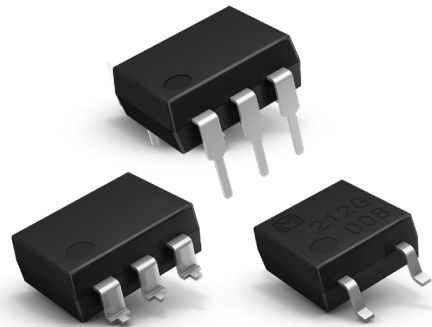


PhotoMOS® with Protection Circuits

PhotoMOS® relays are an ideal switching solution for all kind of electronic applications. Short circuit protection and current limit types are protected against overcurrent and any resulting damage.

Application Note



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A large graphic on the right side of the page features a blue background. Two electrical wires are shown: one is a standard copper wire with a blue plastic jacket, and the other is a bare copper wire. They are positioned as if they are about to strike each other, with a bright, multi-colored lightning bolt striking the point where they meet. The lightning bolt is composed of many thin, branching lines in shades of blue, white, and yellow, radiating outwards from the point of contact.

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Short Circuit Protection

Product

Types with short circuit protection [AQY210KS](#), [AQV112KL\(A\)](#)

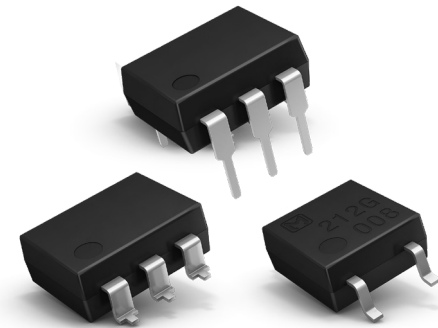
Types with current limiting [AQY210LS](#), [AQY210HL\(A\)](#), [AQW210HL\(A\)](#)

Purpose

PhotoMOS[®] relays switch signal outputs in sensors, control units or on measurement cards. With a short circuit protection, the relay is 100 percent safe against damage from overcurrent by turning off the output. The current limiting types keep an output current at a constant value when the current reaches a specified current limit value.

Features

- Short circuit protection or current limiting
- Galvanic I/O isolation of sensitive electronics
- High switching speed and low control current
- Safety standards UL
- Stable on-resistance over lifetime
- High vibration and shock resistance



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Facts & Figures

Safe load switching

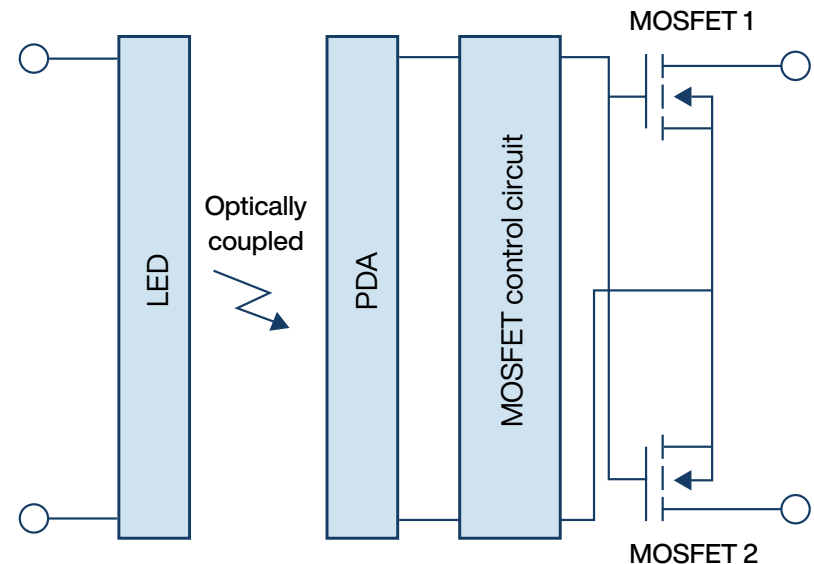
Growing applications like E-mobility, automated machines, or energy management are placing ever higher demands on switching devices. Often, higher loads need to be switched in small and sensitive environments.

For these types of applications, PhotoMOS® relays have emerged as the technology of choice. This type of MOSFET relay typically consists of several elements: An LED diode on the input side emits light to a photodiode array (PDA), which converts the incoming light into electrical current and voltage.

