Strain Measurement Experiment: No Bias at Zero Mechanical Load

In the Strain Measurement Experiment, each lab group of undergraduates at the Mechanical and Aerospace Engineering Departmen, New Mexico State University, is required to measure strains using strain gages in a tensile coupon aluminum alloy specimen at 0, 45 and 90 degrees to the loading axis. Students built Wheatstone Bridges using inexpensive, commercially-available resistors but soon discovered that the large bias voltage at zero mechanical load on the specimen made strain measurement impossible. High precision resistors provided by Vishay Foil Resistors made the Strain Measurement Experiment a success.

Author: Professor Vincent Choo

Company/Institute: New Mexico State University

Industry/Application Area: Education

Product used:
- 1202LB500R ±10%, 10PPM
- Z201 T 3K00000

The Challenge

Our undergraduate students found that the output signal voltage from each Wheatstone Bridge was large at zero load on the specimen. This large bias voltage at no load made the strain measurement impossible.

The Solution

The Vishay Foil Resistors' 1202LB500R ±10% 10PPM Precision Trimming Potentiometer and Z201 T 3K00000 with patented Bulk Metal® Foil technology enabled us to build Wheatstone Bridges with nulling capabilities, which allowed the students to conduct strain measurement successfully.

The User Explains

We did not set up the experiment to test the stability of the resistors. Our primary focus was to enable our students to build Wheatstone Bridges for the purpose of measuring strains on a tensile

specimen. Nevertheless, the stability of the resistors is of vital importance for long term strain measurements.

We knew in advance that the inexpensive resistors had high variability in resistance that would result in large bias voltage at no load to the specimen, making it impossible to measure the strains. We were taking a chance – but had no luck with our results.

