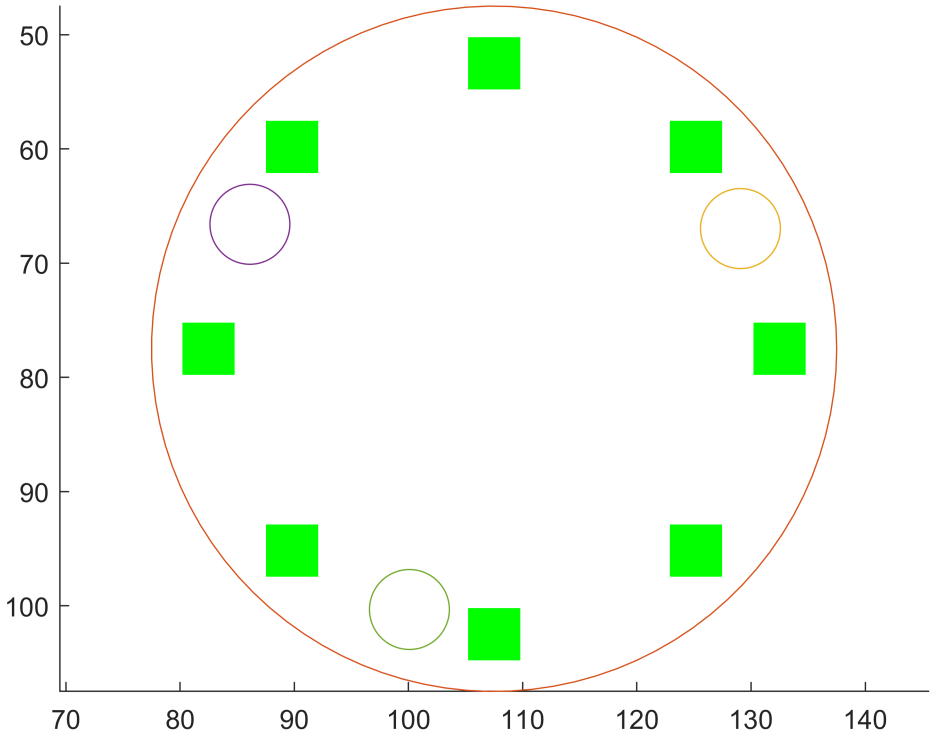
PCB Layout

Component placement (LEDs, mounting holes)

```
led_coords = 8×2
  125.1777   95.1777
  107.5000  102.5000
   89.8223   95.1777
   82.5000   77.5000
   89.8223   59.8223
  107.5000   52.5000
  125.1777   59.8223
  132.5000   77.5000

mountingHolePos = 1×2
  129.0711   66.9791
mountingHolePos = 1×2
   86.1158   66.6042
mountingHolePos = 1×2
  100.0836  100.3254
```



Calculate position of capacitor for .POS file exporting (KiCAD will not put the positions of through hole components, so the capacitor must be interpolated from nearby component data)

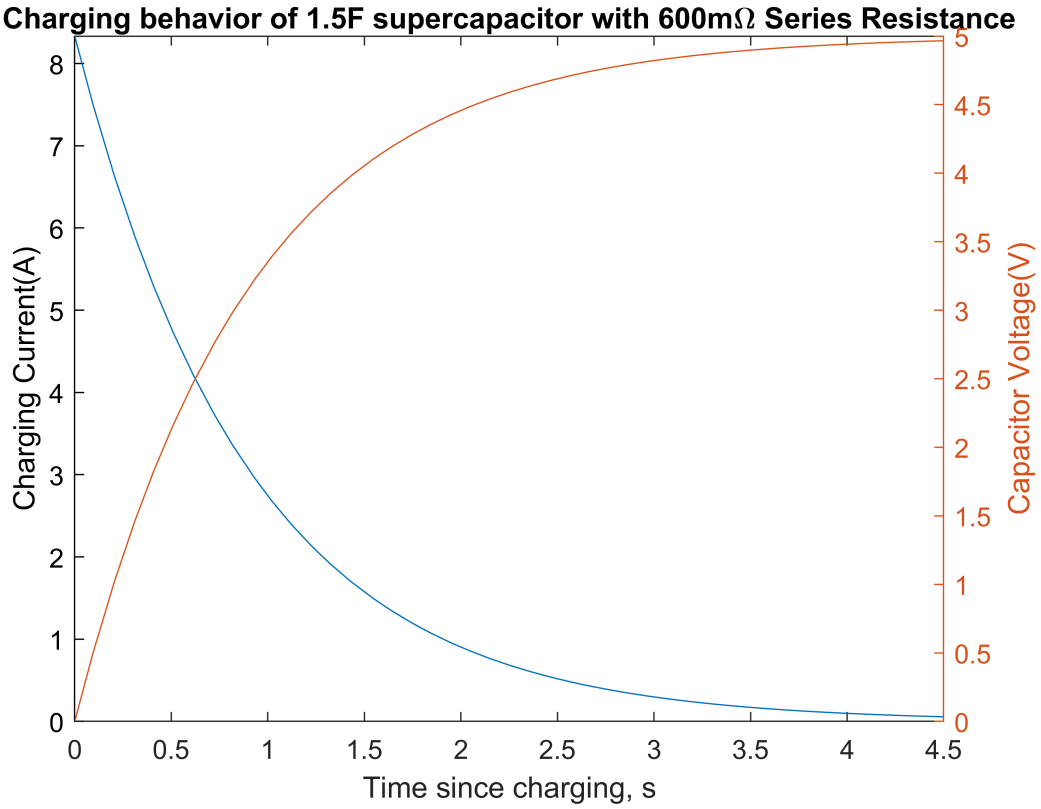
```
cap_pos_x = -11.3435

cap_pos_y = 17.1943
```

