

Direct Torque Controlled Induction Motor Drive Using Ansys Maxwell Simplorer

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Abstract: -- This paper presents the Design and Development of Direct Torque Controlled Induction Motor drive using Ansys Maxwell EM Software. In the Proposed technique induction motor is designed and constructed using RMxpert Toolbox and the analyzed based in Finite Element Analysis using Maxwell Toolbox. The obtained model is exported to Ansys Maxwell Simplorer Toolbox in order to perform DTC. In this paper the Simulated results of Torque Response and Current Response are presented.

Keywords:— Induction motor, Ansys Maxwell Simplorer, Direct torque controller.

I. INTRODUCTION

This paper presents the DTC drive of Induction motor is in RMxpert. Induction motor is the most frequently used machines in various electrical drives because of its simplicity, rugged construction [3][5]. This paper presents a direct torque control induction motor drive. DTC uses an induction motor model to predict the voltage required to achieve a desired output torque [2]. By using the voltage and current measurements, it is possible to estimate the instantaneous stator flux and output torque. An induction motor model is then used to predict the voltage required to drive the flux and torque to the demanded values within a fixed time period. Direct torque control (DTC) is one method used in variable frequency drives to control the torque (and thus finally the speed) of three phase AC electric motors. This involves calculating an estimate of the motor's magnetic flux and torque based on the measured voltage and current of the motor [1]. The basic characteristics of DTC is that the positions of the inverter switches are directly determined rather than indirectly, thus refraining from using a modulation technique like Pulse Width (PWM) or Space Vector (SVM) modulation. In the generic scheme, the control objective is to keep the motor's torque and the amplitude of the stator flux within pre-specified bounds. The inverter is triggered by hysteresis controllers to switch whenever these bounds are violated. The choice of the new switch positions is made using a pre-designed look-up table that has been derived using geometric insight in the problem are used. ANSYS Maxwell is the industry-leading electromagnetic field simulation software for the design and analysis of electric motors, actuators, sensors, transformers and other electromagnetic and electromechanical devices. With Maxwell, you can precisely characterize the nonlinear, transient motion of electromechanical components and their effects on the drive circuit and control system design. By leveraging Maxwell's advanced electromagnetic field solvers

and seamlessly linking them to the integrated circuit and systems simulation technology, you can understand the performance of electromechanical systems long before building a prototype in hardware. This virtual electromagnetic lab gives you an important competitive advantage with faster time to market, reduced costs and improved system performance. To analyze a problem, the user specifies the geometry, material properties, sources of energy and boundary conditions. Maxwell 2D is used to solve a motor application (2D transient with motion finite element problem) with the driving circuits being supplied by a simplorer model [6][11]. This paper presents a direct torque control induction motor drive. DTC uses an induction motor model to predict the voltage required to achieve a desired output torque. By using the voltage and current measurements, it is possible to estimate the instantaneous stator flux and output torque. An induction motor model is then used to predict the voltage required to drive the flux and torque to the demanded values within a fixed time period. The basic schematic diagram of classical direct torque control strategy of induction motor in which there are two different loops corresponding to magnitudes of stator flux and torque provided.

II. SIMULATION OF DTC INDUCTION MOTOR USING ANSYS MAXWELL SIMPLORER

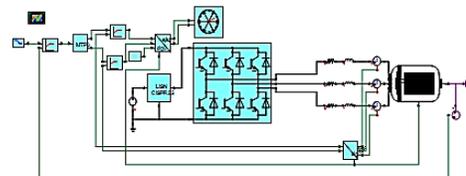


Fig 1.DTC Induction motor using Ansys Maxwell

Simplorer is a multi-domain simulation software program that enables engineers to model, simulate, analyze and optimize complex systems including electromechanical, electromagnetic, power and other mechatronic designs. Using Simplorer powerful modeling features and communication backplane technology, engineers are able to construct virtual prototypes of all aspects of a system including the electronics, sensors/ actuators, motors, generators, power converters, controls and embedded software [4] [5]. This enables engineers to investigate system functionality and performance and to verify overall design. The result is a dramatic reduction in development time and cost, increased system reliability and performance optimization.

III. MAXWELL DESIGN OF IM

In this paper induction motor is designed in RMXprt and then exported in the Maxwell design software for DTC controlled induction motor. In this paper three phase, 440v, 4 poles, 7.5KW, 1440 rpm Induction motor is designed using Ansys Maxwell Software. The machine design tool to perform a detailed motor analysis based on Finite Element method(FEM) [7]. Firstly, the machine geometry is created in the RMXprt in design similar to the three phase induction motor. This shows that the RMXprt machine model depicts the similar behavior which is close to the real motor. Thereafter, the machine model created in RMXprt is exported to ANSYS RMXprt/Maxwell is shown. By using Ansys Maxwell Simplorer DTC controlled Induction motor drive are modeled and simulated.

