CPE 301 – Embedded Systems Design Lab

Lab # 01 – Oscilloscopes, LEDs, Resistors and Push-buttons

Fall 2020

Objectives:

Oscilloscopes and basic lab components such as resistors, buttons, switches, and LEDs will be critical components in future labs. Therefore, practical knowledge of how they work and how they should be used is a foundation for future lab assignments. In this lab you will learn:

1. How to manipulate the controls of the tinkercad oscilloscopes.
2. How to measure and display a signal using the tinkercad oscilloscopes.
3. How to use the tinkercad power supplies.
4. The basics of LEDs.
5. How to construct a pullup push button circuit.
6. How to construct a pulldown push button circuit.

Contents:

Part 1 – Oscilloscope configuration and signal measurement.
Part 2 – Measure an arbitrary signal.
Part 3 – Connect the power supply, a resistor, and an LED to light the LED.
Part 4 – Construct a pullup push button circuit and a pulldown push button circuit.

Required Equipment:

1. Tinkercad Oscilloscope
2. Tinkercad Power Supply
3. 3mm Through-hole LED
4. Through-hole Push Buttons (x2)
5. 330Ω Axial Resistor (x2)
6. Solderless Breadboard

Procedure:

Complete each part of the lab, answer the associated questions, and include them in your lab report. Be sure to label your answers with respect to their relevant lab part and question number (ex. Part 1 #4c). Any handwritten drawings should be scanned and included alongside the text of your lab report.

Part 1 – Oscilloscope Configuration and Signal Measurement

Answer the questions below using the Intro_to_Scopes_Lab.pdf on webcampus, as well as any online resources. List any online resources you used in the references section of your lab report.

1. What does an oscilloscope measure?
2. What is the function of the alligator clip connected to the oscilloscope probe? To what should it be connected? What happens if the clip is left unconnected?

3. Many oscilloscope probes feature a switch which allows the user to change the probe between 1X and 10X. What is the function of this slide switch? Why should we not utilize function generator cables as oscilloscope probes?
4. What is the minimum oscilloscope performance required to properly capture 2 msec of a 1V, 250 MHz sine wave? (List the required Bandwidth, Sample Rate, and Record Length)
5. Answer the questions below based on the display shown here:

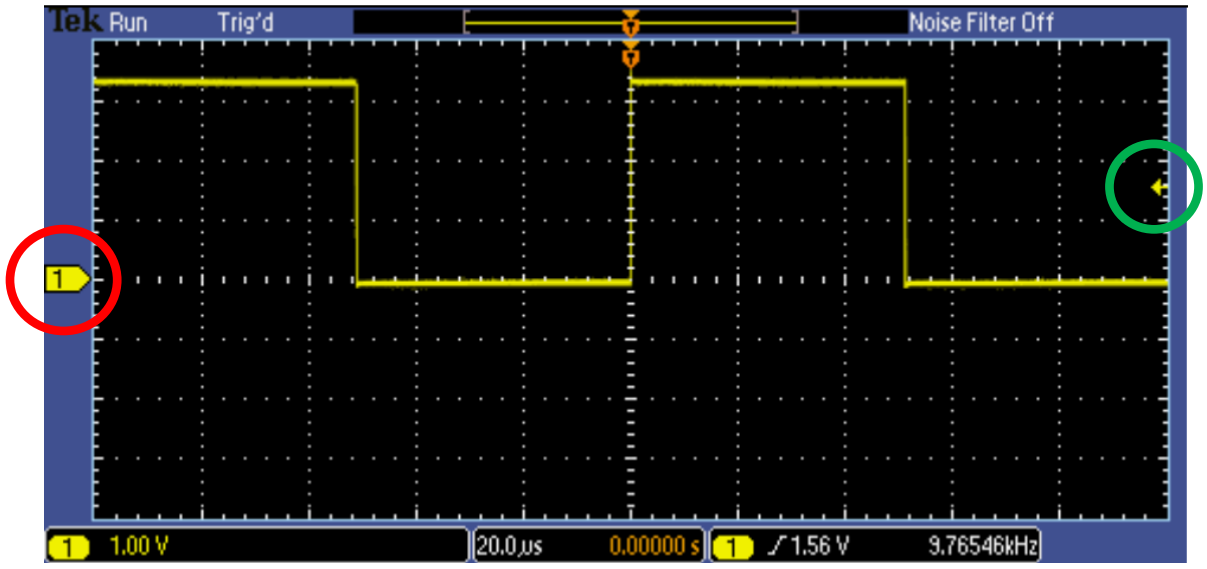
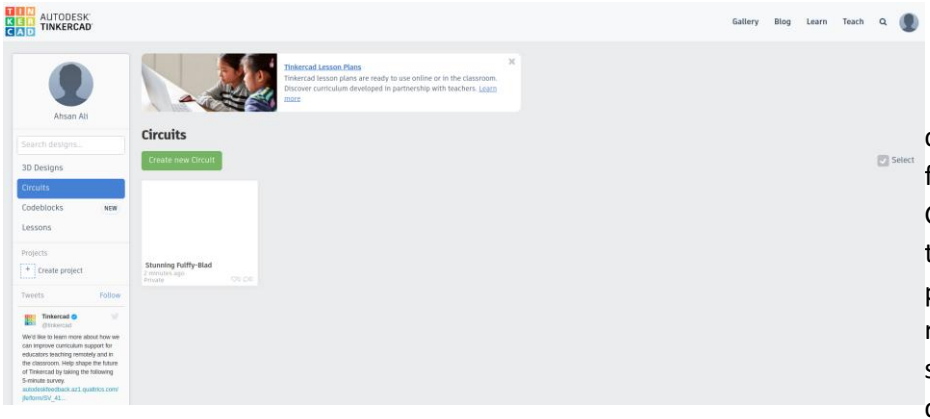


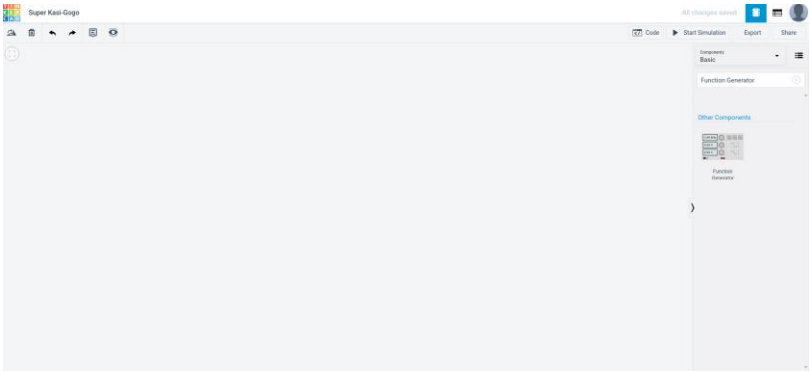
Figure 1- Image taken from Intro_to_Scopes_Lab.pdf

   a) What is the peak-to-peak voltage of the signal?
   b) What is the voltage of the positive peak?
   c) What is the voltage of the negative peak?
   d) What is the period and frequency of the signal?
   e) What does the yellow arrow contained within the red circle on the image above denote?
   f) What does the yellow arrow contained within the green circle on the image above denote?

