UNIVERSIDAD CARLOS III DE MADRID

LABORATORY

Electronic Instrumentation

PROJECT #1

ESCUELA POLITÉCNICA SUPERIOR
DEPARTAMENTO TECNOLOGÍA ELECTRÓNICA

PROJECT #1: WHEATSTONE BRIDGE WITH AC EXCITATION.

In this project we are going to build an instrumentation system to measure weight using a Wheatstone bridge and the experimental setup shown in Figure 1.1. This setup consists of a bar, equipped with two metallic thin film strain gauges (R_1 and R_2 in Figure 1.1), that will be part of the Wheatstone bridge configuration. The bridge is completed with two fixed resistances which are part of the signal conditioning circuit (R_3 and R_4).

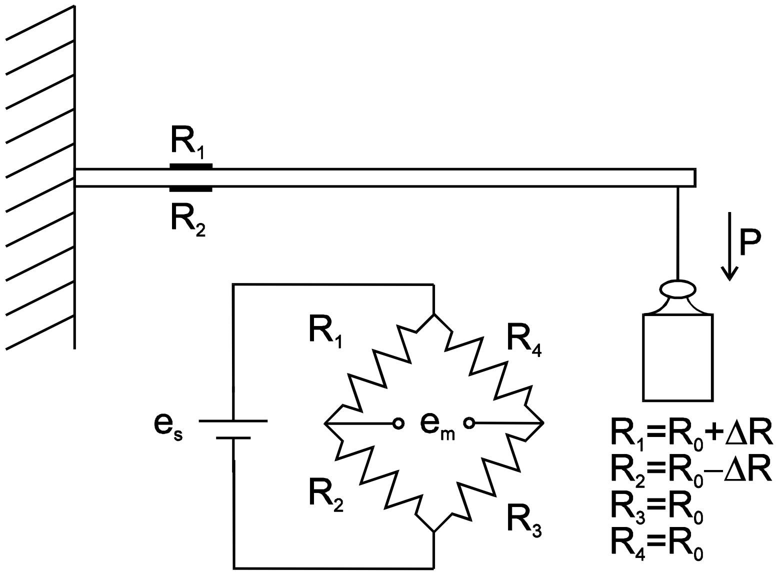

Figure 1.1 *Push-Pull Wheatstone Bridge*

The model of the strain gauge used is the PFL 10-11 (see Data Sheets). The main characteristics of these sensors are:

- Nominal Resistance: 120 Ω.
- Recommended Bias Current: Below 10 mA
- Maximum admissible Current: 25 mA.

A "Push-Pull" Wheatstone Bridge setup using two strain Gauges, along with the integrated circuit AD620 (Instrumentation Amplifier, see Data Sheets) will be supplied to students in the laboratory. The rest of the components are of common use and will be supplied by the students.

The project will be carried out in two steps. In the first part the Wheatstone bridge will be studied under DC bias conditions. In the second part AC bias along with envelope detection will be used.

1.1. DC Biased Wheatstone Bridge.

Build the circuit shown in Figure. 1.1 using a LM317 Voltage Regulator (see Data Sheets). Adjust the DC bias voltage e_s using the regulator for a 2V output so the current through the strain gauges is in the range recommended by the manufacturer. Do never increase the current beyond the maximum recommended value. Easiest adjustment of the bridge is obtained if 120 Ω R_3 and R_4 resistances are 1% tolerance. Over this set-up:

1.- Measure the bridge output voltage (e_m) with a Digital Multimeter. Take note of the value. Apply the supplied set of weights to the suspended end of the bar, measuring each time the bridge output. Comment on the results.

From the results obtained the need for further amplification at the bridge output should appear as evident.

2.- Why should an instrumentation amplifier be used? Calculate the value of the AD620 adjustment resistance R_g in order to obtain a gain of 500. Connect the AD620 at the Wheatstone bridge output. Why should the reference (AD620 REF Pin 5) be connected to ground?

