IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Design of a Quasi-Y-Source DC-DC Converter for Permanent magnet synchronous motor

Manikala Nagarjuna[1], Mr.Ch. Govinda[2], Mr. K.Rambabu[3]
P.G. Scholar[1], Senior Assistant Professor[2], Associate Professor[3]
Department of Electrical and Electronics Engineering
[1]Aditya Engineering College, Surampalem, Andhra Pradesh, India

Abstract: New Architecture Y-source impedance network is designed for high voltage gain converter implementation. A continuous input current characteristic is provided by an enhanced Y-source impedance network proposed in this study. The suggested impedance network may be used with renewable energy sources, such as fuel cells and solar systems, because of its high voltage gain and constant input current. It has been proposed in this study that the constructed network's analysis and operation be explained. As a last check on the network's performance, computer models of a boost dc-dc converter with PMSM fixed and variable speed as well as a Quasi Converter with PMSM fixed speed are given.

Index Terms **- DC-DC converter, Y-source, Permanent magnet synchronous motor (PMSM).**

I. INTRODUCTION

Due to a lack of fossil fuels, renewable energy sources like wind and solar have recently come into focus. FC and PV systems are preferred because of their quiet and emission-free qualities. The output voltage of these devices is highly reliant on the surrounding environment and has a broad range of variation. As a result, a power electronics converter is unavoidable when dealing with dc-link voltage needs. An improved Y-source dc-dc boost converter topology to address the issues of input current discontinuity and excessive inrush current in traditional Y-source converter is presented in [1]. When the output voltages of both the FC and the PV are so low that a converter with a large voltage gain is needed, it is described above [2]. As of this writing, researchers have studied many DC-to-DC converters with varied architectures. When working with low voltage sources, a high voltage gain converter is needed to fulfil dc link voltage requirements. Conventional dc-dc boost converters cannot achieve significant voltage gains owing to efficiency and reliability issues. The higher the turn ratio, the higher the voltage gain may be achieved in transformer-based converters. Strong leakage inductances and high voltage spikes on semiconductor devices can result from high turn ratios. Due to the high number of components used in these converters, they tend to be larger and more expensive. For power conditioning systems, multilevel converters may not be desirable because of their sophisticated control algorithms and huge component count [4 17].

For the first time, linked inductors have become a common feature of power converters. High voltage gain may be achieved with reduced component counts in dc-dc converters by using linked inductors [5-8]. Magnetically connected impedance networks are another use for coupled inductors. [10] In 2003, the Z-source inverter sparked a new generation of these networks known as impedance sources. Recent years have seen an increase in the number of impedance sources that may be used in either dc/ac converters or DC to DC conversion devices. The voltage gain of Zsource and quasi-Zsource networks is too low to be used with renewable energy power conditioning systems from the outset. As a result, efforts have been made to improve Z-source converter characteristics [11-14]. High voltage gain may be achieved with fewer components in magnetically linked impedance networks, which have just come on the market.

Discontinuous input current is inherent in the described impedance networks because of the existence of an input diode. When working with renewable energy sources like FC and PV, a constant input current attribute is critical. Continuous current drawing in a fuel cell system results in a decrease in the FC's efficiency [18]. Photovoltaic systems, on the other hand, are better served by converters with constant input current [19]. So converters with continuous input current are usually desirable since they reduce the DC input source's detrimental effects. High voltage gains may be achieved with minimal duty cycles using the Y-source impedance network. The Y-source, in contrast to the other magnetically linked networks discussed, makes use of three coupled inductors, allowing for greater design flexibility. This research proposes an enhanced Y-source network for dc-dc converters with a constant input current. In addition to the original Y-source network's advantages, the suggested impedance network also includes a continuous input current. Additional magnetically connected impedance sources can benefit from the new approach for producing continuous input current on the Y-source.

A two phase AC converter is designed for PMSM motor drive in [15], it has some drawbacks. To lessen the natural torque ripple that emerges when using direct torque control (DTC) to regulate permanent magnet synchronous motors, matrix converters (MC) are utilized [16]. As the RN calculation for PMSM motor takes less than one second, it was considered in [21] to reduce the sensitivity to load torque fluctuations. PMSM motor has higher efficiency than Brushless DC Motors, No torque ripple when motor is commutated and higher torque and better performance.

