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BLACK LAB SYSTEM
TECHNICAL NOTE #108

SUBJECT: Connecting Strain Gauge Sensors to the Black Lab
See also:
Bulletin on CIM (Connector Interface Modules) available from Analog Interfaces
Technical Note #101, Connecting Analog Sensors to the Black Lab

DATE OF LAST REVISION: 10/18/2005 **REV # 1**

Strain Gauges

Strain gauges are devices whose electrical resistance varies in proportion to the amount of strain in the device. The most widely used type of gauge is the bonded metallic strain gauge. The most common type of this gauge has metallic foil arranged in a grid pattern. The grid is attached to a thin backing that is bonded to the specimen. The resistance of the gauge changes linearly in relation to the strain in the test specimen. Strain gauges are commonly available with nominal resistances of 120, 350, and 1000Ω.

The following description is intended to be only a brief overview. For more detailed information, consult the following web sites.

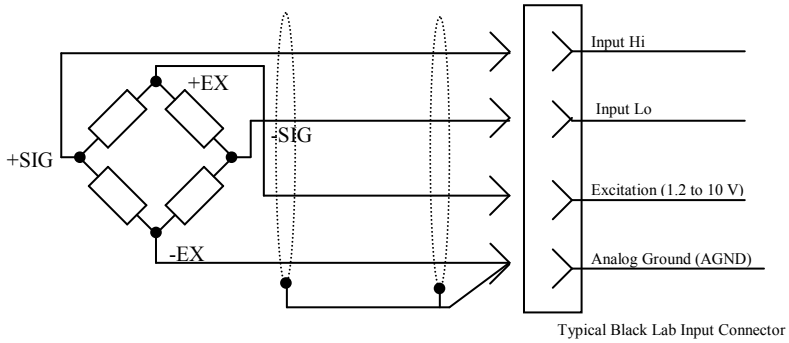
Strain gauge connection chart with equations.
http://www.straingauge.com/pdf/straingauge/straingauge_connection.pdf

General guide about strain gauges and their usage.
http://www.vishay.com/company/brands/measurements-group/guide/ta/sgbt/foreword.htm

Measuring Strain with Strain Gauges – by National Instruments
http://zone.ni.com/devzone/conceptd.nsf/webmain/C83E9B93DE714DB08625686600704DB1?OpenDocument

Industrial Transducers using Strain Gauges

Many types of industrial and laboratory sensors (such as pressure transducers, load cells, force sensors, etc.) use strain gauges in the form of a wheatstone bridge to transform the physical parameter into an electronic signal. In these instruments, the strain gauges are mounted internally and the user makes connection to the external terminals. The following diagram shows how these types of sensors are connected to the Black Lab.



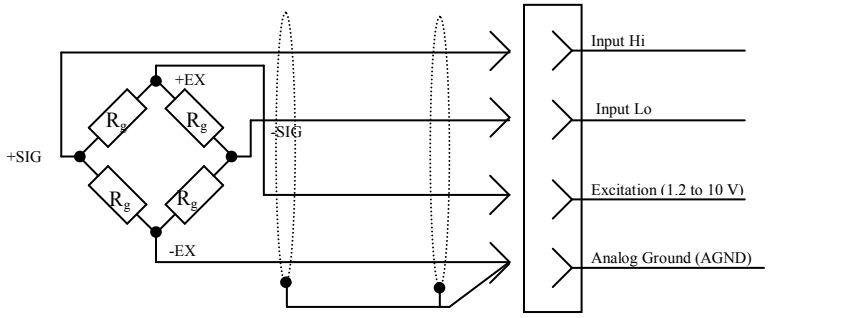
Typical Black Lab Input Connector

These sensors should be connected to the Connector Interface Module using 4-conductor shielded cable (Belden 9940 for example) or 2 pair shielded cable (Belden 8723 for example).

In order to connect to this type of sensor, the Black Lab must be equipped with the optional 1.2 to 10 volt power supply in the Type III Connector Interface Module. The power supply voltage can be set to a nominal value or it can be adjusted so that the voltage signal coming back from the transducer is proportional to engineering units. Also, the jumper inside the Type III Connector Interface Module must be removed so that the **Input Lo** is not connected to **Analog Ground**.

Full-Bridge Circuit

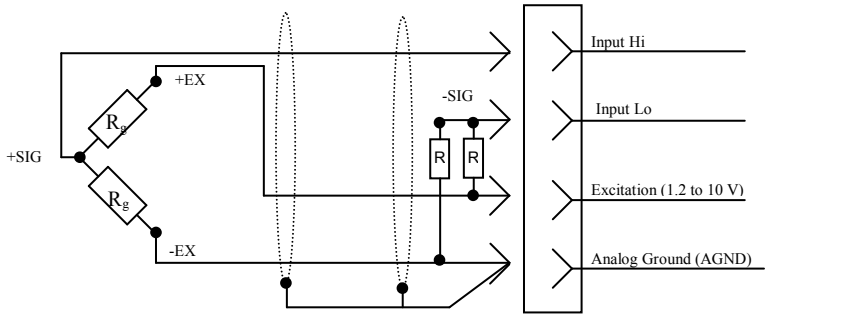
The connection diagram for a Full-Bridge strain gauge is shown below. In this case there can be either 4 active strain elements (marked as R_g in the diagram below) or 2 active elements and 2 thermal compensating elements. Full-Bridge strain gauges should be connected to the Black Lab in the same manner as was shown for the transducers shown above.



Connection Diagramfor a Full-Bridge Circuit

Half Bridge Circuit

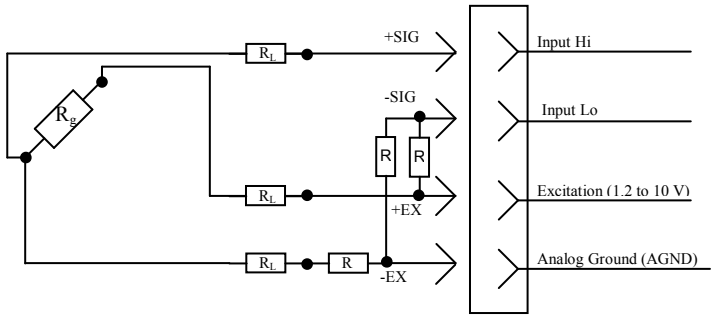
In a half –bridge circuit, there are only 2 strain elements. One element is typically used to sense strain and the other is for temperature compensation. Two resistors called completion resistors (marked as R in the diagram below) must be added to the input connector in order to complete the bridge circuit. The value of these resistors should be approximately the same as the nominal resistance of the strain elements. Three-conductor shielded cable (Belden 9939 for example) should be used for long connections.



Connection diagram for a Half-Bridge Circuit
With 2 completion resistors

Quarter Bridge Circuit

In a quarter-bridge circuit, there is only one active element. The other three legs of the bridge are achieved using three completion resistors (marked as R in the diagram below) added to the input connector. Again, the value of these resistors should be approximately the same as the nominal resistance of the strain element. Connection to the active element can be via a 2-wire connection (not shown) when the connection distance is short and the lead resistance is small in relation to the resistance of the gauge. However, the 3-wire connection shown below has an advantage for longer lead lengths. In this case, the effect of the lead resistance, R_L, is minimized because there is an equivalent R_L in both the upper and lower portions of the bridge circuit.



Connection Diagram for a Quarter-Bridge Circuit Showing the Strain Gauge (R_g), the 3 Bridge Completion Resistors (R), and the Lead Resistance (R_L).