A NOVEL VOLTAGE STABILITY FOR UTILITY GRID BY USING SEPIC CONVERTER

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Abstract: A wind energy conversion system employing *dq* control has been proposed for extracting maximum power from a wind-driven PMSG feeding and feeding it to a three-phase utility grid. It consists of a diode bridge rectifier, SEPIC converter and a voltage source inverter (VSI) and fuzzy logic controller. Besides supplying power to the ac grid, the proposed scheme also feeds a local dc load, as the dc link voltage is maintained constant. The fuzzy logic controller is used for varying the duty ratio of the SEPIC converter to maintain the output dc voltage constant. The stability of the voltage is obtained by maintaining constant output voltage from the SEPIC converter. Therefore, by providing continuous supply to the voltage source inverter efficiency of the system is improved and also THD is reduced.

Keywords: WECS, SEPIC converter, fuzzy logic controller, MATLAB.

I.INTRODUCTION

The decrease in fossil fuel availability and the increase in environmental concerns, such as the greenhouse effect, have resulted in the growing use of renewable energy for generating electricity[1]. Wind energy is a fast-growing renewable energy because it is safe, clean, and suitable for certain applications, with relatively low initial costs. The wind turbine and generator are the key devices of a wind energy conversion system (WECS), used for converting wind energy into electricity. Based on the type of the wind turbine and generator used, variable speed wind turbines (VSWTs) with permanent magnet synchronous[3] generators (PMSGs) have advantages compared to fixed speed wind turbines (FSWTs). The VSWT is more effective than the FSWT because it offers optimized wind energy conversion, increased captured wind energy, operation at the maximum power point (MPP) for wide range, and less mechanical stress.

Wind energy is highly unpredictable and intermittent; thus, VSWTs are widely used to convert wind energy into electricity because they are designed to produce output power that follows the changes in the wind speed. Further, PMSGs are widely used in VSWTs owing to their reliability, high torque density, simple structure[4], and high reliability because a gearbox is not required. Besides, VSWTs are widely used for small-scale wind turbine off-grid applications in remote areas. To improve the captured wind power in a VSWT, wind turbines must work at optimum rotational speed to obtain the MPPs, which are highly dependent on the wind speed, and therefore, require maximum power point tracking (MPPT) control.

The MPPT operation is performed by controlling the power converter to obtain the optimal generator speed. A topology converter using a three phase diode rectifier and a boost converter is generally used for small-scale application WECS due to its simplicity, low cost, high reliability, and ease of controllability. Several MPPT control methods have been studied for wind turbine applications and can be generally classified into three categories: optimal tip speed ratio (TSR), optimum relationship-based (ORB), and perturb and observe (P&O). The TSR method has a fast response and a simple algorithm, but requires the wind [5] speed information. Therefore, wind speed Measurement by an anemometer is required, further increasing the installation cost, and it is not always accurate. Consequently, the MPPT may have a low efficiency. To improve the wind measurement accuracy, wind speed estimation can be utilized.

The permanent magnet synchronous machines are now available which can replace induction machines due to the following: (i) they do not have slip rings and brushes, (ii) neither dc supply nor excitation capacitors are required for voltage build up, (iii) there is no drop out speed, (iv) they operate at higher efficiency due to the absence of magnetizing current and gear. In view of the above advantages, PMSG is widely preferred for stand-alone and grid-tied wind energy applications. The proposed scheme in this paper consists of an uncontrolled converter (three-phase DBR) at the machine side to convert the variable ac voltage into variable dc, a dc–dc converter which is a SEPIC converter to fix the voltage at the dc link constant and a controlled converter (three-phase VSI) with decoupled control scheme at grid side for controlling the real power fed to the three-phase grid as well as the reactive power. The control is relatively simple as only one *dq* controller is required. A fuzzy logic control is used for the dc–dc converter for modulating the duty cycle of the gate pulse to maintain the output voltage (dc-link voltage) constant. [15].