II. Conventional Y source Circuit:

Fig. 1 shows an architecture for a Y-source dc-dc converter based on the Y-source converter concept. There are two modes of operation for the Y-source converter, one for shooting through and the other for not shooting through, similar to the Z-source converter. The Y-source converter's capacitor voltage stress is well-documented because to [12]:

$$V_{c1}=\frac{1-D}{1-\frac{M_1+M_3}{M_3-M_2}D}V_{dc} \qquad (1)$$

The duty cycle of the controlled power switch is D, and the winding turns of the connected inductors are M1, M2 and M3. The Y-source converter's output voltage is then:

$$V_{out}=\frac{1}{1-K1D}V_{dc} \qquad (2)$$

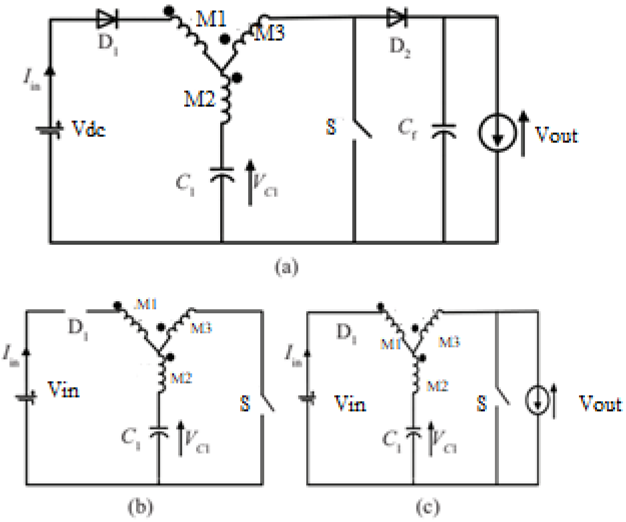

Figure 1.(a) Y-source dc-dc converter, (b) the equivalent circuit in shoot-through state (c) the equivalent circuit in non-shoot-through state.

Where $$K^1=\frac{M_3+M_1}{M_3-M_2} \qquad (3)$$

So when diodes D1 and D2 are reverse biased, the reverse bias voltages of the two diodes are:

$$V'_{D1}=(1-K^1)V_0 \qquad (4)$$

Although the Y-source converter offers a number of notable advantages, it also has a number of drawbacks. An enhanced quasi-Y-source converter (IQY) combining a Y-source and a boost impedance network is proposed in this research for sustainable energy generation. Furthermore, the upgraded Y-source boost converter is not only more efficient than the classic boost converter because of its greater voltage gain and continuous input current, but it also offers a wide range of shoot-through duty ratio and a wide range of inductors' turns ratio to choose from.
For modern energy generating systems, it's a better fit.

III. OPERATING STATES AND SUGGESTED METHOD

A quasi-Y-source dc-dc converter is depicted in Figure 2, which is paired with a boost converter to form the suggested dc-dc. When using a solar power generating system, the converter's input voltage is Vin. Z-source converters have two operational states: (1) S1 is on and S2 is off, or (2) the other way around: S1 is on and S2 is off. The duty cycle of S1 is D = T0 / T if the switching cycle is T and T0 is the turn-on time of S1 and T1 is its turn-off time. Also, in two different working states, the corresponding circuits are depicted in Figures 3(a) and 3(b).

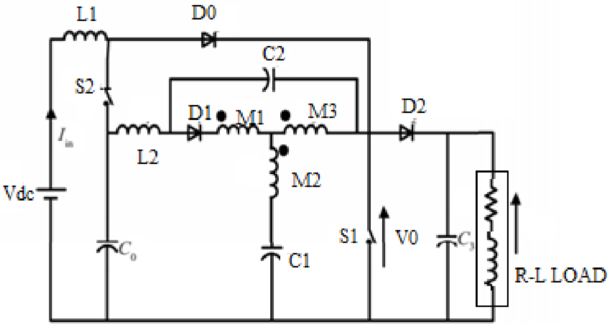

Figure: 2Pproposed dc-dc converter.

