Asian Journal of Electrical Sciences
ISSN: 2249-6297 (P) Vol.10 No.1, 2021, pp.1-4
© The Research Publication, www.trp.org.in
DOI: https://doi.org/10.51983/ajes-2021.10.1.2794

Performance Analysis of a High Gain LUO Converter-Based Hybrid PV-Wind System

N. Amutha Priya[1], M. Aswin[2], S. J. Azis Shane[3], Y. Blessing Dino[4] and D. Dagul[5]
[1]Assistant Professor, [2,3,4&5]Student
[1,2,3,4,&5]Department of EEE, Rohini College of Engineering and Technology, Kanyakumari, Tamil Nadu, India
E-mail: a.amazing13@gmail.com
(Received 13 December 2020; Revised 31 December 2020; Accepted 23 January 2021; Available online 30 January 2021)

Abstract **- This project is aimed at the implementation of a fuzzy logic algorithm based maximum power point tracking in transformer less grid connected PV system along with reactive power compensation. A single diode model is used for PV array and its simulation is performed using MATLAB. In fuzzy logic controller, voltage and current are taken as inputs and the effective value of A.C current corresponding to the maximum power point is obtained as output. Thus, in addition to supplying voltage by the inverter without transformer for compensating the reactive power not exceeding its power rating. This results in utilization of PV system at night and at periods of low irradiation. Rules relating the input and output of fuzzy logic controller are written and simulation is performed. A LUO Converter is used for maintaining DC input to the inverter at various conditions of irradiation and temperature. Gating pulses to the inverter are generated by proportional-integral controller. Hardware model of a10W solar panel is developed and results are obtained with fuzzy logic controller for different irradiation and temperature conditions. Results show the effectiveness of the proposed method in utilizing the PV system. This project is implemented using DSPIC30F2010 controller.**
Keywords: **PV, Fuzzy, LUO, Solar, PI, Controller**

I. INTRODUCTION

Due to the critical condition of industrial fuels which include oil, gas and others, the development of renewable energy sources is continuously improving. This is the reason why renewable energy sources have become more important these days. Few other reasons include advantages like abundant availability in nature, eco-friendly and recyclable. Many renewable energy sources like solar, wind, hide and tidal are there. Among these renewable sources solar and wind energy are the world's fastest growing energy resources. With no emission of pollutants, energy conversion is done through wind and PV cells. Day by day, the demand for electricity is rapidly increasing. But the available base load plants are notable to supply electricity as per demand. So, these energy sources can be used to bridge the gap between supply and demand during peak loads. This kind of small-scale standalone power generating systems can also be used in remote areas where conventional power generation is impractical. Hybrid generation systems that use more than a single power source can greatly enhance the certainty of load demands all the time. Even higher generating capacities can be achieved by hybrid system. In standalone system we can able to provide fluctuation free output to the load irrespective of weathers condition. To get the energy output of the PV system converted to storage energy, and constant power delivered by the wind turbine, an efficient energy storage mechanism is required, which can be realized by the battery bank. Using an isolation transformer in the grid-connected inverter can solve the problem of the leakage current caused by the earth parasitic capacitance in solar modules. There are two types of grid-connected inverter with an isolation transformer,

1. Line frequency transformer
2. High-frequency transformer.

II. EXISTING SYSTEM

In the existing system DC-DC Boost converter is used. It is the single order filter. The boost ratio of the boost converter is 1:1.5. Then the hysteresis controller is used here to control the reference signal of the pulse width modulator to generate the gate pulses which is given to the thyristors of the inverter. Due to these the power quality of the grid is not satisfied clearly.

