Volume 5, Issue 4, October 2018 ISSN: 2348-8565 (Online)

IJMERT

International Journal of Modern Engineering and Research Technology

Website: http://www.ijmert.org Email: editor.ijmert@gmail.com

Simulation of PI and PID Controller Using Enhanced Closed Loop Z Source Converter

Sundari Sravan Kumar
Ph.D. Scholar
Department of Electrical and Electronics Engineering
Shri Jagdishprasad Jhabarmal Tibrewala University
Churela (Rajasthan) [INDIA]
Email:sundarisravan@gmail.com

Yerra Sreenivasa Rao
Professor
Department of Electrical and Electronics Engineering
BVSR Engineering College
Chimakurty (A.P.) [INDIA]
Email:ysrdr.eee@gmail.com

ABSTRACT

The voltage supply electrical converter is outlined because the electrical converter that takes a variable frequency from a DC provide. The input voltage of the voltage supply electrical converter remains constant, and their output voltage is freelance of the load.The magnitude of the load current depends on the character of the load resistivity.This paper presents the closed-loop system management of Z-Source electrical converter fed 3 part induction motor with PI and PID controller. PI and PID controller systems are designed and simulated using MATLAB. The principle of operation and simulation results is mentioned. The simulation results of PI and PID controller square measure compared in terms of your time domain parameters and comparison table are conferred.

Keywords :— *FED Induction motor, ZSI-Z-Source Inverter, VSI-Voltage Source Inverter Z-Source Inverter fed Induction Motor, FED Induction motor drive, Impedance source Inverter.*

I. INTRODUCTION

The vitality request is expanding overall step by step. The non-sustainable power sources, for example, coal, oil and common gases can't be recharged once the store of these powers are drained. So the requirements for sustainable power sources are expanding over the world. Among all the sustainable power sources sun based vitality is required to assume on vital job in future vitality generation [1]-[5]. The PV cells convert sun oriented vitality into electrical vitality. The PV frameworks can be gathered into independent frameworks and lattice associated frameworks. The PV framework produces low voltage and requires high advance up converters for its applications. The DC-DC converter venture up the PV voltage and VSI is utilized to change over DC voltage to AC voltage [6]. The conventional VSI and CSI have a few impediments and issues, for example, two phases of intensity transformation are required. VSI can't have AC yield voltage higher than the DC interface voltage, VSI and CSI are either buck or lift converter can't be buck-support converter thusly they require DC-DC converter to help the PV board DC voltage, shoot through will happen when the switches on same stage leg are turned ON at the same time which demolish the gadgets in the circuit. These downsides have been overwhelmed by the Z -Source Inverter proposed in [7]. ZSI furnishes single stage control transformation with voltage buck-support capacity. The X-molded impedance coordinate with L and C segments makes shoot-through state feasible for ZSI. Amid this shoot-through period both power switches in an equivalent stage leg can be turned on at the same time and along these lines dispense with the dead time and gives voltage boosting capacity. Basic lift control with consistent lift factor was utilized to control the shoot through and yield voltage of the inverter. Steady lift control strategy for ZSI was talked about in [8] to get greatest voltage increase under a given tweak file. F.Z.Peng et al. [9] proposed greatest lift control technique to deliver most extreme voltage increase under a given adjustment file. P.C. Loh et al [10] introduced nitty gritty examination on different PWM system with alterations to switch voltage compose ZSI constantly or spasmodically and holding all the one of a kind consonant execution. Various topologies of ZSI have been produced and talked about, beat width balanced three level nonpartisan point clipped inverter was shown by P.C.Loh et al [11], exchanged inductor semi Z-source inverter was proposed in [12], exchanged inductor semi Z-source inverter was proposed in [13] with lessened voltage weight on capacitor, bring down current weight on inductor and diodes. Anderson et al [14] created four semi Z-source inverters having focal points, for example, bring down segment evaluations and diminished voltage push. ZSI was proposed for private photovoltaic framework in [15], the activity standard, control strategy and attributes of the framework were introduced in this paper. ZSI for flexible speed drives (ASD) was proposed in [16] which gives ride-through ability Z.J. Zhou et al proposed another topology of uninterruptable power supply (UPS) utilizing Z-source inverter, keep up the coveted AC voltage with high effectiveness, low sounds, quick reaction and great enduring state performance[17]. Transient displaying and investigation of PWM ZSI was exhibited by P.C. Loh et al [18]. Air conditioning little flag demonstrating and examination of ZSI in ceaseless conduction mode introduced in [19]. New group of Embedded Z-source inverter (EZSI) was proposed in [20] to keep up smooth voltage or current over the DC source without expansion of LC channel. Different topologies of Asymmetric and Symmetric Embedded Z-source inverter were displayed in [21]. Current mode coordinated control method for ZSI sustained acceptance engine drives was exhibited in [22] by S.Thangaprakash et.al. Inserted exchanged inductor Z-source inverters are displayed in [23] which give a high lift voltage reversal capacity, bring down voltage over the exchanging gadgets, persistent information current and a diminished voltage weight on the capacitors. The PI controller and fluffy rationale controller (FLC) are planned and executed for H6 single stage inverter in [24]. But the above writing overview does not manage shut circle control for EZSIIM. This paper proposes shut circle control for EZSIIM utilizing PI controller and PID controller. PI controller and PID controller circuit are planned and recreated utilizing MATLAB/Simulink and the acquired outcomes are analyzed.

