Circuit senses high-side current

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The accurate, high-side, current-sense circuit in **Figure 1** does not use a dedicated, isolated supply voltage, as some schemes do. Only the selected transistors limit the common-mode range. The circuit measures the voltage across a small current-sense resistor, R_S . The operation of the circuit revolves around the high-side current mirror comprising Q_1 and Q_2 . All the circuit components have one overall function: to make the collector currents equal in Q_1 and Q_2 . The additional current mirror using Q_3 sets the values of the collector currents. The collector current is $(V_{CC}$ -0.7)/(R_5 +R_6)≅100 µA. You can best calculate the gain of the circuit by analyzing the loop formed by R_1 , R_S , R_2 , Q_{1B} (emitter base), and Q_{1A} (base emitter). In Figure 1 , the currents are I_S , the high-side measurement current; I_1 and I_2 , the mirror currents of Q_{1A} and Q_{1B} ; and I_3 , a branch current from the emitter of Q_{1A} .

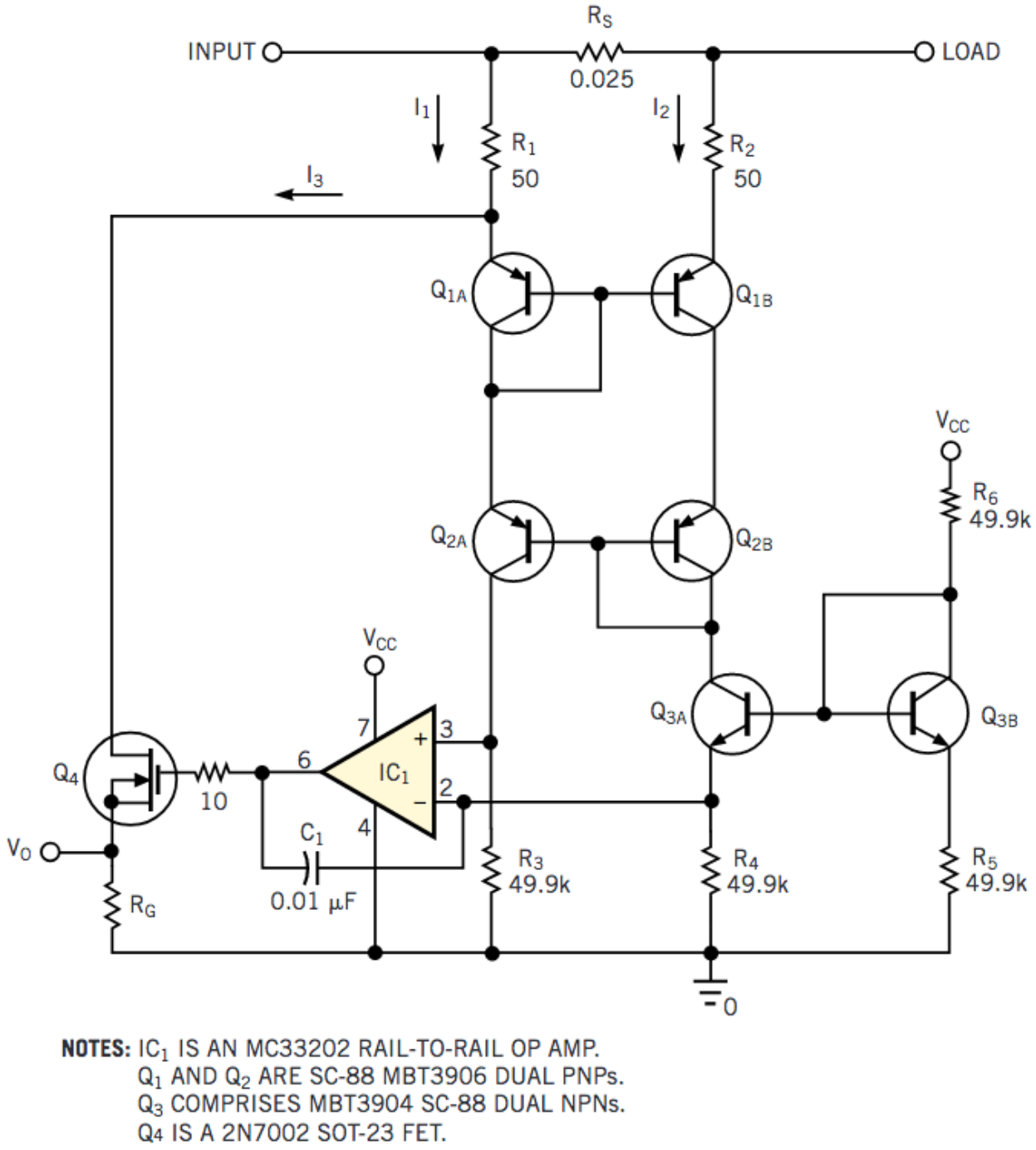

Figure 1 This circuit measures high-side currents without the need for auxiliary power supplies.

When you sum the currents around the loop, $(I_S \cdot R_S) + (I_2 \cdot R_2) + VQ_{1B}$ (e-b)-$((I_1 + I_3) \cdot R_1) = 0$. Because $I_1 = I_2$, $R_1 = R_2$, and the emitter-base voltages are equal, $I_3 = I_S \cdot R_S / R_1$. Looking at the remaining circuitry, the op amp keeps the transistors' collector currents equal by controlling I_3 through Q_4. Therefore, the overall transfer function is $V_{OUT} = I_S \cdot R_S \cdot R_G / R_1$. For $R_G = 1$ k?, the transfer function is $V_{OUT} = 0.5 \cdot I_S$. The circuit can operate over a common-mode input range of approximately 10V to several hundred volts, limited by the selected transistors.

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