Micro Wind Energy Generator Module

K Uma Maheswari, R.Janaki , P Janani, J Mythili
EEE dept., VSBCETC, Coimbatore

Abstract-

Now-a-days the most popular topic in engineering is renewable energy system where energy self-consumption interest is growing. Wind energy source is considered as one of the most promising and fast growing compared to other renewable energy resources. This paper deals with the design of Horizontal Axis Micro wind energy generation. The output power of micro wind turbine can power the small devices such as LED and mobile phones. The turbine is mainly composed of turbine blades, PMDC motor and boost converter. The blades of the turbines were designed such that, it can gain an output of 5 watts to power small electronic devices. The system must be efficient and totally autonomous. Micro wind turbines are low cost, easier to install, produces low noise and less weight system. This paper includes a hardware description of the system and also description of wind turbine simulator. It is developed for testing the wind in favour of different climatic conditions.

Keywords- *Horizontal Wind Turbine, Permanent Magnet DC Motor, Boost Converter, Voltage regulator U17805 IC, LCD display and Arduino controller*

I. INTRODUCTION

Current development and implementation of wind energy is focused on large scale wind turbines that produces the electricity for grid. Large scale turbines produce the output power in megawatts(MW).Micro wind is used for micro generation of power; it opposes to large commercial wind turbines. The large wind turbine has some disadvantages such as high cost, problems with mechanical stress and friction, requires large space and large stand taller, produces more noises, birds and bats are injured and require high velocity of wind to produce power.

The global wind energy capacity is increasing very fast in the rate of 36,023 MW, 51,675 MW, 63,330 MW and 54, 642 MW by the end of the 2013, 2014, 2015 and 2016.The micro wind energy is harvested by wind turbines which generate power should not exceed 100 KW. The energy generated is obtained from the wind by the wind turbine blades and injected into the load by using boost converter and permanent magnet motor. Promotion of self-consumption of energy in a small scale which produces energy by these micro generators.

This paper explains about the development of power electronics which converts wind energy to electric energy by using a variable speed wind turbine. Section-2 shows the Horizontal Axis Wind Turbine Vs Vertical Axis Wind Turbine, Section-3 discuss about the system model, Section-4 explains the simulation result and Section-5 gives the Conclusion

II. HAWT Vs VAWT

In the wind turbine there are basically two types of turbines namely horizontal axis wind turbine(HAWT)and vertical axis wind turbine(VAWT). This project is employed with Horizontal Axis Wind Turbine. In HAWT the axis of rotation is parallel to air stream whereas in VAWT the axis of rotation is perpendicular to air stream. The HAWT is able to produce more electricity from a given amount of wind, this is one of the advantages of this type. HAWT have a good starting performance comparatively.

In HAWT all blades work at a time while in VAWT one blade works at a time. So HAWT's efficiency is much more than VAWT. The Fig.1 and Fig.2 are shows the HAWT and VAWT respectively

Fig.1. Horizontal axis wind turbine

Fig.2.Vertical axis wind turbine.

A. Advantages Of HAWT Over VAWT:

- High efficiency (in VAWT the blades lose energy as they turn out of the wind).
- Ability to turn the blades (in VAWT difficulty in controlling blade over speed).
- Lowest cost to power ratio.
- HAWT is adapted for all atmosphere but VAWT is only suitable for particular atmosphere.

III. SYSTEM MODEL

The wind turbine and the load makes the link for the developed system. The input given to the system is single phase permanent magnet motor that is directly connected to the wind turbine shaft where the kinetic energy from the wind is converted into mechanical energy, the obtained energy is fed to the PM dc motor, where the energy is converted into electrical energy.

The motor works as a generator because of back EMF (Electromotive force). The single phase voltage is generated; it moves through the boost converter where the lower output dc voltage of the motor is boosted up to the higher level dc voltage. This high output voltage is stored in the battery. The storage rate of battery is 8V, 1.5A. The stored voltage is given to the U1 7805IC, it always gives constant voltage of 5V. The C2 is used to filter the voltage from the battery, which is injected into the load. The rated speed of Permanent Magnet motor is 1000 rpm. The maximum output voltage of this system is 12V.The boost up voltage is injected into the power supply where diodes are employed to avoid the reversal of power to the supply.

The resistor limits the current and is given as the input of Arduino ATMEGA328P controller. The LCD display shows the output voltage from the controller. The Fig.3 shows the circuit diagram of micro wind energy generator.

A. PM DC MOTOR

The Fig.4 shows the PM DC Motor. The permanent magnet DC motor is similar to the normal DC motor; it is working on the same principle. The PM DC motor working as generator, because of back EMF. There is no need of field excitation winding and no need of electric supply for field excitation.

