AC-DC-DC Converter for Intermittent Wind Energy

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Abstract **- Energy is one of the most important resources for the growth of any country. Wind energy is playing an important role in meeting today's words energy demand. Renewable energy sources are intermittent in nature. Such uncertainty results in revenue losses to the wind power producers. The main objective of this paper is to focus on the analysis of performance of an open loop AC-DC-DC converter system. Converter is simulated using PSIM software.**

Keywords**: Rectifier, DC-DC converter, PSIM**

I. INTRODUCTION

In India development of wind energy started in early 1950s. Indian wind energy system holds fourth position in the world with total installations having crossed the 31 GW mark at the end of March 2017. The total renewable energy capacity installed in the country crossed the 50 GW mark. Among renewables, wind power accounted for over 57 percent of the installed capacity [1].Need for reducing global warming and significant increase in the prices of conventional energy sources have encouraged many countries to provide new energy policies that promote the renewable energy applications. They are cost effective, user-friendly. By promoting renewable energy sources we can avoid, Air pollution, soil pollution and water pollution. Country's Economy will increase [2]. They are the most economic power plant technology, due to reduced installations costs, no fuel costs and construction time of less than one year, compared to over 10 years to construct nuclear power plants [3]. But these renewable energy sources are intermittent in nature. Such uncertainty results in revenue losses to the wind power producers. Instead wind power producers can purchase or schedule some reserves to offset part of their deviation rather than being fully penalized in the real-time market [4].

Mostly, wind-powered generators are induction generators that absorb reactive power during normal operating conditions. This may create low-voltage issues in power system. Under voltage relay installed at new generator bus will trip the new generator units when its terminal voltage drops down to the setting value [5].

Smoothing the wind power fluctuation in wind power plants is a feasible solution to the wind power integration issue. Lots of researches focus on the wind fluctuation smoothing by the energy storage system [6]. References [9] to [12] explain the performance analysis of DC DC converter used in renewable energy input systems.

II. BLOCK DIAGRAM

Generally wind generators are capable of producing a large amount of power in MW's, but presence of wind is intermittent and unreliable sometimes wind speed will be very slow than the minimum wind speed required start the wind mill.

Figure 1 below shows the block Diagram of wind power converter system [7]. It consists of wind generating system, Rectifier unit, DC-DC Converter unit and an inverter system which may be connected to utility grid. A large wind station may consist of several hundred individual wind turbines.

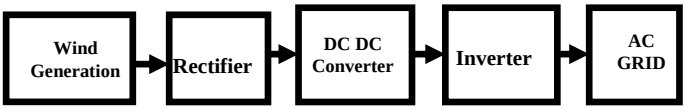


Fig. 1 Block Diagram of wind power converter system

A simple three phase diode bridge rectifier circuit is as shown in figure (2) which is fed from a balanced three phase supply. Rectifier voltage is fed into dc dc converter shown in figure (3)and figure (4)[8]. Depending on the duty cycle, output voltage can be varied or adjusted.

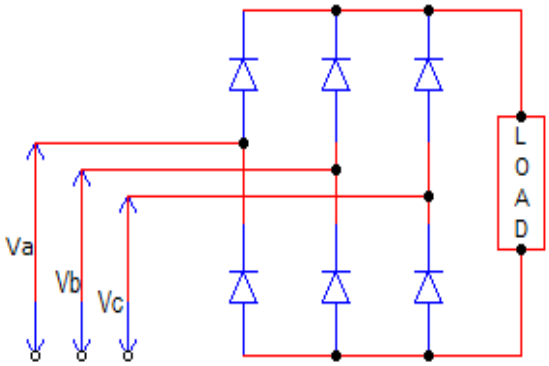


Fig. 2 Diode bridge rectifier circuit

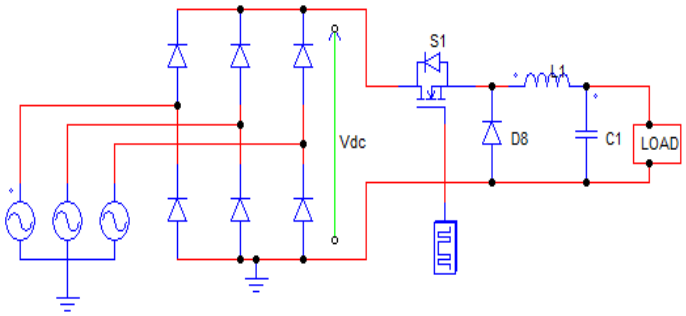
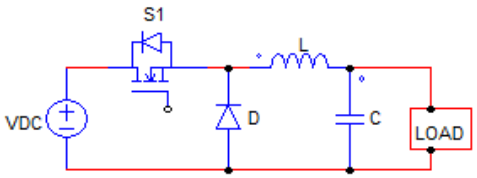


Fig. 3 AC- DC-DC converter



(c)

Fig. DC-DC converter

There are four main components: switching power MOSFET S, freewheeling diode D, inductor L and outputfilter capacitor C[9]. A switching control circuit monitors the output voltage, and maintains it at the desired level by switching 'S' ON and OFF at a fixed rate, but with a varying duty cycle.A buck converter consists of two operating modes which are continuous conduction mode (CCM) and discontinues conduction mode (DCM). Usually CCM technique is applied for efficient power conversion while the DCM is for lowpower and stand-by application

III. SIMULATION RESULTS

The simulations were performed in order to view the characteristics of the proposed AC-DC-DC converter using PSIM software. Fig. 4 is the simulation circuit and Figure 5(a) and (b) shows input voltage at one phase and output

Voltage waveform of open loop Converter respectively. For an input voltage of 440 V ac output voltage, output of rectifier is 420V dc which can be further changed to any other voltage depending on duty cycle vale.

