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PhotoMOS®
Output Characteristics

A power MOSFET is an ideal semiconductor for many switching applications, as it acts like a pure ohmic resistor without any offset or saturation voltage. Nevertheless, the load signal may be distorted by a number of side effects.

Application Note

Your Committed Enabler

Bidirectional switching

Product

PhotoMOS® relays

Purpose

Two power MOSFETs positioned on the output side influence the output characteristics of PhotoMOS® relays.

Features

Low control current and leakage current

Controls wide range of analog signals

Stable on-resistance over lifetime

Extremely long lifetime

Small size

No preferred mounting position

High vibration and shock resistance

No bouncing

No switching noise

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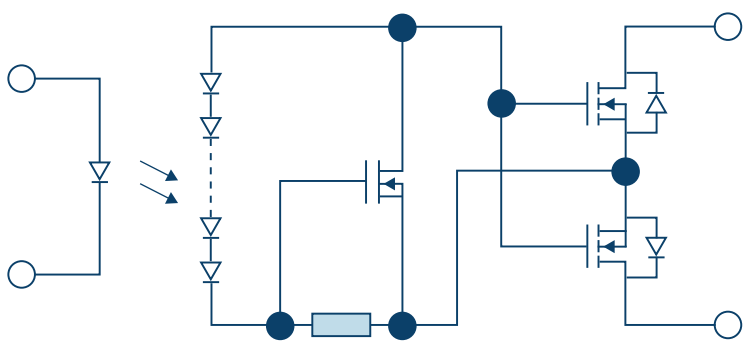
Bidirectional switching

Facts & Figures

Whether in cars, buildings, or automated machines, switching devices have become indispensable for industries and in everyday life. While electromechanical relays (EMRs) are still a popular choice for many applications, semiconductor relays like triac-based SSRs or MOSFET-based PhotoMOS® relays are establishing themselves as an attractive alternative for industries that are concerned about package size, high operating speed, or high power consumption.

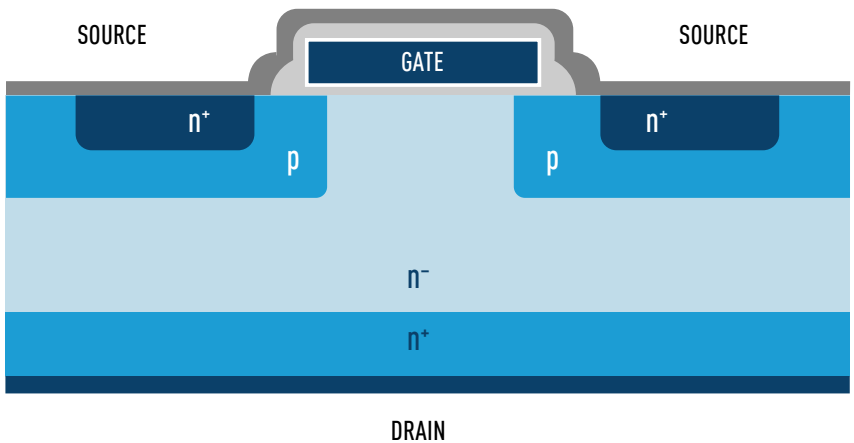
PhotoMOS® relays typically consist of several elements. If a current of about 3 mA is applied to the input pins of the relay, a LED diode on the input side emits light to a photodiode array (PDA) located at least 0.4 mm from the LED. This array of solar cells converts the incoming light into electrical current and voltage, which in turn drive two power MOSFETs on the output side. A resistor and a MOSFET integrated into the PDA serve as a control circuit for switching the power MOSFETs and therefore the load circuit. These DMOS transistors are source-coupled, thus providing bidirectional switching capabilities.
The vertical structure of power MOSFETs and their intrinsic elements influence the electrical characteristics of the PhotoMOS®. In addition to the ohmic resistance of the region between drain and source, the structure of the MOSFET causes a reverse biased drain-source diode and capacitances that are responsible for the output behavior.



The MOSFET's capacitances and their time constants influence not only switching times, but also the output's isolation characteristics for higher frequency load signals. Essentially, they act as a reactance with a frequency-dependent value: The reactance is high for lower frequencies and decreases with rising frequencies. This can cause higher-frequency load signals to leak through the off-state output.

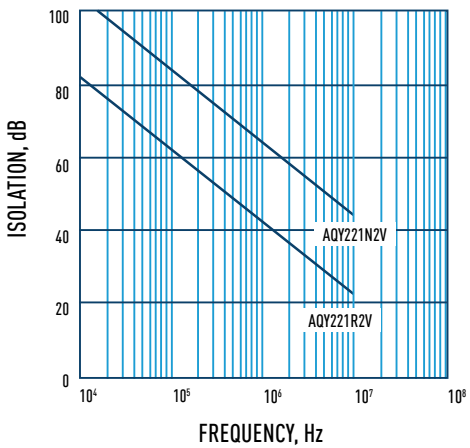
Bidirectional switching

Facts & Figures



This can be calculated by assuming a high-pass filter with the components off-resistance, internal resistance of the signal source, and the output's capacitance value. As for any other high pass filter of first order, the reduction of isolation is typically 20 dB per decade. As there is a relationship between capacitance and on-resistance of a MOSFET, a higher capacitance will result in a lower on-resistance.

Another very important output characteristic of a PhotoMOS® relay in the off-state is the leakage current, the reverse current through the drain-source diode of the blocking MOSFET.
This current depends on both the applied load voltage in the off-state and the mobility of the electrons. As this decreases with rising temperature, the MOSFET's on-resistance is indirectly influenced by temperature effects.



The drain-source diodes of the two power MOSFETs are also responsible for another output behavior in the on-state: During AC operation, one diode is reverse biased while the other is forward biased. The latter is connected in parallel with the ohmic on-resistance of the MOSFET. This causes a non-linear behavior between load current and load voltage for certain types of power MOSFETs with higher on-resistance.

IN Your Future

Learn
more about
PhotoMOS®
technology

Get
here the
PhotoMOS®
relay App!

Application Note - How to solve various tasks with output characteristics of PhotoMOS® relays
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.
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