II. Proportional Integral (PI) Controller

At present, the PI controller is most widely adopted in industrial application due to its simple structure, easy to design and low cost. Despite these advantages, the PI controller fails when the controlled object is highly nonlinear and uncertain. PI controller will eliminate forced oscillations and steady state error resulting in operation of on-off controller and P controller respectively. However, introducing integral mode has a negative effect on speed of the response and overall stability of the system. Thus, PI controller will not increase the speed of response. It can be expected since

PI controller does not have means to predict what will happen with the error in near future. This problem can be solved by introducing derivative mode which has ability to predict what will happen with the error in near future and thus to decrease a reaction time of the controller. PI controllers are very often used in industry, especially when speed of the response is not an issue. A control without D mode is used when 1. Fast response of the system is not required 2. Large disturbances and noise are present during operation of the process 3. There is only one energy storage in process (capacitive or inductive) 4. There are large transport delays in the system. Therefore, we would like to keep the advantages of the PI controller. This leads to propose a PI controller shown in Figure 1. This controller uses of the proportional term while the integral term is kept, unchanged. [25]

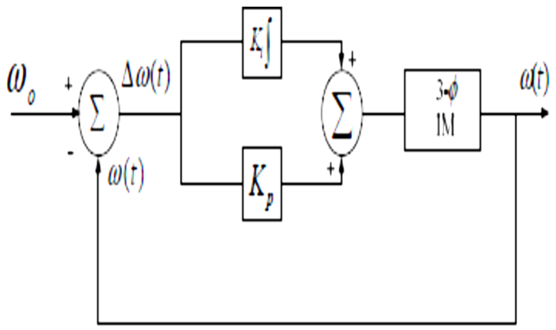

Figure 1: Block diagram of PI controller.

III. Proportional Integral Derivative (PID) Controller.

Many industrial controllers employ a proportional, integral plus differential PID regulator arrangement that can be tailored to optimize a particular control system. PID controller is most commonly used algorithm for controller design and it is most widely used controller in industry. The controllers used in industry are either PID controller or its improved version. The basic types of PID controller are parallel controller, serial controller, and mixed controller. The PID controller algorithm utilized for is design velocity algorithm, it is also called incremental algorithm. In the industry, PID controllers are the most common control methodology to use in real applications. PID controller has all the necessary dynamics: fast reaction on change of the controller input (D mode), increase in control signal to lead error towards zero (I mode) and suitable action inside control error area to eliminate oscillations (P mode). Derivative mode improves stability of the system and enables increase in gain K and decrease in integral time constant Ti, which increases speed of the controller response. PID controllers are the most often used controllers in the process industry. The majority of control systems in the world are operated PID controllers. It has been reported that 98% of the control loops in the pulp and paper industries are controlled by single-input single output PI controllers and that in process control applications, more than 95% of the controllers are of the PID type controller. PID controller combines the advantage of proportional, derivative and integral control action. [25]