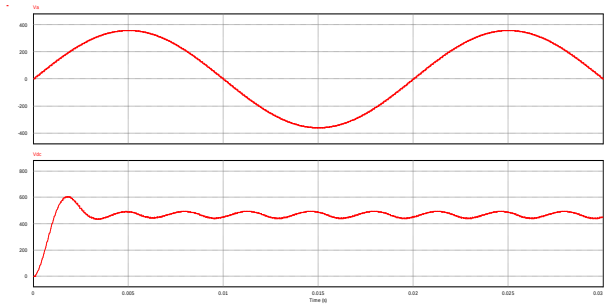


Fig. (5a)

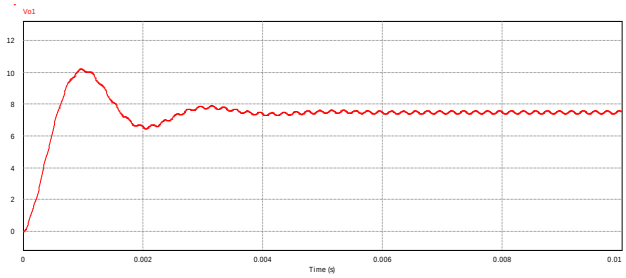


Fig. (5b)

Fig. 5 Simulation Results (a) Input and output waveforms of Rectifier unit, (b) output waveforms of converter

IV. CONCLUSION

This paper presents the analysis of performance of an open loop AC-DC-DC converter system. Converter is simulated using PSIM software. Output of 420V dc is produced from input of three phase 440V, 50 Hz ac supply. For an input voltage of 440 V ac output voltage, output obtained is 420V DC for a given duty cycle.

V. FUTURE SCOPE

Feedback can be taken from output of the converter to operate it in closed loop condition. Uty cycle can be automatically adjusted to give a constant output voltage irrespective of the external disturbances.

REFERENCES

[1]. Indian wind energy: A brief outlook.
[2]. Nada Kh. M. A. Alrikabi, Renewable Energy Types, Journal of Clean EnergyTechnologies, Vol. 2, No. 1, January 2014.
[3]. SuaadJaber, Environmental Impacts of Wind Energy, Journal of Clean Energy Technologies, Vol. 1, No. 3, July 2013.
[4]. Ershun Du., Ning. Zhang, Chongqing Kang, Benjamin Kroposki,Han Huang, Miao Miao,Qing Xia "Managing Wind Power UncertaintyThrough Strategic Reserve Purchasing," IEEE transactions on power systems., vol.32, no. 4, pp. 1-12, Jul. 2017.
[5]. Chai Chompoo-inwai, PraditFuangfoo, Mitch Williams, James R. Liao, System Impact Study for the Interconnection of Wind Generation and Utility System, IEEE transactions on industry applications, VOL. 41, NO. 1, January 2005.
[6]. Diaz-Gonzalez, Francisco, A. Sumper, et al, "Control of a Flywheel Energy Storage system for Power Smoothing in Wind Power Plants," IEEE Trans. Energy Convers., vol. 29, no. 1, pp. 204-214, Mar. 2014.
[7]. H. Sushma and K. M. Chandrasekharswamy, "A dual unequal power converter for wind power applications," 2017 International Conference on Computation of Power, Energy Information and Commuincation (ICCPEIC), Melmaruvathur, 2017, pp. 639-642.
[8]. M. Ben Hamed and O. Elbeji, "Three-cell DC-DC converter for variable speed WECS with MPPT control," 2017 International Conference on Green Energy Conversion Systems (GECS), Hammamet, 2017, pp. 1-6.
[9]. Ubaidulla, Satish Kumar J , Malashree G., Study and Analysis of DC – DC Step down Converter, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 6, Issue 6, June 2017.
[10]. R.Abinaya, M.Jagadeeshraja, V.Seenivasan, A Novel Approach for Integration of Solar-Wind Energy System Using MPPT Algorithm, International Journal of Research and Scientific Innovation (IJRSI) | Volume V, Issue IV, April 2018.
[11]. Ubaidulla, Malashree G., Dual Input DC-DC Converter for Photo Voltaic Applications, International Journal of Innovative Research in Science, Engineering and Technology , Vol. 7, Issue 5, May 2018
[12]. Malashree. G, Gnaneshwari. V, Vinay Shreyas K. V, Ubaidulla, Satish Kumar J, Renewable Based Smart Home Control using Modern Technology, International Journal of Research and Scientific Innovation (IJRSI) | Volume IV, Issue VIS, June 2017.