AND8203/D

Simple Input Adapter Reverse Voltage Protection

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APPLICATION NOTE

Modern electronic systems require a host of different regulated voltages to power various subsystems. The number of voltage rails has risen as new generations of processors, memory, etc. have been introduced with lower voltage requirements driven by deep sub−micron CMOS processes. One of the consequences of these new process technologies is that the absolute maximum ratings have also been lowered, therefore designers are forced to employ protection circuitry to protect sensitive I/O's from transient and steady−state overvoltage and reverse voltage conditions.

Failures and faults in the adapter may, and usually do, result in overvoltage events that can damage sensitive electronic components within the product. Also, due to the proliferation of portable products within the home and office, a risk exists that the user may reach for the wrong adapter which could have a reversed polarity. The challenge of the product designer is to improve the robustness of the design and avoid situations where the product can be damaged.

A series Schottky will clamp the reverse voltage and block any reverse current into the adapter. However, Schottky diodes have a forward voltage drop, V_F, from 0.3−0.5 V depending on the forward current, I_F. Next, Li−Ion batteries have maximum voltage of 4.2 V. Finally, adapter voltages are falling due to the standardization of single−cell Li−Ion as a portable power source, and by lowering the adapter output voltage, the output power is reduced and thus the size and cost of the adapter. So in many cases, there is not enough voltage headroom to support the addition of a Schottky to provide reverse clamping.

The circuit in Figure 1 protects its output from input transients up to 30 V and steady state overvoltage faults of 25 V while allowing normal operation for low voltage adapter inputs. The NCP345/6 senses an overvoltage condition and quickly disconnects the input voltage supply from the load by turning off Q1. The NCP345 senses overvoltage events greater than 6.85 V and the NCP346 comes in two versions which detect overvoltage events greater than 4.45 and 5.5 V respectively. An optional resistor divider may be used to adjust the detection threshold to a higher value as well. Transistor Q2 protects the circuit from a reverse input voltage condition. For a correct, or positive, input voltage (V_{in}), the transistor turns on once V_{in} rises above the body diode voltage of the transistor. The body diode polarity allows the source to pull up to the input voltage which turns on the transistor and shorts out the diode. For a reversed V_{in}, since the gate is grounded, the FET is not allowed to turn on.

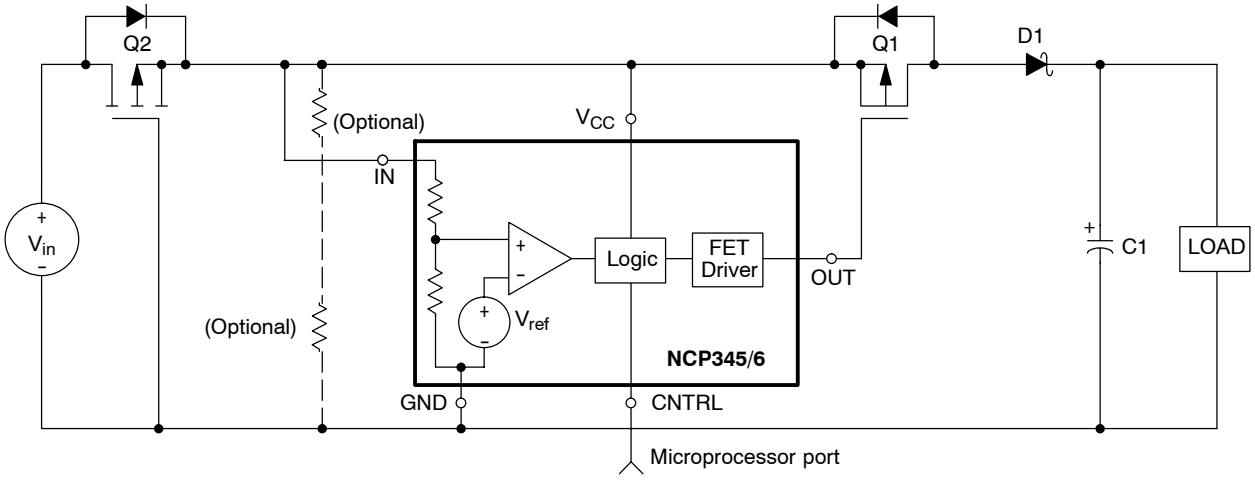

Figure 1. NCP345/6 Circuit with Reverse Input Voltage Protection

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Table 2 shows a variety of MOSFETs that one could choose to implement this solution. The drain−source breakdown voltage (V_{DSmax}) and the gate−source breakdown voltage (V_{GSmax}) should be greater than the magnitude of the expected overvoltage and reverse voltage events.

Table 1. Small, Surface−Mount FETs

Part Number	V_{DSmax} (V)	V_{GSmax} (V)	$R_{DS(on)}$ (mΩ)	Package
NTHS4111P	30	±20	52 @ 4.5 V	ChipFET™
NTGS4111P	30	±20	68 @ 4.5 V	TSOP−6
NTJS4151P	20	±12	70 @ 2.5 V	SC88
NTHS5443	20	±12	95 @ 2.5 V	ChipFET™
NTHS5441	20	±12	70 @ 2.5 V	ChipFET™
NTHS4101P	20	±8	30 @ 2.5 V	ChipFET™
NTHD4102P	20	±8	85 @ 2.5 V	ChipFET™
NTJS3151P	12	±12	67 @ 2.5 V	SC88

This same technique works in a variety of other applications that may be connected directly to the input adapter port. A common circuit which is often connected directly to the adapter port is a Li−Ion battery charger.

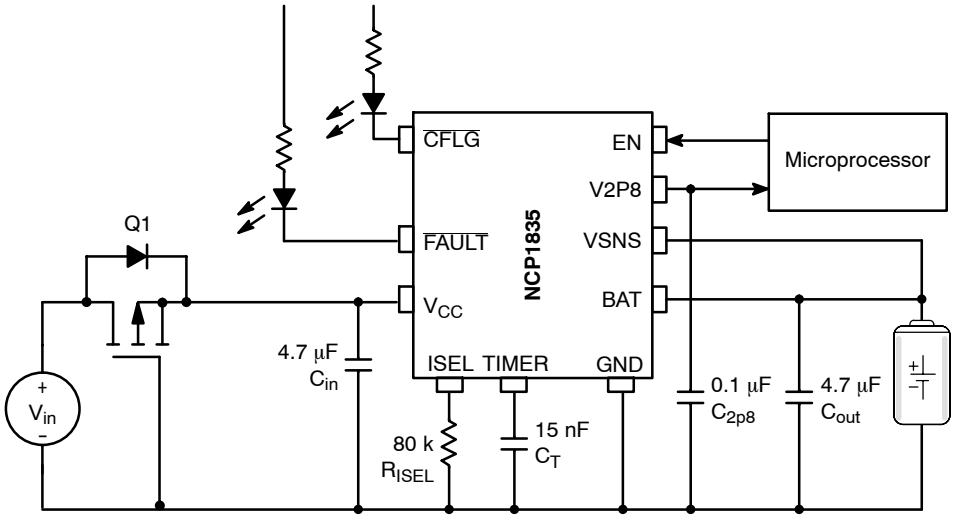

Figure 2. Reverse Protection Circuit with Li−Ion Battery Charger

Designers of portable products must include protective measures to prevent users from unsuspectingly damaging their products. Reversed and overvoltage inputs are common problems which have been addressed here. This proposed addition of the reverse polarity adds reverse protection to a robust overvoltage protection solution with a minimal addition of series conduction loss and without the voltage drop of a Schottky diode.

Notes

ChipFET is a trademark of Vishay Siliconix.

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