Soft Start of Induction Motor Using TRIAC Switching

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***Abstract*—The aim is to design to provide a soft and smooth start to a induction motor which is use in a wide application like industries and domestic purpose. In induction motor starting current is very high which is a approximately 6 to 7 times to rated current.so we need to control the starting current for safer operation of motor and reduce mechanical stress on winding.so we control the starting current by using a semiconductor device.by switching a TRAIC so voltage gradually increase then starting current reduce. It is simulated in MATLAB.**

Key Words: Soft Starter, Inrush Current, Induction motor, MATLAB, TRAIC

I. INTRODUCTION

Induction motors are being widely used for various applications such as conveyor systems, blowers, fans, traction, elevators and pumps etc. These systems efficiency depends on the performance of induction motor which in turn depends on the starting and running performance of induction motor. Direct starting of induction motors, specially, large horsepower motors, will cause sag of supply voltage, heating and torque fluctuation. Generally, the starting current and torque fluctuation can be minimized by reducing the starting voltage of induction motor. Number of methods are available to reduce the starting voltage such as reactor starter, star-delta starter, auto-transformer starter and soft starters. Among all these starters, soft starters are widely used because they are capable of reducing starting current, reliable, noise free and occupy less space. In soft starter, the stator voltage is controlled smoothly at line frequency between zero and full voltage by symmetrically triggered THYRISTORS. As a result the starting current of induction motor increases slowly however, this will leads to number of harmonics which are harmful for induction motor as well as for grid. Hence, when the motor is successfully started, the entire soft starter is bypassed with the help of sensors and contactors.

1) Primary Resistor: - Developed in the early 1900‟s, this simple unit is one of the first soft starter placed into operation. In this technique resistor for each of the three phases of current. Resistors resist the flow of current. When the motor is started the resistor resist the current flow resulting in the voltage drop. Approximately 70% of the line voltage is sent to the motor terminal at the start up. A timer closes a set of contact after the motor has accelerated to a pre determine point. This removes the resistor from the circuit and let‟s full power through to the motor.

Primary resistors starters are known for their smooth starts. They offer two-point acceleration, or one step of resistance. For extra-smooth starting, add additional stages of resistors and contactors.

2) Auto-Transformer: - Autotransformer starting is one of the most effective method of soft starting. It is preferred over primary register starting when the starting current is drawn the line must be held to a minimum yet the maximum starting torque line ampere is required instead of using registers this starter use tap on transformer windings to control the power input to the motor. Taps are usually set up to provide 80%, 65% and 50% of line voltage respectively.

These taps provide built in flexibility. Activating in the one of the three taps on the windings allow different amounts of current to the motor. The motor is receiving voltage through the second of the three taps. This type of Starter can supply more current to the motor than the other soft starter while keeping voltage low. The transformer step up the current making it greater than the line current input during startup.

3) Part Winding: - The part winding method requires dividing the motor windings into two, or more, separate sets. These identical winding sets are intended for parallel operation. At startup, power is applied to only one set of windings. As the motor comes up to speed, power is applied to the other winding set for normal running. When windings are energized in this manner they produce reduce the starting current and reduce the starting torque. Most dual voltage motors are compatible with the part winding starter at 230 volts.

4) Wye Delta:-Wye Delta starting requires the motor have connection point to each of the three coil windings. This is specially wound with six leads for delta and Wye connections. Fig. illustrate the winding configuration as they are connected at start up.

It is called the wye configuration because it is shaped like the letter “Y”. This connection results in line voltage applied to an electrically larger winding, reducing the line current.it provides 33% of the normal starting voltage.

After pre-determined time the starter electrically switches the windings over to a delta configuration. this configuration resembles the Greek letter „delta” .the windings are connected in their normal run configuration with every winding receiving full voltage.

5) Solid state:- the newest soft start method is the solid state type.it replaces mechanical components with electrical components. The key is the silicon control rectifier or SCR. During motor acceleration, this device controls motor voltage, current and torque.

Fig shows how the solid state soft starter controls the current draw and the starting torque. The SCR has the ability to rapidly switch heavy currents. This allows the soft starter to provide smooth stepless acceleration the smoothest of any of the soft start method.

