Soft Start for 3-Phase-Induction Motor

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Abstract

The three-phase induction motor draws current more than its rated capacity during its starting state which may lead to the damage of windings of the 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.The main intention of this project is the designing of a smooth start process for the three-phase induction motor by applying the delayed pulses to the motor through the SCR. The motor thus starts slowly, and then picks-up full speed. The smooth starting of the induction motor is achieved by the principle of SCR-firing-angle-control. This project consists of six-anti-parallel or back to back SCRs connected in each series with an induction motor to the mains supply, wherein two for each phase is used. Opto-coupler is connected to trigger the back-to-back SCRs with isolation from the controlling section. During the start, the firing angle is heavily delayed by receiving delayed triggering pulses from the operational amplifier.

Keywords: SCR triggering; IGBT; Firing angle delay; opto isolators; opto couplers; zero voltage triggering ; motor current control

1. INTRODUCTION

The direct-on-line starting of induction motors produces troublesome torque and current transients. Soft-starting techniques, which are commonly used with three-phase induction motors, lead to more reliable operation and allow the reduction of the motor sizing: they limit the phase currents during the starting transient in order to obtain a smooth connection to the power supply. Unfortunately, little investigation has been made so far on the application of these techniques to single-phase motors, even if they are widely used e.g. in households purpose and of course suffer of the same troubles as in the three-phase motors.

Now a days, the present work can deals with various soft-starting techniques, implemented on a simulation tool. Out of these some are almost based on the so-called point-on-wave technique of switching, which is actually a delayed insertion, either simultaneous or independent, of both the main and auxiliary phases to the main supply. In order to limit the total transient current within the allowed maximum for household appliances, the gradual insertion of the motor's main phase, is also investigated and discussed.

2. EXISTING SYSTEM

Soft starters of motors may offer a much variety of methods which are useful for controlling motor starting. Every soft starting method uses a different primary control parameter.

Soft Start Method	Parameter Controlled	Performance Parameter Influenced
Time Voltage Ramp	Voltage	Start current, Start torque, Acceleration
Constant Current	Current	Start current, Acceleration
Torque Control	Torque	Start current, Acceleration
Adaptive Acceleration Control	Acceleration	Start current, Acceleration

Best results are obtained by selecting the soft start method that directly controls the parameter of most importance for the application. Typically soft starters are mainly used to limit motor starting current or to control load acceleration and/or deceleration [4].

Timed Voltage Ramp (TVR) Starting

Timed voltage ramp (TVR) was the earliest form of soft starting. TVR slows the application of voltage, which reduces the start current. This reduces start torque and slows the motor's rate of acceleration.

Current limit starting

With limiting of current of starting, the soft starter can delivers voltage to the motor so that it reaches a specified current level, then pauses the voltage ramp. When the current drops, the voltage ramp continues. This keeps start current within the required limit, although the motor's actual current level varies throughout the start. This can be useful for generator set applications where the supply is limited.

Constant current

With constant current starting, the current is raised from zero to a specified level and keeps the current stable at that level until the motor has accelerated. Constant current starting is very ideal for all applications where the starting current must have to kept below a particular level.

Torque Control

Torque control is promoted as a method of providing a more linear speed ramp in soft starters. By providing a constant acceleration torque, controlling of torque will allows the motor to speed to be up or slow down in a linear fashion.

Adaptive Control for Starting

Adaptive Acceleration Control is a new intelligent motor control technique. In an adaptive nature of control with soft start method, the soft starter are able adjusts the current value to start the motor within a specified time and using a selected acceleration profile. Every application has a particular starting profile, based on characteristics of the load and the motor. Adaptive Acceleration Control offers three different starting profiles schemes, to be suit the requirements of various applications.

Selecting a profile that matches the inherent profile of the application can help smooth out acceleration across the full start time. Selection of the dramatically different Adaptive Control profile can somewhat able neutralize the inherent profile. The soft starter monitors the motor's performance during each start, to improve control for future soft starts.

COMPLETE BLOCK DIAGRAM

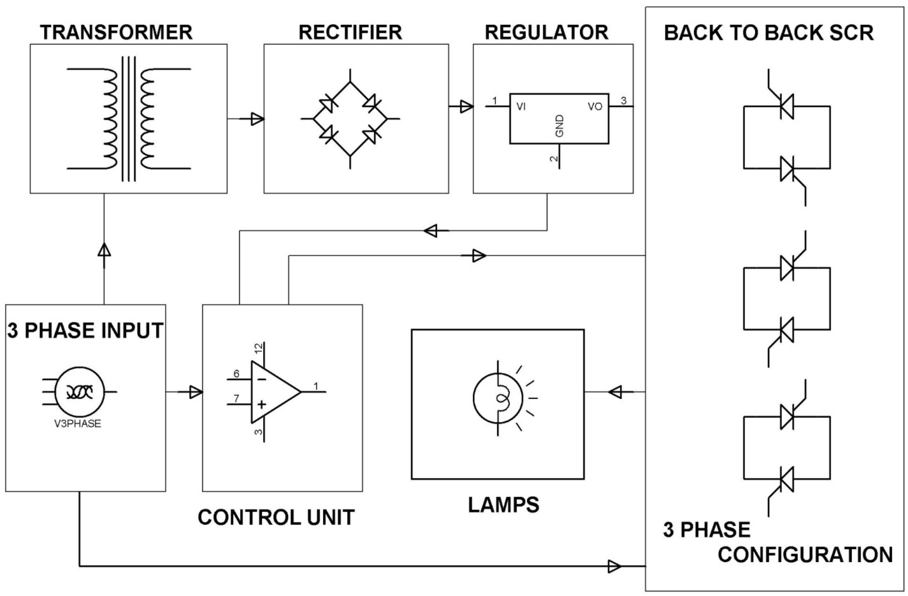

Fig 1: Soft Start for 3-Phase-Induction Motor

The block diagram shown in the fig 1 in this voltage is controlled by SCRs [3].

