Electronic Design

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How to Successfully Connect and Disconnect a Supply Voltage Line

This article discusses the options a circuit designer has available to turn supply lines on and off in electronic systems. While the task sounds trivial, there are many things to consider for a proper implementation.

In some electrical systems, disconnecting a supply line is necessary. This may be in the form of cutting off a battery voltage to retain the battery charge, for example, or separating a load from a live line. Ideally, this involves a mechanical switch.

However, if switching should occur via an electrical signal, an electronic switch is usually more suitable. Such an electronic switch can be built with a MOSFET as a switching element. In addition to a purely discrete solution with a MOSFET, numerous semiconductor ICs are available for easy implementation of an electronic switch.

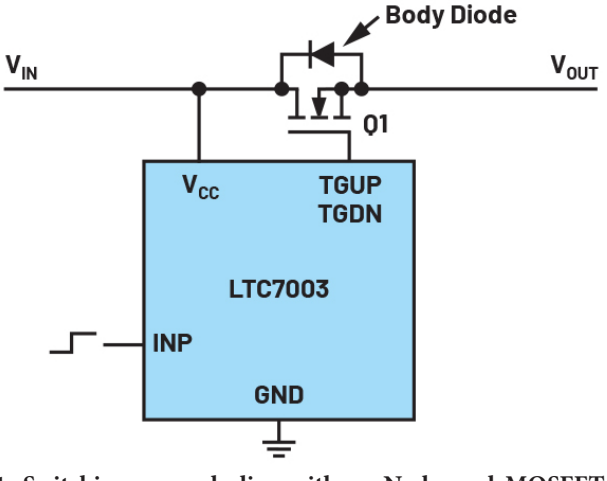
Step-By-Step Method

First, a decision must be made regarding whether the switching element should be an N-channel or a P-channel MOSFET. Both may be suitable. Compared with a P-channel MOSFET, an N-channel MOSFET has a lower resistance and thus lower losses in the on state.

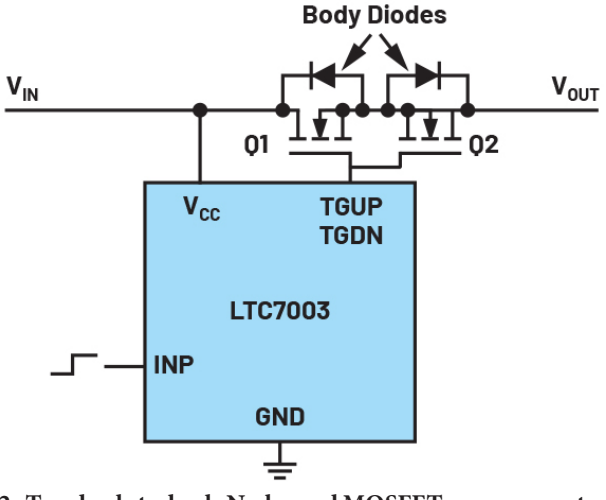
The disadvantage lies in the driving of the N-channel MOSFET. Here, a higher voltage than the available supply-line voltage is required for the gate *(Fig. 1)*. Hence, the driving IC must contain a charge pump of some sort. A P-channel MOSFET doesn't require this type of voltage increase. Nonetheless, there's a large selection of N-channel MOSFETs.

The next step is to select between having the power switch and the driver in a single housing, or using a two-chip solution with the driver circuit in a separate IC and the corresponding MOSFET in a second housing.

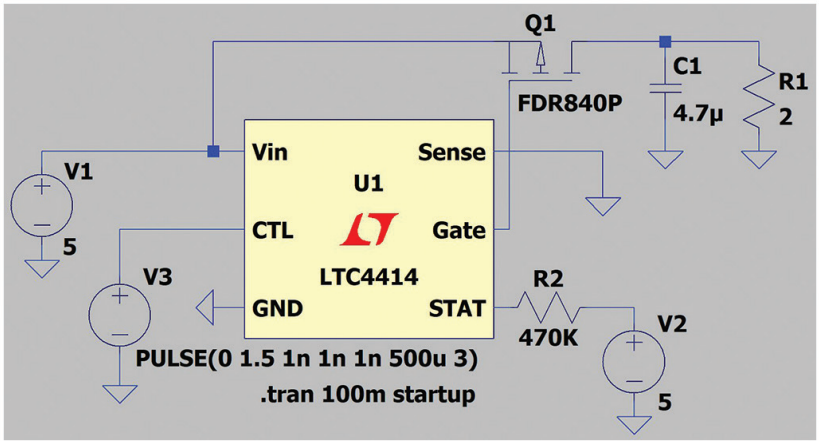
The already optimized selection of the switch for the driver circuit speaks in favor of integration in one package. The



1. Switching a supply line with an N-channel MOSFET and a separate driver circuit (LTC7003).



2. Two back-to-back N-channel MOSFETs can prevent a circuit's current flow in both directions.



3. An LTspice simulation with an LTC4414 low-loss PowerPath controller as a load switch.

switch is usually well-protected through this configuration and thus isn't overloaded during operation. The disadvantages of such an all-integrated solution include a smaller offering on the market and higher cost.

In the third step, a decision must be made regarding whether a single MOSFET is sufficient for a mechanical switch. A MOSFET always includes a body diode. Thus, it can only switch currents in one direction. If an application requires that a line be completely interrupted to stop current from flowing in either direction, a solution with two MOSFETs connected in series in opposite directions is needed. *Figure 2* shows such a switching stage arrangement.

Choosing the Right Driver

Finally, the appropriate integrated circuit, that is, the driver for the MOSFET, or the package with the MOSFET and the driver, must be selected. This step sounds trivial, but it's quite tedious. Load switches are often sought. As a rule, though, there is no large offering here.

Hot swap-controllers, electric fuses, surge protectors, ideal diodes, and power-path controllers can be used in many cases, depending on the application and the additional monitoring functions required. In most of these devices, there's an on/off pin enabling the flow of current to be interrupted when necessary. With the LTspice simulation tool from Analog Devices, it's possible to check whether the precise behavior of the solution meets the specifications *(Fig. 3)*.

Disconnection of a supply voltage can become complex depending on the application. A special MOS driver IC with an on/off control pin simplifies this design.

Frederik Dostal studied microelectronics at the University of Erlangen in Germany. Starting work in the power-management business in 2001, he has been active in various applications positions including four years in Phoenix, Arizona, where he worked on switch-mode power supplies. He joined Analog Devices in 2009 and works as a field applications engineer for power management at ADI in München. He can be reached at frederik.dostal@analog.com.