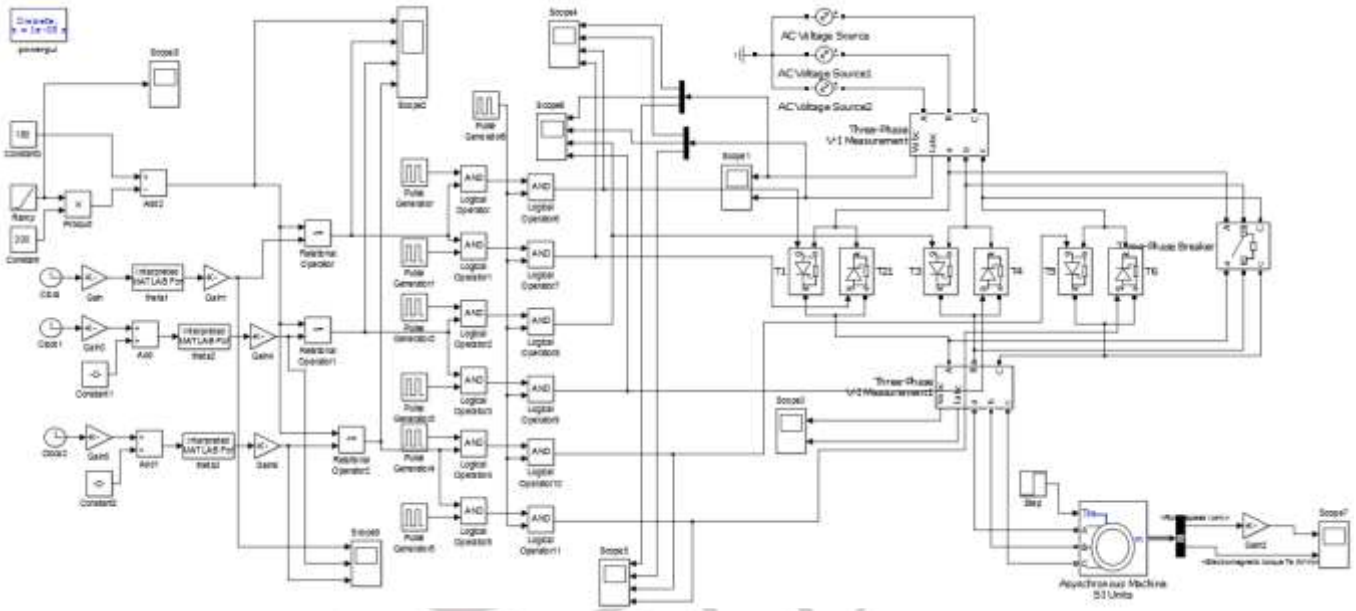
DISCRIPTION:- An Induction motor has the ability to self start owing to the interaction between the rotating magnetic field flux and the rotor winding flux, causing a high rotor current as starting current is increased. As a result the stator draws high current and by the time the motor reaches to full speed, a large amount of current (greater than the rated current) is drawn and this can cause heating up of the motor, eventually damaging it. To prevent this, motor starters are needed.

In technical terms, a soft starter is any device which reduces the starting inrush current applied to the electric motor. It generally consists of solid state devices like SCR to control the application of supply voltage to the motor. The starter works on the fact that the square of starting current is inversely proportional to the torque, which in turn is proportional to the applied voltage. Thus the current can be adjusted by reducing the voltage at the time of starting the motor. A start voltage is applied with time, irrespective of the current drawn or the speed of the motor. For each phase two SCRs are connected back to back and the SCRs are conducted initially at a delay of 180 degrees during the respective half wave cycles (for which each SCR conducts). This delay is reduced gradually with time until the applied voltage ramps up to the full supply voltage.

Components of a basic soft starter:-

Power switches like SCRs which need to be phase controlled such that they are applied for each part of the cycle. For a 3 phase motor, two SCRs are connected back to back for each phase. The switching devices need to be rated at least three times more than the line voltage.

II Simulation:-



Description:-

This circuit consist of a six SCR, two SCR connected in Antiparallel in each phase. SCR firing angle control by a ramp signal. First we generate a ramp of a 180 degree fix value. then we generate a another signal by using a clock ,gain ,function block parameter and gain block. And then we compare this signal with the ramp signal. When a reference signal value gradually increase then a conduction angle is increase. When reference signal value is low then a conduction angle is low and when a reference signal value is a higher then a conduction angle value make a high. So gradually increase a voltage so current is also gradually increase so motor is protected. And this circuit a circuit breaker is connected so when motor get rated current then soft starter is disconnect from circuit and supply is bypass to the motor.

