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Simulation Development of Microcontroller Based Triggering Circuit using Proteus Software

Arvind Kumar Singh

Assistant professor, Dept. of Electrical Engineering, SSITM, Aligarh, Uttar Pradesh, India

ABSTRACT:This paper presents the development of software for triggering the circuit of 1-phase, 2-pulse, and ac to dc controlled converter using PIC microcontroller. The microcontroller will generate two equidistant, synchronized triggering pulses for the converter which finds application in power systems. The controller is required to sense the input voltage and generate the required two trigger pulses irrespective of the variation of the mains frequency and to control the delay angle of these signals equally to control the DC output voltage. Paper deals with design and implementation of control firing scheme for single phase centre-tapped fully controlled rectifier with desired results simulated in proteus software and simulation results are verified experimentally.

KEYWORDS: Controlled converter, Thyristors, PIC16F72 Microcontroller, Power electronics, Trigger pulses, Proteus software.

I.INTRODUCTION

Simple triggering circuit can be realised by R or RC network. They are cheap and consume little power. However the control and hence the load output voltage susceptible to device temperature variations. Moreover feedback control cannot easily be incorporated. Although RC trigger circuits are simple and economical they depend on gate trigger characteristics of thyristors used, and they cannot be used easily in self-programmed, automatic or feedback controlled systems. In a controller a group of thyristers or power semiconductor devices are required to be switched at different switching instants for different duration and in a particular sequence. The switching a large number of these power devices with different control strategy by a simple triggering circuit are almost impossible. Therefore the microcontroller based triggering circuits become necessary to generate trigger pulses [1]. The main task of power electronics is to control the electrical signal in converter circuit and convert electrical power from one form to another. In case of SCR based converters, gate signal is generated from a separate gate trigger circuit. These signals are used to control the conduction period of SCR which ultimately controls the output or the performance of the power electronic converters [4]. Single phase centre-tapped rectifiers utilize thyristor or silicon controlled rectifier (S.C.R.) [2] as switching devices. To turn on a thyristor, various control schemes are used to generate gate pulses or firing pulses which are supplied between gate and cathode of the thyristor [3]. The number of degrees from the beginning of the cycle when the thyristor is gated or switched on is referred to as the triggering angle and when the thyristor is turned off is known as extinction angle [2], [5]. The thyristors of centre-tappedconverter circuit are switched on and off in proper sequence by using control electronics and gate driver circuits to get a controlled dc output voltage. For this a sinusoidal ac voltage is supplied to control circuit and the same supply is given to centre-tappedconverter circuitthrough isolation and synchronization. Proteus software is used to design the triggering circuit that develop the triggering pulses for triggering the circuit of 1-phase, 2-pulse, ac to dc controlled converter using PIC16F72 microcontroller. This paper implements control electronics circuit by using control firing scheme and the controlled dc output voltage thus obtained from the centre-tapped converter circuit is effectively utilized.

II. SNGLE PHASE CONTROLLED CONVERTER

To get the control outputfrom single phase full wave centre-tappedac to dc controlled converter circuit (shown in the figure.1) that contains two thyristor, generate pulses by microcontroller must be equidistant (i.e. 180^0phase difference) and synchronized. The controller is required to sense the input voltage and generate the required two trigger pulses irrespective of the variation of the mains frequency and to control the delay angle of these signals equally to control the DC output voltage.

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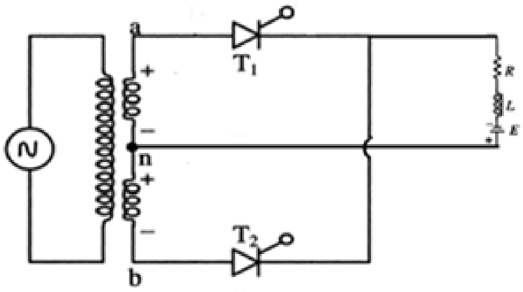

Figure.1 Single phase full wave centre-point converter

III. PROTEUS SOFTWARE

Proteus is one of the most famous simulators. It can be used to simulate almost every circuit on electrical fields. It is easy to use because of the graphical user interface (GUI) that is very similar to the real Prototype board. Moreover, it can be used to design Print Circuit Board (PCB). PROTEUS is a Computer-aided design (CAD) application, composed of three modules: ISIS (Intelligent Input System Schematic) is the schematic capture module, VSM (Virtual System Modelling) is the module simulation, including PROSPICE, ARES (Advanced Routing Modelling) is the module for the production of printed circuit boards (PCB). The ISIS module is a program that allows us to draw on a workspace, a circuit which can then be simulated. In manipulation software almost always several options exist for the same purpose. Normally we can choose to follow a menu icon to access or work with the keyboard. This will grant preference to the fastest and most convenient option that is almost always forgotten the keyboard.

