ME 552 Measurements in Fluid Mechanics and Heat Transfer

Lab 1.5: Wire and interface with LabVIEW Data Acquisition Unit

Due: January 27th, 2017

Purpose: Measurement equipment used in fluid and heat transfer experiments require a data acquisition system to record important thermal data (e.g. temperature, pressure, flow rate) in order to process and conduct data analysis. In some cases, it is important to also be able to interface from the DAQ to perform certain tasks within the actual experiment. For example, it is sometimes convenient to have a solenoid valve open or close when a temperature condition is reached or a relief valve open up if a pressure reading exceeds a certain value. In this lab you will learn and demonstrate how to wire and use a DAQ system to interface with the environment.

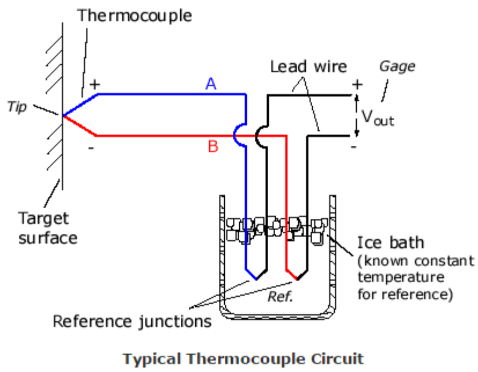

Figure 1: Thermocouple circuit using a cold-junction-reference.[1]

First Objective: Using thermocouple can be an inexpensive way to record temperature in an experiment (especially when uncertainty is not necessarily a priority). Thermocouples work based off the Seebeck effect where a small (measureable) voltage is generated with a temperature difference along the wires when dissimilar metals are in contact, as seen in Figure 1. Here, it is showing a cold-junction-reference temperature (ice bath) but the equipment used today has a cold-junction-reference built in.

Table 1: ANSI color code and conductor alloys for different types of thermocouples.[2]

ANSI Color Code and Conductor Alloy's					
Thermocouple Type: ANSI Color Standard shown	Conductor Color:	Positive Conductor (+) / Alloy	Negative Conductor (-) / Alloy	Extension Wire Color:	Overall TC Wire:
E	Purple / Red	Purple + (Nickel Chromel)	Red - (Platinum-6 % Rhodium)	Purple	Brown
J	White / Red	White + (Iron /Magnetic)	Red - (Constantan)	Black	Brown
K	Yellow / Red	Yellow + (Chromel)	Red - (Alumel)	Yellow	Brown
T	Blue / Red	Blue + (Copper)	Red - (Constantan)	Blue	Brown

---

[1] http://www.efunda.com/designstandards/sensors/thermocouples/thmcple_theory.cfm

[2] http://www.temprel.com/img/ansi.gif

In this first objective, you will connect and record temperature using a thermocouple. At your lab station you will either have a T-Type or K-Type thermocouple. Your first task will be to connect the thermocouple wires correctly to the DAQ module (NI9211) and read in temperature data via LabVIEW. You will need to make a LabVIEW GUI (Graphical User Interface) to visually represent your data (either a graph or numerical value). Make sure to reference Table 1 to ensure which wire lead is positive and negative to ensure correct data reading.

Requirements/Tips:

1. Read temperature data at a rate of 1 Hz
2. Read continuous samples
3. Visually represent data (numerical or graph)

Questions:

1. Hold the thermocouple in your hands, does it increase in temperature or decrease in temperature?
2. Do the temperature readings make sense?
3. What happens if you switch the thermocouple leads?

<u>Second Objective:</u> Recording temperature data is great, and in some cases that is all the data you need for your experiment and analysis. But lucky for you that is *NOT* all we need ☺. The thermocouple readings will be used to sense if the temperature is too hot or too cold. An LED signal is a great way to notify the experimentalist/system operator that the temperature is off from nominal conditions. LED can be replaced with a solenoid valve, relief valve, or any other electrical device that can mechanically interface with the system.

To practice with interacting within LabVIEW, a pseudo-LED (Boolean) in LabVIEW will be used. You will develop a set of logical statement to illuminate the pseudo-LED if the temperature from the thermocouple reading exceeds 25 °C (should exceed this by holding the thermocouple) and if the thermocouple reading falls below 10 °C (ice bath). See Figure 2 for an example case structure for if-then statement set-up.