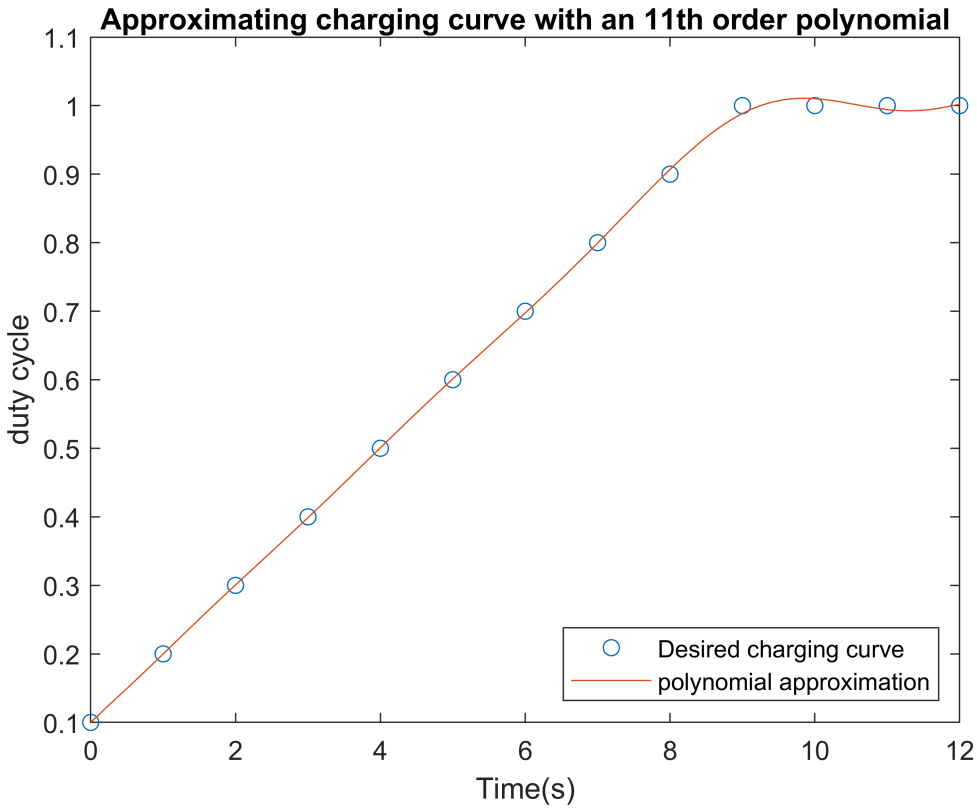
Component choices

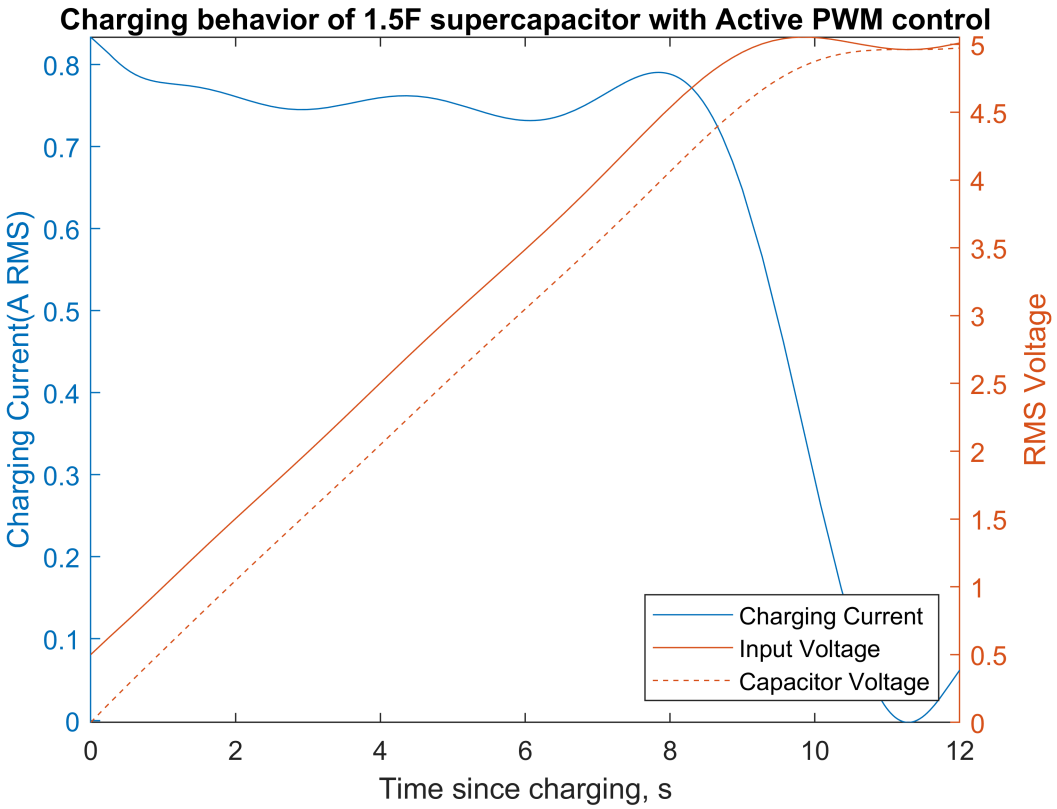
Checking the behavior of C4 (Supercapacitor) and R1 (Shield resistor). Results suggest using