

Wheatstone Bridges

Bridge circuits are useful for making resistance, capacitance, and inductance measurements. Resistive bridges are also known as Wheatstone bridges. These bridges will be very useful in lab and this appendix reviews the basic concepts behind them.

Specifically, Wheatstone bridges are useful in thermistor and RTD circuits because these sensors do not directly output voltages, but rather changes in resistance. Bridge circuits can be used to convert changes in resistance to voltage, which are easier to measure and manipulate using software like LabVIEW.

A basic Wheatstone bridge circuit contains four resistances, a constant voltage input, and a voltage gauge, as illustrated below.

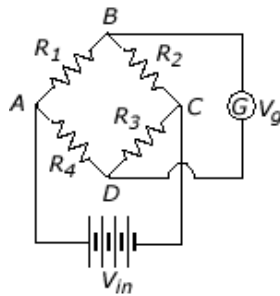


Figure 1—Wheatstone Bridge

Using basic circuit theory, one can come up with the following relationships:

$$V_{in} = V_{ABC} = V_{ADC}$$

$$\Rightarrow I_{ABC} (R_1 + R_2) = I_{ADC} (R_4 + R_3)$$

V_{AB} and V_{AD} can be solved for using the following:

$$\begin{cases} V_{AB} = I_{ABC} R_1 = \frac{V_{in}}{R_1 + R_2} R_1 \\ V_{AD} = I_{ADC} R_4 = \frac{V_{in}}{R_4 + R_3} R_4 \end{cases}$$

From here, it is easy to solve for V_G , the gauge reading:

$$V_g = V_{AB} - V_{AD} = \frac{V_{in}}{R_1 + R_2} R_1 - \frac{V_{in}}{R_4 + R_3} R_4$$

$$= \frac{R_1 R_3 - R_2 R_4}{(R_1 + R_2)(R_4 + R_3)} V_{in}$$

If any of the bridge resistances change during the measurement, the gauge reading will also change. The new voltage reading will be:

$$V_g + \Delta V_g = \frac{(R_1 + \Delta R_1)(R_3 + \Delta R_3) - (R_2 + \Delta R_2)(R_4 + \Delta R_4)}{(R_1 + \Delta R_1 + R_2 + \Delta R_2)(R_4 + \Delta R_4 + R_3 + \Delta R_3)} V_{in}$$

It is also worth noting that when all four resistances are the same, V_g goes to zero and the equation describing the change in voltage can be simplified to the following:

$$\Delta V_g \approx \frac{\Delta R_1 - \Delta R_2 + \Delta R_3 - \Delta R_4}{4R} V_{in}$$

Modified from eFunda: Introduction to Wheatstone Bridges

http://www.efunda.com/designstandards/sensors/methods/wheatstone_bridge.cfm