Efficient Controlling of Three-Phase AC-DC-AC Dual Converter Systems with Vector Control

[1]Atish Kumar, [2]Prakash Narayan Tiwari

[1]Research Scholar Mtech. Power Systems, [2,]Assistant Professor
[1,2,]Department of Electrical and Electronics Engineering,
[1,2] Rabindranath Tagore University, Bhopal-Chiklod Road, Raisen-464993(M.P)

ABSTRACT: In this work the well-known voltage and current DC interface converter systems, used to execute an AC/AC converter, are at first exhibited. Utilizing this learning and their space vector modulation techniques we demonstrate their association with the group of PWM Converters and after that at long last the association with direct PWM Converters. A short exchange of broadened PWM Converter circuits is given and another unidirectional three-level PWM Converter topology is proposed. This plainly demonstrates the topological associations of the converter circuits that specifically prompt a flexibility of the tweak techniques.

Keyword- AC-DC-AC converter, Pulse width Modulation (PWM), PFC Converter, Control Design.

1.1. Introduction

Today's society sees a regularly growing utilization of electrical gadgets and machines that are in-creakingly interfaced or interconnected with each other. The power frames at the interfaces of these gadgets once in a while drive, which requires gadgets that control and process the power stream between them. The controller decides the opening and shutting of the switches, which is typically done by a method known as pulse-width-modulation. Thus, the switches play out the focal part in the activity of a power converter, yet this likewise makes these gadgets nonlinear in their behavior, the Euler-Lagrange or the Port-Hamiltonian (PH) formalism. Particularly, the PH framework holds a few preferences; for it gives a characteristic establishment to the use of lack of involvement based control techniques and takes into account a simple interconnection of various (multi-domain) frameworks.

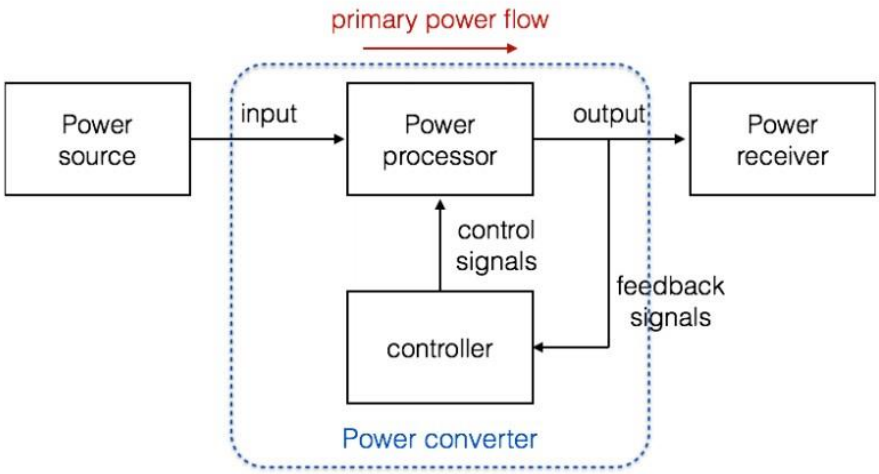

Figure: 1.1 Schematic Representation of a Power Process [6].

1.2. Multilevel Converter Topologies

In demand to facilitate the comprehension of the substance, it will be shown the state of- strength of the particular multilevel converter topologies. Notwithstanding the fact that there are endless converter topologies in the written work, in this part the most broadly perceived topologies will be shown. The most commonplace multilevel converter topologies are: Diode-clamped Converter (DCC), Flying Capacitor Converter (FCC), and Fell Converter. A couple of reviews of multilevel converters have been circulated to show these topologies [6].

1.3. Diode Clamped Converter (DCC)

Power devices concerns were revolved around the converters control increase (extending voltage or current). In fact, Current Source Inverters were the crucial fixation for masters with a particular ultimate objective to extend the current. In any case, extraordinary makers began to tackle growing the voltage rather the current. Remembering the true objective to achieve this objective, makers were growing new converter topologies. Another impartial point-clamped PWM inverter (NPC-PWM) [6].

1.4. Synchronous Rectifier

The synchronous revision is a strategy for enhancing effectiveness of energy converters in control hardware. It involves partner a diode and a transistor (generally a power MOSFET) in parallel. Exactly when the diode is forward-uneven, the transistor is turned on, to reduce the voltage drop. Right when the diode is modify uneven, the transistor is executed, so no charge can course through the circuit. Thusly, a changing characteristic is acquired, without the forward voltage drop related with diodes in the on-state [2].