IV. MICROCONTROLLER BASED TRIGGERING CIRCUIT

A PIC16F72 microcontroller base triggering circuit has been designed to control the switching angle. A zero-crossing circuit is used for synchronization. Zero crossing detectors are used to sense the zero crossing of supply voltage. It acts as a reference signal for control pulse. Microcontroller generates the pulse. The angle is controlled by given the time delay to the generated pulse. To isolate the triggering circuit from the converter circuit opto-coupler is used. Before design a practical circuit, similar circuit is simulate on proteus software and the performance of the circuit is taken on the digital oscilloscope of ISIS professional.

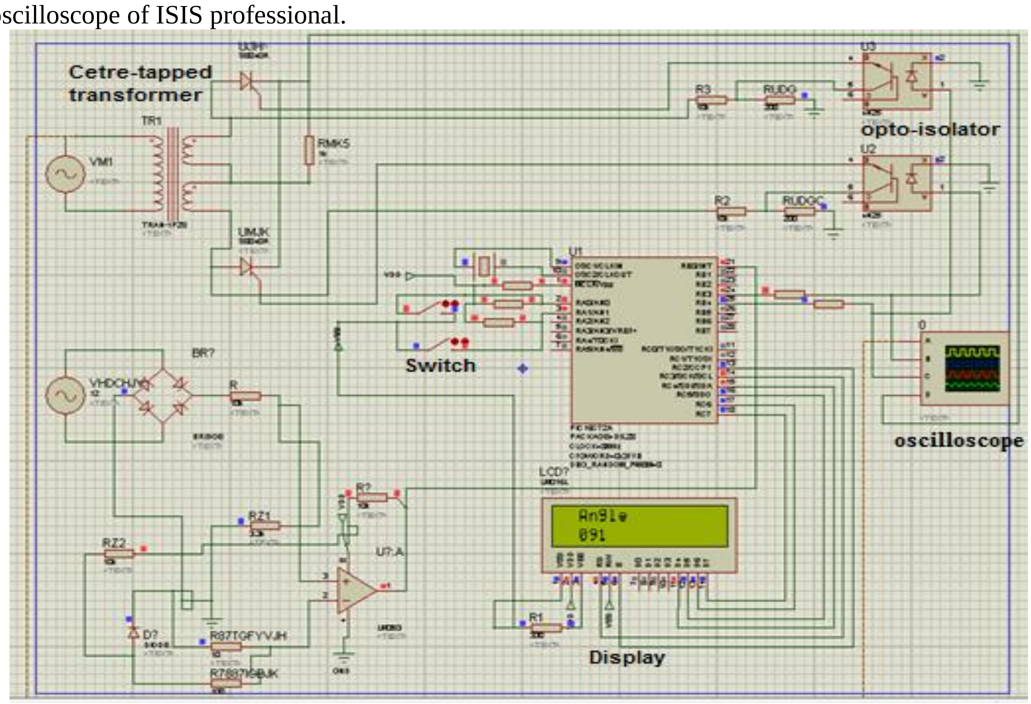

Figure.2 Microcontroller PIC16F72 based triggering circuit on Proteus software ISIS professional editing window

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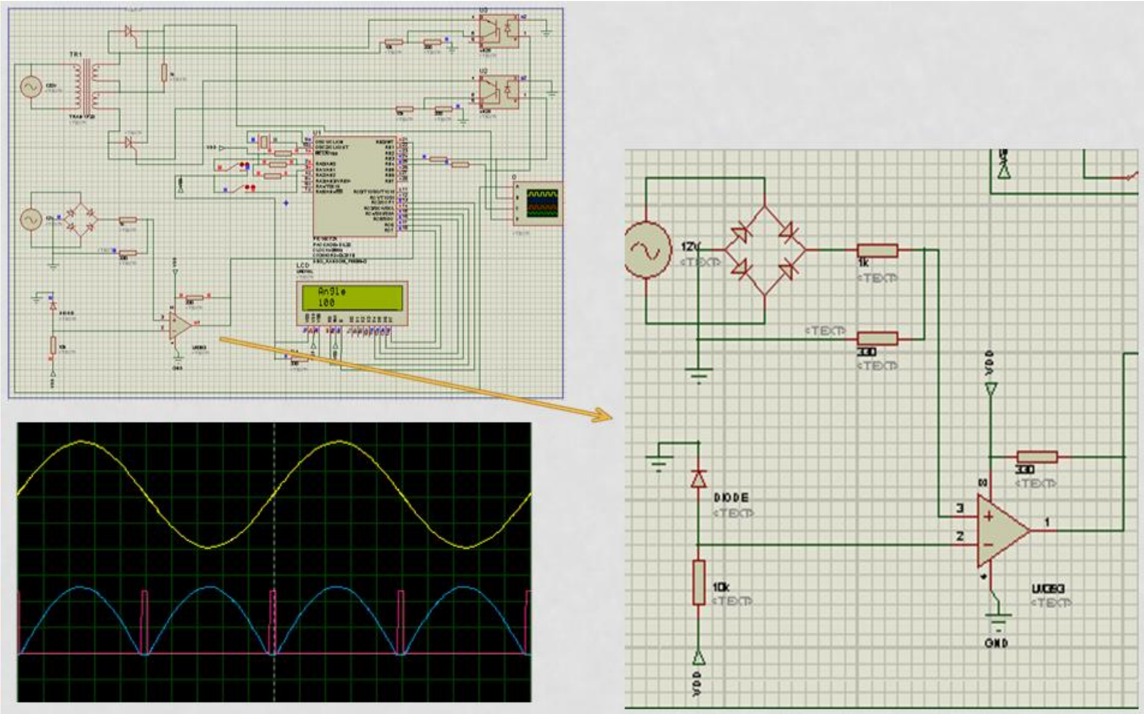

