Bridge Circuit for Transducer Interface

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***Abstract*—A Wheatstone bridge circuit was developed to interface a strain gauge transducer for mechanical deformation sensing. The bridge circuit was paired with an instrumentation amplifier to provide high-gain differential signal amplification. This project highlights practical considerations in bridge design, including resistor matching, mechanical mounting, and signal conditioning for bioinstrumentation applications.**

***Index Terms*—Strain Gauge, Wheatstone Bridge, Instrumentation Amplifier, Transducer Interface**

I. Introduction

Transducers that convert mechanical deformation into electrical signals, such as strain gauges, require careful signal conditioning to ensure accurate measurement. A common method to accomplish this is by integrating the transducer into a Wheatstone bridge circuit as depicted in Fig. 1. The Wheatstone bridge allows for precise detection of small resistance changes by balancing the circuit around a known voltage reference. When combined with an instrumentation amplifier, this setup provides high common-mode rejection and gain to produce a usable output signal.

II. Methodology

The common resistors of the Wheatstone bridge were chosen to as closely match the strain gauge resistance, which was acheived by using a 100Ω resistor in series with a 20Ω resistor; the experimental values of these resistors are given in Table I. The strain gauge effectively acts as a variable resistor completing the Wheatstone bridge. The bridge is powered by a regulated 5V supply generated with a 7805 voltage regulator.

The original implementation of the circuit is shown in left of Fig. 2 where the blue wires are connected to the inputs of an instrumentation amplifier developed in a previous project [1]. However to trim the DC offset, the 100Ω resistor of the bottom right resistors in series of the Wheatstone bridge was replaced with a 100Ω potentiometer as shown in the right of Fig. 2.

The strain gauge was originally mounted on a plastic ruler acting as a cantilever beam. However, to test the full range of the strain gauge, it was later moved to the end of the plastic ruler as depicted in Fig. 3. As a demonstration of the strain gauge in this configuration, the strain gauge was approximately bent to reach ±90° also depicted in Fig. 3.

TABLE I: Wheatstone Resistors in Series

Resistor	Ideal	Measured
Top Left	100Ω	98.10Ω
Top Left	20 Ω	22.07 Ω
Top Right	100Ω	97.68Ω
Top Right	20 Ω	21.91 Ω
Bottom Right	100Ω	97.49Ω
Bottom Right	20 Ω	21.83 Ω
Strain Gauge (No Load)	120 Ω	120.07 Ω

III. Results

The output of the instrumentation amplifier was measured with an oscilloscope and the results are shown in Fig. 4. As seen in the average measurements, the output with no load was around 273 mV, positive bending was around 6.333V, and negative bending was around −7.123V. With a small

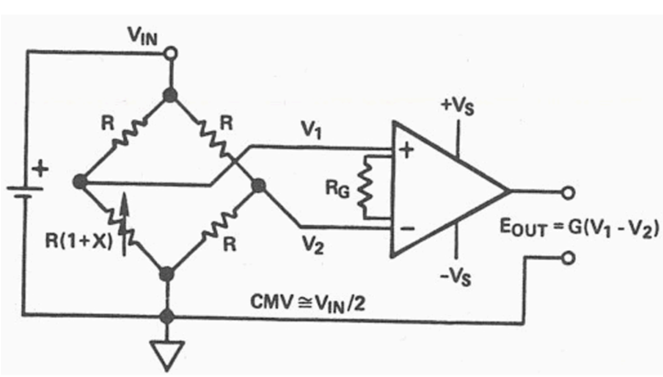

Fig. 1: Wheatstone bridge circuit.

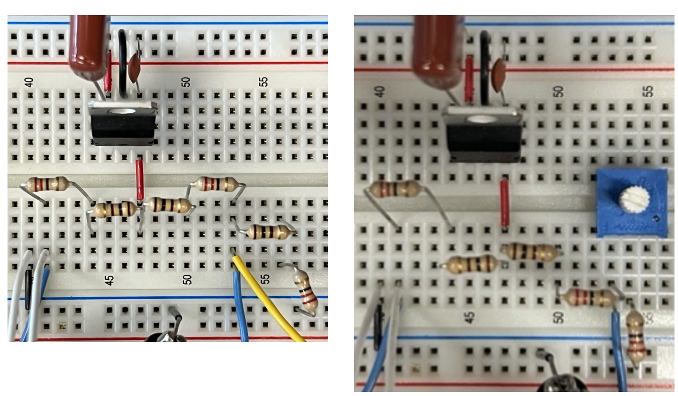

Fig. 2: Wheatstone Bridge Implementation. Left: Original Implementation; Right: Potentiometer Implementation

