



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 4, April 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.512



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Soft Start of 3 Phase Induction Motor Using SCR

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ABSTRACT: A three phase induction motor draws current more than the rated capacity during starting phase which might damage stator windings of three phase induction motor. In order to avoid this problem, for the smooth and soft start of the induction motor (for safer operation), voltage is gradually applied from lower to higher state. A smooth and soft starter is employed in a three phase induction motor to eliminate the surge in current and electromagnetic torque during starting. The surge in current and torque are eliminated temporarily using soft started at the time of starting. The soft starter also eliminates the unwanted effects in electric cables and power distribution network. This paper provides an in depth description of sentimental and smooth start to an induction motor. At the time of starting, an induction motor draws significant amount of current from the supply and this drawn current is higher than the rated current of three phase induction motor. The smooth start of three phase induction motor is predicated on the delay angle of TRIAC circuit. The firing angle is delayed during starting and delay angle reduces as the motor picks up the speed. The firing delay angle is further reduced to zero when motor reaches full speed. This proposed technique provided reduced voltage at the time of starting and full rated voltage when motor reaches full speed. By using soft starters, performance of induction motor is improved and it also improves load torque characteristics.

KEYWORDS: TRIAC, induction motor, firing delay, soft start, voltage dip and brown out,

I. INTRODUCTION

Most of the machines utilized in the industries are three phase induction motors. They need simple and rugged construction and their robust nature make them possible to work altogether environmental conditions. At the time of starting, the worth of slip is extremely high, hence the starting current is extremely high. This type of high starting current is extremely much detrimental for the machine since the machine windings are designed mainly to hold the rated currents. So, to scale back these starting current manual starters are used like direct online, star delta and autotransformer. The ac motor starter provides limited starting current and hence conventional electromagnetic line starters and reduced voltage starters are replaced with ac motor starters. The reduce voltage at starting by soft starters eliminates stress from the electric supply and it also reduces the likelihood of voltage dip and brown out conditions. Thyristor- based soft starters have many desirable properties and provide a viable solution to starting problems in three phase induction motors.

A soft starter is an integration of complex power control apparatus for reducing starting current during a medium voltage solid state soft- starter. 6 TRIACs are connected as 2 units for one phase as switches and reduced voltage by operating TRIACs in various regions.

Soft and smooth starters provide smooth acceleration of rotor of three phase induction motor. Reduced voltage starting reduces high amount of starting torque applied on the shaft and thus eliminates the shock on the driven load. An instant high amount of starting torque can cause a jolt on the conveyor which may damage products, pump cavitations and bang in pipes. The starter works on the very fact that the torque is proportional to the square of the starting current, which successively is proportional to the applied voltage. Thus, the torque and therefore the current are often adjusted by reducing the voltage at the time of starting the motor.

II. RELATED WORK

At the time of starting, an induction motor draws significant amount of current from the supply and this drawn current is higher than the rated current of three phase induction motor. The motor reaches the full rated speed instantaneously

as soon as the voltage is applied. The smooth start of three phase induction motor is based on the delay angle of TRIAC circuit [1]. A 3-phase AC voltage controller is used as a soft-start. But, this takes harmonics-rich current while operating at large firing angles. In this paper, the effect of inserting a shunt active filter to supply harmonic and reactive power compensation during a soft-start has been deliberate [2]. They designed an integrated soft starter that has voltage ramp soft start; current limit soft start, voltage jump soft start, and discrete frequency soft start supported dsPIC6014a within the premise of doing these efforts, and given the system's hardware and software design intimately [3]. In this paper simulation results show stable operation for wide range of speed control. The level of harmonics in the supply currents have been also evaluated for different control strategies [4]. This paper taking three-phase ac induction motor soft starter for research object, soft start analysis principle, design soft starter main circuit and application of Mat lab simulation, the simulation results shows that soft start was used in motor start advantages [5]. The paper introduces a replacement type middle-voltage soft starter supported the on-off transformer. The starting performance of the soft starter is fully analyzed by experiment and simulation within the paper. The control method of eliminating the torque pulsation is produced and hence the soft starting control of constant current is realized [6]. The performance of a voltage-controlled large induction motor soft starter has been upgrade, getting nearly perfect torque and current profiles. They proposed strategies have been verified experimentally on a laboratory machine employing special torque measurement system in the dynamic state [7].

