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Implementation of Soft Starter in Industrial Applications: Vinayaka Steel, Hingna MIDC, Nagpur

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Abstract- *Vinayaka steel is manufacturing steel rods and various steel components. They are using Induction motors in their industries. Soft starters for AC motors offer many benefits, with the most significant being a reduction of mechanical stresses on the motor and shaft as well as other components in a system, thereby extending equipment life. They also contribute to smarter use of power and less inrush current, which can minimize penalties from utility companies. This paper surveys the use of the soft starter in industry for starting of heavy induction motors by the use of power electronic devices, circuit, advantages, applications in industries. In Addition this paper analyze different problems while using the conventional starters, features of soft starter. This paper also includes the application of this starter in the Vinayaka Steel,Hingna,MIDC.*

Keywords: - Block Diagram, Zero Crossing Detector and IGBT Driving Circuit, AT89c52, Advantages and Application.

I-INTRODUCTION

We have visited to Vinayaka steel industry and found that the staring of the motor is done using a star delta starter. This is inappropriate and may cause a high starting current and varying torque and may damage the working material. Soft starters for AC motors offer many benefits, with the most significant being a reduction of mechanical stresses on the motor and shaft as well as other components in a system, thereby extending equipment life. They also contribute to smarter use of power and less inrush current, which can minimize penalties from utility companies. In this project we are developing the soft starter for single phase induction motor and the results were compared with the three phase motors.

By the use of conventional starter in the induction motor the starting voltage can only be limited up to 57.77% of the rated voltage which intern the current at the starting increase above the safe limit of the current and may damage the motor winding. Hence to overcome this problem the use of semiconductor based circuits is use for driving of the induction motor.

The Vinayaka Steel also use the conventional method of starting of the induction motor i.e. star-delta starter on high HP motor so this starter should be replaced with the new starter that is power semiconductor based starter for improving the reliability of the motor and for using the power more efficiently,

In this paper the soft start control technique used for the single phase a.c. induction motor. It presents a design of a low-cost; high-efficiency drive capable of supplying a single-phase a.c. induction motor with a PWM modulated sinusoidal voltage during start. The circuit operation is controlled by an 8051 family microcontroller.

The device is aimed at substituting the commonly used triac phase angle control drives. The circuit is capable of supplying a single-phase a.c. induction motor (or general a.c. inductive/resistive load) with varying a.c. voltage at the start. Same as in triac control, the voltage applied to the load is varied from zero to maximum value in a small span of time during start. On the other hand, it uses a pulse width modulation technique (PWM), and when compared with the phase angle control used for triacs, it produces much lower high order harmonics. It does not use a conventional converter topology to produce the output voltage waveform. It directly modulates the mains a.c voltage. Compared with costly converter, it requires a lower number of active and passive power components. The device attempted here takes advantage of both the low price of the phase angle control and the low harmonic content and high efficiency that we can get with standard converter topology. The drive uses a PWM controlled MOSFET and the load in series with a bridge rectifier.

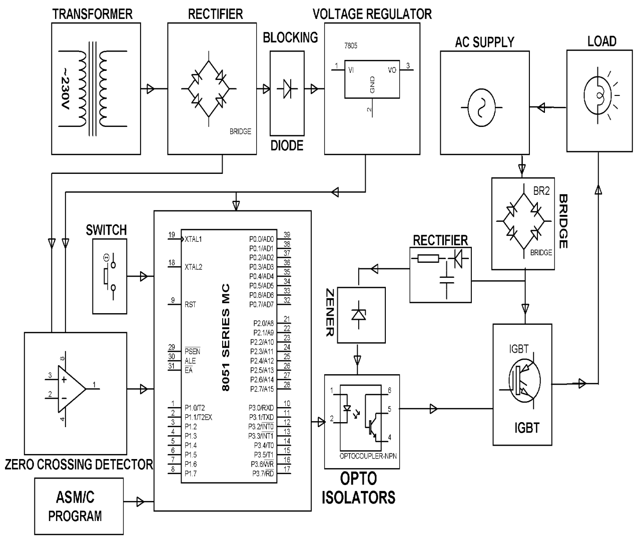

Fig1:-Block Diagram of the Single phase Induction motor using IGBT.

