

# Over & Under Voltage & Short Circuit Protection of Electrical Appliance

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**Abstract-**The aim of this project sudden fluctuation in supply is a very big problem in industries and domestic applications. It causes a major loss for industries, offices and homes. This project gives a low cost and powerful solution for this problem. This Circuit protects refrigerators ACs, Microwave ovens as well as other appliances from over and under voltage fluctuations. Operational amplifier IC LM324 is used here as a comparator.

The preset is adjusted such that for the normal supply of 180V to 240V, the voltage at non-inverting terminal of op-amp is less than 6.8V. The same unregulated supply is given to the second comparator through a 5.6V zener diode. 12V SPDT relay is used to control the Load. An NPN transistor is used to drive the relay. This project uses regulated 12V, 500mA power supply. 7812 three terminal voltage regulator is used for supply voltages and reference voltages for LM324 comparator circuit. Bridge type full wave rectifier is used to rectify the ac output of secondary of 230/12V step down transformer.

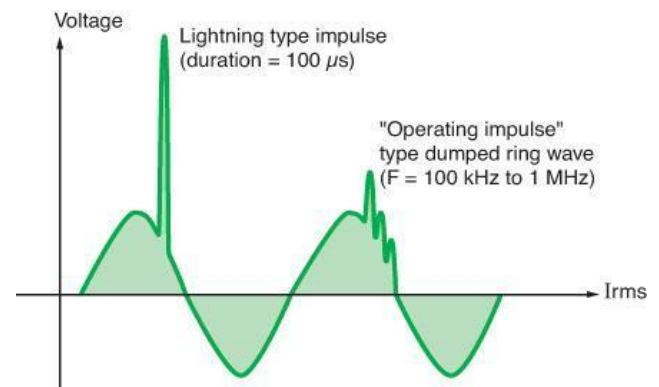
**Index Terms-** short circuit protection, saving energy, home appliance protection.

## I.INTRODUCTION

Modern electrical equipment continues to increase in complexity and importance in industrial, commercial, and residential installations. This equipment is often considered critical for normal system operations. The nominal system voltage in India is now 220/400 volts bringing all 220/380 volt and 240/415 volt systems to a common standard. Under normal service conditions a variation of +10%, -6% is

allowed. However the distribution of electricity at the 240/415 volt level with a tolerance of +/-6% still falls within the Indian standards.

Overvoltage is a condition in which voltage is higher than the level that the object is rated for. The term overvoltage is most often used to refer to voltage conditions in power lines, indicating conditions when too much voltage is traveling through a power system, overvoltage is sometimes used to describe a persistent level of voltage over the range designated for the power line, a problem condition that can affect electronics and energy efficiency in all buildings connected to the malfunctioning power line area.



*Fig. 1: Waveform of overvoltage.*

- Switching surges: high-frequency over voltages or burst disturbance (see Fig.1) caused by a change in the steady state in an electrical network.
- Power-frequency over voltages: over voltages of the same frequency as the network (50, 60 or 400 Hz) caused by a permanent change of state in the network.
- Over voltages caused by electrostatic discharge: very short over voltages (a few nanoseconds) of very high frequency caused by the discharge of accumulated electric charges.

The prevailing mechanism of switching over voltages is conduction, because it starts in the very power supply networks. It's in atmospheric discharge methods can be observed where. Therefore, we can differentiate between the following methods. Lightning can strike aerial lines directly. Surges then propagate and reach the user, finally diverting to ground through the equipment, provoking failures. The electromagnetic field produced by electric discharges induces transient current in nearby conductors, entering then the structures and harming the equipment. There always exists a capacitive coupling, also called stray capacity, between every pair of conductors. Over voltages due to capacitive coupling become more important as the voltage waveform velocity increases.

### 1) PURPOSE OF OVERVOLTAGE PROTECTION SYSTEM:

Overvoltage protection system is the safeguarding of products from overvoltage conditions. However there are following purpose for which overvoltage protection system can be used.

- ☐ Minimize damage
- ☐ Leave unaffected equipment in-service
- ☐ Maintain equipment operating limits
- ☐ Maintain electrical system stability

Under Voltage condition occurs when a load is suddenly connected to a power supply. The load will start to draw current this causes the voltage to temporarily drop.

