OVERVOLTAGE, UNDervoltage Protection of Electrical Equipment

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Abstract - The purpose of this project is trip the relay according to the variations in supply voltage for protecting electrical household as well as industrial equipment in case of overvoltage and under voltage. The electronic devices are very sensitive towards voltage variation, as voltage variation comes in supply the electronic equipment get easily damaged. In that condition it requires an additional protecting mechanism to protect the equipment as a load. According voltage comparator integrated circuits the decision of tripping of relay mechanism get performed, as voltage varies above or below the set value. The main advantage of this relay based mechanism is that it also protects three phase appliances from single phasing and fluctuation of voltage in ac voltage waveform. In future there might be addition of earth fault detection and protection, automatic starting protection circuitry.

Key Words: overvoltage and under voltage protection, voltage comparator circuitry, tripping mechanism of relay.

1. Introduction

Recent year one major problem in industry as well as household is sudden over voltage or under voltage which results damage the equipment. Electronic based load increases day by day in household as well as industrial application and they are very sensitive to voltage variation. In this project, focus the protect the equipment in case of over voltage or under voltage and the study of over voltage and under voltage, various power quality issues.

2. Power quality issues:

2.1 Overvoltage:

An overvoltage is an increase in the rms value of ac voltage greater than 110 percent or 0.11pu at the power frequency for aduration longer than 1 min. overvoltages are usually the result of load switching (e.g., switching off a large load or energizing a capacitor bank). The overvoltages result because either the system is too weak for the desired voltage regulation or voltage controls are inadequate. Incorrect tap settings on transformers can also result in system over voltages.

![Fig-1: waveform for overvoltage](image)

According to IEEE 1159 Classification of overvoltage

<table>
<thead>
<tr>
<th>Types of Voltage</th>
<th>Duration</th>
<th>Magnitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instantaneous</td>
<td>0.5 – 30 cycles</td>
<td>1.1 – 1.8 pu.</td>
</tr>
<tr>
<td>Momentary</td>
<td>30 cycles – 3 sec</td>
<td>1.1 – 1.4 pu.</td>
</tr>
<tr>
<td>Temporary</td>
<td>3 sec – 1 min</td>
<td>1.1 – 1.2 pu.</td>
</tr>
</tbody>
</table>

Table-1: Classification of overvoltage
2.1.2 Some more causes of Overvoltage are given below

- Loss of a Secondary Neutral (When the neutral wire is broken by falling branches).
- Ferroresonance (is a special form of series resonance between the magnetizing reactance of a transformer and the system capacitance (charging capacitors).

![Fig-2: Cause of overvoltage](image)

2.2 Under voltage:

An under voltage is a decrease in the RMS value ac voltage to less than 90 percent or 0.90pu at the power frequency for a time period longer than 1 min. Under voltages are the result of switching events that are the opposite of the events that cause over voltage.

![Fig-3: Waveform for under voltage](image)

2.2.1 Causes of under voltages:

- Closing and Opening of Circuit Breakers
- Due to Fault
- Due to Motor Starting
- Due to Transformer Energizing
- Equipment Failure
- Bad Weather and Pollution (Lightning strikes, Flash over, etc.)
- Construction Activity (damage to underground cables)

3. Method Used For Protection

The aim of our circuit is to protect the load during under-voltage and over current conditions by controlling the relay tripping coil using a LM324 comparator. The comparator will compare the supply voltage with the desired preset voltage and will trip the relay coil if the voltage drops below the desired preset value. The relay coil will also trip if the under voltage and over current protecting device is shown in the block diagram below.

![Fig-4: Method Used For Protection](image)

4. Equipment use in Circuit:

- Transformer 12v
- Bridge wave rectifier
- Capacitors-480, 0.1 micro farads
- Regulator IC 7812
- Potentiometer-50k
- Zener diode-6.8v, 6.0v
- Resistances -10k, 5k, 1k
5. Description of above equipment:

5.1 Transformer:

A 230 by 12 volt single phase transformer is used for power supply of voltage comparator circuit.

5.2 Bridge wave rectifier:

Full wave rectifier with the four diode with capacitor as filter is used for bridge rectifier circuit.

5.3 Regulator IC 7812:

The voltage regulator IC gives +12 volts, after the capacitor it is being used in power supply. In IC 7812, the 78 denotes positive this is a 9V power supply which will work even on power failure.

5.4 Potentiometer-50k:

Potentiometer is used as the variable voltage driver for adjusting the preset value. It is class of variable resistor. We can vary voltage by using variable resistance pot also called as wiper. The main part is a resistive strip inside it through which we can able to adjust the amount of resistance/voltage to pass in a circuit through it.

5.5 LM324:

LM324 is a 14 pin IC. Having four op amp in it, hence also called quadruple op amp IC. Op amps can be used as amplifiers, comparators, oscillators, rectifiers etc. The conventional op-amp applications can be more easily implemented with LM324. Here op amps used as voltage comparator for comparing two voltage levels.

5.5.1 Pin Diagram

5.6 Relays:

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

5.7 Zener diode:

Zener diode is the diode which can allow current flow both from its anode to its cathode and vice versa zener diode can also its break down region reliably. In this project zener diode is used for take constant voltage i.e DC fixed voltage as a preset value.

6. Circuit diagram:
7. Working:

If 220VAC input is applied circuit step-down transformer will reduce voltage to 12volt. Using Bridge rectifier IC 12volt DC output is obtained.

Using IC LM7812 we get regulator DC supply Regulator Input at pin 1 and 2 and from pin 3 and 4 output is taken. IC LM324 serve as heart of protection circuit. It has 4 comparator in it. 4th pin is connected to Vcc and 11th pin is grounded. Two zener diode of 6volt and 6.8volt are used. 6.8 volt zener diode is connected to 2nd pin of ICLM324 (comparator no.1). 6 volt zener diode is connected to 5th pin of ICLM324.

IC2/1 of comparator IC used for overvoltage Protection. IC2/2 of comparator IC used for under voltage protection. When supply voltage raise beyond or fall rated voltage Proportional DC voltage will change and relay driver IC will command to relay driver to relay and relay will get tripped.

8. Possible additional circuits:

- Earth fault detection
- Automatic starting protection

9. Applications:

- Industrial machinery
- House hold items like TV, refrigerator
- Agriculture motors
- Water pumps
- Microwave oven

10. Conclusion

From above discussion it has cleared that of under voltage and overvoltage problem are very common and can create problem for consumer good and industrial application. So system should be protected by certain protection scheme. So here system modeled using comparator and relay to disconnect supply when any overvoltage and under voltage problem occurs.

Reference: