Precision active load operates as low as 2V

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This Design Idea presents a self-powered, precision-active-load circuit that improves on a previously published design (**Reference 1**). Added features include a wider operating-voltage range of 2 to 50V or higher and several flexible current-setting modes. The circuit in **Figure 1** uses National Semiconductor's LM10, which suits this application. The LM10's reference section, IC_{1A}, generates a precision 1.2V reference voltage, V_S. Resistive divider R_1 and R_2 applies a fraction of V_S to IC_{1A}'s reference amplifier, which drives shunt regulator Q_1.

Transistor Q_3 acts as a current mirror of transistor Q_2's collector current and supplies power to shunt regulator Q_1. Resistors R_9 and R_7 set the current-mirror ratio, and the current through resistor R_9 depends on the current through R_6, which V_S establishes. As a result, Q_3, which mirrors the collector current of Q_2, provides power to the shunt regulator. V_S sets R_6, which determines the current through R_9. Thus, the LM10's reference section regulates both its own power-supply voltage and the current that Q_3 provides.

At power-on, Q_2, Q_3, and Q_4 are all off. Resistor R_{10} draws a small amount of start-up current, which Q_3 amplifies to start the current-mirror process. When sufficient current flows through R_7, Q_4 saturates, and R_9 and R_7 then set the current-mirror ratio. The active load's power-handling section comprises the LM10's operational-amplifier section, IC_{1B}, and power transistors Q_6 and Q_8. A 10-turn precision potentiometer, P_1, and range-selection switch, S_1, set the load current as follows:

On Range A, the load current varies at 1A per turn of P_1—that is, 10A maximum with P_1 set fully clockwise. On Range B, the load current varies at 100 mA per turn of P_1—that is, 1A maximum with P_1 set fully clockwise. On Range C, an external voltage source that connects to R_{13} controls the load current at a rate of 1A per volt with P_1 set fully clockwise. You can drive the external input with a function generator to test a power supply's transient response. On Range D, the load circuit emulates an adjustable power resistor with load current proportional to the voltage across the load's terminals. The equivalent resistance varies with P_1's setting—that is, $R_{LOAD}=100\Omega/N_{TURNS}$. Range E is similar to D, with a resistance of $10\Omega/N_{TURNS}$.

To calibrate the circuit, connect it to a suitable power supply delivering any voltage from 2 to 50V. First, set P_1 to one turn—that is, one-tenth of full-scale—and S_1 to Range B. Adjust R_{17} for a 100-mA output current. Then, rotate P_1 fully clockwise and adjust R_{20} to set the output current to 1A. Repeat these two adjustments in sequence because they interact slightly. Current that IC_1 draws through Q_3 sets the minimum current through the load circuit at slightly less than 1 mA.

Because the circuit operates at 2 to 50V, it is suitable for testing the low-voltage outputs of a PC's power supply. You can extend the maximum voltage by selecting suitable transistors for Q_2, Q_3, and Q_5 through Q_8; the LM10's regulated power-supply voltage does not link to the external voltage. Note that when dissipating large amounts of power, transistors Q_6 and Q_8 require adequate cooling to maintain safe junction temperatures. EDN

REFERENCE

1 Toffoli, Tommaso, "Self-powered dummy load checks out multiple power supplies," *Electronic Design*, April 17, 2000, pg 118.

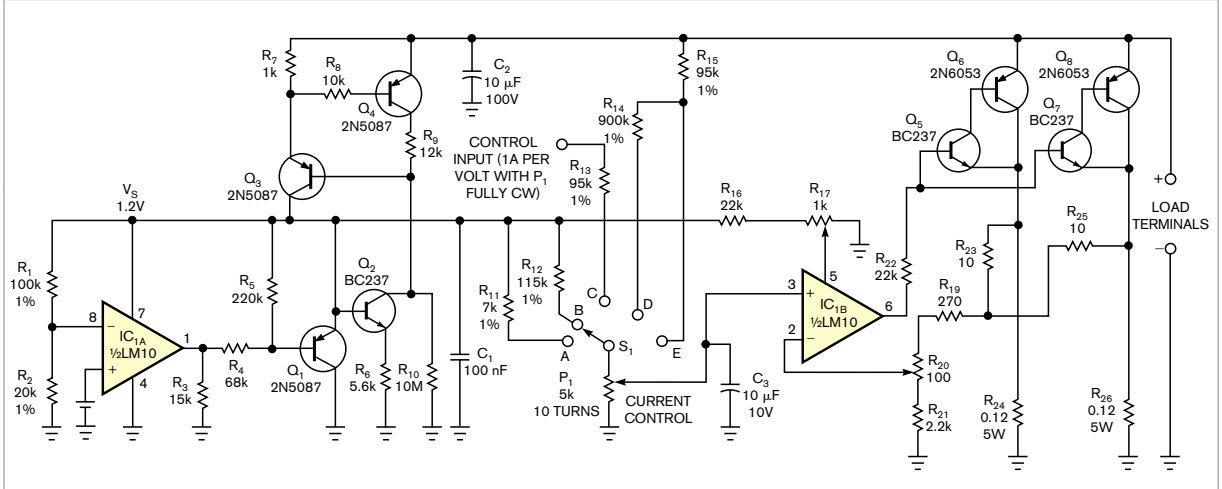

Figure 1 This versatile precision load circuit draws constant current or emulates an adjustable power resistor.