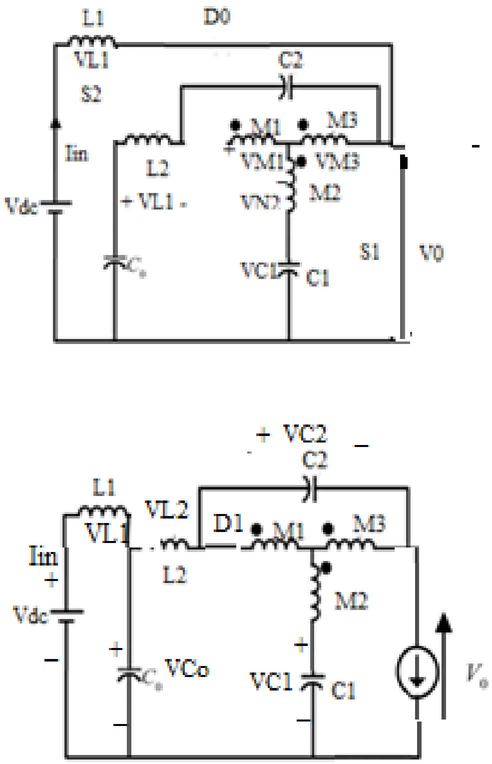

Figure. 3 Improved quasi-Y-source converter equivalent circuits of: (a) S1 is on, S2 is off and (b) S2 is on, S1 is off.

The diode D0 is on and the diode D1 is in a reverse bias state during the time when S1 is switched on. The voltage equations in this condition can be determined by using Kirchhoff's voltage law (KVL) in this mode.

$$V_{in} + V_{L1} = 0$$

$$-V_{C0} + V_{L2} - V_{C1} = 0$$

$$V_{C2} + V_{M2} - V_{M3} = 0$$

$$M_1{:}M_2{:}M_3 = V_{M1}{:}V_{M2}{:}V_{M3}$$

$$V_{M2} = \frac{M_2}{M_3 - M_2} V_{C2} \tag{5}$$

The diode D1 is turned on during the turn-off of S1, whereas the diode D0 is biased in the other direction. According to the equivalent circuit diagram shown in Fig. 3(b):

$$-V_{in} + V_{L1} + V_{C0} = 0$$

$$-V_{C0} + V_{L2} - V_{C1} - V_0 = 0$$

$$-V_{CO} + V_{L2} + V_{M1} + V_{M2} + V_{C2} = 0$$

$$V_{C1} + V_{M1} + V_{M3} = 0$$

$$V_{C1} + \frac{M_1}{M} V_{M2} + \frac{M_3}{M_2} V_{M2} = 0 \tag{6}$$

$$V_{M2} = -\frac{M_2}{M_1 + M_3} V_{C1} \tag{7}$$

By applying voltage-second balance principle to the inductors L1 and L2 and windings of transformer, the average voltage over the inductor is equal to zero, hence:

$$DV_{L2}+(1-D)\,V_{L2}=0$$
$$DV_{L2}+(1-D)\,V'_{L2}=0$$
$$DV_{L0}+(1-D)\,V'_{L0}=0 \qquad (8)$$

By inserting above equations, we will have:

$$\frac{V_{C1}}{V_{C2}}=\left(\frac{M_1+M_3}{M_2-M_3}\right)\left(\frac{-D}{1-D}\right) \qquad (9)$$