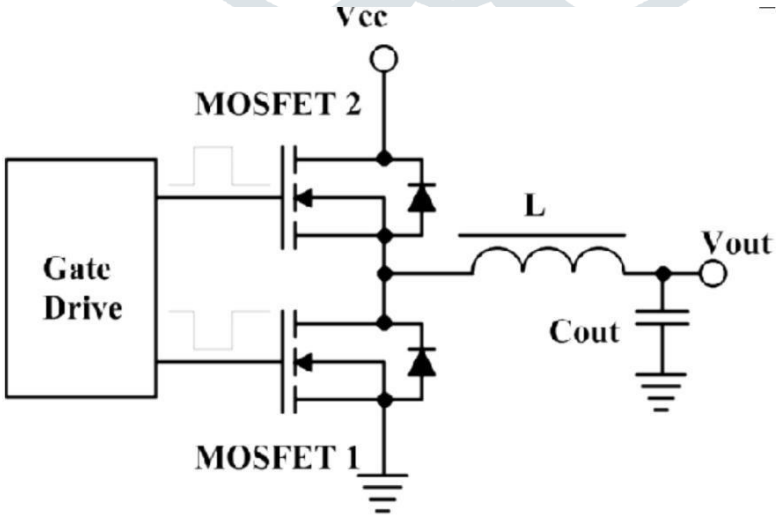

Figure: 1.2 Synchronous Rectifier [2].

1.5 Three Phase Single Stage Power Factor Correction

Although diminished switch front-end AC-DC converters can lessen the size and cost of traditional two-arrange converters, two isolated and autonomously controlled converters are as yet required (Fig.1 . 3). So as to decrease the cost and intricacy related with actualizing two switch-mode converters, control hardware researchers have endeavored to consolidate the PFC capacity of the AC-DC front-end converter with the DC-DC change capacity of the full-bridge converter in a solitary converter. Some oftentimes refered to cases for three-phase single-arrange converters (TPSSCs). Each subfigure shows an alternate TPSSC topology. These converters are ordinarily executed with only a solitary controller to direct the output voltage so that there is no controller to manage the transitional DC transport voltage and no controller to perform input PFC; input PFC is done normally as a component of the converter's task.

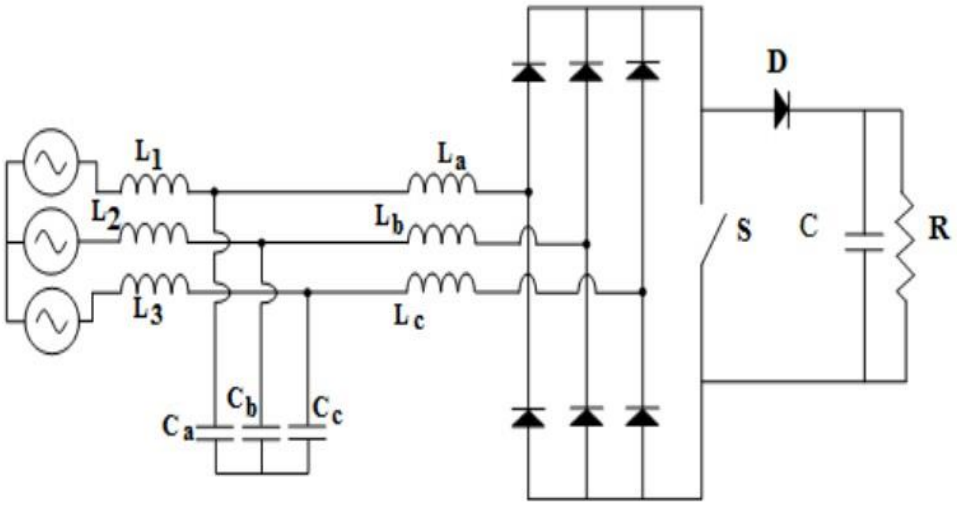

Figure: 1.3 Three Phase AC-DC Single Switch Boost Front End Converter [6].

