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AND8012/D

Solid State Overvoltage Protector for AC Line

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APPLICATION NOTE

INTRODUCTION

It is very necessary and important that appliances and similar kinds of equipment have reliable protection against transient voltage conditions because it is very common that these types of equipment can suffer significant damage caused when a transient voltage appears in the ac voltage line. Transients arise internally from normal circuit operation or externally from the environment. The latter is particularly frustrating because the transient characteristics are undefined. A statistical description can apply though. Greater or smaller stresses are possible. Long duration high voltage transients are much less probable than those of lower amplitude and higher frequency.

The natural frequencies and impedance of indoor ac wiring result in damped oscillatory surges with typical frequencies ranging from 30KHz to 1.5MHz. Surge amplitude depends on both the wiring and the source of surge energy. Disturbances tend to die out at locations far away from the source. Spark−over (6.0KV in indoor ac wiring) sets the maximum voltage when transient suppressors are not present. Transients closer to the service entrance or in heavy wiring have higher amplitudes, longer durations, and more damping because of the lower inductance at those locations.

Currently, MOVs (Metal Oxide Varistors) are the most common device used for protecting equipment against transient voltage conditions. Nevertheless, they have significant disadvantages that sometimes make them inefficient against this kind of phenomena.

This paper shows how thyristors can substitute the function of the MOVs for protecting equipment against transient voltage conditions.

DEFINITIONS

Transient Voltage

This condition can be produced through many transmitters, the most common are opening and closing of a switch or relay contacts, electric motors with commutators, all forms of electric arcs, and electronic circuits with rapidly changing voltages and currents.

MOV (Metal Oxide Varistor)

Commonly made by Zinc Oxides this device is equivalent in functionality to two zeners with their cathodes tied together, which have a high level of breakdown voltage in both directions. Depending which device number is selected, it is possible to chose the voltage range for protecting the equipment against the transient voltage.

August, 2008 − Rev. 1

Publication Order Number:
AND8012/D

The following schematic diagrams show two over voltage protectors, using thyristors in combination with a zener TVS (transient voltage suppressor), for the most common levels of ac line voltage:

Diagram 1: 120−140V rms; 50, 60Hz

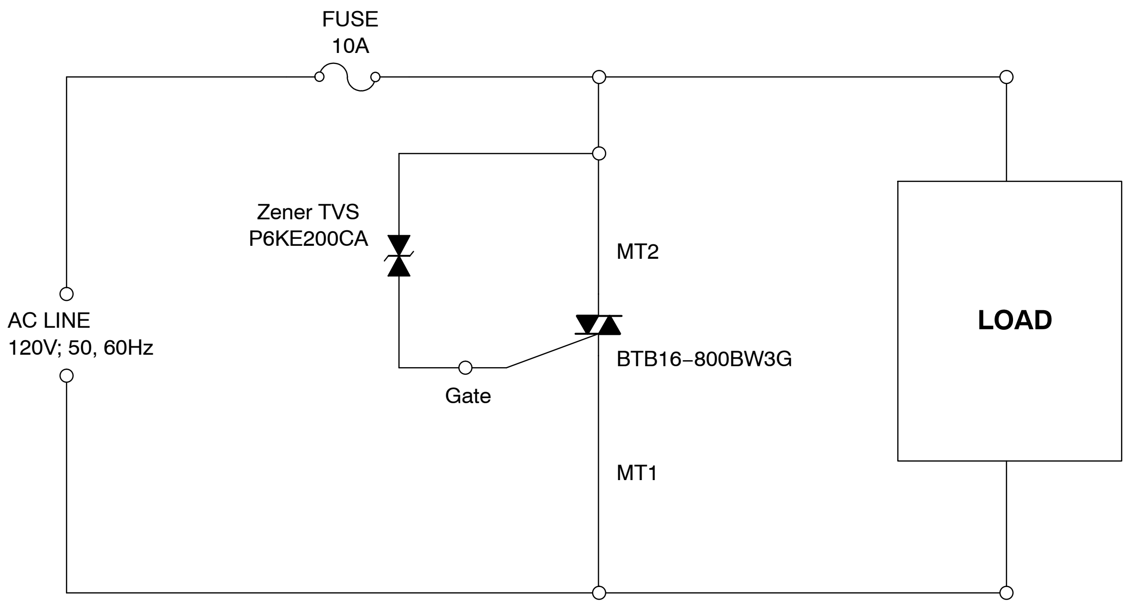

Diagram 2: 220−240V rms; 50, 60Hz, (One phase and neutral or two phases)