II. LITERATURE REVIEW

This study presents a detailed investigation on self-excitation of a squirrel-cage induction generator (SCIG) used in a wind energy conversion system. Air-gap flux[1] of the SCIG is gradually built up through controlled current injection from a voltage source converter (VSC), connected directly across its stator terminals. Dc voltage of the VSC is ramped from a small initial value, which is the rectified output of the small terminal voltage developed because of remanent magnetism. An analogue-based pulse width modulation (PWM) hysteresis current mode controller has been developed for the stand-alone operation of self-excited induction[2] generator (SEIG)-PWM rectifier systems for constant DC voltage [2] applications. The arrangement and usage of the control conspire have been completely portrayed. Utilization of the proposed calculation to a precedent WEGS demonstrates that the time taken by the framework to reach MPP is a lot littler contrasted with a large portion of the current calculations. A model network converter has been created for grid interfacing and the proposed MPPT plot has been actualized related [3] with Venturini and space-vector-balance based exchanging plans. Every one of the aftereffects of this investigation are displayed. This paper introduces an ideal productivity control technique for wind energy conversion systems (WECSs) [4] with squirrel confine enlistment generators (SCIGs). The created control conspire gives an ideal effectiveness of the acceptance generator and greatest power extraction from the wind turbine. Along these lines, greatest power gathering from the entire WECS is accomplished and furthermore development of the [4] exploitable wind speed district toward the lower speed extend is practiced. Oneself energized enlistment generator takes the power for excitation process from a capacitor bank, associated over the stator terminals of the acceptance generator. This capacitor bank additionally supplies the receptive capacity to the heap. The excitation capacitance fills a double need for remain solitary [5] enlistment generator: first ringing with the machine inductance in an adversely damped, thunderous circuit to develop the terminal voltage from zero utilizing just the permanent magnetism of the machine, and after that revising the power factor of the machine by providing the generator responsive power[5]. The striking component of the proposed controller is that it utilizes just a solitary switch, which is an IGBT chopper and does not require any mechanical sensors or machine parameters. This makes the general controller basic, adaptable and vigorous. Further, space warming and battery loads are associated at rotor side of the machine through a diode bridge rectifier and the IGBT chopper. A strategy [6]has been produced for the investigation of such grid associated WRIGs with variable outer obstruction at the chopper circuit. The effective working of the proposed controller has been sufficiently exhibited through broad reenactment and test results on the WRIG framework for MPPT and steady yield control operation[6].A wind energy conversion framework utilizing dq control has been proposed for removing greatest power from a wind-driven permanent magnet synchronous generator (PMSG) and sustaining it to a three-stage utility grid.

III.PROPOSED SYSTEM

The block diagram of the proposed system is shown in Fig.2, the electrical energy generated by the wind is first converted into DC by rectifier. The rectified DC is given to the DC/DC SEPIC converter which converts the input voltage to the desired value, either by stepping it up or stepping it down as required by the load. The use of SEPIC converter eliminates the requirement of filter for the unwanted harmonics in the supply. The output of SEPIC converter is given to the inverter which will convert the DC supply to AC. The output of inverter does not have any unwanted harmonics so it is given to the LOAD. The duty ratio of the converter is controlled by the fuzzy logic technique. The pitiful drawback of wind system is their intermittent nature of energy source. It is capable of supplying huge amount of power but its presence is highly unpredictable, it can be present in any direction so in order to get maximum efficiency we need to incorporate the MPPT algorithms.

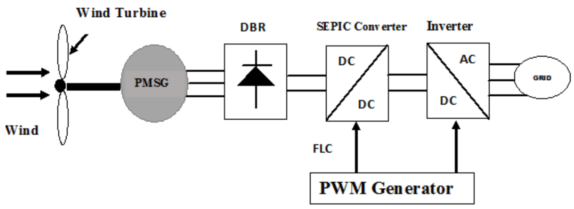

Figure 2:Block Diagram of Proposed System

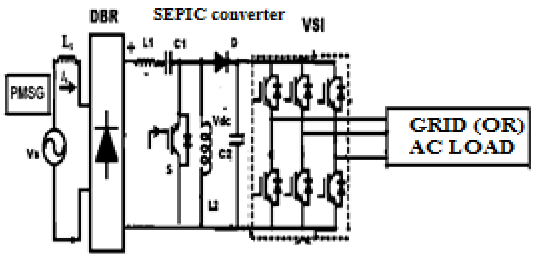

Figure 3: Circuit diagram of proposed system

a) SEPIC Converter

The single-ended primary-inductor converter (SEPIC) is type of DC-DC converter allowing voltage at its output to be greater than, less than, or equal to that at its input. The yield voltage of the SEPIC converter is constrained by controlling the duty cycle of transistor or IGBT OR MOSFET. A SEPIC is a boost converter pursued by a buck-boost converter, it is like buck-boost converter, however has preferences of having the yield has a similar voltage extremity as the input, a coupling Capacitor transfer energy from the input to the output.

