International Journal of Engineering Applied Science and Management
ISSN (Online): 2582-6948
Vol. 1 Issue 3, December 2020

A Single Sensor Based Bridge Less Landsman PFC Converter Fed BLDC Motor Drive with Fuzzy Logic controller

Rameshwar Pathare[1], Sujeet Kumar Soni[2]
Department of Electrical & Electronics Engg., LNCT Bhopal, M.P., India[1]
Department of Electrical & Electronics Engg, LNCT Bhopal, M.P., India[2]
rameshwarpathare@gmail.com[1], sjtsoni5@gmail.com[2]

Abstract: *In this paper a power factor correction-based Landsman converter in bridgeless (BL) feeding a brushless dc motor drives are proposed for low power household application. The speed of brushless dc motor is controlled by varying the dc bus voltage of the voltage source inverter (VSI) feeding to a BLDCM, switching losses of six solid state of switches of VSI are reduce by the low frequency switching signal in electronic communication for the motor. The dc voltage of drive is sensed by a single dc voltage sensor. A landsman PFC converter is modelled with control on the output voltage through voltage-oriented control. The output from the landsman PFC converter is fed to isolated DC-DC converter for running BLDC motor. The output voltage of the PFC converter is controlled using PI controller to generate specific required DC voltage given as a reference by the user. The isolated DC-DC converter is controlled by current-oriented control with feedback from the DC output terminal voltage of the converter. The PI controller is further replaced with fuzzy logic controller for better response and settling of the output voltage of the PFC converter. A comparative analysis of the PFC converter characteristics with PI and fuzzy logic controller are modelled in MATLAB Simulink environment.*

Keywords: *Landsman converter, Pulse Generator, Battery, PI Controller, Fuzzy controller, BLDC Motor MATLAB***.**

1. Introduction

In electromechanical power conversion, the electric motor acts as a bridge for the conversion of power between mechanical and electrical systems as must be in Fig. 1 An electric motor can work as a generator or a car. In any electric car, voltage as well .it currently behaves as a representative of the incoming and outgoing electricity with the energy transferred to the machine load, which is indicated by the speed and torque.

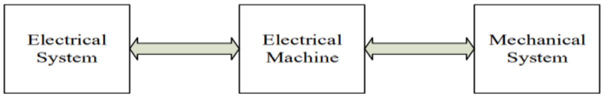

Fig. 1 Energy Conversion Process

A simple and clear block diagram of the electrical unit shown on figs. 2 consists mainly of power supply, conversion machine acquisition and control module. Power can be supplied from an AC power battery; the engine has the desired feature required for its load and its power to distribute power from source to load. The most commonly used electric motors are DC cars, BMDC Motor, Stepper motor

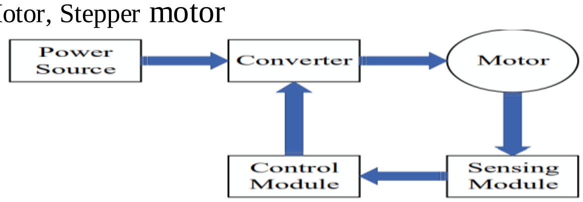

Fig. 2 Block Diagram of an Electrical Drive

Converters are used to convert electrical energy from the input source into the desired form of the machine. Relying on the required power of the input power and motors, by AC to DC converters, DC to DC converters (high or low converters), inverters and circuit transformers are often used in the construction of electric drives. The detection module is provided to detect rotor position, speed and storage capacity of equipment. It is required for the false operation of the loop loop. The control m vodule is the core of everything in the drive. Over the past decade, due to rapid developments in the field of electrical power and semiconductor tools, a flexible speed unit, such as BLDC motor units, has been developed and widely used in a variety of applications. The use of the BLDC Vehicle BLDCM for low power devices is increasing due to its high performance, wide speed range and very low maintenance. Switching to the Permanent Magnet BLDC Motor (brushless DC motor with permanent industrial) is done with a solid three-phase inverter (VSI) switching [1]

