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Digital Simulation of Closed Loop Controlled Micro Grid System with Four Different Sources

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ABSTRACT: Interleaved boost converter is a good interface between four different source and inverter. This Work deals with design, modelling and simulation of the interleaved boost converter inverter based PID controlled four different source systems. Interleaved boost converters to reduce the ripple in the DC output. The DC from the solar cell is stepped up using interleaved boost converter. The output of the interleaved boost converter is converted to 50Hz AC using a single phase full bridge inverter. The objective of this work is to improve dynamic response of closed loop system using PID controller. The simulation results of PI and PID controlled closed loop systems are compared. This paper has presented a simulink model for the closed loop controlled four different source systems.

KEYWORDS: Bidirectional inverter, Interleaved Boost Converter, Maximum power point trackers (MPPTs), Proportional integral derivative (PID), Proportional Controller (PI), Pulse Width Modulation (PWM), DC-distribution applications, Sim Power System.

List of Abbreviations:
ILBC – Interleaved Boost Converter
PID – Proportional integral derivative
ZVS - Zero Voltage Switch
PWM - Pulse Width Modulation
PV - Photo voltaics
WG- Wind generation
SC- Supper capacitor
BS- Battery source
MPPT- Maximum Power Point Tracker
MATLAB- Matrix Laboratory

I. INTRODUCTION

Renewable energy sources have become an important part of energy production. The application of clean and renewable energy sources, such as wind energy, solar energy and hydrogen, in dc micro grids or nano grids has been a focus in academia and industry. However, due to intermittent feature of wind and solar sources, wind power and photovoltaic (PV) systems need energy storage units to balance electricity generation and consumption within a power system, which has a high wind/solar energy penetration. In order to fulfill various system requirements, many hybrid system configurations and converter topologies have been proposed and investigated as reviewed. In order to combine several input power sources two approaches are usually adopted: multiple-converter systems and multiple-port systems. On the one hand, multiple-converter systems are formed by connecting the input sources by individual dc-dc converters. This system configuration offers some advantages such as easier implementation of the power management

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and control scheme. However, it presents the disadvantage of higher number of components and, consequently, low power density and high cost. On the other hand, multiple-port or multiple-input converters (MIC) have recently been introduced and have attracted increased research interest. In these topologies, the common characteristic is the shared output stage by the different input ports, reducing the cost by reducing the number of components, and increasing the system efficiency and power density. However, the control and power management system tend to become more complex. Some of the proposed MIC does not allow bidirectional operation as the input ports are completely decoupled, and therefore they PID be used in systems requiring of energy storage units.

Systems interconnecting a renewable energy source and an energy storage unit are usually known as dual-input converters or three-port converters. In such a system, the mismatch power is handled by the energy storage unit, which will absorb the surplus energy at light load and will supply the energy deficit at heavy load conditions. Therefore, different power flows can take place depending on the power of the renewable energy source and load consumption.

Four Quadrants Integrated Transformers for Dual Input Isolated dc converters is given by Z. Ouyang (2012). Full-Bridge Three-Port Converters with Wide Input Voltage Range for Renewable Power Systems is given by (2012). Interleaved Boost-Half-Bridge Dual-Input DC-DC Converter with a PWM Plus Phase-Shift Control for Fuel Cell Applications is given by Z. Zhang (2013). Multiport Converters Based on Integration of Full-Bridge and Bidirectional DC–DC Topologies for Renewable Generation Systems is given by H. Wu (2014). Dual-Input DC-DC Converter Combining a Boost-Half-Bridge Cell and a Voltage-Fed Full-Bridge is given by Z. Zhang (2013). Buck boost dc–dc converter topology with soft switching is given by M. Pavlovsky (2013). A Novel Capacitor-Switched Regenerative Snubber for DC / DC Boost Converters is given by J. Bauman (2011). High- efficiency two- switch tri-state buck-boost power factor correction converter with fast dynamic response and low inductor current ripple is given by M. He (2013). A dual full- bridge resonant class-e bidirectional dc-dc converter is given by S. Jalbrzykowski (2011). Single-inductor dual-output Buck boost power factor correction converter is given by X. Liu (2015). A novel buck-boost converter Combining KY and Buck converters is given by K. I. Hwu (2012). A high-efficiency positive buck boost converter with mode select circuit and feed-forward techniques is given by J.-J. Chen (2103). A Review of Power Decoupling Techniques for Microinverters with Three Different Decoupling Capacitor Locations in PV Systems is given by H. Hu (2013).

