Industrial Power Control by Integral Cycle Switching Without Generating Harmonics

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ABSTRACT

This paper present integral cycle switching control for industrial power control. The project is designed to achieve integral cycle switching, a method to remove whole cycle, cycles or portions of cycles of an AC signal. It is a well-known and old method of controlling AC power, especially across linear loads such as heaters used in electric furnace. However the concept of achieving the cycle stealing of voltage waveform by use of microcontroller can be very precise as per the program written in assembly / C language so that the actual time-average voltage or current experienced at the load is proportionately lower than the whole signal if applied to the load. In place of a linear load to be used in the output, a series motor or lamp can be used to verify the output.

Key Words: *Integral Cycle Control, Harmonics, , single phase induction motor, Control Strategies, MATLAB Simulation.*

1. INTRODUCTION

AC voltage controller is a power electronic circuit in which fixed ac is converted to variable ac without changing the frequency. The converter circuit consists of SCR as switches and provides variable ac to the load.

Speed control of induction motor, Industrial heating and lighting, on load tap changing transformers, soft start of induction motors, ac magnet controls, etc. The most commonly used power electronic circuit for controlling the ac voltage is using two SCR's connected in anti-parallel between source and load. The control strategy depends upon the gate pulse given to the SCR's. In this project we are using comparator for zero crossing detection which is fed as an interrupt to microcontroller of 8051 family. Here the microcontroller delivers the output based on the interrupt received as the reference for generating triggering pulses. Using these pulses, we drive the opto-isolators for triggering the TRIAC to achieve integral cycle control as per the input switches interfaced to the microcontroller. A lamp is provided in this project in place of a motor for demonstration purpose. asy to use, Self-explanatory kit. The project is designed to achieve integral cycle switching, a method to remove whole cycle, cycles or portions of cycles of an AC signal. It is a well-known and old method of controlling AC power, especially across linear loads such as heaters used in electric furnace.

However the concept of achieving the cycle stealing of voltage waveform by use of microcontroller can be very precise as per the program written in assembly / C language so that the actual time-average voltage or current experienced at the load is proportionately lower than the whole signal if applied to the load.

In place of a linear load to be used in the output, a series motor or lamp can be used to verify the output. One side effect of utilizing this scheme is an imbalance in the input current or voltage waveform as the cycles are switched on and off across the load.

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Using these pulses, we drive the opto-isolators for triggering the TRIAC to achieve integral cycle control as per the input switches interfaced to the microcontroller. A lamp is provided in this project in place of a motor for demonstration purpose.

Further this project can be enhanced by using feedback mechanism to automatically maintain desired output to the load by appropriate cycle stealing.

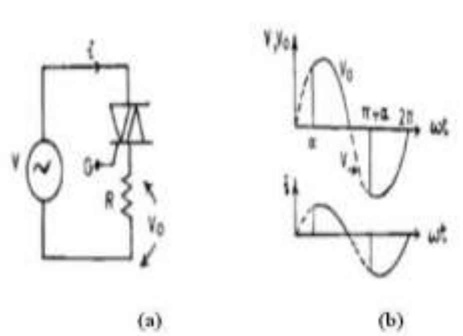

Fig-1: Switching arrangement of phase control circuit,

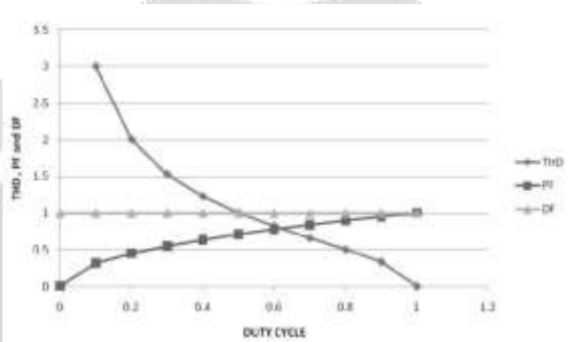

Fig-2: Variation of PF, THD with Switching angle α in Deg.

