

PhotoMOS for measurement applications

Panasonic Electric Works offers a wide range of PhotoMOS relays including General Usage types (GU, GE), High Function Types (HF, HE), Highly Sensitive Devices (HS), Radio Frequency (RF) and Power Types (PD). Figure 1 provides an overview of load current and load voltage and the availability of the above mentioned PhotoMOS types. The input side of a PhotoMOS relay consists of an LED which emits light if current flows through it. After passing through a silicon resin, this light is detected by an array of solar cells leading to a voltage drop across the array. The voltage drop is used to control two source-coupled MOSFETs, thereby switching the output from the on- to off-state and vice versa.

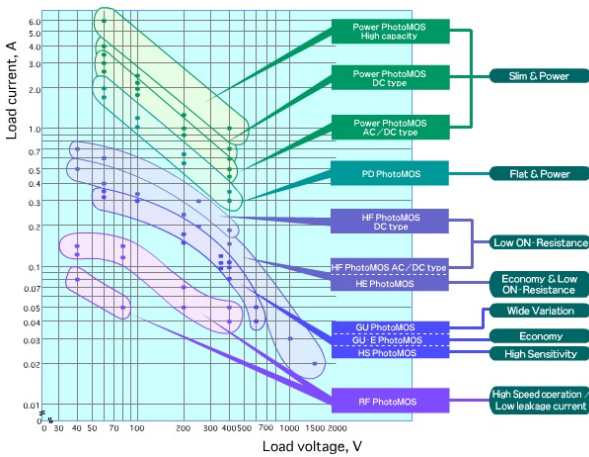


Figure 1: PhotoMOS type relays

Since a MOSFET is used to switch the output side, it is apparent, that the MOSFET's characteristics influence the behaviour of the PhotoMOS relay. For measurement applications, relays with low on resistance, low capacitance and high linearity are required. This application note provides some remarkable facts about such relays and their package forms.

The structural design of a MOSFET, or more precisely a DMOSFET, reveals that the values of breakdown voltage, on resistance and output capacity correlate with each other. These characteristic values can also be seen in Figure 2, Cross section of a DMOSFET. The breakdown voltage is determined by the layout of the Drain-Body Diode leading to a certain n⁻ drift area, which is mainly responsible for the on-resistance of the transistor. The length of the cross sections and chip surface form a capacitor that leads to the marked parasitic capacities, influencing the relay's switching times and isolation characteristics for high frequency signals.

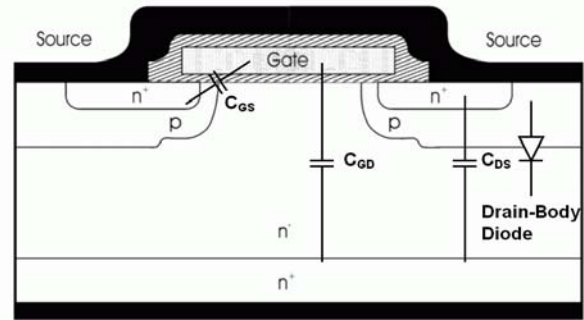


Figure 2: Cross section of a DMOSFET

Due to the aforementioned correlation of load voltage, on-resistance and capacity, PhotoMOS relays with low load voltages have a low on-resistance. If the application requires a low on-resistance in order to reduce power dissipation when switching high currents or to increase the precision of measurements, the designer must also pay attention to the temperature range. Since mobility of electrons decreases with rising temperature, the on-resistance of the MOSFET rises. This can be seen in Figure 3 which is valid for GE type PhotoMOS relays with a load voltage of 30 V (AQY211EH) and 60 V (AQY212EH).

