Solar Based Variable Speed Five Phase Induction Motor With RTIO Implementation

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***Abstract*— This paper presents the solar based variable speed five phase induction motor using RTIO board. The variable speed control is done with the help of pulse width modulation using MATLAB/SIMULINK. Five phase induction motor is advantageous than three phase as it provides lower torque pulsation, higher power, higher torque density, lower current ripple and stability. Sinusoidal Pulse Width Modulation is implemented in the speed control of five phase Induction Motor. The DC Source is the supply from solar panel. It is given to the five leg inverter. The gate of the inverter is driven by the waveforms generated in MATLAB/SIMULINK and is interfaced to inverter by RTIO (Real Time Input Output) board. The five phase supply is then given to the motor. Thus the Solar powered five phase induction motor drives are more variable, better efficiency and performance when compared to fixed frequency motor drive**

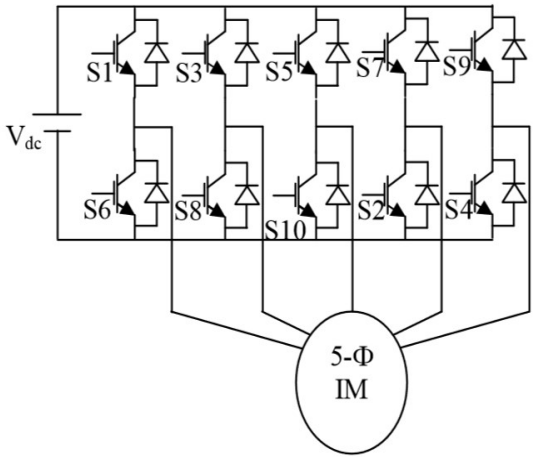
Keywords*— *five phase induction motor; Pulse Width Modulation ; RTIO (Real Time Input Output).

I. INTRODUCTION

Three-phase induction machine in industries are mostly used for speed control. For speed control ac drives are used which require a power electronic converter for their supply ,therefore number of machine phases is effectively unlimited. Motors with phase numbers greater than the traditional three possess certain advantages over their three-phase counterpart [Levi (2008)]. Early interest in multi-phase machines was caused by the need to reduce torque pulsations developed by inverter-fed three-phase drives. The first investigation into the use of a multi-phase machine within a variable speed electric drive was carried out by Ward and Harer (1969). Whenever Three-Phase Induction Motor is in running condition, there is a problem with ripple torque & harmonics. The ripple content can be smoothened by supplying the motor with multi phase supply greater than three phase supply. Selection of even number of phases should be avoided, because it degrades the performance of motor as poles coincide with each other.
Five-Leg Inverter is a converter converts DC to variable AC. Output of the five leg inverter is controlled by PWM control technique method. It is highly economical, has more Efficiency and good controllable. Five phase induction motor is advantageous than three phase as it provides lower torque pulsation, higher torque density, fault tolerance, stability and lower current ripple. Along with a renewable energy source, the application is limitless. With further advancements in power electronics we can have various applications such as propulsion, vehicles etc.

II. VOLTAGE SOURCE INVERTER

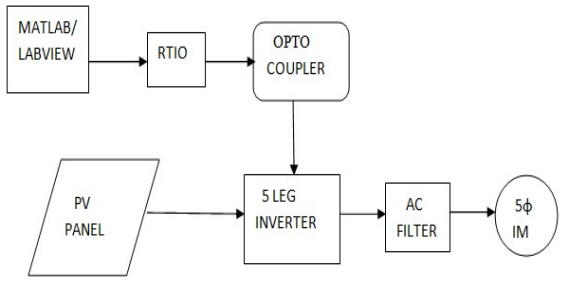
The basic power circuit topology of five phase VSI is shown below. IGBT is used as the power switches. The anti parallel diodes provides reverse current path such that when a particular IGBT is gated on, one output terminal and one input terminal will be connected. In multiphase inverter we can generate n number of phase, as each leg of the inverter represent the phase, thus by increase the number of leg in the inverter we can increase the number of phases. For the five phase motor we require five leg inverter. The input to the inverter is a dc supply. In five phase inverter three switches from the upper switches and two from the lower switches are turned on at a time and vice versa. The two switches which form the leg of the inverter are complimentary to each other, for example when switch S1 is on Switch S6 is off so as to avoid short circuit.



