ECE 206: Supplementary information: STEMTera and Encoder

This is not the lab description. This is supplementary information for Lab 4. Ensure you also read the lab description and perform the prelab contained in the lab description.

Challenge: Arduino Digital Inputs and Encoders

Prelab:
Problem: *Consider your scope traces from Lab 2.2. How many times/second would you need to read the value of the A and B signals to keep track of the encoder position in the "slow" case? How many times/second in the "fast" case? Give an explanation for your answer based on what you recorded in your scope traces.*

Consider: "Times per second" is expressed as "Hertz" (Hz). We are asking you for the minimum frequency that a device could sample the values of A and B in order to see every transition.

By transition, we refer to a change in state, such as A = 0, B=0 to A=1, B=0.

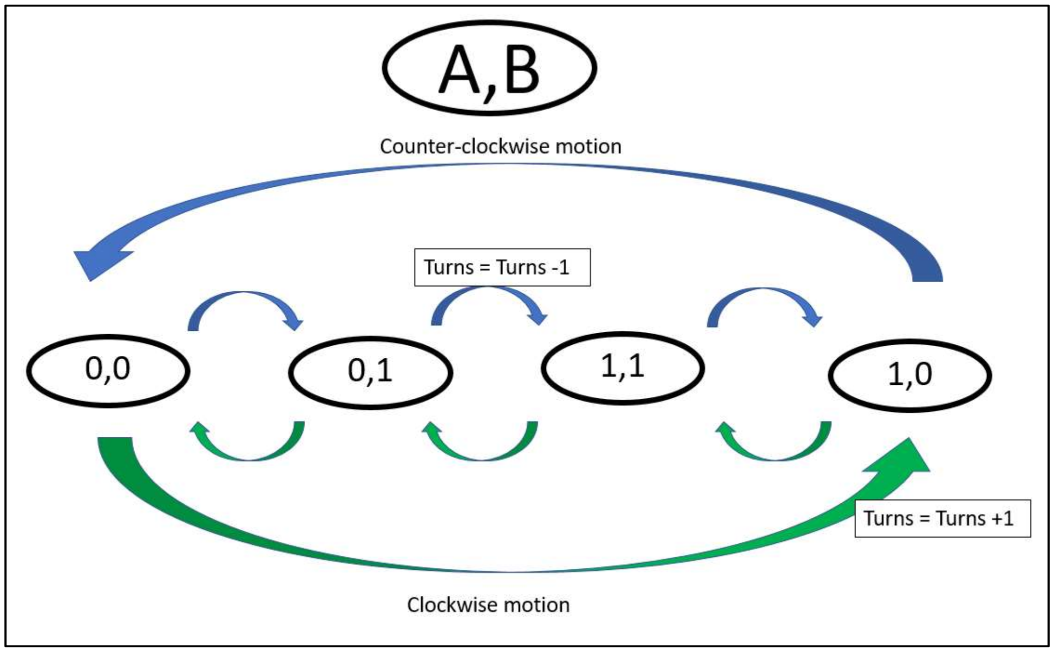
What would happen if we missed a transition? If you saw A=0, B=0, and then the next state you saw was A=1, B=1, you wouldn't know which way the knob turned! Therefore, when you look for timing information, you need to look at the traces for A and B together, not independently.

In Lab 2.1, we had you increase a variable to try to time the blinking of an LED to 1 second. The large number needed to tune the LED time delay gives you an idea of just how fast the Arduino executes. Based on what you learned that day, you should find that the Arduino will have no problem meeting the minimum frequency that you calculate in this prelab.

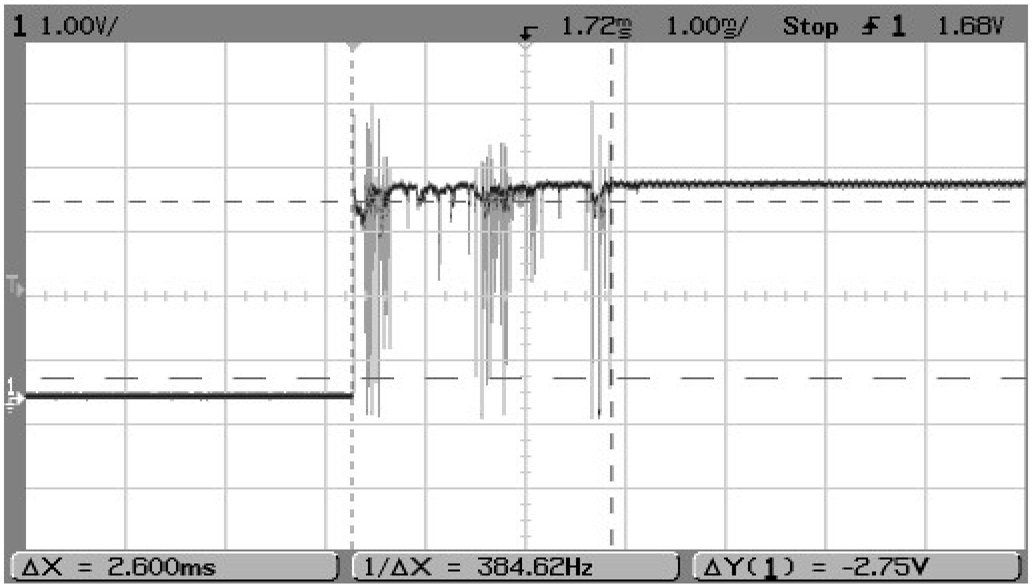
Take a good look at the traces you captured in Lab 2.2. What is the *smallest* interval of time between transitions for each trace? Convert that interval of time into a sampling frequency.

