

A PV FED Three Phase Switched Z-Source Multi Level Inverter for Induction Motor Drives

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ABSTRACT

Generally induction motor drives possess higher harmonic contents in line voltage and current due to high switching frequency used in inverters. Conventional induction motor drives employ two level voltage source inverters which have THD in level of 50%. This paper presents a switched z-source multilevel inverter which has voltage boosting capability and has lesser THD level in comparison with conventional two level voltage source inverters. This drive is fed from a photo voltaic source because of its voltage boosting capability. A single phase five level switched z-source inverter is initially designed and considered as single cell and three such cells are created for powering three phase induction motor. The proposed three cell PV source switched z-source multilevel inverter for three phase induction motor is simulated in MATLAB/Simulink software to verify merits of proposed IM drive.

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1. INTRODUCTION

THREE-PHASE induction motors have been considered one of the most commonly used electric machines in industrial applications due to their low cost, simple and robust construction. Three-phase inverters are considered an essential part in the variable speed AC motor drives. Previously, the traditional six-switch three-phase (SSTP) inverters have been widely used in different industrial applications. A switched z-source multilevel inverter which has voltage boosting capability and has lesser THD level in comparison with conventional two level voltage source inverters. This drive is fed from a photo voltaic source because of its voltage boosting capability. A single phase five level switched z-source inverter is initially designed and considered as single cell and three such cells are created for powering three phase induction motor.

Problem Description

Conventional two level voltage source inverter exhibits higher THD in output voltage and current waveform when fed to three phase induction motor. Three induction motor is a pure inductive load which adds certain order harmonics to voltage irrespective of harmonics from VSI.

Background

[1] Presents a PV powered drive with high motor performance because solar is a power source extracting power from solar is a difficult job hence inverter circuit and controller must be chosen for compensating such disadvantage from PV source. Literature [2] shown a single phase three level multi level inverter for centrifugal pump applications fed from a photo voltaic source. THD should be reduced in order to avoid acoustic noise of motor, reducing THD enhances power quality of line [3]. Literature [4-5] proposed

a PV based Z source inverter for variable speed induction motor drive applications. It uses a space vector based approach for pulse generation of inverter; sector selection algorithm is implemented in space vector approach. In this paper described that the PV inverter topology it is a high efficiency topology [6]. Firefly algorithm is presented in this paper in this algorithm used to generate the reactive power [7]. Predictive Direct Power Control (PDPC) of Grid-Connected Dual-Active Bridge Multilevel Inverter is explained in [8]. Proportional Integral Estimator of the Stator Resistance for Direct Torque Control Induction Motor Drive is discussed in [9]. Comparison Performances of Indirect Field Oriented Control for Three-Phase Induction Motor Drives is presented in [10]. Sensor less Control of BLDC Motor using Fuzzy logic controller for solar power Generation is discussed in [11].

2. PROPOSED SWITCHED Z-SOURCE MULTILEVEL INVERTER DRIVE

Figure 1 shows overall block diagram of proposed induction motor drive using switched-source multi level inverter. Initially single phase photovoltaic powered switched inductor z-source inverter is implemented which is termed as single cell or unit. Three such cells are formed for feeding three phase induction motor. The proposed drive is implemented in closed loop using speed pi controller, pi controller response controls the modulation index of sine carrier PWM. Three phase sine wave is generated and product with pi response and compared with level shifted multi carrier triangular wave to generate PWM for switches used. Single PI controller is used in closed loop which is easier of tuning because achievement of voltage level and speed performance is also considered. If multiple pi controllers involved in closed loop it will make system tuning complex.

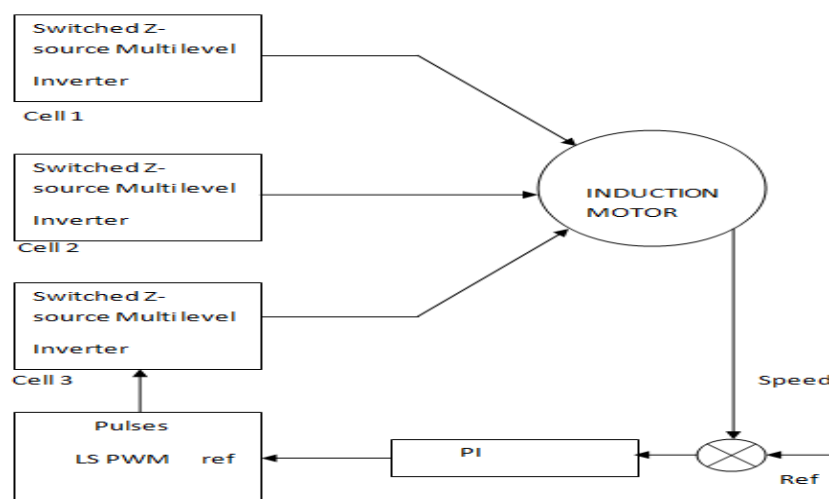


Figure 1. Block Diagram of proposed system

3. SIMULATION RESULTS AND DISCUSSION

Three phase switched z-source multi level inverter powered from photo voltaic source is implemented in Simulink and results are discussed in this section. Figure 3 shows Simulink implementation of proposed switched z-source multilevel inverter fed induction motor drive.