III. METHODOLOGY

A soft starter provides reduced voltage and therefore reduced torque on electric motor. A soft starter comprises of solid state devices like thyristors. For each phase, two SCRs are connected in antiparallel direction and SCR are initially started at a delay angle of 180 during respective half wave cycles. Each SCR conducts in each half cycle. This delay is reduced gradually with time when applied voltage reaches to the full supply voltage. The reduced voltage ramps up to the full voltage and simultaneously, the firing angle is reduced from 180 to 0. Initially to perform soft starting, a firing pulse are given to the SCRs so that only the remaining part of each half period of sinusoidal voltage curve passes through them. Then the instants of firing pulses are reduced which allows larger part of the voltage to pass through SCRs. Finally, the firing pulses are applied exactly at the zero crossing of the voltage which allows 100% of the voltage to pass through. Figure 1 shows block diagram for soft start of induction motor.

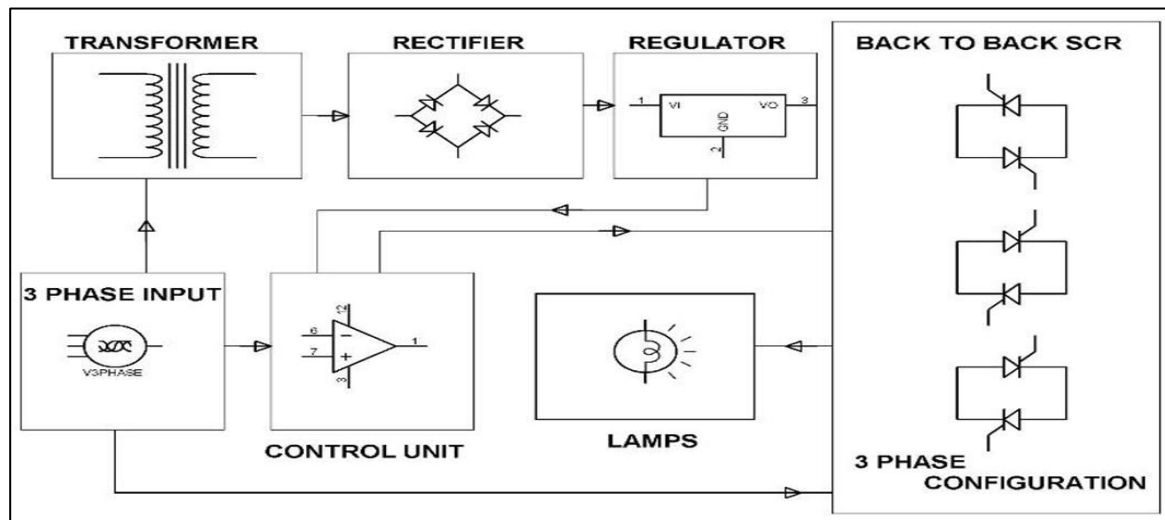


Fig.1 Block diagram for soft starting of induction motor

Now, the circuit diagram has been implemented using the following components and the prototype has been tested for bulb load.

Components Are:

- 3 step-down transformers are used to step down 230v AC to 12v AC for each phase.
- 3 bridge rectifiers are used to convert 12vAC to DC.
- Blocking diode is required after each bridge rectifier to isolate pulsating DC and pure AC as per need.

- After blocking a filter capacitor is employed to get the pure DC.
- Also resistors, transistors, capacitors, diodes are required.
- A 10uf capacitor is connected at the output of 7812 for stability; Also a LED is in series with resistor is connected to indicate the power.

The prototype has been made as shown in the model and its circuit in fig 2 and 3. And the same has been tested for load resembles the induction motor.