3.- With the bar at rest (i.e. no weights applied) measure the instrumentation amplifier output voltage. Use a variable resistor (recommended potenciometer value R = 100 kΩ) to balance the bridge as described in class so that the output of the amplifier is null, V = 0V, for the abovementioned rest condition.

4.- Complete two calibration cycles using the provided set of weights. Tabulate and graphically represent the data obtained (Output voltage versus weight applied to the bar). For the later take into account that each weight is 50 g and that the weight of the support is 80 g.

5.- From the abovementioned calibration and any further characterization considered necessary, obtain the following characteristics of the measurement system:

- Sensitivity
- Linearity
- Hystersis
- Precision
- Resolution
- Dynamic Behaviour: Set the time base of oscilloscope to 0.2 seconds per division and let one of the 50g weights fall to the base of the support to evaluate the dynamic characteristics.

1.2.AC Biased Wheatstone Bridge.

For the second part of this project, the advantages of AC biasing the Wheatstone bridge are investigated. In this sense, replace the bridge continuous (DC) source for an AC source with 2 Vpp at 5 kHz in the previous set up (Wheatstone Bridge + Instrumentation amplifier):

1. - Observe the output of the instrumentation amplifier with an oscilloscope. What do you observe? Use the set of weights to add weight to the bar and describe the changes in the output signal.

Build the circuit shown in Figure 1.2.

2. - Measure the voltage at the output of the precision rectifier using a digital multimeter. Adjust the output of the system to zero when no weight is applied to the bar if necessary using again the variable resistor used previously to balance de bridge (Rp in Figure 1.2).

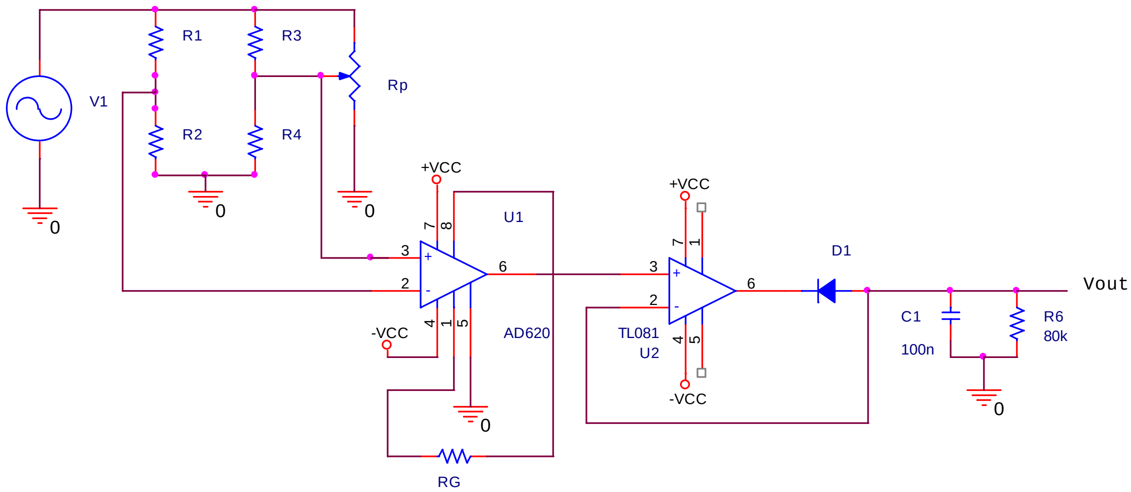

Figure 1.2 *Wheatstone Bridge, Instrumentation Amplifier and Precision Rectifier*

3. – Complete two calibration cycles using the provided set of weights. Tabulate and graphically represent the data obtained (Output voltage versus weight applied to the bar).

4. - From the abovementioned calibration and any further characterization considered necessary, obtain the following characteristics of the measurement system:

- Sensitivity
- Linearity
- Hystersis
- Precision
- Resolution
- Dynamic Behaviour: Set the time base of oscilloscope to 0.2 seconds per division and let one of the 50g weights fall to the base of the support to evaluate the dynamic characteristics.