The above figure shows the block diagram of the single phase soft starter using a IGBT based drive. In which the load connection with the IGBT can be done in the following manner.

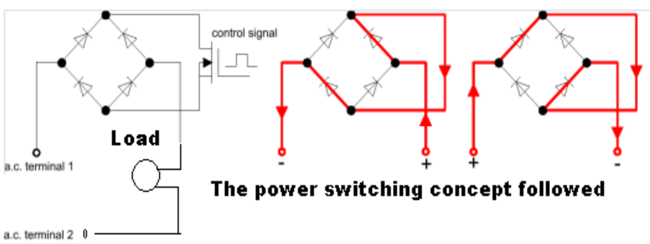

Fig 2:- Connection of load with supply suing IGBT triggering

The input terminals of the rectifying bridge are connected in series to the load. The output terminals (rectified side) has a power transistor (IGBT) connected across them. When the power transistor is off, current cannot flow through the rectifying bridge and the load which is in series remains in an OFF-state. When the power transistor is ON, the bridge output terminals are short-circuited, then current can flow through the rectifying bridge and thus through the load. Thus by changing the duty cycle of the PWM pulses the power to the load is controlled. Special care is taken in the circuit such that the PWM pulses are synchronized with the supply phase by zero voltage sensing points.

For this a special sensing circuit for zero crossing of the ac cycle is use which is used for the calculation of the zero crossing point of the ac wave and is explained further.

Zero crossing Detector using opamp

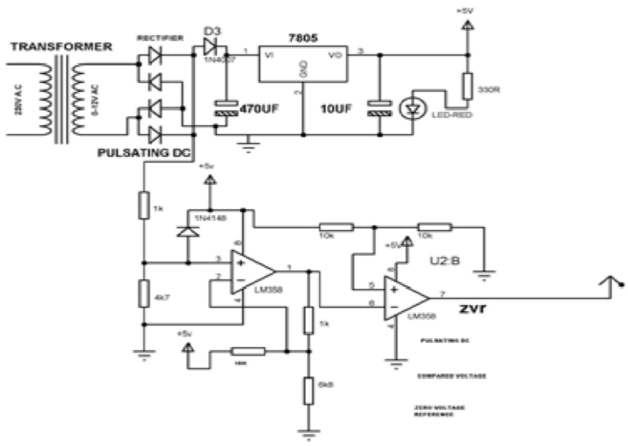

Fig 3:-Zero Crossing Comparator.

Zero voltage cross detection means the supply voltage waveform that passes through zero voltage for every 10msec of a 20msec cycle. We are using 50Hz ac signal, the total cycle time period is 20msec (T=1/F=1/50=20msec) in which, for every half cycle (i.e. 10ms) we have to get zero signals. This is achieved by using pulsating dc after the bridge rectifier before being filtered.

The Operation of the microprocessor is operated as the following sequence.