Table 1. Simulation parameters

Motor Parameters	
Stator Resistance Rs	0.09961 ohms
Stator Inductance Ls	0.000867 H
Rotor resistance Rr	0.05837 ohms
Rotor inductance Lr	0.03039 H
Mutual Inductance Lm	0.000867 H
Inertia J	0.4
Pole pairs	2

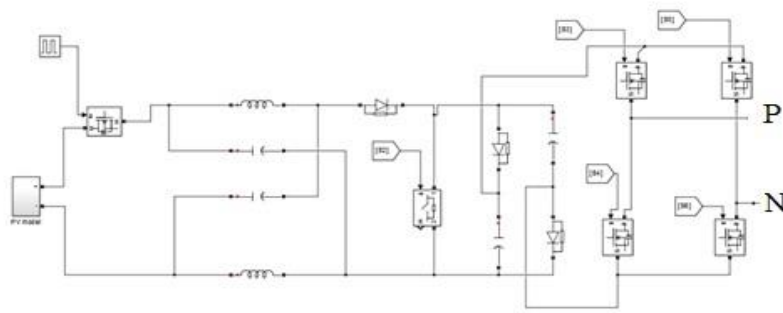


Figure 3. Circuit Diagram of Single Cell of Switched Z-Source Multilevel Inverter