Many students find that sampling frequency, and then double it – claiming that the Nyquist Sampling Criterion states that you must sample twice as fast as the frequency of the signal in order to prevent aliasing. But, strictly speaking, that's not true in this situation.

Additional discussion: Glitches
The original version of this lab had code that first checked whether or not A had changed, then checked the value of B to determine which way the encoder was moving. When plotted on a state diagram, the strategy looked something like this:



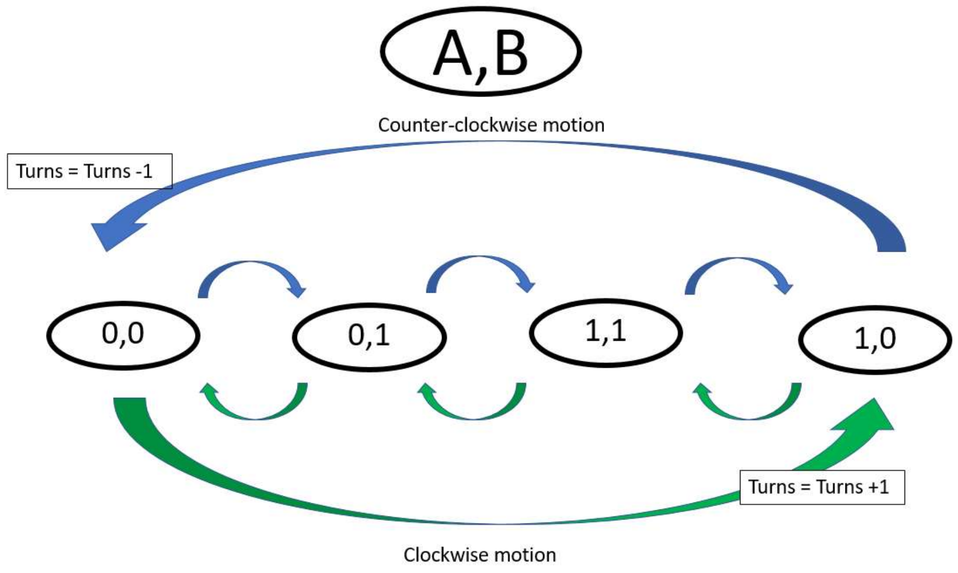
One hazard with this strategy is that it does not take switch bounce into account. When mechanical contacts close, there is often some "bouncing" that occurs. During this period of bouncing, the metal contacts in the switch come apart and together repeatedly, and may alternate as being read as open or closed several times before the switch settles into its new position. When viewed on an oscilloscope, switch bounce may look like the image below:



Switch Bounce as Seen on Oscilloscope. Image Source: https://upload.wikimedia.org/wikipedia/commons/a/ac/Bouncy_Switch.png

How might switch bounce impact the strategy above? If a user moves back and forth between states (0,0) and (0,1), their count will increase repeatedly, even though the knob physically hasn't completed even one cycle of rotation!

Look at the state diagram below. Notice that if the switch bounces, and the state changes rapidly between (0,0) and (1,0), when the bouncing stops the number of turns will settle to the correct value.



For this lab, you will implement the improved strategy that is not vulnerable to contact bouncing, and demonstrate it to your TA.

<u>Report Deliverables</u>:

- Include a <u>diagram/sketch of you circuit.</u>
- Include <u>commented code for your design.</u>
- Obtain your TA <u>signoff</u> on the circuit in operation
- Bonus challenge #1: relevant diagrams, sketches, code and explanations (Bonuses are optional)
- Bonus challenge #2: relevant diagrams, sketches, code and explanations (Bonuses are optional)

Report should contain, at minimum the following elements:

- Title, Names, Dates
  - Names of ALL Team members
  - Either due date of report, or date of lab, or both
- Plan and Execution
- Results / Conclusions
  - Answer any questions posed in the lab challenge.
  - Explain your understanding of what happened and why.