# Bidirectional Dc-Dc Converter for Micro Wind Turbine

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*Abstract :* The paper presents the application of low cost boost rectifier for microwind turbine generator using Bidirectional dc-dc converter. The proposed system with battery storage and microwind generating system provides energy saving and uninterruptable power within distribution network. Hardware can be implemented using a low cost microcontroller.

***Keywords*—Boost rectifier, Microwind, Bidirectional dc-dc converter.**

## I. INTRODUCTION

Wind energy is one of the most effective power technologies that is ready today for global deployment on a scale. Wind power can be installed far quicker than conventional power station. It is safe, clean and abundant. Unlike conventional fuels, wind energy is a massive indigenous power source permanently available in virtually every nation in the world.

Flexible control strategy uses a bidirectional dc-dc converter which acts as a boost converter in case of reduced wind speed to supply the load and buck converter to store excess power in battery.(1)

The battery storage provides rapid response for either charging/discharging the battery and also acts as a constant voltage source for the critical load in the distributed network.(2)

PMSG can be used over Induction generator due to its high power density . PMSG's have the highest advantages because they are stable and secure during normal operation and they do not need an additional DC supply for the excitation circuit.(3)

Induction generator can be used with wind turbine because it has advantage of good frequency regulation. Though IG voltage and frequency are independent of speed variation they can be designed only for specific applications. (4)

## II. PROPOSED MODEL

The proposed model shows the application of bidirectional dc-dc converter with the help of microwind turbine generator to supply domestic load. This can be applied to home appliances like desktop PC. The boost rectifier converts the ac output of PMSG into dc, as well acts as a boost converter.

During low power demand wind power can be stored in battery. This basic working explained above is shown in fig.1.

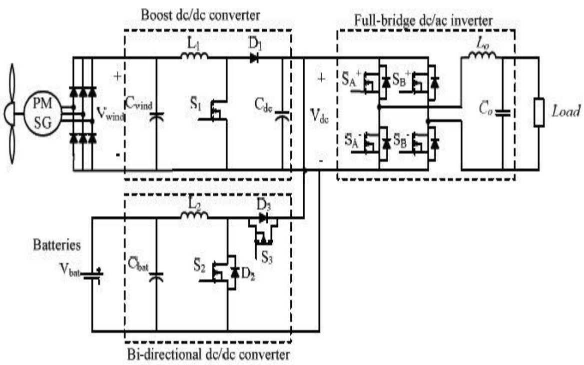
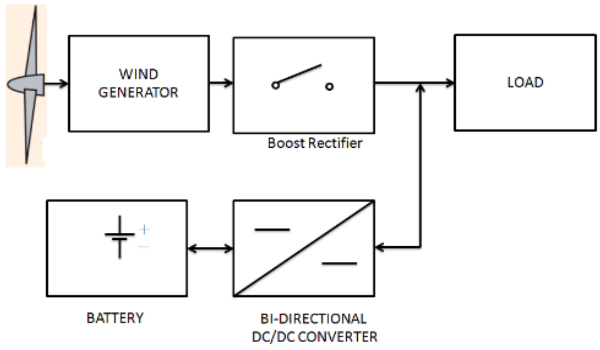



Fig.1.Circuit Diagram

## III. BLOCK DIAGRAM

This is the basic block diagram of microwind energy generation system supplying domestic load. The output of wind generator is rectified, boosted and stored in a lead acid battery using bidirectional dc-dc converter. Bidirectional converter acts in boost mode in case of low output from generator and acts in buck mode during excess wind power output, to charge the battery.