Figure.3 Supply, zero-crossing circuit and synchronised output waveform

A. zero-crossing detector and the power supply

The main sections of the circuit are a rectifier, regulated power supply and zero-crossing detector. Figure.3 shows the supply waveform, zero-crossing circuit and synchronised output waveform.The 230V AC mains is stepped down by transformer to deliver the secondary output of 9V, 500 mA. The transformer output is rectified by a full-wave centre-tapped rectifier comprising diodes and then regulated by IC 7805. Capacitors are used for bypassing the ripples present in the regulated 5V power supply. LED acts as the power-on indicator and resistor limits the current through LED.

B. Switch and Display

Switches are used to increase and decrease the triggering angle. In this microcontroller based triggering circuit two switches are used, one for increasing the triggering angle by one degree and other for decreasing the triggering angle by one degree. And display is used to indicate the triggering angle.

C. Isolation circuit

Transformers not only provide higher or lower voltage differences between their primary and secondary windings, but they also provide “electrical isolation” between the higher voltages on the primary side and the lower voltage on the secondary side.In other words, transformers isolate the primary input voltage from the secondary output voltage using electromagnetic coupling by means of a magnetic flux circulating within the iron laminated core. But we can also provide electrical isolation between an input source and an output load using just light by using a very common and valuable electronic component called an opto-coupler. Pluse transformer can also be used for isolation.An opto-coupler, also known as an opto-isolator or photo-coupler, is an electronic component that interconnects two separate electrical circuits by means of a light sensitive optical interface.To protect the triggering circuit from high voltage converter circuit isolation is necessary. So opto-coupler is used here to isolate the triggering circuit from the converter circuit.

V. RESULT

Output waveform across the resistive load

Digital oscilloscope is display 4 waveform for supply voltage, two controlled (triggering) pulse, voltage across resistive load of single phase full wave mid-point converter circuit respectively and shown in figure.4.

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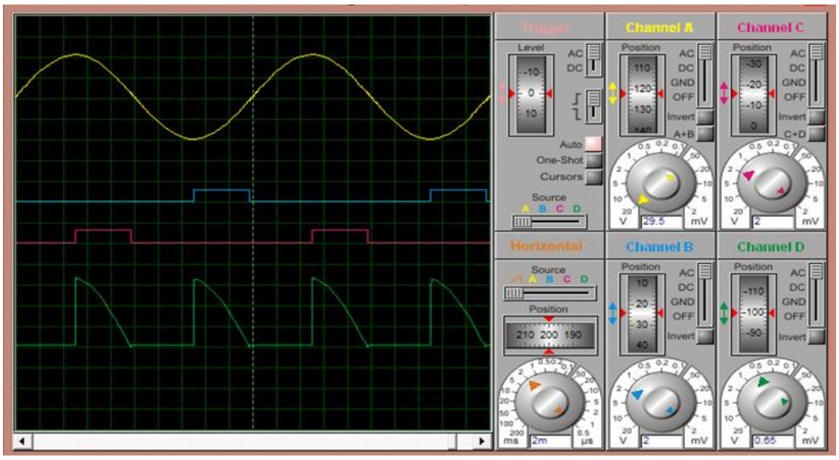

Figure.4 Waveform on Digital Oscilloscope

VI.CONCLUSION

In this paper development of software to trigger two thyristor or SCRs used in the power circuit of single-phase, two-pulse, controlled converters, has been discussed. Single phase fully controlled converters are very popular in many industrial applications particularly in situations where power regeneration from the dc side is essential. It can handle reasonably high power and has acceptable input and output harmonic distortion. The configuration also lends itself to easy series and parallel connection for increasing voltage and current rating or improvement in harmonic behaviour. However, this versatility of a single phase fully controlled converters are obtained at the cost of increased circuit complexity due to the use of two thyristor and their associated control circuit. This complexity can be considerably reduced by using this software for easily triggering the two thyristor or SCRs. Moreover the trigger pulses generated by this software are controllable, i.e. their delay angle can be controlled thus finds application in controlled converters.

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