THE UNIVERSITY OF TEXAS AT ARLINGTON

COMPUTER SCIENCE AND ENGINEERING

MECHATRONICS
LAB 1 REPORT

ELECTROMECHANICAL SYSTEMS & SENSORS

Submitted toward the partial completion of the requirements for CSE 5355-001

Submitted by,

Servando Olvera &

Jennifer Hernandez

Date 09/8/2024

4. When the power is removed from the coil, the back EMF exceeds the breakdown voltage of the neon tube. This causes a dumet electrode to glow according to the sign of the back EMF. In this case, the anode in the neon tube is the one that glows. When reversing the power, the anode still glows relative to the new polarity. This indicates the back EMF voltage's sign is positive relative to the applied voltage.

6. Oscilloscope armed for a single capture. Voltage measurements after powering and un-powering the solenoid.

Voltage spike amplitude: -424 V

Time until solenoid fully releases: 37.2 ms

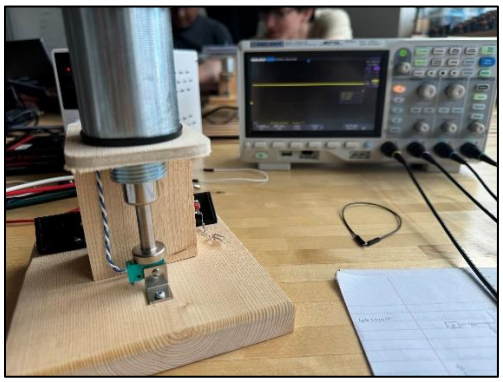
Spike to lower limit: 101 ms

Spike to upper limit: 37 ms

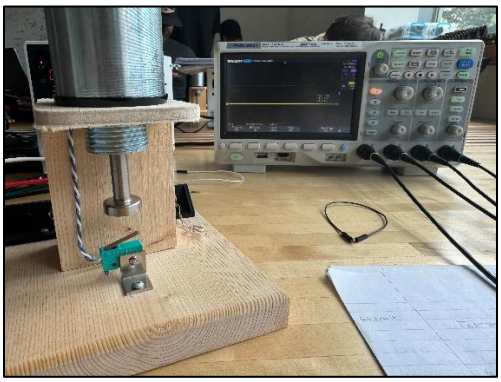
The voltage across the coil reflects the back EMF when the coil is removed from the power source. Inductors create voltage to oppose sudden changes to current. By disconnecting the solenoid from the power source, the magnetic field within the inductor collapses, causing the voltage spike seen at this point.

7. When the solenoid plunger is in the lower position, the green switch is pressed and the GREEN wire will read 12V and when it is released, it will be 0V.

Pressed

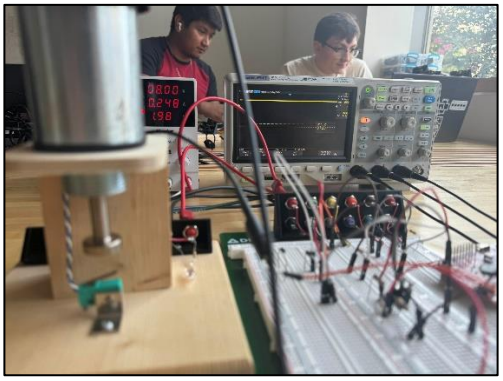


Released

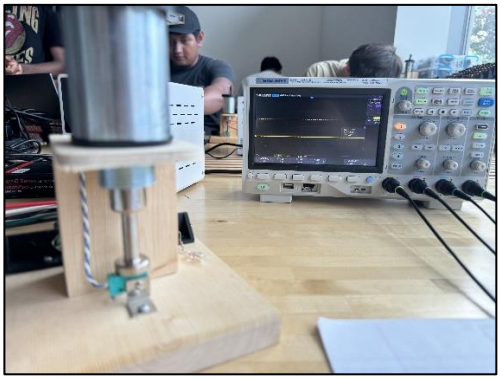


8. When the solenoid plunger is in the upper position, the blue switch is pressed and the BLUE wire will read 12V and when it is released, it will be 0V.