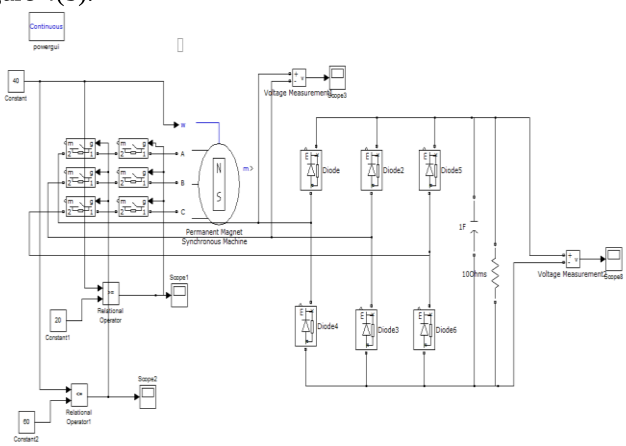



## IV. DESIGN CALCULATION & SIMULATION

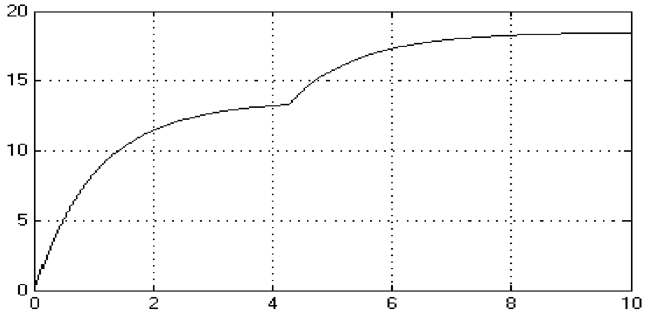
**GENERATOR:**
V=15V
RPM=2300rpm
**RECTIFIER:**
Vr=12V
C=2.5 mF
R=10 ohms
**BOOST CONVERTER:**
Vs=12V
Va=30V
(Vs/Va)-1=k
(12/30)-1=0.6=60%
**R=Va/Ia**=58 ohm
**L=(1-k)KR/(2f)**
=((1-0.6)*0.6*/58)/(2*20*1000)=34.8mH
**C=k/(2fR)**
=0.6/(2*20*1000*58)=25.8µF
**BATTERY:**
V=24V
SOC=50%
**INVERTER:**
INPUT VOLTAGE: 24V
OUTPUT VOLTAGE: 220V

With the above implementation of open loop boost converter the voltage that is received from wind generator is boosted and then used for charging the battery. The implemented boostconverter is shown in the figure 3 (a). The output of the boost converter which settles down after the initial transient period is shown in the figure 3 (b).

The variable speed model of wind generator is shown in the figure 4(a). The output voltage for wind speed of 30 m/s (up to 4.2 sec) and 40 m/s are shown in the figure 4(b).



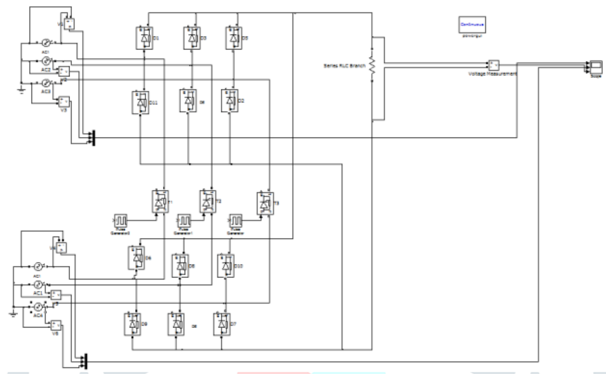
(a)




