Department Of Communication Systems

Benha National University

CSE202: Electronics II

Power Cut Auto Delay Circuit

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Power Cut Auto Delay Circuit

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Abstract:

This report presents the design, working principle, and implementation of a Power Cut Auto Delay System. The system is designed to protect electrical appliances from voltage surges or fluctuations that occur after a power outage, ensuring a safe delay period before reconnection.

1. Introduction:

Power fluctuations and sudden voltage surges can cause significant damage to sensitive home appliances, such as refrigerators, freezers, and other electronic devices. The Power Cut Auto Delay System is designed to mitigate this risk by introducing a delay before reconnecting the appliances to the main power supply. This delay allows the electrical network to stabilize, reducing the chances of damage.

2. Electronic Design:

2.1. Circuit Design Specifications:

1. Input Voltage: 220V AC - 50 HZ

2. Output Voltage (Regulated): 12V DC (Through Zener diode)

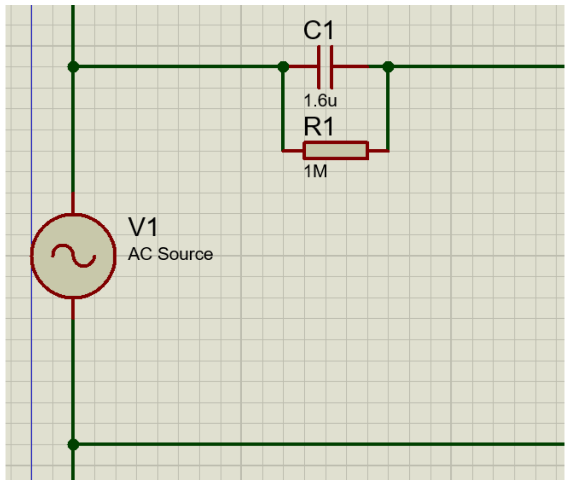
3. Delay Time: Adjustable based on capacitor and resistor values

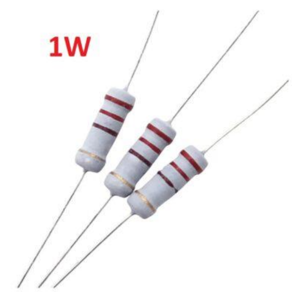
4. Load Capacity: Up to 10A (depend on 12V relay specification)

5. Protection: Overvoltage protection using capacitor polypropylene up to 400V, Zener diode and fast discharge path

3. Circuit Design Explanation:

3.1. AC Protection and Filtering Circuit:





This section is responsible for protecting the circuit from high voltage spikes and ensuring a clean AC input to the bridge rectifier and able to resist up to 400V.

Components Used:

- C1 (1.6µF/ 400V Capacitor): Filters high-frequency spikes and provides a stable AC input.
- R1 (1MΩ – 1Watt): Provides a safe and fast discharge path for the capacitor (C1) when the power is disconnected.

Working Principle:

- The capacitor (C1) acts as a filter, absorbing any high-frequency voltage spikes that may occur on the AC input line.
- The resistor (R1) ensures that when the power is disconnected, the capacitor (C1) safely discharges, preventing any residual voltage.

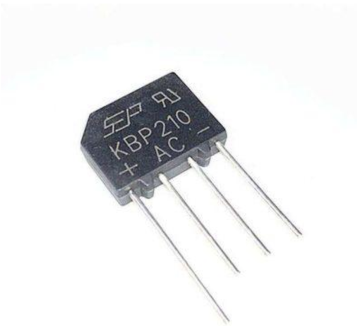
Why These Values Are Chosen:

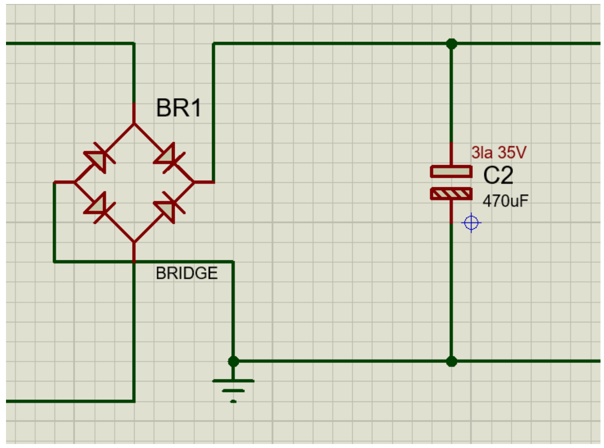
- The 1.6µF/400V capacitor (C1) is chosen to effectively filter out high-frequency noise without significantly affecting the main AC voltage and to resist high voltage.
- The 1MΩ resistor (R1) is selected to provide a slow and safe discharge path for the capacitor without impacting the circuit's performance. The high resistance value (1MΩ) ensures minimal leakage current, maintaining safety.

