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APPLICATION NOTE 4404

Using a Linear Regulator to Produce a Constant Current Source

By: Budge Ing
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Abstract: This application note shows how to use linear voltage regulators to provide a constant current. Two circuits are presented, one for high-side and another for low-side current sources. The MAX1818 and MAX1735 LDOs are featured in the designs.

This design idea appeared in the May 11, 2006 issue of *EDN* magazine.

Linear voltage regulators provide one of the simplest ways to produce a constant current. Because the voltage between a linear regulator's output and ground is tightly regulated, a fixed resistor connected between those two nodes produces a constant current between the output and ground. This configuration applies to both high-side and low-side current sources.

The high-side current source of **Figure 1** feeds R_{LOAD} with a constant current, I = 1.5V/R_{OUT}. The positive linear regulator (the MAX1818, available in a 6-pin SOT23 package) provides a fixed output of 1.5V. The voltage between V_{CC} and GND can be as high as 5.5V.

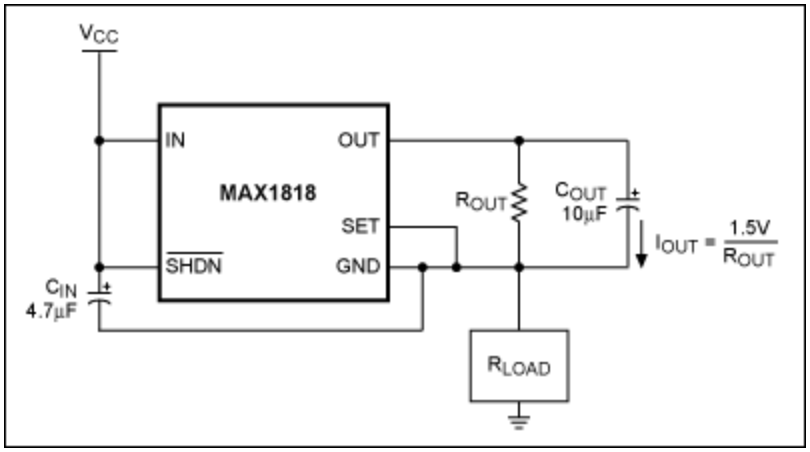

Figure 1. This high-side constant-current source features the MAX1818 LDO and draws 1.5V/R_{OUT} from R_{LOAD}. The circuit requires the voltage for R_{OUT} between the IN and GND terminals to be minimally 2.5V.

There is an important requirement for this circuit: the minimum voltage required for proper operation (2.5V) must be provided between the IN and GND terminals. To satisfy that condition, choose an R_{OUT}

value that allows 2.5V to 5.5V between IN and GND. When driving a load of 100Ω maximum with V_{CC} at 5V, for example, the device functions properly with R_{OUT} above 60Ω. That value allows a maximum programmable current of 1.5V/60Ω = 25mA. Voltage across the device then equals the minimum allowed: 5V - (25mA × 100Ω) = 2.5V. This IC can source up to 500mA.

For a low-side current source, consider the circuit of **Figure 2**. In this design a constant current of I = 2.5V/R_{OUT} is drawn from R_{LOAD}. The IC (the MAX1735, available in a 5-pin SOT23 package) is a negative linear regulator with fixed output voltage of -2.5V. The voltage between GND and IN can be as high as 6.5V.

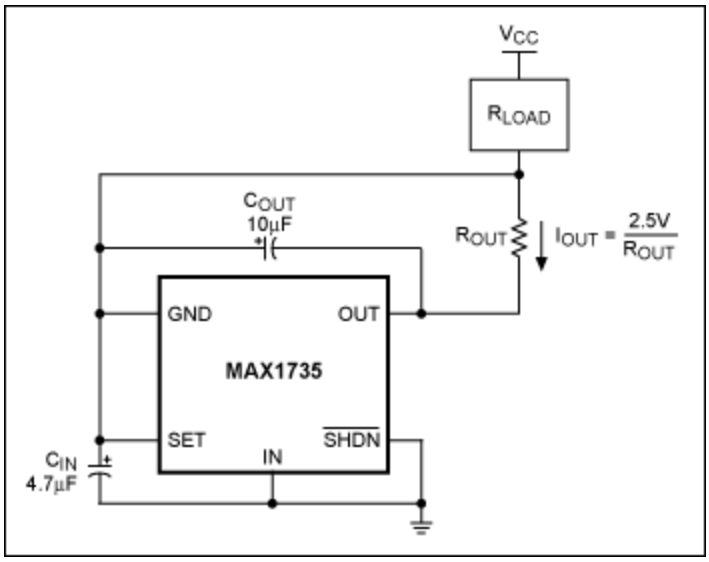

Figure 2. This low-side constant-current source features the MAX1735 and draws 2.5V/R_{OUT} from R_{LOAD}. This circuit also requires that the voltage for R_{OUT} between the IN and GND terminals is minimally 2.5V.

As in Figure 1, this circuit requires a minimum voltage of 2.5V between the GND and IN terminals. To satisfy that condition, choose an R_{OUT} value that allows 2.5V to 6.5V between GND and IN. When sourcing current from a load of 100Ω maximum with V_{CC} at 5V, for example, R_{OUT} should be greater than 100Ω. That value provides a maximum programmable current of 2.5V/100Ω = 25mA. Voltage across the device is at the minimum: 5V - (25mA × 100Ω) = 2.5V. This IC can source up to 200mA.

Note that both configurations allow the regulator's quiescent current to flow through the load in addition to the programmed I_{OUT}. Quiescent currents are thus a source of error, and one that changes with the voltage applied between IN and GND. This error can be mitigated in either of two ways: choose a voltage regulator with low quiescent current; or choose a voltage regulator whose quiescent current is flat through the operating range, thus allowing you to compensate the error by adjusting the value of R_{OUT}. (Quiescent current for the devices shown in these designs is 130µA typical, and varies less than 40µA from 2.5V to 5.0V.)

Related Parts		
MAX1735	200mA, Negative-Output, Low-Dropout Linear Regulator in SOT23	Free Samples
MAX1818	500mA, Low-Dropout Linear Regulator in SOT23	

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