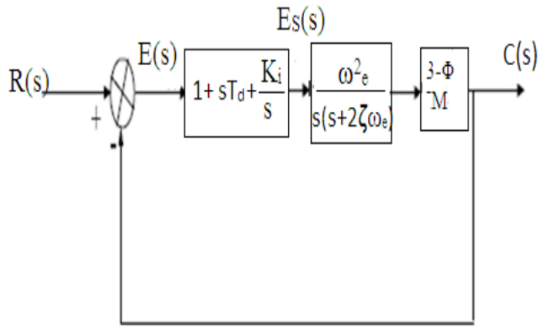

Figure 2: Block diagram of PID controller.

IV. Impedance Source Network

The impedance Source Network is a combination of two inductors and two capacitors. This combined circuit, the impedance Source Network is the energy storage or filtering element for the Impedance Source Inverter (Z-Source). This impedance source network provides a second order filter. This is more effective to suppress voltage and current ripples. The inductor and capacitor requirement should be smaller compared to that of conventional inverters. When the two inductors and L1 & L2 are small and approach zero, the Impedance source network reduces to two capacitors (C1 and C2) in parallel and becomes conventional voltage source inverter. Therefore, a conventional voltage inverter's capacitor necessities and physical estimate is the most noticeably awful case necessity for the Impedance Source Inverter (Z-Source). Considering extra separating what's more, vitality stockpiling gave by the inductors, the Impedance Source Network ought to require less capacitance and littler measure contrasted and the regular Voltage Source Inverter (VSI).

V. Operations of a Z-Source Inverter

The Z-source inverter using a one of a kind LC arrange and prohibited shoot-through states gives one of a kind highlights, for example, the capacity to buck and lift voltage with a solitary stage basic structure. The examination and control strategies gave in the writing depend on a presumption that the inductor is generally expansive and the inductor current is nonstop and has little swell. This suspicion winds up invalid when the inductance is little with the end goal to limit the inductor's size and weight for a few applications where volume and weight are vital. Under this little inductance condition, the inductor current turns out to be high swell or even intermittent. As results, the Z-source inverter shows new activity modes that have not been examined previously. This paper dissects these new task modes and voltage help relationship of the Z-source inverter under the low inductance and huge current swell condition. The fundamental target of static power converters is to create an AC yield waveform from a dc control supply. Impedance source inverter is an inverter which utilizes a one of a kind impedance arrange combined with the inverter primary circuit to the power source. This inverter has one of a kind highlights regarding voltage (both buck and lift) contrasted and the customary inverters. A two port arrange that comprises of a split-inductor and capacitors that are associated fit as a fiddle is utilized to give an impedance source (Z-source) coupling the inverter to the dc source, or another converter. The DC source/load can be either a voltage or a current source/stack. In this manner, the DC source can be a battery, diode rectifier, thyristor converter, power module, PV cell, an inductor, a capacitor, or a blend of those [1].