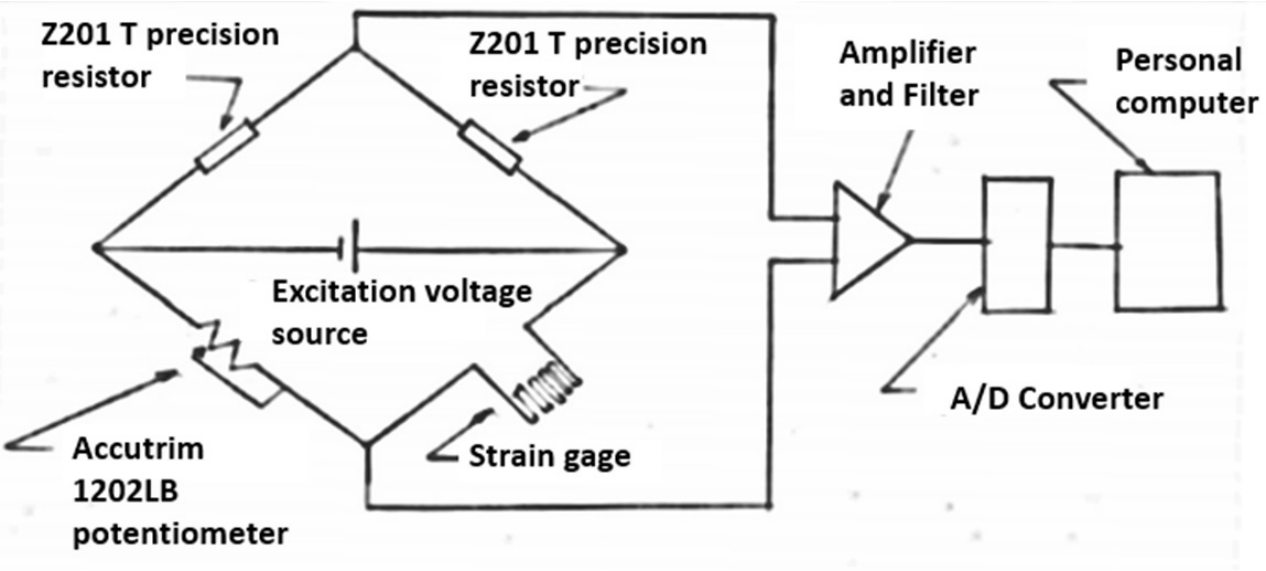

Figure 1: Test setup and Wheatstone Bridge schematic diagram

Our failed experiment taught us that selecting the right components, with the right performance characteristics, is critical in the success of our experiment. This time, the class used two Z201T precision resistors, one Accutrim 1202LB potentiometer and a strain gage to construct a functional Wheatstone Bridge. The two Z201T precision resistors form two arms of the Wheatstone Bridge. The other two arms use the Accutrim 1202LB potentiometer and the strain gage, as shown in the schematic diagram (Figure 1). Three Wheatstone Bridges are built on a circuit board as shown in Figure 2. They are enclosed in an electronic box. Three strain gages are bonded to each specimen by students, requiring three Wheatstone Bridges for the strain measurement. Very often each of the Wheatstone Bridges would be out of balance at no load to the specimen. The Accutrim 1202LB potentiometers would enable us to null the Wheatstone Bridges so that no bias voltage would be present at no load. The absence of a bias voltage would enable us to measure small strains at low load. For the experimental setup shown in figure 3, the loads for the entire loading range are small. A significant bias voltage would prevent us from conducting the strain measuring experiment.

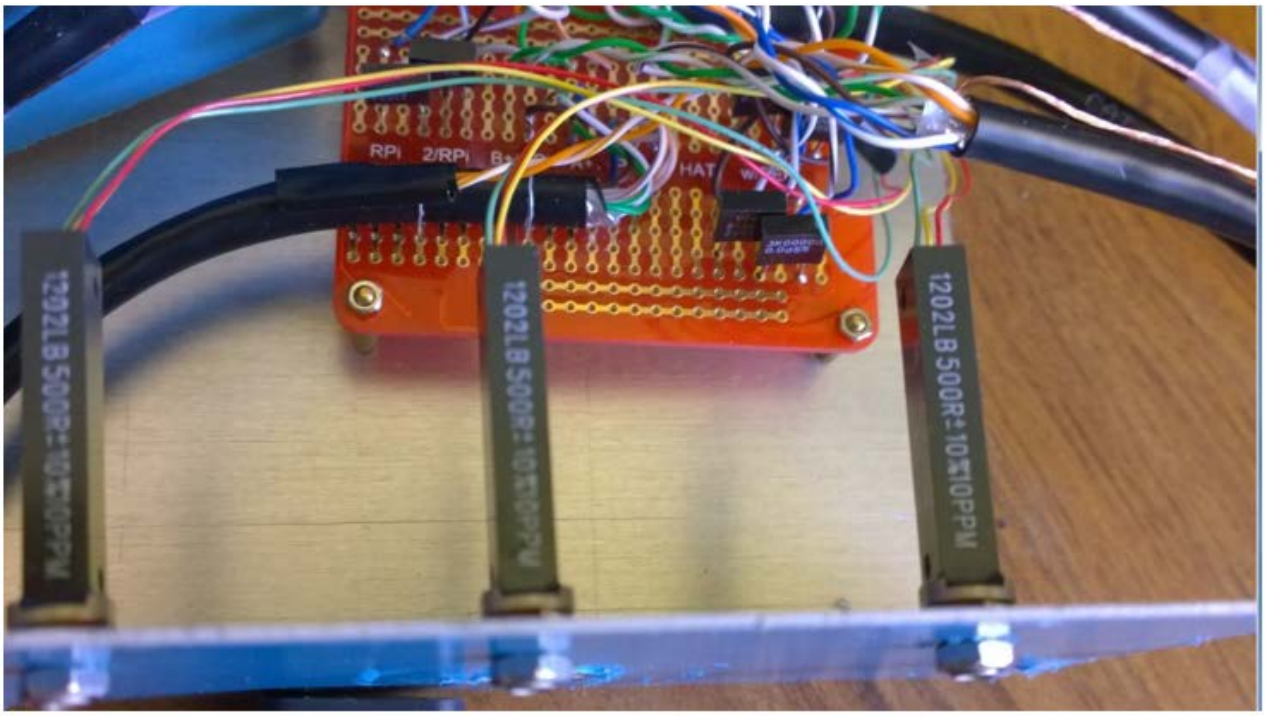

Figure 2: Wheatstone Bridges with the Vishay Foil Resistors' 1202LB 500R ±10%, 10PPM precision trimming potentiometers and Z201T 3K0 precision resistors