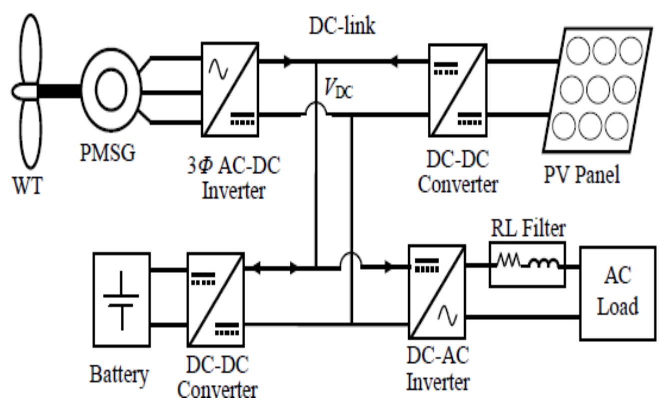

Fig. 1 Existing System

To overcome the disadvantages of the existing system, the following objectives are framed in this work.

1. To implement hybrid energy based single phase voltage source inverter.
2. To maintain constant output voltage to the load or grid using wind and solar energy based system.
3. To implement multi input LUO converter based hybrid energy system.

III. BLOCK DIAGRAM

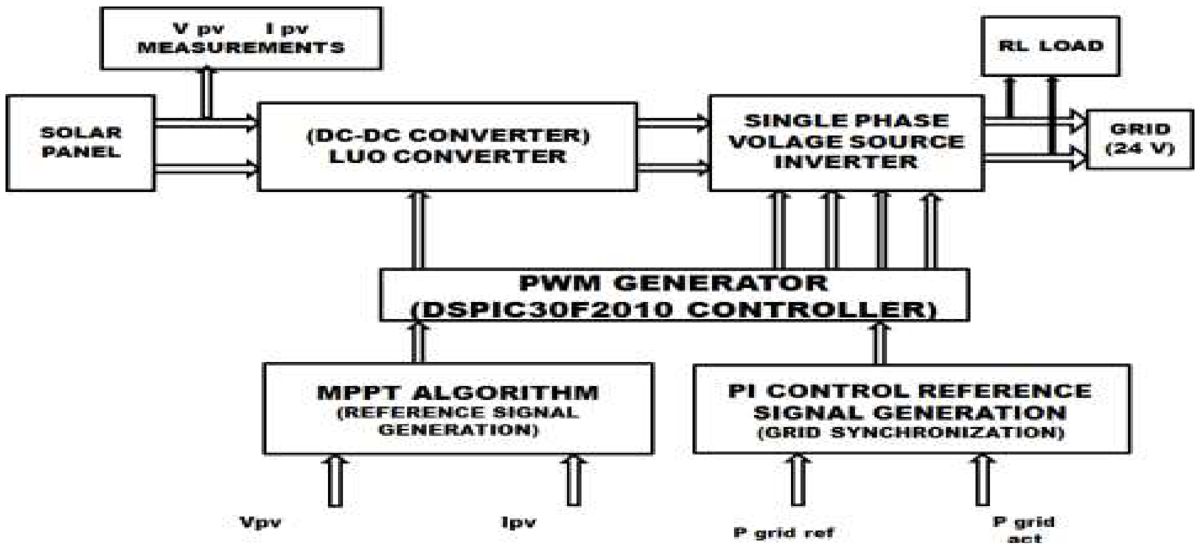

Fig. 2 Block Diagram of Proposed System

In grid connected mode of distributed generation applications, the elimination of line frequency transformer is possible without impacting system characteristics related to grid integration, ground leakage current, dc injection, safety issues etc. This project presents the design, modeling, simulation and implementation of modified LUO Converter based closed loop operation of a novel inverter topology suitable for transformer-less single phase grid connected hybrid systems. The fuzzy logic control scheme ensures extraction of maximum power from the solar Photovoltaic (PV) and wind source, synchronization with the grid and controlled active and reactive power transfer to the grid using PI controller.

