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Matrix Converter Fed Induction Motor Drive for Smooth Operation

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Abstract: This paper a new technique of converter called matrix converter which supplies the induction motor for a smooth operation. Conventionally, the different type of multi-level inverters is used to feed the induction motor which is used in EVs where there are lot of torque ripples in the machine. Replacing the Multi-level inverters with a matrix converter, there is a very smooth operation under load and no-load conditions. The simulation results of the method are presented.

Keywords: Matrix Converter, Induction motor drives, ripples, Multi-level inverter

I. INTRODUCTION

In the modern research era, Induction motors has become a very superior motor in high performance servo applications and EVs, because of its properties such as less weight, high efficiency, fast dynamic response, low rotor inertia, high-power factor, high torque inertia ratio and compact structure [3]. Earlier Scalar based control techniques which controls only magnitude are used to control the speed of PMSM and Induction motor drives. Some of the Scalar based control techniques are Voltage control, Rotor Resistance Control and V/F method. But when scalar-based control is used the motor acts as a non-linear motor and has very sluggish and slow response. Scalar Control has high transient time and takes huge time to settle down [8]. Field oriented control (FOC) scheme is used to improve the characteristics of the motor to reduce the order of torque equation [1]. The Implementation of FOC is difficult but the performance is good when compared to other techniques [2]. Hence, Steady state response has better characteristics if FOC is used, Dynamic response is better is characteristics if DTC (Direct Torque Control) is used [4],[5]. Therefore, DTC includes high torque ripples in steady state response. The field-oriented control has two closed loops which are of current and speed. The concept of PWM inverter used in the paper can also be replaced with a Multi-level DC link inverter with reduced switch count which reduces the number of heatsinks and gate driver circuits [6]. A ten-switch topology UPQC connected for AC machines can also reduce the switching losses [7]. Due to some potential advantages of Space vector pulse width modulation (SVPWM) technique it is widely used in the area of motor speed control [8], they are constant switching frequency of the inverter, small distortion in current waveform and reducing torque ripples [9]. Now-a-days the direct torque control is implement on AC machines without sensors and decoders given in [10]. An Asymmetrical MLI topology can also be used to drive the PMSM drives [11]. A nearest level control scheme is widely used method for multi -level inverter to drive PMSM [12]. The concept used in this paper is matrix converter fed induction machine.

II. PROPOSED METHOD

The proposed method to drive the Induction Machine is shown in fig.1. The three-phase input voltage of each phase 100V is given to the matric converter which generates an output voltage with the matrix switching logic. The generated three phase voltage is given to the induction motor.

The Sequence of switching is same the sequence of the switching used in the space-vector PWM technique. To generate the sequence of switching, the current modulation and voltage modulation technique is used as shown in the fig.1. The three phase VI measurement block is used to measure the voltage and currents at the Input and the output. The model is verified with both steady state and dynamic behaviour under loaded and unloaded conditions. The proposed model has fast dynamic behaviour and smooth operation under loaded conditions. The current waveform of the stator of the Induction motor is purely sinusoidal hence the machine is free from harmonics and heating due to harmonics.

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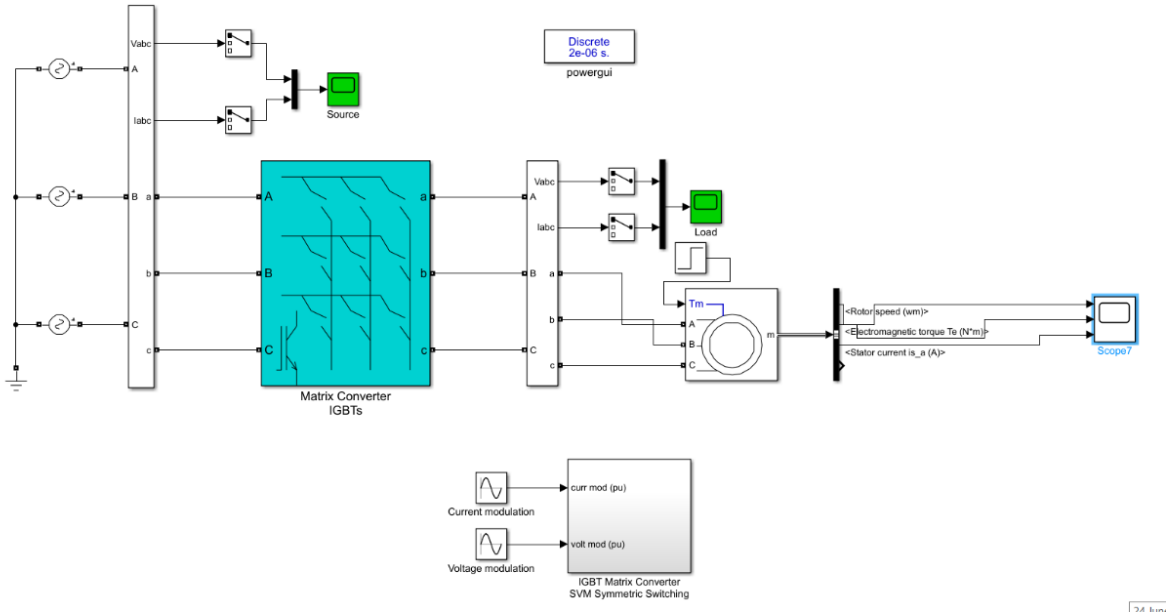

Fig.1 Proposed Circuit Diagram

III. SIMULATION RESULTS

The Speed, torque and stator current waveforms under steady state operation when the motor is operated at the speed of 185 rad/s is shown in Fig. 2. The torque ripples are very low as shown in the fig.2