All dc-dc converters work by quickly turning on and off a MOSFET, for the most part with a high recurrence beat. What the converter does because of this is the thing that makes the SEPIC converter predominant. For the SEPIC, when the beat is high/the MOSFET is on, inductor 1 is charged by the information voltage and inductor 2 is charged by capacitor 1. The diode is off and the yield is kept up by capacitor 2. At the point when the beat is low/the MOSFET is off, the inductors yield through the diode to the heap and the capacitors are charged. The more noteworthy the level of time (obligation cycle) the beat is low, the more prominent the yield will be. This is because the longer the inductors charge, the greater their voltage will be.

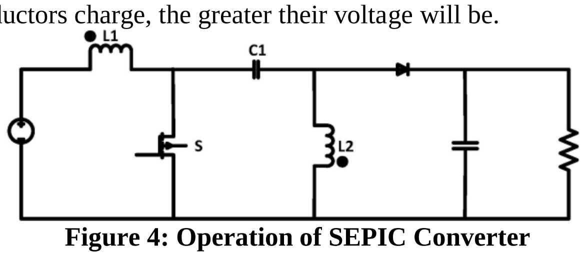

Figure 4: Operation of SEPIC Converter

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b) Fuzzy Logic Based MPPT

In a wind power system with MPPT, the output powercan be controlled by adjusting the duty cycle of the switch in the Sepic converter. Therefore, the output of the fuzzy logic controller is the duty cycle. The inputs of the fuzzy logic controller include the change of the output power and the change of the unit delay duty cycle.

I/P	O/P				
	NB	NS	ZO	PS	PB
NB	NB	NB	NB	NS	ZO
NS	NB	NB	NS	ZO	PS
ZO	NB	NS	ZO	PS	PB
PS	NS	ZO	PS	PB	PB
PB	ZO	PS	PB	PB	PB

Table1.Fuzzy Rules

IV. SIMULATION AND RESULTS SIMULATION DIAGRAM

MATLAB (matrix laboratory) is a multi-worldview numerical computing condition and fourth-age programming language. A restrictive programming language created by Math Works, MATLAB permits matrix controls, plotting of functions and information, usage of calculations, creation of UIs, and interfacing with projects written in different dialects, including C, C++, Java, Fortran and Python. Despite the fact that MATLAB is planned basically for numerical computing, a discretionary tool compartment utilizes the Mu PAD symbolic motor, enabling access to symbolic computing capacities. An extra package, Simulink, includes graphical multi-area reenactment and model based plan for dynamic and frameworks. In 2004, MATLAB had around one million clients across industry and academia.

MATLAB clients come from different backgrounds of building, science, and economics. Cleve Moler, the chairman of the computer science division at the University of New Mexico, began creating MATLAB in the late 1970s. He structured it to give his understudies access to LINPACK and EISPACK without them learning Fortran. It before long spread to different colleges and found a solid audience inside the connected mathematics community.

Jack Little, an architect, was presented to it amid a visit Moler made to Stanford University in 1983. Recognizing its commercial potential, he united with Moler and Steve Bangert. They revised MATLAB in C and established Math Works in 1984 to continue its improvement. These revamped libraries were known as JACKPAC. In 2000, MATLAB was changed to utilize a more current arrangement of libraries for matrix control. MATLAB was first embraced by researchers and practitioners in control designing, Little's specialty, however quickly spread to numerous different spaces.

