



REGISTER | LOG IN

Technologies | News | Markets | Learning Resources | Community | Companies | Part Search

Sponsored by: Agilent Technologies

Hosted by:

New live webcast Wednesday, April 30 at 1:00PM EST
 Tips, Techniques, and Examples on Using your System Power Supply to Improve Test Throughput

HOME > TECHNOLOGIES > POWER > USE SMART LOAD SWITCHES FOR CURRENT LIMIT PROTECTION

Use Smart Load Switches For Current Limit Protection

Owain Bryant | *Electronic Design*

Apr 24, 2014

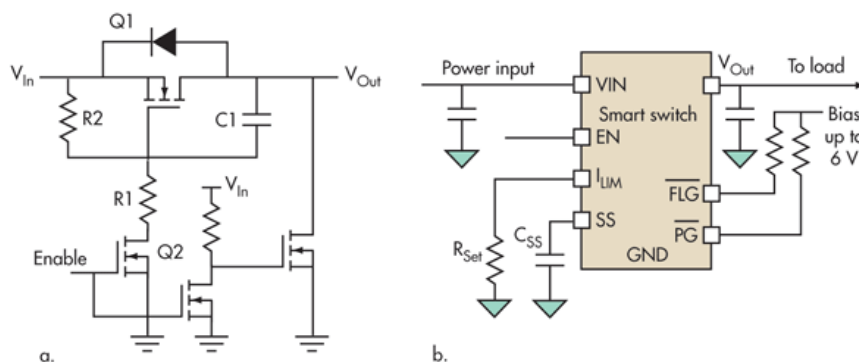
SHARE Tweet Recommend { 1 }

COMMENTS 0

A smart switch device designed specifically for load switching and fault protection applications is much simpler and has far fewer components than a load switch comprising discrete components.

The ability to turn on loads in a controlled manner is important in applications where the power budget is limited. Hard switching a load can cause the input power rail to droop and result in a fault. In some applications, a short of a single rail can damage the entire system by resulting in the reset or damage of the main supply or excessive power dissipation on the system board.

This is why system designers often include high-side load switches as part of the power-supply architecture (*Fig. 1*). To achieve some of the desirable functions such as low-voltage enable/disable, load discharge, and slew-rate control, quite a few discrete components need to be used.



1. A discrete implementation of a “smart” high-side load switch (a) utilizes several external components versus the simplicity of an integrated approach, such as the SIP32429 (b).

Typical high-side load switch circuitry fails to account for the results of a droop in the power rail when the load is suddenly applied. Smart switches, which are available from several semiconductor manufacturers, provide multiple levels of protection.

Related Articles

- [Additions Boost Fault-Protected Current Limited](#)

For example, Vishay offers a smart switch that provides programmable soft start, programmable current limits, over-temperature protection, a fault flag, and under-voltage lockout. It will turn off and retry to turn on through the full soft-start procedure 150 ms after the

Advertisement

XP 25-60 Watts in 2" x 3" package
 ECS series power supplies suit industrial and medical applications
[LEARN MORE](#)

Top Articles

1. [What's All This Bias Current Stuff, Anyway?](#)
2. [What's The Difference Between Watts And Volt-Amperes?](#)
3. [World's Greatest Engineering Movie](#)
4. [What's The Difference Between Bit Rate And Baud Rate?](#)
5. [What's The Difference Between The OSI Seven-Layer Network Model And TCP/IP?](#)

Commentaries and Blogs

[The Aereo Decision and Bluebonnets](#)

by **Lou Frenzel**

Posted 1 day ago
 in **Communiqué**



[What Heartbleed Should Teach Embedded Programmers](#)

by **William Wong**

Posted 4 days ago
 in **alt.embedded**



[Beacons Light The Way To All-Encompassing Bluetooth Connectivity](#)

by **Paul Whytock**

Posted 5 days ago
 in **London Calling**



Advertisement

Precision At Higher Supply Voltages

- **Regulator Limits Dissipation While Capping Current At The Desired Level**
- **Current Overdrive Detector Circuit Protects Automotive ECUs**

switch is off and the fault is removed. Other versions will turn off the switch under fault conditions and remain off.