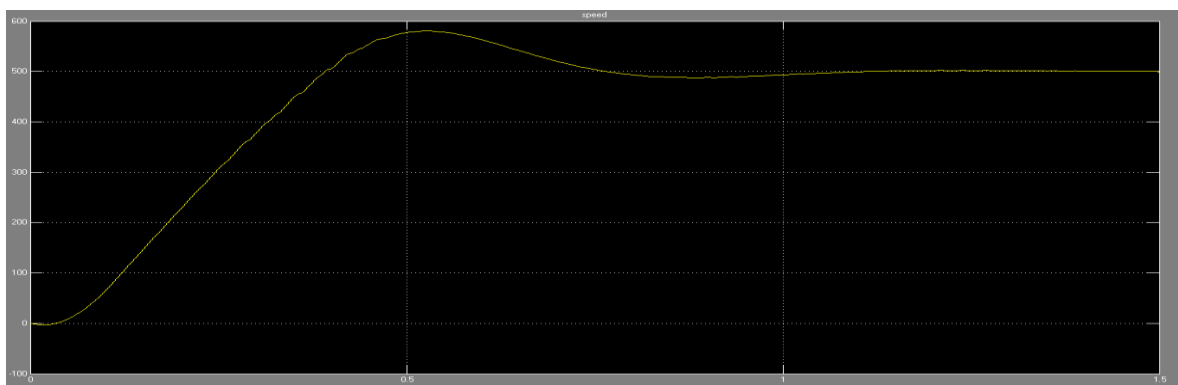


Figure 4. Speed Response of Proposed Scheme

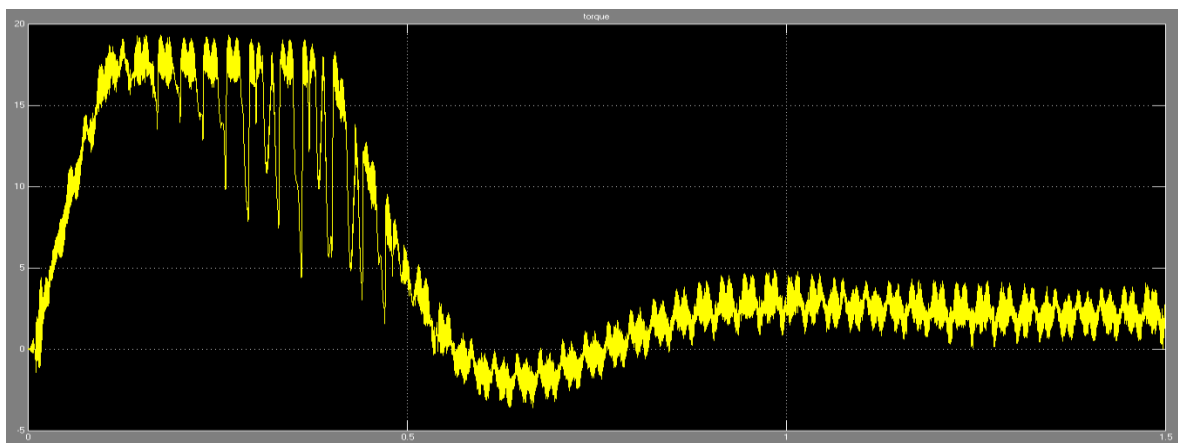


Figure 5. Torque Response of Proposed Scheme

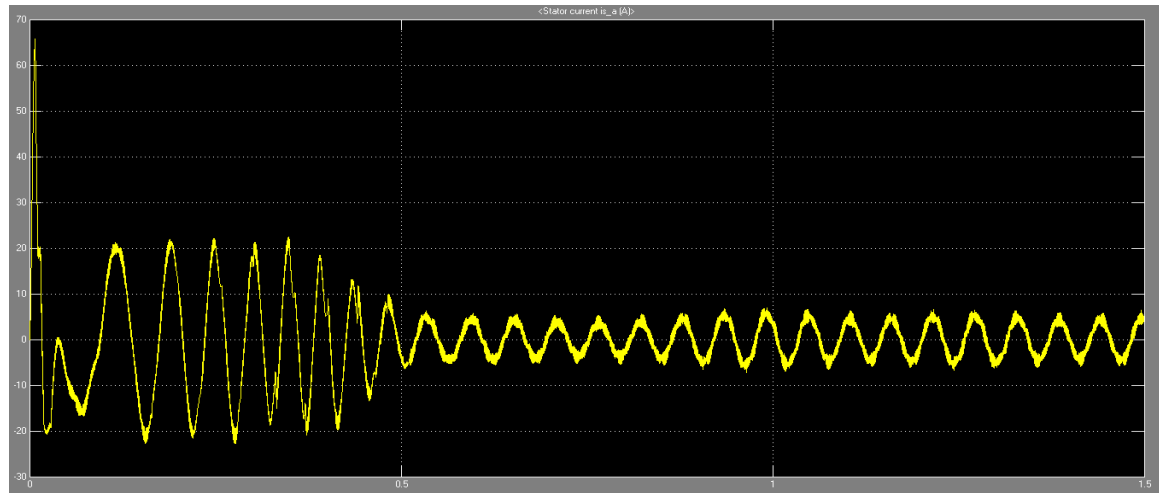


Figure 6. R Phase Stator Current of IM

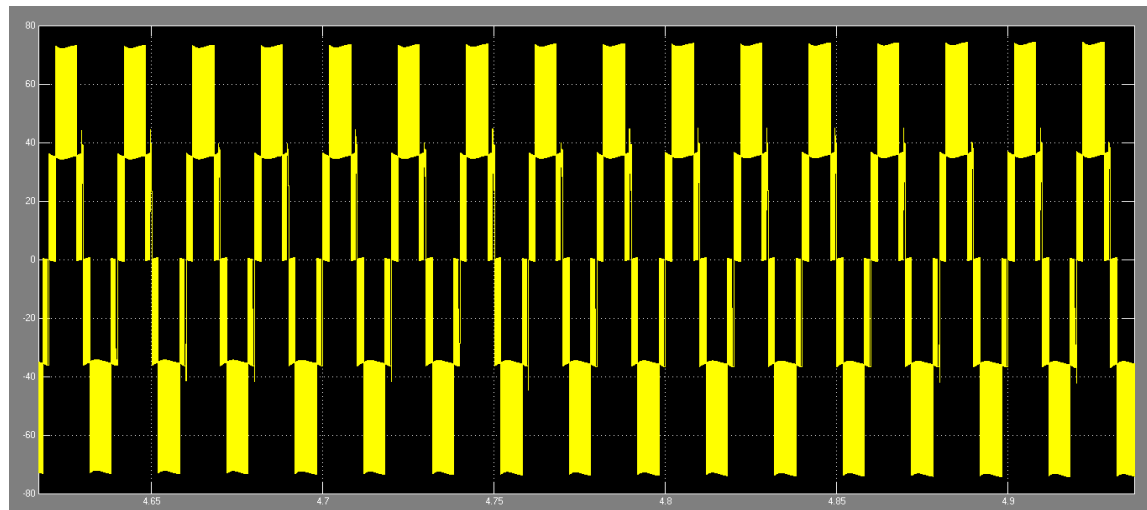


Figure 7. R Phase Stator Voltage of IM

Figure 4 shows speed response of proposed drive for reference speed of 500 rpm and corresponding figures from 5-7 shows performance of induction motor such as electromagnetic torque, stator current and line voltage when fed from switched z-source multilevel inverter circuit.

Table 2. THD Comparison of Proposed Scheme

THD Comparison	
THD of MLI without LC filter R-load	20%
THD of MLI with LC filter R-load	4%
THD of MLI without LC filter IM	30%
THD of MLI with LC filter IM	8%

4. CONCLUSION

This paper presented a new switched z-source multi level inverter for three phase induction motor drive. The proposed topology is simulated using MATLAB software and results shown in previous section verifies the merits of proposed scheme.

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