Measurement of Transient Signals

Objective
The lab gives an exposure to transient signals with the help of a switch and oscilloscope. The major concept that you will be exposed to with the help of the equipments are switch bouncing and the way to de-bounce it using a simple series R-C circuit.

Prelab (10 points) – Due at the beginning of lab
1. Define the term transient signal.
2. Refer to the circuit shown in Hambley, Figure 4.3 and use KVL/KCL to write the integro-differential equation that describes the circuit.
3. What function does the “trigger” perform on an oscilloscope?
4. Describe the different trigger modes of the oscilloscope you used.
5. Bring a couple of floppy disks to the lab.

Equipment and Components
This experiment will require the use of your component and tool kit, the Agilent Oscilloscope, Agilent 3649A Power supply, SPDT (use the microswitch not the slider) switch, two 1 kΩ resistors, 0.0047 μF capacitor.

Part 1: Switch Bounce
Our first task is to create a circuit containing a switch and observe the switch bounce.

1. Construct the circuit in Figure 1. The Agilent 3649A is used for the +5V source of the circuit.

![Figure 1: Switch circuit](image)
2. Connect channel one (CH 1) of the Agilent scope across R1 in the circuit. Adjust the volts/division and the horizontal time scale to get a good view of the signal.

3. The ‘Trigger’ sub-panel on the oscilloscope, shown in Figure 3, is what you will be using to adjust the edge, mode coupling, and trigger level. For the resistor you’re measuring across, it would be a good idea to use rising edge. Since we don’t want the waveform to be displayed until the trigger conditions are met, you’d use Normal mode. Finally, pick an appropriate voltage level at which you want the scope to display the signal, and adjust it using the ‘Level’ knob.
4. After you’ve set the trigger conditions, run a ‘Single’ acquisition by hitting the ‘Single’ button on the Run Control sub panel. This allows for a single measurement that will be taken when the oscilloscope senses an input that crosses the trigger threshold.

5. Hit the switch in circuit. This should create a picture on the oscilloscope of the voltage across the resistor. The voltage should have a lot of bounce to it, such as in Figure 4.

![Figure 3: Run Control and Trigger sub-panels](image)

The bounces can be even distorted lines. The switch bounces are nothing but the initial spike voltages, so don’t worry if you don’t get spikes like the ones in the picture. The display should be such that you don’t get a smooth square wave once you close the switch.

6. Using the cursors on the oscilloscope, measure the time it takes to go from a steady 0 V (the first point at which the voltage is greater than 0 V) to a steady 5 (the first point at which the voltage stays at a constant 5 V) and record it on your data sheet. The value measured here is the full-scale rise time – the time it takes to go from a steady minimum to a steady maximum. Although we are defining our rise time here to be full scale, in general the rise time is defined as the time it takes for a signal to go from 10% of its maximum value to 90% of its maximum value.

7. Show the scope plot to your TA.
8. Have the TA verify your progress on your data sheet.

**Part 2: Eliminating Switch Bounce**

The circuit in Part 1 exhibits a pretty bad rise. It contains the results of unwanted inputs (noise), has a lot of bounce, and takes a long time to actually go from 0 to 5 V. There is a better way of creating this switch using a series R-C circuit combination.

1. First, build the circuit shown in Figure 5.

![Figure 5: ‘De-bounced’ Switch Circuit](image)

2. Connect a series R-C circuit to the switch connections. Connect the probes of the oscilloscope across the capacitor. Set the trigger settings on the oscilloscope as you did in Part 1, hit the “Single” button on the oscilloscope, and then activate the switch in the circuit.
This time, it should be noted that there is very little if any bounce to the signal, such as in Figure 6.

3. Use the cursors to find the rise time from a stable –5V to a stable 5 V and write it on your data sheet.

4. Save the scope plot to disk for use in your report.

5. Have the TA verify your progress for Part 2 on your data sheet.

Post-lab: Summary

Using the data obtained in the lab, prepare a short hand-written summary to turn in at the end of the lab.

Briefly describe a transient signal. Tell what switch bounce is, what causes it, and why and how we want to get rid of it.

Describe what you expected to see on the oscilloscope, draw sketches if necessary. Use KVL to write the integro-differential equation that describes the final circuit that includes the resistor and capacitor. What role does the capacitor play in preventing the switch from “bouncing?”
Lab 4: Measuring Transient Circuits

Name_____________________________  Section______

Part 1: Measurement of Time Varying Signals

1. Rise time for the switching circuit:

2. TA signature for Part 1, step 7: ________
3. TA signature for Part 1: ________

Part 2: Summing Amplifier

1. Rise time for the de-bounced circuit:

2. TA signature for Part 2 step 4: ________
3. TA signature for Part 2: ________