

Low CxR PhotoMOS Relays

Immense advancements in the semiconductor market have had numerous effects on modern electronics: rising clock rates, extended functionality of devices and decreasing size of electronic products. Besides including these features, many applications require switches offering galvanic separation of input and output.

The suppliers of switches and relays are faced by these challenging demands of the market. In most applications which employ semiconductors for their extremely high number of switching operations, optocouplers in combination with MOSFETs or analog CMOS switches are used. Switching solutions like these require an increased number of parts and space on the PCB board because of the components and a necessary power supply. Panasonic Electric Works tackled this problem and extended its product range by refining RF (Radio Frequency) PhotoMOS.

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. It is apparent that the electrical characteristics of the output MOSFET influence the characteristics of the PhotoMOS relay.

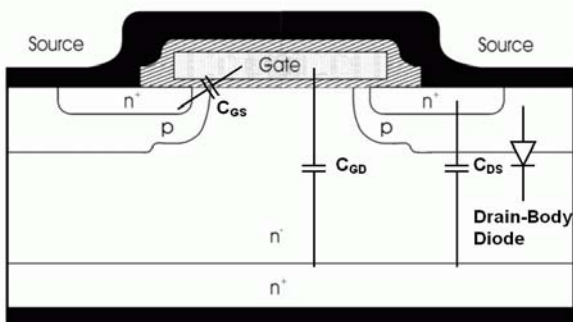


Figure 1: Cell structure of DMOSFET

The breakdown voltage of the output MOSFET is determined by the layout of the Drain-Source area, leading to a certain n- drift area, which is mainly responsible for the transistor's on-resistance.

The length of the cross sections and chip surface form parasitic capacitors which influence the relay's switching times and isolation characteristics for higher frequent load signals. The parasitic components of the output transistor are illustrated in Figure 1, showing a single transistor's cell.

For high precision applications like measurement or data acquisition devices, switches with low on-resistance and low capacitance are needed, whereby the former requirement causes a low signal loss and the latter requirement influences switching times and isolation characteristics for higher frequent load signals. Therefore a new relay's output MOSFET with low on-resistance and low capacitance needed to be developed. Since both values are reduced, these relays are called low CxR PhotoMOS. The improved characteristics are realized by an optimised layout of the MOSFET and its guard ring region, combined with an improved internal structure including the layout of the bonding pads, manner of wire bonding and new terminal leads.

Even though it has been possible to reduce the output MOSFETs' on-resistance and capacitances, there is a trade-off relation between load voltage, resistance and capacitance. For this reason, Panasonic Electric Works offers several PhotoMOS relays with reduced capacitance (C) and on-resistance (R) – low CxR PhotoMOS relays:

Type	Load Voltage (V)	Load Current (A)	OH Resistance (Ohm) typ./max.	Output Capacitance (pF)	Standard Package
AQY221N1S	40V	0.12A	9.80hm typ. 12.50hm max.	2.0pF	4 Pin SOP
AQY221N2S	40V	0.12A	9.50hm typ. 12.50hm max.	1.0pF	4 Pin SOP
AQY221R2S	40V	0.25A	0.80hm typ. 1.250hm max.	13pF	4 Pin SOP
AQY221N2V	40V	0.12A	9.50hm typ. 12.50hm max.	1.0pF	4 Pin SSOP
AQY221R2V	40V	0.25A	0.750hm typ. 1.250hm max.	12.5pF	4 Pin SSOP
AQY221N3V	25V	0.15A	5.50hm typ. 7.50hm max.	1.0pF	4 Pin SSOP
AQY221N2S	40V	0.06A	9.50hm typ. 12.50hm max.	1.0pF	16 Pin SOP

Figure 2: Low CxR PhotoMOS relays

The variety of the electrical characteristics is supplemented by different packages. The low CxR PhotoMOS relays are available in 4-pin SSOP, 4-pin SOP or a 16-pin SOP package. This allows you to find the appropriate PhotoMOS relay for nearly every application.

Low CxR PhotoMOS Relays

An example of a typical application for automatic test equipment (ATE) is given in Figure 3. Usually computer-driven (CPU), these systems are used for testing semiconductors, electronic circuits and printed circuit board assemblies. Various AC and DC signals (Waveform Rectifier and DC Test Unit) are applied to the device under test (DUT), whereby timing may play a major role. With regard to timing (Timing Generator), the input and output signals are monitored (Logic Comparison Unit) and the measurement is taken.

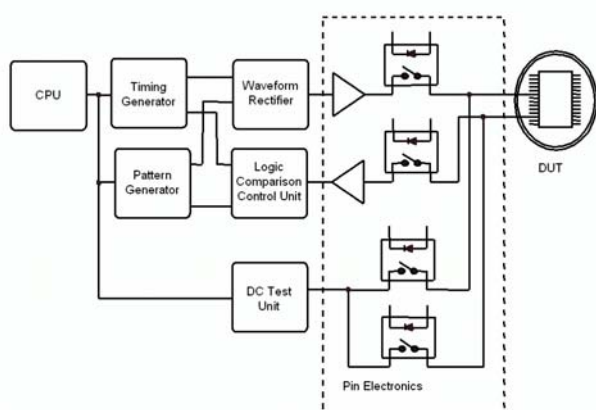


Figure 3: Automatic Test Equipment

Because of the variety of signals in the test system, relays with different characteristics are required. Low CxR relays with reduced on-resistance (R type) are employed to switch DC signals causing a low signal loss in the switch. Conversely, relays with a reduced capacitance are employed to switch AC signals providing optimised isolation.

Besides using low CxR PhotoMOS relays for switching signals and I/O lines to devices being tested, these relays may also be employed in data acquisition circuits, e.g. for selecting the gain of operational amplifiers. With the help of the relay, the device's digital control unit and the analog signal system are galvanically separated, thus enhancing the precision of the device by minimizing noise.

In order to minimize the effects of the relay's on-resistance and its temperature drift, please take care to minimize the current through the relay when designing such applications as illustrated in Figure 4.

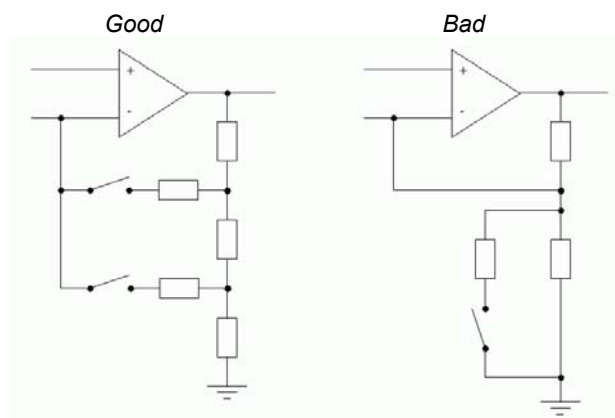


Figure 4: Operational amplifier circuit: good example on the left - bad example on the right

By improving the electrical design in such a fashion, the user is able to profit from the other advantages PhotoMOS relays offer:

- Low control current
- Fast switching times
- Small analog signal control
- Low leakage current
- Stable on-resistance over lifetime
- Extremely long lifetime
- Small size
- No preferred mounting position
- High vibration and shock resistance
- No bouncing and no switching noise

Especially measurement application such as data acquisition devices or automated test systems will profit from these features of semiconductor technology which PhotoMOS relays offer. Other applications like telecommunication, security devices, sensor technologies or industrial applications can utilize the advantages of PhotoMOS relays just as well.