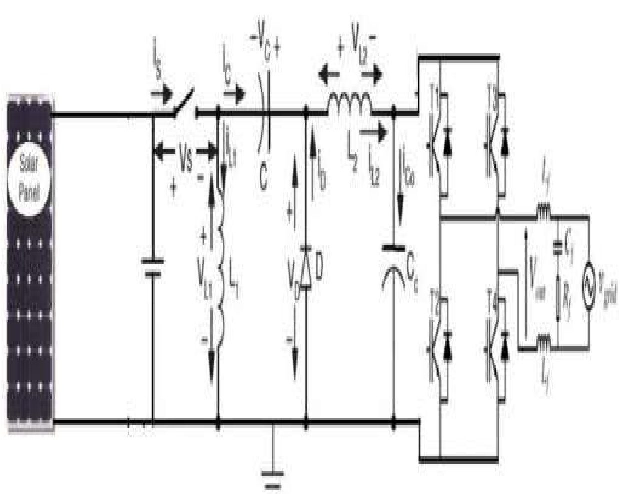

Fig. 3 Circuit Diagram of Proposed System

The DC output voltage is obtained from the solar panel. The AC output voltage is obtained from the wind energy system. In the wind energy conversion system Permanent Magnet Synchronous Generator is used to produce the AC output voltage. Then the uncontrolled diode bridge rectifier is used to convert this AC output voltage into DC voltage. Both voltages are synchronized and fed into the LUO convertor. This LUO convertor converts variable DC voltage into fixed DC voltage. Here MPPT technique is used to obtain maximum power from the solar panel without any loss. In this MPPT technique, fuzzy logic algorithm is used to produce reference pulses which is compared with carrier signal in the pulse width modulator to produce the gate pulses. This gate pulses are given to the LUO converter. Then the fixed DC output voltage is given to the inverter to convert that DC voltage into AC output voltage. For that purpose, single phase three level voltage source inverter is used here, in which PI controller technique is used to reduce the power quality problems. Then the AC output voltage is given to the grid.

IV. HARDWARE SETUP RESULTS

The hardware setup designed for utilizing solar power at night is displayed in Fig. 4. A linear 5V power source is used in this circuit to enable regulation in the circuit with generation of multiple power output. The DC-DC power converter control is specially utilized in the proposed transformer-less grid connection circuit. This helps to get rid off the ripples present the power output of solar panel. Also, frequency ripple is removed or filtered with band-stop filters I and II. PI controller enables the degradation of steady state error. Finally, the reference current signal gets generated and is then supplied to the DC-AC power converter circuit. Phase locked loop in this circuit generates a unity sinusoidal in-phase signal. This is then fed to op to-isolator circuit where the op to-coupler isolates the control unit from power unit to avoid damage occurrence in direct connection. This is handled by DSPIC controller. In this work, DSPIC30F2010 is considered in this design for handling an intermittent floe of energy from source like PV.