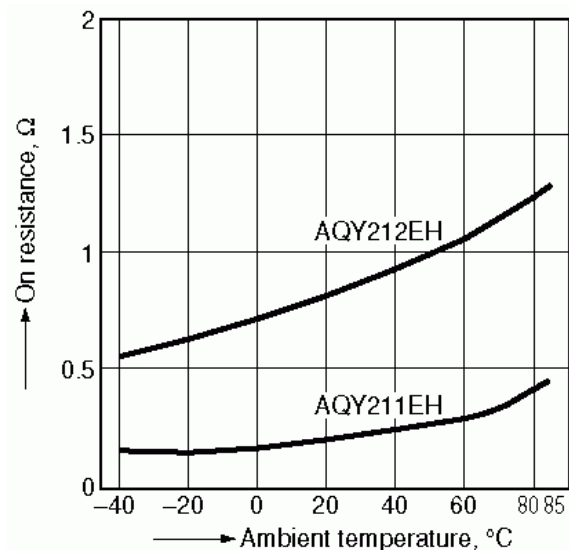


Figure 3: On resistance versus ambient temperature

For a typical temperature range from 40°C to 60°C, the on-resistance will rise by approx. 30%. MOSFETs with higher load voltages have higher values for the on-resistance, which leads to more drastic changes in the absolute value of the on-resistance. On the other hand, PhotoMOS relays with higher load voltage MOSFETs have faster switching times because of lower capacitance

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values, as the formula for a capacitor illustrates:

$$C = \epsilon \cdot \frac{A}{d}$$

diode causes the distance d to increase which leads to lower capacitance values, as described.

For high precision applications like measurement or data acquisition devices, switches with low on-resistance and low capacitance are needed, whereby the last requirement influences switching times and isolation characteristics for high frequency load signals. Therefore Panasonic Electric Works has developed special MOSFETs with low on-resistance and low capacitance. Since both values are reduced, these relays are called "low CxR" PhotoMOS. The improved characteristics are realized by an optimised layout of the MOSFET, combined with an improved internal structure including the layout of the bonding pads, manner of wire bonding and new terminal leads.

Because of their low on-resistance and concurrent capacities, low CxR PhotoMOS relays are especially well suited for measurement and data acquisition applications. For example, AQY221N2V offers a typical on-resistance of 9.5Ω and a low output capacitance value of 1.0 pF , leading to switching times of $20 \mu\text{s}$ and providing good isolation characteristics for high frequency load signals. In addition, measurement applications benefit from the reduced length of internal bonding wires and the flat lead terminals, which results in reduced signal propagation delay. Consequently the new design has been implemented in a reshaped package. The new SSOP's (Shrink small outline package) area is only 60% compared to the conventional SOP (Small outline package) and its volume has been reduced by 40%.

If several switches are used in a system, the SSOP saves significant mounting space and volume. In addition to this space savings, Panasonic Electric Works offers a second package form, incorporating four Form A switches in one single SOP package. Figure 4 shows an example when using four switches with a layout grid of 1.27 mm .

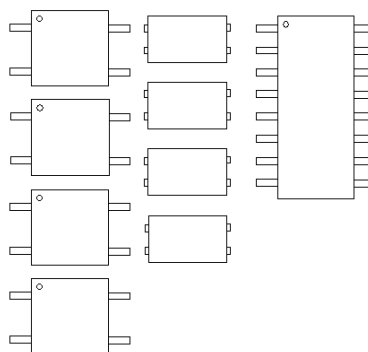


Figure 4: Layout example with various packages

The area of four SSOP packages (centered) is the same as for three SOP packages (left side). A single SOP16 package (right side) incorporates 4 PhotoMOS relays but has the same mounting area as three SSOP packages. The electrical characteristics of the SOP16 type AQS221N2S are comparable to AQY221N2V.

With various package forms and a variety of PhotoMOS relays from General Usage types (GU types) to Radio Frequency types (RF types) with reduced on-resistance or low CxR values, relays for numerous applications can be supplied. If you need help incorporating the right package, choosing a PhotoMOS or using our low CxR (R type or C type) PhotoMOS, please feel free to contact us: info-eu@eu.pewg.panasonic.com