Precision voltage-controlled current sink tests power supplies

Luca Bruno, ITIS Hensemberger Monza, Lissone, Italy

To discover potential power-supply problems, you must run dynamic and static tests. This simple current sink tests low- to medium-power supplies and voltage sources. In this application, the current sink can draw current of 0 to 1.5A for an input-voltage range of 0 to 5V with a supply voltage as high as 20V. The basis of the circuit is precision op-amp IC_1, an OPA277 from Texas Instruments (www.ti.com), which features a maximum input-offset voltage of only 100 μV, maximum input-bias current of 4 nA, and low drift over the temperature range of −40 to +85°C (**Figure 1**). The op-amp IC compares its positive input voltage with the voltage across sense resistor R_{SENSE}.

IC_1's output drives an enhancement-mode N-channel power-MOSFET, Q_1, an STMicroelectronics (www.st.com) IRF530, such that the voltage across the sense resistor equals the positive-input voltage. The voltage across the sense resistor is proportional to the load current from the power supply under test and is independent of its output voltage. Q_1 features a maximum current of 14A at a case temperature of 25°C with drain-to-source voltage of 100V, low gate charge, and maximum on-resistance of 0.16Ω at a gate-to-source voltage of 10V and a drain current of 7A.

The MOSFET can dissipate a finite amount of maximum power—to 30W with the heat sink's thermal resistance of 1°C/W or less and an ambient temperature of 40°C or less in still air. The maximum power depends on the thermal resistance of the heat sink you use and the ambient temperature, so, when you increase the supply voltage, you must accordingly reduce the load current. By pulsing the input voltage, you can increase the supply voltage to several 10s of volts because the average power dissipation is lower and depends on the average load.

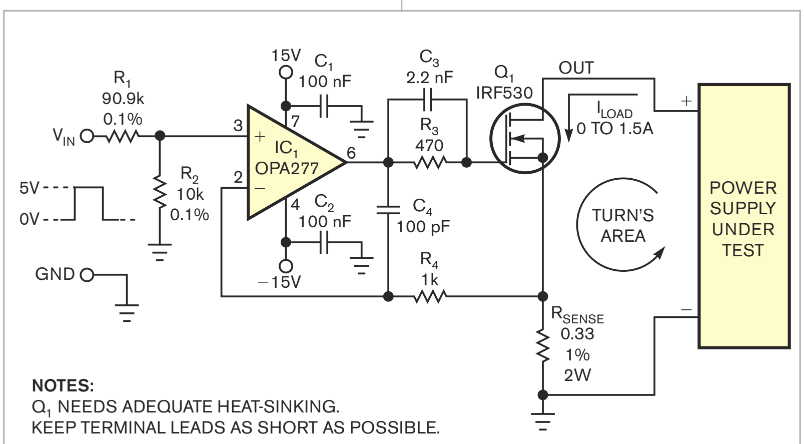

Figure 1 This simple current sink allows you to test both the static and the dynamic behavior of power supplies.

The precision resistive divider, R_1 and R_2, allows you to convert the input-voltage range of 0 to 5V into 0 to 0.495V at the positive input of IC_1, resulting in an output-current range of 0 to 1.5A. In addition, the values of resistors R_1 and R_2 provide 100 kΩ of input resistance, which is adequate for most voltage-function generators having a source impedance of 50 or 75Ω, allowing them to drive the circuit's input without using an input-op-amp buffer.

Analyzing the circuit yields the following relationships: $I_{LOAD}=GV_{IN}$, with $G=1/(\alpha R_{SENSE})=0.3A/V$, where G is the conductance, α is the attenuation factor, and $\alpha=1+R_1/R_2=10.09$. You can change the attenuation factor of the input-voltage divider to adjust

DIs Inside

90 Red LEDs function as light sensors
92 White-noise generator has no flicker-noise component
94 Analog voltage controls digital potentiometer
94 Harvest energy using a piezoelectric buzzer
96 Retriggerable monostable multivibrator quickly discharges power-supply capacitor

▶What are your design problems and solutions? Publish them here and receive $150! Send your Design Ideas to edndesignideas@reedbusiness.com.

the upper limit of the output current to several amperes, which allow you to test low-voltage power supplies with high output current.

Capacitors C_3 and C_4 and resistors R_3 and R_4 ensure loop stability, yielding a circuit with a rise time of 1.4 μsec for an input step voltage of 0 to 5V. So, you can test power supplies in either static conditions, applying a dc input voltage, or dynamic conditions, applying, for example, a pulsed input voltage to simulate fast load transients. Also, you can test power supplies or voltage sources as low as 1V because of the low channel resistance of Q_1 and the R_{SENSE} resistor; the lower limit is $1.5A(R_{SENSE}+R_{DS(ON)})=735$ mV, where $R_{DS(ON)}$ is the on-resistance.

You can also test multiple regulated outputs of power supplies such as a −5 or a −12V supply voltage. In this case, you must connect the ground of the power supply to the output of the current sink—that is, the drain terminal—and the negative output with the ground of the circuit. For accuracy, when you perform dynamic tests, such as load regulation, recovery time, and transient response, you must take care when connecting the power supply under test with the circuit to reduce the turn's area. The pulsed load current produces radiated emissions, which are proportional to this area, to the value of the current, and to the square of the current frequency, and they may disturb the circuit itself and the measuring equipment. **EDN**