Application Note

Measuring a Strain Gage Sensor with the Bridge110

- Bridge110

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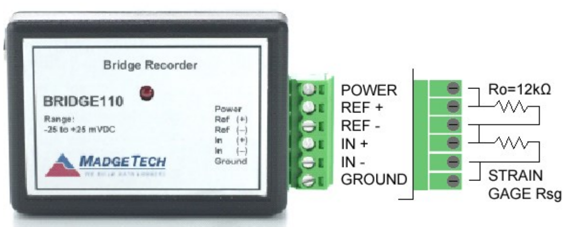
This application Note demonstrates the use of a common value strain gage (120Ω) with the Bridge110. This note will cover both resistor divider (single gage) and Wheatstone Bridge (double gage) applications. In addition we will discuss the conversion from voltage to microstrain.

Voltage Divider Configuration

The Voltage Divider configuration is a simple and frequently used setup to measure bridge strain. It's ease of use makes it an adaptable and user-friendly solution to most general bridge strain applications.



1. Jumper between POWER and REF+
2. Place a 12kΩ resistor between REF+ and REF-
3. Jumper between REF– and IN+
4. Place the strain gage between IN+ and IN-
5. Jumper between IN– and GROUND

To convert the voltage values into ohms, use the following formula:

$$\Omega_{in} = 120\Omega \times \left(\frac{V_{in}}{mV_{ref}} \right) \Rightarrow 4.8 \times V_{in}$$

{Ω_{IN} in Ω, V_{IN} in mV, mV_{ref} 25}

<u>EXAMPLE:</u>

The MadgeTech software reports a voltage of 20mV in the circuit described above. The strain gage resistance is therefore:

$$\Omega_{in} = 4.8 \times V_{in} = 4.8 \times 20mV = 96\Omega$$

The resistor R_o between REF+ and REF- and the strain gage value R_{sg} form the mV reference (mV_{ref}). This may be expressed as:

$$mV_{ref} = 2.5 \times \frac{R_{sg}}{R_o}$$

If R_o is 10kΩ (instead of 12kΩ) then:

$$mV_{ref} = 2.5 \times \frac{120\Omega}{10k\Omega} \Rightarrow 30mV$$

Note: The maximum voltage must be kept within the specified input range. (See datasheet for details)

The Bridge 110-25 has a resolution of about 2µV. If the resistance of the strain gage changes from 120Ω to 120.1Ω the device would measure a change of approximately 20µV. Conversely, this voltage resolution translates in Ohms to approximately:

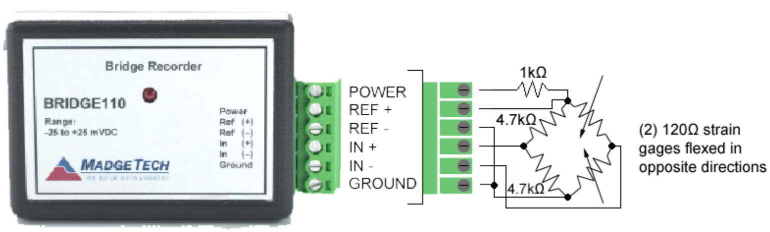
$$120\Omega \times \frac{0.020mV}{25mV_{ref}} \approx 0.096\Omega$$

Note: Depending on sensor implementation, the measurement noise may become significant to these low voltage levels

Wheatstone Bridge Configuration

If it is desired to make strain gage measurements with better signal integrity and not requiring matching the thermal expansion coefficient to the material, then a Wheatstone Bridge configuration ought to be considered. While there are several versions of the Wheatstone Bridge, the least complex configuration that has these desirable qualities is the One-half bridge.

ONE-HALF WHEATSTONE BRIDGE



Note 1: The two strain gages need to bend in the opposite direction when stressed. Under this arrangement, the non-linear error is nulled out and temperature coefficients between the sensors and the material do not have to match.

Note 2: The tolerance of the 120Ω resistors and the "matched" values of the strain gages affect the "null" reading which theoretically ought to be 0V. It is recommended to use 1% or better resistors and identical strain gages.

$$microstrains(\mu\varepsilon) = \left(\frac{\Delta R}{R}\right)\times 1{,}000{,}000 \Big/ GageFactor$$

EXAMPLE:

A common unit of strain gage measurement is microstrains (µε). Microstrain is mathematically expressed below:

Where ΔR/R is the ratio between the change in strain gage resistance (under stress) and the nominal strain gage resistance. The Gage Factor (GF) is specified by the manufacturer or vendor of the particular gage. Typically, GF values are 2 to 4.5 for metal and 50 to 200 for semiconductor strain gages.

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EXAMPLE:

A 120Ω strain gage measures, under stress, 120.1Ω. The GF is 2,1. Convert to microstrains:

$$\left(\frac{0.1}{120}\right)\times 1{,}000{,}000 \Big/ 2.1 = 397\,\mu\varepsilon$$

If you wish to convert to microstrains from the differential bridge voltage, you can use the following equation (assumes you are using the one-half Wheatstone Bridge as shown previously)

$$microstrains(\mu\varepsilon) = \frac{\left(\frac{2\times\Delta v}{V_p}\right)\times 1{,}000{,}000}{GF}$$

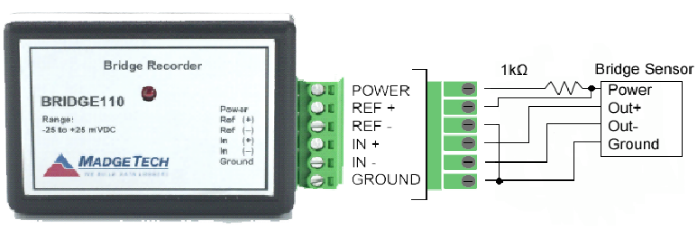
where:

ΔV = measured differential bridge voltage
V_p = bridge excitation voltage
GF = Gage Factor provided by the gage manufacturer

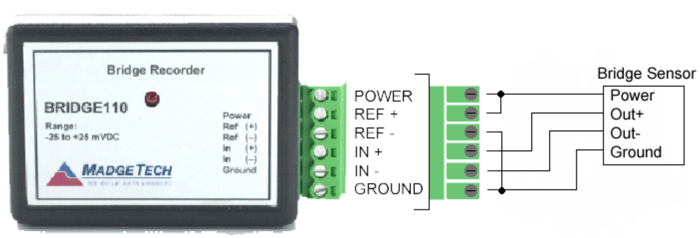
In some circumstances you may wish to plug in a packaged Wheatstone Bridge sensor such as the Omega® PX170 differential pressure gage or Omega® LCGC series Load Cell gages. In these circumstances, the internal resistive bridge cannot be altered.

When using a packaged Bridge sensor, check the specified bridge resistance. If it is less than 1kΩ then add a 1kΩ resistor between the power and bridge. You may use values higher than 1kΩ to conserve battery power, but it will diminish the signal to noise ratio. If the bridge resistance is greater than 1kΩ then no additional resistor is required.

PACKAGED WHEATSTONE BRIDGE SENSOR LESS THAN 1KΩ RESISTANCE



PACKAGED WHEATSTONE BRIDGE SENSOR GREATER THAN 1KΩ RESISTANCE



If you have any further questions about your application, please contact MadgeTech Customer Support at 603.456.2011, or via e-mail: support@madgetech.com