Fig. 4 Hardware Setup

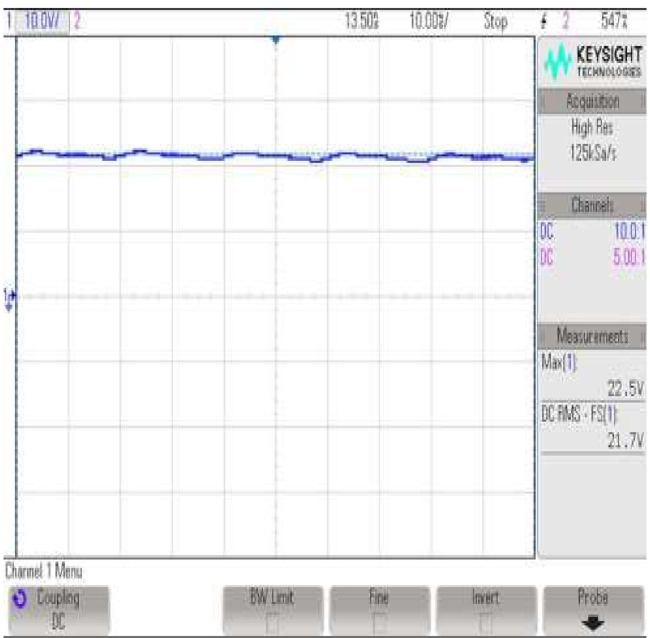

Fig. 5 Solar Panel Output

Fig. 5 shows the voltage output from the considered renewable energy system. It indicates that the DC rms output is 21.7V in magnitude. But the output voltage is not a constant value. This impact is completely removed with the usage of LUO converter and the same is displayed in fig. 6. The output voltage of LUO converter s found to be at a constant value. LUO act as second order filter and has suppressed the ripples completely. Also as LUO is a step-up converter, the magnitude of DC voltage is enhanced from 21.7V to 100V. In this way, the proposed system sufficiently ensures total comfort to the consumers who rely over PV power for electricity input.

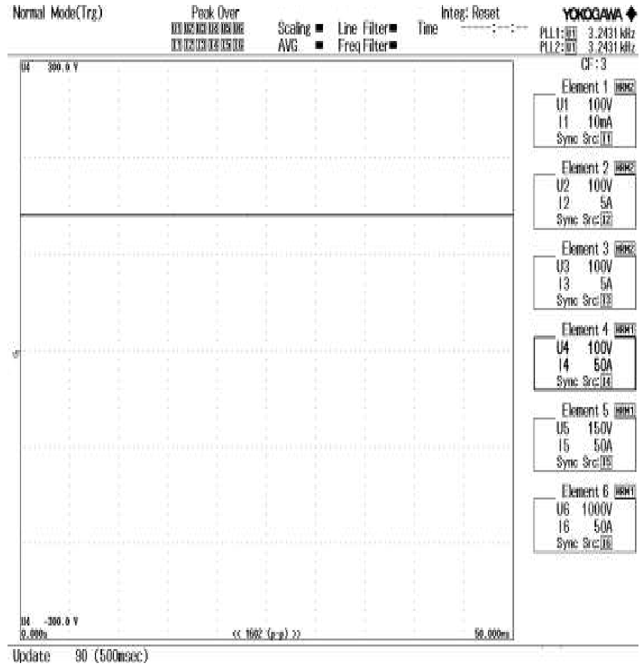

Fig. 6 LUO Converter Output

V. CONCLUSION

Hybrid distributed generation system with PV-wind combination is used for driving a permanent magnet synchronous motor based system. The LUO converter is considered to play the key role in handling the ripples and also in enhancing the voltage output of source circuit before conversion to AC. Inverter stage following the LUO converter is implemented with necessary model of MATLAB software initially for testifying the system performance. The simulation circuit includes two different controllers namely, digital MPPT fuzzy logic controller and PI controller for tracking purpose. The hardware also repeats the simulated output performance. Thus, the proposed system is proved to handle the renewable power output utilization to the maximum. It is known that the system offers maintenance free operation, reliability and low cost. At grid-side, the captured steady state waveforms show that DG system generated power is fed to grid at unity power factor. Obtained THD values, i.e., both voltage and current of the generator is found to meet the required power quality norms of IEEE standards. This system will aid in implementing smart grid aspects in future.

REFERENCES

[1] B. Subudhi and R. Pradhan, "A Comparative Study on Maximum PowerPoint Tracking Technique for Phototvoltaic Power Systems," *IEEE Trans. Sustain. Energy*, Vol. 4, No. 1, pp. 89-98, Jan. 2013.

[2] Byung-Duk Min, Jong-Pil Lee, Jong-Hyun Kim, Tae-Jin Kim, Dong-Wook Yoo, Eui-Ho Song, "A New Topology with High Efficiency Throughout All Load Range for Photovoltaic Pcs," *IEEE Trans. Ind. Elecron*., Vol. 56, No. 11, pp. 4427-4435, Nov. 2009.

