

## 12-A Integrated Load Switch Using TPS24750/51

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### **1 Introduction**

Power management becomes more important than ever. Load switches are widely used in many power management solutions. These found in applications like telecommunication equipment, TV set-top boxes, computer equipment and peripherals, stereo receivers, small appliances, security systems, automated test equipment, automotive motor controls and so on.

The load switches provide a simple and inexpensive method for the system to make the appropriate power management decisions based on which peripherals or sub-circuits are currently in use. The load switch is controlled by the system, and connects or disconnects a voltage rail to a specific load. By turning unused circuitry off, this enables overall system efficiency to be higher. The load switch provides a simple means to power a load when it is in demand and allows the system to maximize its performance.

The simple form of the load switch can be considered as an electronic component that works like a relay with no mechanical parts.

This application note provides the technique of using TI's TPS24750/51 eFuse, as a simple and inexpensive 12-A current load switch. In general, the TPS24750/51 provides highly-integrated load protection for 2.5-V to 18-V applications. The devices integrate a hot swap controller and a power MOSFET in a single package for small form factor applications. These devices protect source, load and internal MOSFET from potentially damaging events. During startup, load current and MOSFET power dissipation are limited to user-selected values. After startup, currents above the user-selected limit will be allowed to flow until programmed timeout.

## 2 Typical Application of TPS2475x

Figure 1 shows the typical application circuit of the TPS2475x. In this case, the device is configured as the 12-A eFuse.

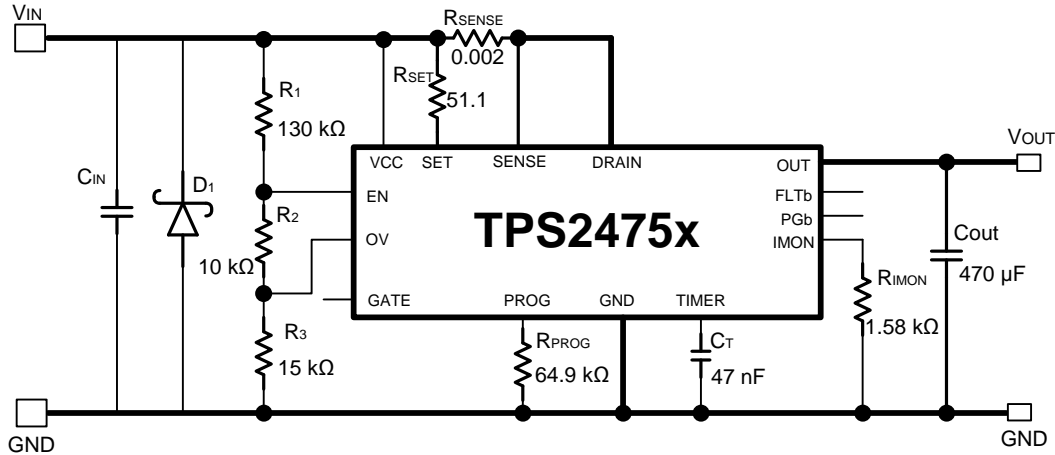


Figure 1. TPSD2475x as the 12-V, 10-A eFuse

## 3 TPS2475x as Load Switch Configuration

The TPS2475x can be configured as a high current load switch with the lowest part count circuit. The schematic diagram of load switch configuration is shown in Figure 2. The output voltage ramp rate is controlled with RC circuit (Rgate and Cgate) at the Gate pin of the device. Detailed design process is discussed later in this report. The EN pin is used as load ON/OFF control input, high at the EN pin enables and low ( $\approx 0$ ) turns “OFF” the power to the output load.

