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Soft Start of Single Phase Induction Motor Using Igbt

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Abstract:

In the given paper we are discussing about soft start of single phase induction motor by using IGBT (Insulated Gate bipolar Transistor) technique. Main aim of this research paper is to minimize the starting inrush current that occurs in starting stage of induction motor. At the starting inrush current is 5-7times that of rated current. This can cause damage to the motor and can burst winding. In order to reduce the inrush current we have simulated the soft starting circuit using MATLAB, hence we got the results that are much more satisfying. We managed to limit the starting current which is less severe than the earlier one.

INTRODUCTION:

The given project presents a soft starting circuit of a split phase single-phase induction motor using an IGBT technique to control motors starting current. The main objective is to minimize the effects of high inrush currents and starting torque with the help of giving gradually increased voltage. This is generated by soft starting circuit using insulated gate bipolar transistors (IGBT).

In this paper, simulation of split phase single phase induction motor operation by using IGBT in MATLAB is given. Basically split phase induction motor is having two winding's in which one is main winding and another is auxiliary winding. Auxiliary winding is used for making single phase induction motor self-starting. But it has some drawbacks. The inrush current at starting stage of single phase IM is more than 5-7 times that of its rated current. Generally we observed that Starting torque is about 1.2-1.7 times to that of full load torque. Hence to eliminate this problems there are many techniques in the market.

We use the technique of controlling inrush current and torque by gradually increasing the voltage at the starting. We have observed and studied that if we give a gradually increased voltage to the split phase IM, it results in limiting the inrush current and torque up to a safety margin. Since IGBT technique is cheap and more efficient, we use it to design the soft starting circuit. Besides IGBT technique there are many technique like AC PWM chopper control technique, thyristor controlled technique, magnetically controlled reactor technique etc.

Basically we compare the normal starting condition and starting using soft starting circuit. The simulation circuit of soft starting and normal starting are given in next section of this paper. We compared the results and waveforms of both the circuits.

SIMULATION CIRCUITS:

1) NORMAL STARTING CONDITION :-

a) NORMAL STARTING CIRCUIT:

We design a simple circuit for studying normal starting of split phase induction motor. The single phase 230 v, 50Hz AC voltage source is given at the input. We observed the output results in scope as shown in the fig1.1 as we can see in fig 1.0 winding current, torque and speed are connected to scope and results are observed.

We simulate the given circuit and certain results are observed as shown in fig1.1

We consider this as a basic circuit for comparing its result with the results of soft starting circuit.

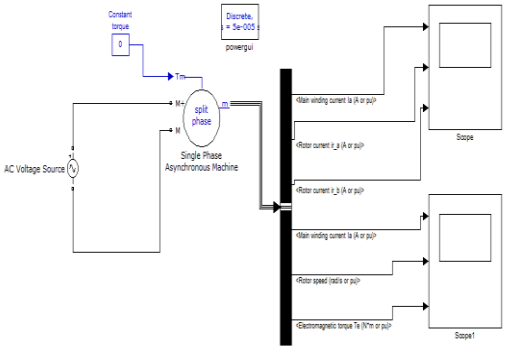


FIG 1.0- NORMAL STARTING CIRCUIT OF SPIM

b) SIMULATION RESULTS:

When we simulate the above given circuit, we got some results which are given in fig. 1.1. As this paper stated earlier the current at starting i.e. inrush current was much more than its rated value. Torque was also higher at starting time of single phase induction motor.

The rated current of the motor is 5 Ampere. As we observed from simulation the starting current was up to 32 A. it means the starting current was actually lies between 5-7 times of its rated current. The resulting values of main winding current, torque and speed are given in waveforms (fig 1.1).