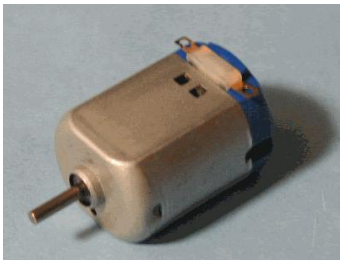

Fig.4. PM DC Motor

B. IRF840(Boost Converter)

It is included as inductor (1 mH), capacitor and N channel power MOSFET, which range of 8A, 500V, 0.850 ohm. The Fig.5 illustrations the IRF840. The N channel enhancement mode silicon gate power tiled effect transistor is an advanced power MOSFET designed. The main features of the IRF840 is, Single phase avalanche energy rated, SOA is power dissipation limited, Nano second switching speeds, linear transfer characteristics, high input impedance.

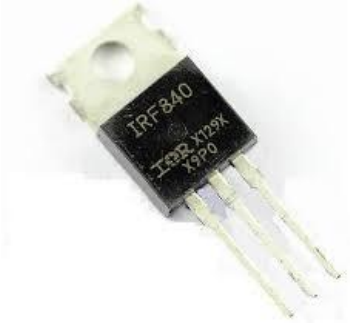

Fig.5. IRF840

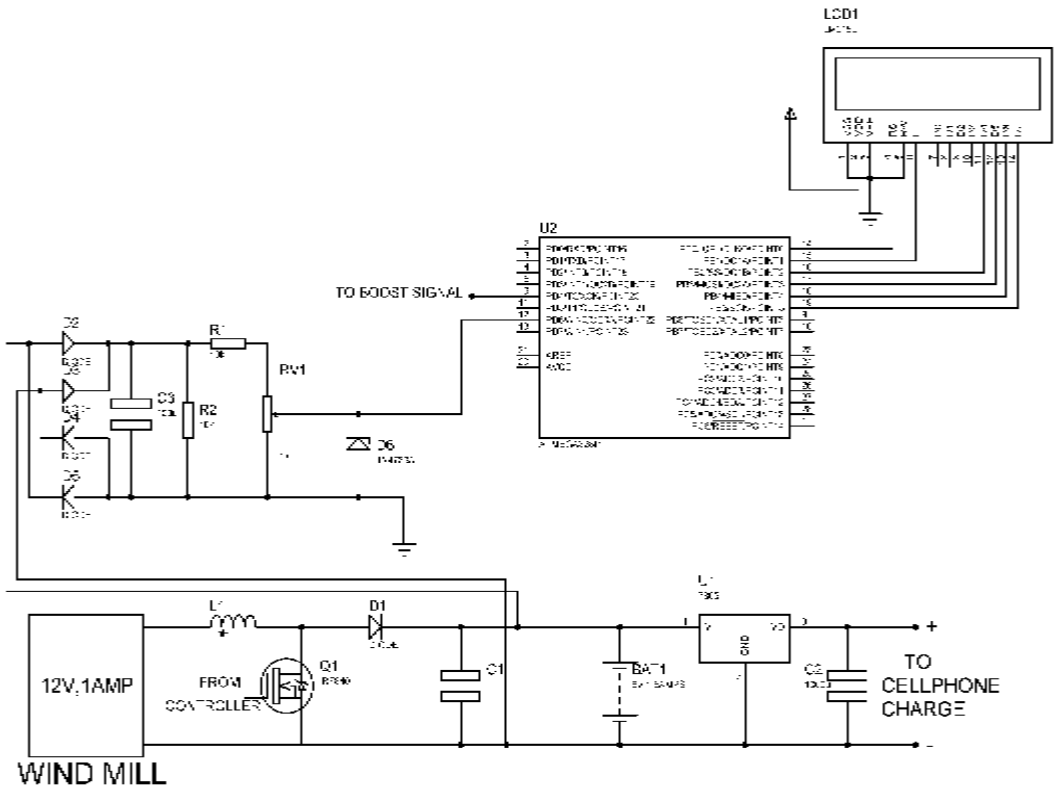

Fig 3. Circuit Diagram for this System

C. Battery

It is used to store the output voltage from the boost converter. The battery rating is 8V, 1.5A.

D. IC 7805 (VOLTAGE REGULATOR)

Where the U1 7805 IC is used, the voltage regulator IC maintains the output voltage at a constant value. 7805 IC provides 5V regulated power supply. Where input voltage should always be greater than the output voltage (at least 2.5V). The input and output current arealways identical, but output will be constant 5V, the remaining power is dissipated as heat.

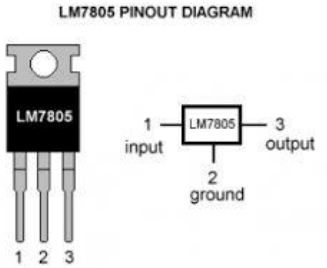

Fig.6.LM7805

E. ATMEGA328p micro controller

Single chip microcontroller formed by Atmel in the megaAVR family. It consists of 32 pins. The Fig.7 shows the pin diagram of micro controller.

