

APPLICATION NOTE 3855

Precision Circuit Monitors Negative Supply Current

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.

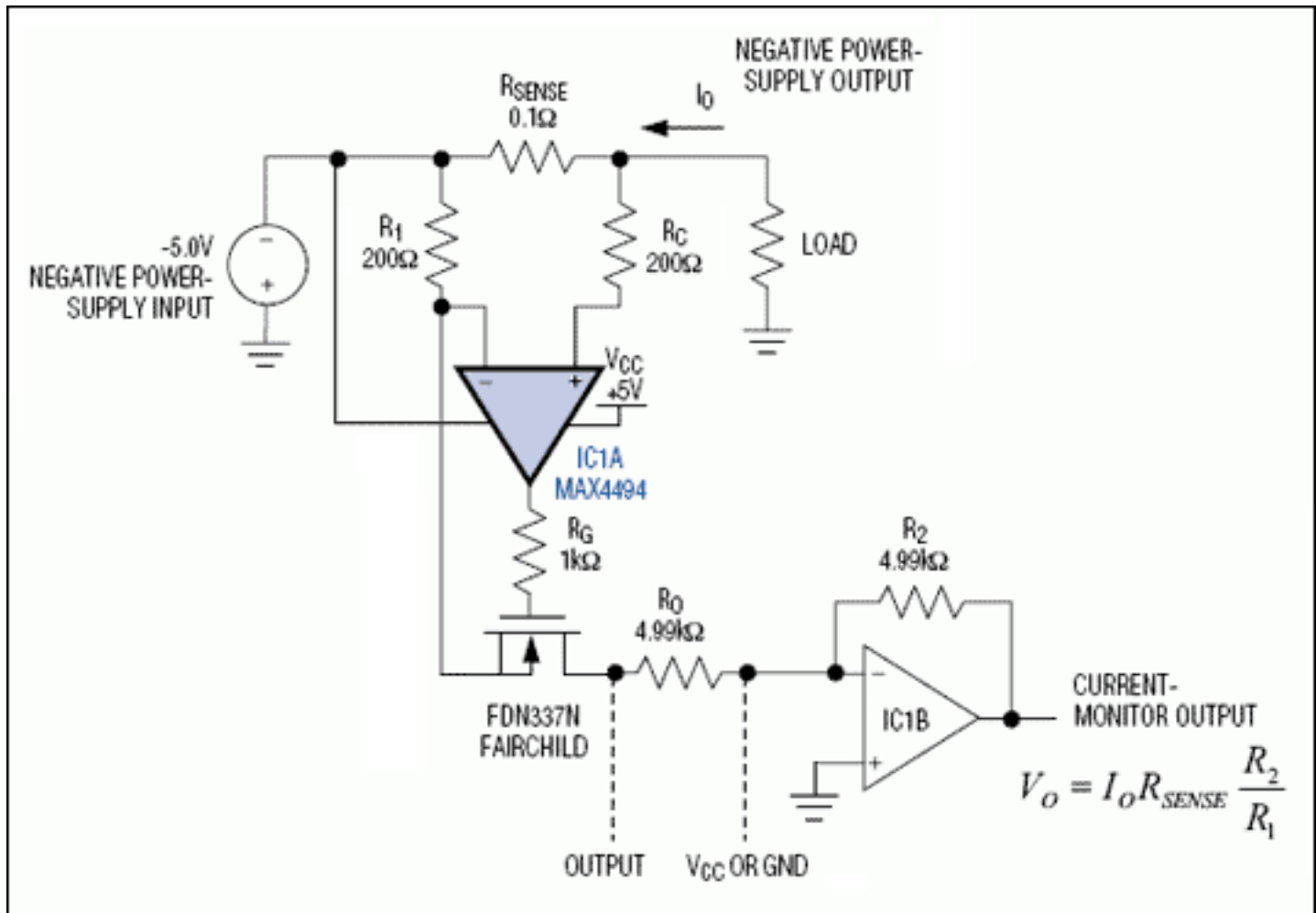


Figure 1. This current-sensing circuit monitors a negative power supply and provides a positive output voltage proportional to the load current.

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:

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

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} :

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

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

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

Note that R_O does not affect output voltage for the inverting-amplifier, but this resistor is usually needed for stability. R_G can be optional, but it also provides stability by isolating the op amp from the capacitive load of the MOSFET gate. Finally, R_C 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 R_G and R_C) should have a tolerance of 1% or better. R_{SENSE} must be rated to dissipate the power associated with high load currents.

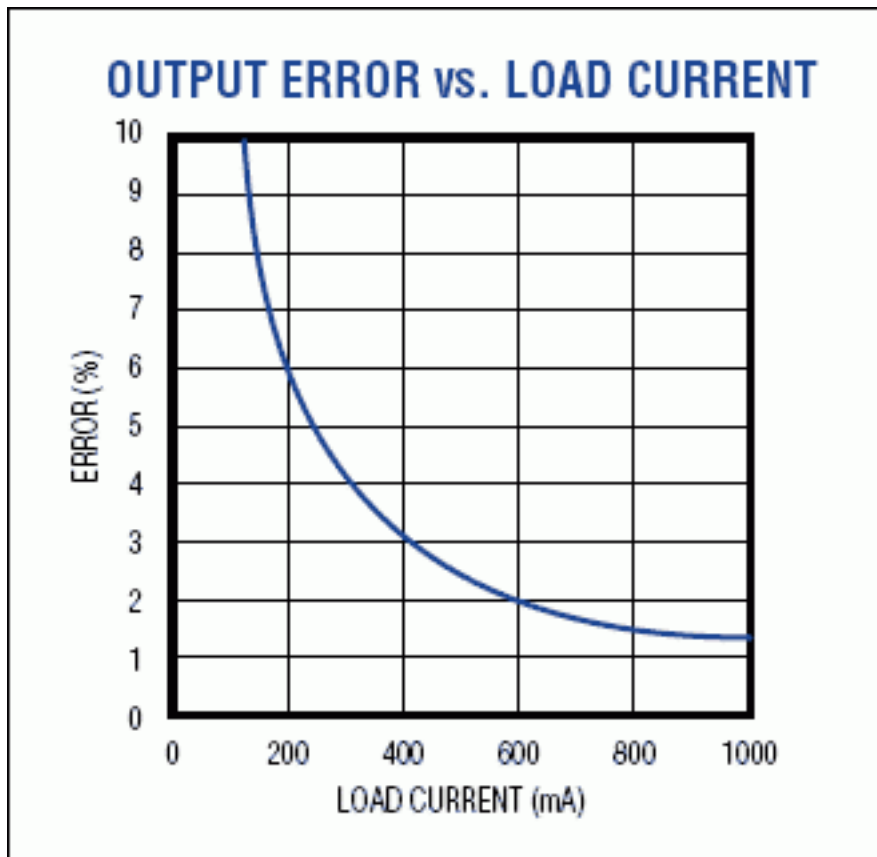


Figure 2. Error for the current sensor of Figure 1 is less than 2% at full scale, but the op amp's inherent input-offset voltage reduces the accuracy at lower levels of current.

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

Application Note 3855: <http://www.maxim-ic.com/an3855>

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