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Permanent Magnet Synchronous Generator Based Wind Energy Conversion System with Grid Connected NSPWM-ZSI


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ABSTRACT:

A Z-source inverter based grid-interface for a medium power wind turbine connected to a permanent magnet synchronous generator is proposed. A control system is designed to harvest maximum wind energy under different wind conditions with the use of a permanent magnet synchronous generator, a diode-rectifier and a Z-source inverter. ZSI have been recently proposed as an alternative power conversion concept as they have both voltage buck and boost capabilities. There is an increasing trend of using space vector PWM (SVPWM) because of their easier digital realization, reduced harmonics, reduced switching losses and better dc bus utilization. This project focuses on step by step development of NSPWM implemented on a grid connected ZSI in WEC application. Simulation results are obtained using MATLAB/SIMULINK environment shows effectiveness of this technique in reducing harmonic content in grid injected voltages.

Keywords:

Z Source inverter (ZSI), Near state (NSPWM), PMSG,.

I.INTRODUCTION:

Differential heating of the earth's surface by the sun causes the movement of large air masses on the surface of the earth, i.e., the wind. Wind energy conversion systems convert the kinetic energy of the wind into electricity or other forms of energy. Wind power generation has experienced a tremendous growth in the past decade, and has been recognized as an environmentally friendly and economically competitive means of electric power generation. Worldwide development of wind energy expanded rapidly starting in the early 1990s.

The average annual growth rate from 1994 to 2001 of the world installed capacity of wind power is 31%, making the wind industry one of the fastest growing. Unlike the last surge in wind power development during 1970s and early 1980s which was due mainly to the oil embargo of the OPEC countries, the current wave of wind energy development is driven by many forces that make it favorable. These include its tremendous environmental, social and economic benefits, its technological maturity, the deregulation of electricity markets throughout the world, public support and government incentives. Among the available renewable energy sources, the wind energy and the solar energy are the most mature technologies for power generation. The main advantage of renewable energy is that it is clean and inexhaustible. But the major disadvantage is that it is interim in nature and depends on seasonal pattern.

Therefore it is difficult to operate the power system only with renewable energy due to their characteristic difference and their uncertainty of availability In fact renewable energy sources help in reducing about 70 million metric tons carbon emission per year that would have been produced by fossils fuels. In recent years, the electrical power generation from renewable energy sources, such as wind, is increasingly attraction interest because of environmental problem and shortage of traditional energy source in the near future. Among various types of energy sources wind energy is fastest growing renewable energy sources. Now-a-days, the extraction of power from the wind on a large scale became a recognized industry. It holds great potential showing that in the future will become the undisputed number one choice form of renewable source of energy This paper present a grid connected configuration of PMSG based wind energy conversion system utilizing Z-source inverter with near state PWM technique.

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II.WIND TURBINE- GENERATOR:

Several techniques are used to converter wind energy in to electrical energy. The most popular and largely used is based on induction generator (IG), this system is relatively simple and don't cope with new grid codes, however double fed induction generator system is more complicated and offers more advantages as for exchange of active and reactive power with the grid and fulfillment with grid codes. Permanent magnet machines are today manufactured up to a rated power of above 6MW They are more efficient than the conventional synchronous machine and simpler because no exciter is needed In order to converter wind energy to the, many technologies of converter are investigated the simpler is small size permanent magnet generator associated with diode rectifiers.

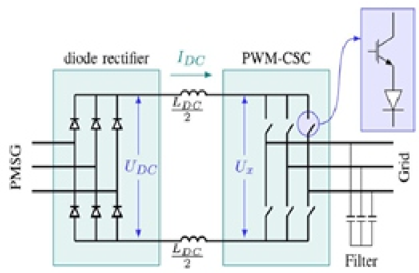

Fig1. Circuit diagram Converter set.

The wind energy conversion system considered under study is 3 MW along with a three phase PMSG. The generator is connected to a diode rectifier allowing an optimal power extraction by the use of adaptive MPPT controller. A PWM inverter ensures the injection of the produced power to the AC grid. Between the two converters, a capacitor is used as a voltage DC bus. The system is connected to the grid via a filter to improve the current quality.

