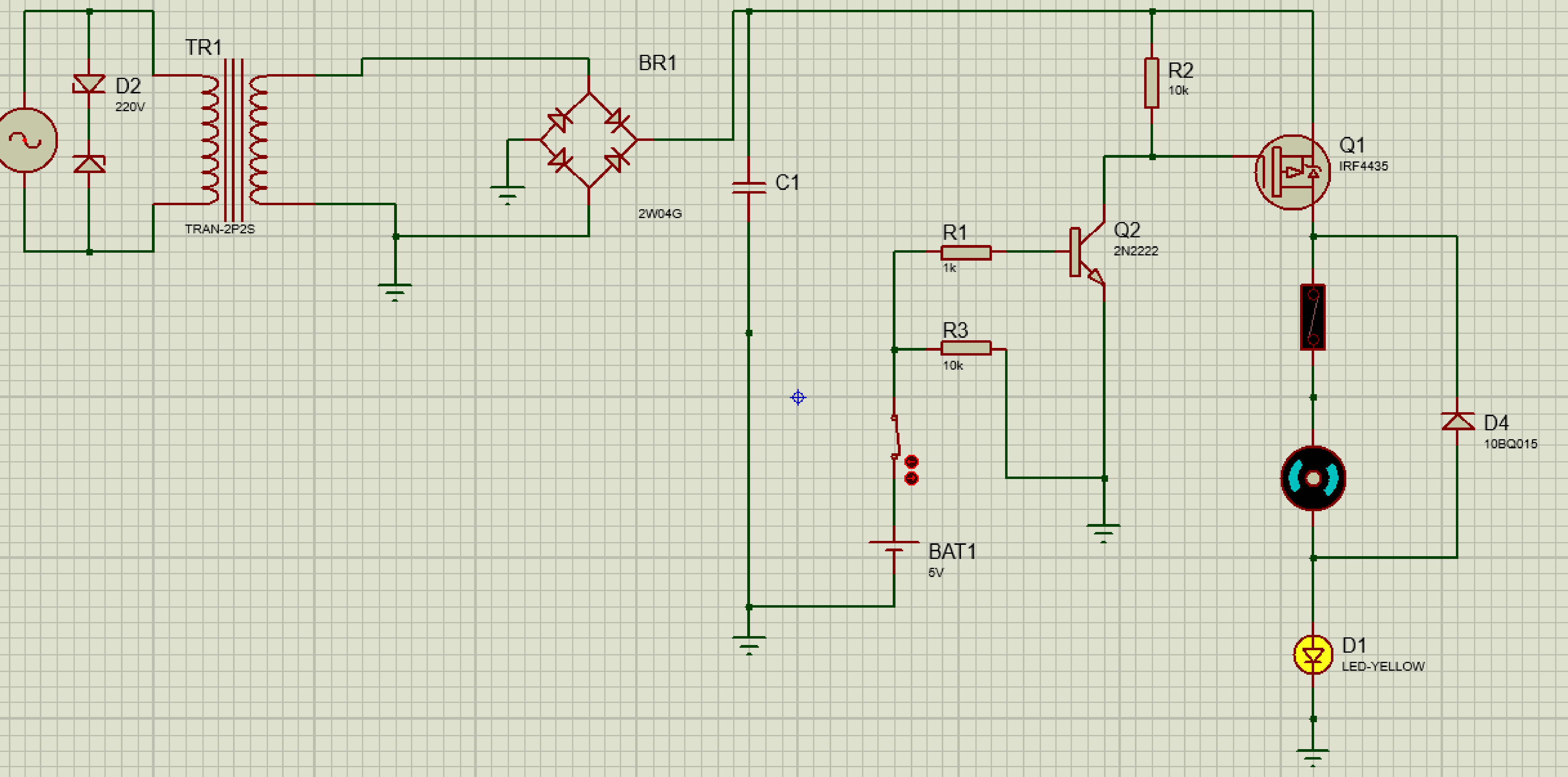
TASK 2

APPROACHES TO CONVERT 220V AC TO 24V DC

- Using a 220V AC → 24V DC (2A) Adapter
  - Pros :
    - Simple , requires only connecting
    - Stable 24V DC output
    - Compact and space-saving
  - Cons :
    - Internal settings (protection/limits) cannot be adjusted
    - Expensive
    - Not customizable
- Using a Transformer + Filtering Circuit
  - Pros :
    - Fully customizable design, adjusted to use with any load
    - Can be lower cost depending on design
  - Cons :
    - Requires more complex wiring
    - Must include safety margin to ensure output stays near 24V

• IDEA BEHIND THE DESIGN

- Following the second approach, I built a fully customizable AC to DC converter, with load control using a 5V signal. The design includes isolation to protect components from common issues such as:
  - Voltage spikes from the AC source
  - Inductive spikes caused by switching
- In the next sections, each part of the circuit will be discussed in detail, including its working principle and relevant calculations.