The above literature does not cover comparison of PI and PID based closed loop controlled Interleaved boost converter inverter based systems. This work aims to develop closed loop simulink model for ILBC inverter based solar system employing the PID. The PID is proposed for the control of ILBC based wind, battery, supper capacitor & solar system. The Photovoltaic system Using PID is shown in Fig. 1. The output of PV system stepped up using ILBC. The output of ILBC is converter into AC using an inverter. The circuit of ILBC is shown in Fig.2.

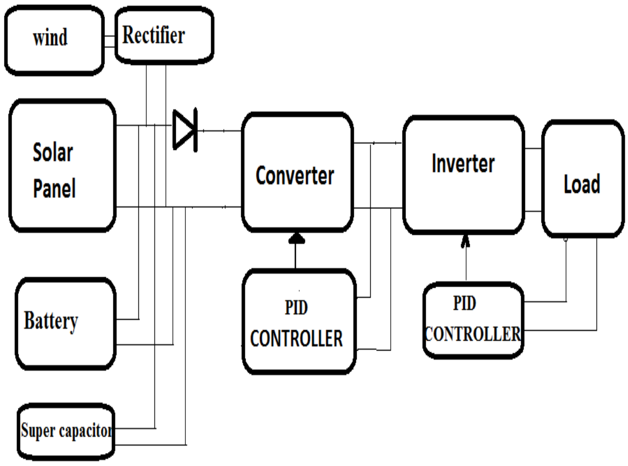

Fig 1: Four different source system Using PID

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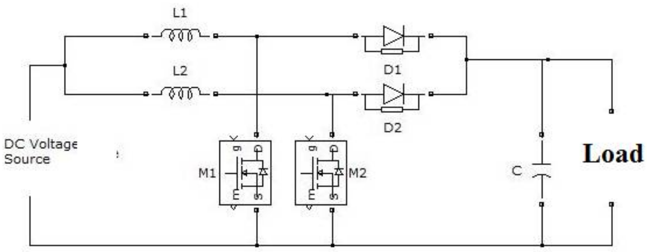

Fig.2. Circuit of ILBC

II. SIMULATION RESULTS

Open loop system with step change in input is shown in Fig. 3. The step change in input due to increase in the wind generation voltage is shown in Fig. 3a. The output voltage of ILBC is shown in Fig. 3b. The voltage increases from 56V to 96V. The AC output voltage and load current are shown in Fig. 3c and Fig. 3d respectively. It can be seen that the steady state errors in the output voltage and current are higher.

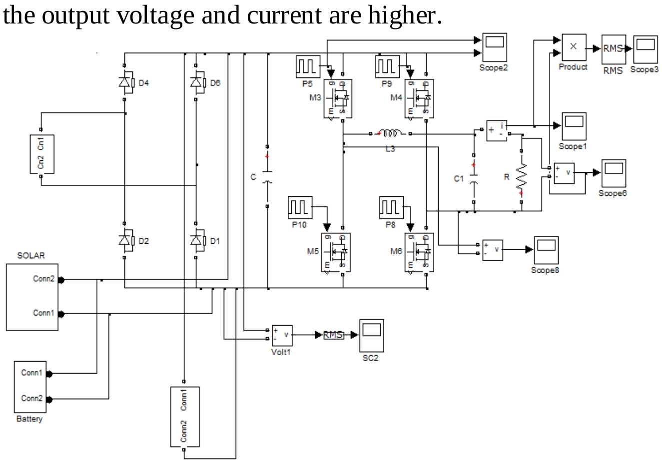

Fig.3. Open loop Controlled system with step change in Input

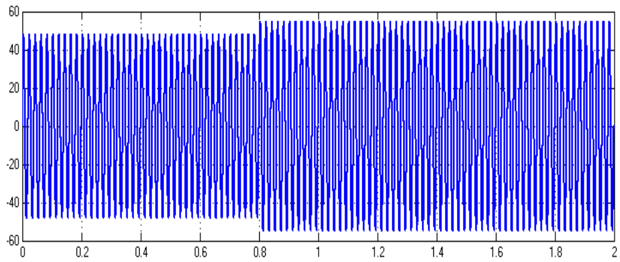

Fig.3a. Input Voltage of the wind generation System.