III DRIVE CONTROL SCHEME

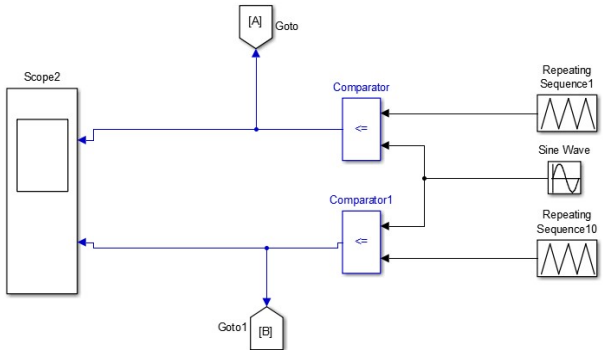
The DC Source is the supply from solar panel. It is given to the five leg inverter. The gate of the inverter is driven by the waveforms generated in MATLAB/SIMULINK and is

interfaced to inverter by RTIO (Real Time Input Output) board. The voltage generated from the software will be around 3.3V to 5V. That voltage cannot be used to run the gate circuit of the inverter. So in order to that we first interface with the RTIO which is a Real Time Input Output board.



This allows the better performance for the inverter and it is given to the isolator which increases the voltage as needed by the gate of the inverter circuit. The sinusoidal pulse width modulation is implemented in the software in order to get the best waveform without distortion. The five phase supply is then given to the motor.

There are different pwm techniques like delta, delta sigma, sinusoidal etc. Generally Sinusoidal pulse width modulation (SPWM) technique is used to generate the pulses to power electronic switch. The following is the MATLAB/SIMULINK Model for Pulse width modulation.



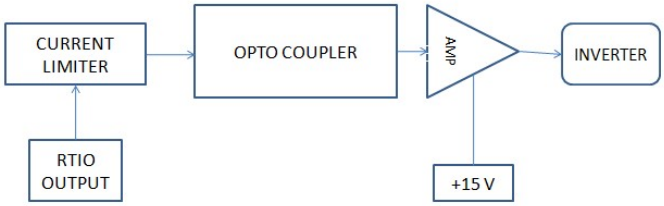
IV. ISOLATOR

The HCF4049UB is a monolithic integrated circuit fabricated in Metal Oxide Semiconductor technology. It is an inverting Hex Buffer/Converter and feature logic level conversions using only one supply voltage (VDD). The input high level signal can exceed the VDD supply voltage when these device are used for logic level conversions.

The features are

■High To Low Level Logic Conversion
■High "Sink" And"Source" Current Capability
■Quiescent Current Specified Up To 20V
■ 5V, 10V AND 15V parametric ratings
■ Input Leakage Current = 100nA (MAX) AT VDD = 18V T A = 25°C.

