Switches

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Laboratory 4 has us focusing on electromechanical relay switches, and solid-state switches. This is to see the differences between a physical bounce that is caused by a restoring force from a spring, and the same type of restoring force that can be seen from a capacitor. We will also see the limitations of a physical arm used to trigger a switch, and at what limit does the electromechanical relay switch stop being effective.

I. BACKGROUND

Laboratory 4 didn't require much background knowledge that we didn't already have. This included the use of an oscilloscope, and following a basic circuit diagram.

II. PROCEDURE

The procedures for Laboratory 4 will be attached as a separate sheet of paper to the back of the laboratory write up.

III. PRESENTATION OF DATA

A. 4-1: Electromechanical Relay Switches

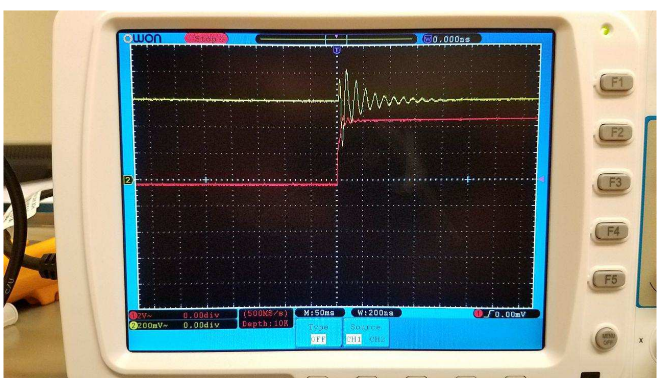

FIG. 1. Input and Output of our circuit at 10Hz. Output is scaled to 200mV increments.

FIG. 2. Input and Output of our circuit at 10Hz.

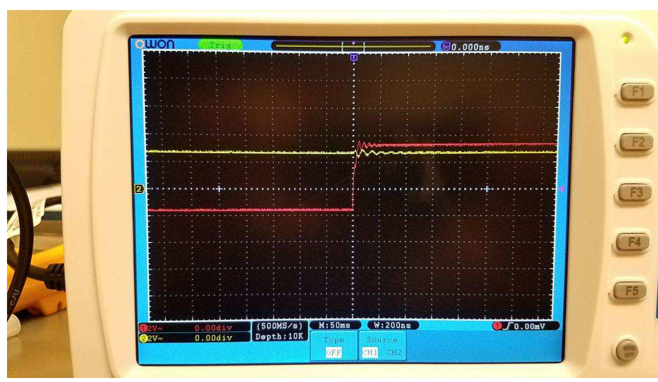

FIG. 3. Input and Output of our circuit at 10Hz.

Freq. of Failure (Hz)	
Destabalized	145
Complete Failure	160

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B. 4-2: Solid-State Switches

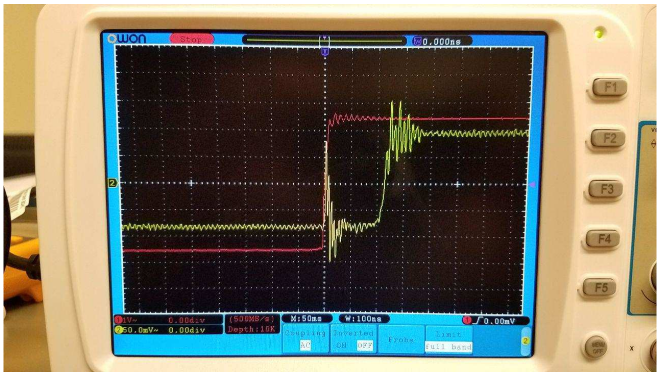

FIG. 4. Time delay at 10kHz from off to on.

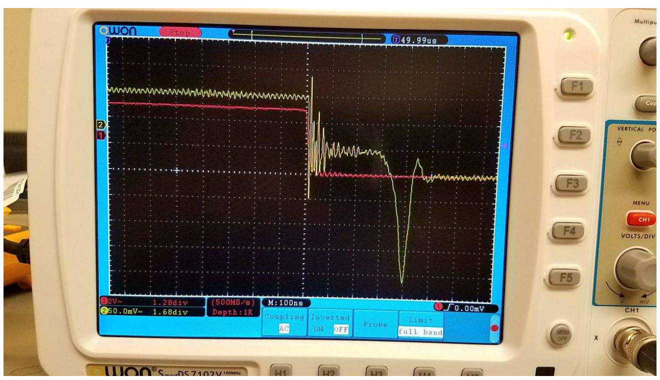

FIG. 5. Time delay at 10kHz from on to off.