These in turn drive two power MOSFETs on the output side. An intermediate control circuit is responsible for the safe and reliable turn-on and turn-off of the output MOSFETs once a certain trigger current is reached. This setup gives PhotoMOS® relays several characteristics which make them the ideal choice for applications concerned about package size, power consumption, operating speed – or all the above.

Because they don't include any mechanical elements, PhotoMOS® relays guarantee bounce-free operation and switching speeds below 1ms. No moving parts inside a PhotoMOS® relay also results in much better shock and vibration resistance and a

long, reliable switching life. Furthermore, this type of semiconductor relay allows for unusually high I/O isolation voltage, maximum switching voltage and low energy consumption.



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Facts & Figures

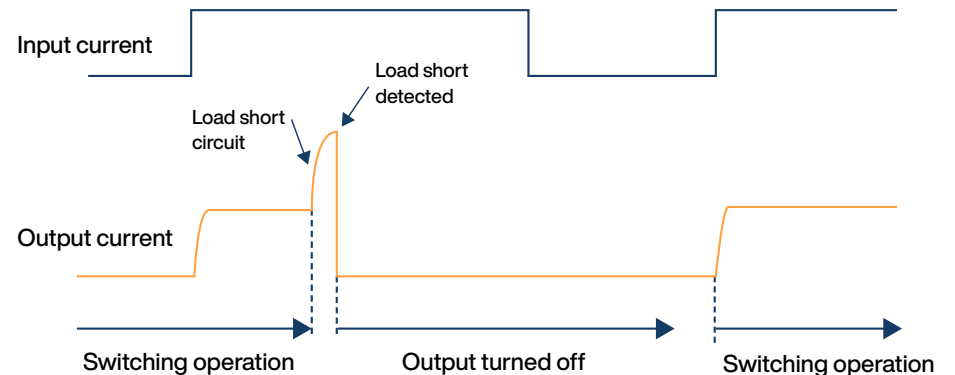
Better safe - with short circuit protection

To make PhotoMOS® relays even more versatile and safe, Panasonic has equipped some families with an additional element protecting both the output MOSFETs and the load circuit against overcurrent. In such short circuit protected PhotoMOS® relays, a protective circuit detects if the load current increases above a certain limiting value, threatening a short-circuit. To this effect, shunts are located at the output side of the PhotoMOS® relay. Excessive current in the event of an error leads to a voltage drop across the shunt, triggering the MOSFET control circuit.

With the **latch type** short circuit protected PhotoMOS® (AQY210KS), the load circuit is completely switched off in the event of an overcurrent. If an input current of 3mA or more flows through the LED, the output of the semiconductor relay has a low impedance of 35Ω and a load current begins to flow. If the load current increases above the limiting value of 200mA (load short circuit), this is detected by the protective circuit. The voltage drop at the shunts then activates an asymmetrical flip-flop gate, which switches off the output. The load current remains interrupted even if continuous input is supplied. Normal switching operations can only resume after the LED input current has been reset.

The integrated protective circuit also improves temperature behavior. As an increase in temperature also raises electrical resistance, a load current produces a higher power dissipation and may lead to malfunction. But because of increased resistor values at higher temperatures, the voltage drop across the shunt in the relay rises.

The protective circuit responds to lower currents and thus has a negative temperature coefficient making it better able to protect the load circuit against destruction.



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Facts & Figures

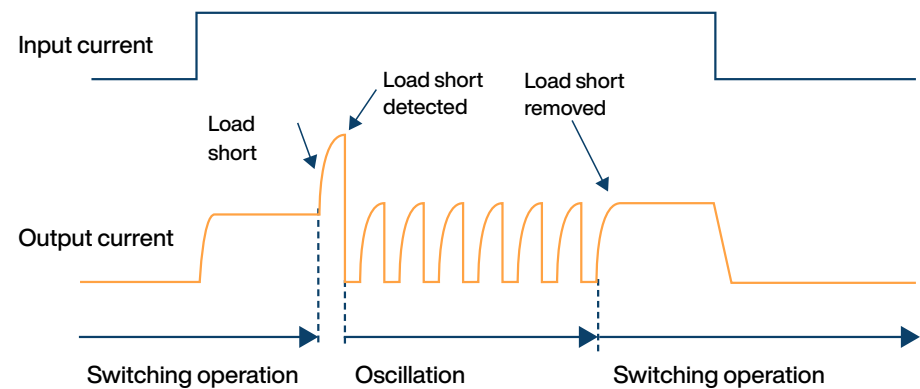
Overcoming overcurrent damages

The **non-latch current-limited type** (AQV112KL(A)) control circuit recognizes a transient overcurrent and limits it to a less critical value. After applying an input current, the load circuit is conductive (typical 0.55Ω) and a current flows through the load.

