Zero Voltage Switching to Extend the Life of Equipment

Pratik Jejurkar[1], Sapana Lokhande[2], Aditya Mate[3], Dr. D. P. Kadam[4]

[1,2,3]*B.E. Student, Department of Electrical Engineering, MET Bhujbal Knowledge City, Adgaon, Nashik, Maharashtra, India*

[4]*Head of Department, Department of Electrical Engineering, MET Bhujbal Knowledge City, Adgaon, Nashik, Maharashtra, India*

Abstract- **The project is designed to develop a device to increase the life of incandescent lamps. Incandescent lamps have a property of very low resistance in cold condition. Due to which lamp draws high current when switched is ON, this results in fast failure of lamps.Random switching of lamps may occur at any instant of the voltage/current waveform. Suppose it switches at the peak value supply voltage. When such switching of the load (Incandescent Lamp) occurs and as the lamp is having low resistance in cold condition, then the current further shoots up leading to premature failure of the lamp.The proposed project provides a solution by connecting a TRIAC in circuit such that the controlling the firing angle of the TRIAC by detecting the zero cross point of the waveform of supply voltage and after to switched ON the load. The project contains comparator here is ZVS (Zero Voltage Switching) which is given as reference interrupt to the microcontroller. A push button is used as a switch which is used to switch ON the load(Lamp) at zero voltage so the lamp draws current gradually from zero to full value.**

Keywords: **Arduino UNO, AC Voltage Regulator, Light Emitting Diode.**

I. INTRODUCTION

Random voltage switching operates like it states, it energizes the output switch whenever the timing circuit signals it to do so, meaning that the external load can turn on at any point in the AC voltage waveform.

An AC circuit changes polarity frequently. I India it changes 50 times per second, and generally written as 50Hz or even50 cps (cycles per seconds). This means that the voltage polarity changes from +/- to -/+ and back to +/- 50 times per second.

If switched is on at random instant suppose here at peak of voltage waveform the transients are created in the waveform which leads to formation of harmonics and leads to the damage of the equipment. To avoid this zero voltage circuit is developed. In the circuit the ZVS is used which is used to detect the zero crossing of the waveform and sends signal to the microcontroller. Microcontroller receives the signal and gives output signal to the opto-isolator.

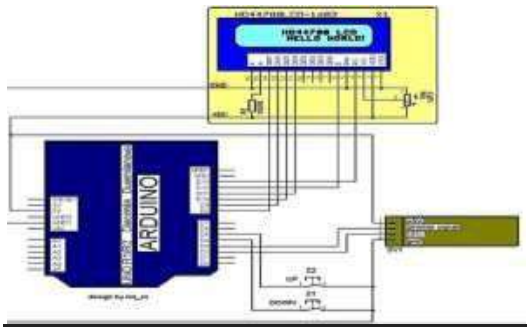
II. IMPLEMENTATION SETUP COMPONENTS

2.1 Arduino Board:

Arduino is a simple microcontroller board based on an open-source physical computing platform. The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the USB-to-serial driver chip.

Fig. Arduino Board

2.2 AC Voltage Regulator:



Circuit diagram

AC voltage regulator is also called as AC voltage controller. It is a electronic module. This electronic module is based on SCRs, TRIACs or IGBTs. These are used to convert a fixed voltage and fixed frequency of alternating current (AC). With this we get the variable output which s delivered to the load. The load in this project is resistive load. The working is in similar fashion of an autotransformer. AC voltage controller modules have high efficiency and low maintenance.

2.3 Zero Crossing Detector:

A Zero Cross Detector or circuit operates on a AC waveform of a load voltage/current. It detects the zero crossing or 0 voltage of the AC sinusoidal waveform.

The main purpose of the circuit is to triggering the TRIAC at zero voltage level of the waveform, so that the output voltage is an complete half cycle.

The fig shows the circuit diagram and the waveforms of the Zero Voltage Crossing Detector.