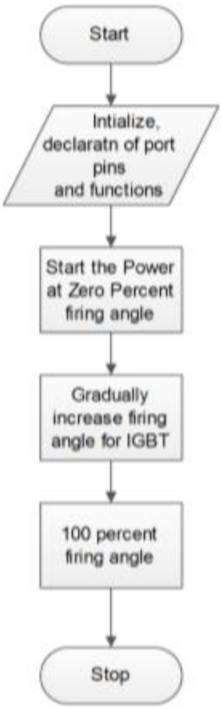

Fig:-Sequence of operation of the Microcontroller

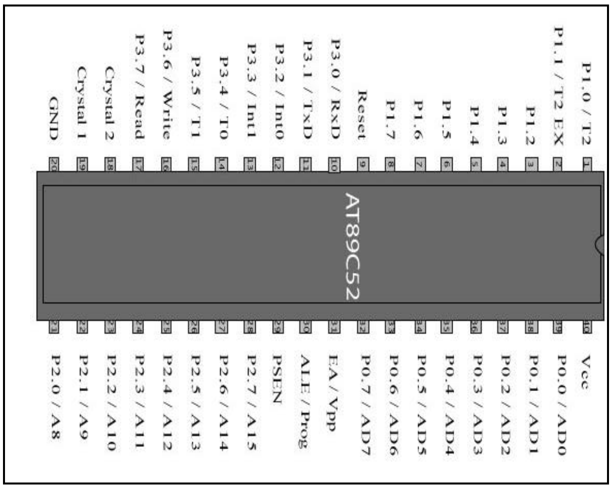

Fig 4:-Pin Diagram of AT89C52

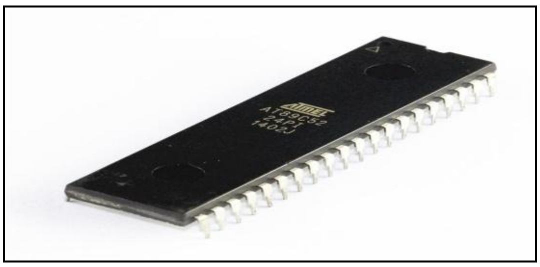

Fig 5:-AT89C52

The Microcontroller is used for to deliver the driving signals to the power semiconductor device i.e. IGBT through the optocoupler. The Driving circuit is controlled by using the AT89C52 IC.

The AT89C52 is a low-power, high-performance CMOS 8-bit microcomputer with 8K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 and 80C52 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C52 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

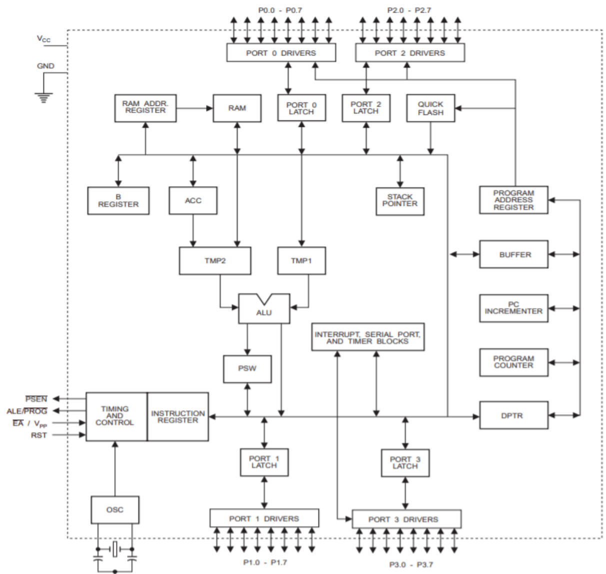

Fig 6:-Internal Block Diagram of AT89c52

The AT89C52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM,40 I/O lines, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full-duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89C52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next hardware reset.

ADVANTAGES:-

Soft starters are used on high tension motors for the following advantageous features:

1. Smooth starting by torque control for gradual acceleration of the drive system thus preventing jerks and extending the life of mechanical components.
2. Reduction in starting current to achieve break-away, and to hold back the current during acceleration, to prevent mechanical, electrical, thermal weakening of the electrical equipment such as motors, cables, transformers & switch gear.
3. Enhancement of motor starting duty by reducing the temperature rise in stator windings and supply transformer.
4. The microprocessor version of the Soft starter has a software controlled response at full speed which economizes energy, whatever may be the load. Because of the tendency to over specify the motor rated power, this feature has benefits for most installations- not only those where load is variable.
5. The power factor improvement is a self-monitoring in built feature. When the motor is running at less than full load, the comparative reactive component of current drawn by the motor is unnecessarily high due to magnetizing and associated losses. Hence the voltage dependent losses are minimized with the load proportional active current component and as a result the power factor also improves simultaneously.

APPLICATIONS:-

The Soft Starter can be applied in the following Industries:-

1. Steel industries (Rolling mills and processing lines)
2. Cement industries
3. Sugar plants
4. Paper
5. Rubber and plastic
6. Textile industries
7. Machine tool applications
8. Power sector
9. Water supply scheme
10. And various process control applications…

(The starting performance of the squirrel cage induction motors using soft starter provides valuable economics of electrical energy. Optimum benefits are gained when a motor duty involves frequent start or stop cycles but is still likely to be worthwhile in systems which are in continuous operation).

CONCLUSION

The use of the conventional starter introduce the harmonics and the starting current rise more than the safe value, hence to overcome the problem the use of the power semiconductor based drive for the starting of the heavy induction motor. The use of the microcontroller based drive in the starting of the high HP motor is to be used as it will increase the life of the motor as well as the cables, Switchgears, and the protective equipment connected with the motor.

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