BURR - BROWN®

APPLICATION BULLETIN

Mailing Address: PO Box 11400 • Tucson, AZ 85734 • Street Address: 6730 S. Tucson Blvd. • Tucson, AZ 85706
Tel: (602) 746-1111 • Twx: 910-952-111 • Telex: 066-6491 • FAX (602) 889-1510 • Immediate Product Info: (800) 548-6132

SINGLE-SUPPLY, LOW-POWER MEASUREMENTS OF BRIDGE NETWORKS

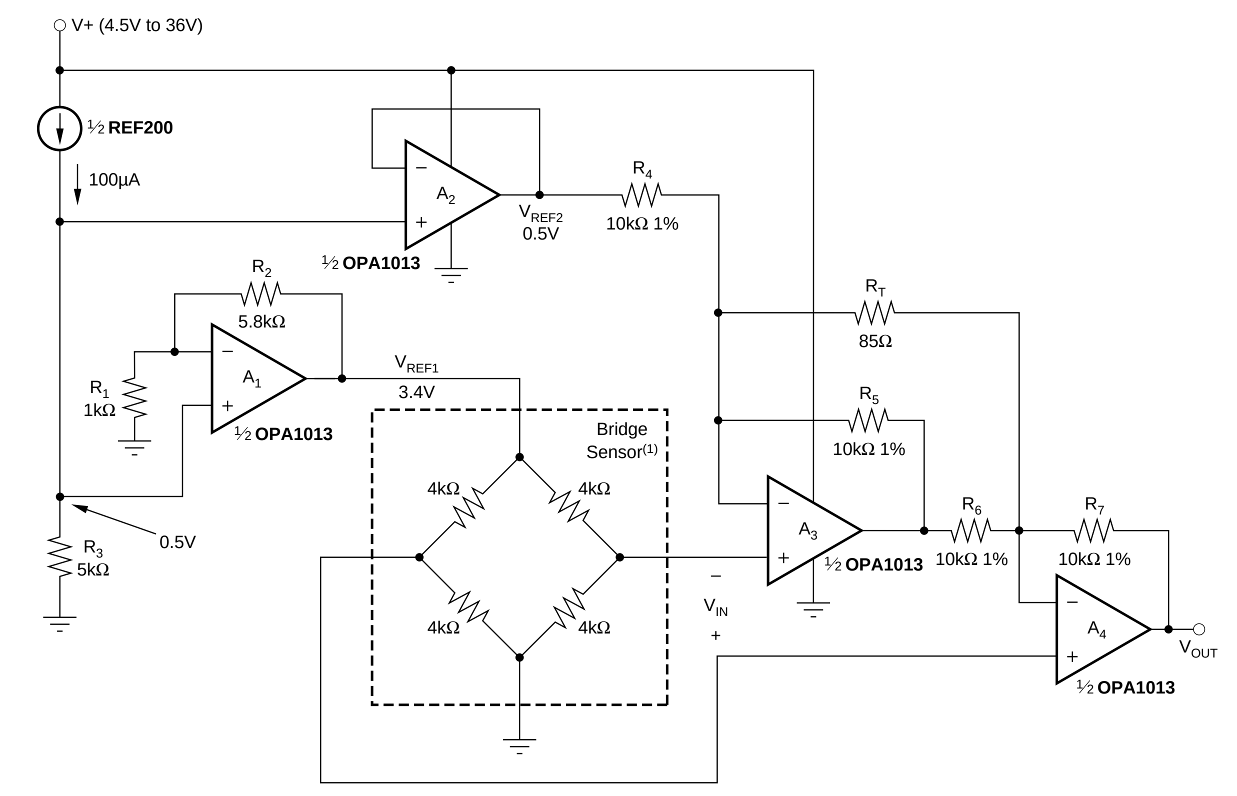
By Bonnie Baker (602) 746-7984

Bridge sensor measurements often need to be made in systems operating on a single 5V power supply. An OPA1013 dual op amp along with a REF200 current source, makes an excellent bridge measurement system which features low power single-supply 5V operation and immunity to power supply variations. One OPA1013 dual op amp is used as a two-op-amp instrumentation amplifier. A second OPA1013 is used with a REF200 to make two voltage references. One voltage reference is used to power the bridge, the other is used to offset the instrumentation amplifier.

In Figure 1, A_1 and A_2 (an OPA1013 dual operational amplifier) along with one of the current sources from the REF200 establishes a 3.4V voltage reference for excitation of a pressure transducer bridge. Although the REF200 contains two current sources, the second current source is not used, which keeps power consumption low.

A second OPA1013 (A_3, A_4), connected as a two op amp instrumentation amplifier, amplifies the differential voltage output from the bridge. Gain is easily adjusted with R_T. If 1% resistors are used for R_4-R_7, common-mode rejection will be better than 80dB for gains greater than 200V/V. A CMR of 80dB is quite acceptable in this application.

The instrumentation amplifier's reference connection is made to a 0.5V reference at the output of A_2. This voltage sets an instrumentation amplifier offset so that a zero bridge output will result in a 0.5V instrumentation amplifier output. The value of the offset can be changed by adjusting R_3.



NOTE: (1) Bridge sensor: SenSym part number BP101.

FIGURE 1. Single-Supply Bridge Measurement Circuit.

For V_{REF2} = 0.5V, R_3 = 5kΩ.

For V_{REF1} = 3.4V, R_1 = 1kΩ, R_2 = 5.8kΩ.

The required instrumentation amplifier gain can be calculated from its input voltage and the output span. The output voltage equation is:

$$V_{OUT} = V_{IN} [2(1 + R/R_T)] + V_{OUT1}$$

This equation can be rewritten as:

$$V_{OUT} = V_{IN} \bullet GAIN + V_{OUT1}$$

Where: $V_{OUT1} = V_{OUT}$ for zero instrumentation amplifier input or for zero pressure applied to the pressure transducer,

$$GAIN = –V_{OUT}/–V_{IN} = 2(1 + R/R_T)$$
$$R = R_4 = R_5 = R_6 = R_7$$

For example, a pressure sensor specified for 12.6mV full-scale output with 3.4V excitation voltage:

$$GAIN = 238V/V$$
$$\text{if } R = 10k\Omega,\ R_T = 85\Omega$$

If adjustment is required:

Adjustment Procedure

1. With zero-pressure applied, adjust R_3 for V_{OUT} = 0.5V.
2. Apply full-scale pressure to the sensor and adjust R_T for V_{OUT} = 3.5V.
3. Repeat procedure if necessary.

There is no true single-supply instrumentation amplifier on the market today. Although some come close, their applications are limited because they are fixed gain. The OPA1013 provides the best solution for this application because of its single supply operation and output swing range within 15mV from ground. The REF200 requires one power supply and is ideal for use in single supply systems. The REF200 provides a simple, economical way to make adjustable voltage references.

The supply voltage of the bridge conditioning circuit can range from 4.5V to 36V without affecting the operation of the circuit. Because of the low quiescent current of the OPA1013 (350µA) and the low current requirements of the REF200 (100µA), this is an excellent circuit for battery operated applications.