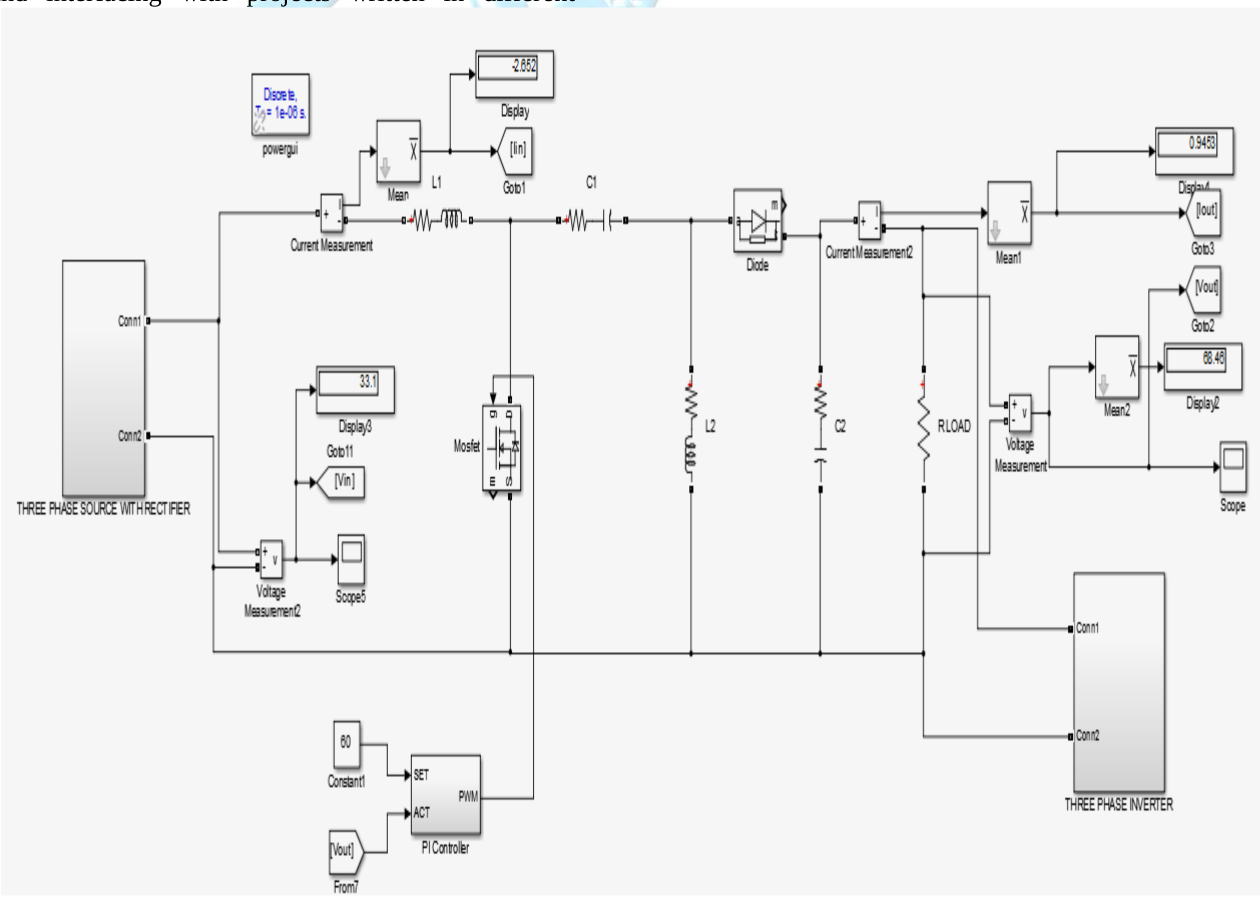

Figure 5: Proposed system MATLAB Simulink view

The figure shows the diode rectifier output voltage which is given to the SEPIC converter.

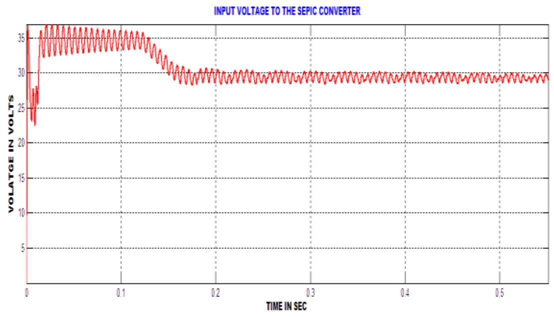

Figure 5.1: Diode rectifier output voltage waveform

The rectifier voltage has stepped up using SEPIC converter, the PWM pulse has produced using MPPT fuzzy logic algorithm. The figure shows the PWM pulses to the SEPIC converter.