  Laws:

$$I = 2\pi f v c = 2\pi(50)(220)(1.6 \times 10^{-6}) = 110mA$$

3.2. Rectification Circuit:





This section is responsible for converting AC voltage to DC voltage.

Components Used:

- AC Source (V1): 220V AC supply.
- Bridge Rectifier (BR1): Converts AC to pulsating DC.
- Filter Capacitor (C2 - 470µF/35V): Smooths the rectified voltage.

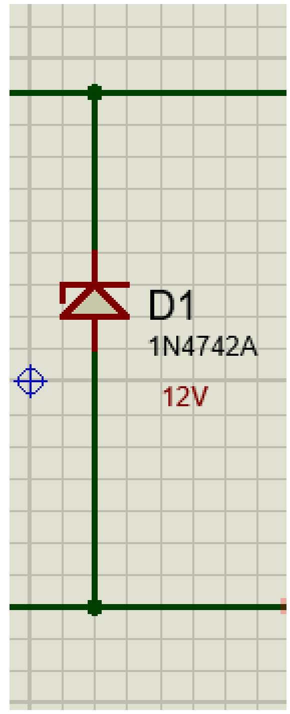
Working Principle:

- The AC voltage is passed through the bridge rectifier (BR1) and converted to pulsating DC.
- The filter capacitor (C2) smooths this DC voltage, providing a stable DC output.

Why These Components Are Used:

We Use a bridge with KBP210 because it can resist up to 1000V and 2A, Not use diodes 1N4007 Because it resist up to 1A only.

3.3. Voltage Regulation Circuit:



This section is responsible for maintaining a stable 12V DC output.

Components Used:

- Zener Diode (D1 - 12V): Regulates the output voltage at 12V.
- Resistor (R5 - 3kΩ): Limits the current through the Zener diode.

Working Principle:

- The Zener diode ensures a constant 12V output, regardless of input variations (above 12V).
- The resistor (R5) controls the current through the Zener, ensuring safe operation.

Why These Components Are Used:

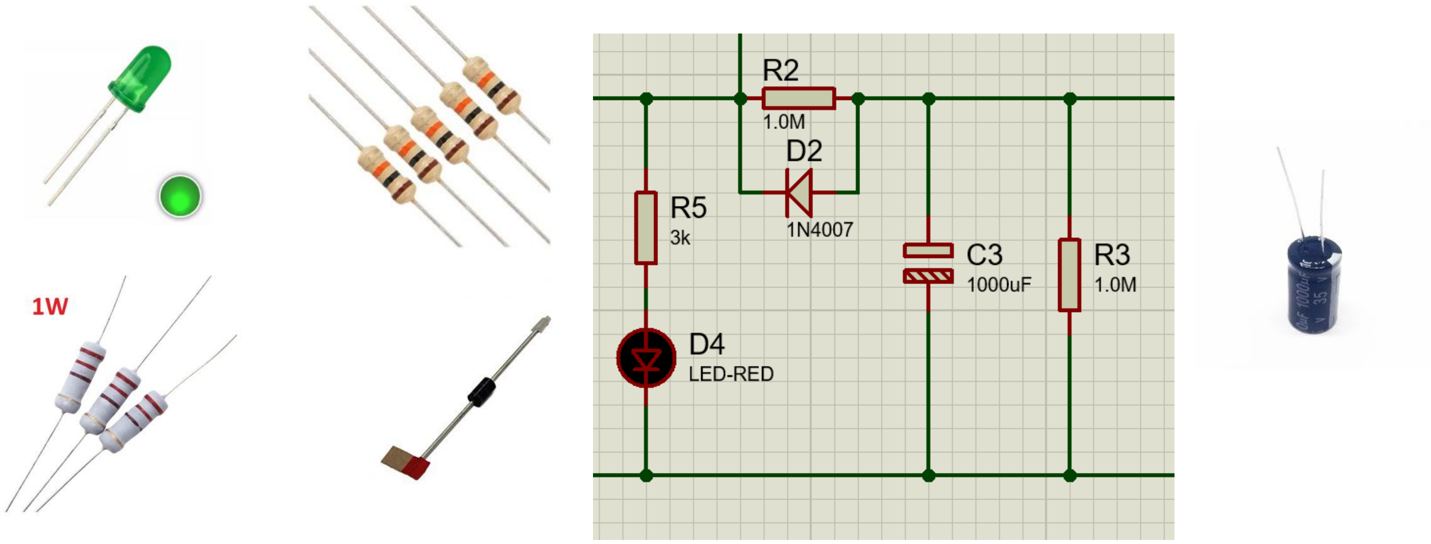
• Zener Diode (D1 - 12V): Chosen because it maintains a stable 12V output, which is ideal for the control circuit and relay.