TR1
TRAN-2P2S
D2
220V
BR1
2W04G
C1
R1
1k
R3
10k
BAT1
5V
R2
10k
Q2
2N2222
Q1
IRF4435
D4
10BQ015
D1
LED-YELLOW

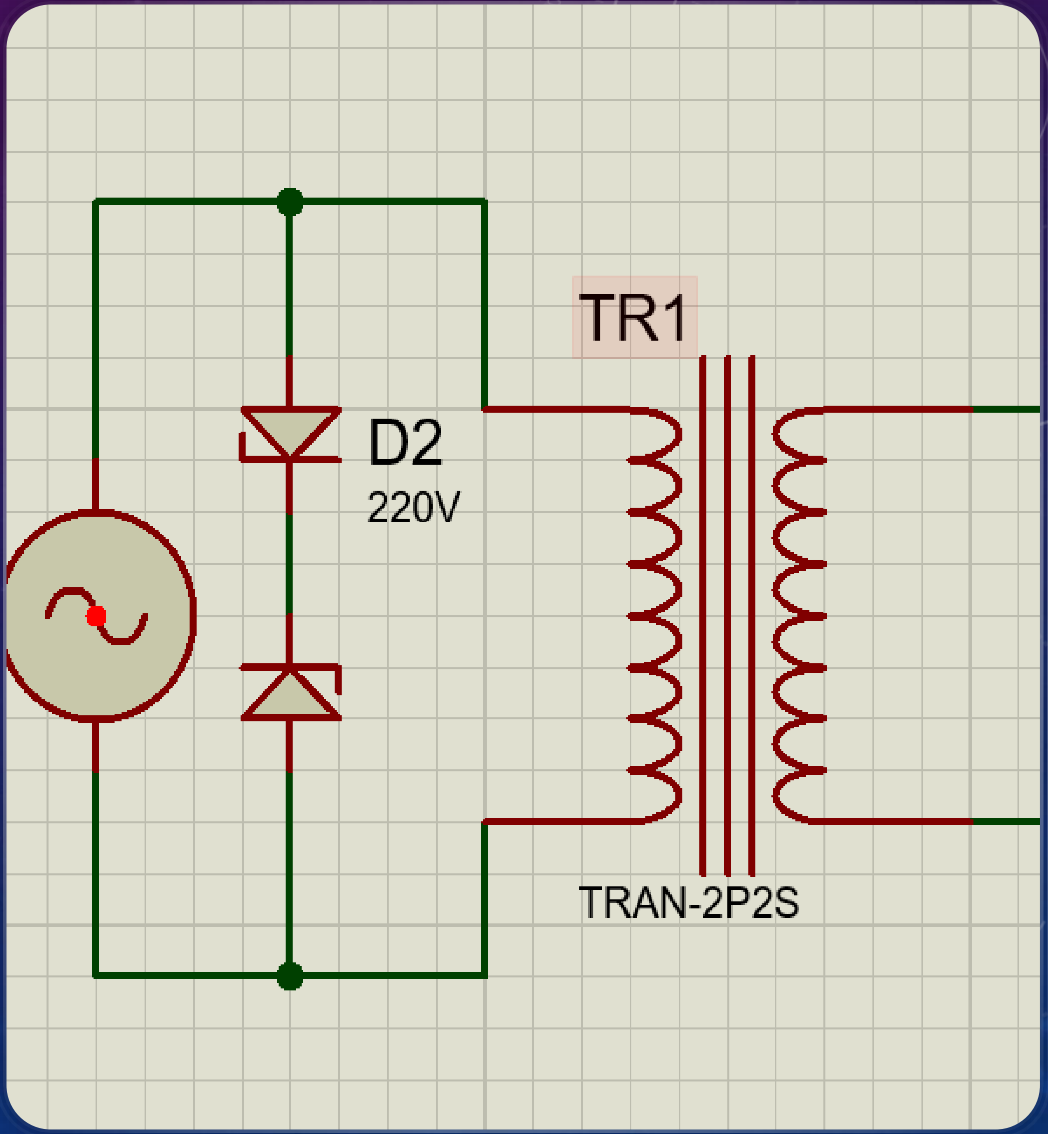
STEPPING DOWN

[1] A step down transformer

- Designed with a primary/secondary inductance ratio of **148**
- Based on ($^{v_p}/_{v_s} = \sqrt{\frac{Lp}{L_s}}$)
- Steps 220V AC down to **~18.08V AC_25.57Vmax_**, accounting for voltage drops