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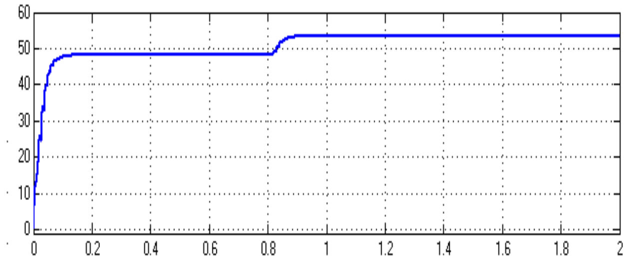

Fig.3b. Output Voltage of ILBC

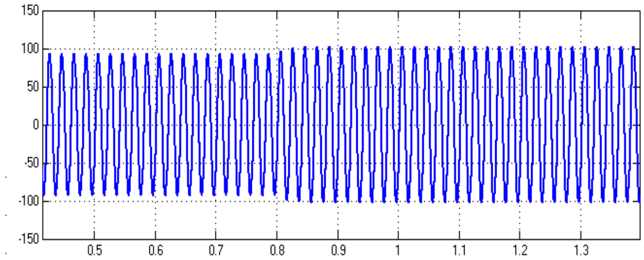

Fig.3c. Output Voltage of the Inverter

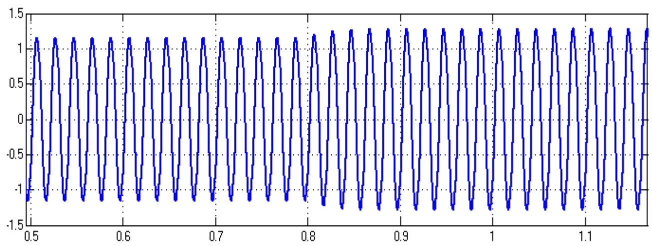

Fig.3d. Output Current of the Inverter

The Simulink diagram of the closed loop system with PI controller is shown in Fig. 4. The DC output voltage of the ILBC is compared with the reference voltage. The error is processed using a PI controller. The output of the PI controller is used to update the pulse width applied to the ILBC converter. The step change in input voltage is shown in Fig. 4a. The input voltage increases from 48V to 56V. The output of the boost converter is shown in Fig. 4b. The output voltage settles at 96V. The output voltage and current waveforms are shown in Figs. 4c and Fig. 4d respectively.

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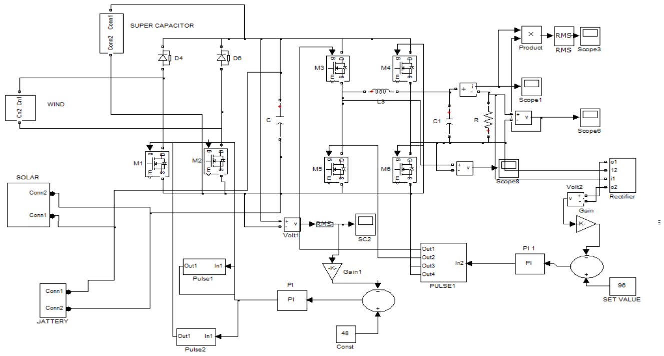

Fig.4. Simulink Model of the Closed Loop System with PI Controller

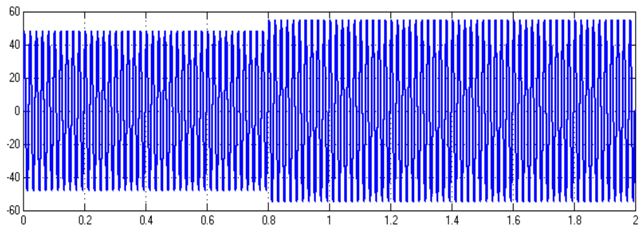

Fig.4a. Input Voltage of the wind generation System

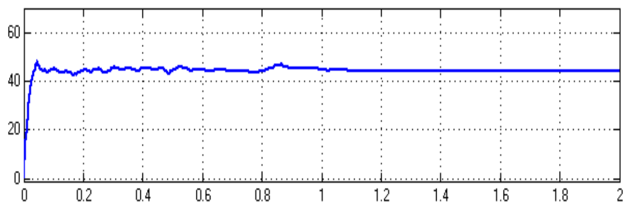

Fig.4b. Output Voltage of the ILBC

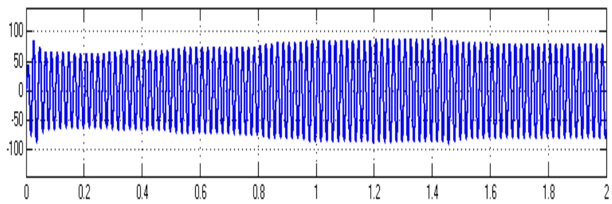

Fig.4c. Output Voltage of the Inverter

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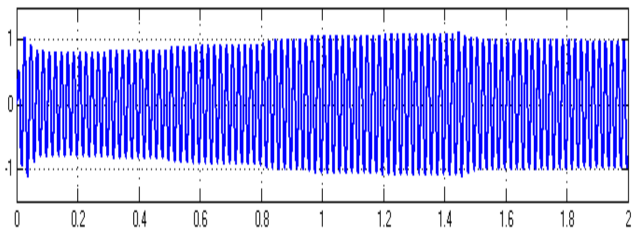

