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AC PHASE FIRING CIRCUIT USING MICROCONTROLLER

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Abstract- *AC Voltage is controlled using Phase firing signals. This signal is generated using Microcontroller. One Potentiometer is connected to microcontroller for the setting the values of phase firing angle. Zero Crossing Detector (ZCD) is used for the sensing of zero voltage of AC Voltage. Based on the Rising Edge and Falling Edge of ZCD microcontroller it generates gate signals for TRIAC Power circuit. For the isolation between Power circuit and control circuit Opto isolator is used. These isolated signals are given to the TRIAC and then AC Voltage is controlled.*

Index Term- *TRIAC; Root Mean Square; Block Diagram; Result; Simulation.*

I. INTRODUCTION

AC voltage controllers are used to vary the Root Mean Square value of the alternating voltage applied to a load through TRIAC which are connected between the load and constant ac voltage source. The Root Mean Square value of voltage is applied to a load circuit is controlled by controlling the firing angle of the TRIAC in the ac voltage controller circuits. In phase control the TRIAC are used as switches to connect the load circuit to the input ac supply for every cycle. So the ac supply voltage is chopped using TRIAC during every input cycle. The TRIAC switch is turned on every cycle, so the supply voltage appears across the load and then turned off during the remaining half cycle to disconnect the ac supply from the load. By controlling the phase angle the output Root Mean Square voltage across the load can be controlled which is shown in the display of the circuit diagram. The firing angle 'a' is defined as the phase angle at which the TRIAC turns on and the load currents begin to flow.

Some general problem that should be taken into account for practical applications areas follows.

i. Silicon Controlled Rectifier (SCR) is an unidirectional device and it allow current in one direction only. So, here I used TRIAC because it allows current in both direction. Hence, it is mainly used in AC circuits only.

II. BLOCK DIAGRAM

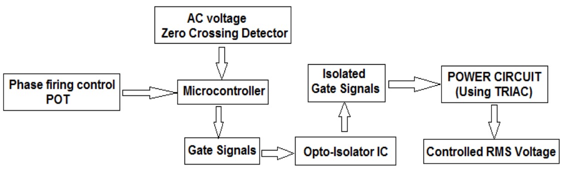

Figure 1: Process Flow for AC Phase Firing Circuit

A. AC Voltage Zero Crossing Detector.

Zero Crossing Detector (ZCD) is used for the sensing of zero voltage of AC Voltage and used to convert sine wave or other signal into square wave, the output should be low if the input is negative and high if the input is positive. Many zero crossing detector is used split supply (symmetric supply), but this zero crossing detector circuit only need a single supply, thus suitable for battery- operated circuits. The zero crossing detector circuit is an important application of the op-amp comparator circuit. It can also be called as the sine to square wave converter. Anyone of the inverting or non-inverting comparators can be used as a zero-crossing detector. The only change to be brought in is the reference voltage with which the input voltage is to be compared, must be made zero (Voltage reference = 0volt). An input sine wave is given as Voltage input. These are shown in the circuit diagram and input and output waveforms of an inverting comparator with a 0volt reference voltage.

B. Microcontroller

Based on the Rising Edge and Falling Edge of ZCD microcontroller it generates gate signals for TRIAC Power circuit. Looking at the board, this is an Arduino uno board. We used the ATMEGA328 board. The pin functioning of this board is listed.The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, 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 a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip.

Operating Voltage	5V
Input	7-12V
Input Voltage	6-20V
Microcontroller	ATmega328
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O	40 mA
DC Current for 3.3V	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

Table I: Data Sheet of ATMega 328

C. Opto-Isolator IC.

The isolation between Power circuit and control circuit Opto isolator is used. An Opto-isolator contains a source (emitter) of light, almost always a near infrared light-emitting diode (LED), that converts electrical input signal into light, a closed optical channel (also called dielectrical channel), and a photo sensor, which detects incoming light and either generates electric energy directly, or modulates electric current flowing from an external power supply.

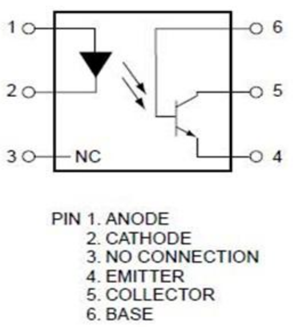

Figure 2: Functional Block Diagram of mct 2 e [1]

D. Power Circuit using TRIAC.

Isolated signals are given to the TRIAC and then AC Voltage is controlled. TRIAC, from triode for alternating current, is a generalized trade name for an electronic component that can conduct current in either direction when it is triggered (turned on), and is formally called a bidirectional triode thyristor or bilateral triode thyristor. The ac voltage regulator apparatus of the present invention uses TRIAC power output switches which are triggered into conduction after being delayed for a period of time from the previous ac supply voltage zero point. The TRIAC switches are switching the load voltage at a determinate phase angle in order to obtain a constant true RMS voltage. The delay time of the trigger signal is variable and is changed to obtain regulation of the RMS voltage applied to the ac load. This regulation feature, ac supply voltage variations, and ac load current changes.

