4-Channel Strain Gage Amp

The 4-channel strain gage amplifier is a stackable collection of 4 individual boards configured for pre-conditioning strain gages in a Wheatstone bridge arrangement. The Wheatstone bridge is a 4-resistor arrangement for impedimetric measurement that helps compensate for temperature and other confounding effects on impedance-based sensors and provides a true differential output. The bottom 2 channels use the Analog Devices AD524 integrated instrumentation amplifier with configurable gain and filtering, while the top 2 channels use Texas Instruments TL084 operational amplifiers in an instrumentation amplifier arrangement.

A Wheatstone Bridge is a collection of 4 resistors that are all nominally the same resistance. Arranged as shown in Fig. 1, the resistors are powered by a single power source across points A and C and produce a true differential output across points B and D that reflects the difference in the resistances. If R1, R2, R3 and R4 are all the same value, the pairs R1/R2 and R3/R4 act as voltage dividers and split the source, E, in half. Therefore, the difference, measured between points B and D, will be zero. This is referred to as a "balanced bridge." The benefit of the Wheatstone bridge is that if one of the resistors changes by a small amount (see R2 in the figure), it will "unbalance" the bridge and produce a voltage between points B and D. If a differential input amplifier with a high gain is connected to B and D, it can detect very small changes in R2. (Useful for strain gages and many other types of transducers.) Another benefit of the Wheatstone bridge is that if the circuit changes temperature, all of the resistors will drift. If they all drift the same amount, the drift will be cancelled, leaving no impact on the signal measurement. Finally, if long wires are used to carry the signals from a device, the wires can pick up interference. Using a Wheatstone Bridge can cancel this interference, too, if all the legs of the bridge experience the same interference.

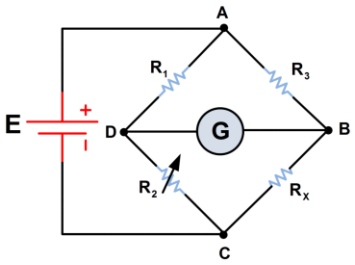

Figure 1: Wheatstone Bridge.

In summary, Wheatstone bridges are very helpful in measuring sensors in the presence of noise. For strain gages, sets of 2 or 4 strain gages can be used in all resistors of the bridge if they are on opposite sides of a beam or equivalent and will double or quadruple the signal.

Strain gages are normally connected to a ribbon cable that routes them to R_1, R_2, R_3, R_4 as needed. Dual power supplies (+/- 12-15 V) with a common ground are connected to the polarized connector on the top board. An excitation signal is provided that can either be a DC source, an AC source, or a stepped DC signal. The single-ended outputs are routed through another ribbon cable

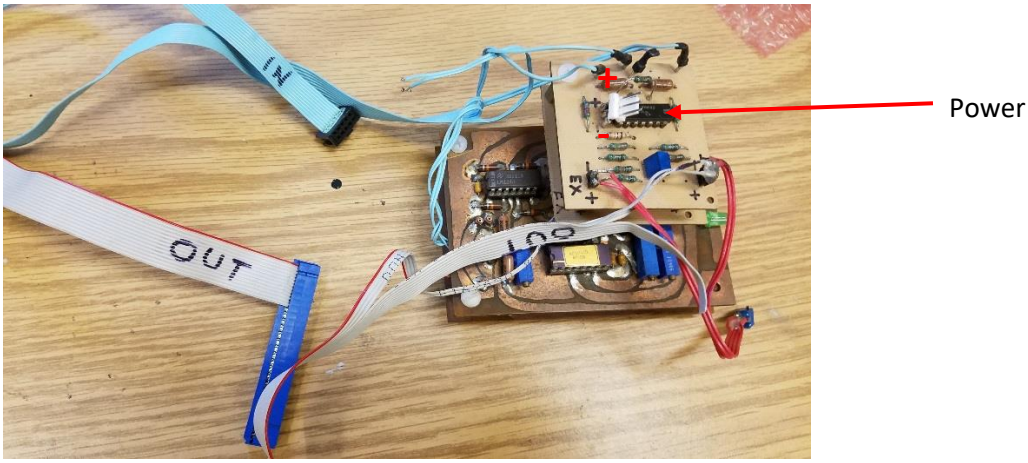

Figure 2: Stack of strain gage amplifier boards with input and output cables connected. The excitation circuit provides a constant voltage source from the power supply.

AD524 Board

The AD524 Board uses the Analog Devices AD524 instrumentation amplifier which implements an instrumentation amplifies using Op Amps and laser-trimmed resistors in silicon. It provides a jumper-selectable gain. See the AD524 data sheet for details and the uses of the trim resistors and filters.