Under voltage is a decrease in voltage below 90% of its nominal value for more than one minute. Under voltage may go unnoticed until new equipment is installed or the electrical system is otherwise changed and the new combined load depresses. Under voltage is generally a chronic problem aggravated by a number of factors beyond the end user's control. Electric utilities try to maintain voltage levels delivered to customers at  $\pm 5\%$ . However, factors like weather, high demand and others can cause the utility voltage to fall within a  $\pm 10\%$  range. Even under ideal conditions, most customers will see a drop in utility voltage levels over the course of the day as demand begins to increase around 8 AM and peaks around 3 or 4 PM. Distribution system characteristics can also contribute to chronically low voltage situations.

Your appliances have many layers of protection against voltage surges. First, there are the fuses and/or circuit breakers in your house--they will "blow" and interrupt a circuit that becomes overloaded. Second, your larger appliances will often have an internal fuse. Third, solid-state electronics often have a surge protector (your laptop's power supply has one). Fourth, the electrical utility has its own protections against power surges

Low voltage can occur during period of heavy electrical demand (such as during heat waves, when air

conditioners are all running). The electric utility slightly decreases the amount of voltage being fed into the system to compensate for the high demand.

### II. Working principle

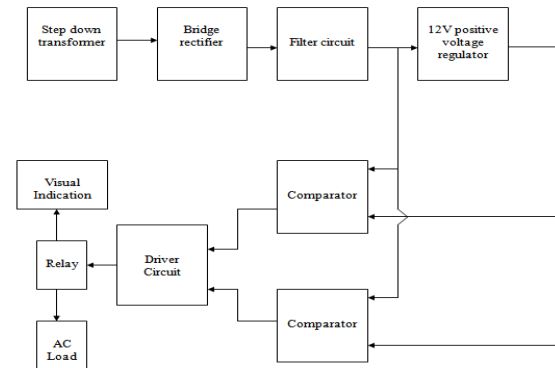


Fig. 2 Block diagram.

12V SPDT relay is used to control the Load. An NPN transistor is used to drive the relay. This project uses regulated 12V, 500mA power supply. 7812 three terminal voltage regulator is used for supply voltages and reference voltages for LM324 comparator circuit. Bridge type full wave rectifier is used to rectify the ac output of secondary of 230/12V step down transformer.

Relay which operates when the current flow in the circuit is greater then pick up current of the relay is known as overcurrent relay. The minimum value of current above which the relays operate is known as pick-up current. The over current relay is normally used to individually protect the major parts of the machinery against abnormally high current. The base method of providing over current relay protection on a circuit is to install current t/f on the circuit which then feed current into the over current relay proportional to the circuit current. When the current exceeds a preset value, the relay will operate at a time determined by the characteristics of the relay to initiate tripping of the associated circuit breaker.

#### A. IC7812 General Description

7812 is a famous IC which is being widely used in 12V voltage regulator circuits. Truly speaking it is a complete standalone voltage regulator. We only need to use two capacitors, one on the input and second one on the output of 7812 in order to achieve clean voltage output and even these capacitors are optional to use. To achieve 12V 1A current, 7812 should be mounted on a good heat sink plate.

Output Current up to 1A, Output Voltages of 12 volt, Thermal Overload Protection, Short Circuit Protection,

Output Transistor Safe Operating Area Protection.

□ All the Conventional Op Amp Circuits

### C. SPDT Relay

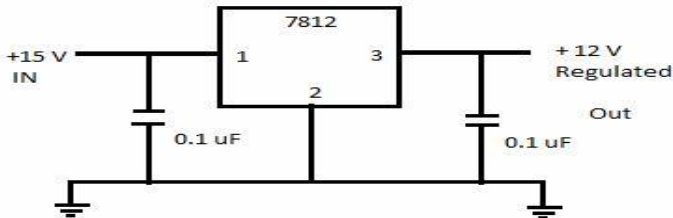


Fig:3 7812 circuit diagram

### B. LOW POWER QUAD OPERATIONAL AMPLIFIER (LM324)

The LM324 consists of four independent, high gain internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide voltage range. Operation from split power supplies is also possible as long as the difference between the two supplies 3Volts to 32 volts.