IV. MATLAB/SIMULINK RESULTS

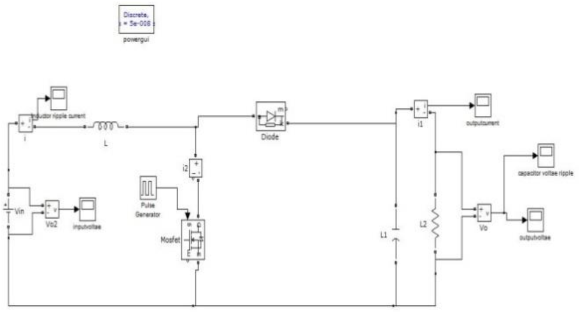

Figure 4 Simulink Diagram of Open loop Boost Converter

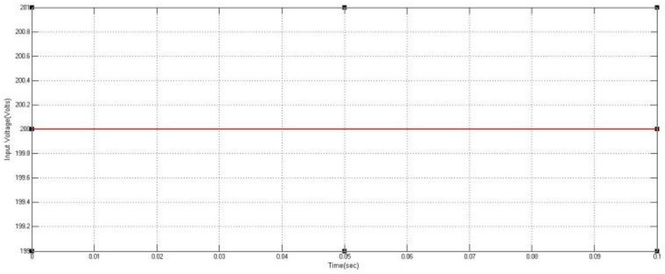

Figure 5 Simulation waveform of Open loop Boost Converter Input Voltage

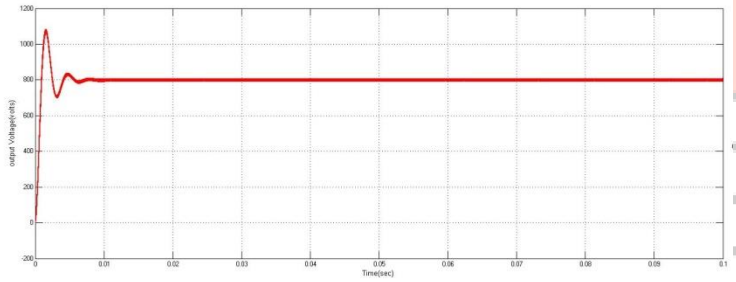

Figure 6 Simulation waveform of Open loop Boost Converter Output Voltage

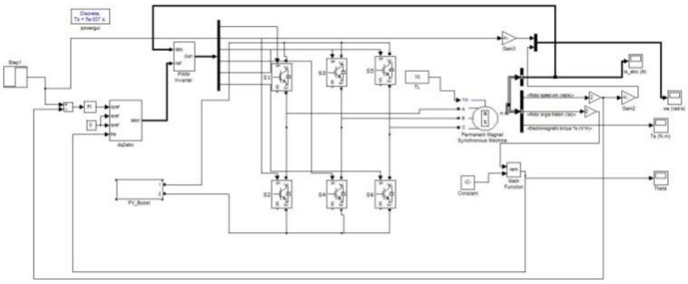

Figure 7 Simulink Diagram of Boost Converter Based PMSM Motor With fixed speed

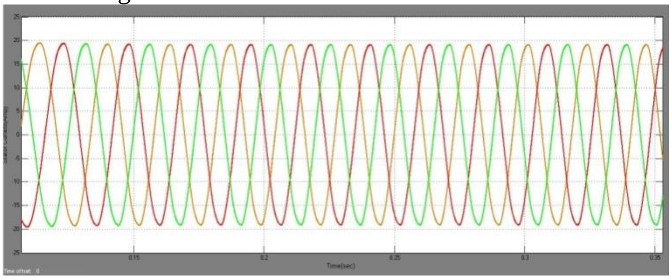

Figure 8 Simulation waveform of stator Current Boost Converter Based PMSM Motor With fixed speed

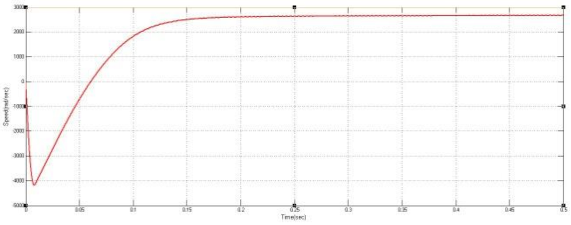

Figure 9 Simulation waveform of speed Boost Converter Based PMSM Motor With fixed speed

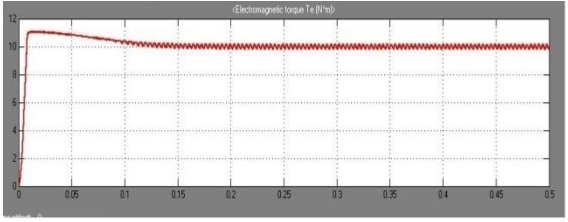

Figure 10 Simulation waveform of Torque Boost Converter Based PMSM Motor With fixed speed

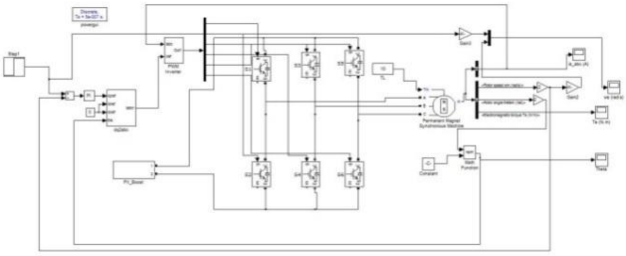

Figure 11 Simulink Diagram of Boost Converter Based PMSM Motor with Variable speed