(b) Fig.4. (a)Variable speed model of wind generator

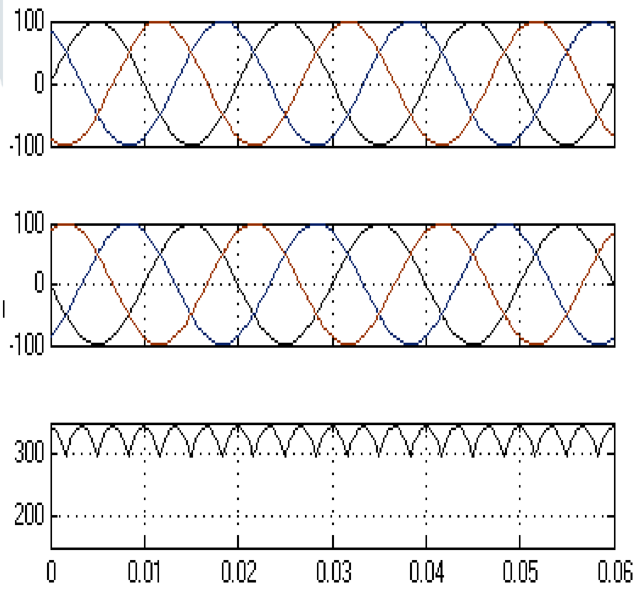
(b) Output of variable speed model

The implementation of low cost boost rectifier is shown in the figure 5 (a). It does not include a boost converter but uses a generator with double stator winding to feed to rectifiers. The input from the windings of generator is phase shifted so as to obtain boosted output from a single generator and hence reduce the cost of using a boost converter.



(a)

The phase shifted input from both ac source (used instead of generator with double stator winding) and the boosted output from rectifier is shown in figure 5(b)

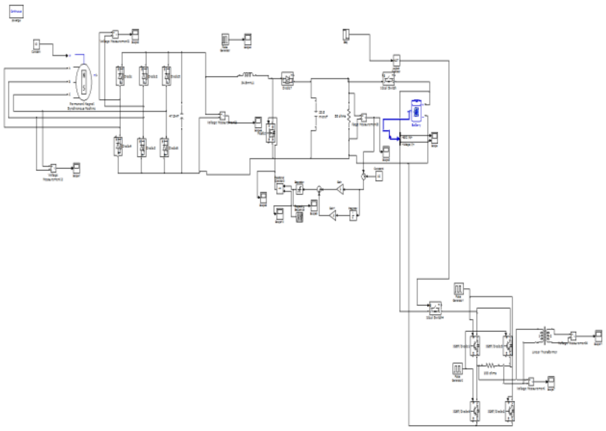



(b)

Fig. 5.(a) Boost rectifier circuit

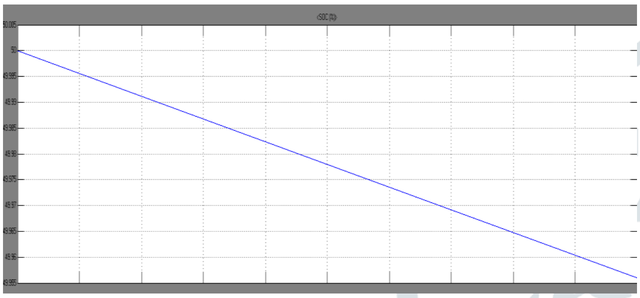
( b) Input and Output waveforms of boost rectifier

The closed loop implemented for the converter with battery storage is shown in fig 6 (a). The output from rectifier is stored in the battery when the load is supplied by the grid. In case of grid failure the battery will discharge to supply to the load. A full bridge inverter is used to convert the dc output of battery to ac and supply ac loads.



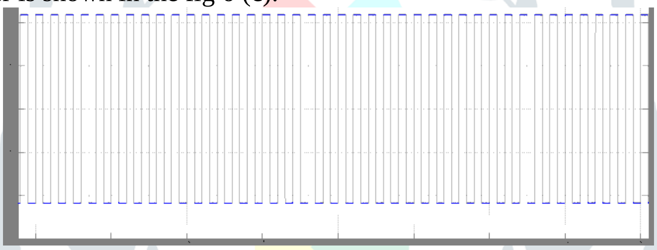
(a)

The SOC (State Of Charge) of battery as it discharges is shown in the fig 6 (b).