1.6 RESULT

The Fast Fourier Transform (FFT) is a standout amongst the most utilized calculations in sign preparing and remote correspondence applications. The FFT which facilitates effective transformation from time space to frequency area and the other way around. The inspected sign uses this transformation adequately for different applications like discourse sign handling, radar correspondence, sonar and remote correspondence applications.

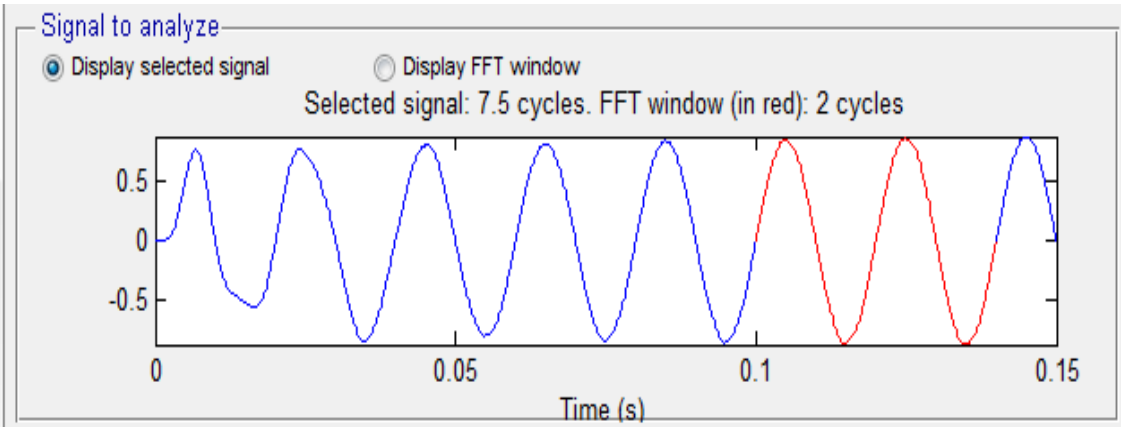

Figure: 1.4 FFT Analysis Window for THD Calculation

In Figure 1.5 are shown are total harmonic distortion for the proposed system for using the vector controlled technique. The designed converter is provided the 0.99 THD calculation for proposed system.

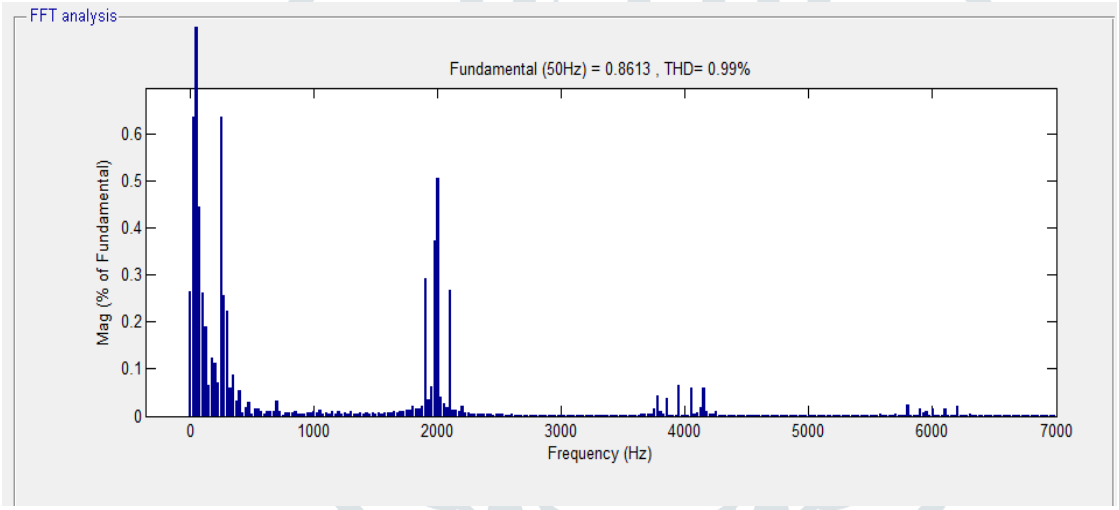

Figure: 1.5 THD of Propose System with Vector Control is 0.99%.

REFERENCES

[1]. Z. Zhang, A. Mallik and A. Khaligh, "A High Step-Down Isolated Three-Phase AC-DC Converter," in IEEE Journal of Emerging and Selected Topics in Power Electronics, vol. 6, no. 1, pp. 129-139, March 2018.