2. PRINCIPLE OF OPERATION

Integral cycle control is used for controlling power to AC load by permitting few full cycles to power the load followed by off period. This is repeated cyclically. The duty cycle is controlled for changing the output power basically on - off control similar to the obtained through SCR switches except that integral number of cycle are passed. In literature, ICC is also described as On - Off control, Burst firing, Zero Voltage Switching, Cycle Selection and Cycle Syncopation [2]. Fig. 3 Variation of PF, THD with Switching angle α in Deg.

When the power is ON, during N cycle the speed or temperature increases exponentially from a minimum value and reaches a maximum at the end of the Nth cycle. If N us the number of full cycles passed per M cycles of the source voltage then it is said to have a duty cycle of $\delta = N / (N + M)$. The difference between maximum of temperature and the minimum temperature is called the differential. PRINCIPLE OF OPERATION

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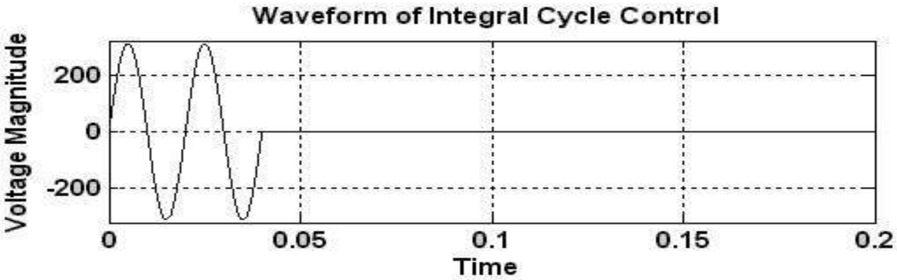

Fig-3: describes the output voltage waveform in ICC with duty cycle D= 0.2 and harmonics