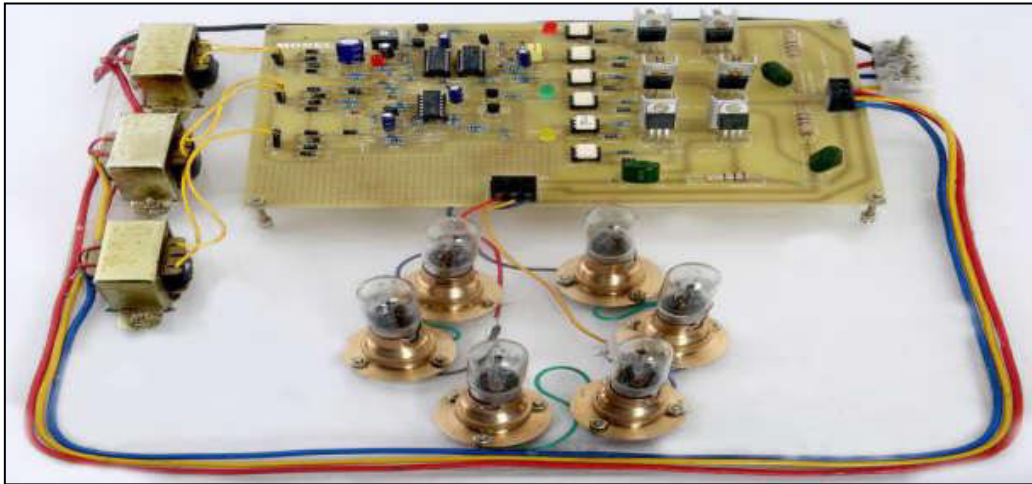


Fig 2.The circuit involved in prototype

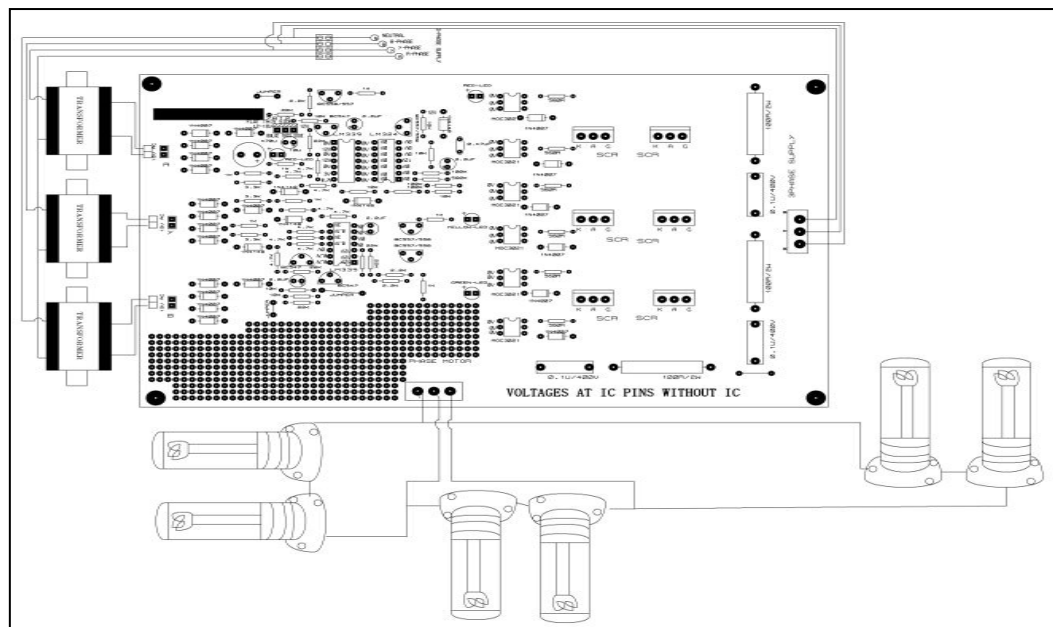


Fig 3.The complete prototype and its circuit

IV. EXPERIMENTAL RESULTS

The expected outcome in the form of wave form has been shown in fig 4. These are the waveforms which could be seen in CRO. It shows variations in the power, voltage variations and the current variations in the prototype for the soft starting of the induction motor.

