International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 06 | June 2021 www.irjet.net p-ISSN: 2395-0072

SIX-LEG AC–DC–AC ISOLATED CONVERTER FOR UPS AND UPQC APPLICATIONS

RAJESWARI.M [1], MOHANKUMAR.G[2]

[1]*P.G Scholar, Department of EEE, PRIST UNIVERITY, Thanjavur, Tamil Nadu (Puducherry Campus)*

[2] *Assistant Professor& Head, Department of EEE, PRIST UNIVERITY, Thanjavur, Tamil Nadu (Puducherry Campus)*

Abstract – *In this paper a single-phase ac-dc-ac multilevel converter consists of two three-leg converters series connected throughout two transformers one on the grid side and one on the load side sharing the same dc-link are proposed. The proposed converter allows feed the load with sinusoidal voltages keeping constant frequency and amplitude under grid voltage disturbances. Circuit model equations, PWM technique based on space vector approaches and a control system are presented. The converters can then be used as uninterruptible power supplies (UPSs) and unified power quality conditioners (UPQCs) for non regenerative applications. The proposed topology is compared in terms of semiconductor losses, transformers losses and total power losses with the conventional one. The proposed model will be developed using MATLAB/Simulink to validate control strategies.*

Key Words: ac-dc-ac converters, high grid power factor, voltage disturbances, space vector pwm, control strategies.

1.INTRODUCTION

Electrical grid disturbances such as voltage and current waveforms are mainly characterized by a power quality issue. These disturbances on power grids are caused by nonlinear loads, system faults and variation of heavy loads. It may lead to damage and mis operation in electrical equipments as a consequence of power quality besides power and financial losses. A voltage with constant amplitude, phase, and frequency, regardless of disturbances on power grid voltage, AC-DC-AC configurations provide bidirectional power flow and they can be applied to feed loads. Furthermore, if the grid current is controlled input power factor can be maximized and harmonic distortions reduced. The ac-dc-ac converters are mainly applied in uninterrupted power supplies (UPS), unified power quality compensator (UPQC), generation systems, voltage regulator, and harmonic compensators. UPS are able to ensure they should provide sinusoidal output voltage with low harmonic content and high reliability and sinusoidal input current with low harmonic content and high power factor. Even during long grid interruptions supplying loads with proper voltage. These systems are quite suitable for critical loads such as hospital equipments, internet and financial data centers, telecommunication and security facilities.

UPQCs are devices combinations of series and parallel active filters connected to the grid in order to solve problems related to power quality. This type of conditioner can compensate for voltage disturbances such as sags, swells, avoiding the introduction of harmonic distortions in electrical systems as well as is capable of mitigating fast and successive transitions currents produced by non-linear loads. Series-compensators usually requires decoupling transformers these transformers can be series-connected to improve the quality of generated waveforms. In UPS and UPQC applications, which allows reducing the number of power switches by sharing legs between the converter stages and ac-dc-ac converters have the same input grid, output load fundamental frequencies.

2. DIFFERENT TOPOLOGY FOR UPQC AND UPS APPLICATIONS

The most popular single-phase UPQC structure composed of four legs and a transformer named as 4L-T (four legs and a transformer) configuration as shown in figure1 and its characteristics according the choose of transformer turn ratio, a space vector pwm strategy for this topology. Other topologies with reduced component (with three and two legs) were proposed as alternative to 4L-T.

