: DA ----- 4~ 32 VDC input

AA ----- 90~280 Vac

VA----- 200K ohms potentiometer input

2: 24 ------- 280 VAC

48-------- 530 VAC

3: 10------10A

25------25A

40------40A

Solid State Relay : Using and Installing

There are three main areas to watch when installing Solid State Relays:

a. Ambient Temperature and Load considerations

b. Electrical Fuse Protection

c. Heat Sink Calculations

Ambient Temperature and Load considerations

1. The temperature of the silicon junction (measured on the base) of the SSR limits the "Load Carrying Capacity" of all SSR's.

2. The allowable load current for any specific SSR at a specified base temperature (panel ambient) can be determined from "Temperature De-rating Curves" published by manufacturers.

3. In practice we recommend that if you are drawing more than a few amps you should use a heat sink.

4. We supply din rail heat sinks with a footprint marginally bigger than the SSR base itself, which is easy to install, uses minimal panel space and is effective for most applications up to 75 % of maximum load current of the SSR.

5. This is simply a guideline, as in truth the actual load possible relies not solely on the maximum design load, but on other factors such as panel layout and duty cycle of the application etc.

6. Be advised though that if you are planning on using our 40 amp SSR's in general the load should be limited to 30 ~ 33 amps or with special design factors possibly an amp or two higher. (See notes below)

7. When using our SSR's above the 30 amp mark with a duty cycle of 60% or more it is advisable to install the heat sinks leaving a 2 mm gap between each to facilitate best natural air flow across the heat sink fins.

8. Depending on how many SSR's you will have in one panel, in applications such as described above, it is always advisable to install a small extraction/ventilation fan at the top of the panel and have a vents at the bottom of the panel on both sides to allow maximum forced draft ventilation.

9. **When installing any SSR on a heat sink, *you must use "Silicon Heat Transfer Paste"* to fill the minute air gaps between the base of the SSR and the heat sink.**

Electrical Fuse Protection

1. The most common problem encountered when installing SSR's is the lack of adequate Electrical Short Circuit Protection for the device.

2. A circuit breaker or general fuse (GL) will not provide protection, as they are far too slow.

3. A SSR will fail in the first half cycle following a short circuit fault.

4. ***You must use an "Ultra High Speed" semiconductor fuse to protect the SSR.***

5. For purposes of choosing the correct fuse to use, each SSR has an I^2t rating against which the fuse must be matched.

6. Our 25 amp SSR has an I^2t value of 450 and the 40 amp unit $I^2t = 1120$

7. The fuse you use must have an I^2t value that is less than this rated value at the operating voltage.

8. You may use any make of fuse but we recommend that our customers use the Ferraz make.

9. For the 25 amp Solid State Relay we suggest the Ferraz French Ferrule 660 gRB 25 amp 10 x 38 fuse. The I^2t rating at 660 VAC is 470 which when reduced to 240 VAC operating voltage will be $I^2t = 225$ or thereabouts.

10. For the 40 amp Solid State Relay we suggest that you use the French Ferrule 6.600-6.621 cp Ur 14 x 51 fuse which has an $I^2t = 700$ at 660 VAC which is $I^2t = 336$ at 240 VAC

11. As most heating applications are resistive in nature and therefore not prone to "overload" conditions, as long as you satisfy any statutory electrical wiring installation requirements applicable, you do not need a circuit breaker as well as the selected fuse to protect the Solid State Relay.

12. You must however,   provide suitable isolation for each Solid State Relay circuit, so we recommend that you use a Modular Din Rail mount "clip open" Fuse Holder that provides isolation when you open the holder to inspect or change the fuse.

Heat Sink Calculations

When using our 40 amp SSR, as an example, the following may help in deciding on the maximum allowable load current relative to ambient temperature in the panel.

There are the following junctions in a heat sink application.

Symbol	Description	Unit	Value
Tj	Allowable triac junction temperature	℃	100
Rjc	Thermal resistance junction to SSR case	℃/watt	1.2
Tc	Case temperature	℃	100
Rcs	Thermal resistance case to sink	℃/watt	0.1

Ts	Heat sink temperature	°C	
Rsa	Thermal resistance heat sink to ambient	°C/watt	
Ta	Ambient air temp in panel	°C	

Each heat sink has a "Thermal resistance" rating that should be supplied by the manufacturer. You calculate an allowable thermal resistance for a suitable heat sink with two main given values:

Ta= Allowable max ambient air temp in the panel, which for this example we will assume is 50 °C

Tj= Maximum allowable triac junction temperature in the SSR, which in our case we have taken as 100 °C (allowing a small factor for safety).

Vdrop= On state forward volt drop across the SSR which in our case is 1.6 volts for the 40 amp SSR.

Rjc = Thermal resistance junction to case which in our case is 1.0 °C

Rcs = Thermal resistance case to heat sink which we are taking as 0.1 °C/w

So the formulae (cutting it short) is

Rsa = (Tj-Ta)/((Vdrop x max current) – (Rjc + Rcs))

Rsa = (100-50)/ ((1.6 x 40)-(1.2 + 0.1))

Rsa = 0.795 °C/watt

This means that our heat sink with an estimated thermal resistance of 1.6 °C/watt (estimated for calculation purposes only) is not suitable. You need one with a thermal resistance of 0.75 °C/watt or lower.

In this example we would have to drop the maximum current down to 20 amps to reach a thermal resistance of 1.6 °C/watt or increase the cooling factor by forced draft keeping the ambient below 50 °C.

As an example if we could restrict the ambient to 30 °C and a maximum load current of 28 amps the formulae would give us a Rsa = 1.6 °C/watt which is roughly suitable for our heat sink.

NOTE:
As you can see there are so many variables to consider (not forgetting the effect of duty cycle of the application or the number of SSR's to be mounted in one panel and ambient temperature in the panel etc) that the rule of thumb is to rate the SSR at about 75% of its maximum load capability when it is used in a panel mounted on our heat sinks but without forced draft cooling.

You can raise the design % load by installing forced draft cooling with an extraction cooling fan (or two) mounted at the top sides of the panel and cutting air vents in the bottom sides of the panel. When doing this you can raise the design load to about 85% ~ 87% of maximum rated load current of the SSR.

You can of course source a heat sink with a lower thermal resistance in the order of or below 1.0 °C/watt.

All these calculations are impacted on by the duty cycle of the control application. The lower the duty cycle the higher the allowable maximum current capacity will be. If you can estimate the duty cycle on and off time you can use the following formulae to estimate the RMS current loading and then use that in the above heat sink calculations.

$Irms = \sqrt{(((Ion)^2 \times T1)/(T1 + T2))}$

Irms   = Average current loading to be used in the heat sink calculations.

T1   = Time current is on

T2   = Time current is off

Ion   = RMS value of load current during the on period.

The above information is offered as a theoretical guide and is not necessarily to be taken as absolute in the design of your specific application.   QIS scope of supply is limited to the sale only of the SSR's and is not responsible for the design and application engineering   in which they are used.

Visit our web site at http://www.qis-uk.co.uk

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