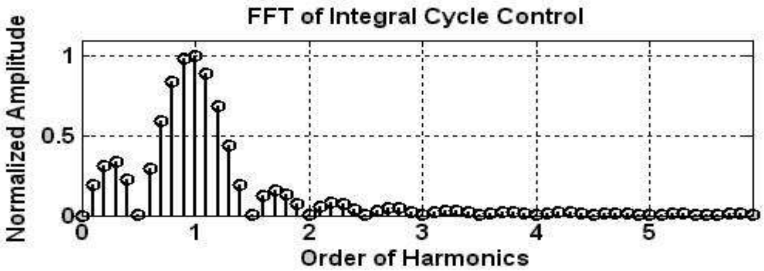

Fig-4: Output Voltage in ICC with D= 0.2 and harmonic profile

3. BLOCK DIAGRAM

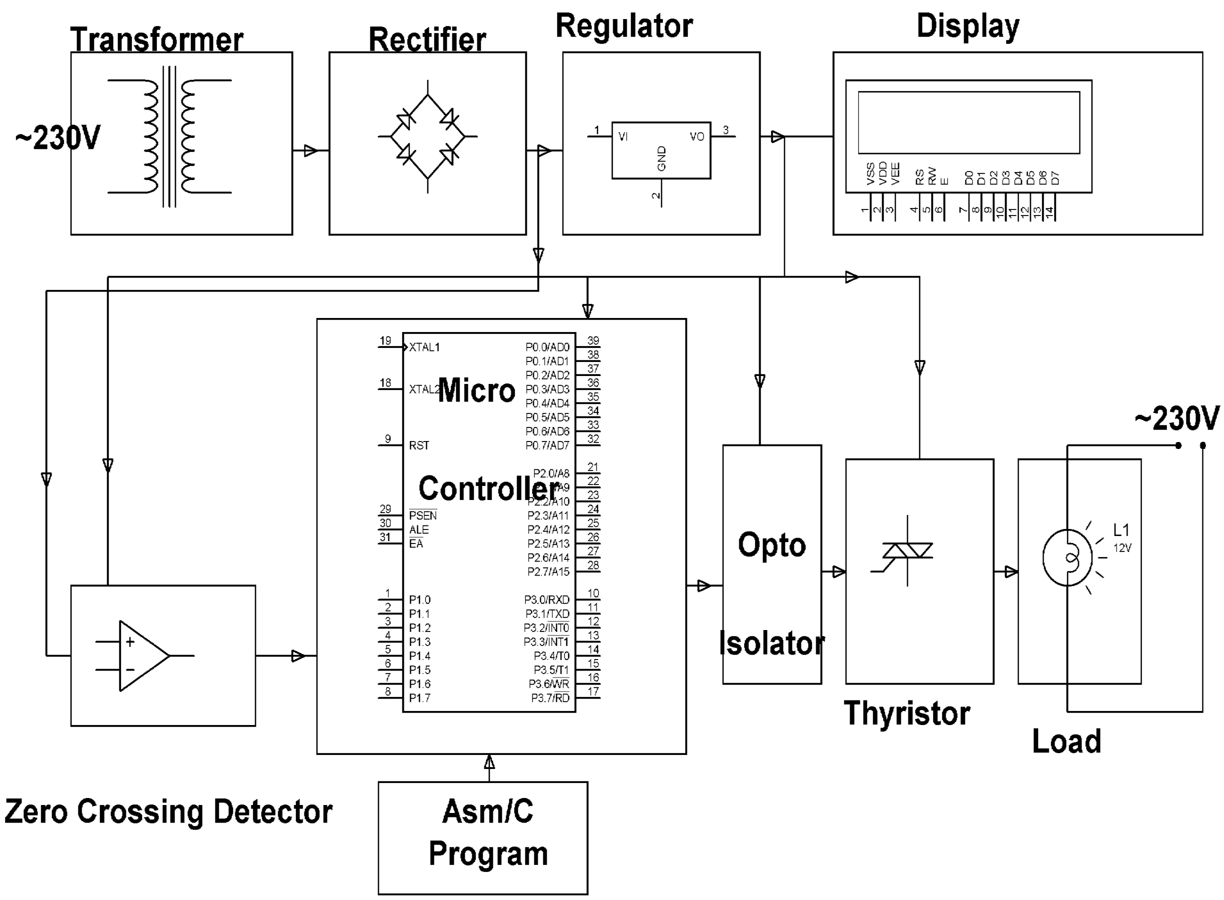

Fig-5: Block Diagram of the Harmonic Reduction

Block Diagram of ICC circuit involves the basic three sections. First section comprises of a power supply stage to drive all internal amplifier and feed the gate energy to the power semiconductor devices. In second section a zero voltage detecting stage, which sense the instant of zero supply voltage. This stage releases the power amplifier for a short duration pulse this cross over point so that they may trigger the power semiconductor if required or separate some other more continuous drive circuit. Finally in third section an amplifier stage is required which magnifies the control signal to provide the drive needed to turn on the power switch on. As shown in the block diagram, the control block consists of control circuit for the ICC, Firing Circuit and Power Amplifier (FCPA) and power supply for controlling the load.

4. IMPLEMENTATION & RESULTS

Here system is described by ATmega32 micro-controlling programing which can control the motor speed. In implementation of LCD (LM016L) is a 16 pixels there will be number of cycle are display in the simulation.