• Resistor (R5 - 3kΩ): Selected to limit the current through the Zener diode, ensuring stable operation without overloading the diode.

Why Zener not LM7812 IC?

- Compact Design: It takes up less space than a 7812 voltage regulator circuit, which requires additional capacitors for stable operation.
- Cost-Effective: Zener diodes are generally cheaper than 7812 regulators, making them more suitable for low-cost designs.
- Low Power Application: This circuit is designed for low-power usage (like controlling a relay). A Zener is sufficient without the need for a high-current regulator like 7812.

3.4. Delay Circuit:



Delays the connection of the main load after power restoration.

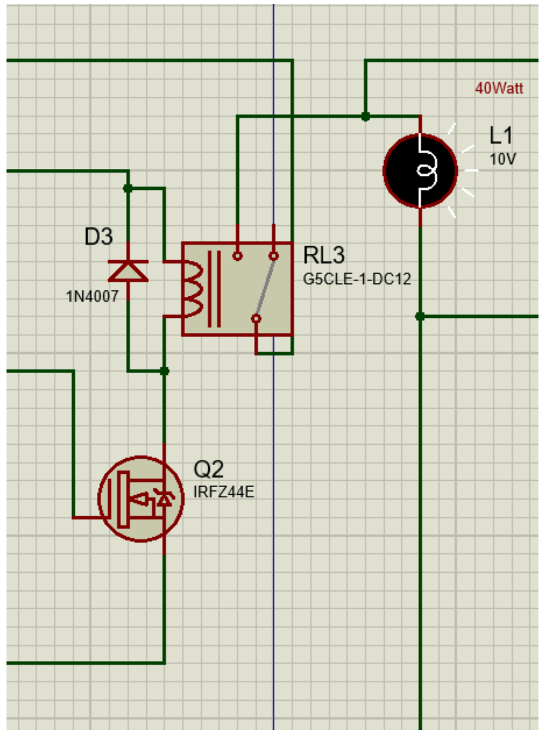
Components Used:

- Delay Capacitor (C3 - 1000µF/35V): Sets the delay duration (Time Delay).
- Charging Resistor (R5 - 3kΩ): Controls the charging speed of C3.
- Led: to indicate that the electricity is available and the circuit is working.
- Discharge Resistor (R2 - 1MΩ) and Diode (D2): Provide a fast discharge path for C3.

Working Principle:

- The capacitor (C3) charges through the charging resistor (R5) when power is restored.
- Once the capacitor voltage reaches the threshold, it triggers the MOSFET (Q2).
- When power is lost, D2 ensures a quick discharge of the capacitor.

3.5. Relay Control Circuit



Controls the activation of the load after the delay.

Components Used:

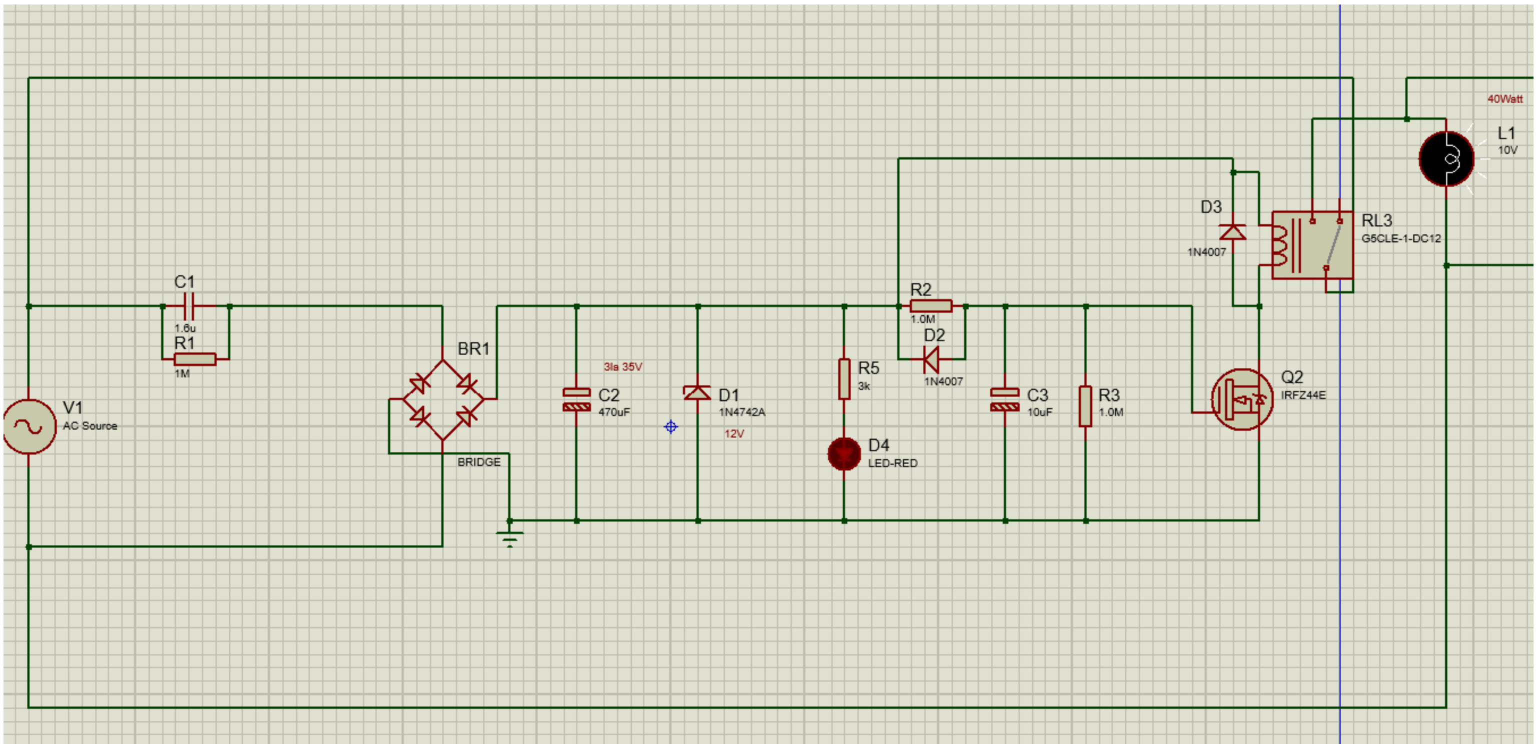
- MOSFET (Q2 - IRFZ44N): Acts as an electronic switch.
- Relay (RL3 - G5CLE-1-DC12): Switches the load.
- Load (L1 - 40W): Represents the connected appliance.
- LED Indicator (D4): Shows the system status.

Working Principle:

- When the capacitor (C3) reaches the trigger voltage, it activates the MOSFET (Q2).
- This energizes the relay (RL3), which connects the load (L1) to the main AC supply.
- If power is lost, the relay immediately disconnects, and the system resets.

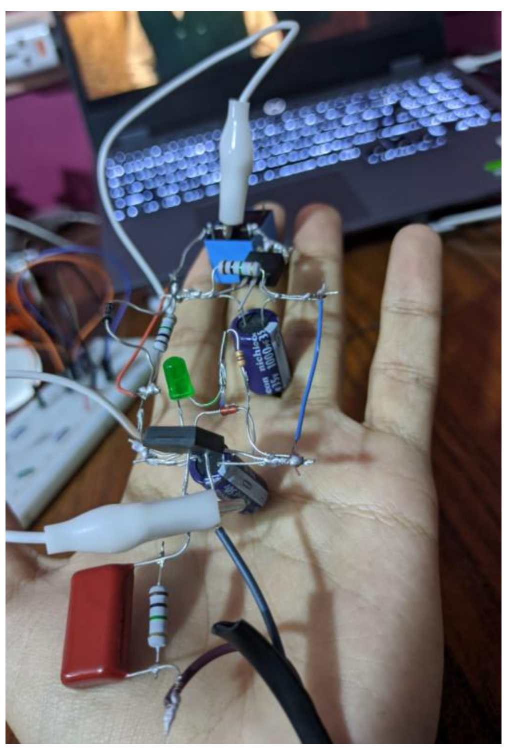
4. Circuit Design Explanation:

4.1. Proteus Simulation:



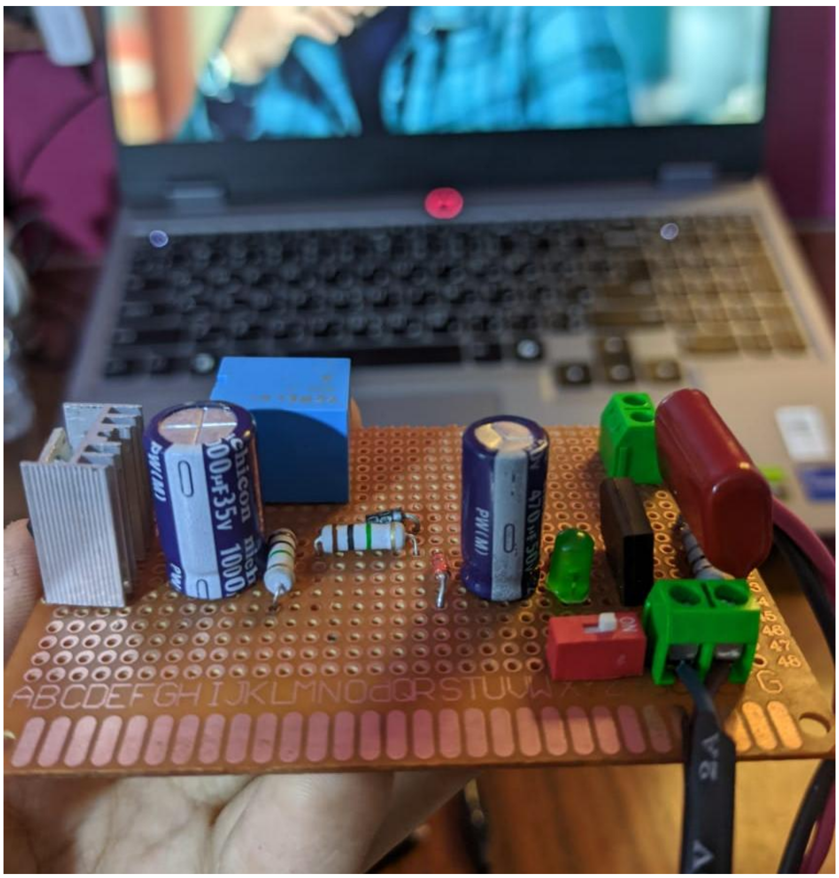
Download Proteus simulation from here: https://github.com/Kirolos-Tamer/Power-Cut-Auto-Delay-Circuit