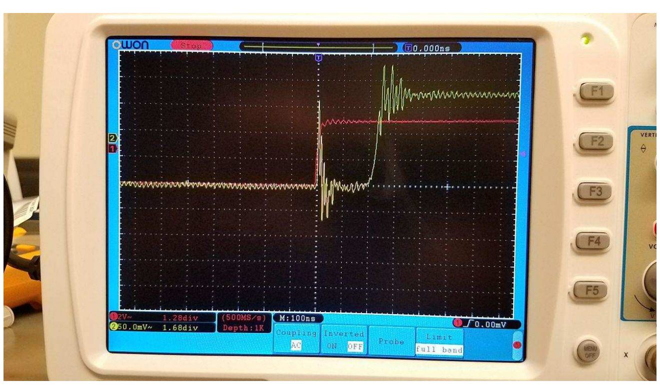

FIG. 6. Time delay at 50kHz from off to on.

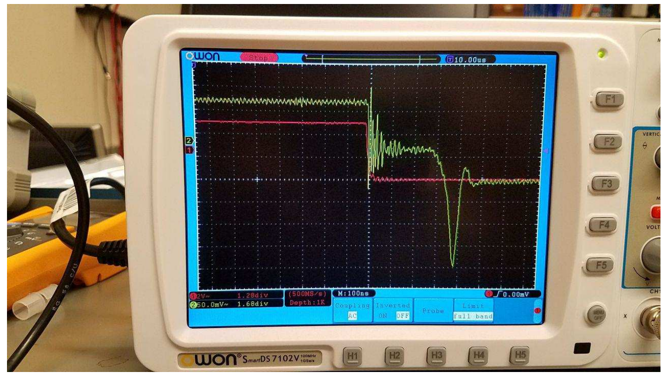

FIG. 7. Time delay at 50kHz from on to off.

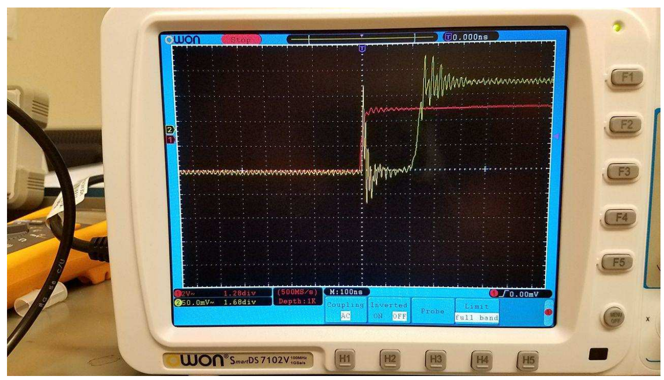

FIG. 8. Time delay at 100kHz from off to on.

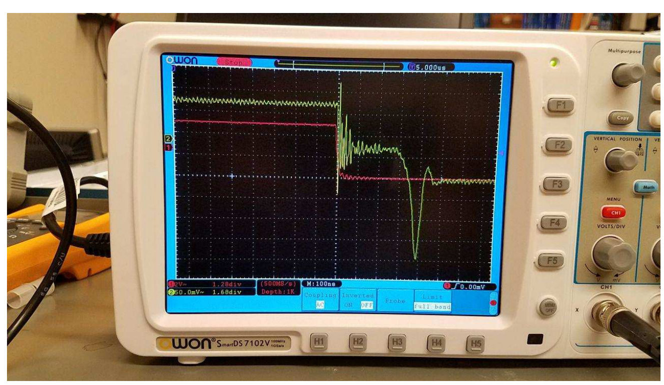

FIG. 9. Time delay at 100kHz from on to off.