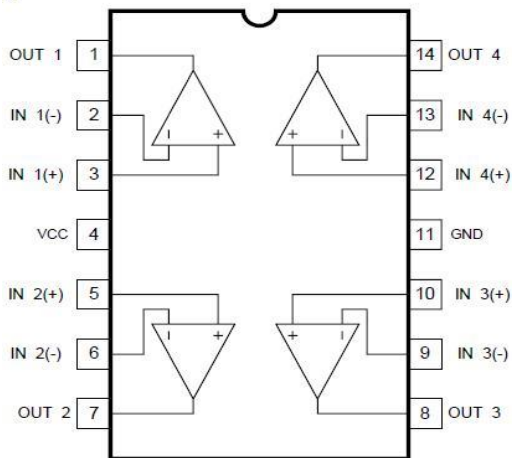


Fig:4 Pin diagram Of IC LM324

#### FEATURES:

- Internally frequency-compensated for unity gain (Top View) ,Large DC voltage gain: 100 dB
- Wide bandwidth (unity gain):1 MHz(temperature-compensated) , Wide power supply range:
- Single supply: 3VDC to 32 VDC, Dual supplies:  $\pm 1.5\text{VDC}$  to  $\pm 16\text{VDC}$

#### APPLICATIONS:

- Transducer Amplifiers
- DC Gain-blocks

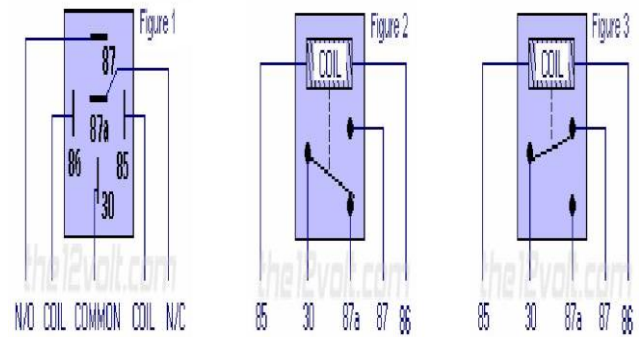


Fig:5 SPDT Relay

SPDT Relay: (Single Pole Double Throw Relay) an electromagnetic switch, consist of a coil (terminals 85 & 86), 1 common terminal (30), 1 normally closed terminal (87a), and one normally open terminal (87) (Figure 1). When the coil of an SPDT relay (Figure 1) is at rest (not energized), the common terminal (30) and the normally closed terminal (87a) have continuity.

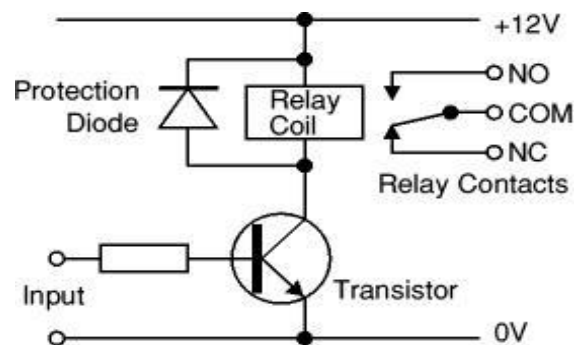
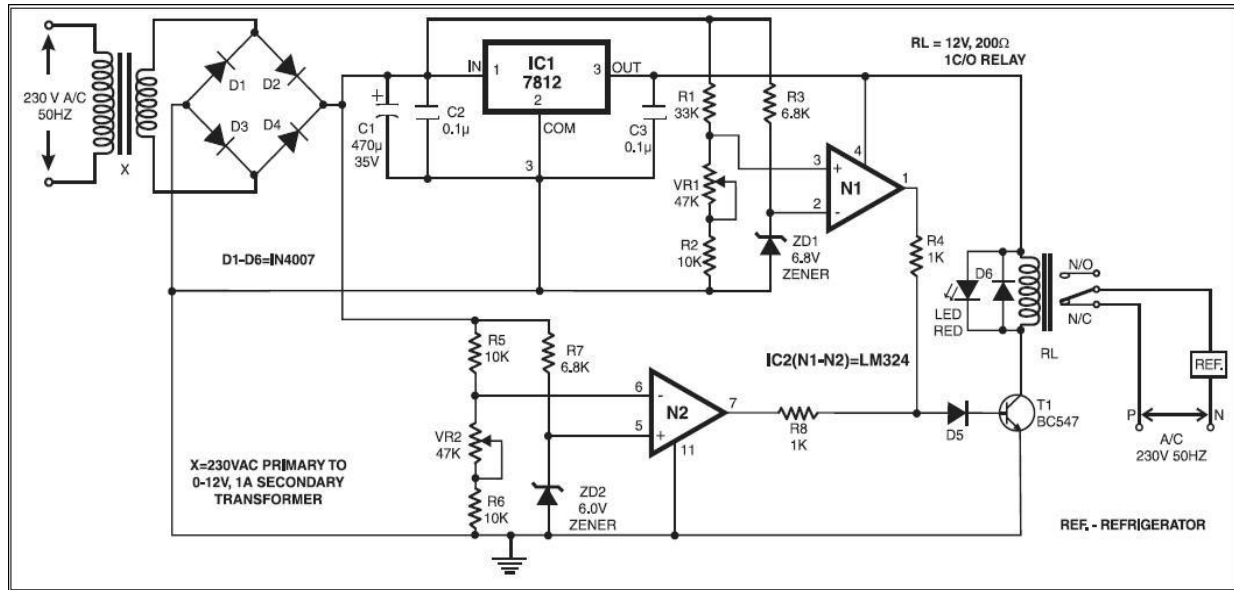