III.NSPWM TECHNIQUE-ZSI:

Current fed Z-Source inverter, exhibiting both buck and boost capabilities, has been presented advantageous for overcoming the barriers and limitations of traditional VSI & CSI. As the additional LC impedance network, ZSI beneficially utilizes the shoot through states to boost the dc bus voltage by gating on both the upper and lower switches of a phase leg. In this way, it can buck and boost to a desired output greater than the available DC bus The introduction of Z-Source network provides a reliable, highly efficient and low-cost structure for buck and boost power conversion. For these reasons, the ZSI is well suitable for wind power systems due to the fact that the wind turbine output power varies widely along with wind speed changes.

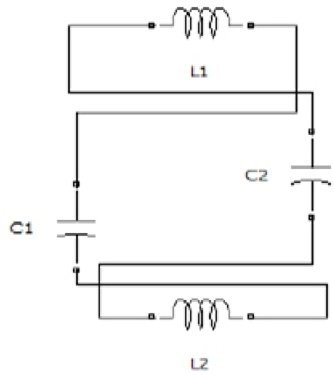

Fig.2 Impedance network

The near state PWM (NSPWM) algorithm uses a group of three neighbor voltage vectors to construct the reference voltage vector. In order to reduce the common mode voltage variations, the proposed NSPWM algorithm did not use the zero voltage vectors. These three voltage vectors are selected such that the voltage vector closest to reference voltage vector and its two neighbors are utilized in each sector. Hence, the utilized voltage vectors are changed in every sector. As shown in Fig. 3, to apply the method, the voltage vector space is divided into six sectors. Here also, as all six sectors are symmetrical, the discussion is limited to the first sector only. For the required reference voltage vector, the active voltage vectors (V1, V2 and V6) times can be calculated as in The total number of commutations in SVPWM algorithm is three in a sampling time interval, where as the number of commutations in NSPWM algorithm is two. Hence, the switching losses of the associated inverter leg are eliminated. Hence, the switching frequency of the NSPWM algorithms is reduced by 33% compared with SVPWM algorithm.

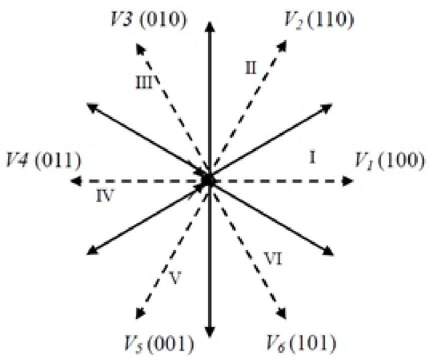

Fig.3 Possible voltage space vectors and sector definition in NSPWM algorithm

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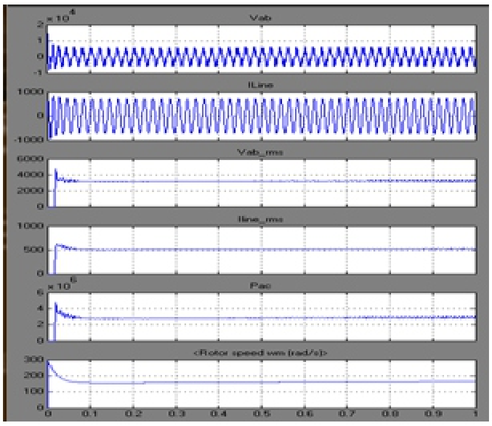
IV.SIMULATION RESULTS:

The proposed system is analyzed virtually using MATLAB/SIMULINK software. The analysis is carried out in two parts, one as steady state response of the system where the steady state quantities like power, voltages, currents & power factor are calculated. Then the dynamic performance of this system is tested under a three phase fault at grid side.