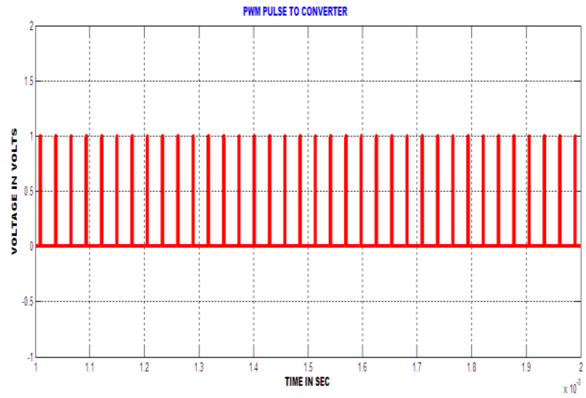

Figure 5.2: PWM pulse to the SEPIC converter

This pulse maintains constant output voltage from the SEPIC converter, the figure shows the SEPIC converter input and output voltage waveform.

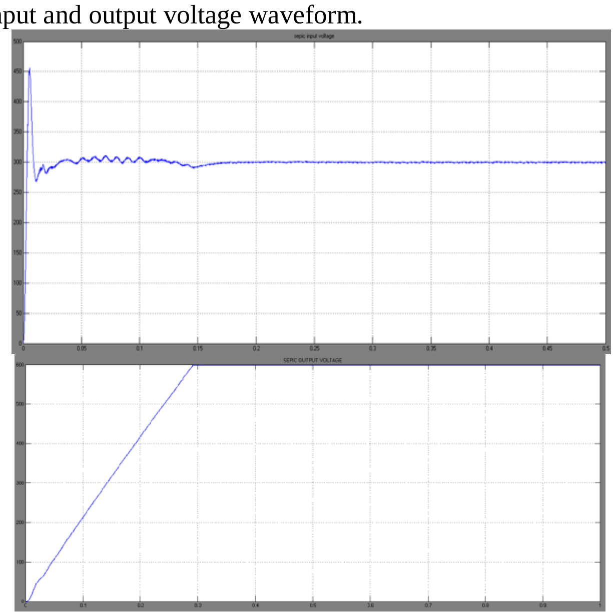

Figure 5.3: SEPIC converter input and output voltage waveform

This constant voltage is given to the three phase voltage source inverter. The inverter voltage is given to the three phase AC grid.

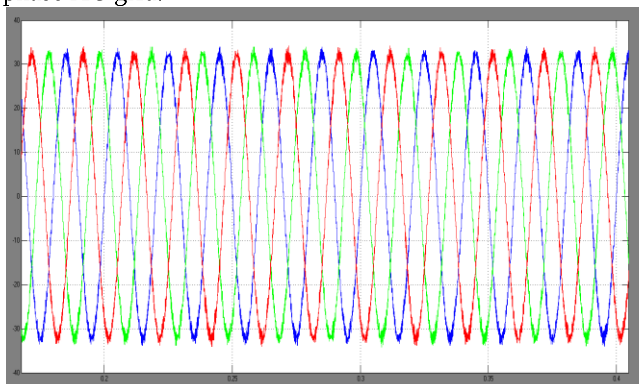

Figure 5.4: Three phase AC output voltage waveform

VI. CONCLUSION

The performance of a system is demonstrated with the help of MATLAB. A power electronic controller for interfacing the wind-driven PMSG with a three-phase utility grid has been developed by using a DBR, a dc–dc converter and VSI with simple control technique. The power generated from the PMSG is fed to a three-phase utility grid. The constant dc-link voltage helps in obtaining the MPPT control with a single (dc link current) sensor in addition to enhancing the utility of the scheme for feeding dc loads as well. Independent control of both real and reactive power has been demonstrated by the decoupled control strategy. The controller feeds the power to the grid at unity power factor. The versatility of the controller to drive the VSI to act as a bidirectional converter for feeding power to the grid and from the grid to the dc load is an important advantage of the proposed scheme.

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