Connection Methods for PhotoMOS Relays

In comparison to electromechanical relays, semiconductor relays - due to their design – offer optimal solutions for applications in telecommunication, measurement, security devices and industrial control. This application note describes the construction of a PhotoMOS relay and how to take advantage of its flexible connection methods.

The construction of the PhotoMOS relay can be described quite easily: The input pins are connected to a light emitting diode (LED), which is located on the upper part of the relay. A current flowing through it causes the LED to emit infrared light. This light leads to a voltage drop across an array of solar cells which are located at least 0.4 mm from the LED at the lower part of the relay. The voltage drop is used to control the gate of two DMOSFET transistors which are source coupled. The connection of the parts is illustrated by the schematic of the PhotoMOS relay (Figure 1). The LED is galvanically separated from the driving circuit with the solar cells which are controling the photo voltage and thus switching the output transistors.

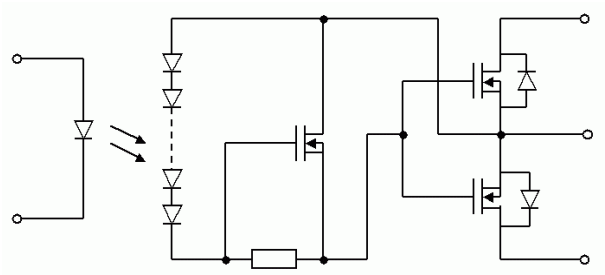

Figure 1: Schematic of a PhotoMOS relay

By integrating different output transistors in the PhotoMOS relay, a whole range of relays can be supplied. Therefore we have to take a closer look at the DMOSFET output transistor. It has a vertical channel structure; source and drain are placed opposite the wafer as shown in Figure 2. As a result, more space for the source and drain region is available, leading to an increased current rating.

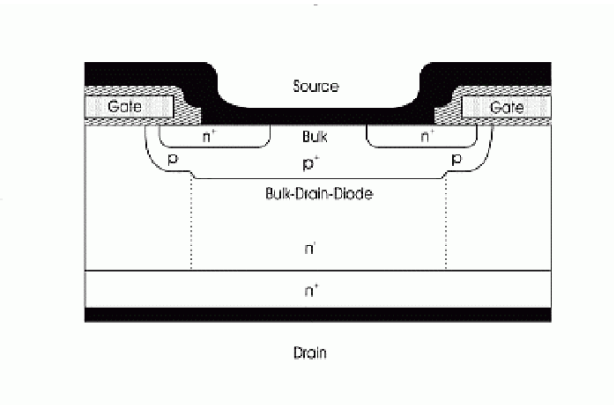

Figure 2: DMOSFET structure

An important factor for understanding the behaviour of the PhotoMOS relay is the DMOSFET's intrinsic bulk-drain-diode in connection to drain and source. For this reason, a single transistor is only capable of switching a DC voltage since the diode will become forward biased if the polarity is reversed. Thus it is mandatory to use two source coupled DMOSFETs in the output stage of the PhotoMOS relay to enable switching of AC voltages. If in addition, the source coupled node of the PhotoMOS relay (see Figure 1) is connected to an external pin, there are various possibilities to connect the load to the relay. These connections are denoted as A, B and C herein and in the datasheet.

The A connection is used for switching AC and DC loads. Since the polarity changes for an AC voltage, the two DMOSFETs need to be source coupled to enable the switching operation. Consequently, the connection method must resemble that illustrated in Figure 3.

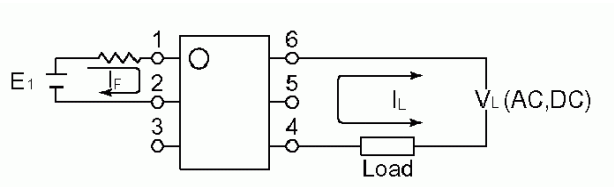

Figure 3: A connection

B connection

The B connection uses only one of the two output transistors. Thus it is only possible to switch DC voltages. Since the case has to dissipate the heat caused by the load current to the ambient, the B connection produces less heat than the A connection because only one DMOSFET's on resistance is responsible for the switches' total on resistance.

The B connection is shown in Figure 4.

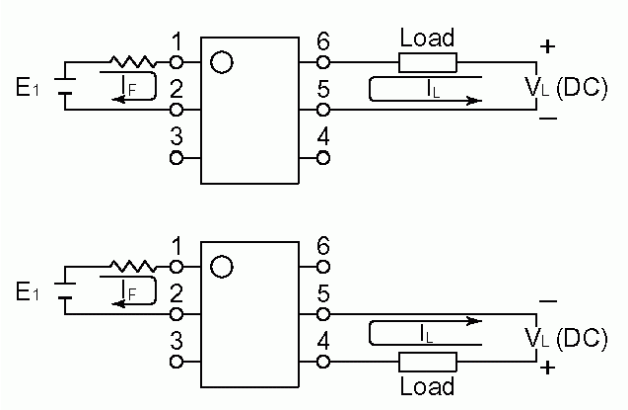

Figure 4: B connection

C connection

The C connection uses both output transistors in a parallel connection (see Figure 5). Consequently, only DC voltages can be switched (compare also to B connection). The total on resistance of the relay is now halved because of the DMOSFET's parallel connection when compared to the B connection. Considering power dissipation again, the current rating can be further increased because of the reduced on resistance of the relay.

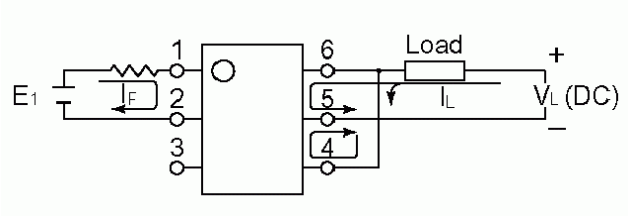

Figure 5: C connection

The afore mentioned relationships can be understood quite easily, when one keeps in mind that maximum power dissipation of the PhotoMOS relay, caused by on resistance of the output transistors and the load current, is limited by the relay's case.

The following table for a AQV252G, which is capable of switching voltages of up to 60 V, provides a typical overview for these kinds of connections in relationship to on resistance and load current.

AQV252G	Typical On resistance	Maximum Load current
A connection	80 mΩ	2.5 A
B connection	40 mΩ	3 A
C connection	20 mΩ	5 A

The above connection methods demonstrate that PhotoMOS relays can be connected to the load in various ways, offering flexible solutions in regard to the circuit's load, the total resistance in the circuit and the load current. Besides these flexible connection methods, PhotoMOS relays are the optimal choice when an application requires:

- Low control current
- High switching frequency
- Extremely long lifetime
- Stable on-resistance over lifetime
- High reliability
- Small relay size
- No preferred mounting position
- High vibration and shock resistance
- No switching noise