

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 R₁ and R₂ applies a fraction of V_S to IC_{1A}'s reference amplifier, which drives shunt regulator Q₁.

Transistor Q₃ acts as a current mirror of transistor Q₂'s collector current and supplies power to shunt regulator Q₁. Resistors R₉ and R₇ set the current-mirror ratio, and the current through resistor R₆ depends on the current through R₅, which V_S establishes. As a result, Q₃, which mirrors the collector current of Q₂, provides power to the shunt regulator. V_S sets R₆, which determines the current through R₉. Thus, the LM10's reference section regulates both its own power-supply voltage and the current that Q₃ provides.

At power-on, Q₂, Q₃, and Q₄ are all off. Resistor R₁₀ draws a small amount

of start-up current, which Q₃ amplifies to start the current-mirror process. When sufficient current flows through R₇, Q₄ saturates, and R₉ and R₇ 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 Q₆ and Q₈. A 10-turn precision potentiometer, P₁, and range-selection switch, S₁, set the load current as follows:

On Range A, the load current varies at 1A per turn of P₁—that is, 10A maximum with P₁ set fully clockwise. On Range B, the load current varies at 100 mA per turn of P₁—that is, 1A maximum with P₁ set fully clockwise. On Range C, an external voltage source that connects to R₁₃ controls the load current at a rate of 1A per volt with P₁ 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 P₁'s setting—that is, R_{LOAD} = 100Ω/N_{TURNS}. Range E is similar to D, with a resistance of 10Ω/N_{TURNS}.

To calibrate the circuit, connect it to a suitable power supply delivering any voltage from 2 to 50V. First, set P₁ to one turn—that is, one-tenth of full-scale—and S₁ to Range B. Adjust R₁₇ for a 100-mA output current. Then, rotate P₁ fully clockwise and adjust R₂₀ to set the output current to 1A. Repeat these two adjustments in sequence because they interact slightly. Current that IC₁ draws through Q₃ 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 Q₂, Q₃, and Q₅ through Q₈; the LM10's regulated power-supply voltage does not link to the external voltage. Note that when dissipating large amounts of power, transistors Q₆ and Q₈ 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.

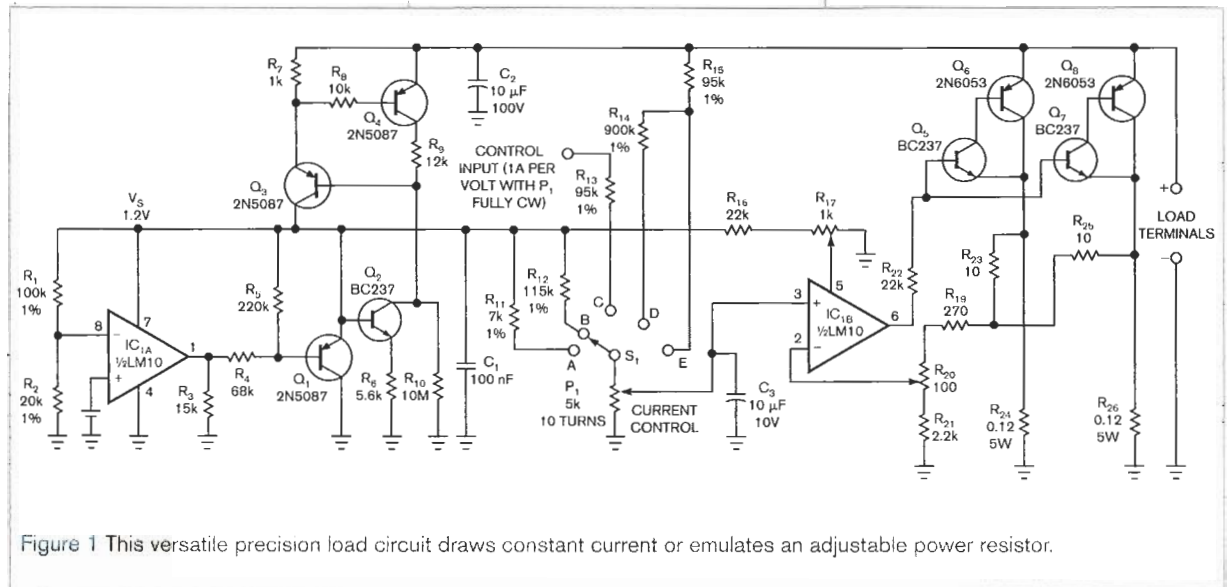


Figure 1 This versatile precision load circuit draws constant current or emulates an adjustable power resistor.