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MAXIMUM POWER POINT TRACKING FOR VARIABLE WIND SPEED TURBINE WITH SEPIC CONVERTER

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Abstract:
The main focus of this thesis is on control of active rectifier for maximum power extraction from wind power using Permanent Magnet Synchronous Generator (PMSG). This thesis presents fours different control strategies for variable speed Wind Energy Conversion System (WECS). The thesis begins with the simulation of conventional vector control approach whose control reference depends on priori information of wind turbine parameters and its characteristics. This dependence is avoided using a basic well defined Maximum Power Point Tracking (MPPT) algorithm, Perturbation and Observation method. In this method the control reference is dynamically varied based on the direction of active power change. In this thesis two different MPPT techniques are proposed by applying MPPT algorithm on modulation index and MPPT algorithm on generator terminal voltage, used in WECS. The MPPT algorithm on modulation index obviates the measurement of wind speed, while MPPT on generator terminal voltage obviates the position sensor along with wind speed measurement. The use of LCL filter is observed to be advantages to avoid the effect of switching voltages. PO algorithm along with above mentioned effective and efficient techniques is applied on WECS to harness maximum power. The performance of the proposed control methods is validated through simulation results with various changes in wind velocity.

Keywords – PMSG, WECS, MPPT.

1. INTRODUCTION

Recent trend indicates that wind energy will play a major role to meet the future energy target worldwide to reduce reliance on fossil fuel and to minimize the adverse impact of climate change. Wind energy is the fastest growing generation technology among the renewable energy sources. Over the last decade, the global wind energy capacity has increased rapidly and wind is an important competitor to the traditional sources of energy. In 2013, more than 35 GW of wind power capacity was added to the global wind generation capacity which became 318 GW as shown in Fig.1.1 Since 2008, annual growth rates of cumulative wind power capacity have averaged 21.4%, and global capacity has increased eightfold over the past decade.Recently, capital costs of wind generation technologies have declined primarily due to the competition and advanced technology development including taller towers, longer blades, and smaller generators in low wind speed areas—have increased capacity factors. The technological development contributed to reduce the costs of wind turbines and made it competitive relative to fossil fuel based generation. Onshore wind-generated power is now more cost competitive on a per kWh basis with new coal/gas fired power plants, in several markets (including Australia, Brazil, Chile, Mexico, New Zealand, South Africa, Turkey, much of the EU, and some locations in India and the United States) .As a result of this trend, high level of wind energy (>30%) will be integrated into the power grid and major challenges

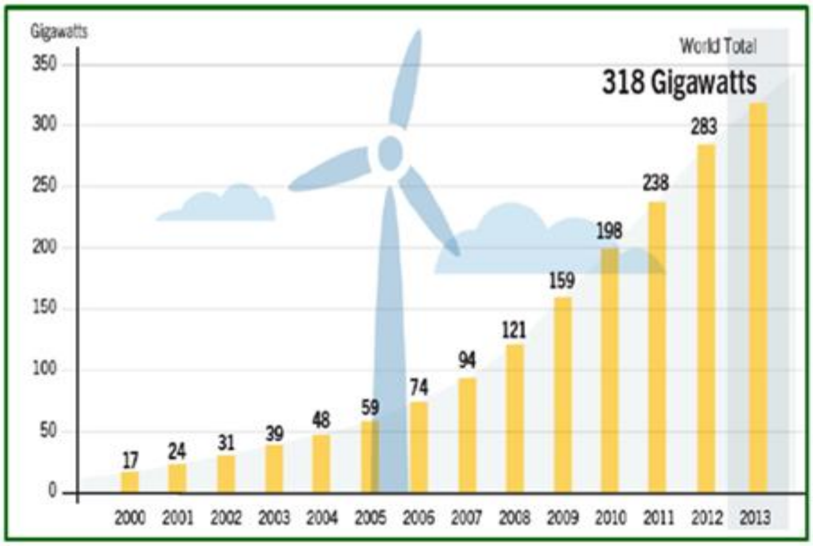

Fig.1. Global wind power capacity

and issues will appear, which are needed to be addressed for efficient and reliable operation of the existing power system. As the wind penetration increases, the structure and dynamics of the power system network will change significantly over the coming decades. Due to the intermittent nature of wind power, the replacement of traditional synchronous generators with power electronic converter-based synchronous generators will introduce special challenges in; grid interconnections and bi-directional power control, tight voltage and frequency regulation, dynamic stability, low voltage fault ride through, satisfy grid code, system security, reliability, and protection .

