When to Make the Switch to an Integrated Load Switch

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Many load switching solutions use a power MOSFET surrounded by discrete resistors and capacitors to turn on and off power supply rails. Although simple, these solutions are often physically and electrically oversized and can lack protection features. In comparison, an integrated load switch can provide similar functionality while providing additional system benefits including inrush current limiting and smaller solution size. This application note highlights some benefits of using an integrated load switch over a discrete FET solution.

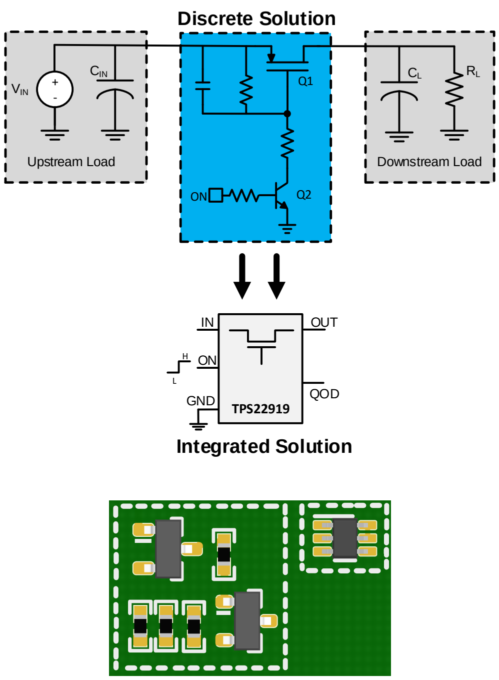

Figure 1. Discrete FET vs TPS22919 Solution Size

Reduced Size

One advantage of using a load switch is the integration of key power path features into a simpler, smaller solution, including thermal shutdown, controlled rise times, output discharge, and short circuit protection. To achieve the same functionality discretely, additional components need to be included to increase the solution size and complexity. In some instances, such as thermal shutdown, this cannot properly be implemented with discrete components.

Figure 1 compares the solution size of both switching solutions. In this example, the discrete FET solution consists of six components with a total solution size of 17 mm^2 . In comparison, the TPS22919 load switch consists of the single IC at 4.1 mm^2 with a 76% reduction in solution size.

Table 1. TPS22919 Load Switch vs Discrete FET Comparison

	TPS22919	PMOS Discrete Solution
BOM Count	1	6
Solution Size	4.1mm^2	17.08mm^2
Rise Time	Linear, Lower Inrush Current	RC Based, Higher Inrush Current
Thermal Shutdown	✓	
Short Circuit Protection	✓	
Quick Output Discharge (QOD)	✓	Requires additional components

Linear Soft Start

A key advantage to using an integrated load switch is the capability of reducing the inrush current by using a linear soft start (SS) on the output voltage. On a discrete implementation, an RC delay is created by connecting a capacitor from the source to the gate of the PMOS FET (Q1). Although this helps reduce the inrush current by reducing the switching speed of the PMOS, it makes it difficult to control the peak value of the current due to the non-linear behavior of the output voltage rise time. A load switch, on the other hand, uses a linear soft start to control the rise time that minimizes the inrush current.

For instance, when observing the VOUT ramp behavior of both circuits into a 100 µF load with similar rise times, as shown in Figure 2 , the current spikes over 400 mA in the discrete solution.

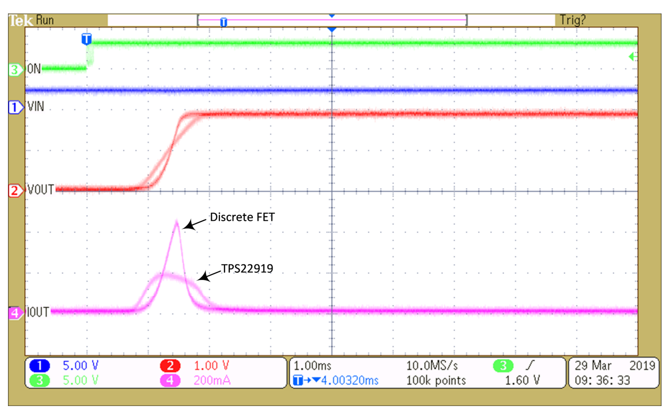

Figure 2. TPS22919 vs Discrete FET Inrush Current Control

Features Difficult to Implement Discretely

During operation, the junction temperature can rise due to many factors, including a high current load, large inrush current during startup, or during a fault condition. Thermal shutdown turns off the switch to reduce the power dissipation, protecting itself and also potentially avoiding damage to upstream and downstream components. In comparison, a discrete FET cannot protect itself if it exceeds its thermal junction temperature. In this case, the FET could potentially break, causing a short and damaging the downstream load or peripheral.

