FET High-Side Switch

By:Kross Moore

What is High-Side Switch?

A high-side switch is a type switching where you are taking an initially low logic voltage and switching to a higher voltage to allow the circuit to operate and conduct a current throughout. It cannot work with a P-channel though as that limits the amount of logic voltage and thus does not produce enough power to turn on the PFET off which prevents current from being conducted since it is not allowed to connect to ground. This is where a different channel, usually an N-channel is used to solve this issue. An N-channel FET is comprised mostly of electrons that carry the current making it more efficient and powerful. A P channel is comprised of holes that carry the current making it weaker when it comes to switching, hence why we need a N-channel FET. N-channels will carry the power we need for the current with the most accuracy allowing for the gate to be switched on which connects the circuit to ground.

Where Would We Use A High-Side Switch?

We would use a high-side switch any point where we switch from a low logic voltage to a higher voltage, such as 5V to a higher voltage. However there are instances where we can use a P-channel MOSFET switch over a N-channel. This is because when we use a MOSFET we have some control on whether it turns on faster or slower. It is still harder to do with a P-channel than with an N however N-channels are a lot easier to use and still more efficient. Making it a case of which would you rather use and do you want or need the enhancement that a P-channel would offer. The reason this is harder is due to the fact it is much easier to use a low-side switch with a P-channel because P-channels are used with lower voltages and don’t carry enough power to support the load that a high-side switch is trying to use.

What Are The Advantages Of A High-Side Circuit?

“High-side switches are used to turn electrical loads ON and OFF by switching the positive (high-) side of the load supply. Additionally, smart high-side switches are designed with the ability to protect themselves and diagnose possible unintended system behavior.” (AG,2023). This is one of the biggest advantages of a high-side switch, their ability to protect themselves and diagnose unintended behaviour. Because it is a hide-side switch involved in the circuit it is made for higher currents and higher impact currents meaning it has more protection against short circuits and high loads. It also has the ability to reduce strain on the circuit with adjustable current limits which can also impact the cost of implementing these circuits into different projects. While high-side switches have a few more advantages these are the ones they are known for because they are the main difference between low-side switches.

What Are The Disadvantages Of A High-Side Circuit?

High-side switches are harder to use with lower voltages if they can be used at all due to the slower movement of current throughout the circuit, this also means that you have to put in more thought to which channel needs to be used even in comparison to costs as well. Low-side switching is often easier to connect to ground because it does not require a high voltage current, whereas a high-side switch starts out with a lower logic voltage and then switches to a higher one. This makes it harder to connect to ground because if the current does not connect to ground then the circuit will not activate and the gate will not turn on which allows the current to circulate. This also changes slightly based on the channel used as P-channels have more resistance than N-channels and P-channels also have a lower maximum current limit which makes them very similar to low-side switches.

What Are Some Variations Of The Circuit?

High-side switches are extremely versatile as long as the voltage allows the gate to be triggered on, the circuit will run. The first variation uses a P-channel which means that the circuit will have higher resistance with lower voltages. The use of an N-channel often means that there are no external drivers or power supplies as the N-channel can provide that and also provides over-temperature protection and current-limiter protection which allows the circuit to handle more with little extras attached. An N-channel can also use the resistors in the circuit to program the current-limiter so that the circuit runs most efficiently. Another variation can be used with a P-channel if the DC input is high enough or if the voltage is high enough but regardless will have to have a negative charge between the input source and the gate itself. There is also a way to use both a P-channel and N-channel by using a dual supply with a motor connected to the common drain between both channels and ground.

Reference Sites

Prater, M. (2023). *Fet high-side switch*. Prof. Prater's Page. https://praterma2.github.io/cards/src/fet_high_side_switch.html

Learning About Electronics. (2023). *Channel MOSFET BASICS*. N. https://www.learningaboutelectronics.com/Articles/N-Channel-MOSFETs#:~:text=A%20N-Channel%20MOSFET%20is%20a%20type%20of%20MOSFET, current%20flowing%20are%20electrons%20moving%20through%20the%20channel.

Storr, W. (2022, August 3). *MOSFET as a switch - using power MOSFET switching*. Basic Electronics Tutorials. https://www.electronics-tutorials.ws/transistor/tran_7.html

AG, I. T. (2023). *High-side switches: PROFETTM product families contain a wide range of high-side power switches designed for 12, 24 and 48 V automotive and industrial applications - infineon technologies*. High-Side Switches | PROFETTM product families contain a wide range of high-side power switches designed for 12, 24 and 48 V automotive and industrial applications - Infineon Technologies. https://www.infineon.com/cms/en/product/power/smart-power-switches/high-side-switches/

M, A. (1961, October 1). *Difference between high- and low- side switching of power?*. Electrical Engineering Stack Exchange. https://electronics.stackexchange.com/questions/188072/difference-between-high-and-low-side-switching-of-power

Baldengineer. (2023, February 23). *Low side vs. high side transistor switch*. Bald Engineer. https://www.baldengineer.com/low-side-vs-high-side-transistor-switch.html

Knight, D. (2016). *Introduction to high-side load switches - digi-key electronics*. Introduction to High-Side Load Switches. https://www.digikey.com/en/maker/tutorials/2016/introduction-to-high-side-load-switches