Keywords: charge-pump voltage doublers, current-sense amplifiers, n-channel MOSFETs, inrush current

APPLICATION NOTE 4501

Simple Current Limiter Is Programmable

Nov 05, 2010

Abstract: This circuit lets you program a current limit without using microcontrollers or data converters. It consists of a charge-pump voltage doubler (U1), a current-sense amplifier (U2), and two n-channel MOSFETs. The sense-resistor value determines the maximum current limit.

A similar version of this article appeared in the May 18, 2009 issue of *EE Times* magazine.

Available integrated circuits can let you program a current limit, but they generally involve microcontrollers or data converters (or both). As an alternative, the **Figure 1** circuit lets you program a current limit without the intervention of microcontrollers or data converters. It consists of two miniature SOT-5 devices and a few external components. The sense-resistor value determines the maximum current limit.

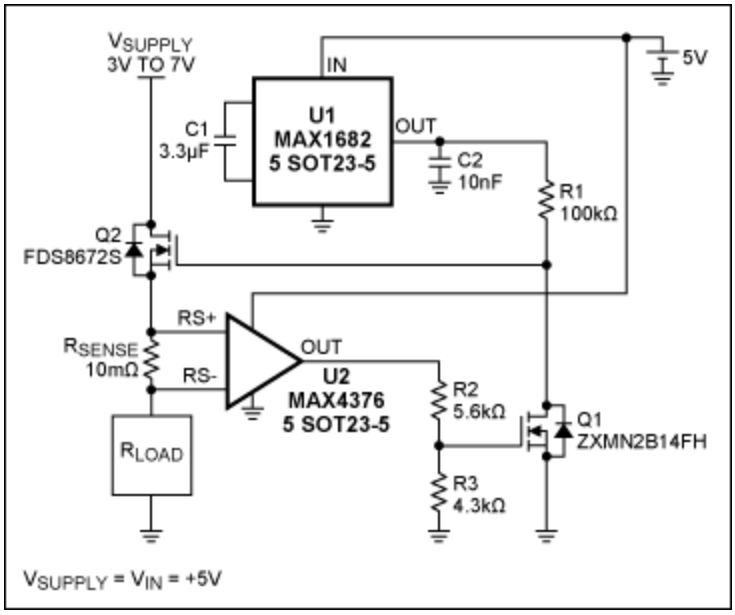

Figure 1. This circuit limits the R_{LOAD} current to a value determined mainly by R1.

The circuit consists of a charge-pump voltage doubler (U1, MAX1682), a current-sense amplifier (U2, MAX4376), and two n-channel MOSFETs. U1 doubles the supply voltage to provide gate drive for Q2, and U2 amplifies the voltage across the sense resistor (R_{SENSE}) with a gain of 20. This U2 output drives the Q1 gate via the R2/R3 divider, which modulates the current through R1, which in turn sets the Q1

drain voltage and Q2's gate-drive voltage.

U2's output voltage is 20 times the voltage between RS+ and RS-, but has a full-scale limit of 2V. **Figure 2** shows the response of this circuit when you suddenly impose a heavy (low resistance) load. It allows an initial current surge to 10A, and then (after 20µs) settles to the desired limit of 7.25A.

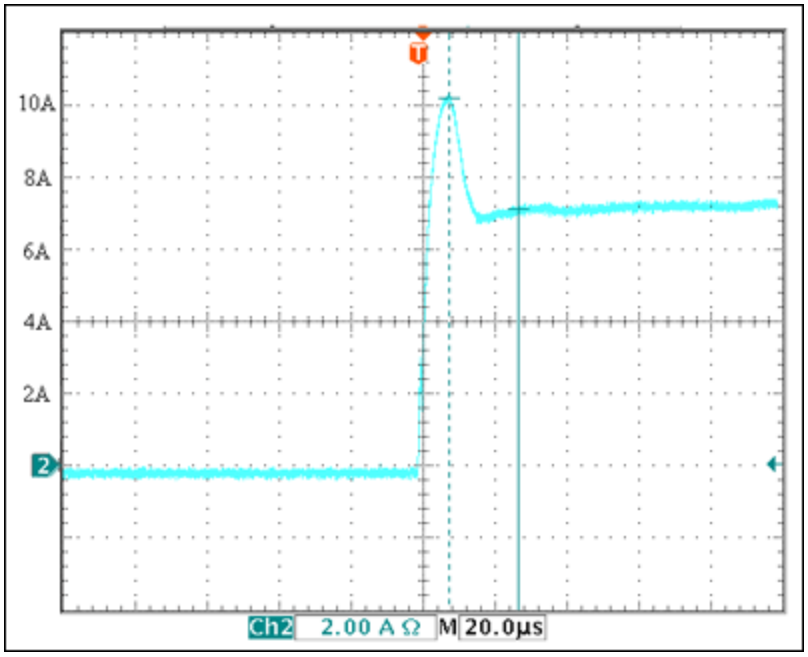

Figure 2. With V_{SUPPLY} and V_{IN} (at U1) equal to 5V, the Figure 1 circuit limits load current to 7.25V.

The maximum allowed in-rush current is set by the sense resistor. A 10mΩ value, for instance, allows a maximum in-rush current of 100mV/10mΩ = 10A. This steady-state limit is determined by the operating characteristics of Q1 and Q2, together with the values chosen for resistors R1–R3. **Figure 3** shows the I_{LIMIT} values obtained by varying R1 alone. To set other values of I_{LIMIT}, you can vary the ratio R2/R3 while holding the R1 value fixed.

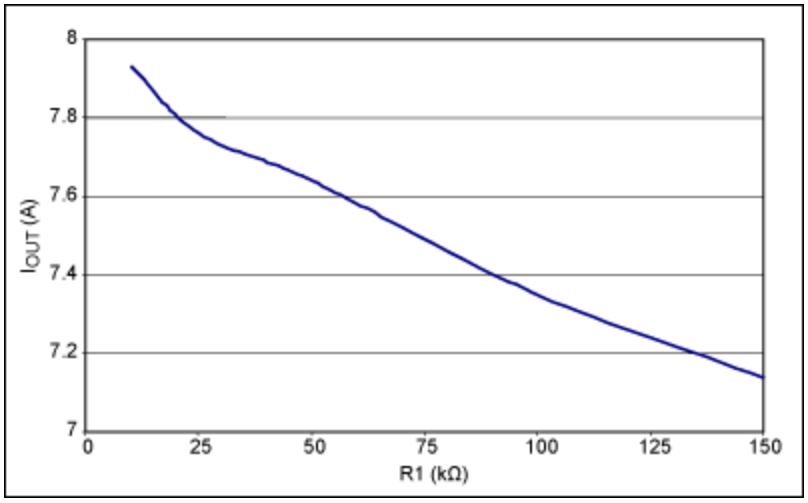

Figure 3. With V_{SUPPLY} and V_{IN} (at U1) equal to 5V, the Figure 1 circuit's steady-state current limit varies with R1 as shown.

Related Parts		
MAX1682	Switched-Capacitor Voltage Doublers	Free Samples
MAX4376	Single/Dual/Quad High-Side Current-Sense Amplifiers with Internal Gain	Free Samples

More Information
For Technical Support: http://www.maximintegrated.com/support
For Samples: http://www.maximintegrated.com/samples
Other Questions and Comments: http://www.maximintegrated.com/contact