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Linear control starter for single phase induction motor

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ABSTRACT

This paper is based on the advancement of power electronics technology. In this paper, we forced on designing and development of linear control starter for single-phase induction motor. An induction motor takes a large current while starting so we had to make a starter which will be reduced starting current of induction motor. In this circuitry, we also gave high voltage and low voltage protection circuitry. In this, we have used a microcontroller with solid state power electronics device that is, thyristor. The results show that this method can be reduced starting current.

Keywords— *Induction motor, Thyristors, Microcontroller*

1. INTRODUCTION

A linear control starter is compact, easy to an operation designed for use with a standard single phase induction motor. It provides an advanced method of reducing current during motor starting and stopping. A smooth starter supplying a reduced voltage to the motor increasing up to the rated voltage, so avoiding high currents and generating soft starting and stopping. The motor has to be able to start in reduced voltage. With the development in power electronics technology the requirement of speed regulating system more and more strict especially the introduction of the advanced control strategy. Two starting modes can reduce the current shock at startup the torque is limited when starting. The ramp current control technique limit starting current method proposed in this paper [2]. Also, we have given the undervoltage and overvoltage protection circuitry. The under voltage protection i.e. low voltage is below180V and overvoltage protection i.e. high voltage is above 270V. If the load is crossed this voltage then it will be tripped by the protection circuitry which is control by PIC microcontroller.

2. DESCRIPTION

2.1 Linear Starter

At starting, an induction motor develops more torque is required than at full speed [1]. This stress is transferred into the mechanical system which results in premature failure of chains, gears, belts, seals, etc. The use of start delta only provides a partial solution to the problem up to 15 HP. The starter provides a reliable and economical solution to these problems by delivering controlled release power to the motor, which directly provides smooth, step-less, acceleration and deceleration. Motor life will be increased as damaged to bearings and windings is reduced. Linear starter generally based on the power electronics technology which gives results efficient. At starting induction motor takes large current 4 to 5 times rated current practically. So in whenever we start induction motor we used a different type of starter i.e. direct online starter up to 10 HP, star delta starter up to 15 HP and with the advancement in control electronics and power electronics soft drives are used in industrial applications.

2.2 PIC Microcontroller

PIC microcontroller stands for "Peripheral Interface Controller". It is the brainchild of Microchip Technology. It is being used in industrial automation and embedded applications because easily available with low cost and easily programmable. We used PIC 16F886 microcontroller in this Analog to digital converter and speed of operation is very high and efficient as per our need.

2.3 Solid state switches

These solid switches are phase controlled in a similar manner to a light dimmer in that they are turned on for a part of each cycle. The average voltage is controlled by varying the conduction angle of the switches. Increase the conduction angle will increase the average output voltage. Typically the power dissipation in the starter during start will be less than 1% of the power dissipated in a primary resistance starter during start. By variation in conduction angle, the output voltage can be easily increased or decreased. The major advantage of linear starter based on solid state switching is that the average voltage can be easily altered to suit the required starting condition.

2.4 Block Diagram

The block diagram is shown in figure 1 for voltage controlled by thyristor.

3. PRINCIPLE OF OPERATION

Basically, the main aim was to develop this hardware is to modify the complex system into a simple and efficient technique of linear control starter for a single phase induction motor [2].

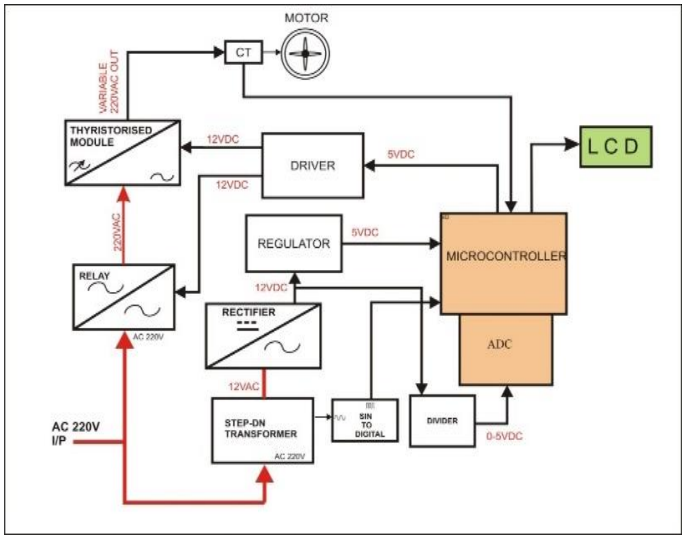

Fig. 1: Block diagram of linear control starter for induction motor

The system which can easily start the single phase induction motor. At initial conditions, it takes up a larger current than its capacity practically 4 to 5 times rated current. This leads the motor to capture the speed resulting in mechanical stress, electrical stress and also causing some damage to the motor winding. Sometimes the windings may also get burnt. Linear start to the induction motor is based on the solid state firing angle control principle. This project consists of two solid state switches which are anti-parallel and are further connected series with an induction motor to the supply.

The two solid-state switches used for positive and negative cycle control. The microcontroller calculates the firing angle and it will send to optocouplers for triggering. They are triggered slowly at initial states and gradually the triggering pulse is increased. So that motor gets high current after a time delay when windings are in the position of withstanding the high current to trigger the gates of SCR's the optocouplers are used linear start of an induction motor has a certain time constant and back to back SCR. Solid switches are being triggered by optocouplers from RC time delay arrangement where the induction motor starts slowly. It starts from slow to full speed. Switch on the circuit and then the circuit will slowly the pick up the speed.