Despite that sophistication, a smart switch device designed specifically for load switching and fault protection applications is much simpler and has far fewer components than a load switch comprising discrete components. Besides the obvious benefit of reduced board area, additional benefits include:

- The response of the smart switch is very accurate and repeatable due to on-chip current-sensing and current-limiting circuitry.
- The smart switch really adds value in terms of functionality compared to a discrete solution. The feature set can include over-current protection (OC), over-voltage protection, adjustable and fixed slew rate, output discharge, and reverse blocking.
- Flat on resistance is achieved over a wide operational input voltage. By using a charge pump, a constant voltage can be applied to the MOSFET gate regardless of input voltage to ensure consistent on resistance. This is virtually impossible to achieve discretely.



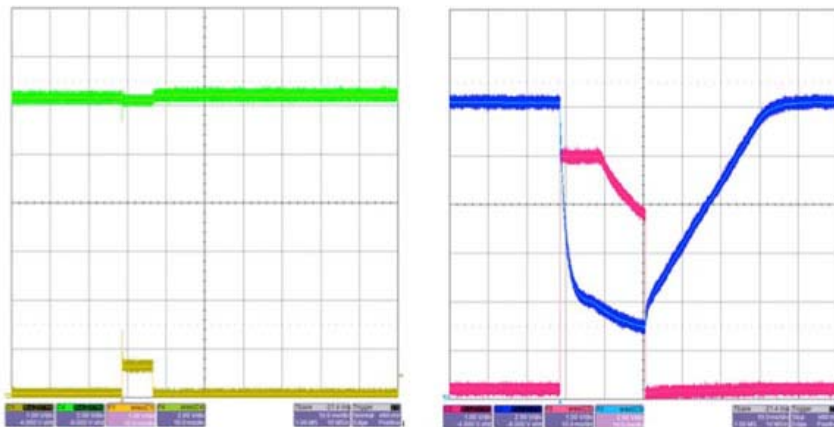
Download this article in .PDF format

This file type includes high resolution graphics and schematics when applicable.

Application Areas: Power-Supply/Battery Power Savings And Protection

The high-side load switch often is used in applications in which battery life is very important. In such systems, all but the most crucial of circuitry is removed from the battery output. A number of high-side load switches can be used to disconnect unused loads and save power.

Besides the battery life improvement, the advantage of using a current limiting switch instead of a resettable fuse is clear from the following comparison. A resettable fuse is commonly used in notebook applications, such as in backlighting circuits where a boost regulator is used to power strings of LEDs. If a short occurs on the output, it can compromise the system rail because a non-synchronous boost has a path from the input to the output via the inductor and diode (Fig. 2).



2. A current-limiting smart switch (a) and a polyfuse (b) display different responses. Notice the large increase in load current during the overcurrent event with the polyfuse. This results in a large dip in Vin. In contrast, the load switch responds quickly, limiting the overload current and hence the dip in the input supply level.

A comparison of the input current and voltage of a 12-V bus when protected by a polymeric positive temperature coefficient device (PPTC or polyfuse) shows that the smart switch reacts faster to the short and starts limiting current quickly, resulting in only

Contributing Technical Experts

How Mobile Devices Are Transforming Embedded Design

by Chris Ault

Published 23 hours 52 min 27 sec ago

in **Embedded**



Software Process Standards Ensure Safe Transportation

by Mark Pitchford

Published on Apr. 24, 2014

in **Embedded**



ZigBee Drives The Smart Home Industry

by Cees Links

Published on Apr. 24, 2014

in **Communications**



Media Reports Fuel Unfounded Fears About EV Batteries

by Micheal Austin

Published on Apr. 18, 2014

in **Power**



Advertisement

Forums

[Dissertation writing service](#)

[What is cell phone detector?](#)

[Wireless / RF transmission to Smart phone?](#)

[View All](#)

Search Parts

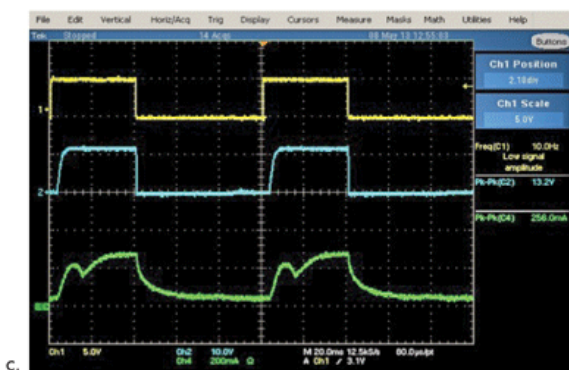
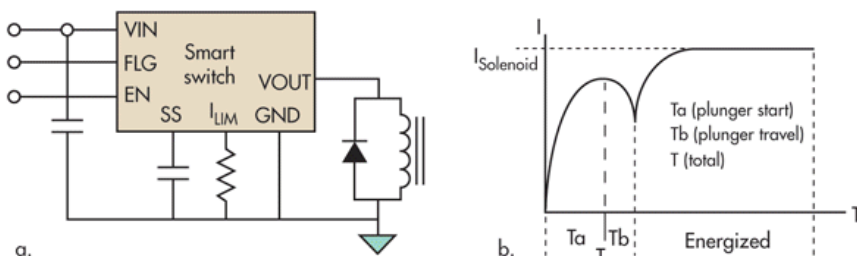
a minor droop of the input supply, compared to the wild voltage and current swings on the resettable-fuse configuration. Using the smart switch means that less bulk capacitance can be used on the input to the system and that there is no risk of the system being reset due to a mains-supply fault.