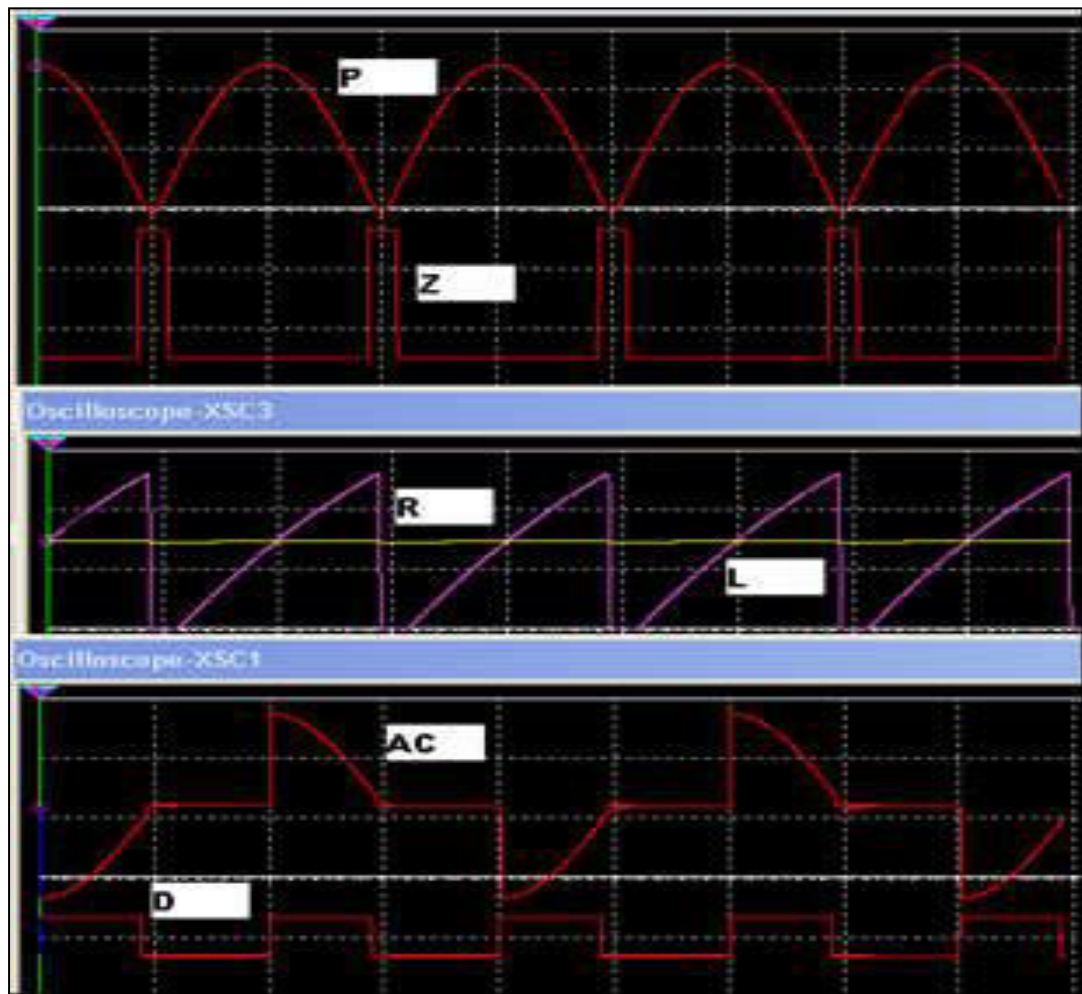


Fig4.Experimental Outcome

V. CONCLUSION

The main objective of the project is to reduce the terminal voltage of the induction motor, so that the motor could start smoothly from rest and thereby increasing the terminal voltage across the motor in steps, as the motor gains speed. In this way, the starting current of the motor which is 4-6 times of the full load current. The motor is protected from any electrical disturbances which can damage the motor. We have successfully built a soft starter by using a triac and an optocoupler, which can initially reduce the terminal voltage across the motor during starting and gradually increase the voltage once the motor starts. Therefore, our main objective of this project is successful.

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