4.2. Soldiering :

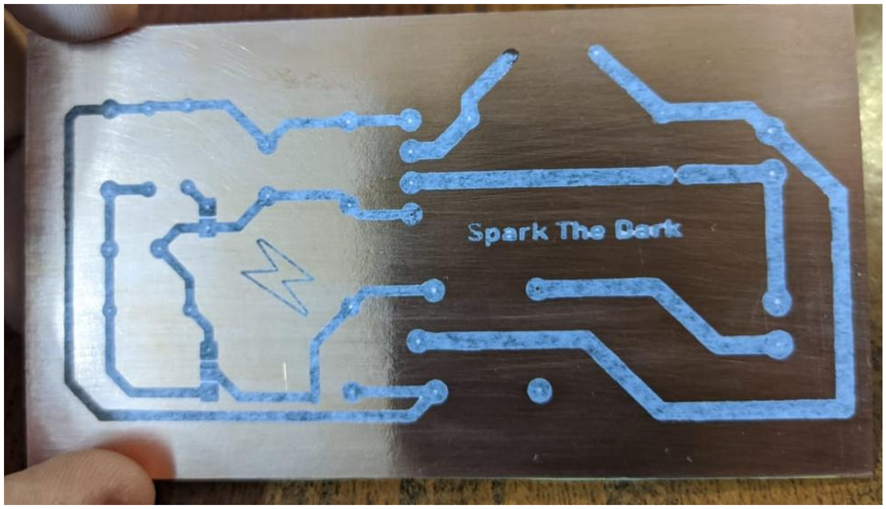


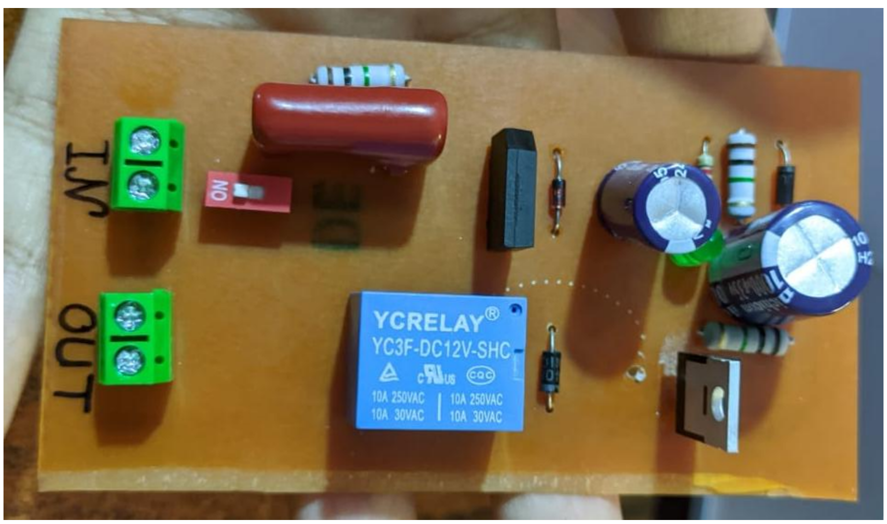
4.3. PCB Design and Implementation:

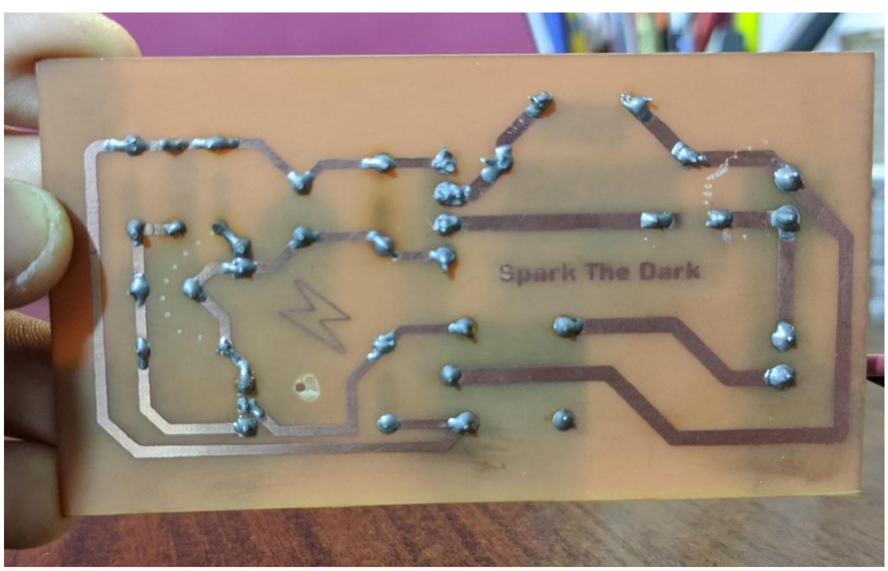
I. Zero PCB (test and soldering on bord):



II. PCB Implementation with Acid:







5. Conclusion:

The Power Cut Auto Delay System effectively protects connected appliances by introducing a controlled delay before re-energizing them. This prevents damage from electrical surges after power restoration.

6. Resources

[1] https://www.alldatasheet.com/datasheet-pdf/view/36752/JGD/KBP210.html

[2] https://www.alldatasheet.com/datasheet-pdf/view/25751/SURGE/1N4742.html

[3] https://www.eevblog.com/forum/beginners/different-between-78xx-regulator-and-zener-diode/

[4] https://www.alldatasheet.com/datasheet-pdf/view/17807/PHILIPS/IRFZ44N.html

[5] https://www.alldatasheet.com/datasheet-pdf/view/1132031/SONGLERELAY/SRD-12VDC-SL-C.html

[6] https://www.electronics-tutorials.ws/rc/rc_1.html

[7] https://en.wikipedia.org/wiki/RC_time_constant

[8] https://www.digikey.com/en/resources/conversion-calculators/conversion-calculator-time-constant

[9] https://www.allaboutcircuits.com/tools/resistor-capacitor-time-constant-calculator/