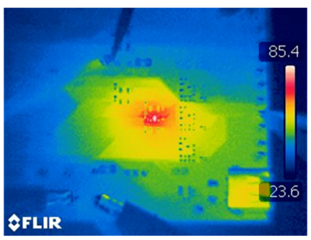

Figure 3. TPS22919 Thermal Cycling after Fault Condition (85C)

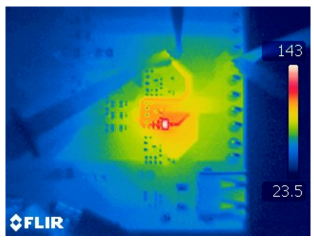

Figure 4. Discrete FET Thermal Image after Fault Condition (143C)

Another feature is Quick Output Discharge (QOD). QOD is a load switch feature which discharges VOUT through an internal path to ground when the switch is disabled. This ensures that all loads have been discharged and are turned off, preventing the output from floating or entering an undetermined state. To add this feature discretely, an external FET needs to be included on the output to discharge VOUT when the body FET is disabled. The TPS22919 has this feature integrated into the device.

In the case of a *Power Into Short* or a *Hot Short event*, the TPS22919 protects itself while the discrete FET becomes damaged. In Figure 5, the discrete FET passes more than 10 A downstream before getting damaged in a Power Into Short event.

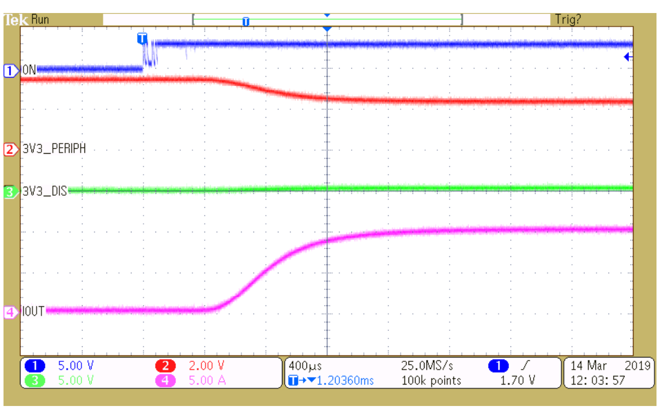

Figure 5. Discrete FET: Power into Short (Damages Discrete FET)

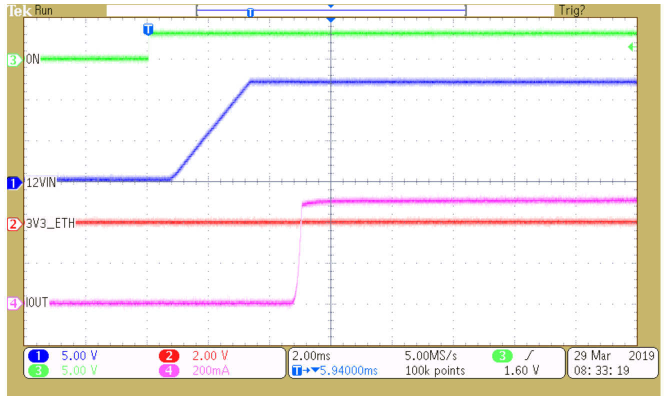

Figure 6. TPS22919: Power into Short (Limits to 500 mA)

Conclusion

While a discrete MOSFET solution can be used for power switching, it requires a larger solution size and can also cause a spike of inrush current. A load switch provides a controlled rise time (and therefore less inrush current for the same turn on time), a smaller solution size, and several additional features which can benefit the desired application.

Table 2. Load Switch Examples

Device	Specifications	Description
TPS22810	2.7 V to 18 V, 2 A I_{MAX}, SOT Package	Adjustable rise time, adjustable QOD
TPS22916	1 V to 5.5 V, 2 A I_{MAX}, CSP Package	Space-constrained applications
TPS22918	1 V to 5.5 V, 2 A I_{MAX}, SOT Package	Adjustable rise time, adjustable QOD
TPS22919	1.6 V to 5.5 V, 1.5 A I_{MAX}, SOT Package	Self protected with controlled rise time
TPS22975	0.6 V to 5.5 V, 6 A I_{MAX}, SON Package	Adjustable rise time, low ON-resistance
TPS22990	1 V to 5.5 V, 10 A I_{MAX}, SON Package	Lowest ON-resistance, power good indication

Table 3. Related Documents

Document Type	Title
Application Report	Basics of Load Switches (SLVA652)
Application Report	Integrated Load Switches Verses Discrete MOSFETs (SLVA716)
Reference Design	Muti-rail TV Power Supply Reference Design, with Flexible Partitioning to Maximize Power Savings

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