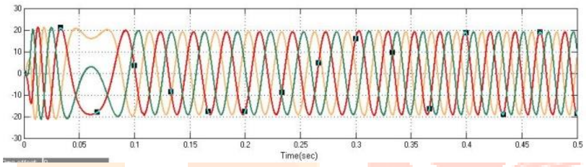

Figure12 Simulation waveform of stator Current Boost Converter Based PMSM Motor With Variable speed

Figure 13 Simulation waveform of speed Boost Converter Based PMSM Motor With Variable speed

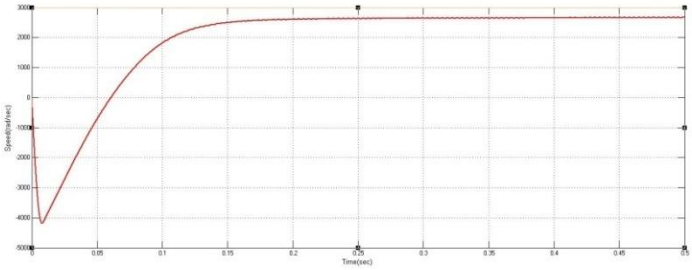

Figure 14 Simulation waveform of Torque Boost Converter Based PMSM Motor With Variable speed

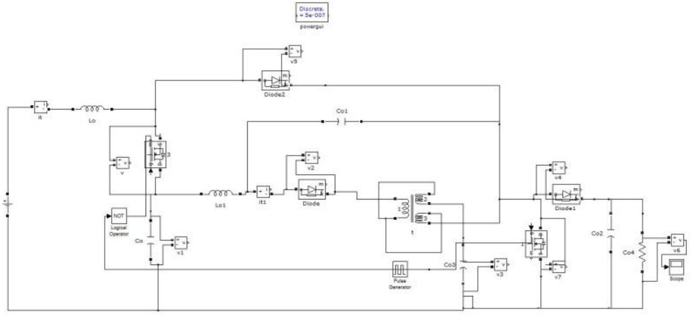

Figure 15Simulink Diagram of Quasi Boost Converter

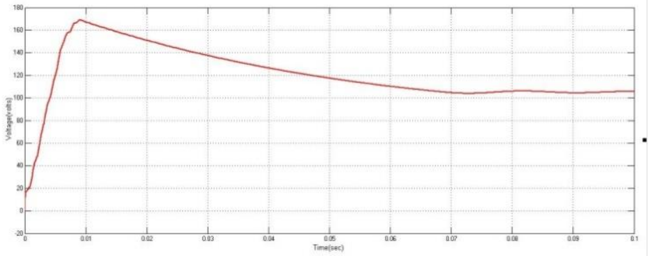

Figure 16 Simulation waveform of Quasi Boost Converter Output Voltage

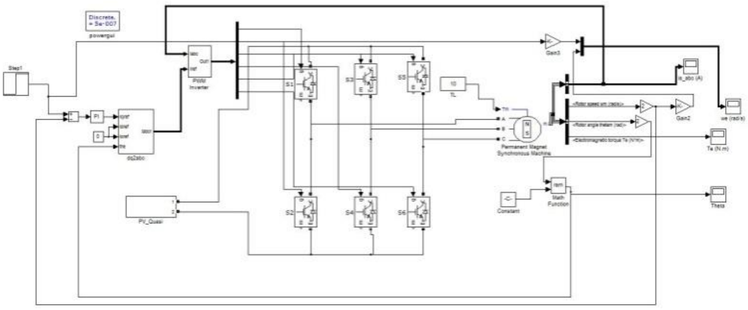

Figure 17 Simulink Diagram of Quasi Boost Converter Based PMSM Motor With fixed speed