(b)

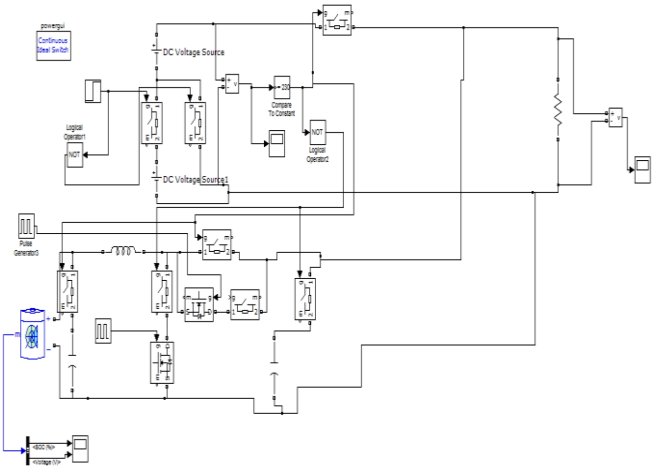
The ac voltage output from inverter is shown in the fig 6 (c).



(c)

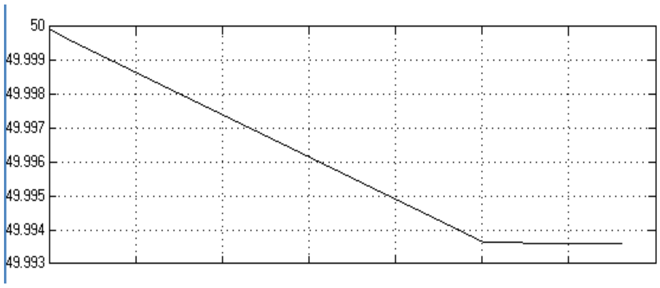
Fig 6: (a)Closed loop of power converter with battery storage(b)Output waveform of SOC of battery (c) Output waveform from inverter of power converter

A bidirectional dc-dc converter can be used instead, which stores charge during excess supply from wind generator and supplies it to the load during reduced wind speed. Hence the load will be supplied continuously either from WEG or battery through a boost converter. The bidirectional dc-dc converter is shown in the figure 7(a).



(a)

The output from the battery which discharges till 0.01sec (for 220 V input) in order to supply 230 V load is shown in the figure 7(b).




(b)

Fig. 7. (a) Bidirectional dc-dc converter circuit
(b) Output of battery SOC from bidirectional dc-dc converter

# I. CONCLUSION

The paper presents a model of power converter for micro wind generator with a low cost rectifier and bidirectional dc-dc converter. The output from wind turbine is thus harvested and used for various household appliances e.g.: Desktop PC. The simulation is done using matlab software. In the near future the proposed model can be implemented as the work is under progress. system is highly efficient. The model can be implemented in normal on a PIC microcontroller.

The proposed model can be implemented with a Maximum Power Point Tracking algorithm (MPPT), to raise the charging efficiency and completely employ the finite power. The

# REFERENCES

[1] Chiang Hua, Chien-Hung Cheng "Design and Implementation of Power Converters for Wind Energy Conversion System" The 2010 International Power Electronics Conference IEEE.

[2] Sharad W. Mohod, *Member, IEEE*, and Mohan V. Aware "Micro Wind Power Generator with Battery Energy Storage for Critical Load". IEEE systems Journal, Vol. 6, No. 1, March 2012.

[3] K. Tan and S. Islam, "Optimum Control Strategies in Energy Conversion of PMSG Wind Turbine System Without Mechanical Sensors," IEEE Transactions on Energy Conversion, Vol. 19, No. 2, pp. 392-399, June 2004.

[4] Ghita, Chirila, Deaconu, Ilina, "Wind turbine permanent magnet synchronous generator magnetic field study" IEEE conference.

Jiacheng Wang, Dewei (David) Xu, BinWu, and ZhenhanLuo "A Low-Cost Rectifier Topology for Variable-Speed High-Power PMSG Wind Turbines", 2192 IEEE Transactions On Power Electronics, Vol. 26, No. 8, August 2011.