[2] Zener diodes

- Added to **suppress voltage spikes**
- Limit the input voltage to **220V max**



FILTERING

[3] Full bridge rectifier

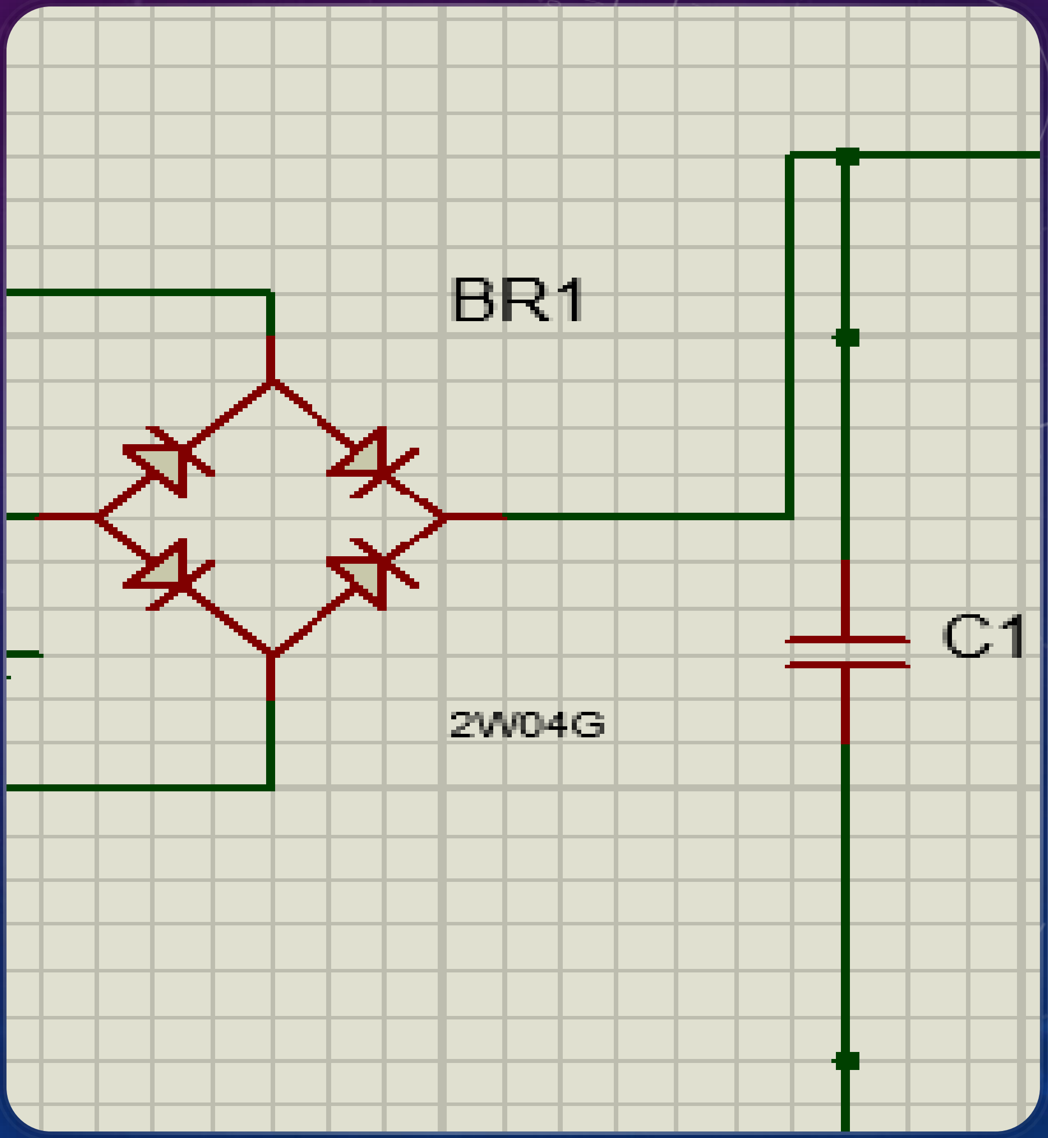
- rectifies the signal
- more efficient than HWR in filtering (higher Vdc and frequency)
- $V_m = v_{sec} - 1{,}4(loss\ in\ diodes) = 24.17V$