PWM to adjust the charging voltage of C4, as suggested below. Suggested charging curve of

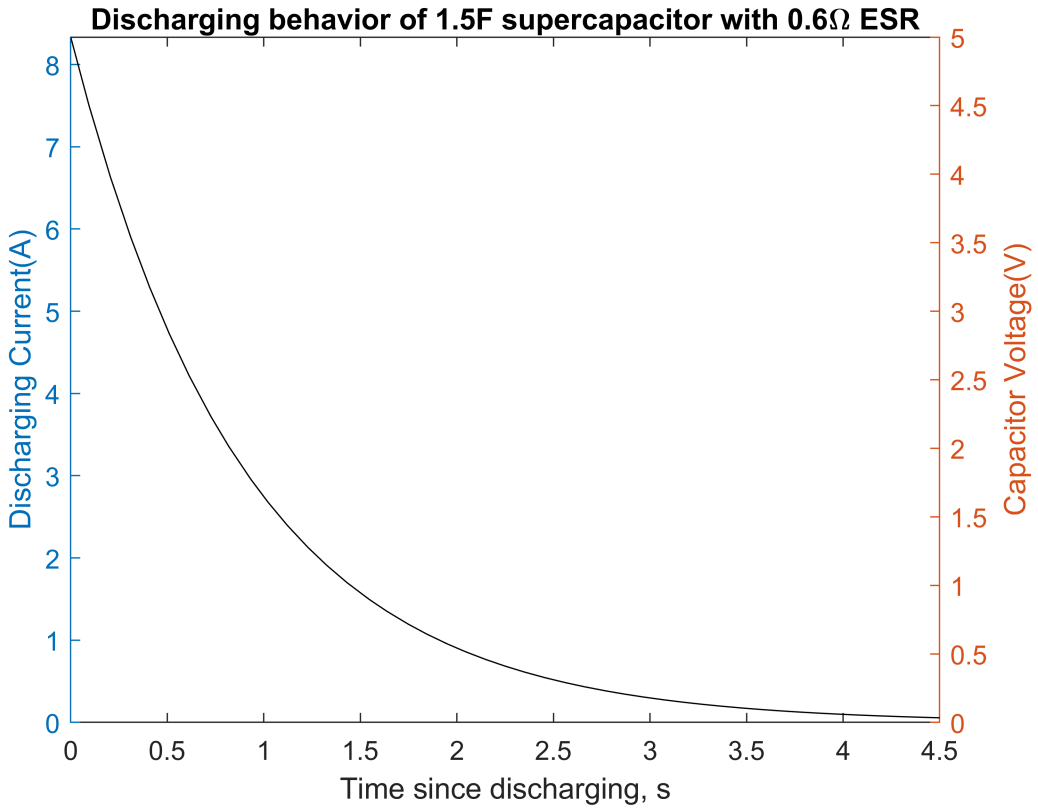
$$\text{Duty Cyle} = \text{constrain}(0.1 + 0.1t,\ 0,\ 1)$$