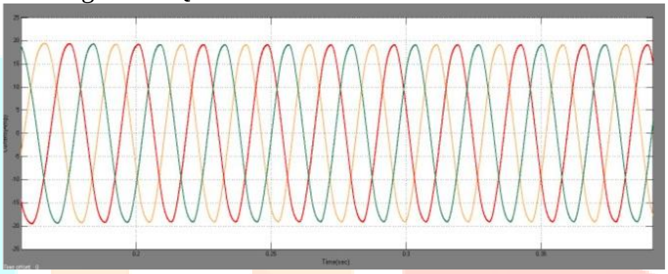

Figure 18 Simulation waveform of stator Current Quasi Boost Converter Based PMSM Motor With fixed speed

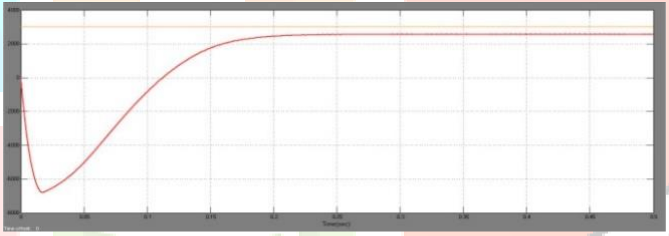

Figure 19 Simulation waveform of Speed Quasi Boost Converter Based PMSM Motor With fixed speed

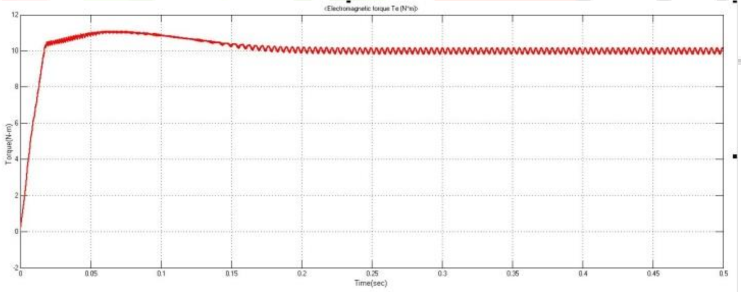

Figure 20 Simulation waveform of Torque Quasi Boost Converter Based PMSM Motor With fixed speed

To more clearly demonstrate the boosting performance of the suggested converter, which is shown in the preceding Figures, the overall gain can be changed by altering D (the shoot-through duty cycle) and K (turn ratios). It will be demonstrated that by raising the turn ratio K, substantial transfer gains may be obtained with a low shoot through (ST) duty cycle. The enhanced quasi-Y-source converter has a greater voltage gain than the traditional Y-source converter. Figure 5 to figure 14. Shows the outputs of open loop converter for PMSM and performance of PMSM. Figure 17 shows the simulation diagram of Y source converter and figure 18 shows the stator current for PMSM. From open loop boost converter shows some disturbances initially as shown in figure 12, it was improved by proposed converter as shown in figure 18.

V. CONCLUSION

There are several advantages to the quasi-Y source design, such as an exceptionally high boost gain and the ability to build winding magnetic, that are not present in the current quasi-Y-source design. This work introduces an upgraded version of the quasi-Y-source design that retains these advantages. Higher voltage gain, constant input current, and low start-up inrush current are all features of the converter is used to operate PMSM , it eliminates ripple in torque wave form. In this paper compared the open loop boost converter and Y source Quasi DC-DC converter for distributed generators to fed supply for PMSM for getting good performance in Industrial applications.

REFERENCES

[1] X. Fang, X. Ding, S. Zhong and Y. Tian, "Improved quasi-Y-source DC-DC converter for renewable energy," in CPSS Transactions on Power Electronics and Applications, vol. 4, no. 2, pp. 163-170, June 2019, doi: 10.24295/CPSSTPEA.2019.00016.

[2] K. I. Hwu and Y. T. Yau, “High Step-Up Converter Based on Charge Pump and Boost Converter,” in IEEE Transactions on Power Electronics, vol. 27, no. 5, pp. 2484-2494, May 2012.

[3] Y. Huangfu and S. Wang, "Radiated EMI simulation for high-power ultra-precision PMSM system driven by PWM converter," *2016 IEEE Conference on Electromagnetic Field Computation (CEFC)*, 2016, pp. 1-1, doi: 10.1109/CEFC.2016.7816251.

[4] Fang Zheng Peng, “Z-source inverter,” in IEEE Transactions on Industry Applications, vol. 39, no. 2, pp. 504-510, March-April 2003.