The Brushless DC (BLDC) motor has high reliability, high technology, and high torque / malfunction, advanced cooling, low frequency radio interference and clam or also requires all targets, support, and small size for some motors. The transmission from the PV source to the vehicles is difficult and through statistical modeling the engine can draw a lot of power from the sufficient PV source on the motor drive [1-3]. To extract energy from the solar system, the MPPT process is applied in a variety of parameters and an additional process based on MPPT power tracking tracks higher energy from the solar system while compared to perturb and viewing technique. The increase and power output is followed by the power from the PV source during the parameters variation such as the given work rotation, irradiance and temperature. Connecting the PV source to a BLDC motor vehicle is a challenging task requiring additional converters and current limited circuits. The use of [5, 6] of special DC-DC converters is limited within its limitations such as low step up ratio, idle calculation, and large capacitor requirement. The Landsman converter used only minor components compared to special converters such as Zeta, Cuk, SEPIC. The Landsman converter used has been found to be able to break down the problems associated with these converters such as the input ripple filter requirement in the event of a Canonical switching Cell (CSC) converter and Luo converter and the requirement for small inductor installation compared to the Cuk converter.

The Landsman DC-DC converter mainly comes from the CSC dynamic phase and contains all of its benefits. It is used to make good regulation in conditions of easy loading and high efficiency, without the cost of a large number of inert elements, as associated with the BL Landsman converter.

In Brushless DC motors it operates electrically and does not require mecha
nical flexibility. Continuous monitoring of the rotor position is required for electronic switching. With continuous monitoring of the rotor position is detected using the Hall Effect position sensors. With the use of high-speed electric power, BLDC motors are the most preferred and researchers are upgrading BLDC drive motors due to improved performance at lower cost. The BLDC motor is operated on a ground-based converter from a PV source, and a simple mind control system is used to maximize the performance of motors in the past.

2. Proposed Methodology

A BLDCM Fed through based a PFC Bridge less landsman converter. The proposed model is shown in fig. 3. the proposed model is consist of different component such as Bridge less PFC converter, Brush less dc motor, Hall Effect Sensor and Fuzzy Logic controller. A Variable DC Bus voltage of the VSI Directly control the speed of brushless dc motor drive. This allow the low frequency switching operation for VSI switches, by Electronic communication of BLDCM to reduce the switching losses in six insulated gate bipolar transistor of VSI.

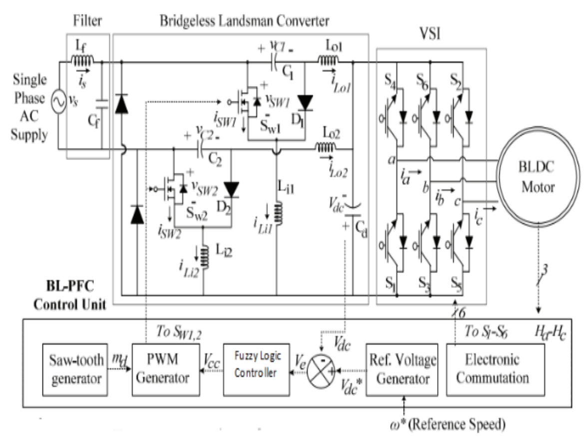

Fig. 3 Proposed BLDCM Drive with PFC Based Landsman Converter

2.1 Proportional Integral Controller

PI Control is a common solution for many industrial applications. The main reason is its simple, easy-to-understand and practical structure, and the fact that many complex control techniques, such as model forecasting controls, are based on it. A high-speed operating system requires different PI benefits than a high-speed application In addition, industrial machines operating over multiple speeds require a different gain in the lower and upper extremity speeds to avoid overshoots and collisions. In general, adjusting the balance and integration of a large speed control system is expensive and time consuming. The task becomes increasingly complex where sometimes the wrong PI parameters are selected due to a lack of understanding of the process the rule of action of the controller PI is defined by the following equation:

$$u(t) = K_p e(t) + K_i \int_0^t e(t)dt$$

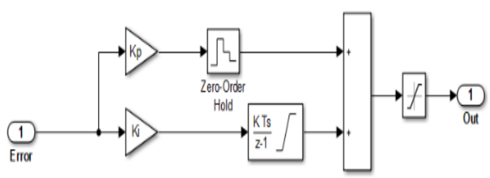

Fig.4 Control Structure of PI Controller

The PI controller sets its output range between zero and one; this range characterizes the duty cycle required by a pulse width modulator (PWM) that controls the landsman converter connected to the BLDC Motor.

2.2 Fuzzy Logic Controller

The fuzzy controller has four main components: The rule-base, which holds the knowledge, in the form of a set of rules, describing the best way to control a system. The membership functions are used to quantify knowledge. The inference mechanism evaluates which control rules are relevant at the current time and then decides what input of the plant should be enabled. The fuzzification interface modifies the inputs, so that they can be interpreted and compared to the rules in the rule-base. The defuzzification interface transforms the conclusions reached by the inference mechanism into the inputs of the plant.