Fig.4d. Output Current of the Inverter

Closed loop system with the PID is shown in Fig 5.The PI controller is replaced by the PID. The inputs to the PID are the error and its derivative. The increase in input due to increase in insulation is shown in Fig 5a. The input voltage increases from 48V to 56V. The output of the ILBC is shown in Fig 5b. The output voltage and current of the inverter are shown in Fig 5c and Fig 5d respectively. The comparison of responses between PI and PID is given in Table – I. The settling time and steady state error are very much reduced using PID.

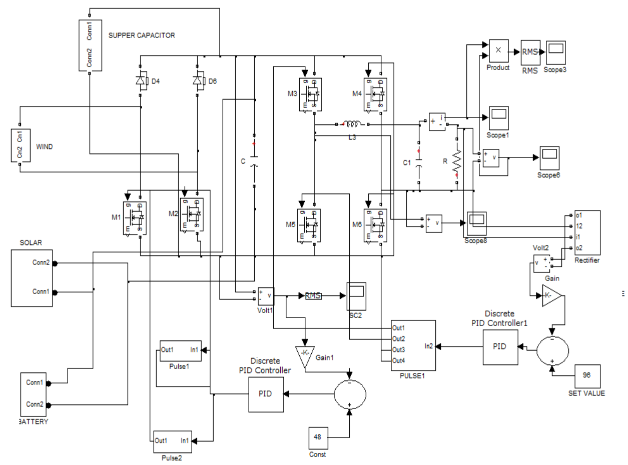

Fig 5. Simulink Model of the closed loop System with PID

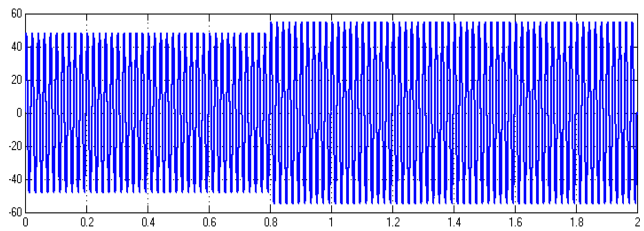

Fig 5a. Input Voltage of Solar System

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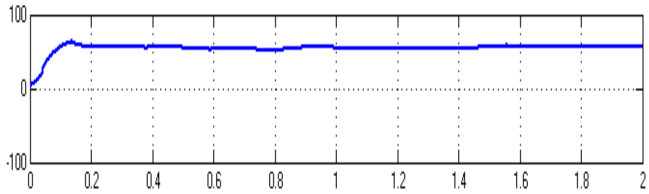

Fig 5b. Output Voltage of the Buck Boost Converter

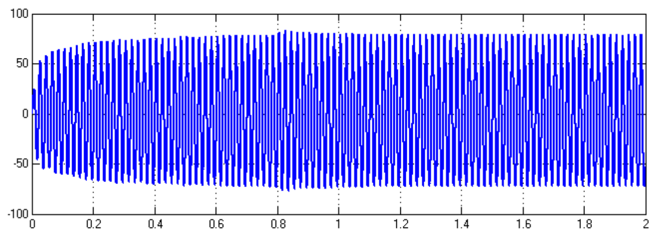

Fig 5c. Output Voltage of the Inverter

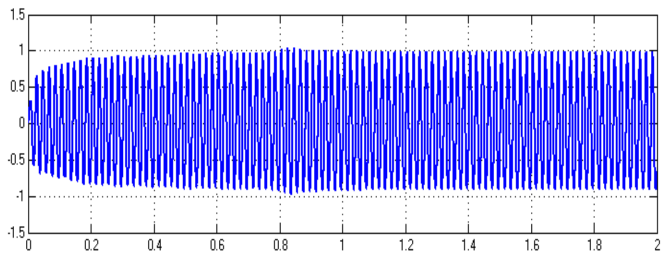

Fig 5d. Output Current of the Inverter

Table – I

Comparison of responses with PI and PID Controllers

Controllers	Rise time (s)	Peak time (s)	Settling time (s)	Steady state error (v)
PI controller	0.2	0.21	1.1	5
PID	0.17	0.15	0.9	3.1

III. CONCLUSION

This work has reviewed various controllers for improving dynamic response of four different sources inverter system. Closed loop controlled ILBC inverter systems with PI and PID are successfully modelled and simulated using sim power system. The results of open loop and closed loop systems were presented. The closed loop system was capable of reducing the steady state error to minimum value using PID. The Simulation results indicate reduction in settling time and rise time. The simulation results were in line with the predications. The closed system had advantages

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like improved response and reduced steady state error. The disadvantage of this system was that it had limited voltage tracking range.

