Make a –10V to +10V Adjustable Precision Voltage Source

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ABSTRACT

Many situations require a precision voltage source which can be adjusted through zero to both positive and negative output voltages. An example is a bipolar power supply. Have you ever adjusted your unipolar lab supply down to 0V, then swapped the output leads and adjusted it back up to get a negative voltage output? What happened to your circuit when the input from the low impedance source went open circuit? Were you able to actually adjust the output to 0V, or did a small voltage offset limit the range? This precision bipolar voltage source can solve these problems.

Perhaps the most obvious implementation of a bipolar voltage source would be to use a bipolar voltage reference.

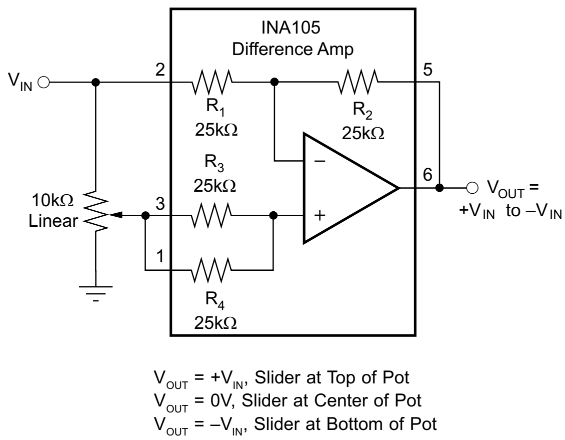

Figure 1. –1.0V/V to +1.0V/V Linear Gain Control Amplifier

However, a simpler solution is to use a single voltage reference and a precision unity-gain inverting amplifier. If you use a precision difference amplifier for the unity-gain inverting amplifier, the circuit requires just two chips and a potentiometer.

To understand how the circuit works, first consider the – 1.0V/V to +1.0V/V linear gain control amplifier shown in Figure 1. An INA105 difference amplifier is used in a unitygain inverting amplifier configuration. A potentiometer is connected between the input and ground. The slider of the pot is connected to the noninverting input of the unity-gain inverting amplifier. (The noninverting input of a unity-gain inverting amplifier would normally be connected to ground.) With the slider at the bottom of the pot, the circuit is a normal precision unity-gain inverting amplifier with a gain of –1.0V/V ±0.01% max. With the slider at the top of the pot, the circuit is a normal precision voltage follower with a gain of +1.0V/V ±0.001% max. With the slider in the center, there is equal positive and negative gain for a net gain of 0V/ V. The accuracy between –1.0V/V and +1.0V/V will normally be limited by the accuracy of the pot. Precision 10- turn pots are available with 0.01% linearity.

The –1.0V/V to +1.0V/V linear gain control amplifier has many applications. With the addition of a precision +10.0V reference as shown in Figure 2, it becomes a –10V to +10V adjustable precision voltage source.

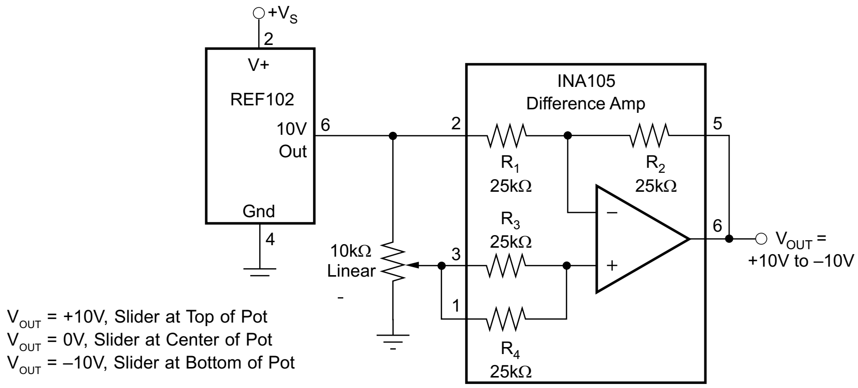

Figure 2. –10V to +10V Adjustable Precision Voltage Source

In many instances adjustable voltage sources need the ability to drive high-capacitance loads such as power-supply bypass capacitors. The additional circuitry needed to drive high capacitance is shown in Figure 3. For stability, keep $C_{LOAD} \times R_3 < 0.5 \times R_2 \times C_2$. Since access to the op amp inverting input is needed, the unity-gain inverting amplifier is made with an op amp and discrete resistors. For precision, R_1 and R_2 must be accurately matched. Also, load current flows in R_3. The resulting voltage drop adds to the required swing at the output of the op amp. Keep the voltage drop across R_3 low —less than 1V at full load—to prevent the amplifier output from swinging too close to its power-supply rail.

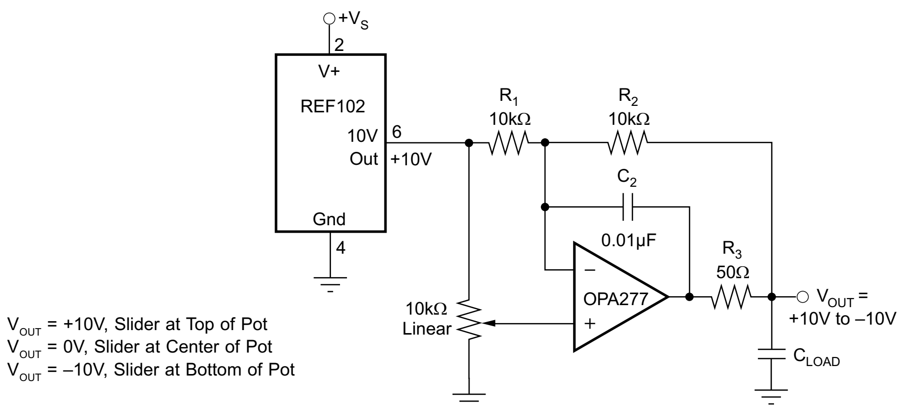

Figure 3. –10V to +10V Adjustable Precision Voltage Source with High Capacitance-Load Drive Capability

Revision History

Changes from Original (October 2000) to A Revision **Page**

- Changed formatting to standard TI application note. 1

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.