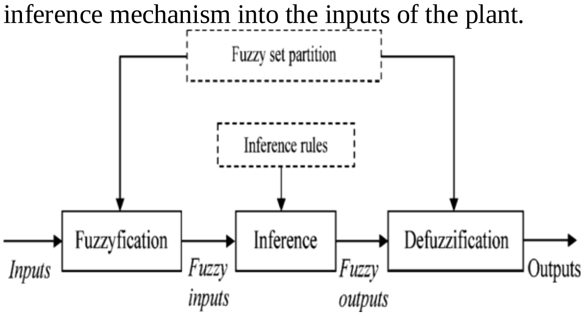

Fig. 5 Control structure of Fuzzy Logic controller

3. Simulation parameters of proposed system

Table 1Parameter used in simulation

Parameter	Value
AC Voltage (V_{ac})	220V
Diode Resistance	0.001 ohm
IGBT Internal Resistance	0.001 Ohm
Capacitance	580 nF
Inductance	1.7mH
PWM Switching frequency	20000
Proportional Gain	0.01
Integral Gain	0.001
Stator phase resistance of BLDC motor (Rs)	14.56 Ohm
Stator phase inductance of BLDC motor (Rs)	25.71 mH
Voltage constant (Kb)	78V/K rpm
Torque Constant (Kt)	1.2 Nm
Rated speed of BLDC Motor	4000 Rpm

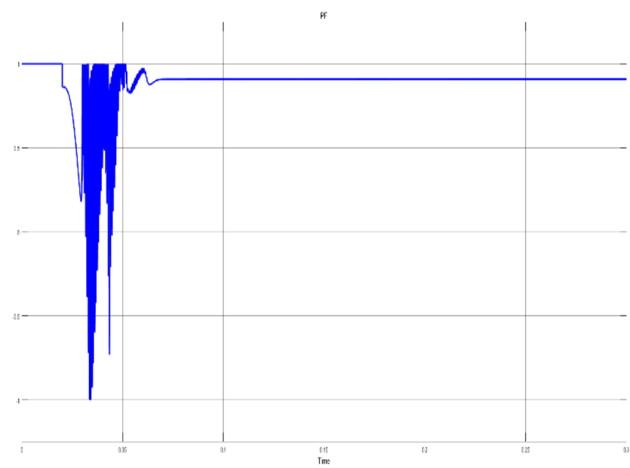

Fig. 6 Modelling of proposed topology with PI controller

3.1 Simulation Result and Discussion

Case I: PF improvement in bridgeless landsman converter fed EV Battery charger with using PI logic controller. The proposed model is shown in fig. no.6

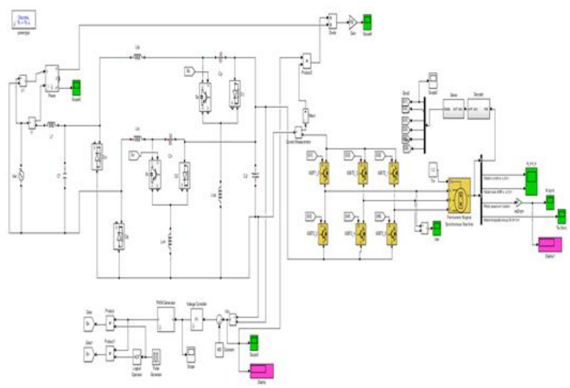

Fig.7 Power factor of source with PI Controller

Fig. No.7 shows PFC test system with PI controller charging the battery with state of charge (SOC 20%). The PFC converter uses voltage-oriented control with PI controller which generates duty ratio for the switches S_p and S_n. The switches S_p and S_n operate alternatively with respect to the input voltage. The S_p switch operates during positive cycle and S_n operates during negative cycle of the input voltage. This is controlled by pulse generator with time period 1/50 and time of conduction of 50%. The reference voltage of PFC converter is taken as 400V and the reference voltage of the interleaved converter is taken as 300V. The results for the same are observed below.