3. SYSTEM ANALYSIS AND DESIGN

Regulated voltage supply

The 12V DC regulated voltage supply is achieved with the help of following circuit diagram. The step down transformer (230V/12V AC) is used initially after that the bridge rectifier circuit is used to convert ac supply to dc supply. By getting output of bridge rectifier circuit it is further fed to regulating IC7812 to get positive 12V DC regulated supply. The LED used for indicating purpose.

Amplifier circuit

Initially at the time of switch on the base of transistor allows current flow from emitter to base and charges the capacitor as well as current flows from emitter to collector and charges capacitor. When capacitor is fully charged, the base becomes high due to which the current stops flowing from emitter to base and collector. The positive terminal of capacitor is connected to the non-inverting pin of LM324 comparator, the inverting terminal of comparator is fed from a fixed voltage. When the capacitor is charging the voltage at non-inverting terminal is greater than the inverting terminal, hence the output of comparator is high during this time. When the capacitor starts discharging the voltage at the output of comparator also falls gradually because the voltage at non inverting terminal falls lower slowly than the inverting terminal. Hence the level of the voltage is initially high and gradually falls down, this level voltage L is fed to another comparator of Op-amp LM339 [2].

SCR power circuit

In this circuit antiparallel SCR's are connected per phase. The 440 V, 3-phase, 50 Hz supply is fed to SCR's the opto-coupler circuit used in triggering for isolation purpose. The capacitors are used in circuit for certain amount of voltage regulation. The cathode of SCR's are connected to load terminal of induction motor [5].

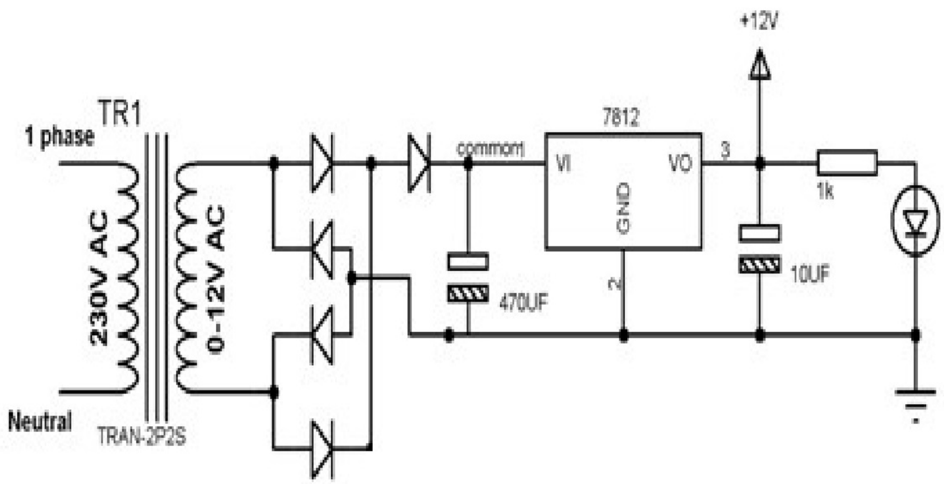

Fig 2: +12 V DC Regulated supply.

4. PROBLEM STATEMENT

Various studies have shown that nearly 91% of the motors employed or used in industrial applications use no form of control other than simple electromechanical switching. This results in increased machine wear as rapid acceleration causes damaging torque transients and high peak currents. Soft starters able solve this problem by controlling the application of starting current during acceleration and deceleration.

The purpose of this project is to give soft starting to the induction motor by controlling amount of staring current with the help of thermistors. This method also covers some of the advanced functionality that can be found in today's modern soft starters as well as the considerations when choosing and sizing soft starters.

5. MAJOR COMPONENTS

Resistors	Capacitors	Diodes	Integrated circuits
560R 1K 2.2K 3.3K 4.7K 10K 22K 27K 100K 2.2M 100R/2W	470uF/35V 10uF/63V 2.2uF/25V 0.47uF (470nF) Polyester 0.1uF/400V Polyester	1N4007 IN4148	LM7812 LM339 LM324 MOC3021

IC Base	Transistors	Miscellaneous
14-Pin Base 06-Pin Base	BC558/BC557 BC547	Push Button 2-Pin Transformer 0-12V, 500 mA LED-Red LED-Yellow LED-Green Male Burge 2-Pin Female Burge 2-Pin (For Transformers) Heat Sink Screw Nut for Heat SCR (TYN612 0R TYN616) PCB Connectors 3-Pin Lamp

6. RESULT

This Method of soft starting initially after switching on the triggering is done and this implies the on condition of SCR which are connected anti parallel in each phase. The triggering is done by amplifier triggering method. The current limiting process in the soft starting method is very efficient than that D.O.L. starter and star-delta starter. The amount of limiting current can be vary or adjusted by changing the triggering angle for SCR's.

7. CONCLUSION

The complete system is tested in power electronics laboratory. The experimental results obtained using the designed three phase motor drive system are studied in two parts, namely, the control part and the soft starter part. The controlling of the speed motor with almost an accuracy of ±10 rotation per minute (r.p.m.) is achieved. The different pulse of gate and voltages are seen on oscilloscope. The use of soft starter circuit suppressed the starting current very significantly. With this above project we can conclude that by using the soft starter the starting losses will be reduced by 50%, so that heating of the motor can be avoided and at the same time it will result in the increased life of the motor as well as the efficiency of operation of motor gradually increases.

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