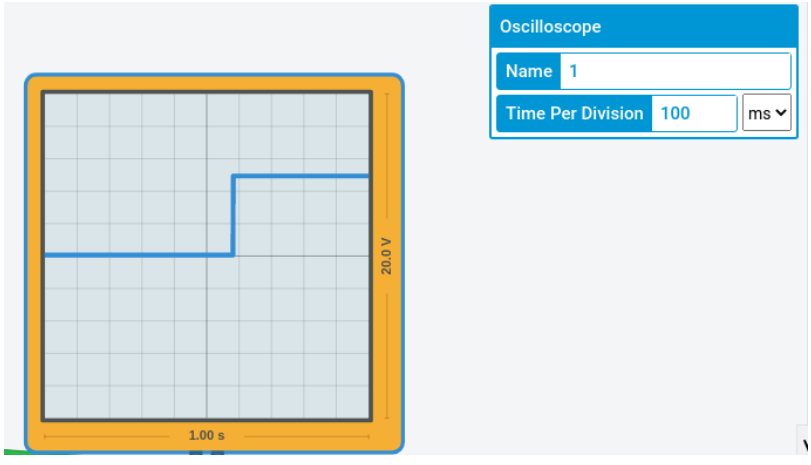
6. An oscilloscope's vertical axis controls are used to control which parameter?
7. If the horizontal scale factor were set to 1 µsec/div, how long would the displayed waveform be?
8. With the horizontal scale factor set to 200 µsec/div and the record length set to 1 Mpoints, what is the oscilloscope's sample rate?
9. Signal Measurements using tinkercad oscilloscope and Function Generator
   a. Open tikercad using the link "https://www.tinkercad.com/." If you do not have an account, create an account and login.
   b. On the dashboard screen from the design menu on left hand side select "Circuits." Next click on "Create new Circuit" button.



c. Search for Function Generator in the search panel on the right hand side component menu. Drag and drop the function generator to the workspace.



d. Repeat Step C for Oscilloscope.
e. Connect the Negative outlet of Function Generator to the Negative input terminal and Positive outlet of Function Generator to the Positive input terminal of Oscilloscope.
f. Click on the “Start Simulation” button in the top right corner of the screen.
g. Click on Oscilloscope to adjust the horizontal scale per division from the drop down menu.



h. Measure the peak-to-peak voltage, frequency, and time period of the signal using the divisions per horizontal and vertical box.
i. Briefly explain how the measured values are obtained. Add screen shots of the adjusted values.

Part 2 – Arbitrary Signal Measurement

For each of the figures below calculate the horizontal scale factor, vertical scale factor, peak-to-peak voltage, frequency, and period. Briefly explain your answers.