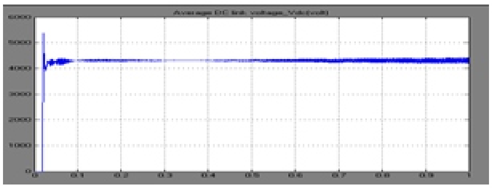
S.No	SYSTEM ELEMENTS	PARAMETERS
1	Wind Turbine	Horizontal axis 3-blade turbine, Vw=12m/sec; 3.2MW, R=40m
2	Generator	PMSG with 96% efficient; 3MW
3	Rectifier	Full bridge diode rectifier, Rs=0.1Mohm, Cs=inf
4	DC Link Impedance	L1=L2=1mH C1=C2=100uF
5	Inverter	IGCT based, 3-arm, 6-pulse Carrier frequency=10KHz Sampling time=2usec
6	Filter capacitors	3-Ph start-GND 900uF/ph capacitor bank
7	Power transformer	3MVA, 1.6/13.2KV, 50 Hz, delta/Y
8	Grid ratings	3-Ph, 13.2KV, 100MW, 50Hz
9	PI controller	Kp=3; Ki=1

1.Wind Turbine parameters:

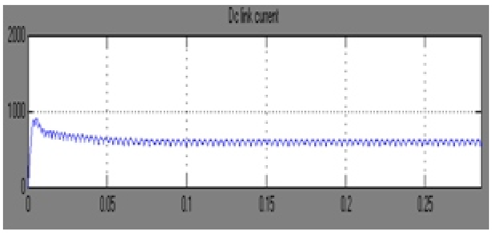
2.Generator parameters:



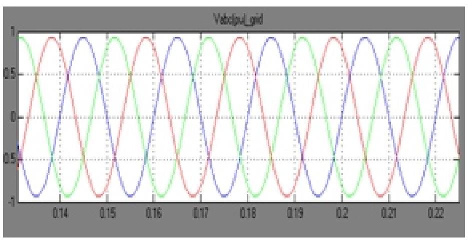
3.DC link voltage:



4.DC link Current:

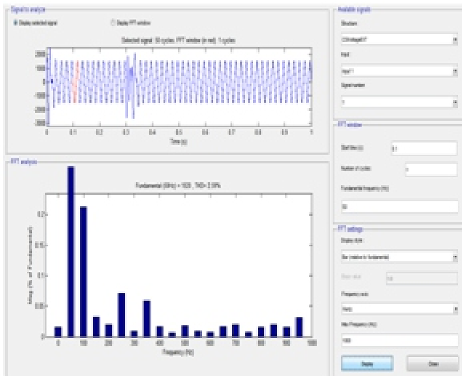


5.Grid voltages:

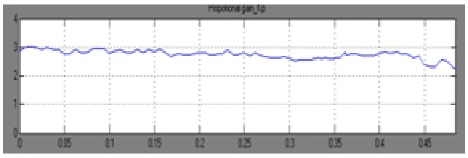


Power factor of inverter output PF=0.998

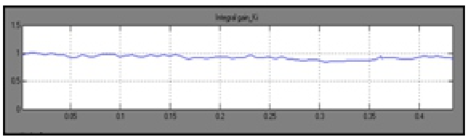
6.Harmonic content in grid injected voltages



7.Kp



8.Ki



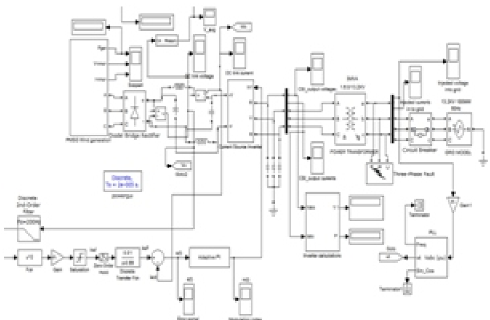


Fig 4: SIMULATION CIRCUIT DIAGRAM

V.CONCLUSION:

In this paper, ZSI-NSPWM is been implemented for grid connected PMSG based wind turbine. This technique gives better quality in the voltage generated with reduced switching losses of 33%, which is proved by measuring THD using FFT. Results are validated through simulation study employing MATLAB/SIMULJINK.

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VII.Author's Profile:

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