[3] C. Liu, K. T. Chau and X. Zhang, "An Efficient Wind-Photovoltaic Hybrid Generation System Using Doubly Excited Permanent –

Magnet Brushless Machine", *IEEE Trans. Ind. Electron*, Vol. 57, No. 3, pp. 831-839, Mar. 2010.

[4] C. N. Bhende, S. Mishra and Siva Ganesh Mala, "Permanent Magnet Synchronous Generator-Based Standalone Wind Supply System," *IEEE Trans. Sustain. Energy*, Vol. 2, No. 4, pp. 361-373, Oct. 2011.

[5] Chen, W. Wang, C. Du and C. Zhang, "Single-phase hybrid clamped three-level inverter based photovoltaic generation system," in Proc. *IEEE Int. Symp. Power Electron. Distrib. Generation Syst.*, pp. 635–638, Jun. 16-18, 2010

[6] H. C. Chiang, T. T. Ma, Y. H. Cheng, J. M. Chang and W. N. Chang, "Design and implementation of a hybrid regenerative power system combining grid-tie and uninterruptible power supply functions," *IET Renewable Power Generation*, 2010, Vol. 4, No. 1, pp. 85-99, 2010.

[7] H. Polinder, F. F. A. van der Pijl, G. J. de Vilder and P. J. Tavner, "Comparison of direct=drive and geared generator concepts for wind turbines," *IEEE Trans. Energy Convers*., Vol. 21, No. 3, pp. 725-733, Sep. 2006.

[8] J. Byun, S. Park, B. Kang, I. Hong and S. Parh, "Design and implementation of an intelligent energy saving system based on standby power reduction for a future zero energy home environment," *IEEE Trans. Consum. Electron.,* Vol. 59, No. 3, pp. 507-514, Oct. 2013.

[9] Jinwei He, Yun Wei Li and F. Blaabjerg, "Flexible Microgrid Power Quality Enhancement Using Adaptive Hybrid Voltage and Current Controller," *IEEE Trans. Ind. Electron*, Vol. 61, No. 6, pp. 2784-2794, June 2014.

[10] Kerekes, M. Liserre, R. Teodorescu, C. Klumpner and M. Sumner, "Evaluation of three-phase transformer less photovoltaic inverter topologies," *IEEE Trans. Power Electron*., Vol. 24, No. 9, pp. 2202-2211, Sep.2009.

[11] L. Ma, T. Kerekes, R. Teodorescu, X. Jin, D. Floricau and M. Liserre, "The high efficiency transformer-less PV inverter topologies derived from NPC topology," *in Proc. Eur. Conf. Power Electron. Appl.*, pp. 1-10, Sep. 8-10, 2009.

[12] M. A. G de Brito, L. Galotto, L. P. Sampaio, Guilherme de Azevedoe Melo and C. A. Canesin, "Evaluation of the Main MPPT Technique for Photovoltaic Applications", *IEEE Trans. Ind. Elecron*., Vol. 60, No. 3, pp. 1156-1167, Mar. 2013.

[13] O. Lopez, F. D. Freijedo, A. G. Yepes, P. Fernandez Comesaa, J. Malvar, R. Teodorescu and J. Doval Gandoy, "Eliminating ground current in a transformerless photovoltaic application," *IEEE Trans. Energy Convers*., Vol. 25, No. 1, pp. 140-147, Mar. 2010.

[14] S. L. Brunton,C. W. Rowley, S. R. Kulkarniand C. Clarkson, "Maximum power point tracking for photovoltaic optimization using ripple-based extremum seeking control," *IEEE Trans. Power Electron*., Vol. 25, No. 10, pp. 2531-2540, Oct. 2010.

[15] S. V. Araujo, P. Zacharias and B. Sahan, "Novelgrid-connected non-isolated converters for photovoltaic systems with grounded generator*," in Proc. IEEE Power Electron*. Spec. Conf, pp. 58-65, June 15-19, 2008.