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Integral Cycle Control AC Power without Generating Harmonics

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***Abstract*: The project is designed to achieve integral cycle switching a method to remove whole cycle or portions of cycles of an ac signal. It is a well-known and old method of controlling ac power, especially across liner 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 per the program written in assembly/C language so that the actual time-average voltage or current experienced at 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. 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. Further this project can be enhanced by using feedback mechanism to automatically maintain desired output to the load by appropriate cycle stealing.**

***Keywords*: transformer, Rectifier, Regulator, Display, Zero Crossing Detector, 8051 microcontroller, Opto Isolator, Thyristor, Load).**

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. we induction motor controller for reducing harmonics for controlling at mega8 pin to provide fast and reliable control operations. The controller also includes 28 digital input/output pins. This has wide applications in manufacturing, light dimmer, induction motor speed controlling etc. $Vo=V[1/\pi \{ (\pi - \alpha) - 1/2 \sin 2\alpha\}]1/2$ P F=Vo/V where input supply voltage v(t) = Vm sin ωt; Vm and V are maximum and rms values of the supply voltage and α is the switching angle of the circuit. Where I is the fundamental value of the line or input supply current and Ii are represents the harmonics current components of I. when α varies between 60 and 120, the supply voltage is close to its peak value (86.7% to 100%) and the corresponding voltage control range is from 44.2% to 89.7%. at the switching instant (ω t = α), the line current jumps from zero to almost its peak value. Thus, di/dt is high over a wide range of control. Moreover, there is heavy inrush current when furnace element R is heated from cold. At a higher value of α, PF is also low and THD is significantly high.

2. Block diagram

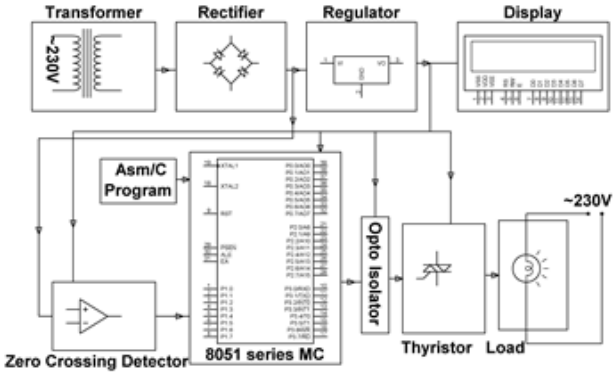

Fig. 1. Block diagram

3. Working mechanism

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 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 δ=N/(N + M). The difference between maximum

of temperature and the minimum temperature is called the differential.

4. Software requirements

- Keil compiler
- Language: Embedded core assembly

5. Information about block diagram

A. Transformer

A transformer is an electrical device used to change the voltage level. Here a 12- 0-12 step-down transformer is used. Through this the 230V AC is stepped down to 12V AC. the output of this transformer is fed to the rectifier and also to the zero crossing detector.

B. Rectifier

It is used to convert the ac signal to a pulsating dc signal. Output of rectifier can be further smoothen by using filter circuits consisting reactive elements. its output is then controlled by using regulator.

C. Zero Crossing Detector

A zero crossing detector is a basically a comparator having the reference level set at zero. It is used for detecting the zero crossings of AC signals. It can be made from an operational amplifier with an input voltage at its positive input. Output of this zero crossing detector is fed to PIC microcontroller.

D. PIC microcontroller

It is used to control the triggering pulses of TRIAC. It is a 40 pin IC. It has four input output ports. PIC is referred to Peripheral Interface Controller.

E. Opto-isolator

Opto-coupler is also called opto-isolator, photo-coupler and optical isolator. It is used to provide isolation between two electrical circuits. It is an electrical component which is used to transmit input signal by using light energy signals. It provides electrical coupling between input and output through light waves. Its main purpose is to avoid changes in voltages in output side to appear in input side. Higher voltage fluctuations may damage input side electrical components.

F. FTRIAC

A TRIAC is bidirectional thyristor with three terminals. It is used extensively for the control of power in ac circuits. TRIAC is the word derived by combining TRIode and AC. Basically it is a switching device.

6. Hardware costing

8051 series Microcontroller	120
Op-amp	20
Opto-isolator	20
TRIAC	30
Resistors	2
Capacitors	10
Diodes	6
Voltage Regulator	20
LED	2
Crystal	15
Lamp	3

7. Merits

- It reduces harmonics.
- It is more efficient than convention firing angle modulation method.
- Load operates safely.
- This method is easy and less costly
- This method is more in many small and large applications

8. Application

- This method is used in industry for controlling power.
- This method is also used in house such as fan, motor, water pumping etc.
- It is used to controlling the power in linear loads.
- Where we have to control the speed, intensity and power then this method is applicable.

Future Scope Research is a continuous process. An end of a research project is a beginning to a lot of other avenues for future work. Following aspects are identified for future research work in this area –

- The industrial loads considered in the present work are varying continuously with respect to time. Hence the design of efficiency optimization controllers with less convergence time will be useful to operate such drives with good dynamic performances. Further work can be focused to minimize convergence time in hybrid optimal energy controller.
- Since the performance of VSD is based on the accuracy of induction motor drive system loss models further work especially in converter losses and magnetic saturation is needed to get more accurate results.

9. Conclusion

In this Project 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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