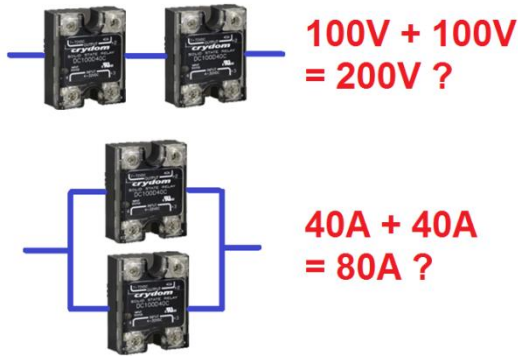


September 2012

## Using Solid State Relays in parallel and/or series



A question that not infrequently comes up in the technical help lines regarding solid state relays is the possibility of using the relays in a parallel or series configuration, usually to increase the maximum load current and/or operating voltage of a circuit . This newsletter will try to answer some of these questions. In all circuits it is advised to use similar relays, i.e. same part number, to ensure proper voltage and/or current sharing.

### When can I use AC SSRs in series or parallel?

AC SSRs can be used in series in order to increase the maximum line voltage. A relay with a snubber should be preferred to facilitate good voltage sharing. For example, two 230V D2425 relays could be placed in series to operate a 400V application.

This would not, however, increase the load capability; the maximum current of the circuit would still be the 25A of a single D2425.

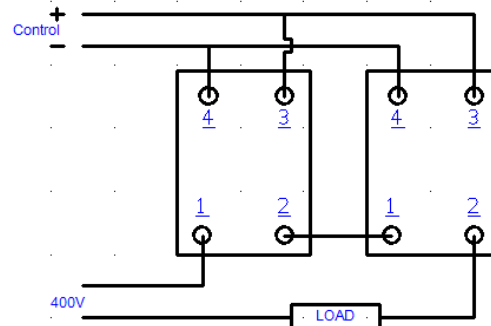


Diagram 1

Placing AC relays in parallel to increase the load current of a circuit is unfortunately not possible. The relays will not turn on simultaneously, and thus one relay would carry the entire current at turn-on. As the AC relays require a voltage across the output terminals to function correctly the second relay would then not switch on as the voltage is now dropped across the load, all it now “sees” is the on state voltage drop of the first relay. The first relay will carry on conducting the full load until it fails, at which point the second will turn on, also to then fail at some point due to overcurrent

Do not connect AC outputs in parallel

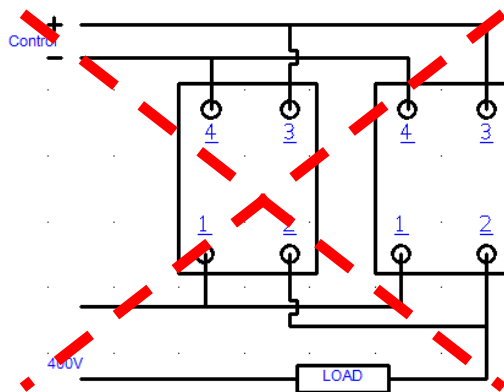


Diagram 2

**When can I use DC SSRs in series or parallel?**

DC relays using bipolar transistors, usually in the lower voltage and current range, should not be paralleled as they do not share current. If a higher voltage is required it is advisable to use the MOSFET based DC relays which have a wider voltage range. Crydom offers such a series with voltage ranges of up to 500VDC

The situation with DC relays that use MOSFET switching in the output is rather different, here both series and parallel connections are possible to achieve the following goals.

**AC load switching with two DC relays in series**

AC switching with DC relays is possible and though of course a far more costly method, may bring advantages with it that make this configuration feasible. These advantages include a lower EMI emission due to the lack of the repetitive turn-on spike when the SCRs switch in a conventional AC relay.

As the MOSFET is a bidirectional device one may wonder why two relays are required. This is due to the intrinsic "body diode" of the device. This diode would then conduct the corresponding half cycle of the sine wave (depending on polarity) and the second relay is required to then block this path in the off state.

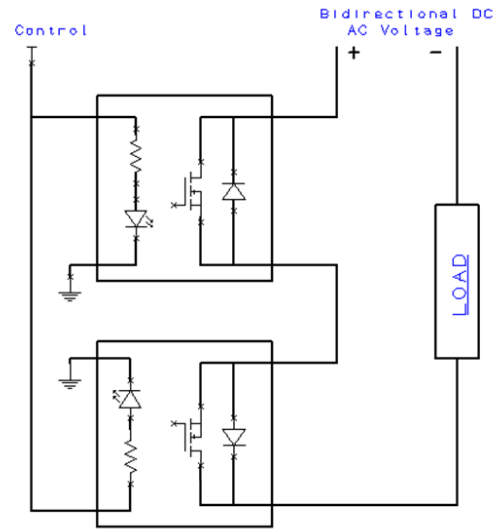


Diagram 3

Another possibility this configuration makes feasible is the complete phase control of a sine wave, being able to switch on and off at any point in the wave. With a standard SCR AC relay the relay can be turned on at any point in the sine wave but will always only turn off once the wave goes through zero. Due to the voltage and current waveforms not being in phase on inductive or capacitive circuits this form of control is only recommended for resistive loads.