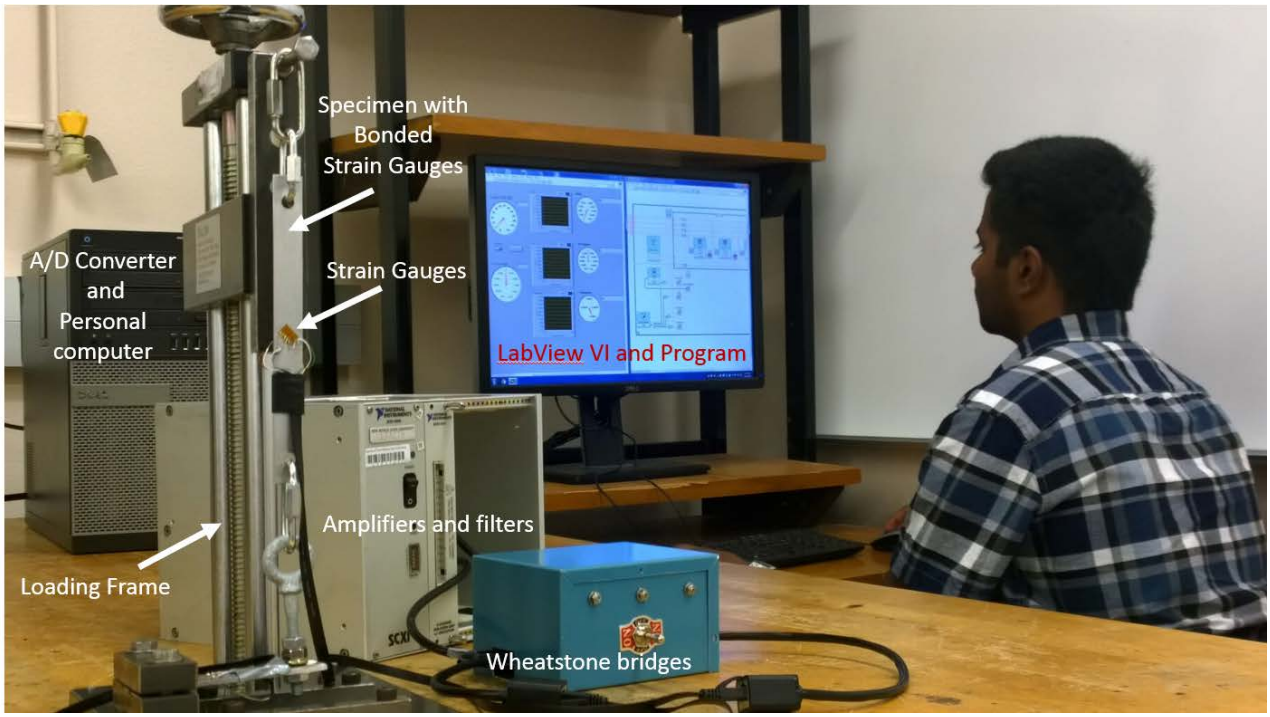

Figure 3: Experimental Setup

We have four experimental stations for each lab class session. Each station requires three Wheatstone Bridges. Normally, in this ME345 Experimental Methods I class the number of students conducting the strain measuring experiment varies from 65 to 75 in a semester.

“Through a failed first attempt, the students learned the value of choosing the right components with the right characteristics, and that in the end, sometimes it is beneficial to pay more for higher quality; these considerations can be critical to ensuring the success of an experiment.”

Acknowledgement:

New Mexico State University (NMSU) sits on a 900-acre campus and enrolls more than 15,000 students from 49 states and 89 foreign countries. NMSU is a NASA Space Grant College and is home to the very first Honors College in New Mexico. NMSU serves a multi-cultural population of students and community members across the state at five campuses, a satellite learning center in Albuquerque, cooperative extension offices located in each of New Mexico's 33 counties, and 12 agriculture research and science centers. Plus, distance education programs give students maximum flexibility. hwww.nmsu.edu

NMSU’s Mechanical Engineering Department has been educating mechanical engineers since the university opened in 1888. Beginning in Fall 2006, the ME Department expanded to include an undergraduate degree program in Aerospace Engineering; the first and only Aerospace program in New Mexico and west Texas. https://mae.nmsu.edu/

Contact Information

Vincent Choo, Professor
Mechanical and Aerospace Engineering Department
New Mexico State University
Las Cruces, NM 88003
Cell Phone: +1 575 571 6977
Office Phone: +1 575 646 2225
Email: vchoo@nmsu.edu

Vishay Precision Group, Inc. (VPG)
Vishay Foil Resistors
foil@vpgsensors.com

Click here for your regional
Vishay Foil Resistors contact.