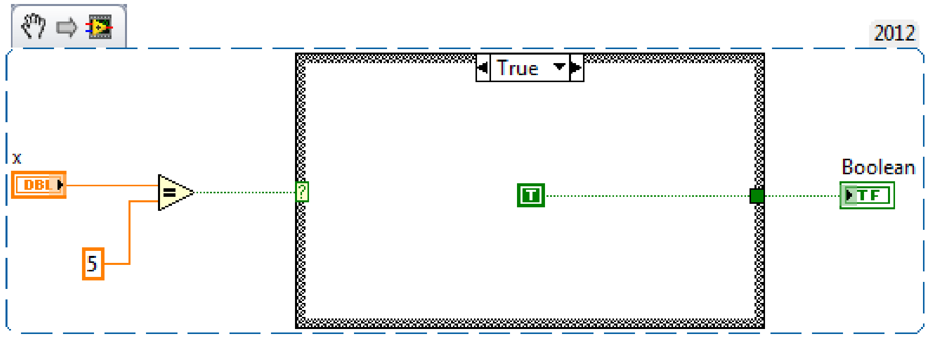

Figure 2: Case structure for if statement interface with LabVIEW.[3]

[3] http://digital.ni.com/public.nsf/allkb/3B3D68F6EC5F2EFB8625694C00654805

Requirements/Tips:

1. Code up pseudo-LED in LabVIEW
2. Write if-then statement structures to turn on/off LED (see above for details)
3. Google is your friend if you don't know exactly how to do this.

Question:

1. Does the LED turn on/off when at the correct temperatures?

<u>Third Objective:</u> Instead of only using a code that turns on a pseudo-LED on LabVIEW it would be nice to directly output the signal using an analog output to a real LED! Again, this analog output can be used to power a solenoid valve (or something of the sort), but in this case we are going to power a physical LED. The challenge is the analog module only has a 1 mA output per channel, therefore a different circuit needs to be set-up to actually power the LED.

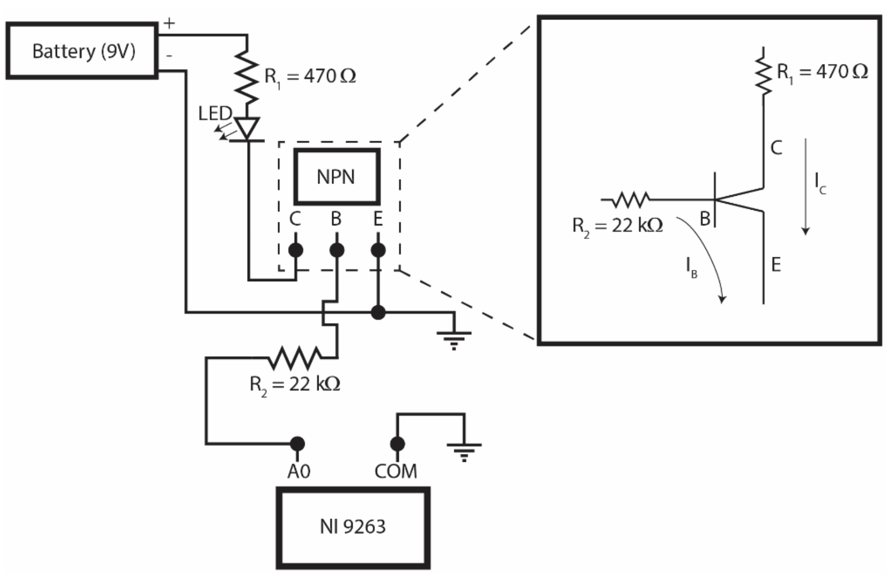

Figure 3: Transistor circuit to power LED using DAQ module NI 9263.

An external power supply (9V battery) will be used to power the LED, a relay-like device is simply needed to complete the circuit. Transistors are semiconductor devices used to either amplify, or in our case, to switch electronic signals and electrical power[4]. A 2N2222 NPN transistor will be used to switch the power. The LED driver circuit will be constructed and tested in this objective as seen in Figure 3.The electrical equipment that is needed to wire this has been provided at each of your lab stations. **<u>DO NOT CONNECT TO THE NI MODULE YET!!!</u>**

[4] https://en.wikipedia.org/wiki/Transistor

Requirements/Tips:

1. Carefully wire up the transistor circuit (READ THE DIAGRAM, more than once and ask questions)
2. Check the functionality of your circuit by using power from your battery in place of the NI DAQ output (check LED lights up)
3. Make sure you use the correct resistor at each segment

Question:

1. Does the LED turn on when you plug in the extra battery?

Fourth Objective: *If time is available at this point in the lab*, you will be wiring and interfacing with LabVIEW to turn on and off the external LED for different temperature conditions. The module that will be used in this portion is the NI9263 module with a ±10V analog output and 1 mA (MAX) current drive. The connections you made in the previous segment with the extra battery will now be made with the module where the power will be connect to the analog output of the module (A0) with the B pin of the transistor and the other portion will be connected to (COM) to complete the circuit.

At this point the LED should not turn. Remember the if-then logical statements you made in the LabVIEW code in objective two? Now you are going to interface with the analog module output with this code. I will allow you some time to do some quick google search to see how this is completed (there are a few examples online). If you have any questions do not hesitate to ask.

Requirements/Tips:

1. Connect your transistor LED circuit CORRECTLY to the NI9263 module
2. Interface the module with LabVIEW and if-then statements
3. Check for system functionality and LED turns on when at the correct temperatures?

Question:

1. Does the LED turn on when you put the thermocouple in the cold water or hold it in your hand?
2. What else could you use this type of set-up in your research?