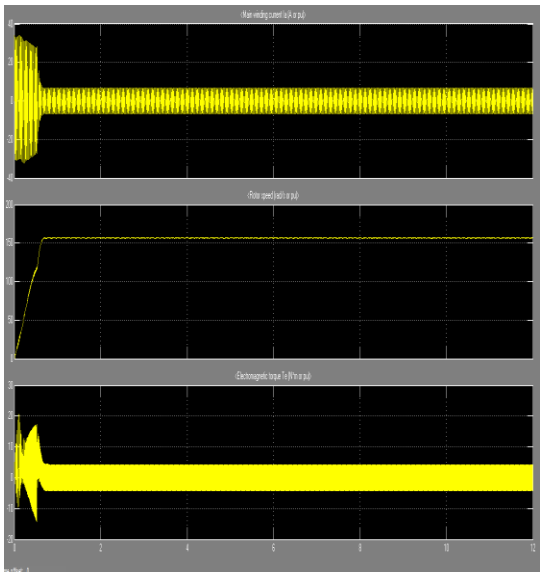


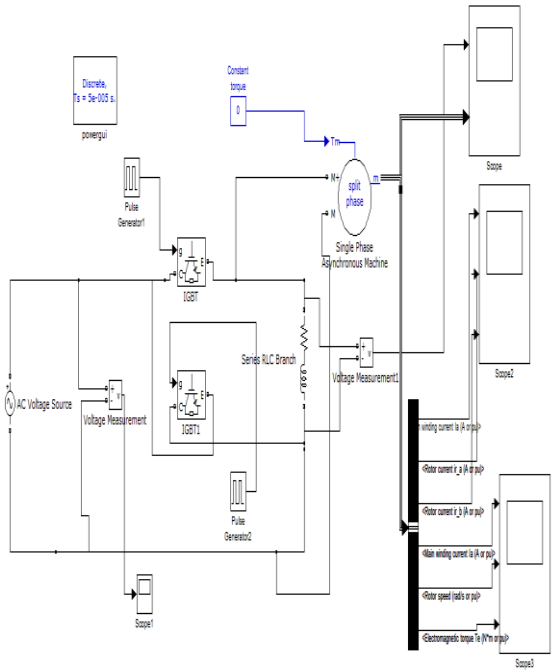
FIG 1.1 – NORMAL STARTING WAVEFORM OF a) MAIN WINDNING CURRENT b) ROTOR SPEED c) ELECTROMAGNETIC TORQUE

2) SOFT STARTING CONDITION USING IGBT TECHNIQUE :-

A) SOFT STARTING CIRCUIT-

We use the IGBT in the following soft starting circuit of single phase induction motor. The gradual increase in voltage will affect the starting condition mainly the inrush current. The below diagram is of soft starter circuit for single phase induction motor using IGBT with R-L load.

The ac voltage regulator connected with single phase ac supply in which insulated gate bipolar transistor is used. The voltage regulator used in circuit is having IGBT. In the diagram two triggering circuits are given which is connected with individual anti parallel IGBT pair. After triggering circuit next section is controlling unit, which will control the regulator circuit output with respect to time. This stable output is then fed as the input for single phase induction motor and R-L load.



CIRCUIT USING IGBT

FIG.1.3 SOFT STARTER CIRCUIT

b) SIMULATION RESULTS:

We simulate the circuit shown in fig 1.2 and got results which are given in the form of waveforms in fig.1.3.We know that this circuit is made for limiting the inrush current and high starting torque. We can now observe that the inrush current is limited up to certain extent. Our main aim was to protect motor from being damaged. Hence the current that we got in this circuit will not harm the windings of motor, because now motor have to face the reduced current.

We can also see the torque which was too high in normal condition is also limited. Now torque increases gradually. Therefore this changes makes our motor more efficient. All this things can be observed from fig 1.3.

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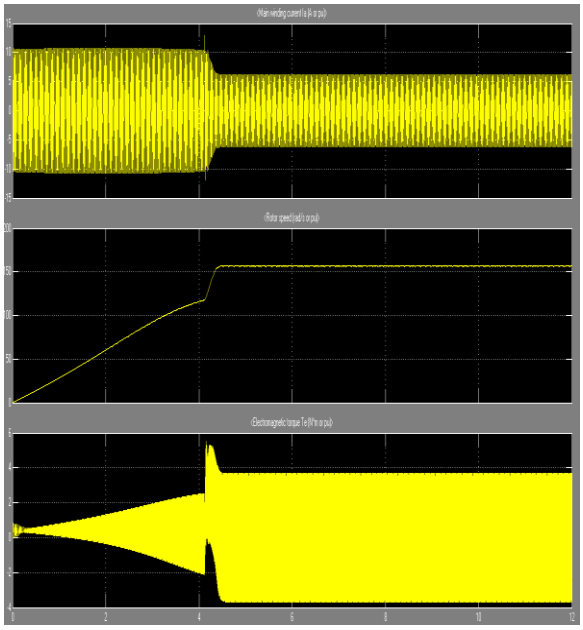

FIG 1.3- SOFT STATER CIRCUIT OUTPUT WAVEFORMS a) MAIN WINDING CURRENT b) SPEED c) TORQUE

CONCLUSION:

Our main objective of this research work was to limit the inrush current up to safety margin (200 % of rated current). At output of soft starting circuit, we got inrush current nearly 200% of rated current which is safer for starting operation of motor. The earlier current was 5-7 times the rated current which is shown in fig.1.1 (i.e. 32-35 A) whereas the rated 5A current is observed in its normal operation.

As shown in fig 1.3, the inrush current is ranging from 10-11A in output of the soft starting circuit. The rated current of our motor is 5 A. it means we have decreased the inrush current up to 70% of its previous value of normal condition.

We compare both the simulation diagram and simulation results. After comparison we achieved what we eyed for. The inrush current is finally limited by giving gradually increased voltage as input to single phase induction motor.

Hence by using IGBT technique we limit the inrush current, so that now motor will become more efficient, this will affect the motor's life span in positive way.

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