Accelerometer Tilt Sensor Experiment

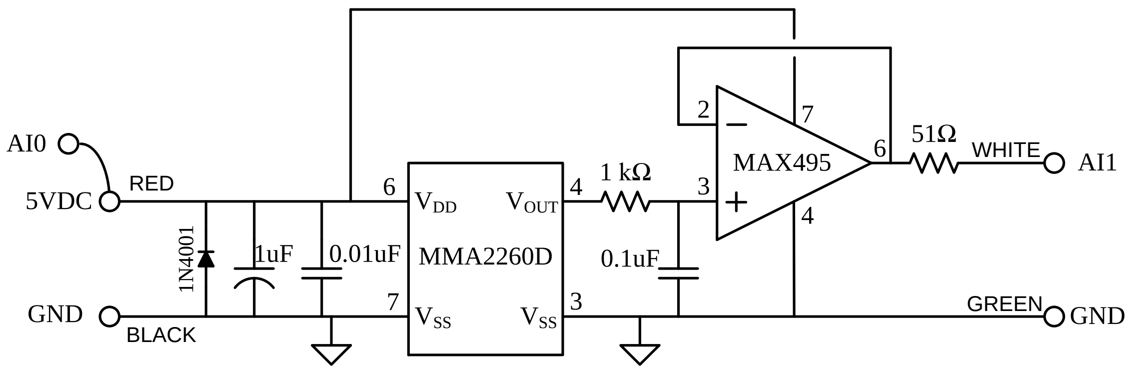

Figure 1. Tilt Sensor and Amplifier Board Schematic (Inside the black box)

In this experiment, the characteristics of the MMA2260D accelerometer will be measured. Here the device will be used as a tilt sensor. The output voltage will be measured at various angles of tilt. From this information, the *zero-g bias* voltage and transducer *sensitivity* can be determined.

The NI USB-6003 will be used to measure the transducer voltages. The accelerometer circuit shown above is built on a printed circuit board that is connected to the USB-6003. Power for the circuit is also obtained from the USB-6003 so no other external connections are needed.

The op-amp is used as a unity gain amplifier to buffer the accelerometer output voltage so that the USB-6003 input bias currents do not affect the voltage measurement. The op-amp output voltage with respect to ground is measured using Analog Input 1. The power supply voltage is measured with Analog Input 0 such that a ratiometric voltage reading can be calculated in the software (AI1/AI0).

Connect the accelerometer circuit board wires to the DAQ unit as shown in Figure 1 (match the wire colors as shown). Additional jumper wires are needed to connect the +5V to AI0 as shown. **Do not connect the USB-6003 USB cable until after the accelerometer wires have been connected.** Figure 2 shows a photograph of the accelerometer enclosure with the lid removed to show the orientation of the device within the box. Note the direction in which the device is sensitive to acceleration. (Refer to the datasheet as needed) Place the accelerometer box on the tilting apparatus with the lid side facing upward.

Obtain data, using LabVIEW, for Vout and V_{DD} at various tilt angles (about every 10 degrees) between -90 and +90 degrees with respect to horizontal. The VI, "Ratiometric Voltage Measurement" is on Canvas. The tilt angle is determined by using an electronic "bubble" level unit. (This will be demonstrated during the laboratory period).

The relationship between tilt angle and accelerometer output voltage can be expressed as:

$$Vout = \left[k \times sin(tilt\ angle) + V_{zg}\right] * \frac{V_{DD}(meas)}{V_{DD}(ideal)}$$

where k is the sensitivity and Vzg is the zero-g bias voltage. k and Vzg can be determined from a least-squares best-fit of the data when it is properly plotted. Note that V_{DD}(ideal) is the value of V_{DD} used in the data sheet (5.0V). V_{DD}(meas) is the measured value of V_{DD} during the experiment. Because the MMA2260D output voltage is ratiometric with V_{DD}, the actual value of

V_{DD} must be known in order to determine k and Vzg. The equation for the output voltage versus the tilt angle used in the data sheet is given by:

$$Vout = k \times sin(tilt\ angle) + V_{zg} \quad \textbf{(for } \mathbf{V_{DD}=5.0V)}$$

Homework Submission

1. Include a table of your measured data including the tilt angle, Vout, and V_{DD}(meas). Remember to use proper units.
2. Include a plot of the measured data {Vout vs. sin(tilt angle)}.
3. Use Method #4 to adjust for V_{DD}(meas) not being equal to V_{DD}(ideal). Add a column to your table of measured data that has the adjusted values for Vout {Vout(adj)}. Add another plot to your chart of Vout(adj).
4. Determine measured values for k and Vzg from the chart for both Vout and Vout(adj).
5. Compare the measured values of k and Vzg to the data sheet values (% error calculations). Do this for both plots {Vout and Vout(adj)}.

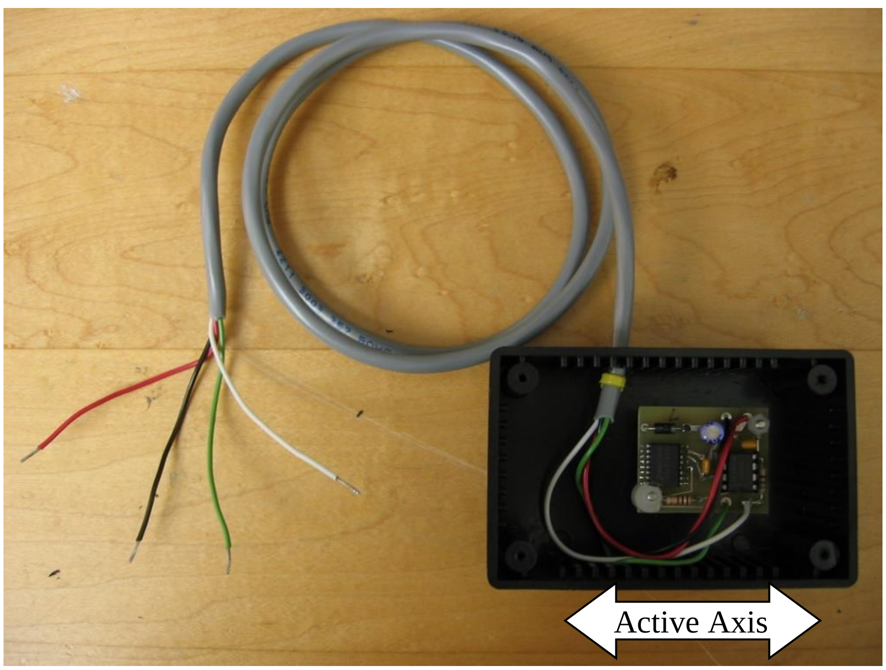

Figure 2. Accelerometer Enclosure and Cabling