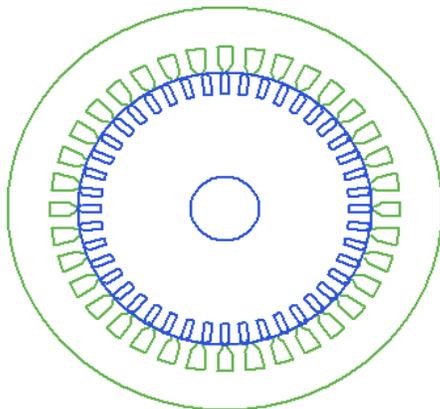


Fig 2.DTC Induction motor

The frame of the stator and rotor are shown in fig 2.where the stator is highlighted in green color and rotor in blue [8] [9]. In Maxwell, there are options available for exposing the RMXprt design in to Maxwell 3D design for future specific analysis

where there is a need to specify from the boundary values, this allow us to analysis complex design by reducing symmetrical portions [10].

IV. INDUCTION MOTOR 2-D MODEL

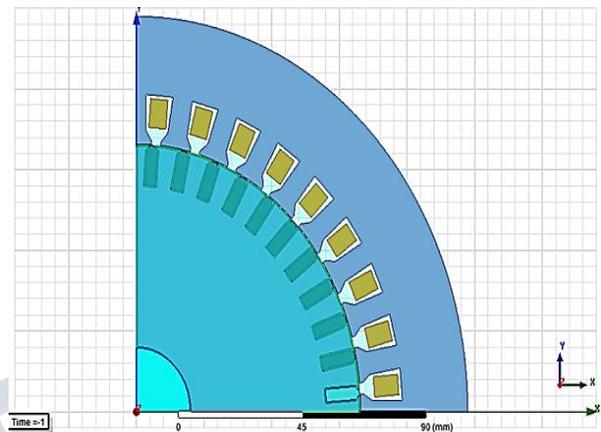


Fig 3. Induction motor 2-D Model

V. PERFORMANCE ANALYSIS DTC CONTROLLED IM

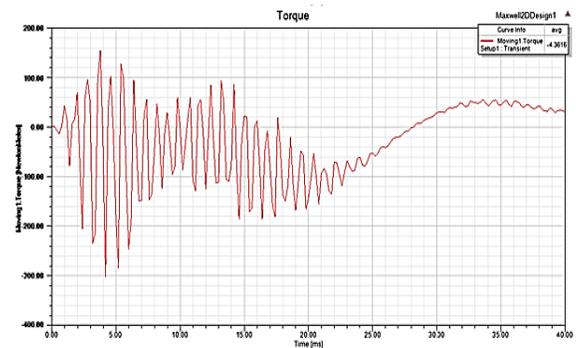


Fig 4.Torque Response of DTC controlled Induction motor

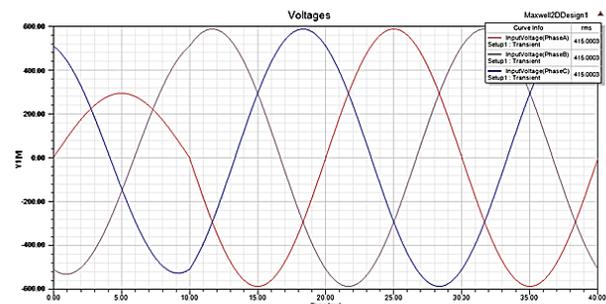


Fig 5. Voltage Response of DTC controlled Induction Motor

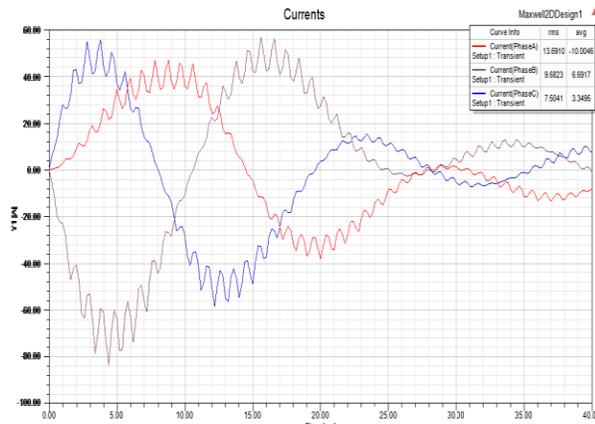


Fig 6. Phase Current Response of DTC

VI. CONCLUSION

In this Paper, the Designing of Induction motor in Ansys maxwell. An induction motor with 36 slots and 4 poles is designed in RMxprt Simulation Results are presented.. Finite element analysis simulation results confirm that the designed motor can achieve a high efficiency of 93%. Speed of induction motor was controlled by Direct Torque Control method. Switching losses are less. It is more preferable for Industrial application.

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