More Applications: Solenoid Driver

An interesting use for a smart switch is as a solenoid driver. A solenoid is essentially a large inductance. When voltage is applied, the current through the solenoid will rise at a rate determined by its inductance and dc resistance. When enough magnetizing current is applied to the solenoid, it will activate, causing a dip in current before the current again reaches steady state. At this point the input signal can be changed to pulse-width modulation (PWM), using a micro controller with a predetermined control program, to lower the operating loss or simply to reduce the power applied to the solenoid.

In this particular instance of the application, in which an SiP32429 is being used to drive a solenoid, the device has a turn-on delay time of 550 μ s, a rise time of approximately 7 ms into a 10- Ω load, and a turn-off delay time of 1 μ s. This gives a total of 7.56-ms minimum operation time. This is more than adequate for operation of solenoids up to 20 Hz for smaller 5 VA.

On the scope screen capture of Figure 3, yellow is the applied voltage, blue is the solenoid voltage, and green is the solenoid current. In the schematic, the solenoid is connected between 0 V and V_{Out} of the device with a Schottky in parallel to disable transients and for energy removal. This approach also can be used as a relay driver in the same configuration.



3. A smart switch can be used as a solenoid driver (a). The solenoid draws a large current when it's energized (b). The circuit in operation is shown in (c).

An advantage of using a current limiting, slew-rate controlled load switch in this application is that the protection features will never allow a constant on condition of the solenoid. If the smart switch encounters an over-current event, it will shut down before an automatic retry is attempted. If the failure persists, the part will again shut down.

Brushed DC Motor Driver Or Fan Driver Applications

The SiP32429 works as a high-side switch in motor driver applications (Fig. 4). The schematic for this is quite straightforward. The fan is connected in parallel to a Schottky diode (for switch-off freewheeling) between V_{Out} of the SiP32429 and ground. The enable

Powered by:

The Original Electronics Parts Search
And Procurement Tool

Newsletter Signup

Sign-up to receive our free newsletters

E-MAIL:

COUNTRY: UNITED STATES

By clicking below, I acknowledge and agree to Penton's [Terms of Service](#) and to Penton's use of my contact information to communicate with me about Penton's or its third-party partners' products, services, events and research opportunities. Penton's use of the information I provide will be consistent with Penton's [Privacy Policy](#).

SUBSCRIBE

Webcasts

[MIPI Physical Layer Transmitter Test Solutions](#)

[Simulation-Measurement Workflow for DDR Compliance](#)

View All

White Papers

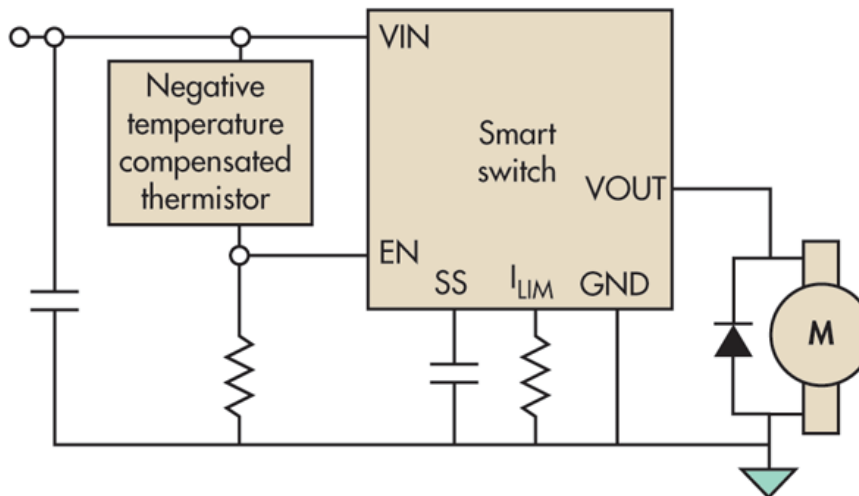
[USB 3.x Receiver Testing with Agilent's J-BERT M8020A High Performance BERT](#)

[When to Use a Fast Cure Adhesive](#)

View All

Connect With Us

pin is connected between V_{in} and ground via a thermistor/resistor divider.



