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Over Voltage Protection Using Crowbar Devices for Low Voltage Loads

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Abstract:- All electronics and electrical instruments can be damaged mainly by voltage transient. This paper present s the development of over voltage protection circuits using crowbar devices such as SCR and TRIAC. Using the gate triggering a silicon controlled rectifier (SCR) and TRIAC is made to turn ON which protects the load from damage caused by overvoltage. With the help of transistor amplifier by amplifying the excess output voltage of the regulator the gating signal is generated. In actual practice when regulators gets shorted such a condition arises. To check this type of condition the resistance connected between input and output of the regulator is changed to produce the excess voltage. The sensitivity of the over voltage protection circuit is discussed.

Keywords : *Over voltage protection, SCR, TRIAC, Regulator, Crowbar circuit.*

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1. INTRODUCTION

In electrical distribution systems, always there exist an electrical transients which are available in the form of voltage surges. Actually, they were not given the due importance prior to the existence and implementation of semiconductor devices.

Most of the electrical and electronics devices can be affected and / or damaged by voltage transients or it may be due to combination of voltage and current. High voltage can open unintended current paths such as forward or reverse breakdown of diodes or oxides reaching their breakdown voltage within integrated circuits.

In electronics circuits three pin positive and negative regulators are commonly used to provide stable DC voltages. These regulators are very simple to use and easy to replace components. But sometimes, fault can occur in such regulators. Inside the chip of these types of regulators, temperature sensitive circuit is provided. Due to excessive load of current, excess heat is produced which turns off the regulator, thus making the safeguard for the device/load.

When such integrated circuits are used continuously for hours or days together, it can make the input and output short which can be a critical situation if the load is expensive or sensitive one. In such cases to protect the load from excessive voltage, over voltage protection circuit using crowbar devices is developed. This paper discusses the details of the developed over voltage protection crowbar circuits for low voltage loads.

The designed circuit uses silicon controlled rectifier (TYN 204) as a protective component which gets turned ON when overvoltage is produced. The output of the regulator IC is connected to the amplifier circuit which gives required trigger signal. The zener diode (12V/2W) is connected to the base of the transistor which is turned on when the output of the regulator exceeds 12V. The transistor which in turn produces current to trigger the SCR.

2. OVER VOLTAGE PROTECTION USING SCR AS A CROWBAR DEVICES

The protection circuit described here consists of single stage transistor amplifier, zener diode and silicon controlled rectifier. The zener diode is connected across the base of the transistor. The output taken from the emitter of the transistor

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is applied to the gate terminal of SCR via resistor R6 which controls the gate current of SCR under normal course of operation.

The circuit of over voltage protection using SCR as a crowbar device is as shown in Fig.1. It protects the load from over voltage. If the voltage exceeds beyond the withstanding voltage capacity of the device it may damage it. As soon as the regulator output voltage starts increasing, the crowbar protection circuit disconnects the load from supply.[1]

In the circuit, the large change in collector current produces small change in the base current of a transistor. The SCR just behave as a conducting wire in the conducting state. Even if the gate current is removed, the operation of the SCR is not affected.

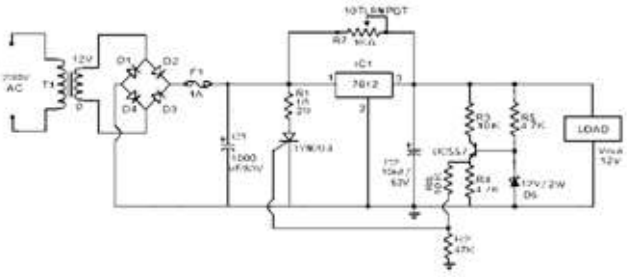

Fig. 1 Over voltage protection using SCR as a crowbar device

3. OVER VOLTAGE PROTECTION USING TRIAC AS A CROWBAR DEVICE

Some circuit uses TTL ICs. For this, the supply voltage is a great concern. Slight increase in supply from the rated 12 V may damage the IC. When fuse is used alone it doesn't serve the problem because to blow off the fuse may take some time as much as several milliseconds which is enough time for the IC to get damaged.

Fig. 2 shows the development of an over voltage protection circuit using TRIAC as a crowbar device. In this circuit the TRIAC short circuits the power supply and burns the fuse. Here it is not a matter of fact for the burning time of the fuse because the power supply is already shorted by the TRIAC and the output voltage will be zero. When the output voltage exceeds 12V, the zener diode D5 conducts and switches ON the TRIAC T1.Here TRIAC acts as a closed switch thus, shorting the circuit. The output voltage drops to zero and fuse gets burned off. The switching of the TRIAC is very fast. It takes only few microseconds. so there will be no damage to the TTL ICs or any other such voltage sensitive components in the load circuit.

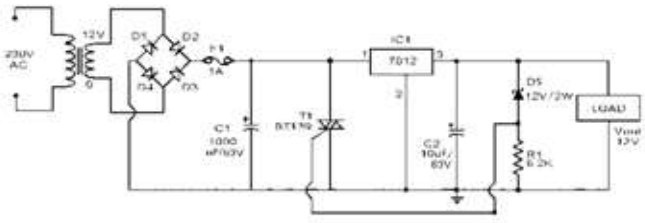

Fig. 2 Over voltage protection circuit using TRIAC as a crowbar device

4. RESULTS AND DISCUSSION

The circuit as shown in Fig. 1 is mounted on the bread board. The value of resistance R7 is changed and corresponding voltage across the load is measured using digital multimeter. The value of resistance R7 is changed (reduced) from 600Ω in steps of 50Ω till it becomes 100 Ω. Experimentally, it was observed that for R7=100Ω, the output starts rising and meter reading shows 12.05 V. If the resistance is reduced to R7=50Ω, output voltage still increases to 12.12V. Further decrease in R7=40Ω, the output voltage increases to 12.15V, fuse wire glows and it blows out.

Table :1 Load voltage for different values of R7 and corresponding Fuse condition

Resistance R7 (Ω)	Voltage across load (V)	Fuse condition
600	12.00	Ok
550	12.00	Ok
500	12.00	Ok
450	12.00	Ok
400	12.00	Ok
350	12.00	Ok
300	12.00	Ok

250	12.00	Ok
200	12.00	Ok
150	12.00	Ok
100	12.05	Ok
50	12.12	Ok
40	12.15	Blown

When resistance R7 is withdrawn, momentarily the output increases slightly. At this moment SCR receives a triggering pulse, it turns ON and carries heavy current through the fuse wire. Due to this, fuse wire blows out immediately and the load gets disconnected from the supply. Table 1 shows the voltage corresponding to different values of R7, as read on digital multimeter and corresponding fuse condition. Finally, the output voltage suddenly drops to 0V.

The circuit shows that the load is protected from the output voltage if it exceeds 12.15V.Reducing the value of resistance R7, the effect of short circuit in the regulator IC is believed to be produced. Due to the short circuit in the regulator IC, the change in output voltage occurred from 12V to 12.15V. The regulator IC,SCR & TRIAC should be mounted on suitable heat sink to avoid damage to them.

5. CONCLUSION

Over voltage protection circuits using crowbar devices for low voltage loads was designed, developed and tested critically.SCR and TRIAC were used as a crowbar devices. Fuse condition was checked by changing the resistance value connected across the regulator. Experimental results shows that when resistor value is 40Ω, fuse is blown thereby protecting the load from over voltage.

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