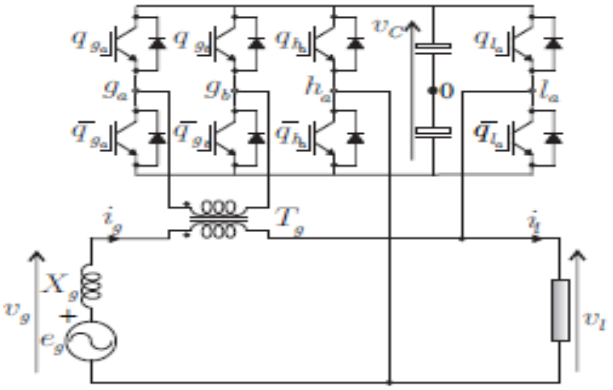

Figure 1 4Leg-Transformer Topology

To obtain multilevel structures and improves the system reliability and series transformers to connect this module is used. This paper investigates a single-phase ac-dc-ac multilevel converter composed of two three-leg converters series-connected throughout two transformers (one at the grid side, and one at the load side), sharing the same dc in electrical devices capable of compensating for voltage disturbances and maintaining a load voltage with constant amplitude and phase. This topology is named as six legs and two transformers (6L-2T) configuration as shown in figure2. The 6L-2T topology, the ability to compensate for swells at the power supply without increasing the dc-link voltage with the insertion of the transformer in the grid side. The topology 6L-2T is an interesting option for UPS and UPQC applications In addition it can generate input and output voltages with low harmonic content.

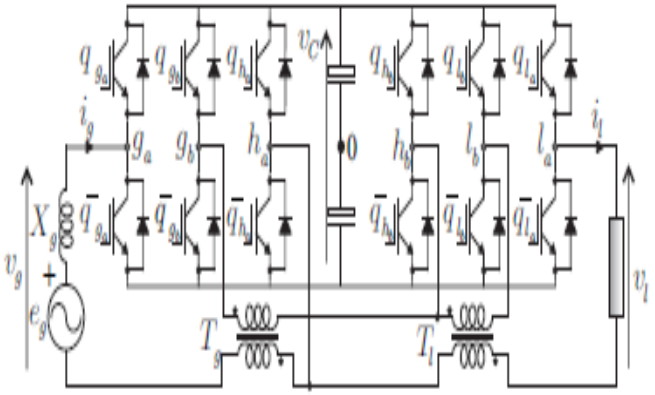

Figure 2 4Leg-2Transformer Topology

Overall compared to conventional structure proposed converter presents the following benefits:

1) By synthesized voltages and currents by reduction of harmonic distortions.

2) To contributes increase life span of the system and efficiency by reduction of semiconductor power losses.

3) Decreases the voltage rating of the switches used to build the proposed converter in which reduction in the minimum value voltage required by the dc-link.

4) Flexibility for application with different voltage levels scenarios.

The benefits of proposed 6L-T topology can compared to conventional 4L-T in generate long-term cost despite having a great number of components and for some critical applications the performance should be weighted more than the cost.

3. Control Strategy for a Single-Phase AC-DC-AC Converter

The modulation strategy must synthesize a square MF-AC voltage into an equivalent sinusoidal pulse width modulation (SPWM) in the full bridge converter. To reach this objective the input and output converters must be synchronized and commuting at the same frequency rate. In the proposed converter it is important to apply a proper modulation technique phase-shifted multicarrier sinusoidal PWM (PSPWM) modulation that output voltage produced will be multilevel. Output voltage VPWM obtained with the PSPWM modulation, effective switching frequency in which is an attractive feature. A direct effect of implementing the PSPWM, considering a low-frequency modulation ratio is a widely free zone of switching harmonics the most significant harmonic appears in this modulation, the amplitude and frequency of all triangular signals are the same.

The control diagram of proposed structure is shown in figure3. A pulse generator is utilized to control the dc-link voltage v_C and to generate the reference amplitude of i_g. Proportional integral (PI) controller named Rv is utilized. The Phase angle of voltage can be detected by the PLL (Phase-locked-Loop) block. To maximize the input power factor, the block synchronizes instantaneous reference current i_g with the grid voltage. A double-sequence PI controller named R_i is used to adjust grid current ig and is responsible for setting the reference voltage v_g .