2. PROPOSED SYSTEM

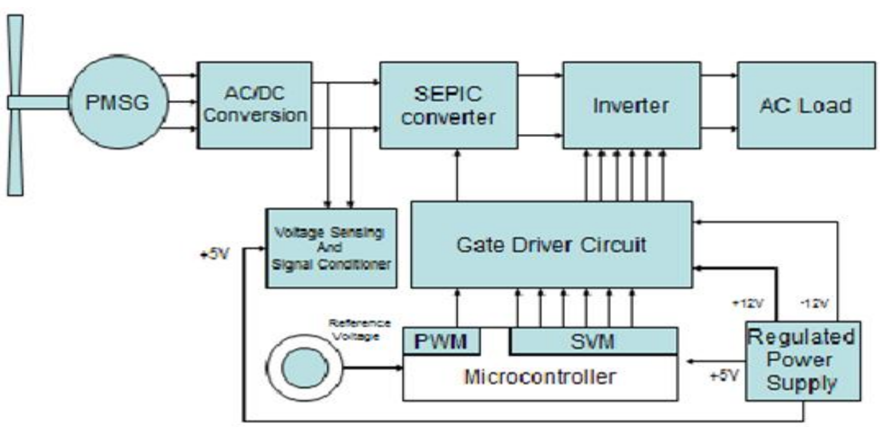

Fig.1. Proposed Methodology

A prime mover is used in the setup instead of a wind turbine. it is connected to PMSG(permanent magnet synchronous generator) which acts as AC source. A rectifier is linked with the PMSG to convert the ac source into DC source.The output DC voltage from the rectifier is then given to the SEPIC (single ended primary inductor converter) which is either used to buck or boost the DC voltage. it is then given to the inverter which converts DC to AC.Then supply from AC is given to the AC load. DC voltage obtained from the rectifier is made to pass through the voltage and sensing conditioner, this voltage sensing and signal conditioner senses the voltage signal which is required for SEPIC converter and gives it to the microcontroller and mppt block.A regulated power supply is separately provided to microcontroller unit and gate driver circuit. Microcontroller compares the reference voltage with that of the DC voltage obtained from the voltage sensing and signal conditioner and gives it to the gate driver circuit.

3. SEPIC CONVERTER

The Single-Ended Primary-Inductor Converter (SEPIC) is a type of DC/DC converterallowing the electrical potential (voltage) at its output to be greater than, less than, or equal to that at its input. The output of the SEPIC is controlled by the duty cycle of the control transistor.

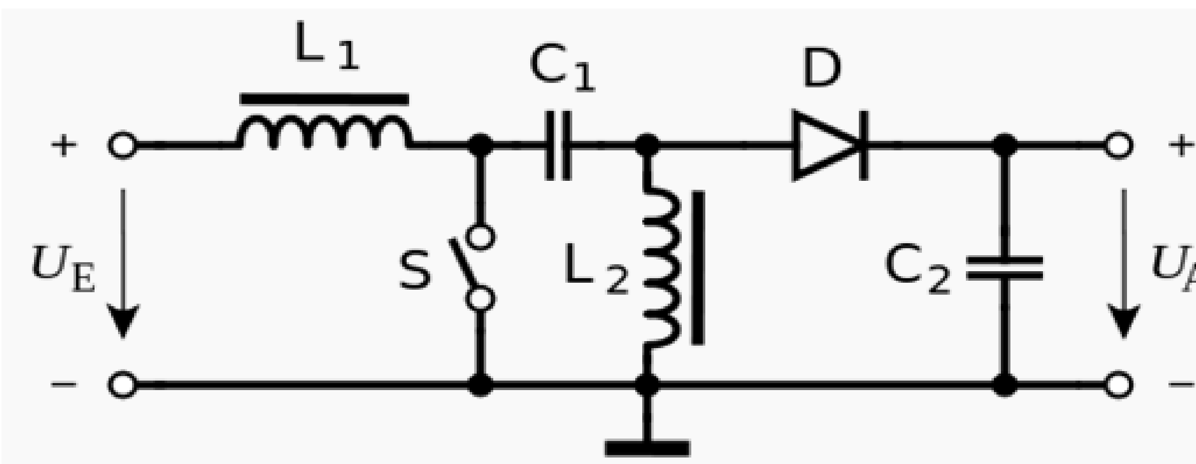

Fig.2.Schematic of SEPIC

A SEPIC is essentially a boost converter followed by a buck-boost converter, therefore it is similar to a traditional buck-boost converter, but has advantages of having non-inverted output (the output has the same voltage polarity as the input), using a series capacitor to couple energy from the input to the output (and thus can respond more gracefully to a short-circuit output), and being capable of true shutdown: when the switch is turned off, its output drops to 0 V, following a fairly hefty transient dump of charge.SEPICs are useful in applications in which a battery voltage can be above and below that of the regulator's intended output. For example, a single lithium ion battery typically discharges from 4.2 volts to 3 volts; if other components require 3.3 volts, then the SEPIC would be effective.