III Simulation Result:-

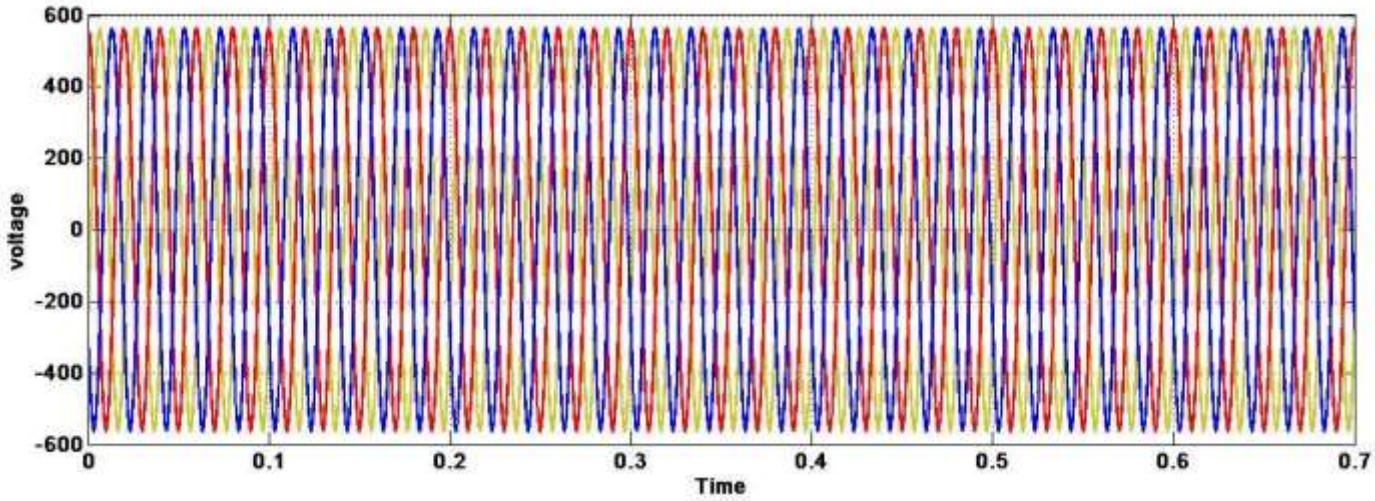


Fig. (a) Starting voltage of induction motor without soft starter

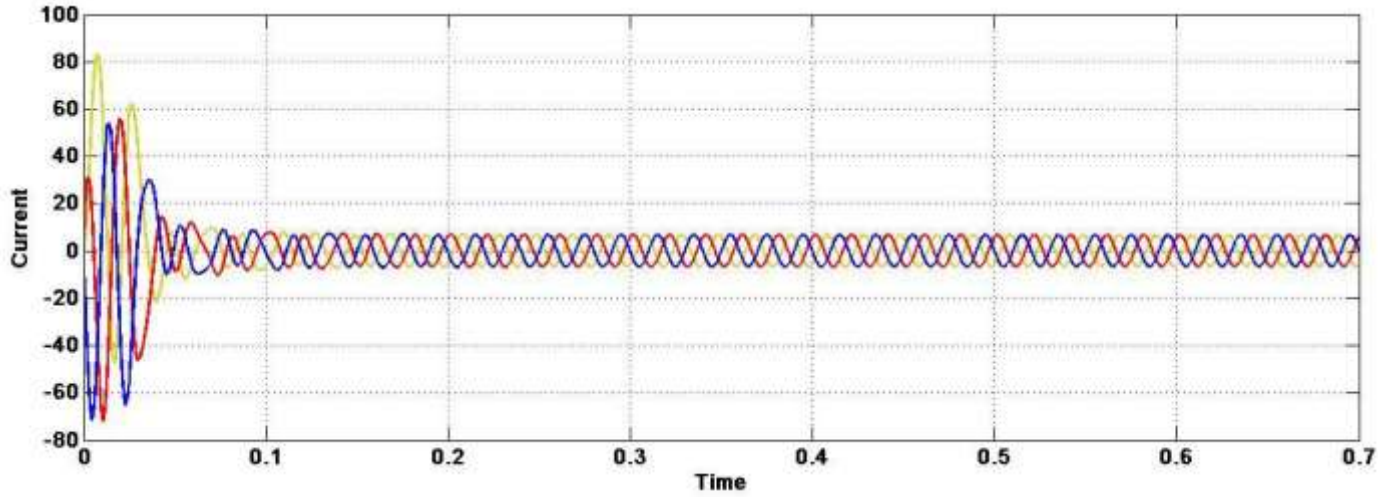


Fig. (b) Starting current of induction motor without soft starter

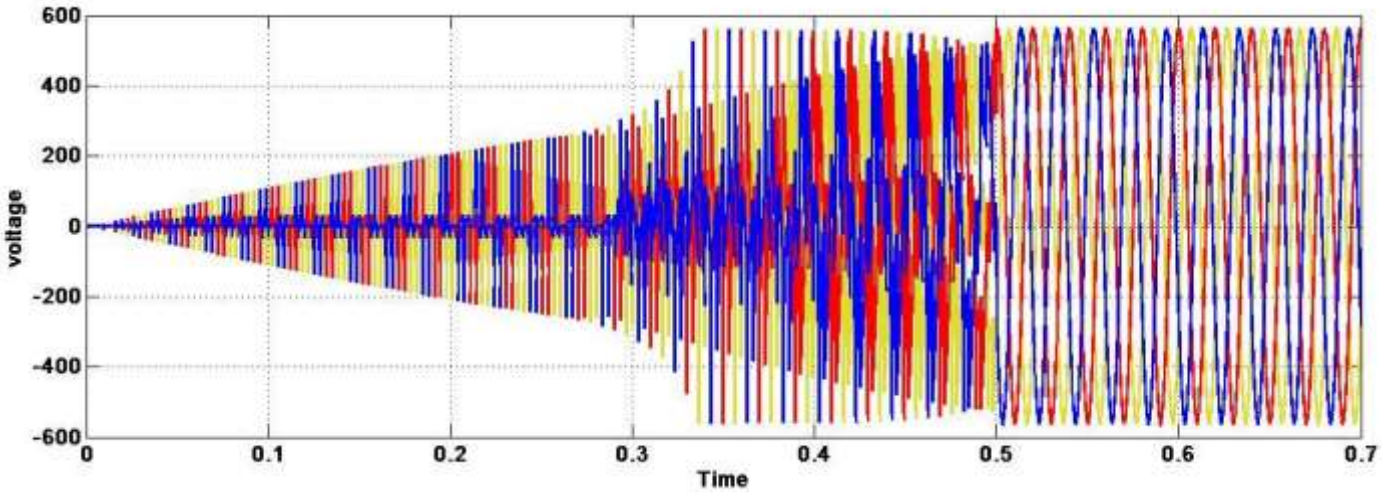


Fig. (c) Starting voltage of induction motor with soft starter

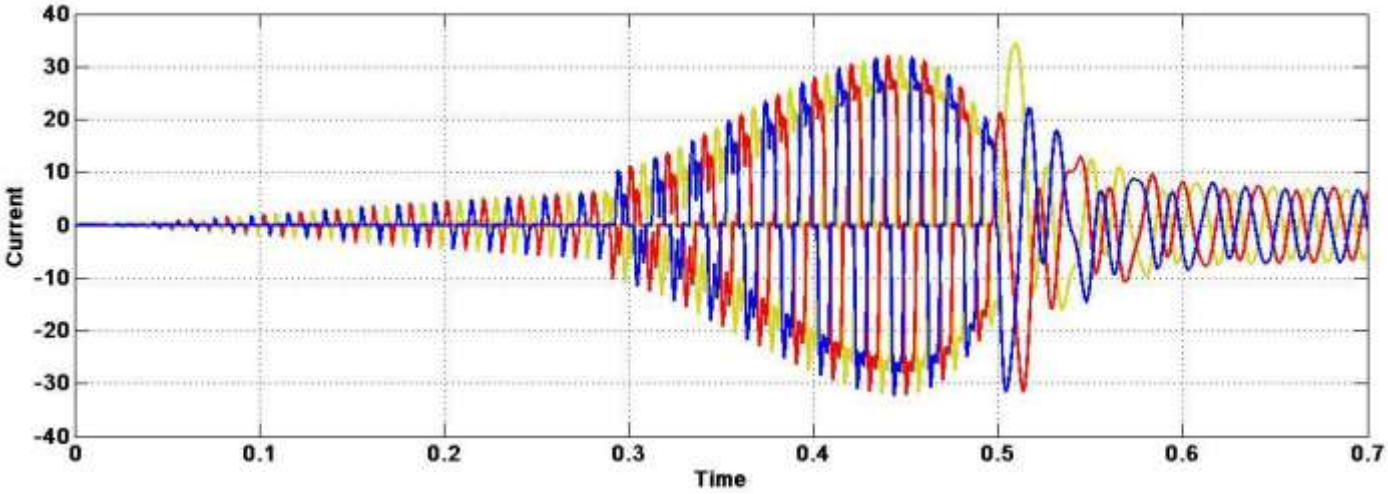


Fig. (d) Starting current of induction motor with soft starter