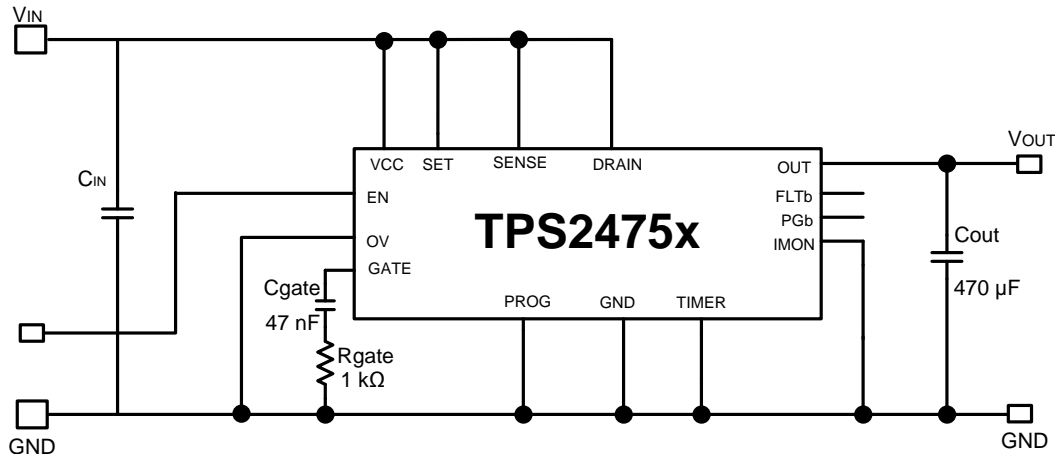


Figure 2. TPS2475x Configured as Simple High Current Load Switch

Figure 3 shows the load switch response when EN signal is applied, this shows the output voltage ramps up at the configured dV/dt rate (selected by Rgate and Cgate) and it takes about 20 ms to change the 470- $\mu$ F load capacitor while 7-A load is connected at the output.