Pressed

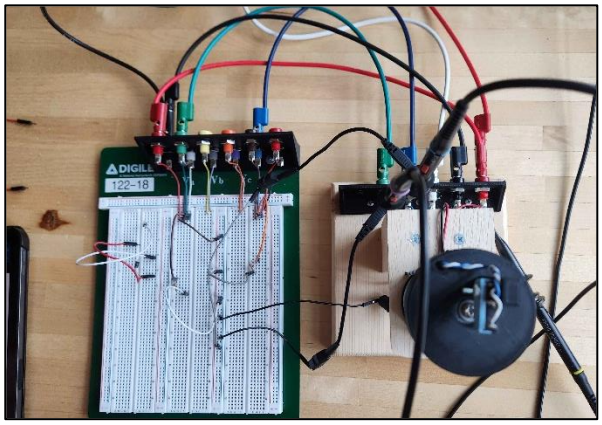


Released

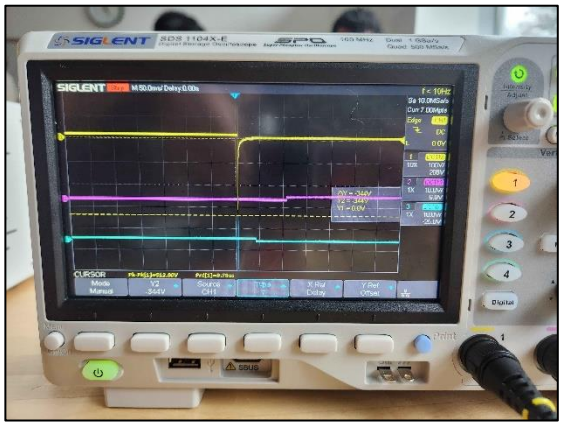


10. Only measuring across coil

Circuit



Reading



Voltage spike amplitude: -344 V

Time until solenoid fully releases: 109 ms

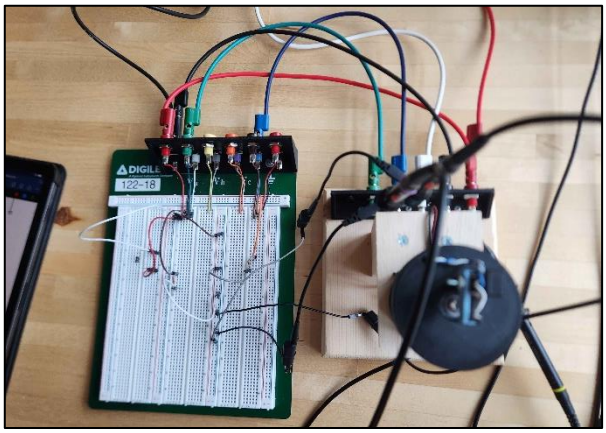
Spike to lower limit: 101 ms

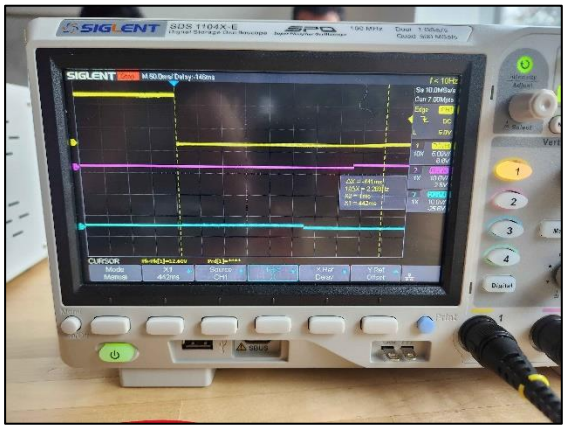
Spike to upper limit: 37 ms

In this iteration of the circuit, there are no components preventing the back EMF voltage from reaching high values. The solenoid stays charged for an extended amount of time extending the time the magnetic field within the solenoid stays intact. This is shown by the length of time until the solenoid fully releases and the time until the lower limit switch is triggered.