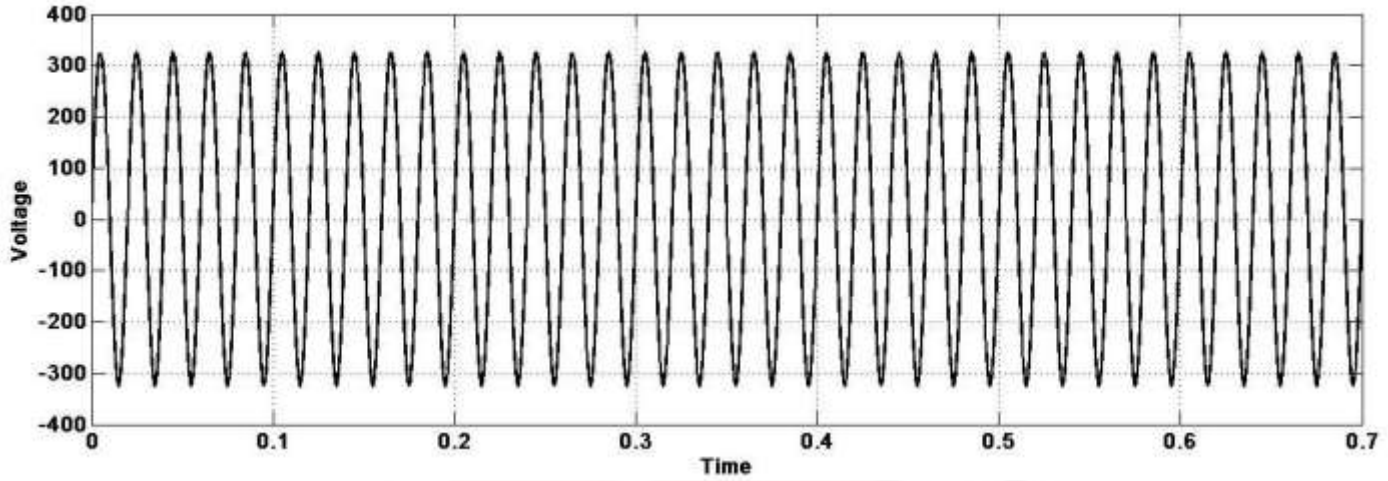


Fig (e) voltage in one phase

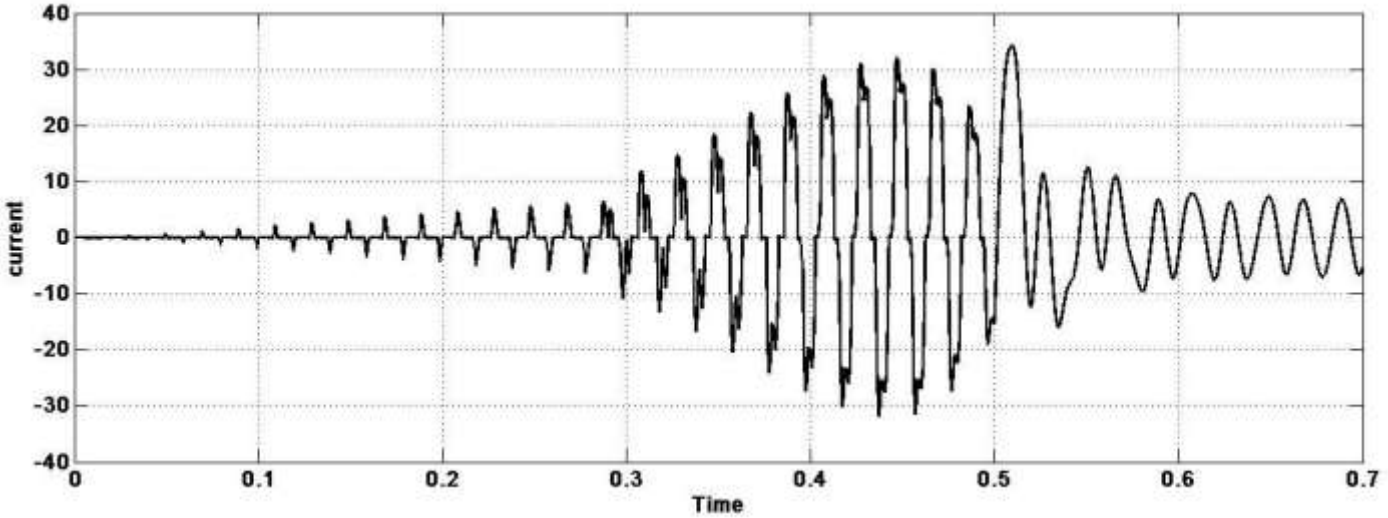


Fig (f) current in one phase

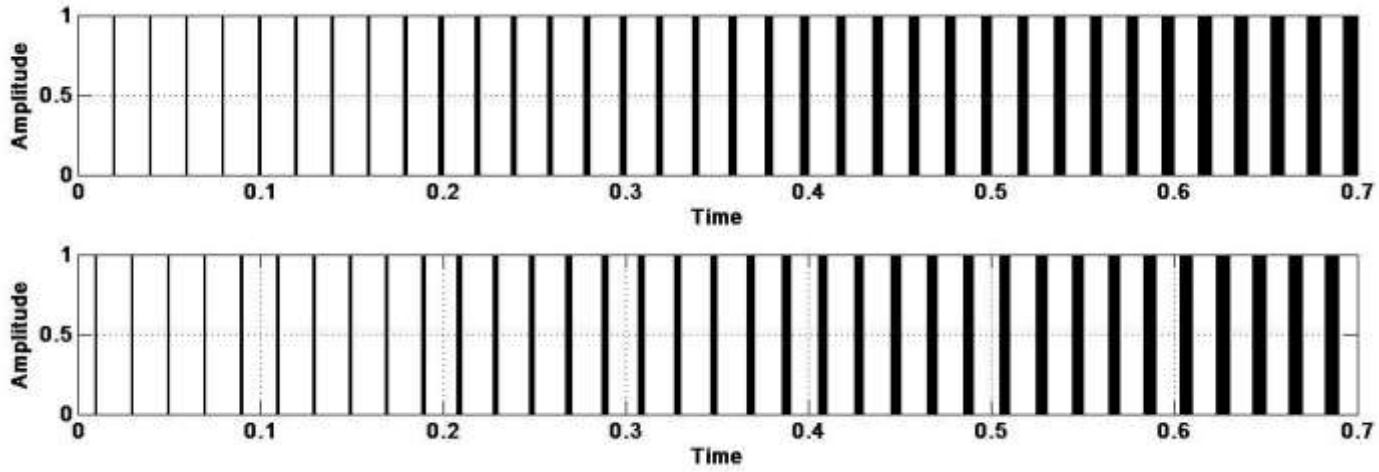


Fig (g) conduction angle of triac

Figure (a) shows a waveform of voltage and Figure (b) shows a current waveform of without soft starter simulation waveform in this we can see that inrush current is approximate 80 amps.
Figure (c) shows a voltage waveform of induction motor in a simulation with soft starter.
Figure (d) shows a starting current waveform of induction motor in a simulation with soft starter and we can see that inrush current is reduce approximately 80 amp to 30 amp.
Figure (e) shows a voltage waveform which is flow in one phase.
Figure (f) shows a current waveform which is flow in one phase.
Figure (g) conduction angle of positive and negative cycle of triac.

IV Conclusion:

For protection of motor from inrush current, we simulate soft starter using solid state device. In this project we control the voltage by switching of TRIAC at different angle and we control the inrush current of induction motor. From the result we can see that inrush current is reduced to 38 ampere from 82 amps. So motor cannot be damage and runs smoothly.

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