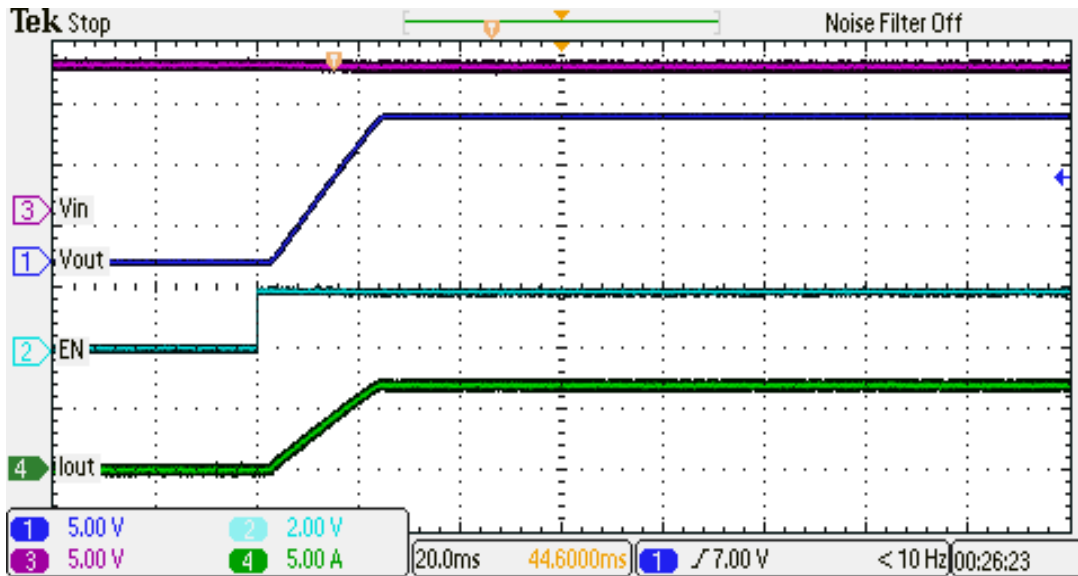


Figure 3. Load Turn “ON” Behavior Upon Application of the EN Control Signal

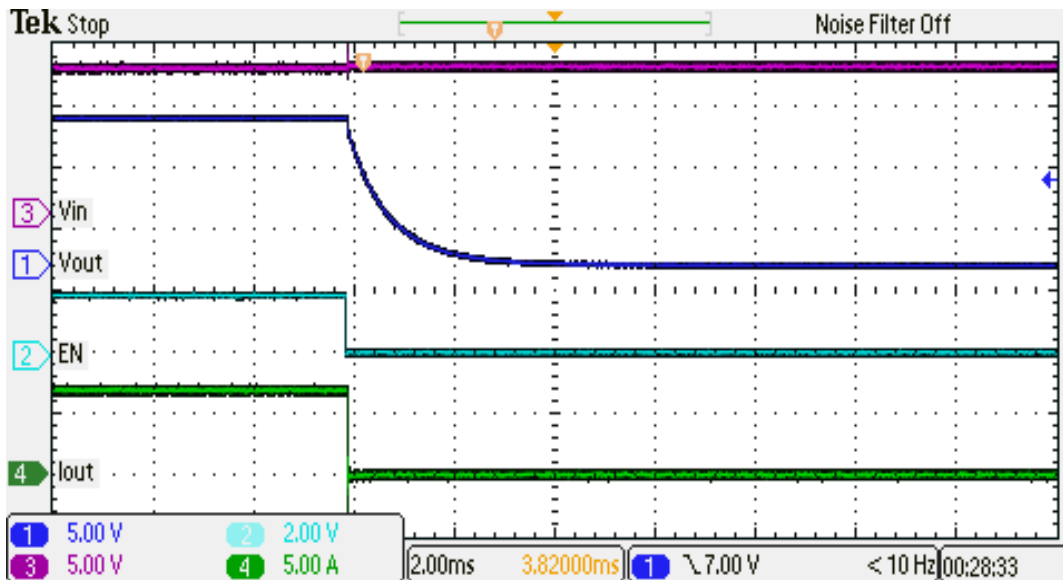


Figure 4. Load Turn “OFF” Behavior When EN Control Signal is Removed

Figure 4 depicts load switch turn “OFF” behavior when the EN signal is removed, this shows the load voltage and current drops to zero quickly after EN is disabled.

## 4 GATE Capacitor Selection for (dv/dt) Control

The  $R_{GATE}$  and  $C_{GATE}$  values can be designed to achieve desired ramp time of the output voltage/current. This is done by a capacitor ( $C_{GATE}$ ) connected from the GATE terminal to GND. A resistor ( $R_{GATE}$ ) of 1 k $\Omega$ , placed in series with this capacitor prevents it from slowing a fast-turnoff event. In this mode of operation, the internal FET operates as a source follower, and the slew rate of the output voltage approximately equals the slew rate of the gate voltage.

To implement a constant-inrush-current mechanism, choose the time to charge,  $\Delta t$ , as per Equation 1.

$$\Delta t = \frac{C_{OUT} \times V_{VCC}}{I_{CHG}} \quad (1)$$

Where  $C_{OUT}$  is the output capacitance,  $V_{VCC}$  is the input voltage, and  $I_{CHG}$  is the desired charge current.

The  $I_{CHG}$  is selected,  $I_{CHG} < P_{LIM} / V_{VCC}$ .

Now Gate capacitor ( $C_{GATE}$ ) can be selected as Equation 2.

$$C_{GATE} = \left( I_{GATE} \times \frac{\Delta t}{V_{VCC}} \right) - C_{INTRS} \quad (2)$$

Where  $I_{GATE}$  is the nominal gate current ( $\approx 30 \mu A$ ),  $C_{INTRS}$  is the effective capacitance of internal FET ( $\approx 175 \text{ pF}$ ).

For the 20-ms ramp-up time ( $\Delta t$ ) of the output voltage, the calculated  $C_{GATE}$  is 49.8 nF, 47 nF is selected as the standard value, which aligns with the output voltage ramp-up time as shown in [Figure 4](#).

**NOTE:** This load switch is not designed to provide any overload or short-circuit protection.

## 5 Conclusion

The low-cost eFuse, TPS2475x is used to implement a simple and inexpensive 12-A load switch with minimum parts count. In this configuration, the load switch can be enabled or disabled via microcontroller or some other control mechanism. The ramp rate of the output voltage is also programmable by simple RC network at the GATE pin.

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