The input is 220v AC it is then converted to 12v AC with the help of step down transformer 12-00-12. After that, it is converted to 12v AC to 12 DC by the rectifier circuitry. For microcontroller, we used 7805 IC so 5v DC is being used in our circuitry, LCD, PIC controller and CT for overcoming the unstable effect we used stabilizer capacitor. So initially we give 25% voltage according to firing angle calculation and current at that voltage done by the controller then gradually increased by 50%, 75% and 100% full rated voltage. This is how the linear start of induction motor works which is important as per the industrial applications. It starts drawing less current in the start and that is how a linear control technique starter works. The block diagram is shown in figure 1. The applications of this, we can be used this type of starting Blower, Cement industries, Textile industries, Ginning industries, Machine tool applications, power sector etc.

The advantages are eliminated high inrush current, reduce stress on coupling and another transmission of power devices, avoid current and torque peak, increase in efficiency, durability, ease of operation, lightweight, compact unit with speed variations. And the most known disadvantage is harmonics due to power electronics. It can not handle the overload, non-uniform torque, high insulation cost and also this type of starter as compared to VFD is not used for controlling the speed of induction motor, the operating speed of the motor should be fixed, speed regulation is not possible, acceleration and deceleration time more on load.

4. OUTPUT RESULTS

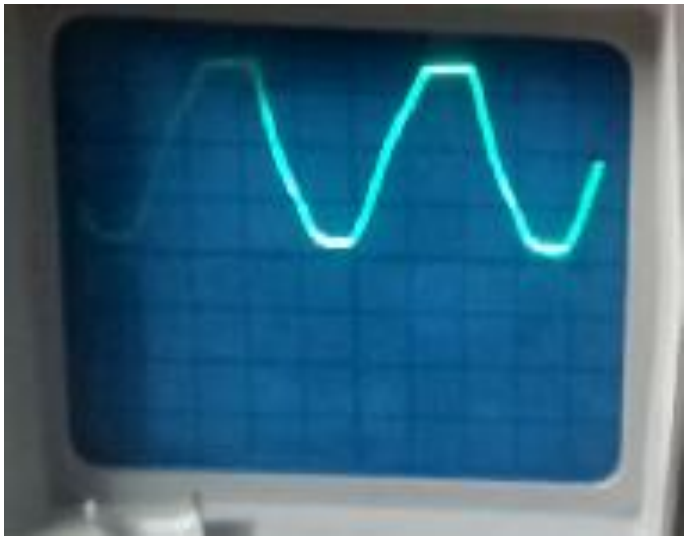

Fig. 2: Input Voltage

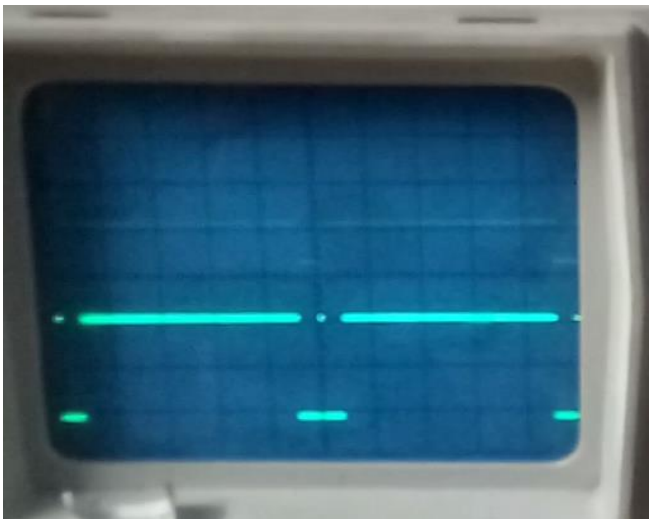

Fig. 3: Firing angle with reference to zero cross detector

Fig. 4: Output of zero cross detector in pulsating

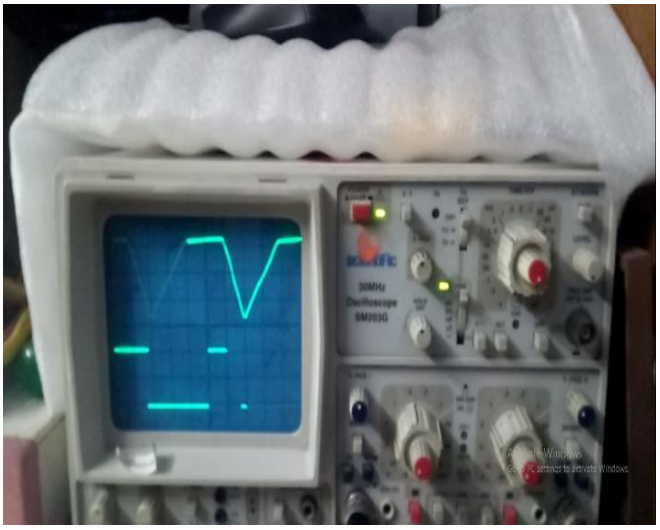

Fig. 5: Firing angle with reference to full wave

From the output waveform of figure 2 shows the input supply voltage across the step-down transformer which is 220v/12v ac 50Hz. In figure 3 shows in which we have given the full wave input voltage to zero cross detector which detects voltage both for the positive and negative half cycle and also with reference to firing angle.

In figure 4 which shows after zero crosses of voltage in pulsating form, and figure 5 the output has been shown firing angle with reference to full wave. From results we can say that at starting firing angle is high and current is low and gradually the voltage will be increased and the firing angle will be decreased.

5. CONCLUSION

We can conclude that this linear control starter is beneficial for industrial applications point of view. The author took the trial of the blower motor and the linear starter was being worked. This hardware can be installed at industries but we have to care and make proper maintenance of component because a large amount of heat will be generated. So, heat sinks have been installed. This circuitry can be modified with three phase circuitry using the advancement of power electronics and industrial engineering.

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