Some Importance words for TRIAC.

(1) Gate threshold current

(2) Latching current
(3)Holding current

III. EXPERIMENTAL RESULTS OF POWER CIRCUIT

Sr. No	Firing angle	$V_{0\ rms}$
1	30	226.97
2	60	206.30
3	90	162.63
4	150	39.06
5	180	0.77

Table II: V_{0rms} value at the different firing angle.

In a Power circuit when we set the firing angle then we shown the different value of $V_{0rms.}$ Figure 3(a) and 3(b) has show that when I set the value of alpha 60 then the value of V_{0rms} is 206.30 on LED and the intensity of bulb. Figure 3(c) shown that waveform of V_{0rms} in Oscilloscope. And it will be continue for alpha 90, and 150.We have noted that when the firing angle is increase the value of V_{0rms} is decrease and the intensity of bulb is also change (decrease).

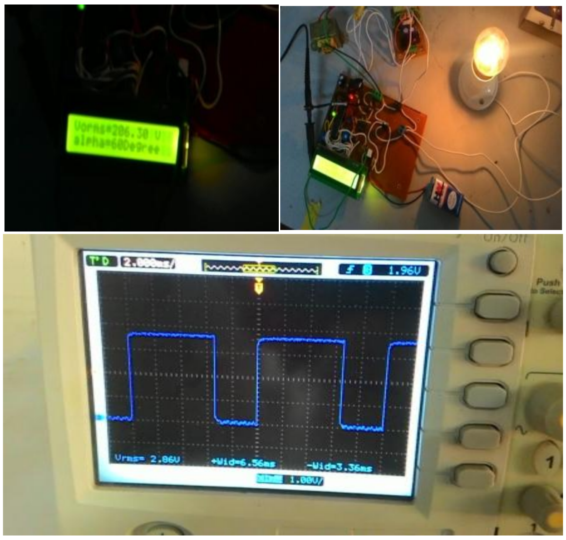

Figure 3: (a) (b) value of alpha,V_{0rms} and intensity of bulb. (c) Waveform of V_{0rms} in Oscilloscope.

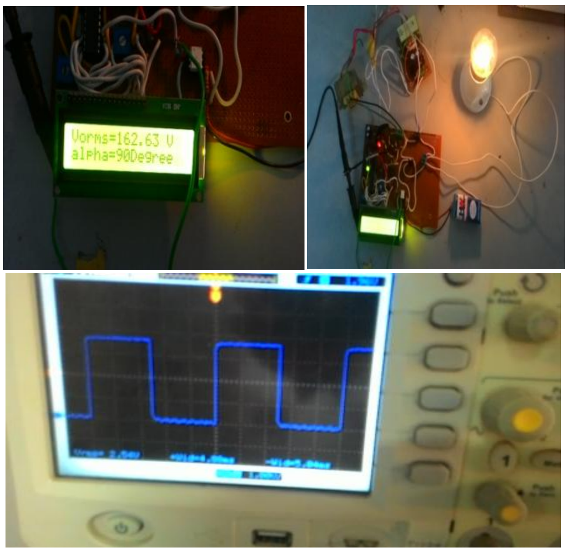

Figure 4: (a) (b) value of alpha,V_{0rms} and intensity of bulb. (c) Waveform of V_{0rms} in Oscilloscope.

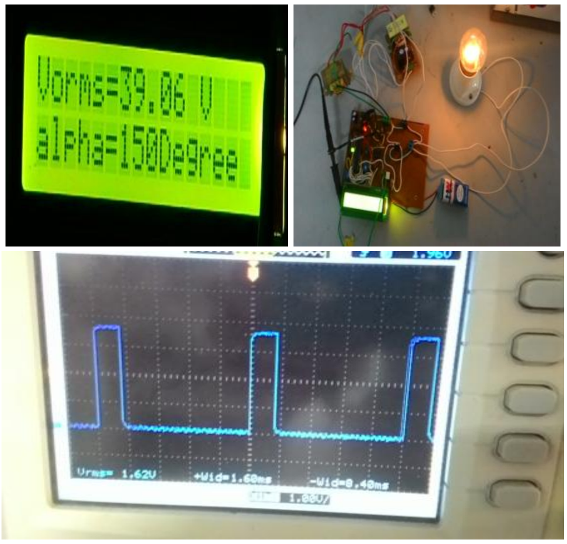

Figure 5: (a) (b) value of alpha,V_{0rms} and intensity of bulb. (c) Waveform of V_{0rms} in Oscilloscope

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IV. SOFTWARE AND SIMULATION

I have done the simulation of power circuit in PSIM software and simulation of control circuit in PROTEUS 8.