[5] J. Anderson and F. Z. Peng, “Four quasi-Z-Source inverters,” 2008 IEEE Power Electronics Specialists Conference, Rhodes, 2008, pp. 2743-2749.

[6] D. Cao and F. Z. Peng, “A family of Z-source and Quasi-Z-source dc-dc converters,” 2009 Twenty-Fourth Annual IEEE Applied Power Electronics Conference and Exposition, Washington, DC, 2009, pp. 1097-1101.

[7] P. C. Loh and F. Blaabjerg, “Magnetically coupled impedance-source inverters,” in IEEE Transactions on Industry Applications, vol. 49, no.5, pp. 2177-2187, Sept.-Oct. 2013.

[8] Y. P. Siwakoti, F. Z. Peng, F. Blaabjerg, P. C. Loh, and G. E. Town, “Impedance-source networks for electric power conversion part I: A topological review,” in IEEE Transactions on Power Electronics, vol. 30, no. 2, pp. 699-716, Feb. 2015.

[9] S. Jiang, D. Cao, and F. Z. Peng, “High frequency transformer isolated Z-source inverters,” 2011 Twenty-Sixth Annual IEEE Applied Power Electronics Conference and Exposition (APEC), Fort Worth, TX, 2011, pp. 442-449.

[10] M. Nguyen, Y. Lim, and Y. Kim, “TZ-source inverters,” in IEEE Transactions on Industrial Electronics, vol. 60, no. 12, pp. 5686- 5695, Dec. 2013.

[11] W. Qian, F. Z. Peng, and H. Cha, “Trans-Z-source inverters,” in IEEE Transactions on Power Electronics, vol. 26, no. 12, pp. 3453-3463, Dec. 2011.

[12] M. Nguyen, Y. Lim, and S. Park, “Improved trans-Z-source inverter with continuous input current and boost inversion capability,” in IEEE Transactions on Power Electronics, vol. 28, no. 10, pp. 4500-4510, Oct. 2013.

[13] P. C. Loh, D. Li, and F. Blaabjerg, “Γ-Z-source inverters,” in IEEE Transactions on Power Electronics, vol. 28, no. 11, pp. 4880-4884, Nov. 2013.

[14] R. Strzelecki, M. Adamowicz, N. Strzelecka, and W. Bury, “New type T-source inverter,” in Proc. CPE’09, May 2009, pp. 191-195,Badajoz, Spain.

[15] O. Aydogmus and E. Deniz, "Design of a two-phase PMSM fed by an AC-AC converter," 2015 IEEE International Conference on Industrial Technology (ICIT), 2015, pp. 690-695, doi: 10.1109/ICIT.2015.7125178.

[16] C. Ortega, A. Arias, C. Caruana, M. Apap and J. Balcells, "Torque ripple reduction in PMSM DTC drives using matrix converters," *2007 European Conference on Power Electronics and Applications*, 2007, pp. 1-10, doi: 10.1109/EPE.2007.4417749.

[17] K. Tseng, C. Huang, and W. Shih, “A high step-up converter with a voltage multiplier module for a photovoltaic system,” in IEEE Transactions on Power Electronics, vol. 28, no. 6, pp. 3047-3057, June 2013.

[18] M. M. Haji-Esmaeili and E. Babaei, “Quasi-Y source based buckboost DC-DC converter,” IECON 2017 - 43rd Annual Conference of the IEEE Industrial Electronics Society, Beijing, 2017, pp. 8033- 8038.

[19] Y. P. Siwakoti, F. Blaabjerg, and P. C. Loh, “Quasi-Y-Source BoostDC–DC Converter,” in IEEE Transactions on Power Electronics, vol. 30, no. 12, pp. 6514-6519, Dec. 2015.

[20] J. Solsona, M.I. Valla, C. Muravchik, State Estimation of a Permanent Magnet Synchronous Motor with Unknown Load Torque, IFAC Proceedings Volumes, Volume 28, Issue 19, 1995, Pages 135-140, ISSN 1474-6670.

[21] Sabrina K. Rechkemmer, Ryosuke Izumi, Weimin Zhang, Oliver Sawodny, Estimation of Permanent Magnet Synchronous Machine Performance for Pre-Design Using a Reluctance Network, IFAC-Papers On-line, Volume 51, Issue 31, 2018, Pages 75-80, ISSN 2405-8963.

.