### DC relays in series to enable bidirectional DC switching

In some applications a bidirectional DC circuit is required and here two relays in series would be required as, in the off state, one relay would always be needed to block the conduction of the others body diode.

This is similar to the AC switching and therefore the same wiring diagram (3) is used

Here it should be ensured that both relays are switched together to minimize the power dissipation.

If only one relay is switched (that corresponding to required current direction) the current would flow over the MOSFET of the switched relay and the body diode of the second relay. This in itself is not a problem as the body diode is rated to the same current capability of the relay itself, the voltage drop though would be higher, causing a higher power dissipation.

### DC relays in series to increase the maximum line voltage

The same configuration as in diagram 3 can be used with a DC load voltage to increase the maximum line voltage of the circuit. Of course here the correct polarity would have to be observed as an incorrect connection would lead to the body diode conducting in the off state.

Placing 2 relays in series would effectively double the maximum line voltage possible. There is of course the disadvantage that the heat dissipation is doubled as the current flowing through

each relay is the same, thereby requiring a much larger heat sink.

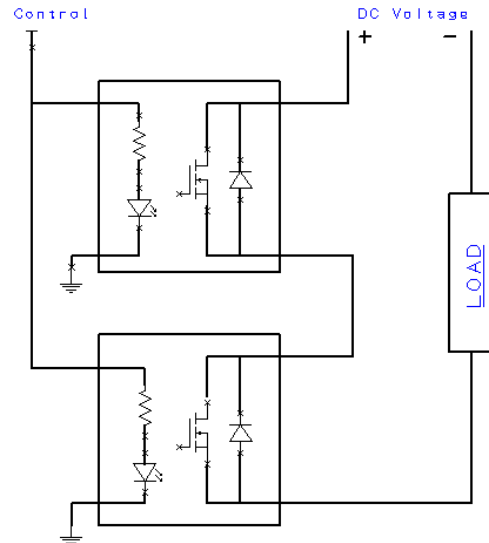


Diagram 4

### DC relays in parallel to increase the maximum current

Probably the most common use of multiple MOSFET relays in a single circuit is the parallel connection in order to increase the maximum current switching capacity.

In this configuration the maximum current of the circuit is twice the current of a single relay. There is though a limitation of the number of relays that can be used in parallel. The surge current of the circuit must not exceed the surge current rating of a single relay. This rating can be found on the data sheet.

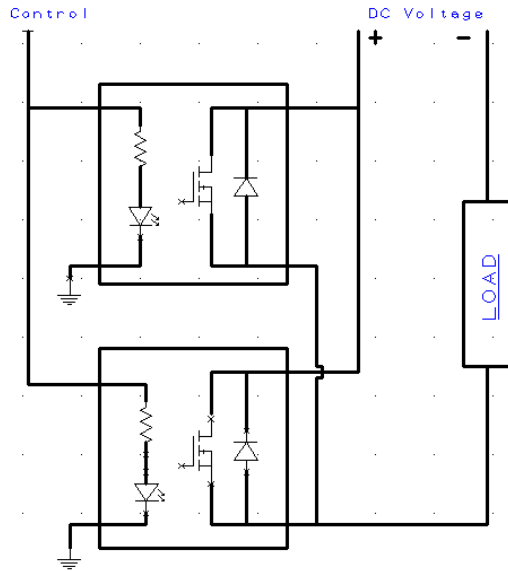


Diagram 5

In this circuit relays Q1 and Q4 would be energised to turn the motor in one direction and relays Q3 and Q2 for the other direction.

Here it has to be made absolutely certain that only Q1 & Q4 or Q3 and Q2 are turned on at any one time. If this is not ruled out by some form of interlock circuit a direct short would occur. This would lead to, at the very least, a blown fuse in the circuit and could very well lead to the destruction of the relays.

### DC relays as an H-Bridge

DC relays are also very often used in an H-bridge configuration to control the direction of a DC motor.

Here 4 DC relays are used, two in series and two in parallel, to change the direction of current through the motor.

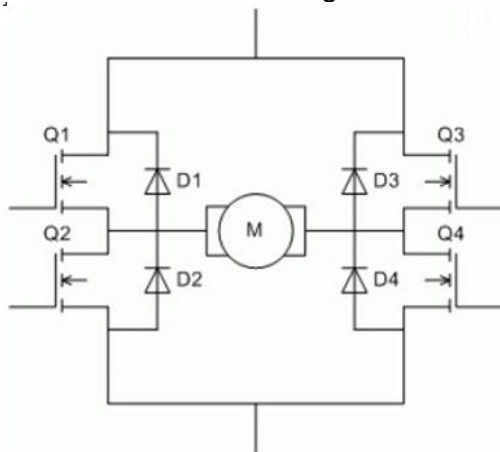


Diagram 6

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