A. Simulation of power circuit in PSIM.

Figure 6 shown that when I set the frequency100 and trigger the TRIAC at 30° then we show the TRIAC Conduction Waveform ,followed by Figure 7 at 120° and Figure 8 at 180°.If noticed, when I increase the firing angle then we show the effect in TRIAC conduction Waveform.

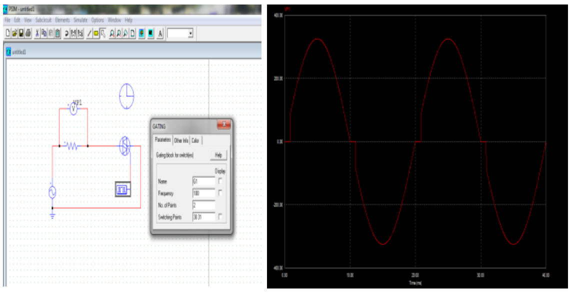

Figure 6: Power circuit TRIAC Triggering at 30° and Conduction Waveform.

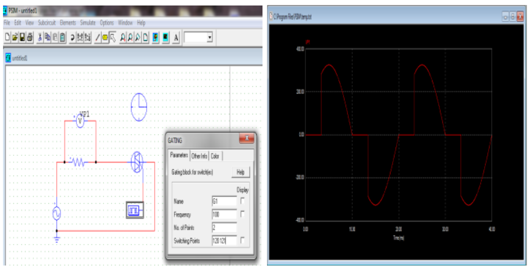

Figure 7: Power circuit TRIAC Triggering at 120° and Conduction Waveform.

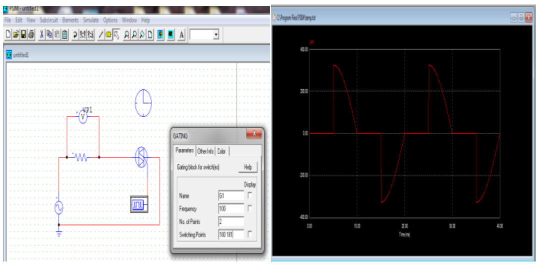

Figure 8: Power circuit TRIAC Triggering at 180° and Conduction Waveform.

B. Simulation of control circuit (PROTEUS 8).

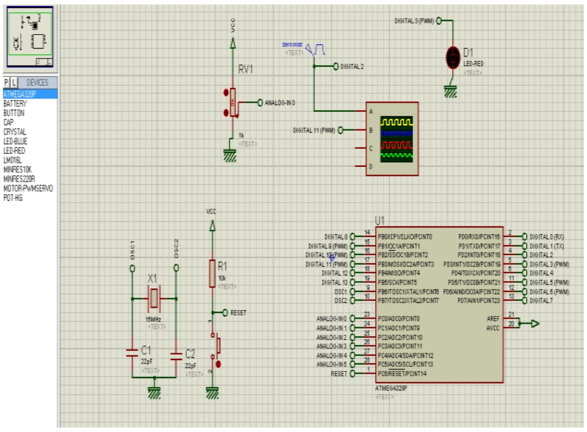

Figure 9: Diagram of control circuit.

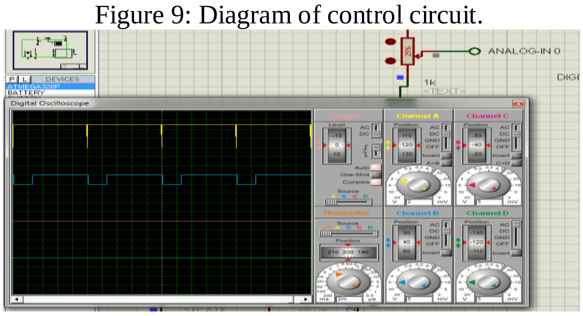

Figure 10: Alpha is 25°

V. CONCLUSION.

In conclusion of this project by doing the firing of TRIAC or changing value of firing angle we will get their respective output waveform input value and also respective controlled Root Mean Square value of input voltage.

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