Transition Times (s)			
10kHz			
td	tr	td'	tf
71.6μs	<80ns	59.0μs	32.6μs
50kHz			
td	tr	td'	tf
10.32μs	<40ns	14.88μs	3.08μs
100kHz			
td	tr	td'	tf
5.32μs	<20ns	9.92μs	120ns

C. 4-3: Transistor Switches

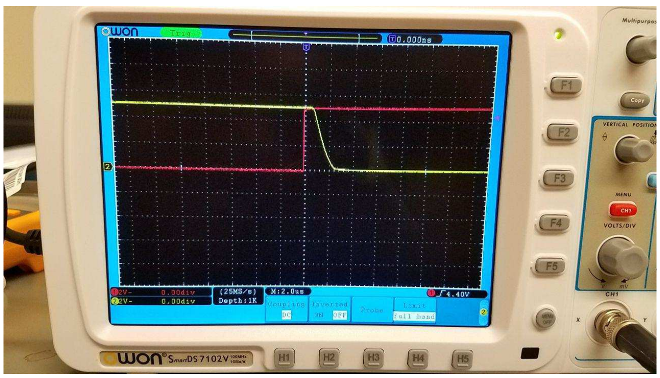

FIG. 10. Time delay at 100kHz from on to off.

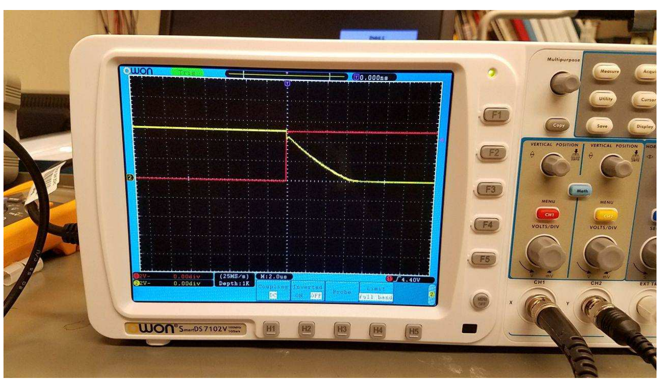

FIG. 11. Time delay at 100kHz from on to off.

IV. DISCUSSION

A. 4-1: Electromechanical Relay Switches

With the SPDT 5V electromechanical relay switch, we were able to hear an audible tick when the switch was changing positions. This is because there is a literal arm being moved due to our voltage coming into our micro relay. We found that at a low frequency, the overall voltage was incredibly low. If we upped the frequency to 50Hz, it got higher, and higher so for 75Hz.

You can also hear when the latch when it fails, because it no longer triggers. We get an interesting stutter at 145Hz, and complete failure at 160Hz.

Looking further and zooming in, we can see instability when each transition happens with the switch. This is because the switch is a physical arm (or pole) being moved back and forth between two terminals or throws. When it hits one of these, because of the speed at which it's doing so, you're going to get a bounce from the physical impact. Since the potential doesn't change, there is a restoring force that dampens this effect until it stabilizes again.

B. 4-2: Solid-State Switches

One thing that seems off about this circuit diagram compared to our previous one, is the requirement of extra input voltages. This seems like an interesting overhead cost of a solid-state relay (SSR) switch compared to an electromechanical relay (EMR) switch. This one doesn't make any noise, though, and thus, doesn't seem to have physical moving parts like the EMR switch does. This can be a benefit, especially with how noisy the EMR switch was. Though there is a delay for time on and time off, if this is constant, it can be factored into calculations. With less moving parts as well, the failure rate seems lower than an EMR switch.

C. 4-3: Transistor Switches

For the transistor circuit, there is a very small delay for the transition when we don't use a capacitor, but when we involve a capacitor, there we see an instant drop in our output voltage for a small moment, before we see an exponential decay due to the capacitor's ability to store potential. Though the delay is no longer there, we have long transition times, were as without the capacitor, we had a delay, but a very short transition time.

V. CONCLUSION

From EMR, to SSR, to Transistor switches, we see that there can be common uses to each of these, depending on granularity, overhead cost (both in cost of electricity, and cost of parts), ease of use, and longevity. It seems that all 3 types of switches have their applications, and we demonstrate their our ability to use them in this Laboratory, so their implementation is up to situation.