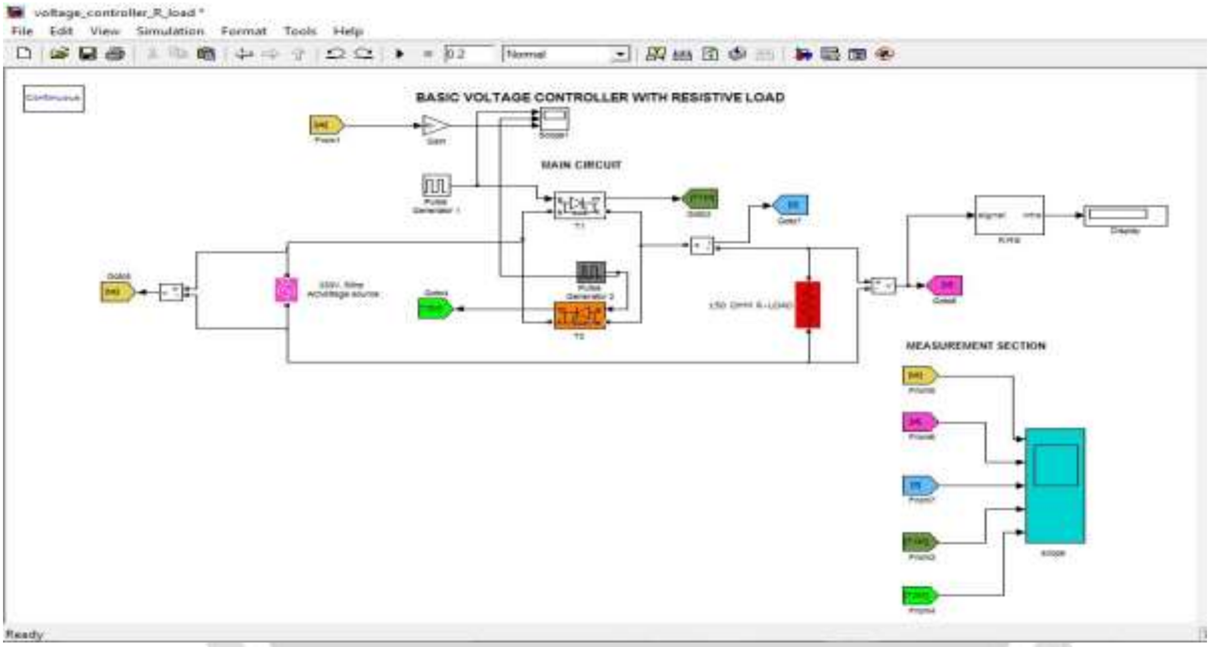

Fig-6: Simulation diagram for Integral cycle switching control

5. RESULTS

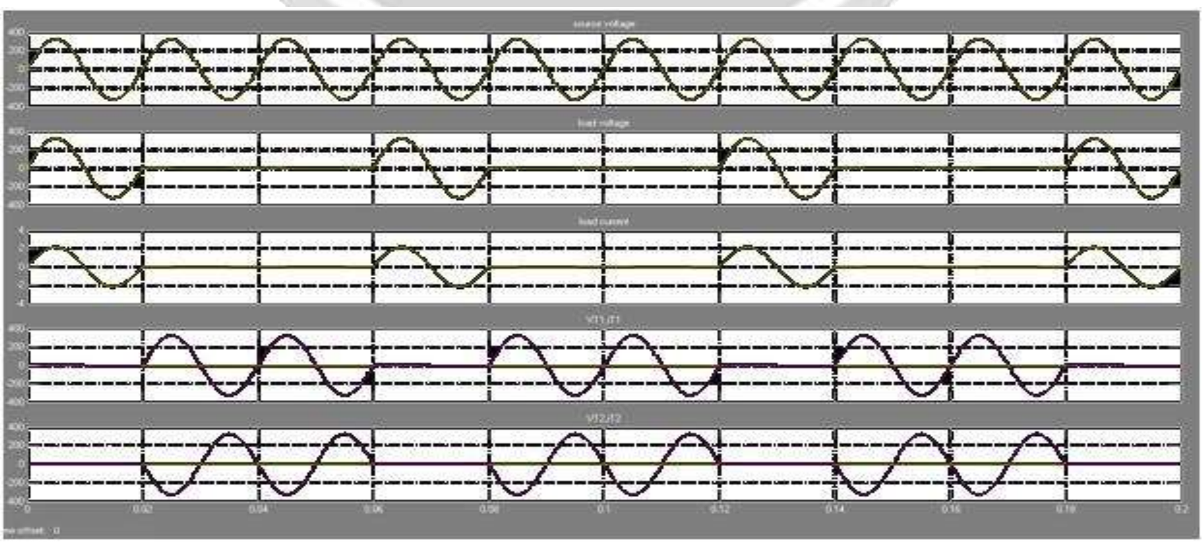

Fig-7: load output voltage and current waveform for firing angle = 30 deg and duty cycle 0.06

7. CONCLUSION

In this paper voltage is controlled through integral cycle switching and controlling AC power is used. Through integral cycle output signal we get pure sine wave so it reduces harmonics and improving power factor. It has low cost and easy to operate. Less AC power losses. So better efficiency output in AC power.

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