The block diagram for the isolator is below



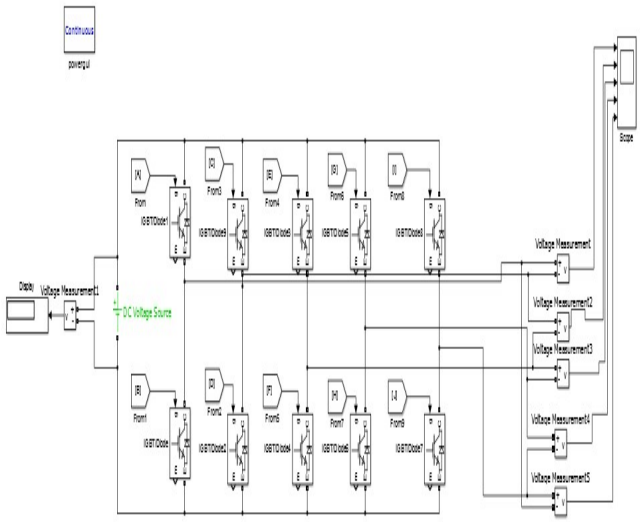
V. RTIO

RTIO provides complete Power Electronics and control .
RTIO Controller Generates the proper switching patterns to control the motor's motion based on feedback and motion profile information from the host directly from MATLAB/SIMULINK/LABVIEW. RTIO Gate drivers Generate the necessary voltage and current required to accurately and efficiently drive the MOSFETS or IGBTs Power stage. RTIO also provides IGBTs or MOSFETS Sensing Analog circuitry which processes/conditions the feedback from the motor to control torque , speed or position
The features of RTIO are
1. 32 Channel Real time Digital IO's for driving PWM signals with update rates up to 10MHz.
2. 20 Analog Channels that can be configured as ADC's or DAC's. Its superior flexibility of configuring and channel as Analog Input or Output makes very flexible for testing with Real-time hardware in the loop. Real time load voltage and current waveforms are typically fed to these Analog IO's for Field Oriented Control of Motors. Typically Motor Speed, Torque can be controlled in closed loop allowing Vector and scalar control.
3. 12 Channel GPIO's for auxiliary signal monitoring and controls.
4. Dual temperature sensors.
5. 400KHz to 10MHz programmable clock.
6. Direct Link with USB connection.

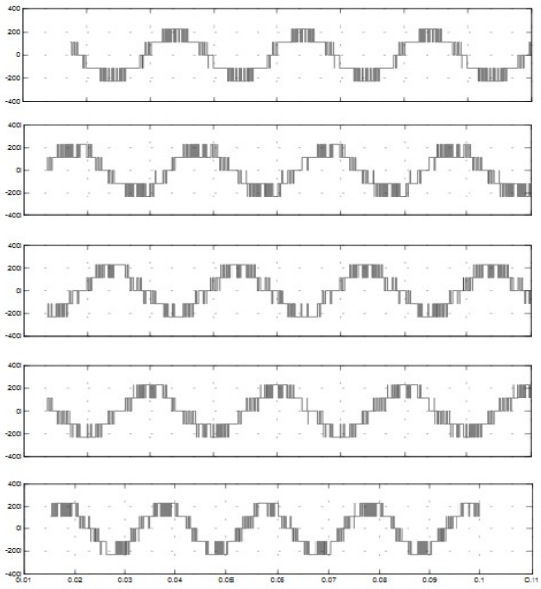
VI. SIMULATION RESULITS

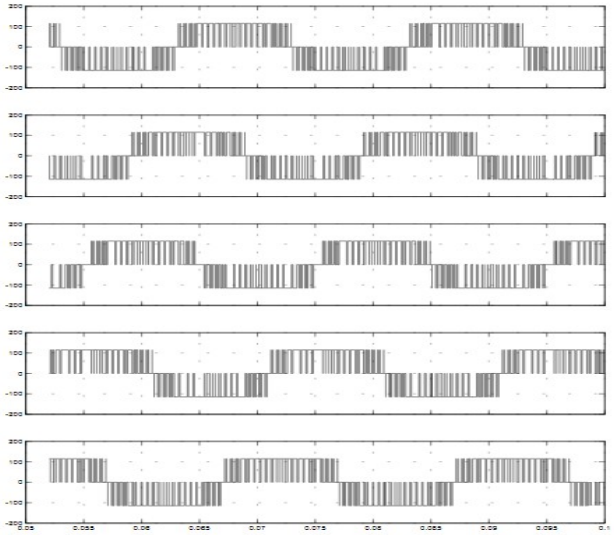
The simulation is done using Matlab / Simulink. The model for the classical inverter, five phase inverter based on PWM switching technique and the proposed technique has been developed. The basic operating principles of the five-phase VSI are developed in at any instant in time there are five switches that are 'on' and five switches that are 'off'.

Assuming the ideal commutation and zero forward voltage drops. Each switch is assumed to conduct for 180°, leading to the operation in the ten-step mode . Phase delay between firing of two switches in any subsequent two phases is equal to 360°/5 = 72° shown in below Figure



The simulation waveforms obtained are given below in the following figures





VII . CONCLUSION

This paper presents a complete simulation model to simulate a five-phase induction motor drive system using RTIO. Sinusoidal Pulse Width Modulation is implemented in controlling the gate circuit of the five phase inverter. The Solar powered five phase induction motor drives are more variable, better efficiency and performance when compared to fixed frequency motor drives

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