The scope of this work is the simulation of closed loop controlled converter – inverter system with PI and PID controllers. The closed loop simulation using Fuzzy logic based controller will be done in future.

IV. ACKNOWLEDGEMENT

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REFERENCES

[1] Z. Ouyang, Z. Zhang, M. Andersen and O. Thomsen, "Four Quadrants Integrated Transformers for Dual Input Isolated dc dc converters," *IEEE Transactions on Power Electronics,* vol. 27, no. 6, pp. 2697-2702, 2012.

[2] H. Wu, K. Sun, R. Chen, H. Hu and Y. Xing, "Full-Bridge Three-Port Converters With Wide Input Voltage Range for Renewable Power Systems," *IEEE Transactions on Power Electronics*, vol. 27, no. 9, pp. 3965-3974, 2012.

[3] Z. Zhang and M. Andersen, "Interleaved Boost-Half-Bridge Dual-Input DC-DC Converter with a PWM Plus Phase-Shift Control for Fuel Cell Applications," in *39th PIDual Conference of the IEEE Industrial Electronics Society, IECON 2013*, 2013.

[4] H. Wu, P. Xu, H. Hu, Z. Zhou and Y. Xing, "Multiport Converters Based on Integration of Full-Bridge and Bidirectional DC–DC Topologies for Renewable Generation Systems," *IEEE Transactions on Industrial Electronics,* vol. 61, no. 2, pp. 856-869, 2014.

[5] Z. Zhang, O. Thomsen and M. Andersen, "Soft-Switched Dual-Input DC-DC Converter Combining a Boost-Half-Bridge Cell and a Voltage-Fed Full-Bridge Cell," *IEEE Transactions on Power Electronics,* vol. 28, no. 11, pp. 4897-4902, 2013.

[6] M. Pavlovsky, G. Guidi, and A. Kawamura, "Buck boost dc–dc converter topology with soft switching in whole operating region,"*IEEE Trans. Power Electron.*, vol. PP, no. 99, p. 1, 2013. DOI:10.1109/ TPEL.2013.2258358.

[7] J. Bauman, M. Kazerani, and S. Member, "A Novel Capacitor-Switched Regenerative Snubber for DC / DC Boost Converters," *IEEE, Trans. Ind.Electron.*, vol. 58, no. 2, pp. 514–523, 2011.

[8] M. He, F. Zhang, J. Xu, P. Yang, and T. Yan, "High- efficiency two- switch tri-state buck-boost power factor correction converter with fast dynamic response and low- inductor current ripple," *IET Power Electron.*, vol. 6, no. 8, pp. 1544–1554, Sep. 2013.

[9] S. Jalbrzykowski, A. Bogdan, and T. Citko, "A dual full- bridge resonant class-e bidirectional dc-dc converter," *IEEE Trans. Ind. Electron.*, vol. 58, no. 9, pp. 3879– 3883, Sep. 2011.

[10] X. Liu, J. Xu, Z. Chen, and N. Wang, "Single-inductor dual-output Buckboost power factor correction converter," *IEEE Trans. Ind. Electron.*,vol. 62, no. 2, pp. 943–952, Feb. 2015.

[11] K. I. Hwu and T. J. Peng, "A novel buck-boost converter Combining KY and Buck converters," *IEEE Trans. Power Electron.*, vol. 27, no. 5 pp. 2236–2241, May 2012.

[12] J.-J. Chen, P.-N. Shen, and Y.-S. Hwang, "A high-efficiency positive buck boost converter with mode select circuit and feed-forward techniques," *IEEE Trans. Power Electron.*, vol. 28, no. 9, pp. 4240– 4247, Sep. 2013.

[13] H. Hu, S. Harb, N. Kutkut, I. Batarseh and Z. Shen, "A Review of Power Decoupling Techniques for Microinverters With Three Different Decoupling Capacitor Locations in PV Systems," *IEEE Transactions on Power Electronics,* vol. 28, no. 6, pp. 2711-2726, 2013.