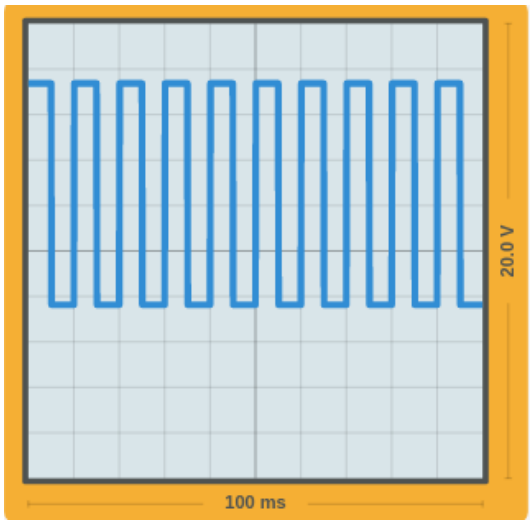


Figure 2.1

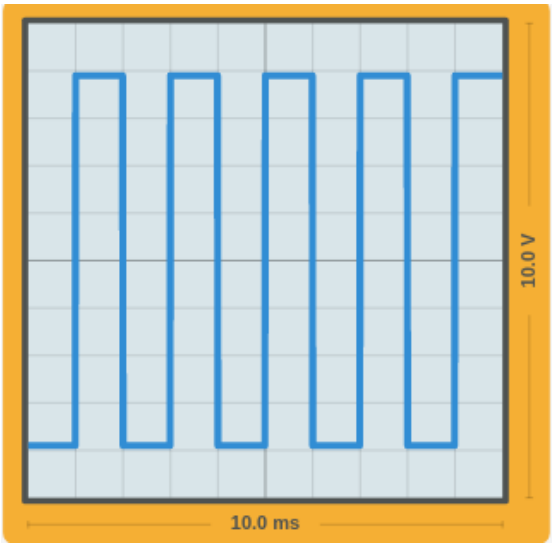


Figure 2.2

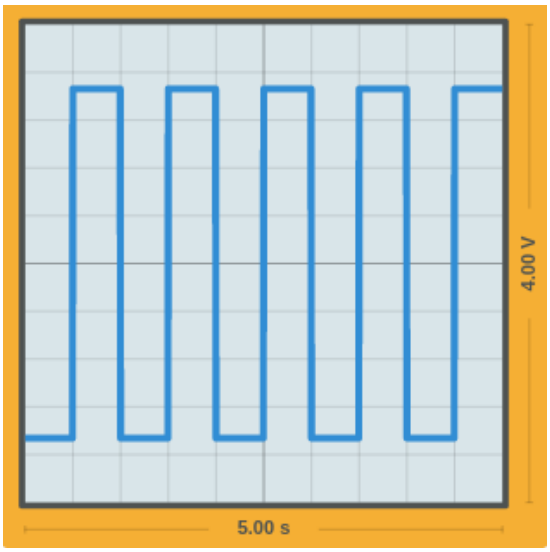


Figure 2.3

Part 3 – Lighting an LED

Using the tickercad power supply, LED, and a resistor construct the circuit depicted below. Be sure to use the fixed 5V output on the power supply.

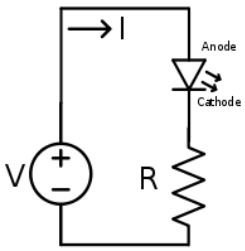


Figure 3 - http://www.oem-pcb.com/Content/ue/net/upload/2017-03-02/42a449e4-5d13-4ec4-b353-959d12a96a72.png

When the circuit is complete, notify the lab instructor, then answer the following questions:

1. What is the voltage drop across the terminals of the power supply?
2. What is the voltage drop across the legs of the LED?
3. What is the voltage drop across the legs of the resistor?
4. Do the voltage drops sum to the expected value? Explain what the expected value is.
5. Using Ohm's law (V = IR), calculate the current flowing through the circuit.
6. If the power rating of an LED is 10W, and the circuit's power supply is fixed at 5V, what size resistor would you use to result in the brightest LED without burning it out? (Remember P = VI)
7. What happens when you reverse the LED? Why does this happen?

Part 4 – Pullups, Pulldowns, and Push-buttons

Using the tickercad power supply, push button, and a resistor construct the circuits depicted below. Be sure to use the fixed 5V output on the power supply.

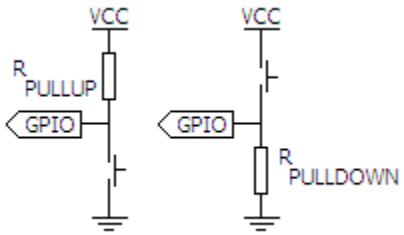


Figure 4- http://www.christec.co.nz/wp-content/uploads/2007/07/pullup-configurations.PNG

When the circuit is complete, notify the lab instructor, then answer the following questions:

1. Measure the point in both circuits la belled GPIO. For both circuits, what is the voltage at the measurement point when the button is not pressed? What is the voltage when the button is pressed?
2. What is the function of the resistor? What would happen if the circuit did not include a resistor?
3. Most microcontrollers can accept digital inputs. Where would you connect a microcontroller's digital input pin to the above circuits to read the state of the push button?
4. What is the functional difference between a push button and a toggle switch? Draw both of the above circuits, but substitute a toggle switch for the push button. Include the drawings in your lab report, and label where the signal from the switches should be measured.

Extra Credit (10 %)

Build the circuits as described below. **Circuits which cause the power supply to short will not be considered for credit.** Demonstrate the circuit to the lab instructor and include the circuit drawings in your lab report.

1. Construct a circuit with an LED, push button, and resistors such that the LED is **on** when the button is pressed.
2. Construct a circuit with an LED, push button and resistors such that the LED is **off** when the button is pressed.