11. Introduced the 1N5819 Schottky diode (flyback diode) across the coil.

Circuit Reading





Voltage spike amplitude: -6.1 V

Time until solenoid fully releases: 441 ms

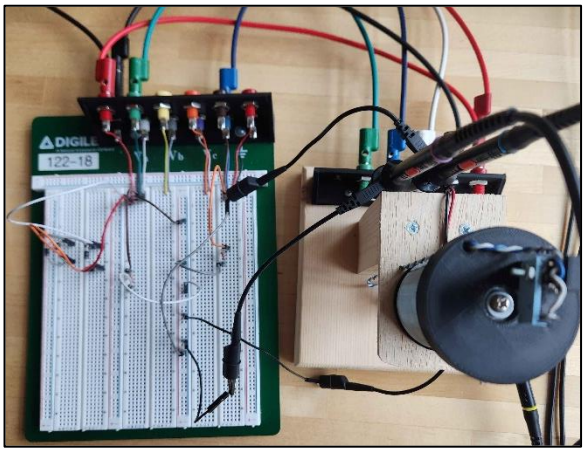
Spike to lower limit: 379 ms

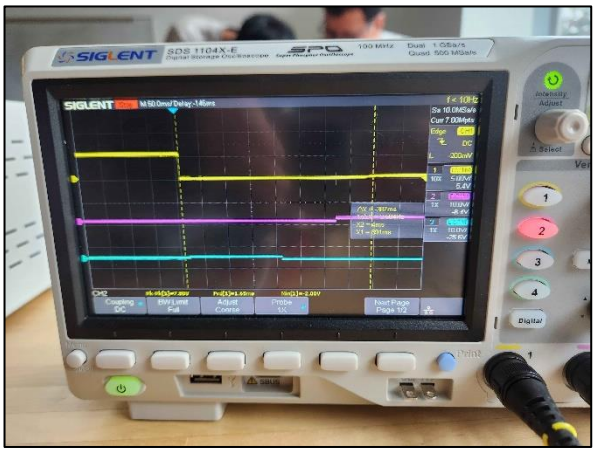
Spike to upper limit: 278 ms

The purpose of a flyback diode is to reduce the spike in voltage caused by the solenoid being abruptly disconnected from power. The back EMF is chopped, but the current stays in the circuit longer. Therefore, the introduction of the diode lengthens the amount of time necessary for the lower limit switch to be enabled after power is removed.

12. Introduced 2 different voltage zener diodes in series with the 1N5819 diode across the coil.

Circuit Reading





Voltage spike amplitude: -2.72 V

Time until solenoid fully releases: 392 ms

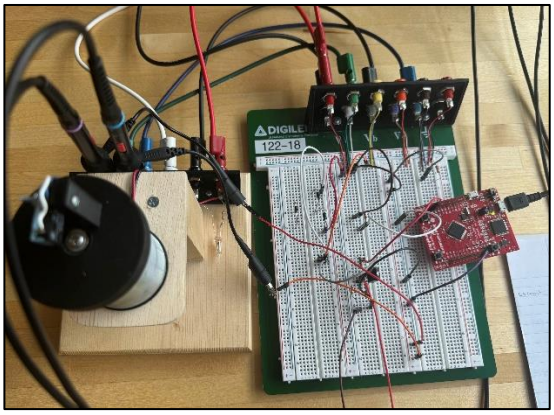
Spike to lower limit: 310 ms

Spike to upper limit: 204 ms

The addition of two Zener diodes to the circuit further reduced the magnitude of the back EMF. The amount of time necessary for the solenoid to be fully released is shorter than before the Zener diodes were introduced. The voltage spike was clamped to the lowest breakdown voltage present in the Zener diodes (2.2V), adjusting for the additional forward voltage of the Schottky flyback diode (0.60V).

15. Introduced FQP20N06L n-channel MOSFET configured as a low side driver with flyback diode. Used software to toggle pin as fast as possible

Circuit

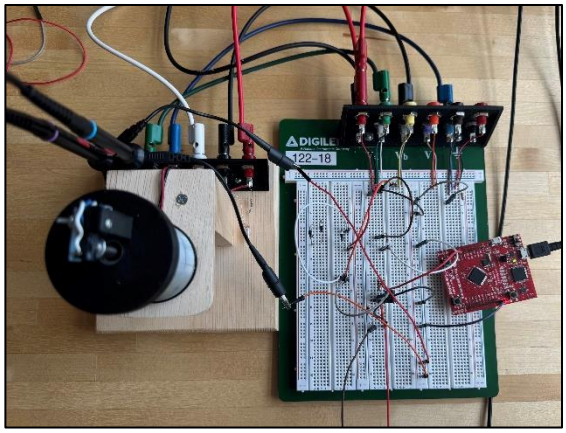


Reading

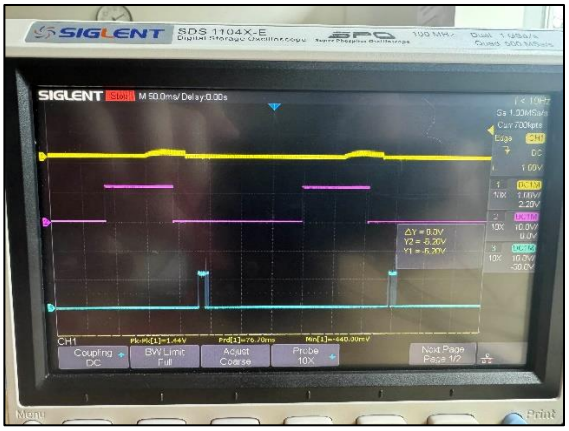
This iteration of the circuit was successful with software powering the circuit for 0.063s and disabling the circuit for 0.25s.

16. Introduced two Zener diodes in series with flyback diode

Circuit



Reading



This iteration of the circuit was successful with software powering the circuit for 0.055s and disabling the circuit for 0.18s. The Zener diodes allowed for faster toggling.