Over-Voltage & Under-Voltage Protection Circuit

Objective: To design and implement a DC power supply monitoring circuit that automatically disconnects the load during over-voltage or under-voltage conditions. The system also provides early warning indications before critical thresholds are crossed.

. Features:

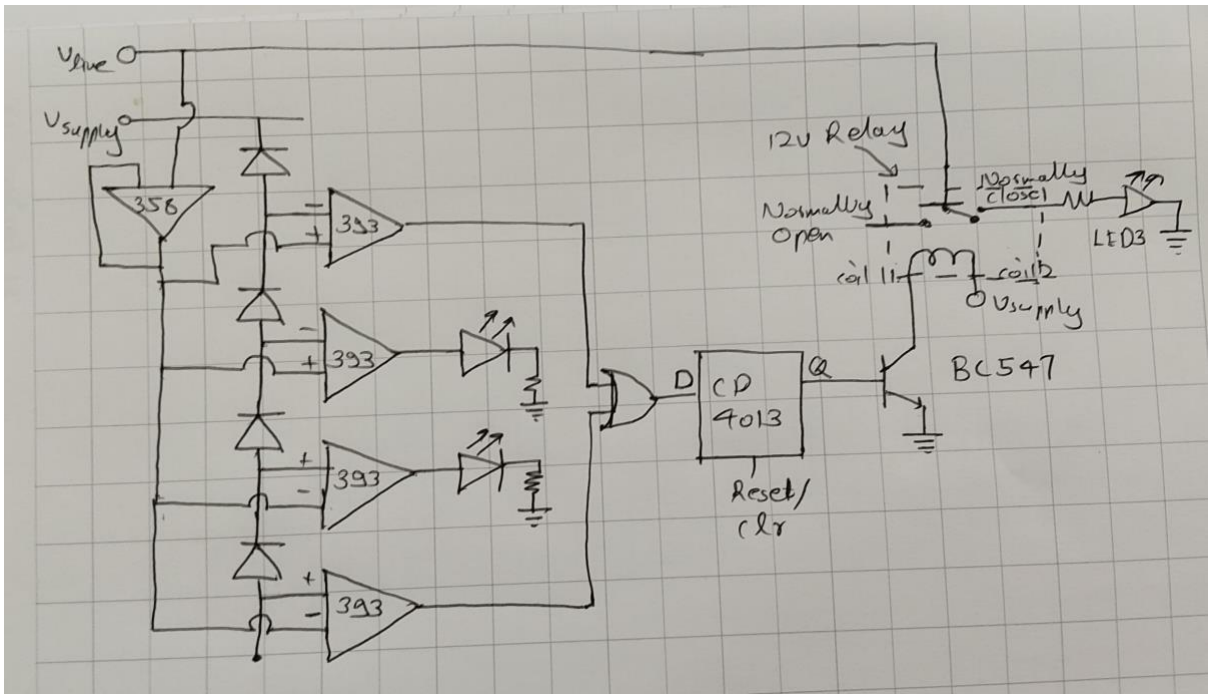
1. Monitors DC voltage levels
2. Provides visual warning (LED) at pre-fault conditions
3. Disconnects load on critical voltage breach
4. Uses D Flip-Flop for fault latching
5. Manual reset button to restore operation
6. Fully analog, no microcontroller involved

.Components Used:

Component, Specification

LM358 Op-Amp, Dual op-amp, used for voltage buffering ,LM393 Comparator , Dual comparator IC, 2 required , CD4013 D Flip-Flop Dual D flip-flop IC , Zener Diodes(10V, 10.8V, 13.2V, 14V (threshold refs)), Relay 12V SPDT , NPN Transistor(BC547 / 2N2222 for relay drive) ,Resistors For voltage dividers, LED limiting , Capacitors (100nF - 1uF for stability) LEDs Yellow (warning), Red (fault) Push Button Manual reset ,Diodes (1N4007 / 1N4148 for logic and flyback)

Circuit Description:



A. Voltage Divider & Buffer:

The input voltage (e.g., 12V) is stepped down using a resistor divider and buffered using LM358 to stabilize and isolate the signal.

B. Comparator Stage:

4 Comparators (2 LM393 ICs) are used:

Comparator 1: Under-voltage warning (<10.8V)

Comparator 2: Under-voltage fault (<10.0V)

Comparator 3: Over-voltage warning (>13.2V)

Comparator 4: Over-voltage fault (>14.0V)

Outputs from warning comparators drive yellow LEDs.

Fault comparators drive the set pin of the D flip-flop.

Circuit Description:

C. **D Flip-Flop Latch:**

The CD4013 latches fault state when any fault comparator output goes high.

Flip-flop Q output drives relay control transistor.

Reset pin is connected to a push button to clear fault state.

D. **Relay Driver Circuit:**

A BC547 transistor acts as a switch for the relay.

Relay cuts off load connection when fault is latched.

E. **Diode Usage:**

Zener diodes provide reference voltages.

Diodes used for OR-ing fault signals to flip-flop.

Flyback diode across relay coil to protect transistor.

Applications:

Battery management systems

Automotive power control

Industrial power supply protection

Solar charge controllers

Advantages:

Microcontroller-free design

Cost-effective and reliable

Adjustable and simple to calibrate

Conclusion:

The proposed circuit effectively protects DC-powered devices from damage due to voltage irregularities. Its analog nature ensures simplicity and reliability, making it ideal for low-cost power protection applications.

References:

Datasheets: LM358, LM393, CD4013

Basic electronics and comparator application guides