Digitally programmable resistor serves as test load

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FIGURE 1 ILLUSTRATES a digitally programmable precision resistance that can serve as a microprocessor-driven power-supply load in custom-designed ATE (automatic-test equipment). An 8-bit current-output DAC, IC_1, a DAC08, drives current-to-voltage converter IC_{2A}, which in turn drives the gate of power MOSFET Q_1. The device under test connects to J_1 and J_2. In operation, current from the device under test develops a voltage across sampling resistors R_{8A} and R_{8B}. Amplifier IC_{2B} drives IC_1's reference input and closes the feedback path. Transistor Q_2 provides overcurrent protection by diverting gate drive from Q_1 when the voltage drop across R_{8A} and R_{8B} reaches Q_2's $V_{BE(ON)}$. V_O and I_O represent the output voltage and current, respectively; N represents the decimal equivalent of the binary input applied to IC_1; and A represents the gain of the amplifier stage IC_{2B}. R_1 comprises the parallel combination of R_{1A} and R_{1B}. **Equation 1** describes the circuit's load current:

$$\frac{V_0}{R_1} = I_{OUT} = \frac{V_I}{R_6}\times\frac{N}{256} = \frac{I_0\times R_8\times A}{R_6}\times\frac{N}{256}. \qquad (1)$$

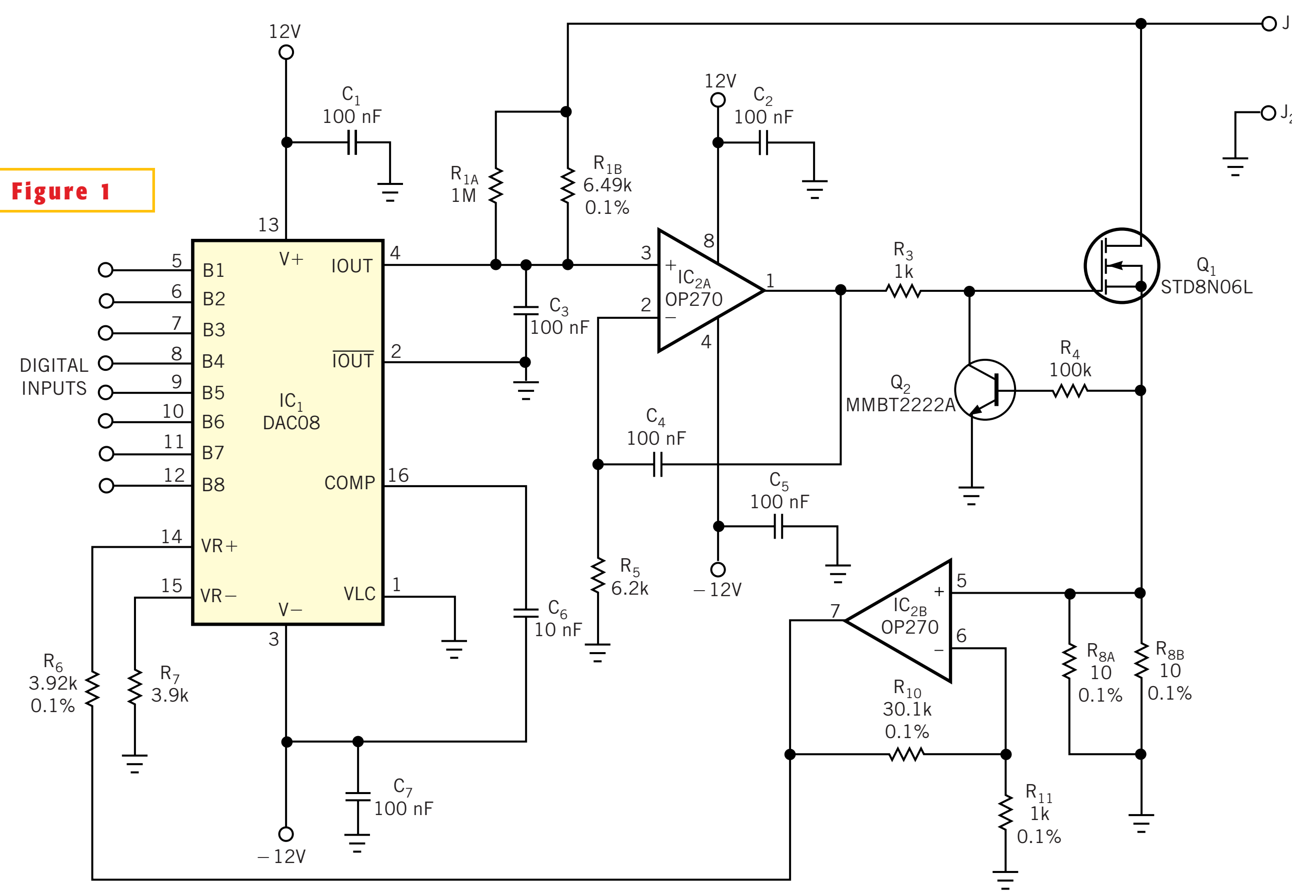
Solving **Equation 2** yields the circuit's output resistance:

$$\frac{V_0}{I_0} = \frac{A\times R_8}{R_6}\times\frac{N}{256}. \qquad (2)$$

Using the component values shown, the circuit's equivalent resistance ranges from approximately 5.5Ω for N=0, an all-zero binary input, to 255Ω for N=255, an all-one binary input.

You can modify circuit values to cover other resistance ranges. Replacing the 8-bit DAC08 with a 10-bit D/A converter increases resistance resolution. To increase the circuit's power-handling capability, replace Q_1 with a higher power MOSFET and an appropriately sized heat dissipator. Capacitors C_3 and C_4 control the circuit's bandwidth.□

Figure 1



This digitally programmable resistor features low component count and inexpensive parts.