

Controlled current source is versatile and precise

by Jerald Graeme
Burr-Brown Research Corp., Tucson, Ariz.

A precision voltage-controlled current source can be made by placing a pair of complementary field-effect transistors in the feedback loop of an operational amplifier. The resulting circuit will have a differential input, as well as a bipolar output current that can be used to drive either grounded or floating loads. From signals of up to ± 10 volts, the circuit develops a ± 10 -milliamper output, accurate to within $\pm 0.01\%$.

Signal voltages are usually derived from control voltages, but sometimes it is better to derive signal currents from the control voltages for either testing or driving certain loads. For example, a voltage-controlled current source can provide a simple programmable bias current for transistor testing.¹ Or it can be used for resistance measurement, since contact resistance will not affect the

test signal supplied by a current source. A current output is also needed for process-control instrumentation or for driving a meter or a dc torque motor.

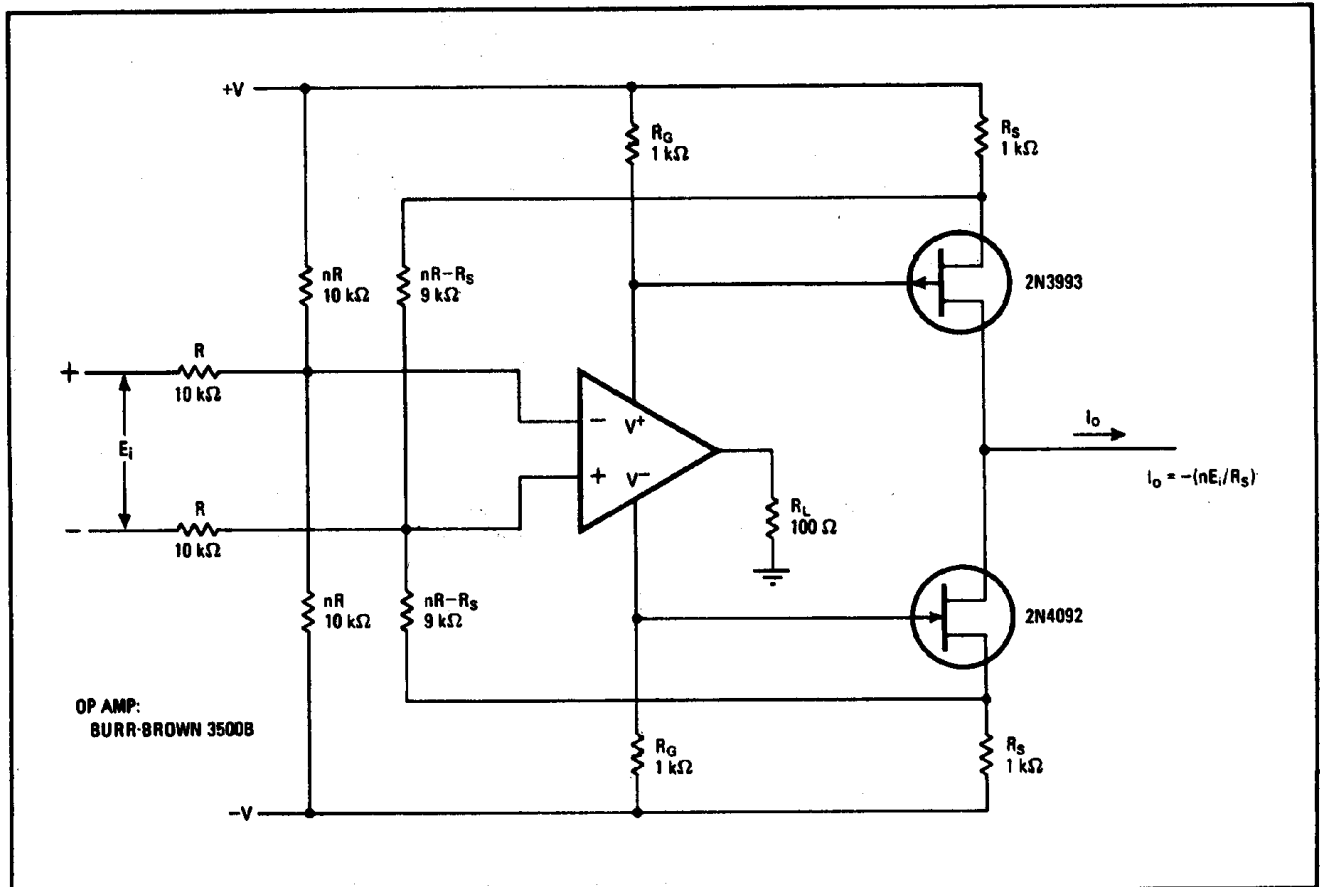
These varying applications may involve unipolar or bipolar output currents, single-ended or differential inputs, grounded or floating loads or sources, and varying degrees of accuracy. The circuit shown in the diagram can satisfy all of these requirements, and it is simpler than many previous not-as-versatile current sources.^{1,2}

The circuit here consists of opposing FET current sources that are controlled by high-gain feedback around an op amp. The difference in FET currents produces the output current, and this difference current is controlled by summing the feedback, at the amplifier input, from the current-sensing source resistors (R_S). At feedback equilibrium, the sum of the two feedback signals is directly related to the differential input signal. The circuit's output current is given by:

$$I_o = -nE_i/R_S$$

where n represents the desired resistance-ratio factor.

Differential inputs and high power-supply rejection are provided by an attenuator network at the inverting amplifier input; it matches the feedback network con-



Current drive. Voltage-controlled current source can accept a single-ended or differential input, supply a unipolar or bipolar output, and handle a grounded or floating load or source. The difference current developed by the complementary FETs is sensed by resistors R_S and fed back to the amplifier input, where it is summed with the input signal voltage. Both FET gates are driven from the op-amp supply terminals.