[4] Capacitor

- The higher the capacity the better the filtering based on

  $v_{ripple} = \frac{v_m}{F * C * R}$

- 30000 uf would result in maximum ripple of 0.33 without accounting for the load resistance (12 ohm -> 0.0277 ripple)



LOAD CONTROL

[5] MOSFET

– Acts as the high-side

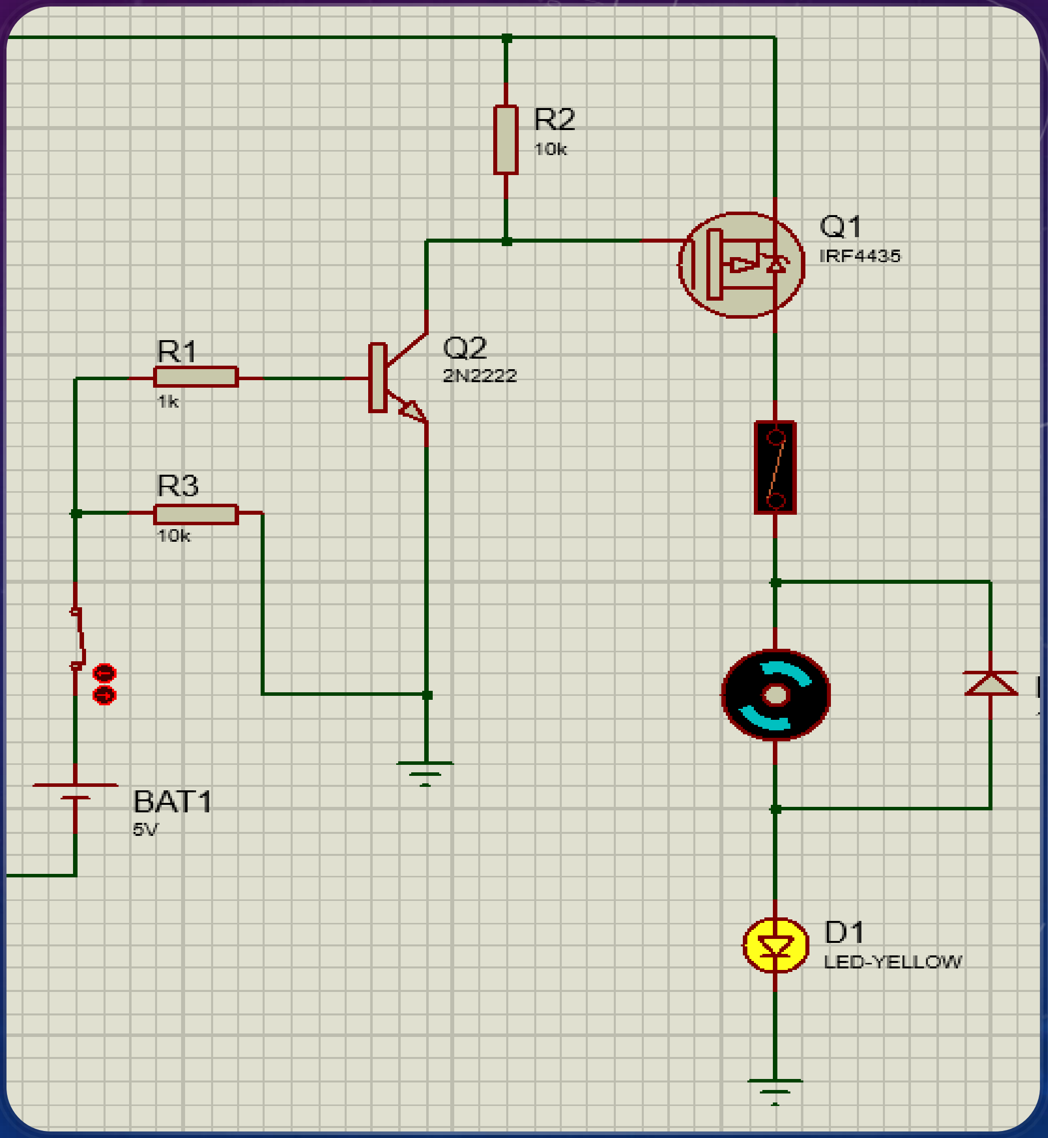
- Off when V_G = V_S
- On when V_G is pulled low switch for the motor:

[6] Transistor

– Level-shifts the 5 V logic to drive the MOSFET gate:

- Q2 only conducts when V_IN > V_BE (~0.7 V), so small noise spikes won’t turn it on
- When 5 V is present, Q2 saturates and pulls the gate to 0 V
- When 5 V is absent, Q2 is off and R2 (10 kΩ) pulls the gate up to 24 V

– The V_BE threshold provides inherent noise immunity; for even stricter “5 V only” switching you can add a diode or small cap on the base to sharpen the turn-on edge