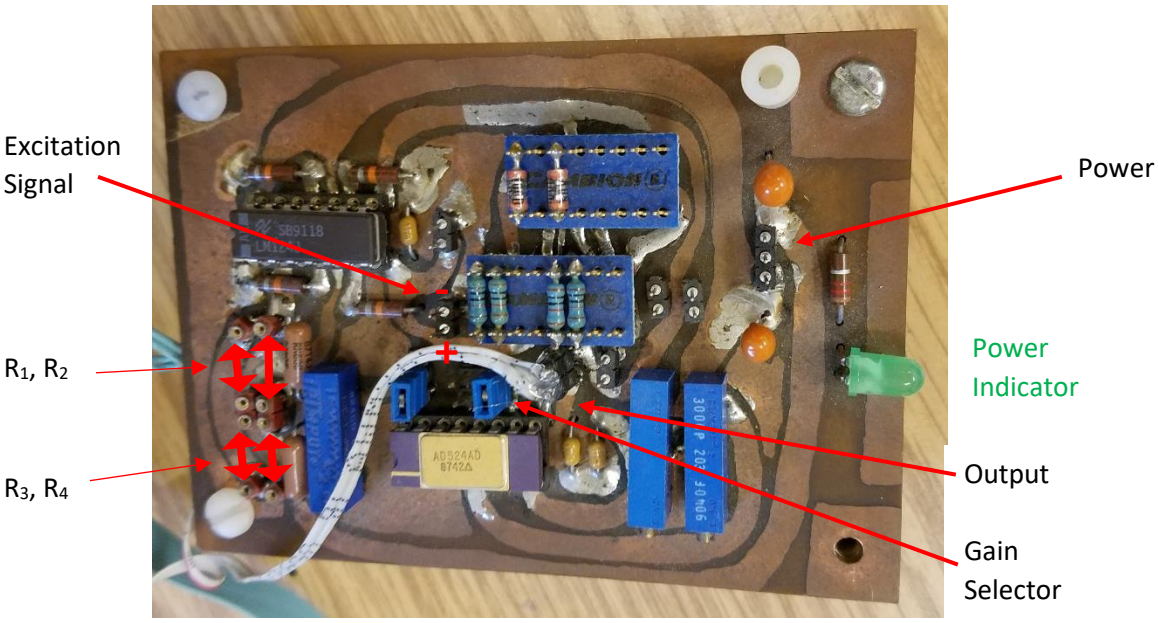

Figure 3: AD524 Board with connectors and configurable resistor/capacitors banks.

Power

Analog power to the board is +/- 12-15 V. All four boards stack together and distribute power to all boards through the top board.

Input Circuits

The input circuits of the AD524 boards provide a configurable Wheatstone bridge with 1, 2, 3, or 4 matched variable resistances. Indicated as R_1, R_2, R_3, R_4 in the figure

Excitation Circuit

The excitation circuit takes the input signal and reduces it to one-tenth of its amplitude and drives the Wheatstone bridge.

TL084 Board

The TL084 is a general purpose operational amplifier (Op Amp), configured in an instrumentation amplifier, as shown in Fig. 4.

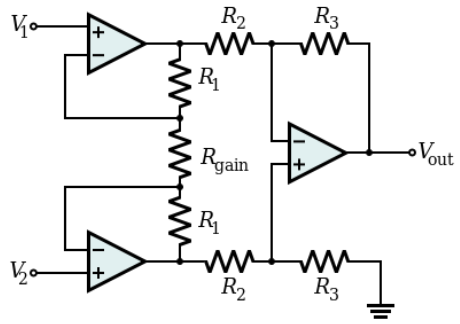

Figure 4: Instrumentation amplifier circuit made out of Op Amps.

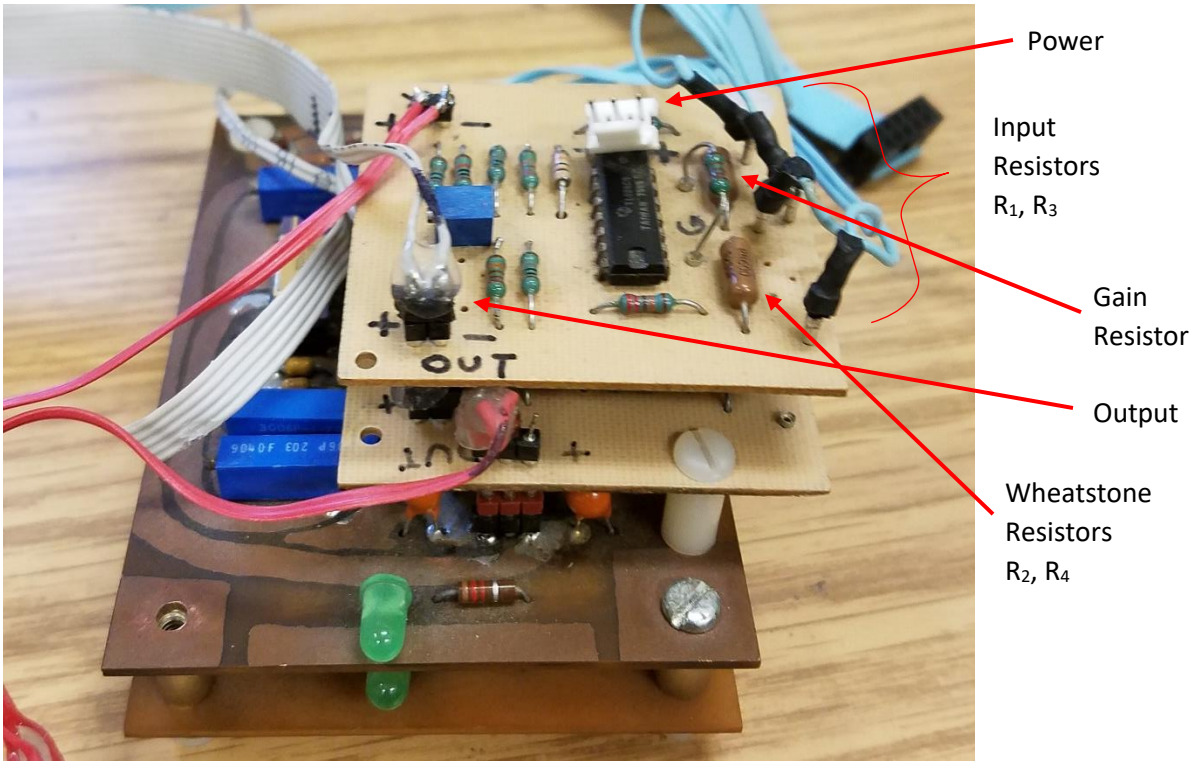

Figure 5: TL084 Board with inputs and outputs labeled.