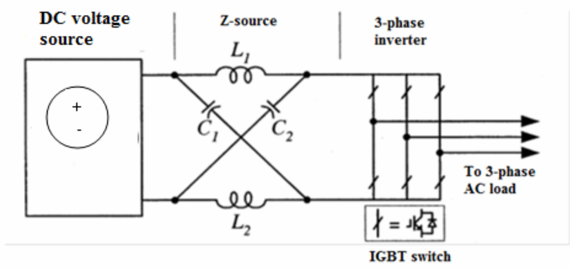

Figure 3: Z-Source Inverter

It proposes an impedance-source (or impedance-nourished) control converter (condensed as Z-source converter) and its control strategy for executing dc-to-air conditioning, air conditioning to-dc, air conditioning to-air conditioning, and dc-to-dc control change. The Z-source converter utilizes a special impedance system (or circuit) to couple the converter fundamental circuit to the power source, therefore giving exceptional highlights that can't be gotten in the customary voltage-source (or voltage-nourished) and current-source (or current-encouraged) converters, in which a capacitor and inductor are utilized individually. The Z-source converter defeats the applied and hypothetical boundaries and impediments of the conventional voltage-source converter and current-source converter and gives a novel power transformation idea. To portray the working guideline and control, this paper is centered around a precedent: a Z-source inverter for dc-air conditioning power change required in energy component applications. Recreation and trial results approve the new highlights.

VI. Simulation Results

The reproduction circuit of ZSI sustained three stage enlistment engine with PI controller is appeared in Figure 4. The speed of the acceptance engine is estimated constantly and contrasted and the reference set speed. The distinction in velocities is connected as mistake flag to the PI controller. The yield of PI controller is given to ZSI framework to run the acceptance engine at required speed. The speed of the enlistment engine with PI controller shut circle is appeared. What's more, its esteem is 1248 RPM. The torque of the engine is 1.2 N-m appeared.

