Julia DiTomas
ECEN 3730 Lab 18
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The objective of this lab is to measure the current drawn from the power supply for a periodic circuit (555 timer) during steady state and when initially turned on. We accomplish this by inserting a small sense resistor between the 5V power supply and the power rail of the solderless breadboard. We can measure the voltage across this resistor and then calculate the current through it.

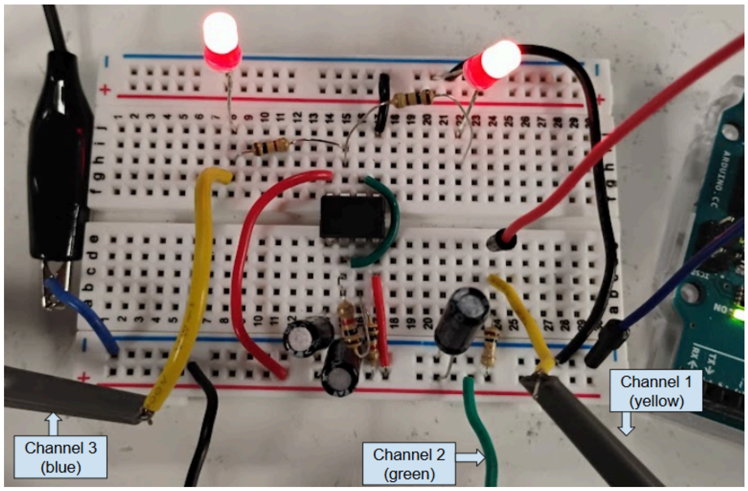

Figure 1: Circuit under test with 1 Ω sense resistor. Each LED is in series with a 100 Ω current-limiting resistor.

The high output of the 555 timer will be about 3.3 V, and each LED will have a voltage drop of 1.9 V. Therefore we expect the total current through the two LEDs to be 28 mA. This can safely go through the 1 Ω resistor as the power dissipated will only be 0.8 mW.

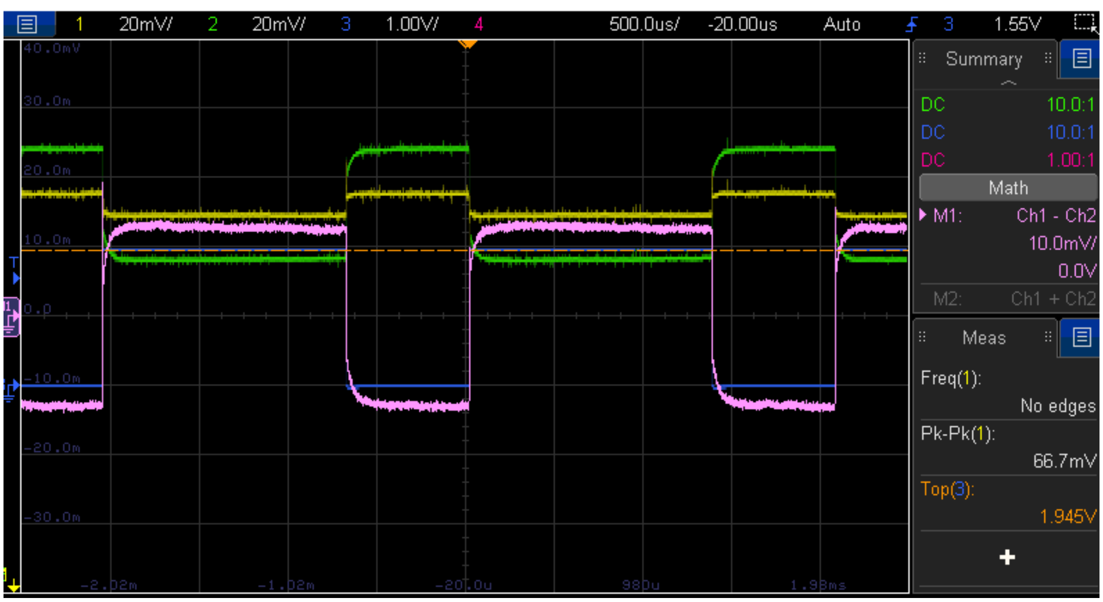

Figure 2: Steady-state scope display, showing the high side of the sense resistor (yellow), the low side of the sense resistor (green), the difference between the two (pink), and the voltage across one LED (blue).

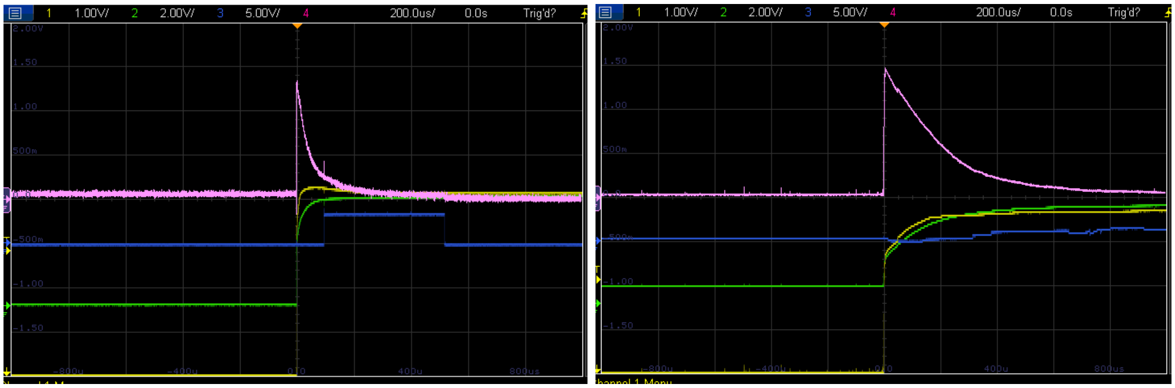

Figure 3: In-rush current with 10 μF decoupling capacitor (left) and 100 μF decoupling capacitor (right). Note that as the sense resistance is 1 Ω, the current in amps equals the voltage read on the vertical axis.

In Figure 2, we see that the voltage across the sense resistor forms a square wave with an amplitude of approximately 26 mV, which is close to the expected value of 28 mV. The pink trace goes below zero on the low side, which is likely due to differences between the two probes and their grounds, rather than an actual current flowing back into the power supply.

Figure 3 displays the voltages when the circuit is initially switched on. We see that with the 10 μF decoupling capacitor on the power rail, the current spikes up to 1.3 A but decays to approximately its steady-state value in 200 μs. By switching the decoupling capacitance to 100 μF, we increase the maximum in-rush current to 1.5 A and the analogous decay time to about 500 μs.

From this lab, we have learned to approximate and measure the current that is drawn by a given circuit, which allows power requirements and specifications to be defined. We also observed how much current can be drawn when a circuit is turned on, but also how short-lived this very high current is (which is why it doesn't start smoking the sense resistor or any other component). Finally, we saw that more decoupling capacitance requires more inrush current for a longer duration of time. This is because there is a larger reservoir of charge to be filled initially. Although this is a disadvantage of adding a lot of decoupling capacitors, for most of our circuits the in-rush period is negligible.