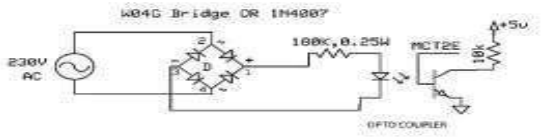


Fig. Circuit Diagram of Zero Crossing Detector

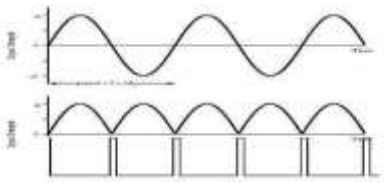


Fig: Waveform of Zero Crossing Detector

III. WORKING MODEL

In this project, adjustment of lamp switching is done by connecting to the circuit through serial port. The brightness can be changed according to the commands provide to the serial port.

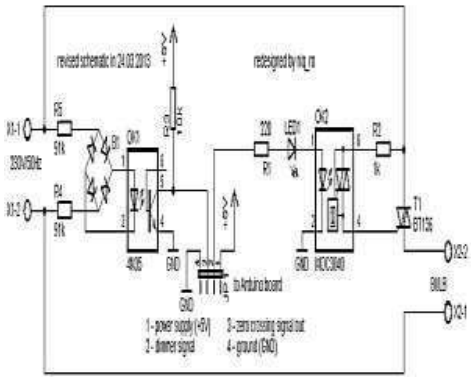


Fig. working model

Using these particular commands in this project, and design a Pulse Wave Modulated (PWM) dimmer circuit which will use in a full bridge rectifier. This full ridge rectifier output is used to control the voltage across the load(lamp). The rectifier used consist of an IN4007 diodes which are connected as shown in a diagram.

The diode D6, the load resistor R5, and the capacitor C2 connected as shown in figure. This forms a rectifier. From figure resistor R5 is a Positioning resistor. The function of the positioning resistor is that it limits the current pulses through diode D6 up to 1.5A. The opt coupler and the resistor R2 are used for driving the gate. Opto coupler contains LED which is protected by resistor R1. The opto coupler used is MCT2E. this opto coupler provides the class-2 isolation.

IV. ADVANTAGES

1. *Reduced Inrush Current*

In random switching of the equipment the inrush current is high. Switching or turning ON the equipment at Zero voltage reduces the inrush current considerably.

The reduction in inrush current has advantage that it extends the life of the equipment and also reduces the amount of EMI (Electromagnetic Interference) produced when turning on the load.

2. *Reduced EMI & RFI:*

High inrush currents causes Electromagnetic Interference. This EM waves causes the improper operation of the sensitive electronics components.

RFI is a Radio Frequency Interference. The sudden change in the voltage level in a circuit leads t the formation of RFI. Therefore, the random switching leads to the formation of RFI, which causes high-frequency ringing which can also interfere with the operation of sensitive electronic equipment.

3. Construction of AC regulator is simple and compact.
4. External commutation circuits are not required.
5. Maintenance required is very less.
6. Running cost is also less.
7. Efficiency is high.

V. DISADVANTAGES

1. In ON-OFF control strategy periodic power is sent to the load which influence load performance
2. In phase control strategy harmonics are produced in supply current because of non-sinusoidal load current

REFERENCES

[1]. A review of Zero Voltage Switching and its importance to Voltage Regulation by Steven keeping Contributed by Electronic products (2014-08-05).

[2]. Implementation of Arduino based AC Zero Voltage Switching for Electrical Equipment. International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE). Vol 4, Issue 2, February 2018.

[3]. MaHuasheng, Zhao Liang, Zhang Bo, Zheng Jianchao.:'AC/AC Buck Converter Instantaneous Value Control Modeling, System Analyzing and Designing', Proc. of the IEEE Electrical Machines and Systems Conference, Nanjing, Sept 2005, 2, pp. 1391 – 1395.

[4]. Rosas-Caro, J.C., Mancilla-David, F., Ramirez-Arredondo, J.M., Bakir, A.M.: 'Two-switch three-phase ac-link dynamic voltage restorer', IET J. Power Electronics, 2012, 5, (9) , pp. 1754-1763.

[5]. Jothibasu, S., Mishra, M.K., 'An Improved Direct AC–AC Converter for Voltage Sag Mitigation', IEEE Transactions on Industrial Electronics, 2015, 62, (1), pp. 21- 29.