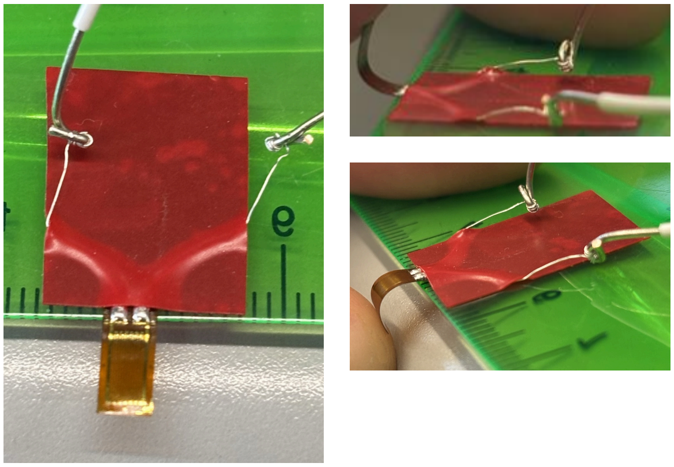

Fig. 3: Strain Gauge Setup. Left: No load Setup; Top Right: Negative Bending; Bottom Right: Positive Bending. Positive bending is defined as bending the strain gauge away from the soldered leads, while negative bending is defined as bending the strain gauge into the soldered leads.

difference between positive and negative bending, it seems that the strain gauge is equally sensitive to both bending directions.

IV. Discussion

The method of trimming the DC offset with a potentiometer in the Wheatstone bridge was opted over a potentiometer in the instrumentation amplifier circuit. This was done to avoid the need of altering the already implemented circuit.

The strain gauge was difficult to work with due to its small size and fragility, and in the end after breaking a couple leads, I was unable to implement further features for this project, like adding another strain gauge to the other side of the beam.

References

[1] J. Cho, “Instrumentation Amplifier,” Mar. 25AD.

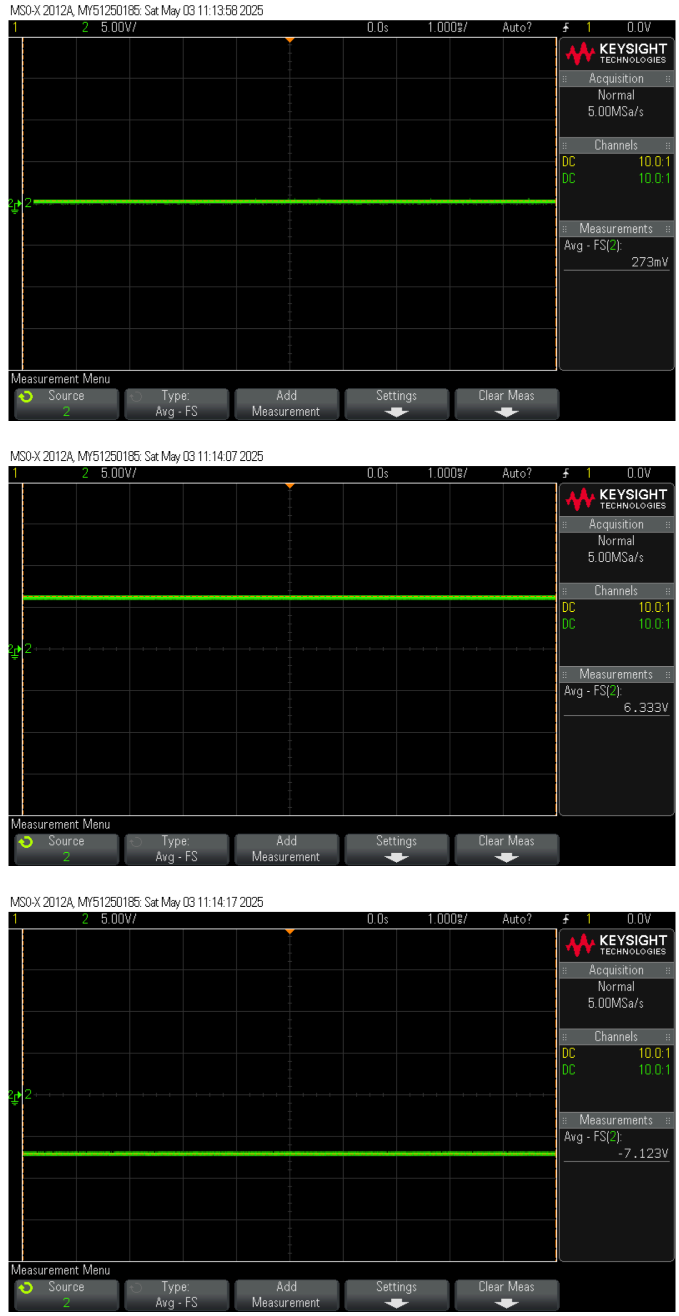

Fig. 4: Oscilloscope Screenshots. Top: No Load; Middle: Positive Bending; Bottom: Negative Bending