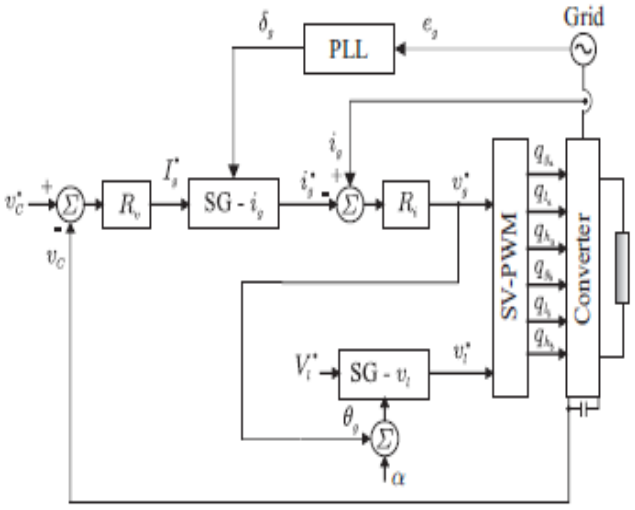

Figure 3 Control diagram of proposed structure

4. SIMULATIONS AND RESULTS

The computer simulations are performed employing MATLAB/Simulink as shown in figure 3. The simulations results for proposed topology 6L-2T are carried out.

