MAT JOURNALS
Journal of Power Electronics and Devices
Volume 2 Issue 2

Wind Energy System based on Buck-Boost Controller

Ansari Nabila Alravi Arif Husain, R. K. Agrawal

Department of Electronics & Telecommunication,

SNJB College of Engineering, Chandwad

Nashik, India

E-mail: deshmukh_nabila@yahoo.in, rkdhule@yahoo.co.in

Abstract

In this edge most of the countries are facing energy related problem, therefore, researchers are now try to find such a system which should not create any environment issues. In nature there is various non-conventional resources use for the generation of electricity such as water, sunlight, geothermal energy. But there is disadvantage of solar energy is that we cannot generate power using solar energy in rainy season and in night time. Whereas, wind energy is very safe clean and natural source to generate energy. If the wind speed is low, the output voltage will not be up to that level to charge the battery as it is lower than the required charging voltage of the battery. This reason reduces the overall performance efficiency of the Wind Machine to 20%. This suggested idea and design will enable effective utilization of wind machine. The buck boost converter bucks/reduces this high voltage to the required battery charging voltage and if wind machine output voltage is low then converter will boost the voltage to charge the battery, thereby protecting the battery from over charging. Thus, the effective utilization of the wind machine has been achieved by the use of the proposed Buck Boost Controller.

Keywords: *Buck boost converter, continuous current mode (CCM), control circuit, pulse width modulation (PWM), wind machines*

INTRODUCTION

The demand for energy has increased tremendously from the past few decades. As a result, the use of renewable energy sources like solar energy, wind energy etc. are gaining popularity. As wind energy is clean and does not creates any greenhouse gas emission during its operation and required little land area and safe source to generate energy. This method is cheap as well as provides higher efficiency. Therefore, power generation using Wind

Machine are extensively used in domestic as well as Industrial application. In Domestic Wind Machines, if the wind speed is low, the output voltage of the Wind Machine after rectified into DC is less. The battery will not charge as it is lower than the required charging voltage [1, 2]. This condition occur most of the time in a day, since the wind speed in domestic areas is in between the range of 0 to 4 m/s. which reduces the efficiency of an existing domestic Wind Machine to 20%. Therefore, an effective control system is essential, so as to utilize the wind power efficiently and effectively.

The Exiting system block diagram is as shown in Figure 1. In the existing system, the output of the Wind Machine is given to rectifier which used to charge the battery directly. If the output voltage is less than the required battery charging voltage, the battery will not charge even when considerable output is available. Almost 30% of the total output is in this range and thus the overall efficiency reduces to 20%. Because in conventional system no controlling action is taking place because of absence of buck boost converter. And output of the wind machine is directly given to load through the rectifier. And wind machine output is totally depending on wind speed, generated output voltage at the rectifier will be either high or low depending on wind speed.

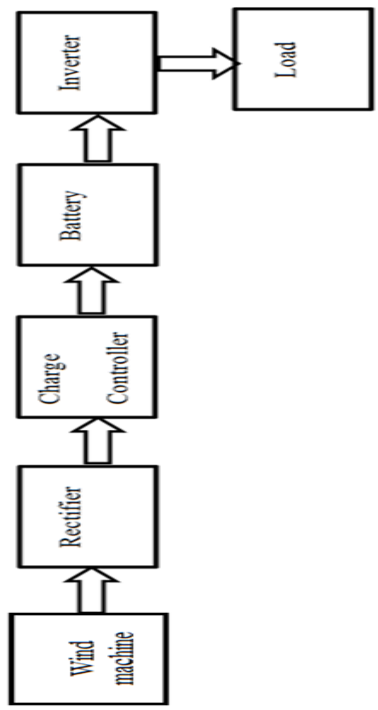

Fig. 1: *Block Diagram of Existing Wind Machine System.*

PROPOSED SYSTEM

In this study, controller based Buck Boost converter is suggested, so that whatever amount of the voltage occurs at the wind machine can be utilized after boosting or reducing voltage to the specified charging voltage of the battery. Because wind power output is highly variable at various timescale hourly, daily or seasonally. The controller continuously examines the output voltage from the Wind Machine. Figure 2 shows the block diagram of the proposed system. Which consist of wind machine, rectifier, buck boost converter and processor [3, 4].

Wind Machine

The term wind energy or alternative energy describes the method by that wind is employed to get mechanical power or electricity. Turbine convert K.E. wind to mechanical power will be used for specific task or a generator will be accustomed convert this mechanical power to electricity to produce power to industries, homes, colleges and hospitals etc. Majority of recent windmills take the shape of turbine accustomed generate electricity. It generates AC voltage it is applied to Rectifier. The output of Wind machine is reckoning on timescale wind speed [5, 6].

Rectifier

The output of wind machine is AC which is converted to DC through Rectifier. Rectifier is an electronic circuit which carries Rectification. After the rectification the rectified DC output from the wind turbine is depends on the wind speed, it may be high or low.

Microcontroller

The controller creates the Pulse Width Modulation (PWM) signal that is used to switch the operation of MOSFET in the power circuit of the Buck Boost Converter. ARM processor, with an integral ADC and PWM generator, has been intended for PWM generation. The processor generates a PWM signal frequency of 8 kHz, and then PWM signal is used to trigger the MOSFET to control the output voltage. The input and output voltages are calculated dynamically and converted to digital values by the Voltage Sensor Circuit and ADC. The duty cycle of PWM signal is varied in accordance to this feedback and the output voltage is either bucked or boosted, to ensure that whether the battery is charging. In this way the application of buck boost converter can be achieved efficiently [7].

Buck Boost Converter

A Buck Boost Converter is a DC-DC regulator which provides an output voltage that may be less than or greater than the input voltage - hence the name “Buck-Boost”. As the polarity of the output voltage is opposite to that of the input voltage, the regulator is also known as an inverting regulator (Farhangi and Farhangi, 2005; Wang *et al.*, 2008). Among all the topologies that are used to Buck as well as Boost the voltage, Buck Boost converter has wider acceptance as it provides a significant improvement in performance and efficiency by eliminating the transition region between buck and

MAT JOURNALS
Journal of Power Electronics and Devices
Volume 2 Issue 2

boost modes (Mitchell, 1988; Mohan *et al*., 1995). The circuit arrangement of the Buck Boost converter is shown in Figure 3.

Operation Modes:

The circuit operation can be divided into two modes:

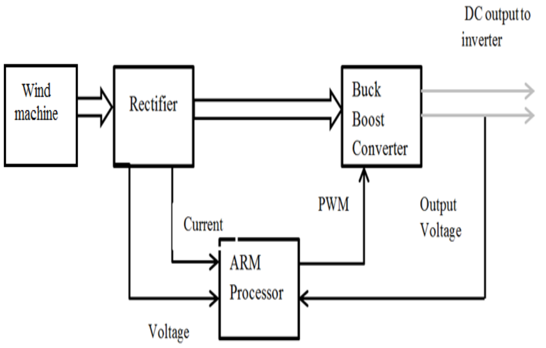

Fig. 2: *Block Diagram of the Proposed System.*

Mode 1

Let D be the duty cycle and TS be the time period of the PWM signal. During mode 1, the transistor is switch ON by the PWM signal for a period (DTS) and the diode is reverse biased. The input current flows through the inductor L and the transistor. Figure 4 shows the mode 1 operation of Buck Boost Converter.

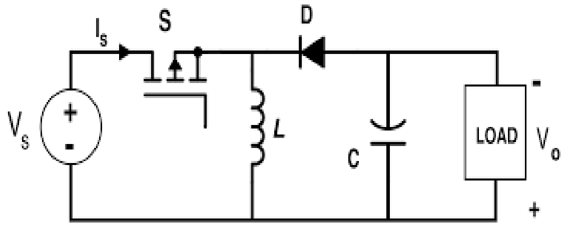

Fig. 3: *Buck Boost Converter.*

Mode 2

During the mode 2, the transistor is switched off by the PWM switching for the period (1-DTS).

The current, which was flowing through the inductor L during mode 1, would now flow through the inductor L, capacitor C, Diode and the load. The energy stored in the inductor L would be transferred to the load and the inductor current would fall until the transistor is switched on again in the next cycle. The amount of energy stored in the inductor is determined by the duty cycle of the PWM signal.

The greater the duty cycle, higher will be the energy stored in the inductor. If the duty cycle of PWM is below 50%, the circuit bucks the output voltage as the amount of energy stored is less and if it is above 50%, the output voltage will be boosted to the nominal battery charging voltage. Operation of Buck Boost converter may be in Continuous Current Mode (CCM) or Discontinuous Current Mode (DCM) of operation depending on the Wind Machine output. The converter should be operated in CCM to charge the battery which depends on the value of the inductor and the load [8, 9].

