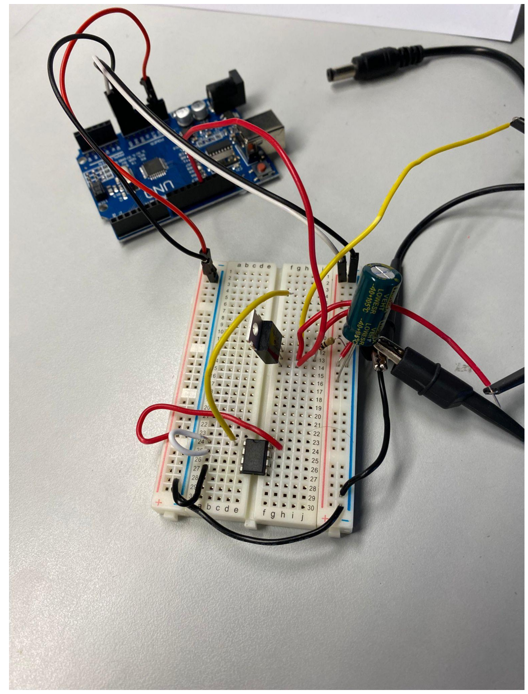
Lab Report 3 - Sam Freed

This lab introduced us to slammer circuits, which draw large amounts of current from the power rail very quickly. When they do, inductance is generated on the power rail, which is what necessitates the need for a decoupling capacitor.

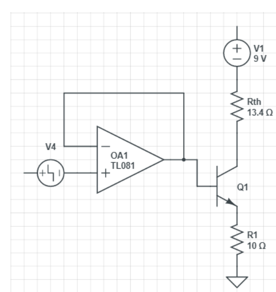
The scope image below demonstrates what happens when the Arduino pin voltage goes high, causing the voltage on the 9V power supply to be loaded and drop to 7.93V. Using this and the load resistance between the collector of the transistor, the Thevenin resistance of the VRM can be determined.



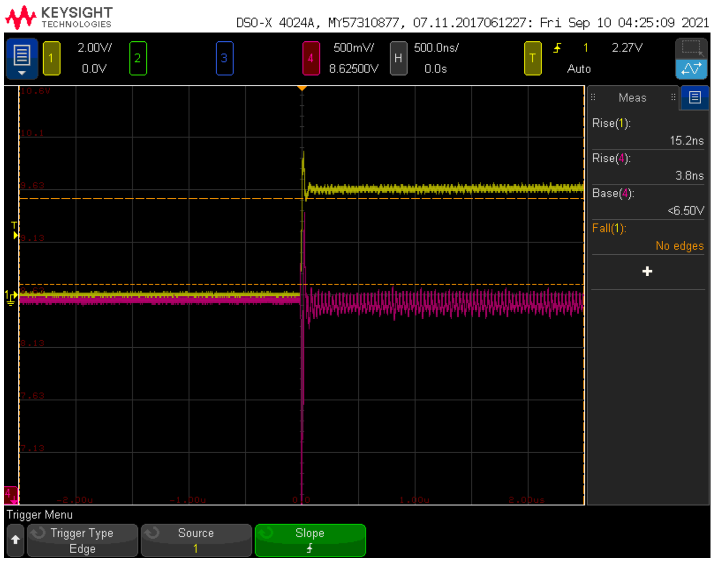
$$R_{th} = R_l * \frac{V_{th} - V_l}{V_l}$$

$$\frac{V_{th} - V_l}{V_l} = \frac{9 - 7.93}{7.93} = 0.134V$$

$$R_{th} = 10\Omega * 0.134V = 1.34\Omega$$



Next, the loop inductance can be determined. The two different connections for the source signal result in two different inductances, which also cause the difference in noise seen. With the decoupling capacitor, the rise time is observed to be 3.8ns, as in the scope image below



$$V = L\frac{dI}{dt} \Rightarrow \frac{dI}{dt} = \frac{9V/1.34\Omega}{3.8ns} = 1.82A/ns \Rightarrow L = \frac{1.82A/ns}{9V} = 20.2\ nH$$

Finally, the effect of a decoupling capacitor can be seen when comparing scope probes of the two different setups. The decoupling capacitor helps to mitigate the inductance between the power lines, and as shown in the screenshots below, changing the location from further away (left) to closer to (right) to the power pin of the transistor helped to decrease the noise. I was unable to compare the difference between a 2200uF capacitor and a 1 uF capacitor, as my kit lacked the latter.