In case of an error, the protective circuit detects the increase in current, leading the relay output to close and open the load circuit alternately. The voltage peak value at the output resistance drops to a maximum of 7V and the alternating change of output resistance leads to an oscillating load current. This decreases the load current's root mean square (RMS) value in such a way that the resulting power dissipation does not exceed the component's maximum permissible energy dissipation.

After the output disturbance has disappeared, the relay behaves like a conventional semiconductor switch. Thus, the relay prevents an excessive increase in energy dissipation and rise in temperature in the component. This differs from conventional cur-

rent-limited devices that increase their on-resistance, whereby power dissipation rises to a self-destructive level. This non-latch type, by contrast, can handle an increased load current for a longer period without suffering damage.



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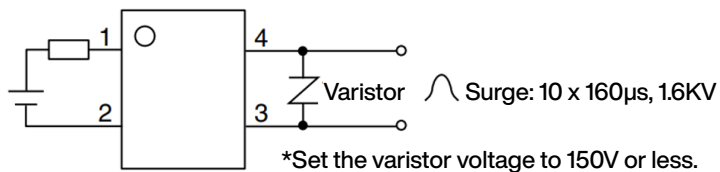


Facts & Figures

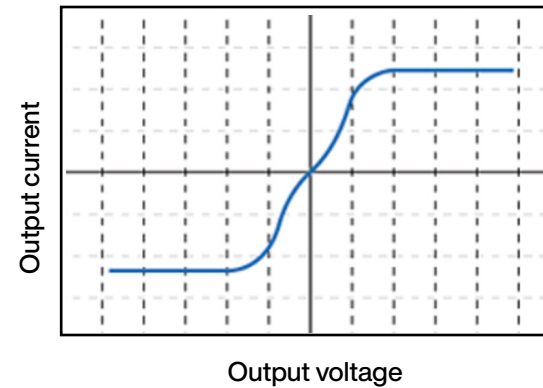
Built-in control for circuit protection

The limit function of our **current-limited type** controls the instantaneous load current to effectively ensure circuit safety. Thanks to its built-in control circuit it recognizes a transient overcurrent and limits it to a less critical value. If an unrestricted current flows between the output pins the trigger circuit lowers the gate voltage of the two MOSFETs which leads to an increased $R_{DS(on)}$. As soon as a value of typ. 180mA is reached, this limit function keeps the load current constant at this value. Thus, overcurrent can be blocked and the PhotoMOS® and subsequent circuits can be protected.

If you expect some voltage surges in your application, please connect a Varistor to the output as shown in the figure below.



However, if the current limit function continues for a long period of time, PhotoMOS® may malfunction due to heat generation. Therefore, set the output loss to the max. rate or less.

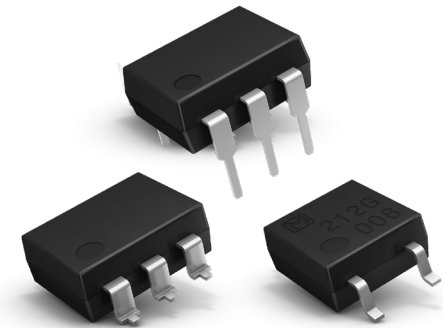


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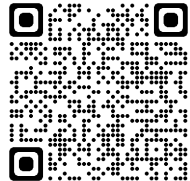


„Miniaturized, powerful, long-lasting, eco-friendly and reliably immune against overcurrent damages: Short circuit protection and current limit PhotoMOS® relays are in many regards prototypical of switching quality in the post-electromechanical age.“

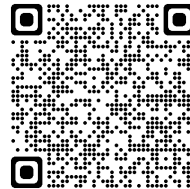
Michael Renner, Senior Product Manager PhotoMOS® Relays



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Application Note - How to solve various tasks with PhotoMOS® Protection Circuits

Date: April 2024

Contact: Panasonic Industry Europe GmbH, photomos@eu.panasonic.com

Notes: Data and descriptions in this document are subject to change without notice.

Product renderings are for illustration purposes only and may differ from the real product appearance.

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