FLOWCHART

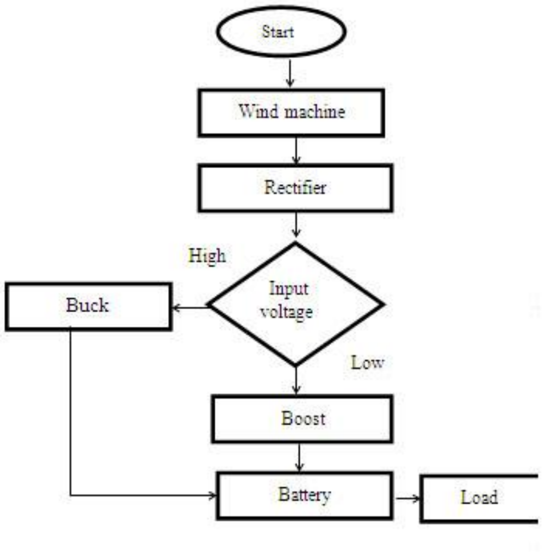

Fig. 4: *Buck Boost Converter*.

RESULT

Wind Speed	Input Voltage	Buck/Boost	Duty Cycle	Output Voltage
Low	7V	BOOST	750	13.7V
High	17V	BUCK	100	13.8V

The input voltage is 7V then the output of duty cycle is 750 and circuit is boost. When the input is 17V the duty cycle is100 and the circuit is buck.

ADVANTAGES

1. Suggested designed provide effective utilization of wind power as well as buck the high voltage and protect battery from over charging similarly boost low wind machine output voltage to required voltage level.
2. It does not produce atmospheric emissions that cause acid rain or greenhouse gases.
3. It does not pollute the air like power fossil fuel plants.
4. It is clean fuel resource and requires less land area.

DISADVANTAGES

1. The strength of wind is not constant and it varies on time scale hourly, daily and seasonally.
2. Wind turbines are noisy. They produce same level of noise generated by cars, SUVs.
3. It requires high installation cost.

CONCLUSION

The Buck Boost converter is based on ARM processor is very compact, user friendly and provide a high efficiency. ARM processor has inbuilt ADC and PWM channels to make the control module of the buck boost converter very compact. According to the duty cycle of PWM signal the output of Buck Boost converter varies and we get specified output. By introducing a controller based on Buck Boost converter the voltage produced at the minimum wind speeds can also be utilized effectively by boosting it to the specified particular charging voltage of the battery. Hence, the voltage produced at lower wind speeds can also be utilized effectively by the application, hence overall performance efficiency of the proposed system is higher than the conventional system without buck boost converter.

REFRENCES

1. Mitchell, D.M. DC-DC switching regulator analysis. McGraw-Hill, New York; 1988.
2. Mohan, N., T. Undeland, W. Robbins. Power electronics: Converters, applications and design. 2nd Edn. John Wiley and Sons, New York. Pearson Education (Singapore) Pvt. Ltd., New Delhi; 1995.
3. Stihi, O., B.T. Ooi. A single-phase controlled current PWM rectifier. *IEEE T. Power Electron*. 1988; 3(1988): 453p.
4. Tan, K., K.B. Ng, S. Sugiarto. Shunt active power filter harmonic mitigation technique in a grid-connected permanent magnet wind generation system. *Proceeding of Australian Universities Power Engineering Conference*. Melbourne, Australia. 2006; 15–20p.
5. T. Tafticht, K. Agbossou, A. Chériti. DC bus control of variable speed wind turbine using a buck-boost converter. *Power Engineering Society General Meeting, IEEE*; 2006.
6. Aditya Raw Gautam, D.M. Deshpande, Arisutha Suresh, Arvind Mittal. A double input DC to DC buck-boost converter for low voltage photovoltaic/wind systems. *International Journal of Chemtech Research CODEN (USA)*. 2013; 5(2): 1016–1023p.
7. Mahmoud M. Hussein, Tomonobu Senjyu, Mohamed Orabi, Mohamed A. A. Wahab, Mohamed M. Hamada. Control of a stand-alone variable speed wind energy supply system. *IEEE International Conference on Power and Energy*. 2012.
8. Rashid, M.H. Power electronics: Circuits, devices and applications. Pearson Education (Singapore) Pvt. Ltd., New Delhi; 2004.
9. Precaution, D. Ranithottungal, M. Sundaram. An effective wind energy system based on buck-boost controller. *Research Journal of Applied Sciences, Engineering and Technology*. 2013.