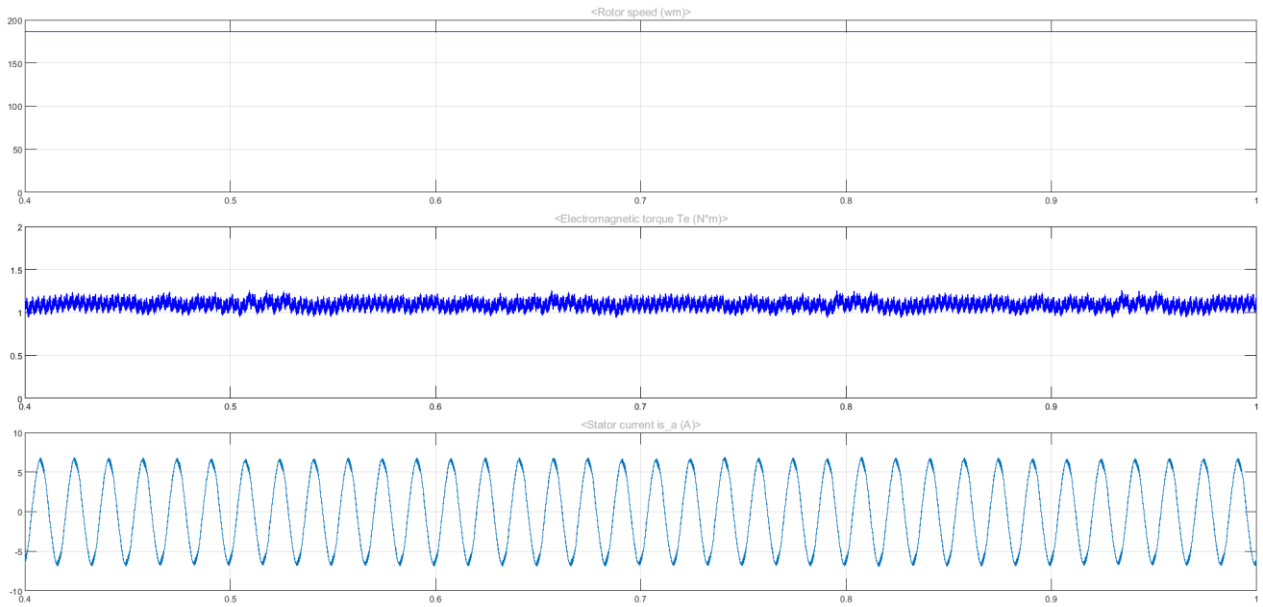

Fig.2 Speed, Torque and Current Waveforms for No load conditions of Induction Machine

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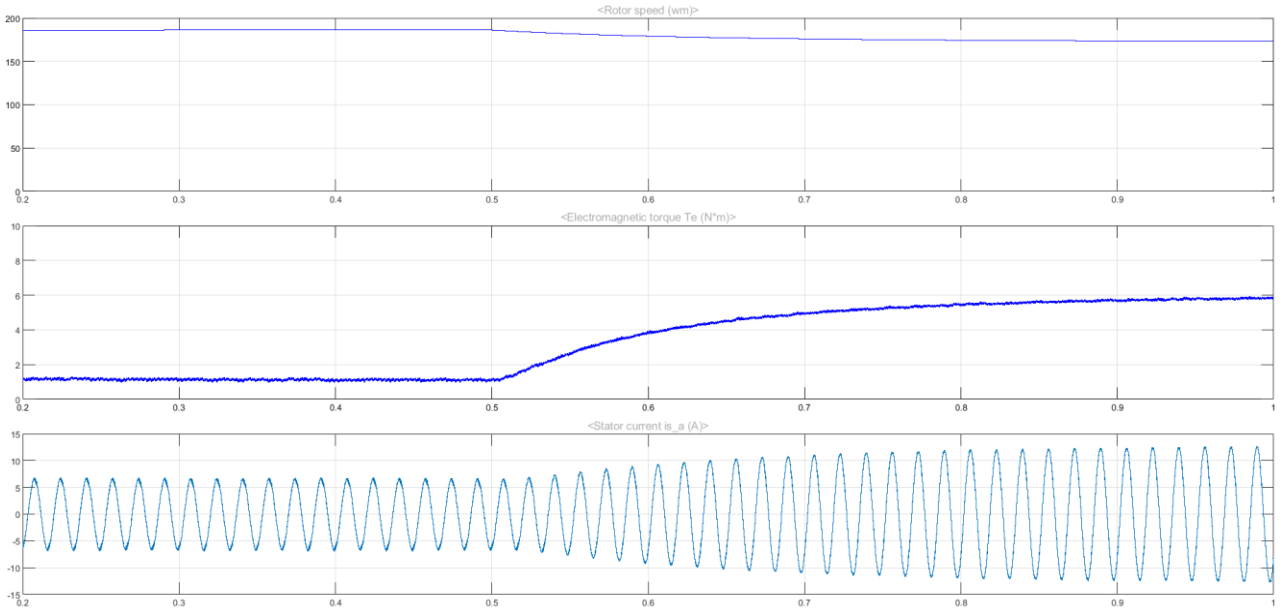

Fig.3 Speed, Torque and Current Waveforms of Induction Machine for load change of 5Nm at 0.5sec

The Speed, torque and stator current waveforms under loading operation when the motor is operated at the speed of 185 rad/s is shown in Fig. 3. The torque ripples are very low and there is a sudden change applied of 5Nm load at 0.5secs

IV. CONCLUSION

The paper deals with Matrix converter-based induction motor drive. Generally, the Induction motors used in EVs are subjected with high torque ripples. But here matrix converter is used to avoid that condition. The ripples are very low in Induction motor torque and speed waveform is very smooth

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