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Induction Motor Soft Stater Using Solid State Switching Devices

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Abstract: ***In this paper two solid state switching devices i.e. Thyristor and IGBT are used to compare the performance of split phase induction motor at different firing angles.Firing angles are changed by changing the degree of two pulse generators used separately for two thyristors and in case of IGBT based two IGBTs. Total harmonic distortion is calculated for RL load in both thyristor and IGBT cases.***

Keywords: Variable speed induction motor, thyristor, IGBT, soft starter, THD.

1. Introduction

The circuit arrangement of two solid state switching devices is such that it reduces the high initial current of the split phase motors and hence called power electronics based soft starters.

Harmonics are cause of voltage changing and increasing fluctuating torque, surge as well as creating losses in supply line which causes great problem in motor starting. Harmonics is a component of the sine wave that is an integral multiple of the fundamental wave. Harmonic causes losses and depreciation in the transmission and distribution equipment and power consumers, so to control them is essential. Due to harmonics sudden voltage dips and large fluctuating torque causes a great problem in the starting of large induction motors. Sometimes due to tripping of relays, equipment failure, surge, no load or overload motor fluctuates resulting in failure of motor starting. So we use soft starting technique.

Soft starters give smooth and jerk free start to the induction motor. Subsequently, high frequency component from this voltage can be easily attenuated by using semiconductor based control circuit model.This control circuit not only reduces harmonics but also reduces problem of direct online starting and give smooth jerk free start to the motor.Solid state switching devices based soft starters are economical, simple and reliable. They can be economically employed in medium voltage large induction motor starting. Where starting torque requirement is low. By using power electronics converter based starting, the initial current of motor can be reduced significantly additionally they offer smooth acceleration. The paper focuses on classical topology of soft starters based on thyristors and IGBT in single phase (split phase induction motor).A complete simulation model is obtained using MATLAB /Simulink software for this purpose. The topology uses two pulse generators for both the switching devices. The firing angle can be changed by changing the degrees in pulse generators. Thus we find the resulting wave at different firing angles with also their harmonic components calculation.so the behaviour of the starters can easily be verified by the proposed simulation models. Thyristor based induction motor drive used in medium voltage low torque rating, where light load is connected at the output side of motor and require low torque. By using soft starting scheme value of supply current as well as voltage of induction motor can be controlled to give jerk free smooth acceleration to the motor.Direct online starting of induction motors poses a great problem to the grid as well as to the motor itself.Due to sudden voltage dips and large fluctuating torque.Sometimes due to tripping of under voltage and overvoltage load relays the motor may fail to start. Alternatively reduced voltage starting is being used especially for starting of large induction machines using auto-transformers. However, the volume and cost of auto transformer limit its use**.** T**w**o topologies of soft starters are more commonly employed.

1) Back to back connected thyristor based soft starters also called A.C. voltage regulators.
2) Insulated gate bipolar transistor (IGBT) based D.C. link converter.

2. Literature Review

In this paper the performance of a split phase motor and a three phase motor drive for soft starting is evaluated. The paper systematically investigates and compares the characteristics of a variable voltage fed induction motor drive for two different type of soft starters; one based on IGBT and another based on thyristor. Experimental validation is done using analogue circuit based system, developed in the laboratory. The novelty of the work lies in the development of simple and flexible models for simulation purpose and their experimental validation. Power electronics based induction motor starters more commonly called soft starters are becoming popular and are replacing the conventional reduced voltage starters using auto transformer. Two topologies that based on solid state switching devices. Thyristors are being commonly employed.

Inserting a shunt active filter to provide harmonics and reactive power compensation has been studied.The shunt active filter has been inserted between the AC voltage controller and the power supply to take care of the reactive power requirement of the motor and AC voltage controller and also to provide harmonics compensation.

Direct on-line starting of large induction motors poses a great problem to the grid as well as to the motor itselfdue to sudden voltage dips and large fluctuating torque.Sometimes due to tripping of relays the motor may fail to start.Alternatively reduced voltage starting is being used especially for starting of large induction machines using auto-transformers. However, The volume and cost of auto trans formers limit it's use. Power electronics converters based induction motor starters more commonly called soft starters are becoming popular and are replacing the conventional reduced voltage starters using auto transformers.