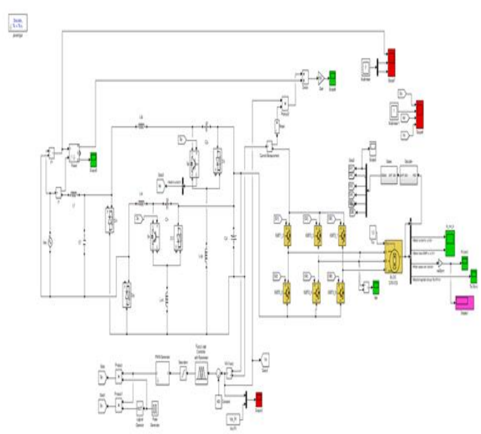

Fig.8 Modelling of proposed topology with fuzzy interface system

Fig 5.2 sows modelling of proposed topology with fuzzy interface system. The interleaved converter is controlled by a switch S_f which either reduces or increases the voltage at the output. The output of the converter is controlled by current oriented control with voltage and current feedback from the output. The PI controller generates required duty ratio for the interleaved converter with respect to charging current of the battery.

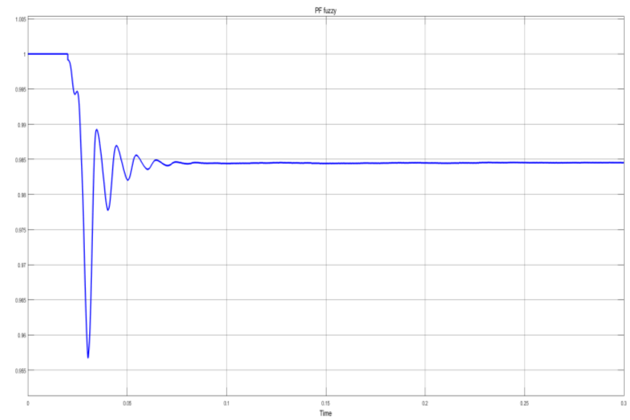

Fig. 9 Power factor of source with fuzzy controller

From fig. 8 and fig.9 we see that the PF of the source is more stable at the initial stage in fuzzycontrolled feedback system as compared to that in PI controller. Also the output of the PI (for PF) curve changes from 0 to 0.05 seconds. After that the power factor curve settles down and correspondingly the output of the fuzzy (for PF) curve changes from 0 to 0.01 seconds, after that the power factor curve settles down. It means that the transients in the power factor are reduced to minimal value and are also maintained near to unity. MAKING use of fuzzy logic controller. The proposed representation is shown in fig.8

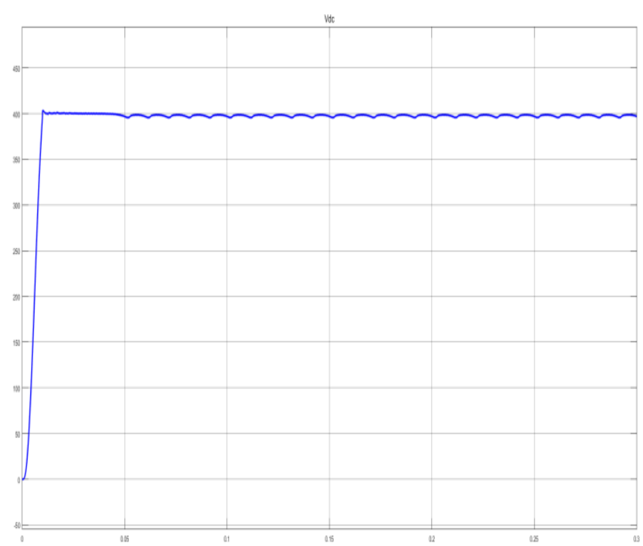

Fig. 10 DC-DC isolated converter output voltage (Vdc)

International Journal of Engineering Applied Science and Management
ISSN (Online): 2582-6948
Vol. 1 Issue 3, December 2020

When the DC-DC isolated converter voltage output is maintained at 400V at stable condition. This is revealed in fig no. 10

3.3 Comparative analysis between PI and Fuzzy logic controller:

The model is updated with fuzzy controller replacing PI controller and the output voltages of the PFC converter are compared below.