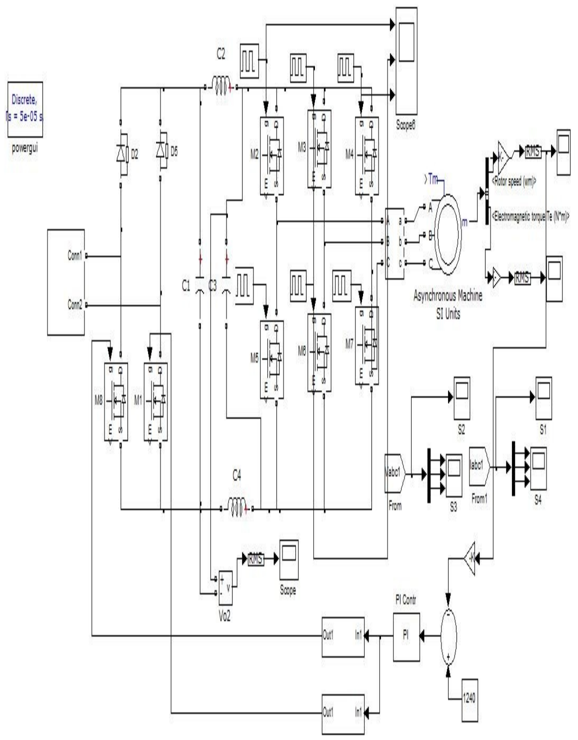

Figure 4: Z-Source Inverter 3-phase Induction Motor

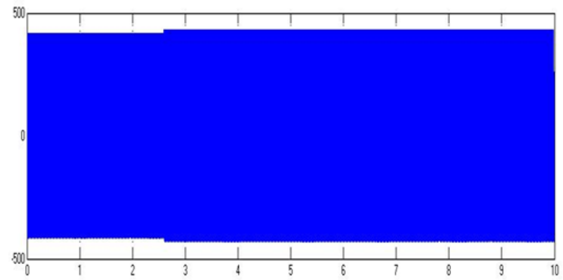

Figure 5: Input Voltage for Z-Source Inverter

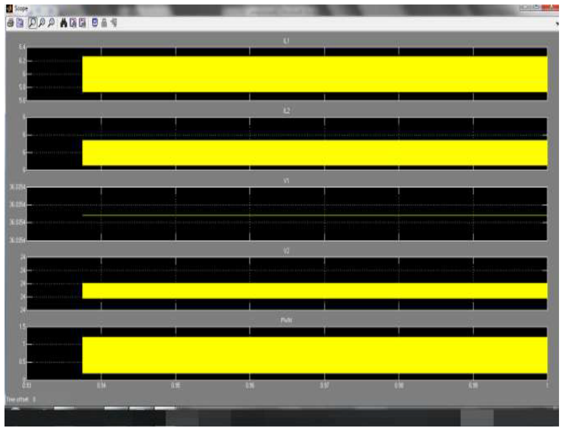

Figure 6: Simulation Results of a PID Controller

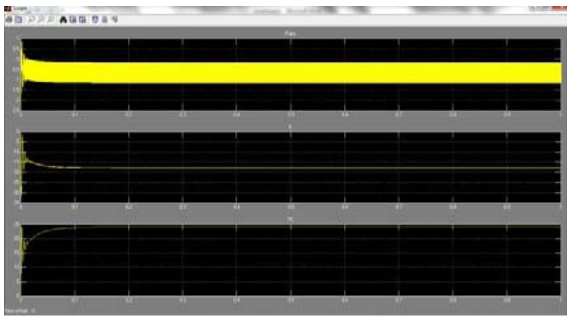

Figure 7: Closed Loop Buck Booster

Table 1 : Results of PI and PID controller

Controller	Rise Time(s)	Peak Time (s)	Sitting Time (s)	Steadu Stae error (RPM)
PI	2.6	2.7	3.2	5.6
PID	2.5	2.6	2.7	3.2

V. Conclusion

The shut control of ZSI bolstered three stage enlistment engine with PI controller and PID controller are reenacted effectively. It is seen from the recreation results that PID controlled shut circle framework gives preferable outcomes over PI controller, since PID controlled framework decreases rise time, settling time of the shut circle framework and the enduring state mistake in speed is diminished to 3.2 RPM. Commitment of this work is to acquire the better powerful reaction of the ZSIIM shut circle framework. The fluffy rationale based shut circle framework will be reenacted in future.

REFERENCES:

[1] D. J. Arent, A. Wisel, and R. Gelman, "The status and prospects of renewable energy for combating global warming," Elseiver Energy Economics, Vol. 33, No. 4, pp.584-593, Jul. 2011.

[2] F.Blaabjerg, Z. Chen, and S.B. Kjaer, "Power electronics as efficient interface in dispersed power generation systems," IEEE Trans. Power Electron, Vol. 19, No. 5, pp. 1184-1194, Sep. 2014.

[3] L. Zhang, K. Sun, Y. Xing, and M. Xing, "H6 Transformerless full - bridge PV grid-tied inverters," IEEE Trans. Power Electron, Vol. 29, No.3, pp. 1229-1238, Mar.2014.

[4] Rong-Jong Wai and Wen-Hung Wang, "Grid-connected photovoltaic generation systems," IEEE Trans. Circuits and systems., Vol.55. No.3. Apr. 2008.

[5] J.A. Gow and C.D. Manning, "Photovoltaic converter systems suitable for use in small scale stand-alone or grid connected applications," Proc. IEE Electric. Power Appl. Vol. 147, No. 6, pp. 535-543, Jun.2000.

[6] N. Vazquez, J. Almanan, J. Alvarez, C. Aguilar, and J.Arau, "A comparison between the buck, boost and buck- boost inverters, " in Proc. IEEE 30th Annu. Power Electron. Spec. Conf., Vol. 2. pp.801-806, 1999.

[7] F.Z. Peng, Z-Source Inverter, IEEE Tran.Ind. Tran.Appl., Vol. 39, no.2. pp, pp.504-510, Mar/Apr.2003.

[8] M.S. Shen, J. Wang, A.Joseph, F.Z.Peng, L.M. Tolbert, and D.J. Adams, "Constant boost control of the Z-source inverter to minimize current ripple and voltage stress," IEEE Trans. Ind. Appl., vol. 42, no.3, pp. 770-777, May/Jun. 2006.

[9] F.Z. Peng, M. S. Shen, and Z. Qian, "Maximum boost control of the Z-source inverter," IEEE Trans.Power Electron., vol. 20, no. 4, pp. 833-838, Jul. 2005.