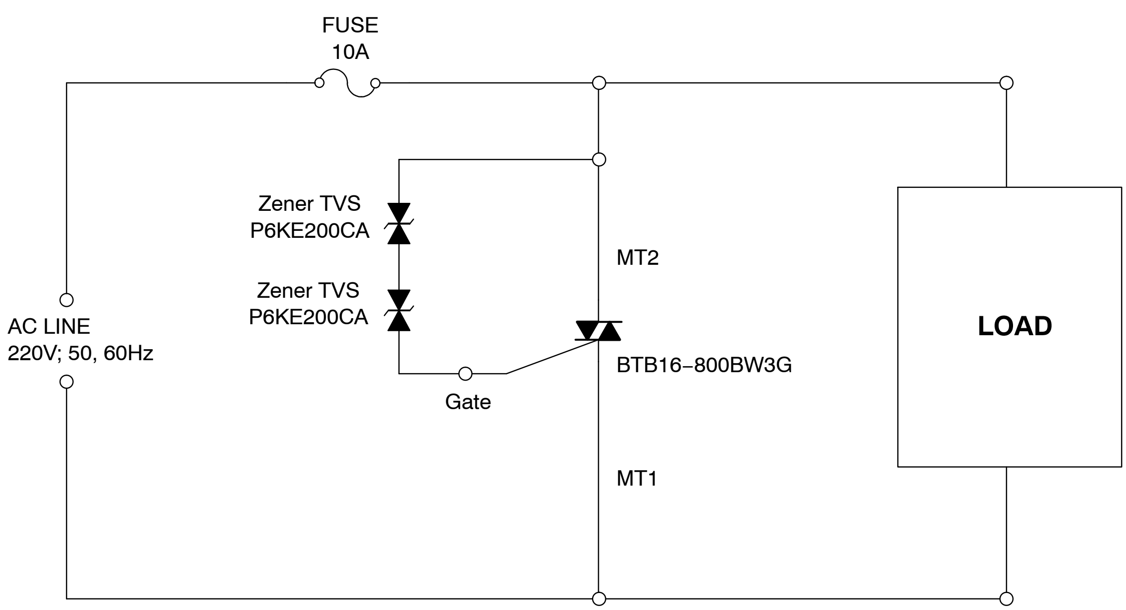

Diagram 1

In the case of diagram 1, the electronic circuit is providing a protection to the load (which can be any kind of voltage sensitive equipment such as a TV sets, VCRs, Computers, etc.) against over voltage conditions. The triacs (BTB16−800BW3G) will be triggered whenever the ac line voltage is higher than 140V rms since the TVS (P6KE220CA) device is controlling the triggering condition for the triac. If the triac (BTB16−800BW3G) is triggered (because of higher ac voltage than 140Vrms), the fuse will be damaged, and because of this, the load is going to be protected against these kind of over voltage conditions.

On the other hand, it is important to mention that the maximum RMS current consumption for the load must be 10A since the triac (BTB16−800BW3G) is only able to drain during a short circuit event up to 180−200 Amps for a few full cycles within itself when it is activated due to an over voltage condition. Therefore, if a higher current load is needed, it would be necessary to put a triac with higher current drain capability than the BTB16−800BW3G for draining the current through the triac without any problems when an over voltage condition occurs.

Diagram 2

In the case shown in diagram 2, the electronic circuit offers the same protection to the load against over voltage conditions and it operates under the same operating principle as the previous one (Diagram 1). The main difference is that the triac (BTB16−800BW3G) will be triggered whenever the ac line is higher than 240V rms.

Like the previous electronic circuit (Diagram 1), the maximum RMS current consumption of the load must be 10A rms maximum.

Another important item to mention about the previous electronic circuits (diagram 1 and 2) is the ability to protect the load against surge current pulses (10x1000 μsec waveform) which could be induced in the ac line voltage due to electrical disturbance due to thunderstorms. the maximum surge current pulse (10x1000 μsec) that the previous electronic circuits are able to drain is up to 500A peak.

On the other hand, the kind of fuse that it is recommended to connect into the previous circuits is a fast crystal fuse of 10A in order to get a faster disconnection from the ac line voltage to the load if any transient voltage condition occurs. In addition, an important factor to take into consideration is with reference to the load. If the load has a high inductive characteristic, it would be necessary to connect a snubber in parallel with the triac (BTB16−800BW3G) in order to protect it against false triggering caused by dv/dt conditions. Otherwise it could be triggered easily because of this effect.

It is important to mention that the previous electronic circuits offer more advantages than the conventional MOVs (Metal Oxide Varistors) for protecting voltage sensitive equipment against fast voltage transients or over voltage conditions. some of these advantages are:

- Reliable protection against any kind of over voltage conditions for load current consumption up to 10A rms.
- Two different options of protection depending on the kind of ac line:
  Option 1: ac line 120V−140Vrms; 50−60Hz
  Option 2: ac line 220V−240Vrms; 50−60Hz
- High capability for draining surge current pulses (10x1000 μsec waveform) up to 500A peak.
- Ambient temperature operation range from −10°C to 65°C.
- Fast activation when an over voltage condition occurs.
- Long life span and safely.

In conclusion, both electronic circuits (Diagram 1 and 2) provide a very important protection for any kind of appliances or equipment against over voltage conditions and fast voltage transients as well as for surge current pulses (10x1000μsec). It eliminates the possibility of any damage on the load current by those kind of phenomena. In addition, the total price of the electronic circuitry is inexpensive when compared to the cost of the equipment if it suffers any damage. This concept could be used in Power Strips with a maximum current capability of 10 amps rms.

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