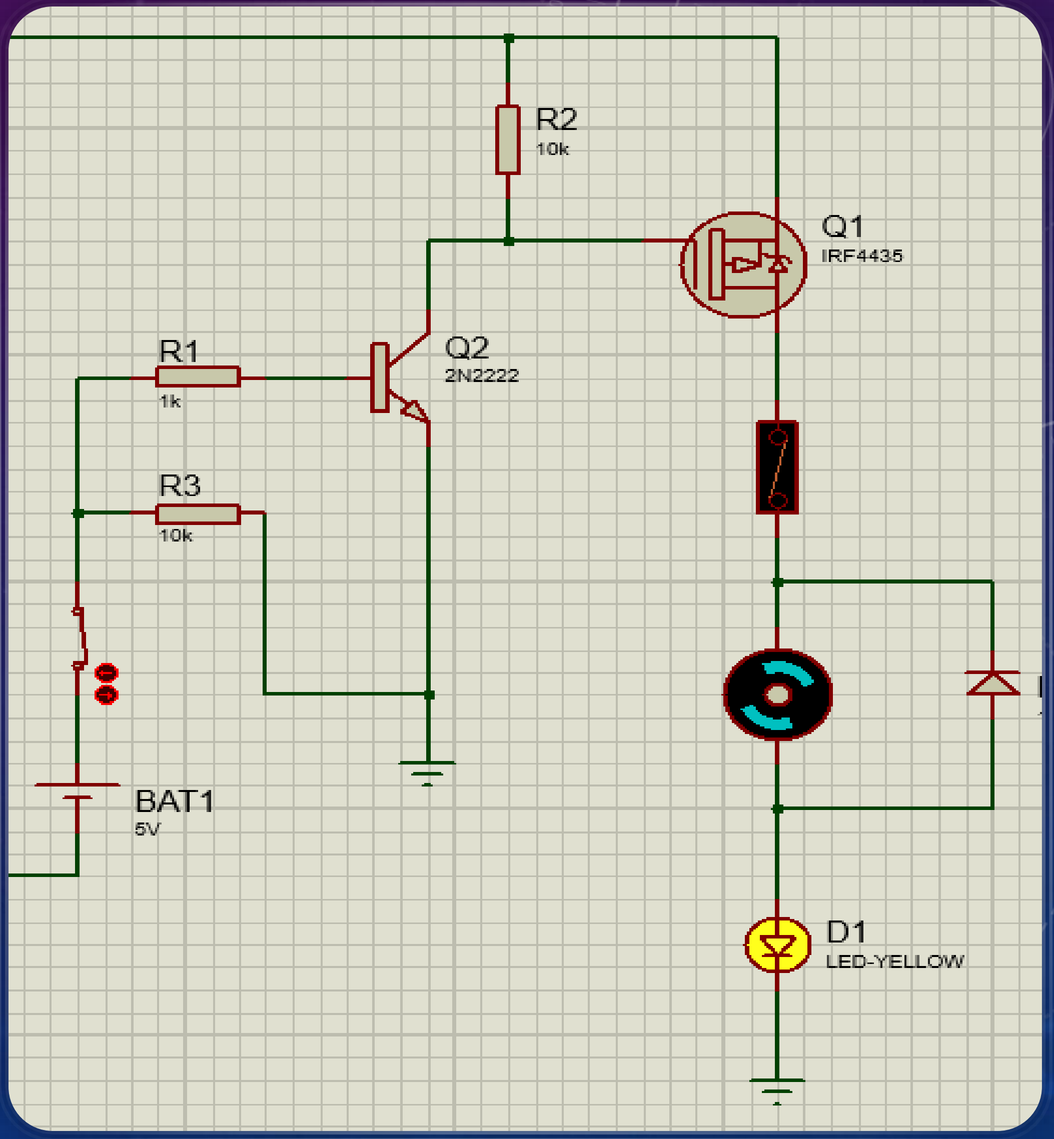
LOAD PROTECTION

[7] Fuse

- Protects the motor against currents above 2A

[8] Diode

- a parallel diode to protect the load against inductive spikes when turning on and off



COMPONENTS LIST

- [1] A step down transformer https://makerselectronics.com/product/transformer-220v-18v-0-18v-2a/
- [2] Zener diodes https://eu.mouser.com/ProductDetail/Vishay-Semiconductors/BZT03C220-TR?qs=ylvl1B2wDi5PnCFRlEdTug%3D%3D
- [3] Bridge Rectifier https://makerselectronics.com/product/kbp310-bridge-rectifier-single-phase-3a-1000v-kbp-3/
- [4] Capacitor https://makerselectronics.com/product/capacitor-10000uf-25v/ , https://makerselectronics.com/?s=Capacitor+10000uF&post_type=product&type_aws=true _higher voltage reating_
- [5] MOSFET https://makerselectronics.com/product/irf5305-p-channel-power-mosfet/
- [6] Transistor https://makerselectronics.com/product/2n2222-npn-bipolar-transistor-to-92/?srsltid=AfmBOorky8ROlIQvZzZKDBB-F59rn8hUrCcQOKfq-K9LY0OpdQEr32jk
- [7] FUSE https://makerselectronics.com/?s=FUSE&post_type=product&type_aws=true