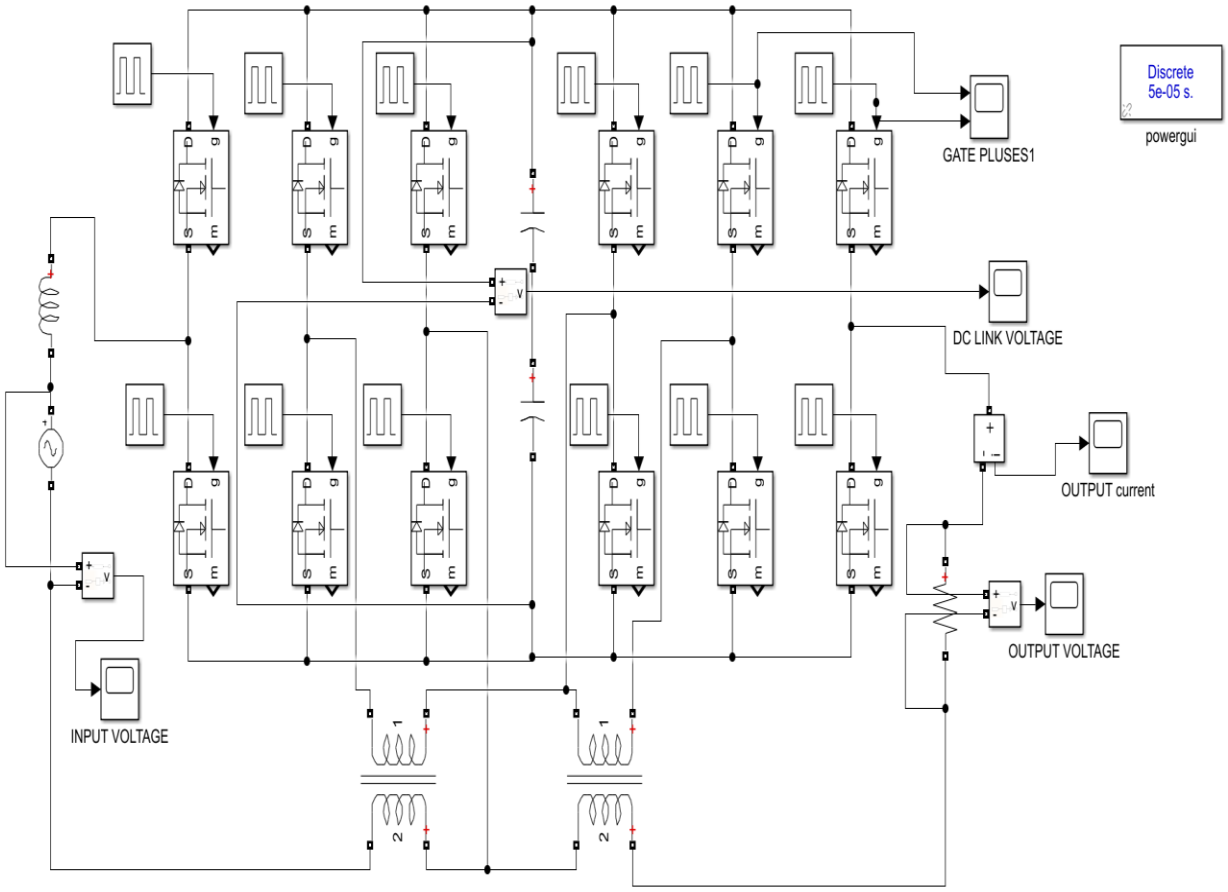

Figure 4 Simulation Circuit for proposed topology 6L-2T

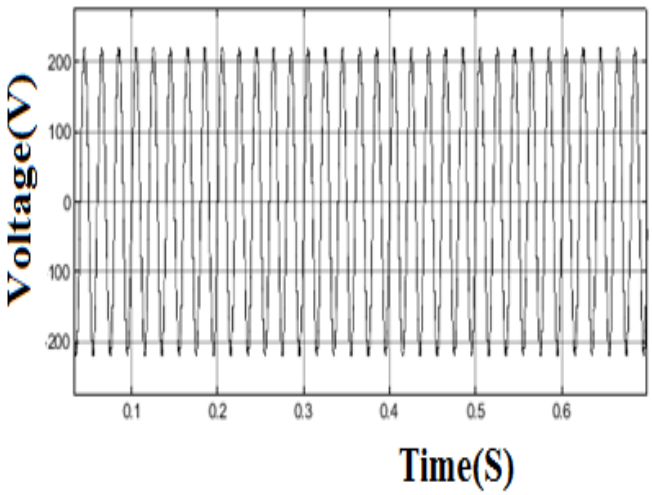

Figure 5 Input Voltage

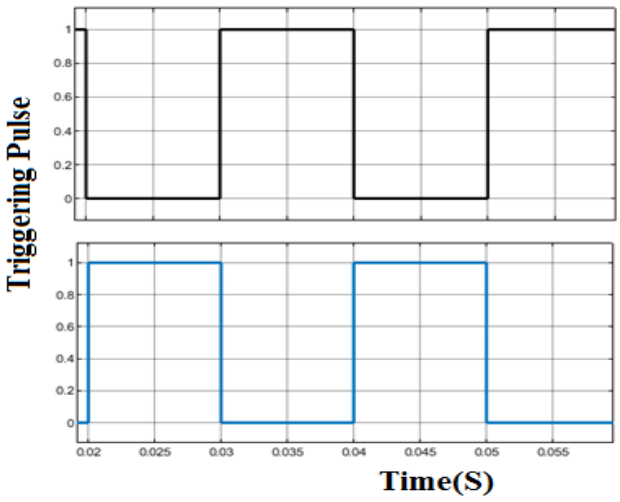

Figure 6 Trigger pulse

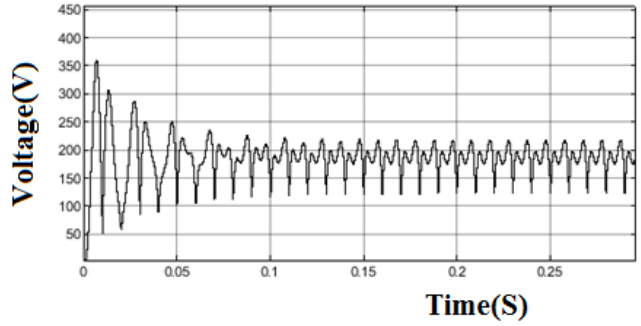

Figure 7 DC link voltage

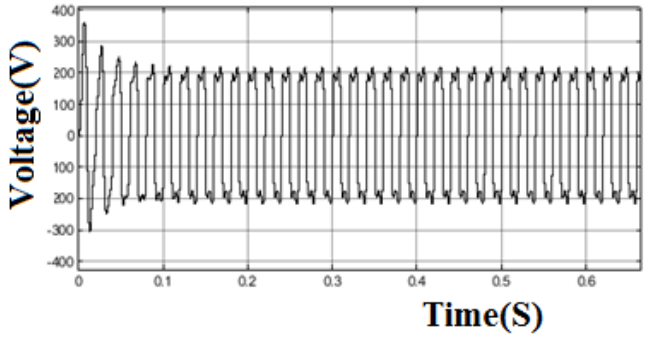

Figure 8 Output Voltage

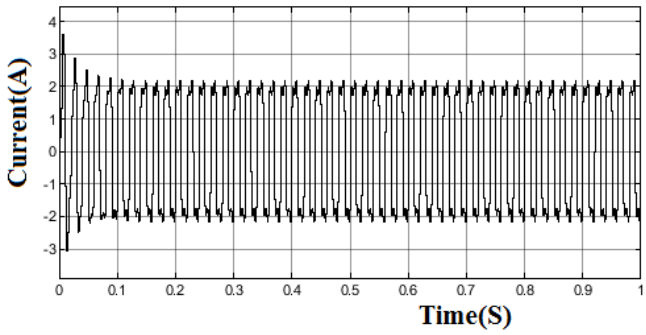

Figure 9 Output Current

5. CONCLUSION

In this paper a single-phase ac-dc-ac multilevel converter consists of two three-leg converters series connected throughout two transformers one on the grid side and one on the load side sharing the same dc-link was designed and simulated using MATLAB/simulink. The proposed structure has shown to be suitable to operate under grid disturbances, maintaining the grid power factor optimized, and the load voltage with constant amplitude and frequency. Simulation results showed the operation of proposed topology under grid disturbances and load transients, demonstrating that 6L-2T is feasible for applications in electrical energy conversion and compensation systems.

REFERENCES

[1] N. B. de Freitas, C. B. Jacobina, and R. P. de Lacerda, "Single-phase ac-dc-ac topology for grid voltage compensation," in 2017 IEEE Energy Conversion Congress and Exposition (ECCE), pp. 659–666, Oct 2017.

[2] C. B. Jacobina, N. Rocha, G. A. de Almeida Carlos, and E. C. dos Santos, "Flexible series/parallel ac-dc-ac motor drive system," IEEE Transactions on Industry Applications, vol. 51, pp. 259–270, Jan 2015.

[3] J. w. G. Hwang, M. Winkelnkemper, and P. W. Lehn, "Control of ac-dcac converters with minimized dc link capacitance under grid distortion," in 2006 IEEE International Symposium on Industrial Electronics, vol. 2, pp. 1217–1222, July 2006.