4. SIMULATION ANALYSIS

The libraries contain models of typical power equipment such as transformers, lines, machines, and power electronics. These models are proven ones coming from textbooks, and their validity is based on the experience of the Power Systems Testing and Simulation Laboratory of Hydro-Québec, a large North

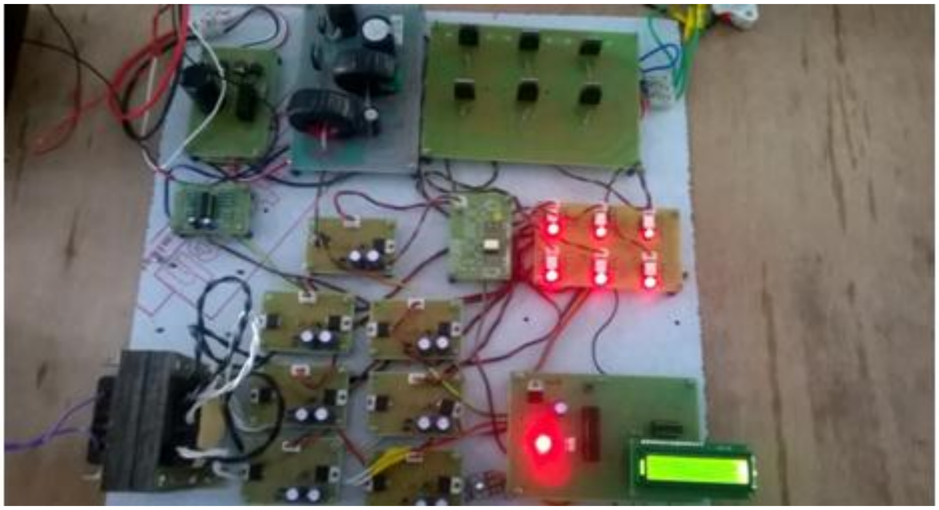

Fig.3.Hardware Circuit

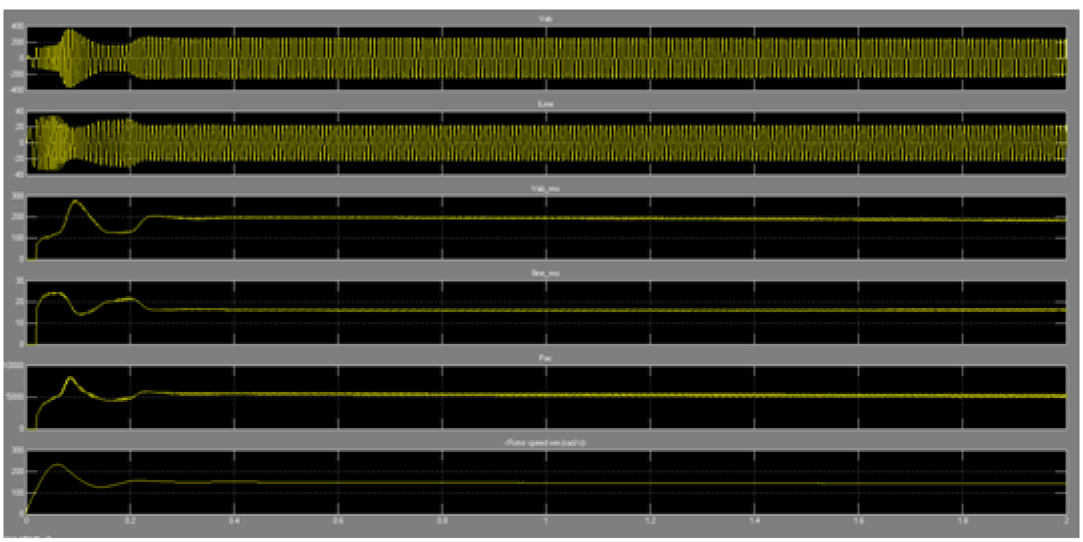

Fig.4.Generator output

American utility located in Canada, and also on the experience of Evolve de Technologies superior and Universities Laval. The capabilities of SimPower Systems for modeling a typical electrical system are illustrated in demonstration files. And for users who want to refresh their knowledge of power system theory, there are also self-learning case studies. The SimPower Systems main library, power lib, organizes its blocks into libraries according to their behavior. The powerlib library window displays the block library icons and names. Double-click a library icon to open the library and access the blocks. The main

SimPower Systems powerlib library window also contains the Powergui block that opens a graphical user interface for the steady-state analysis of electrical circuits.

CONCLUSION

In the existing system, with the change in the wind speed the generator output also varies. Thus the output could not be maintained constant. And also the harmonics generated at the output is also high. In the proposed system, with the change in the wind speed, the generator output is maintained constant with the implementation of the SEPIC CONVERTER which is used for the voltage regulation or maintenances at the output. And also the harmonics generated at the output is very low when compared to the existing method.

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