3. Simulink Model of Split Phase Asynchronous Motor

This is the diagram of single-phase soft starter of single phase induction motor using Thyristors with R-L load. There is a ac voltage regulator connected with single phase ac supply. The regulator is equipped with thyristor. There are two Triggering circuits connected with individual anti parallel thyristor pair. Now the next section is controlling unit which will controlled output of regulator circuit with respect to time. This stable output fed into the input of single phase induction motor and R-L load. For different values of firing angle there are their individual appropriate results and we can analyse the results on scope.

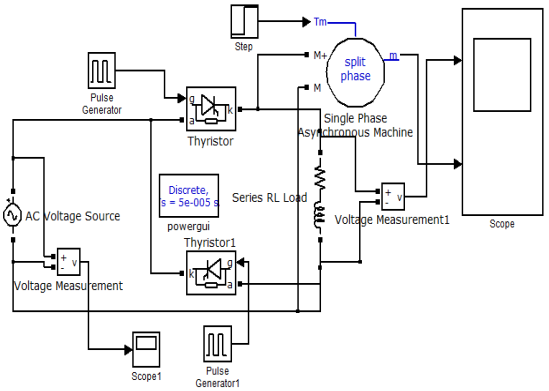

Figure 1.1: Simulink model of thyrister based model

This is the diagram of single-phase soft starter of single phase induction motor using IGBT with R-L load. There is aac voltage regulator connected with single phase ac supply in which insulated gate bipolar transistor used. The regulator is equipped with IGBT. There are two triggering circuits connected with individual anti parallel IGBT pair. Now the next section is controlling unit which will controlled output of regulator circuit with respect to time. This stable output fed into the input of single phase induction motor and R-L load. For different values of firing angle there are their individual appropriate results and we can analyse the result on scope.

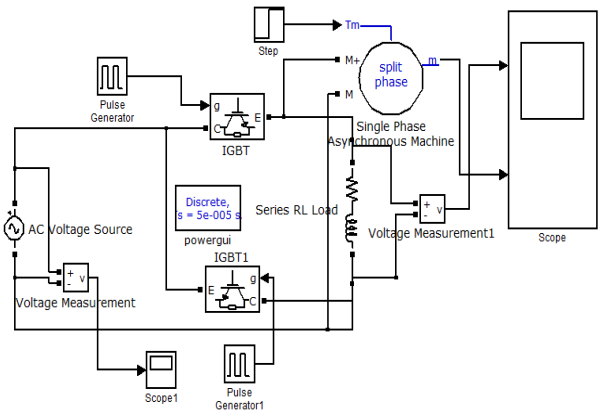

Figure 1.2: Simulink model of IGBT based model

4. Results

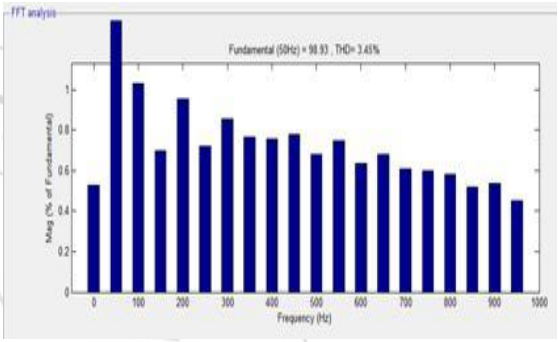

Figure 1.3: Total harmonic distorsion for thyrister based model at 60 hz

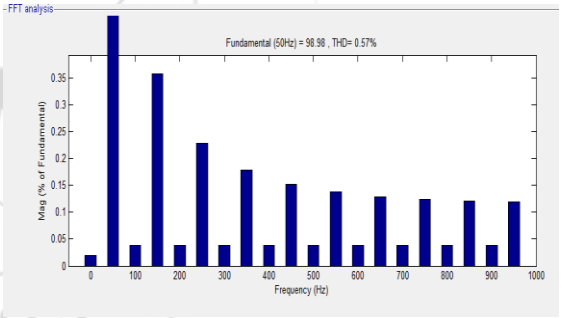

Figure 1.4: Total harmonic distorsion for IGBT based model at 60 hz.

5. Conclusion

It is seen that the IGBT based soft starter are more efficient than the thyristor based soft starters. After calculating the THD we come to the result that IGBT based converters are more efficient because they give low values of harmonic factor at large firing angles as well.

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