[2]. K. Mozaffari and M. Amirabadi, "A versatile inductive-link three-phase converter topology," 2017 IEEE Energy Conversion Congress and Exposition (ECCE), Cincinnati, OH, 2017, pp. 3476-3483.

[3]. A. K. Singh, E. Jeyasankar, P. Das and S. K. Panda, "A Matrix-Based Nonisolated Three-Phase AC–DC Rectifier With Large Step-Down Voltage Gain," in IEEE Transactions on Power Electronics, vol. 32, no. 6, pp. 4796-4811, June 2017.

[4]. R. Babu, Raghavendiran, B. P. Glady and G. T. S. Rajan, "Novel non-isolated high step-down three phase interleaved DC-DC converter with capacitor voltage division techniques," 2017 International Conference on Circuit ,Power and Computing Technologies (ICCPCT), Kollam, 2017, pp. 1-7.

[5]. D. R. Joca, L. H. S. C. Barreto, D. d. S. Oliveira and J. d. O. Pacheco, "Three- phase AC-DC solid-state transformer for low-voltage DC power distribution applications," 2016 12th IEEE

International Conference on Industry Applications (INDUSCON), Curitiba, 2016, pp. 1-8.

[6]. M. Young, M. H. Chen and H. L. Chen, "A single-stage three-phase to single- phase current-fed high step-up AC-DC matrix converter with PFC," 2012 IEEE Third International Conference on Sustainable Energy Technologies (ICSET), Kathmandu, 2012, pp. 281-286.

[7]. S. H. Hosseini, F. Sedaghati and M. Sarhangzadeh, "Improved power quality three phase AC-DC converter," 2010 International Conference on Electrical Machines and Systems, Incheon, 2010, pp. 148-153.

[8]. W. Li, Q. Jiang, Y. Mei, C. Li, Y. Deng and X. He, "Modular Multilevel DC/DC Converters With Phase-Shift Control Scheme for High-Voltage DC-Based Systems," in IEEE Transactions on Power Electronics, vol. 30, no. 1, pp. 99-107, Jan. 2015.

[9]. A. Tripathi, K. Mainali, D. Patel, S. Bhattacharya and K. Hatua, "Control and performance of a single-phase dual active half bridge converter based on 15kV SiC IGBT and 1200V SiC MOSFET," 2014 IEEE Applied Power Electronics Conference and Exposition - APEC 2014, Fort Worth, TX, 2014, pp. 2120-2125.

[10]. W. Li, C. Xu, H. Yu, Y. Gu and X. He, "Analysis, design and implementation of isolated bidirectional converter with winding-cross-coupled inductors for high step-up and high step-down conversion system," in IET Power Electronics, vol. 7, no. 1, pp. 67-77, January 2014.

[11]. M. R. Islam, Y. Guo and J. Zhu, "A High-Frequency Link Multilevel Cascaded Medium-Voltage Converter for Direct Grid Integration of Renewable Energy Systems," in IEEE Transactions on Power Electronics, vol. 29, no. 8, pp. 4167- 4182, Aug. 2014.

[12]. H. Keyhani, H. A. Toliyat, M. H. Todorovic, R. Lai and R. Datta, "A step- up/down three-phase resonant high-frequency AC-link inverter," 2013 Twenty- Eighth Annual IEEE Applied Power Electronics Conference and Exposition (APEC), Long Beach, CA, 2013, pp. 128-135.

[13]. M. R. T. Hossain, A. H. Abedin, M. H. Rahaman, M. S. Arifin, M. A. Choudhury and M. N. Uddin, "Input switched single phase high performance bridgeless AC- DC Zeta converter," 2012 IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES), Bengaluru, 2012, pp. 1-5.

[14]. M. S. Hamad, M. I. Masoud, B. W. Williams and S. Finney, "Medium voltage 12-pulse converter: ac side compensation using a shunt active power filter in a novel front end transformer configuration," in IET Power Electronics, vol. 5, no. 8, pp. 1315-1323, September 2012.

[15]. Lung-Sheng Yang, Chia-Ching Lin and Ming-Rong Lee, "Study and implementation of a single-phase isolated AC-DC converter," 2012 IEEE International Symposium on Industrial Electronics, Hangzhou, 2012, pp. 527- 532.