

SIMULATION OF AC VOLTAGE CONTROLLER USING MATLAB AND PROTEUS

M. Narayanan¹, P. Yuvaraj², R. Vidhya³, S. Lakshmi Narayana Moorthy⁴

¹ Assistant Professor, Electrical & Electronics Engineering, Info Institute of Engineering, Tamil Nadu, India

² Assistant Professor, Electrical & Electronics Engineering, PPG Institute of Technology, Tamil Nadu, India

³ Assistant Professor, Electrical & Electronics Engineering, Info Institute of Engineering, Tamil Nadu, India

⁴ Lab Technician, Electronics & Communication Engineering, Info Institute of Engineering, Tamil Nadu, India

Abstract - This paper presents the study of phase control strategy of ac voltage controller using MATLAB and PROTEUS simulation software. PIC microcontroller (PIC 16F877A) is used to generate the clock pulses for the triac based ac voltage controller circuit.

Key Words: AC Voltage Controller, MATLAB SIMULINK, PROTEUS software.

1. INTRODUCTION

AC voltage controller is a circuit used to convert fixed ac to variable ac without changing the frequency. This conversion with the advent of power electronic devices such as SCR, IGBT, MOSFET, etc. is made very efficiently and flexibly.

The control strategies available to vary fixed ac to variable ac in ac voltage controller circuits are [1]:

1. On - Off cycle control
2. Firing angle control
3. Integral cycle switching control

By the use of above control strategies the output rms voltage can be varied and hence variable supply can be given to the load. Application such as heating furnaces, pumps, induction motors, lights, blowers, etc. require variable ac supply.

The implementation of any converter circuit needs to be tested before going for hardware. This reduces cost, man power, time. This is achieved by using simulation software's where the same model or topology can be tested with the real time hardware ratings and device specifications. One such software for testing power electronic converter circuit is MATLAB and PROTEUS. The application of these software's really prove their worth through their real time applications [6].

Hence in this paper ac voltage controller circuit working in firing angle control is simulated using MATLAB SIMULINK and PROTEUS software and its output rms voltage is compared.

2. PHASE ANGLE CONTROL

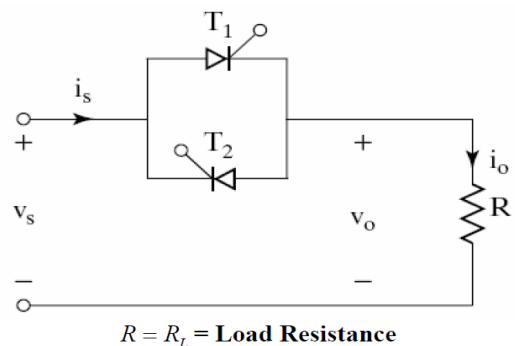


Fig -1: Circuit diagram

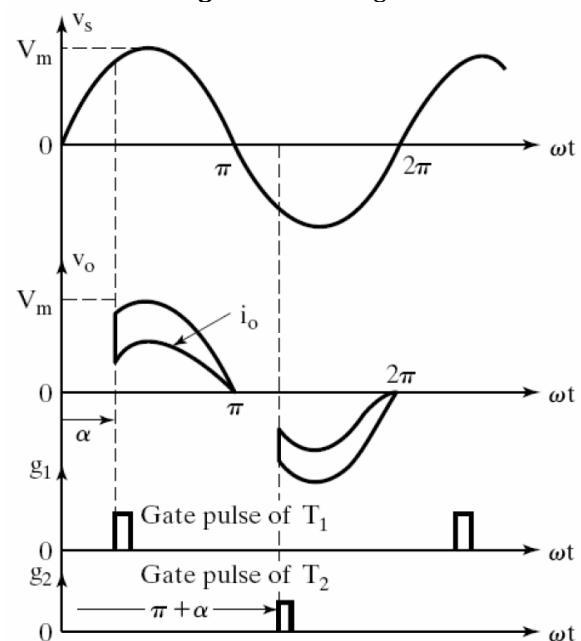


Fig -2: Input and output waveforms

In this method, the output voltage is controlled by triggering the SCRs T1 and T2. By varying the firing angle the rms value of output voltage is varied [4]. Since the sine wave pattern is getting changed, harmonics will be

introduced in the system and hence %THD will get increased.

The expression for rms value of output voltage for resistive load is given by:

$$V_o(rms) = V_s \sqrt{\frac{(\Pi - \alpha) + (\sin 2\alpha) / 2}{\Pi}}$$

where, $V_s = \frac{V_m}{\sqrt{2}} = \text{RMS Value of input supply voltage}$

3. SIMULATION RESULTS

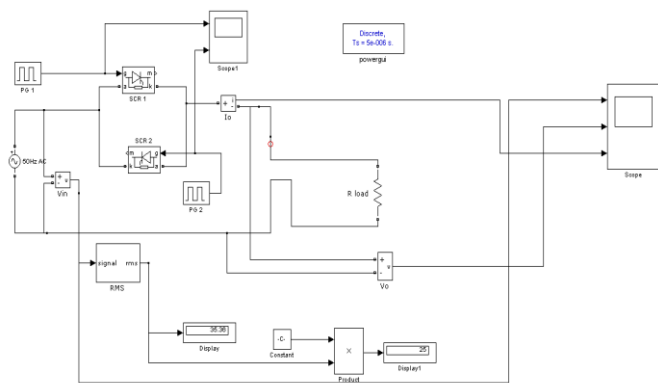


Fig -3: MATLAB circuit simulation diagram

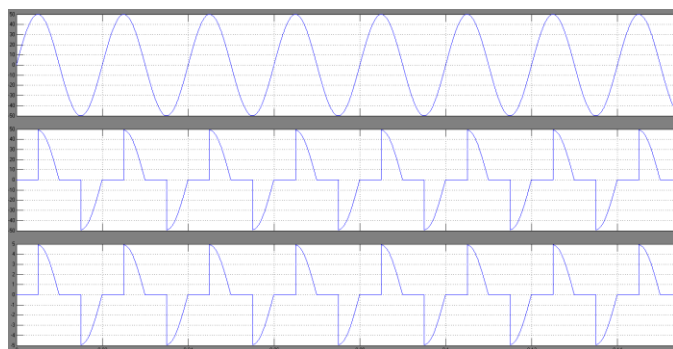


Fig -4: Phase angle control input and output waveforms

Fig -3: shows the MATLAB circuit simulation diagram where two SCR's are connected in anti-parallel to control the output rms voltage. By varying the firing angle required rms output voltage can be obtained.

Fig -4: shows the input voltage, output voltage and output current waveforms for resistive load with a firing angle of 90 degrees.

Circuit Parameters for simulation:
 MATLAB version: 7.8.0(R2009a)
 PROTEUS version: 8
 PIC controller: 16F877A
 Maximum input voltage = 50V
 Frequency = 50Hz
 Load resistance = 10 ohms
 Time Period = 20ms

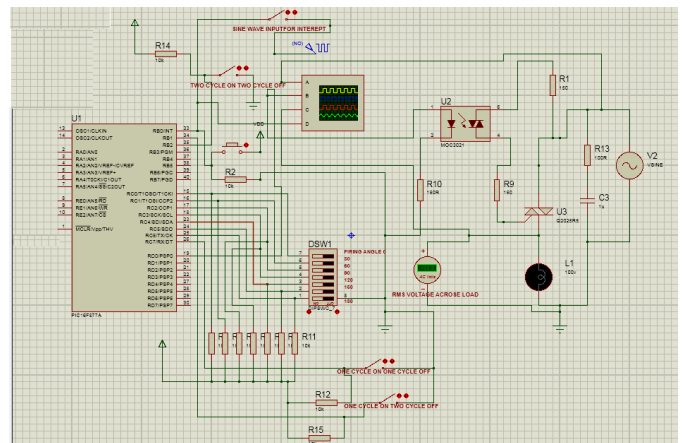


Fig -5: PROTEUS circuit simulation diagram

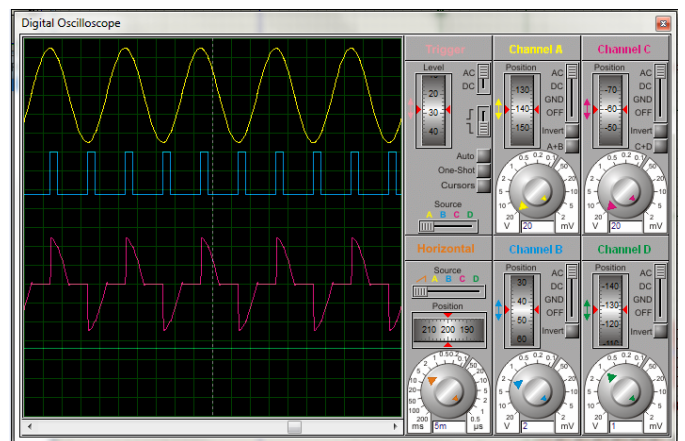


Fig -6: Input voltage, clock pulse and output voltage waveform

Table -1: Comparison of rms output voltage using Phase control method

| Firing angle α (deg) | RMS output voltage (V) | | |
|-----------------------------|------------------------|--------|---------|
| | Theoretical value | Matlab | Proteus |
| 30 | 34.8 | 34.2 | 33.6 |
| 60 | 31.75 | 31.1 | 30.9 |
| 90 | 25 | 24.5 | 24.2 |
| 120 | 14.9 | 15.1 | 14.9 |

From Table -1: the rms output voltage obtained for various firing angles using MATLAB SIMULINK and PROTEUS software are compared. The table shows the values obtained theoretically is almost nearer to the one obtained by MATLAB and PROTEUS software.

Even though the results are obtained by MATLAB SIMULINK, the implementation of the converter circuit requires knowledge on control circuits to provide clock pulses to SCR's since pulse generators are used to provide

clock pulses in MATLAB. But the use of PIC 16F877A in PROTEUS requires efficient coding to activate its pins and to produce a clock signal of required timing. The implementation of real time circuits using PROTEUS proves reliable and accurate. Modification in embedded coding helps to produce rms output voltage closer to the theoretical one.

4. CONCLUSIONS

This paper discusses the simulation of AC voltage controller using MATLAB SIMULINK and PROTEUS software. Firing angle control method is used to control the rms output voltage. It is concluded that for real time application of AC voltage converter PIC 16F877A can be used and hence PROTEUS proves effective than MATLAB.

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