where t is in seconds.




Approximating charging curve with an 11th order polynomial
duty cycle
Time(s)
Desired charging curve
polynomial approximation


Charging behavior of 1.5F supercapacitor with Active PWM control
Charging Current(A RMS)
RMS Voltage
Time since charging, s
Charging Current
Input Voltage
Capacitor Voltage



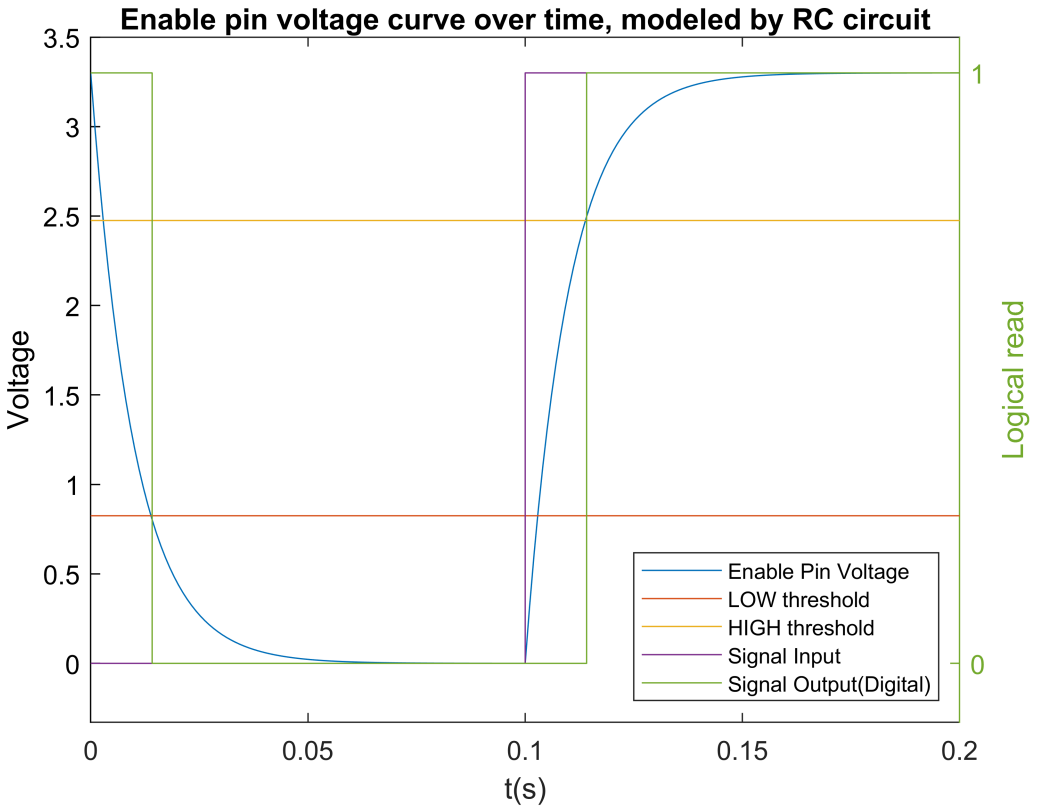

```
temperature_increase_of_steel_wool_after_discharge = 101.9022

R_shield = 500

drain_tau = 12.5000

max_power_shield_resistor = 0.0500

resistance_value_ok = logical
   1
```

Battery life calculations

```
energy_per_capacitor_charge = 0.0052 A V h

battery_life = (5.2351 h   3.5150 h)

battery_life_loss_one_capacitor_discharge = (0.0042 h   0.0028 h)
```

Checking delay RC circuits on the reset pin

```
enable_delay_time_ms = 14.1414
```



Calculations for the acceleration that is measured by the accelerometer while spinning