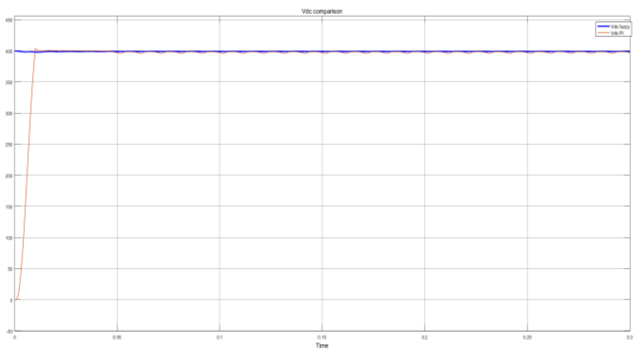

Fig.11 Output voltage comparison of landsman PFC converter with PI and fuzzy

4. Conclusion

The PF correction has been effectively implemented using the Bridge less Landsman PFC Converter for low power and adjustable speed domestic application. Minimum switching losses have been achieved by operating the VSI in low frequency switching with variable. As per the graphs generated with respect to time the power factor of the source is more stable at the initial stage with fuzzy logic controller when compared to PI controller. The fuzzy controlled updated in voltage-oriented control of the landsman PFC converter is increasing the stability in input power factor and also the output voltage of the converter. And also improve the performance of speed of brush less dc motor. The ripple in the output DC voltage is also suppressed in the updated fuzzy interface controlling system. The simulation model is a developed by MATLAB software.

References

[1] B. Singh and V. Bist, "A BL-CSC Converter fed BLDC Motor Drive with Power Factor Correction", IEEE Trans. on Ind. Electron. vol.62, no.1, pp.172-183, 2015.

[2] V. Bist and B. Singh, "A Unity Power Factor Bridgeless Isolated- Cuk Converter Fed Brushless-DC Motor Drive", IEEE Trans. on Ind. Electron., vol.62, no.7, pp.4118-4129, Jul2015.

[3] V. Bist and B. Singh, "An Adjustable Speed PFC Bridgeless Buck- Boost Converter Fed BLDC Motor Drive", IEEE Transactions on Industrial Electronics., vol.61, no.6, pp.2665-2677, June2014.

[4] A. M.Al-Gabri, A. A. Fardoun and E. H. Ismail, "Bridgeless PFC Modified SEPIC Rectifier with Extended Gain for Universal Input Voltage Applications," IEEE Trans. Power Electron. IEEE Early Access, 2014.

[5] B. W. Williams, "Generation and Analysis of Canonical Switching Cell DC-to-DC Converters," IEEE Trans. Ind. Electron, vol. 61, no. 1, pp. 329–346, Jan,2014.

[6] B. Singh and V. Bist, "A PFC Based BLDC Motor Drive Using a Bridgeless Zeta Converter", 39th Annual IEEE IECON (Industrial Elect. Conf.), Vienna, Austria, pp. 2553-2558, 10-13 Nov.2013.

[7] H. Wang, Y. Tang and A. Khaligh, "A Bridgeless Boost Rectifier for Low-Voltage Energy Harvesting Applications," IEEE Trans. Power Electron., vol.28, no.11, pp.5206-5214, Nov.2013.

[8] Y. T. Chen, C. L. Chiu, Y. R. Jhang, Z. H. Tang and R. H. Liang, "A Driver for the Single-Phase Brushless DC Fan Motor With Hybrid Winding Structure," IEEE Trans. Ind. Electron., vol.60, no.10, pp.4369-4375, Oct.2013.

[9] B. W. Williams, "DC-to-DC Converters With Continuous Input and Output Power," IEEE Trans. Power Electron., vol.28, no.5, pp.2307- 2316, May2013.

[10] B. Singh and V. Bist, "An Improved Power Quality Bridgeless Cuk Converter Fed BLDC Motor Drive for Air Conditioning System", IET Power Electronics, Vol. 6, no. 5, pp. 902–913,May2013.

[11] C. S. Joice, S. R. Paranjothi and V. J. S. Kumar, "Digital Control Strategy for Four Quadrant Operation of Three Phase BLDC Motor With Load Variations," IEEE Trans. Ind. Inform., vol.9, no.2, pp.974-982, May 2013

[12] B. W. Williams, "Basic DC-to-DC Converters," IEEE Trans. Power Electron., vol.23, no.1, pp.387-401, Jan.2008.

[13] V. Vlatkovic, D. Borojevic, and F. C. Lee, "Input filter design for power factor correction circuits," IEEE Trans. Power Electron., vol. 11, no. 1, pp.199–205, Jan.1996.

[14] D. Maksimovic and S. Cuk, "A unified analysis of PWM converters in discontinuous modes," IEEE Trans. Power Electron., vol.6, no.3, pp.476-490, Jul1991.