Institute of Radio Physics and Electronics, University of Calcutta

<u>Mini Project Topic</u>:

Overvoltage protection using Comparator circuit

<u>Project Members</u>:

1. Amitrakshar Sanyal - ECE422

2. Aniruddha Mandal - ECE421

3. Deepra Chakraborty - ECE423

Design description of the project

This overvoltage protection circuit controls a P-Channel MOSFET that connects the SUPPLY to the LOAD using a high-voltage comparator with a push-pull output stage. The output of the comparator goes HIGH when the SUPPLY voltage exceeds the overvoltage threshold (V_over), disconnecting the LOAD from the SUPPLY by opening the P-Channel MOSFET. When the SUPPLY voltage falls below V_over, the comparator's output is LOW, connecting the LOAD to the SUPPLY.

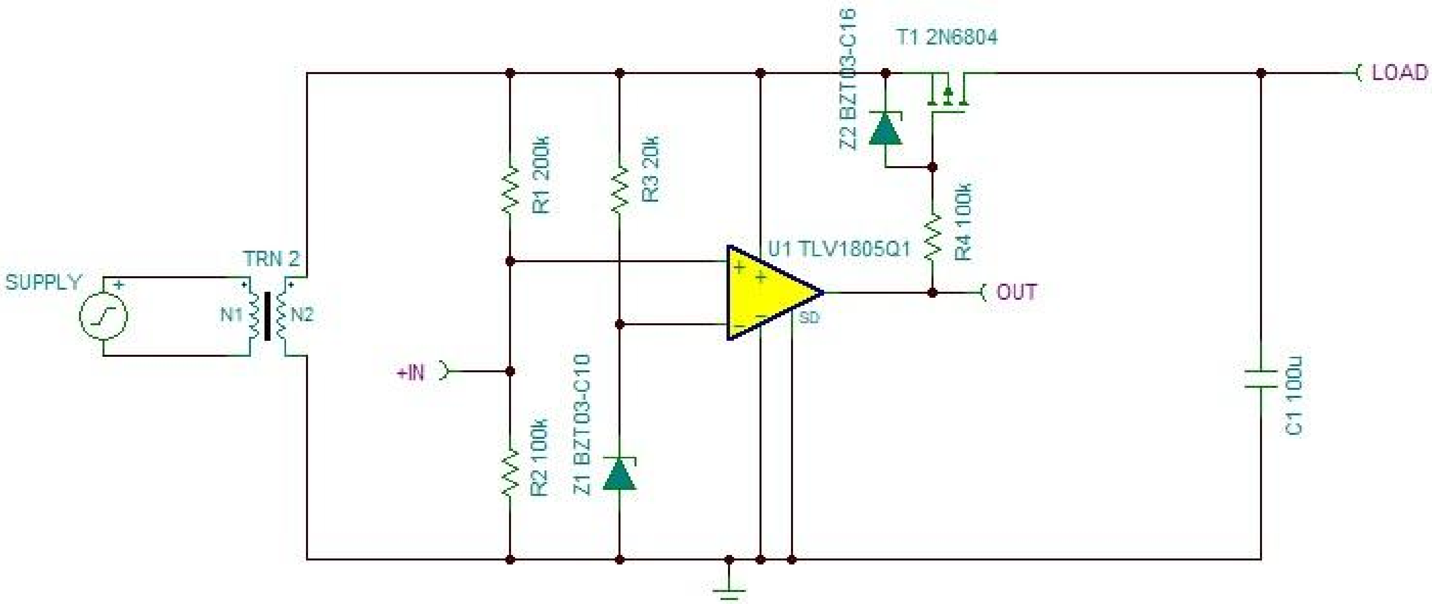
Why we are doing this?

Overvoltages are any voltages that temporarily exceed the mains voltage's threshold value. Any additional current and voltage peaks are too much for the tiny electronic circuits on circuit boards, motherboards, network adapters, and so on. Overvoltages harm sensitive electronic components in the circuits of connected appliances if there is no appropriate protection. Switching impulses from powerful motors, welding equipment, or other large electric appliances, for example, can generate overvoltages. Very high voltage peaks induced by indirect lightning strikes are the most deadly.

Importance of Overvoltage protection

Device protection products, which are used between the power source (socket) and the device, can protect against overvoltages and electromagnetic current peaks. Voltage-dependent resistors and gas discharge valves are critical components that ensure that harmful overvoltages are earthed in milliseconds, preventing the destructive high voltage from reaching the protected electronics.

Circuit Diagram:



Components used:

1. AC Supply connected to step down transformer to get 12-36 V
2. 4 resistors - R1(200K), R2(100K), R3(20K), R4(100K)
3. Operational Amplifier with Voltage rails as a comparator
4. 2 Zener Diodes

5. P-channel MOSFET (available in market)

6. Capacitor(100 micro Farad)

Design steps:

1. Select a high voltage comparator to operate at a higher supply voltage, in this case, the highest is 36V.

2. Select a reference voltage, in our case 12V.

3. Calculate the value of R3 using the given formula:
$$(Supply(min) - V_{zener})/I_{bias}(min)$$

4. . Calculate the resistor divider ratio needed so the input to the comparator crosses the reference voltage (10V) when the SUPPLY rises to the target overvoltage level (V_{over}) of 30V.
$$V_{ref} = V_{over} \text{ x } (R2/(R1+R2))$$

5. Select R1 and R2 on the basis of the resistor divider ratio.

6. Verify that the current through the resistor divider is at least 100 times higher than the input bias current of the comparator. The resistors can have high values to minimize power consumption in the circuit without adding significant error to the resistor divider.

7. Select a Zener diode (Z2) to limit the source-gate voltage (VSG) of the P-Channel MOSFET so that it remains below the device's

maximum allowable value. It is common for P-Channel, power MOSFETs to have a VSG max value of 20V, so a 16V Zener is placed from source to gate.

8. Calculate a value for the current limiting resistor (R4). When SUPPLY rises above 16V and Z2 begins to conduct, R4 limits the amount of current that the comparator output will sink when its output is LOW. With a nominal SUPPLY voltage of 24V, the sink current is limited to 80µA.

$$I_{sink} = (Supply - V_{z2})/R4$$