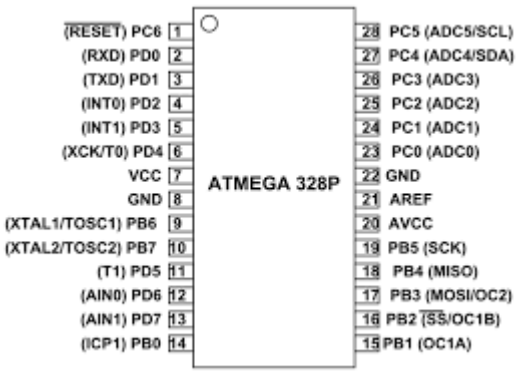

Fig.7. Pin diagram of micro controller

F. LM016L

It is an electronic display; it can display 2 lines of 16 characters. It interfaces with the Arduino controller.

IV. SIMULATION RESULT

The micro wind energy generator is modelled and its performance is simulated in MATLAB/Simulink under variable wind speed conditions. A simulated result shows the worthiness of proposed system as shown in figures. The maximum power of this simulated system is 280W and minimum power is 72W. The minimum voltage of this system is 24v.the output wave The input voltage of 24v is wind turbine and the output is shown in the figure 8(a). the voltage is boosted up by using the boost converter and the output from the boost converter is shown in the figure 8(b). the obtained voltage is a dc voltage and is given to the inverter. The output from the inverter is ac output. The ac voltage is given to the step up transformer for amplifying the ac voltage. The amplified output is given to the grid and the output is shown in the figure 8(c). from the grid theac voltage is given to the load i.e. the light. By taking the ac voltage the light will glow.

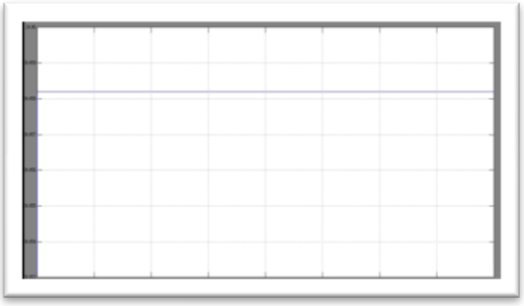

Figure.8 (a). wind power

Figure.8 (b). boost converter

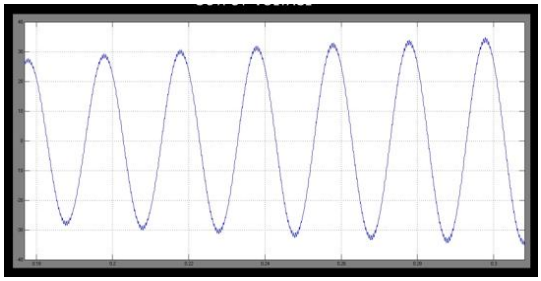

Figure.8 (c). output voltage

The wind simulator is used to test the system under different climatic conditions.

The table.1 shows the simulation ratings

Table.1 Simulation Ratings

Min Power	72 W
Max Power	280 W
Min Voltage	24 V
Max Voltage	>24 V

V. CONCLUSION

In this paper a hardware of themicro-wind energy generator is reviewed. Also a method to simulate the behaviour of the wind turbine is presented here where these kinds of systems can be tested independently at the outside climatic conditions.

The wind turbine simulator has been developed and tested so that the hardware system can be developed and implemented successfully.

REFERENCE

[1] Chub, O. Husev, A. Blinov and D. Vinnikov, "Novel Isolated Power Conditioning Unit for Micro Wind Turbine Applications," in IEEE Transactions on Industrial Electronics, vol. 64, no. 7, pp. 5984-5993, July 2017. doi: 10.1109/TIE.2016.2645890

[2] S. Sharma, K. Pradeepkumar, N. Dhinesh, Y. A. Anbarasu, S. Vignesh and V. Kirubakaran, "Development of micro wind turbine for rural livelihood improvement," 2017 International Conference on Advances in Electrical Technology for Green Energy (ICAETGT), Coimbatore, 2017, pp. 114-120. doi: 10.1109/ICAETGT.2017.8341458

[3] M. Arifujjaman, M. T. Iqbal, J. E. Ouaicoe and M. J. Khan, "Modeling and control of a small wind turbine," Canadian Conference on Electrical and Computer Engineering, 2005., Saskatoon, Sask., 2005, pp. 778-781. doi: 10.1109/CCECE.2005.1557044

[4] D. P. Drumheller, G. C. D'Antonio, B. A. Chapman, C. P. Allison and O. Pierrakos, "Design of a micro-wind turbine for implementation in low wind speed environments," 2015 Systems and Information Engineering DesignSymposium, Charlottesville, VA, 2015, pp. 125-130.

[5] S. W. Mohod and M. V. Aware, "Micro Wind Power Generator With Battery Energy Storage for Critical Load," in IEEE Systems Journal, vol. 6, no. 1, pp. 118-125, March 2012.
doi: 10.1109/JSYST.2011.2163015oi: 10.1109/SIEDS.2015.7116959.