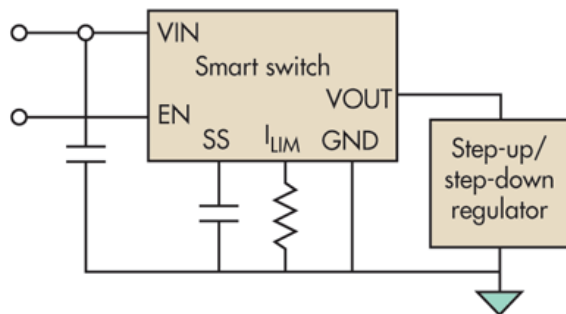
4. In a fan application, a smart load switch can be used to turn on a fan when the temperature rises using a thermistor. The soft turn-on reduces inrush current during the startup of the motor.

This approach can be used, for example, in applications in which a single-speed fan is used for cooling. When a system over-temperature is sensed, the extra functionality of the smart switch is quite useful. If the device were to overheat because of extreme ambient temperature, the flag pin would be used as an alert to shut down the main system.

Another positive aspect of using such a part is in the current limiting features. If the fan were to become blocked, then the SiP32429 would react within $1\ \mu\text{s}$ to remove the voltage, preventing massive voltage spikes created by the fan inductance.

Power-Supply Enabling And Sequencing

Another alternative application is a smart switch supplying voltage to a step-up/step-down switching regulator or, indeed, several of these circuits (*Fig. 5*). The ability to slowly charge into capacitance allows again for smaller source power-supply dimensioning while the power-up sequencing will be easily achievable. The possibility of removing several circuits when the system is in standby reducing quiescent current is another application specific option, which is very useful.



5. Using a smart load switch on the front end of a switching regulator allows for easy implementation of sequencing while protecting the system supply and downstream loads.

Conclusion

Broadly, protecting the system power rails from fault conditions is an important part of a good power design. A high-side load switch with features such as current limiting and slew-rate control is very useful in implementing protection schemes or simple circuits where inductive and capacitive loads require soft switching.

In applications where the source has a large amount of energy, a short can cause

considerable damage if the power architecture is not designed for fault tolerance. In such applications, the use of a current limiting switch is not only prudent, it also can reduce system cost and improve reliability. Even if a fault does occur, the damage is limited and can be serviced at a lower cost.

Owain Bryant is a field application engineer with the IC Division at Vishay Intertechnology. Previously, he was the senior electronic engineer at Dyson, Classe Audio, and Harman Becker Automotive Systems. He holds a BEng (Hons) from Cardiff University.

SHARE Tweet  Recommend { 1

Please [Log In](#) or [Register](#) to post comments.

Related Articles

[Smart Switches Offer Programmable Human Interface](#)

[Smart Switches Display Animations, Graphics And Text](#)

[Additions Boost Fault-Protected Current Limiter Precision At Higher Supply Voltages](#) 2

[Simple Current-Limiter And Power Switch Offer Overcurrent Protection](#)

[Use Smart Load Switches For Current Limit Protection \(.PDF download\)](#)

Search Parts

GO

powered by: 

Newsletter Signup

Sign-up to receive our free newsletters

E-MAIL:

COUNTRY:

UNITED STATES

By clicking below, I acknowledge and agree to Penton's [Terms of Service](#) and to Penton's use of my contact information to communicate with me about Penton's or its third-party partners' products, services, events and research opportunities. Penton's use of the information I provide will be consistent with Penton's [Privacy Policy](#).

SUBSCRIBE



ElectronicDesign.com

[Technologies](#) [News](#) [Markets](#) [Learning Resources](#) [Community](#) [Companies](#) [Part Search](#)

Site Features

Newsletters

RSS

Site Archive

Sitemap

Submit Articles

View Mobile Site

Penton Corporate

About Us

Privacy Policy

Terms of Service

Contact Us

Follow Us

Search ElectronicDesign.com



Electronic Design Related Sites

Microwaves & RF **Defense Electronics** **Engineering TV** **Global Purchasing** **Source ESB** **Power Electronics**

Copyright © 2014 Penton