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APPLICATION NOTE 3855

Precision Circuit Monitors Negative Supply Current

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Abstract: This current-sensing circuit monitors a negative power supply and provides a positive output voltage proportional to the load current.

Supply-current monitoring is a necessary feature in high-reliability systems where excessive current can cause damage or compromise safety. Such systems avoid overload faults by monitoring their power supply and shutting it down before a fault occurs. Most current-monitoring ICs, however, are designed for positive-voltage supplies. For negative supplies, the circuit of **Figure 1** monitors load current and provides a proportional output voltage.

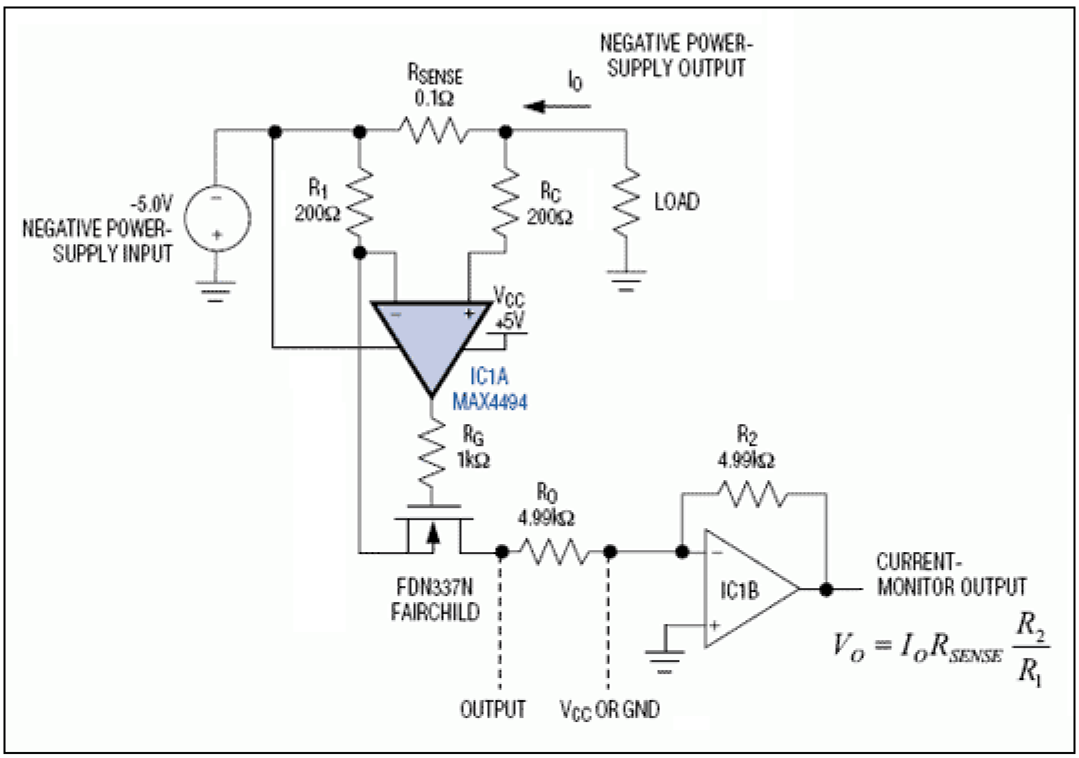

Figure 1. This current-sensing circuit monitors a negative power supply and provides a positive output voltage proportional to the load current.

Voltages at the inverting and noninverting terminals of the op amp (IC1A) are forced to be equal by an active-feedback current mirror. $V_{R1} = V_{SENSE}$ and therefore:

$$I_{R1} = I_O \frac{R_{SENSE}}{R_1}$$

Three alternatives are now possible. You can convert the output current (I_{R1}) to voltage by connecting resistor R_O to ground, to V_{CC}, or to an inverting amplifier. Connecting R_O to ground (GND) eliminates the need for a positive supply. In that case, the output voltage is negative and proportional to load current:

$$V_O = -I_O \frac{R_{SENSE}}{R_1} R_O \qquad \text{(}R_O\text{ connected to GND)}$$

You can connect R_O to V_{CC} for applications that require a positive output voltage, but the output will be referenced to V_{CC}:

$$V_O = V_{CC} - I_O \frac{R_{SENSE}}{R_1} R_O \qquad \text{(}R_O\text{ connected to }V_{CC}\text{)}$$

To reference the positive output voltage to ground, you must use an inverting amplifier (IC1B), as shown in Figure 1:

$$V_O = I_O R_{SENSE} \frac{R_2}{R_1} \qquad \text{(}R_O\text{ connected to an inverting amplifier)}$$

Note that R_O does not affect output voltage for the inverting-amplifier, but this resistor is usually needed for stability. RG can be optional, but it also provides stability by isolating the op amp from the capacitive load of the MOSFET gate. Finally, RC compensates for the op amp's input bias current.

Figure 2 shows measurement error vs. load current for the Figure 1 circuit. To ensure accurate current measurements, the resistors (except for RG and RC) should have a tolerance of 1% or better. RSENSE must be rated to dissipate the power associated with high load currents.

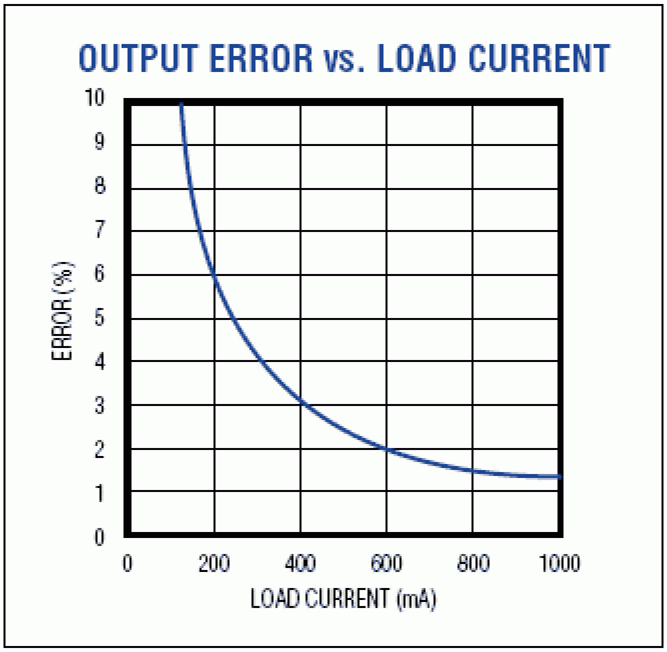

Figure 2. Error for the current sensor of Figure 1 is less than 2% at full scale, but the op amp's inherent input-offset voltage reduces the accuracy at lower levels of current.

A similar article appeared in the September, 2005 issue of *Power Electronics Technology*.

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