[10] P.C. Loh, D.M. Vilathgamuva, Y.S. Lai, G. T. Chua, and Y.W. Li, "Pulse-width modulation of Z-source inverters," IEEE Trans. Power Electron., vol. 20, no 6, pp. 1346-1355, Nov.2005.

[11] P.C.Loh, Feng Gao, Frede Blaabjerg, Shi Yun Charmaine Feng, Kong Ngai Jamies Soon, "Pulsewidth –Modulated Z-Source Neutral-point-clamped inverter," IEEE Trans. On Industry Applications., vol. 43, no 5, pp. 1295-1308, 2007.

[12] Miao Zhu, Kun Yu, Fang Lin Luo, "Topology analysis of a switched-inductor Z-source inverter," 5th IEEE Conference on Industrial Electronics and Applications, pp. 364-369, 2010.

[13] Minh-Khai Nguyen, Young-Cheol Lim, Geum-Bae Cho, "Switched inductor Quasi Z-source inverter,"

IEEE Trans. Power Electron., vol. 26, no.11, pp. 3183-3191, 2011.

[14] Joel Anderson; F. Z. Peng, "Four quasi-Z-Source inverters," 2008 IEEE Power Electronics Specialists Conference, pp. 2743 – 2749, 2008.

[15] Yi Huang; Miaosen Shen; Fang Z. Peng Jin Jin Wang, "Z-Source inverter for Residential Photovoltaic Systems," IEEE Transactions on Power Electronics, vol. 21, no. 6, pp 1776-1782, 2006.

[16] Fang Z. Peng, Xiaoming Yuan, Xupeng Fang, and Zhaoming Qian, "Z -Source inverter for adjustable speed drives," IEEE Power Electronics Letter., vol. 1, no.2, pp. 33-35, June.2003.

[17] Zhi Jian Zhou, Xing Zhang, Po Xu and Weixiang X. Shen, " Single-phase uninterruptible power supply based on Z-Source inverter," IEEE Trans. Ind. Electron., vol. 55, no. 8, PP. 2297-3004, Aug.2008.

[18] P.C. Loh, D. Mahinda Vilathgamuwa, Chandana Jayampathi Gajanayake, Yih Rong Lim and Chern Wern Teo, "Transient Modeling and Analysis of Pulse-Width modulated Z-Source Inverter," IEEE Trans. Power Electron., vol. 22, no. 2, March 2007.

[19] Veda Prakash Galigekere and Marian K. Kazimierczuk, "Small Signal Modeling of PWM Z-Source Converter by Circuit-Averaging Technique," IEEE Conf. 2011.

[20] Chiang, Loh, "Embedded EZ-source inverters," IEEE Trans. Ind.Appl. vol. 46, no. 1, PP. 256-267, Jan/Feb.2010.

[21] F. Gao, P.C. Loh, D.Li, and F.Blaabjerg, "Asymmetric and Symmetric Embedded EZ-source inverters," IET Power Electron. vol.4, no.2, pp. 181-193, 2011.

[22] Sengoden Thangaprakash and Ammasai Krishnan, "Current mode integrated control technique for Z-Source inverter fed induction motor drives," Journal of Power Electronics, vol.10., no.3, May 2010.

[23] Minh-Khai Nguyen, Young-Cheol Lim, Yong-Hak Chang, Chae-Joo Moon, "Embedded switched –inductor Z-Source inverters, " Journal of Power Electronics, vol.13, no.1, January 2013.

[24] A. Radhika and A. Shunmugalatha, "A novel photovoltaic power harvesting system using a transformerless H6 single-phase inverter with improved grid current quality," Journal of Power Electronics, vol.16, no.2, pp.654-655, March 2016.

[25] K. Smriti Rao, Ravi Mishra "Comparative study of P, PI and PID controller for speed control of VSI-fed induction motor" International Journal of Engineering Development and Research pp 2740-2744.

* * * * *