[4] A. C. N. Maia and C. B. Jacobina, "Single-phase ac-dc-ac topology for grid overvoltage and voltage harmonic mitigation," IET Power Electronics, vol. 10, no. 12, pp. 1626–1637, 2017.

[5] P. L. S. Rodrigues, C. B. Jacobina, and M. B. R. Correa, "Single-phase universal active power filter based on ac/ac converters," in 2016 IEEE Energy Conversion Congress and Exposition (ECCE), pp. 1–8, Sep. 2016.

[6] M. Shahbazi, M. Mohamadian, and A. Y. Varjani, "Parallel operation of series-parallel uninterruptible power supplies," in 2016 7th Power Electronics and Drive Systems Technologies Conference (PEDSTC), pp. 268–272, Feb 2016.

[7] Q. N. Trinh, F. H. Choo, J. Chi, and W. Peng, "An improved control strategy for three-phase ac/dc/ac converter in ups application," in 2016 Asian Conference on Energy, Power and Transportation Electrification (ACEPT), pp. 1–6, Oct 2016.

[8] H. Fujita and H. Akagi, "The unified power quality conditioner: the integration of series and shunt-active filters," IEEE Transactions on Power Electronics, vol. 13, pp. 315–322, Mar 1998.

[9] Po-Tai Cheng, Chian-Chung Huang, Chun-Chiang Pan, and S. Bhattacharya, "Design and implementation of a series voltage sag compensator under practical utility conditions," IEEE Transactions on Industry Applications, vol. 39, pp. 844–853, May 2003.

[10] H. Awad, H. Nelsen, F. Blaabjerg, and M. J. Newman, "Operation of static series compensator under distorted utility conditions," IEEETransactions on Power Systems, vol. 20, pp. 448–457, Feb 2005.

BIOGRAPHIES

M. RAJESWARI received the Engineer degree in 2001 from University of Madras, Chennai, Tamilnadu. From 2008 to 2019 worked as Assistant Engineer various field in TNEB and Served Public. Her Specialization in TNEB is Operation in Maintanence in Distribution network dealt upto 110KV and Materials Procurement for Distribution network.