Fig:6 Relay Operation and use of protection diode.

### III. SCHEMATIC DIAGRAM



*Fig:7 Circuit diagram*

#### IV. POWER SUPPLY

The circuit uses standard power supply comprising of a step-down transformer from 230V to 12V and 4 diodes forming a Bridge Rectifier that delivers pulsating dc which is then filtered by an electrolytic capacitor of about 470 $\mu$ F to 1000 $\mu$ F. The filtered dc being unregulated, IC LM7805 is used to get 5V DC constant at its pin no 3 irrespective of input DC varying from 9V to 14V. The input dc shall be varying in the event of input ac at 230volts section varies in the ratio of

$$V_1/V_2=N_1/N_2$$

The regulated 5V DC is further filtered by a small electrolytic capacitor of 10 $\mu$ F for any noise so generated by the circuit. One LED is connected of this 5V point in series with a resistor of 330 $\Omega$  to the ground i.e., negative voltage to indicate 5V power supply availability. The 12V point is used for other applications as on when required.

## V. CONCLUSION

This report is prepared on the basis of study of project over & under voltage & short circuit protection of electrical appliance. Over & under voltage & short circuit of electrical appliance

may be due to damage the electrical & electronics equipment and void formation, because of these effects there are chances of fault in the circuit which can be reduced to some extent using this project at home appliance level. The most important aspect during my project was to study the circuit for over & under voltage & short circuit protection.

During this time we were able to relate the theoretical part to the practical. This project as a whole proved to be extremely informative and experience building and things learnt would help a lot in snapping the future ahead a better way.

## V. BIBLIOGRAPHY

1. <http://www.atmel.com/products/smart-energy/power-metering/default.aspx>.
2. <http://www.beyondlogic.org/usbnutshell/usb2.shtml#Electrical>.
3. <http://ww1.alldatasheets.com/?ep1=pCIRRIPb8x1RSE3SM9K09ABrkuQLCYVTJHfxT3IktZiAJtE7>.
4. [http://en.wikipedia.org/wiki/Multiway\\_switching#](http://en.wikipedia.org/wiki/Multiway_switching#)

Low\_voltage\_relay\_switching.

5. [http://www.arpnjournals.com/jeas/research\\_papers/rp\\_2011/jeas\\_0911\\_555.pdf](http://www.arpnjournals.com/jeas/research_papers/rp_2011/jeas_0911_555.pdf)
6. [http://www.pcbheaven.com/wikipages/How\\_Over\\_Under\\_Voltage\\_Work/](http://www.pcbheaven.com/wikipages/How_Over_Under_Voltage_Work/)