International Journal of Advanced Technology and Innovative Research
www.ijatir.org
ISSN 2348–2370
Vol.07,Issue.18,
December-2015,
Pages:3682-3686

Interconnection of Wind Generation to Grid with SPMC Based Boost Rectifier

MAJJI. KAVITHA[1], T. BHAVANI[2]
[1]PG Scholar, Dept of EEE, Sarada Institute of Science Technology and Management, Srikakulam (Dt), AP, India.
[2]Assoc Prof & HOD, Dept of EEE, Sarada Institute of Science Technology and Management, Srikakulam (Dt), AP, India.

Abstract: This Paper focused on boost rectification by Single Phase Matrix Converter with fewer numbers of switches for wind energy based synchronization to the grid. The conventional matrix converter consists of 4 bidirectional switches, i.e. eight set of IGBT/MOSFET with anti parallel diodes. In this proposed matrix converter, only six switches are used. The switch commutation arrangements are also carried out in this work. The SPMC topology which have many advantages as a minimal passive device use. It is very flexible and it can be used as a lot of converters. The gate pulses to the switches are provided by the PWM techniques. The duty ratio of the switches based on Pulse Width Modulation (PWM) technique was used to produce the output waveform of the circuit, simply by turning ON and OFF the switches. The voltage from SPMC given to the grid side voltage source converter. The simulation results using MATLAB/Simulink were provided to validate the feasibility of this proposed method of wind generation based grid interconnection with SPMC.

Keywords: Single-Phase Matrix Converter (SPMC) With Reduced Switch Counts; Boost Rectifier, Wind Generation And Grid.

I. INTRODUCTION

Development of an advanced semiconductor devices in power electronics are increased. Matrix Converter (MC) which used the recent power semiconductor devices. Matrix Converter is a single stage converter. It uses bi-directional fully controlled switches for direct conversion from ac to ac. A matrix converter that can directly convert an ac power supply voltage into an ac voltage of variable amplitude and frequency without a large energy storage element. Earlier Z-source converter have a number of merits, such as providing a larger range of output voltages with the buck–boost mode, reducing inrush, and harmonic current. The single phase version called the Single-phase Matrix Converter (SPMC) was first introduced by Zuckerberger [3] based on direct AC-AC converter. Recent research on matrix converters has extended its operation to inverter, controlled rectifier, boost rectifier and buck-boost rectifier [4-7]. The research in [8, 9] focused on step up / step down frequency operation with a safe-commutation strategy. However in all these topologies, the AC output voltage cannot exceed the AC input voltage (since no energy storage components are present between the input and output side and the output voltage waveform is synthesized by sequential piecewise sampling of the input voltage waveforms, the output voltage have to fit within the curve of the input voltage). Furthermore, it is not possible to turn both the bidirectional switches of a single phase leg on at the same time; otherwise the current spikes generated by this action will destroy the switches.

The four different conversions of supply are grouped to form SMPS. They are AC-AC, AC-DC, DC-DC and DC-AC conversions. In this AC-DC conversions are used in many portable applications. The converted DC supply has to be change according to the load connected to it. This is achieved by DC-DC chopper. Widely using DCDC choppers are Buck (step down) and Boost (Step up). The Matrix Converter (MC) topology was first introduced by Gyugyi in 1976 [2]. It is mainly used for AC-AC conversion. Other name for MC is PWM cyclo converter. It provides the all-silicon solution for AC-AC conversion by removing the DC link, which is used in conventional rectifier-inverter based system. Other advantages of MC are good input power quality, potentiality of increasing power density, reducing size and cost, bidirectional energy flow. The single phase matrix converter (SMPS) was first identified by zuckerberger in 1997 [1] as the direct single phase ACAC converter. The MC is also capable of rectifying [5], inverting, and chopping [6].The bidirectional switch is not readily available in market. So it is formed by connecting two IGBT with anti-parallel diode pair in series. Totally 8 switches are used in conventional SPMC. When we consider the SPMC for rectifier operation there is 2 switches which are unused for all purpose including safe commutation strategy [5] & [10]. Reduce switch count SPMC is obtained by removing the unused switches. The rectifier operation with this reduced SPMC was analyzed. In this paper, basic SPMC topology was reviewed based on controlled rectifier operation by suitable switching schemes. IGBTs are used as the main power switching device. Simple RC load was used, by inclusion of an inductance in the input side to provide boost operation.

II. BOOST TOPOLOGY

Boost converted electronic power supplies as shown in Fig.1 are used actually to achieve the desired output voltage that is higher compared to the input voltage level [6]. The operation of this circuit was divided into two parts. First part for switch is turn ON and second part for the switch is turn OFF. When the switch is turn ON, the current from the positive supply of the source will flow through the line inductor, flow through switch, then flow back to the negative source. In this stage, the inductor will store the energy, hence inductor current will increase as shown in Fig. 2. Then, during the switch is turn OFF, the inductor current will be decrease as shown in Fig. 2 since the energy stored by the inductor is released to the load, resulted to the output voltage greater than the input.

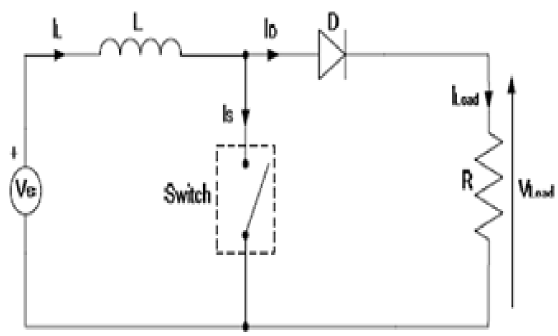

Fig. 1. Basic circuit of boost converter.

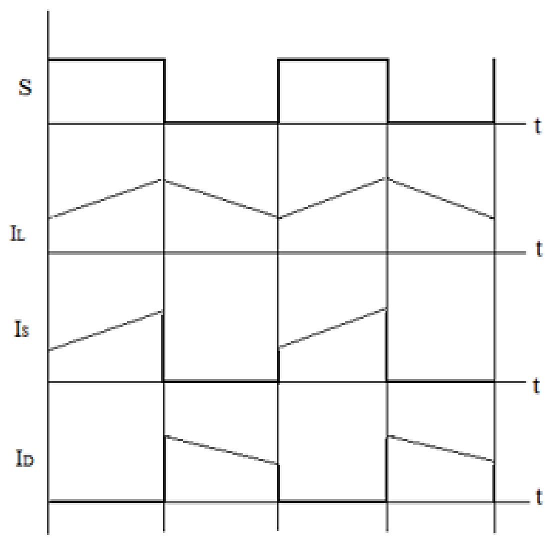

Fig. 2.Ideal Waveform of Boost Converter.

III. SINGLE-PHASE MATRIX CONVERTER

The Single phase Matrix Converter (SPMC) was first realized by Zuckerberger in 1997 [4]. Thus SPMC of a matrix of input and output lines with four bidirectional switches connecting the single phase input to the single phase output at the intersections as shown in Fig. 3. Fig. 4 shows the bidirectional switch module using a common emitter anti-parallel IGBT with diode pair switch-cell to allow current flow in both directions, whilst at the same time blocking the voltage.

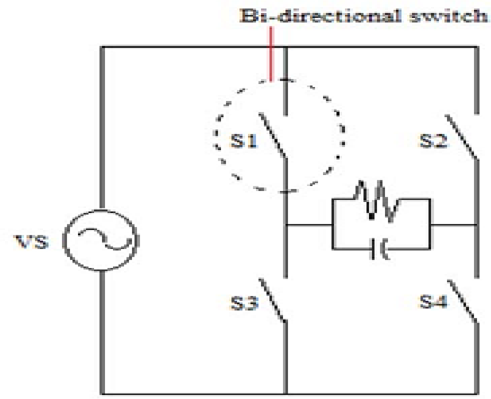

Fig. 3. SPMC circuit.

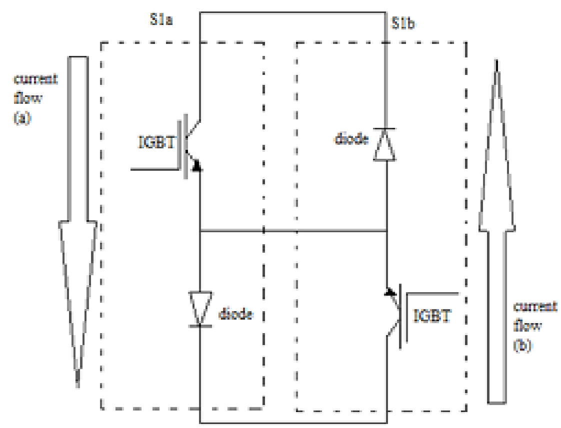

Fig. 4. Bi-directional switches module (common emitter).

IV. SPMC WITH REDUCED SWITCH COUNTS

Implementation of SPMC with reduced switch counts was done by removing the two unutilized switches that have been identified from conventional boost rectifier operation using SPMC topology as shown in Fig. 5.

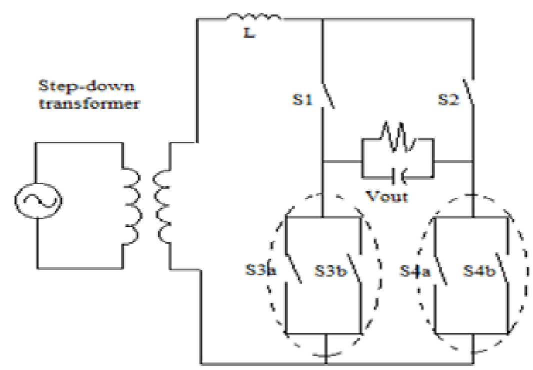

Fig. 5.Proposed SPMC circuit topology with reduced switch count.

A. Control Implementation

The propose boost rectifier uses duty ratio based on PWM technique which will produce output voltage waveform, simply by turning ON and OFF the switches.

Fig. 6 shows the generated PWM switching. If the magnitude of the modulating signal (constant) is higher than or equal to the carrier signal (triangular wave), the output pulse produced and otherwise a zero output is obtained. By considering the fundamental frequency equals to 50Hz, the PWM pulse train was divided into two parts; positive cycle operation that will begin from 0 to 10ms and negative cycle operations conduct from 10ms to 20ms. This is done by using phase detector that produce high signal (1) during sine wave signal is greater than zero whilst produce low signal (0) during sine wave signal is less than zero. Table 1 shows the switching algorithm for control the propose boost rectifier using SPMC with reduced switch counts.

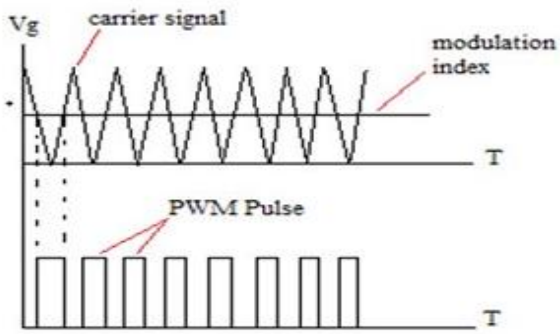

Fig. 6. PWM Pulse Generation.

TABLE I: Switching Controlled Boost Rectifier Using SPMC with Reduced Switch Count

Switches	Positive cycle	Negative cycle
S1	PWM	OFF
S2	OFF	PWM
S3a	OFF	OFF
S3b	OFF	PWM
S4a	PWM	OFF
S4b	OFF	OFF

B. Switching Strategies

Fig. 7 and Fig. 8 show control boost rectifier operation using SPMC with reduced switch counts for positive and negative cycle. During positive cycle operation, only two switches S1 and S4a will be turn ON. Meanwhile for negative cycle operation, switches S2 and S3b will be turn ON.

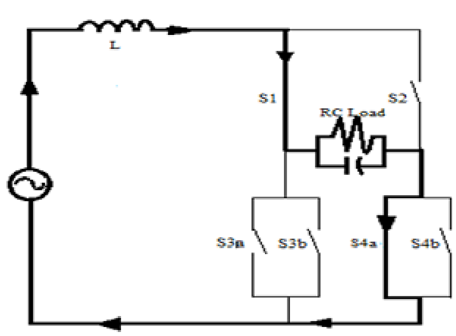

Fig. 7. Controlled boost rectifier using SPMC.

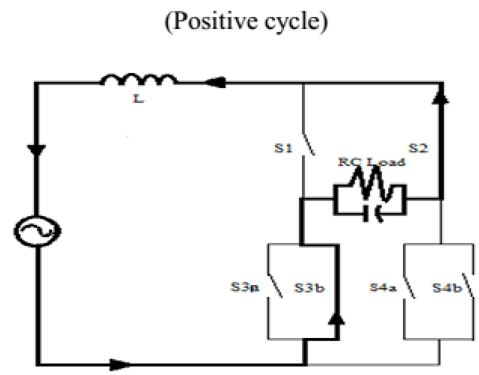

Fig.8. Controlled boost rectifier using SPMC (Negative cycle).

V. WIND ENERGY & GRID-CONNECTED VSC

The modern lifestyle depends tremendously on the use and existence of fossil fuels. With levels of these fuels constantly decreasing, we should act now to become less dependent on fossil fuels and more dependent on renewable energy sources. Renewable energy provides 19% of electricity generation worldwide. Renewable power generators are spread across many countries, and wind power alone already provides a significant share of electricity in some areas. The terms "wind energy" or "wind power" describe the process by which the wind is used to generate mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks (such as grinding grain or pumping water) or a generator can convert this mechanical power into electricity to power homes, businesses, schools, and the like. After passing the Ac to the proposed AC to DC converter, with improvement of power factor and Dc regulation given to VSC for grid connection. A scheme of the main circuit of the VSC is shown in Fig.9. The valves are of the IGBT type. The VSC is connected to a symmetric three-phase load, which has the impedance R+jωL and the emfs $e_1(t)$, $e_2(t)$and $e_3(t)$.

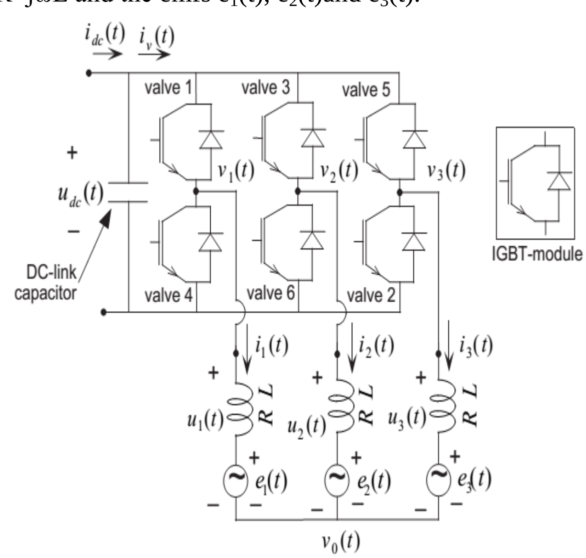

Fig.9. Grid Connected VSC.

The neutral point of the star-connected load has the potential v0(t), due to a floating ground. The phase potentials of the VSC are denoted as $v_1(t)$, $v_2(t)$and $v_3(t)$. The phase voltages of the VSC are denoted as $u_1(t)$, $u_2(t)$and $u_3(t)$. The current flowing from the dc-link to the converter is denoted as iv(t), the dc-link current is denoted as idc(t)and the dc-link voltage across the dc-link capacitor is denoted as udc(t).

VI. MATLAB/SIMULINK RESULTS

Case I: Analysis of the Single Phase Matrix Converter

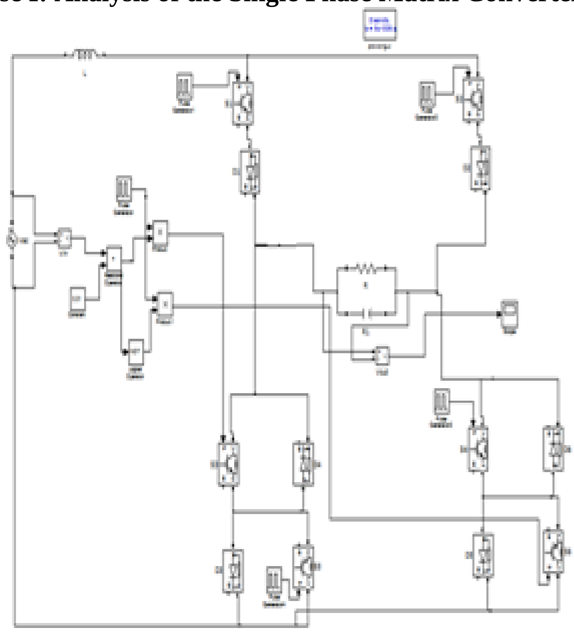

Fig.10. Matlab/Simulink model of boost rectifier.

Fig.10 shows the Matlab/Simulink model of boost rectifier. Fig.11 shows the output voltage of boost rectifier.

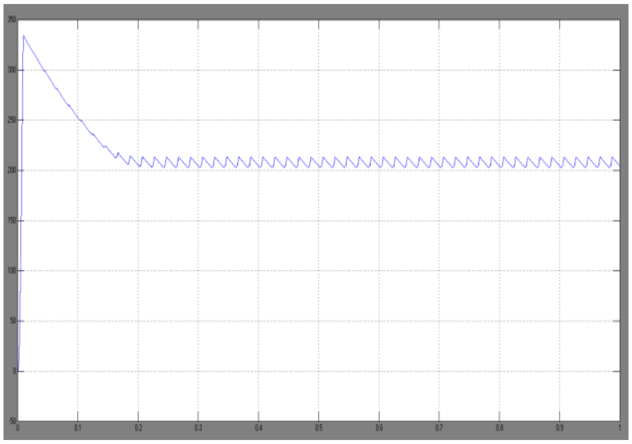

Fig.11. output voltage of boost rectifier.

Case II: Analysis of Wind Energy Input Connected To Grid With Single Phase Matrix Converter

Fig.12 shows Matlab/Simulink model of boost rectifier with six switches with Wind energy based Grid connected System. Fig.13 shows Simulated output wave form of the Voltage form wind generator. Fig.14 shows Simulated output voltage wave form of the Dc voltage form the SPMC.

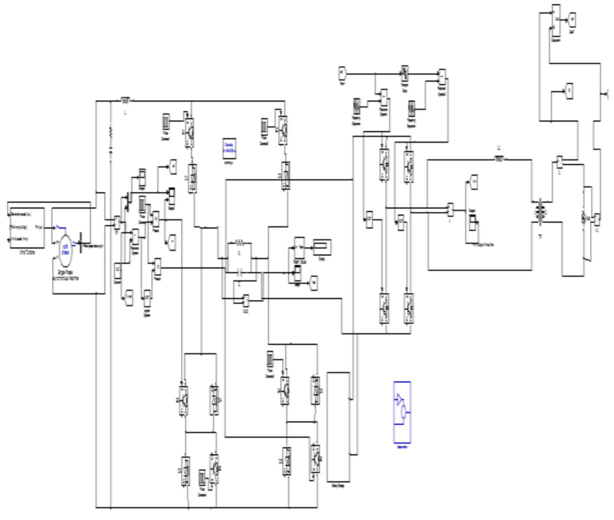

Fig.12. Matlab/Simulink model of boost rectifier with six switches with Wind energy based Grid connected System.

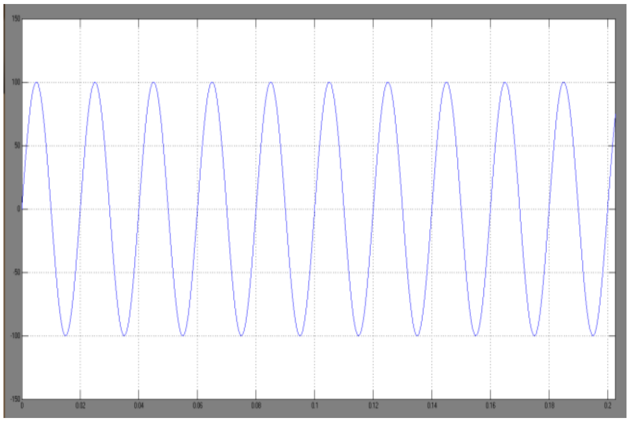

Fig.13. Simulated output wave form of the Voltage form wind generator.

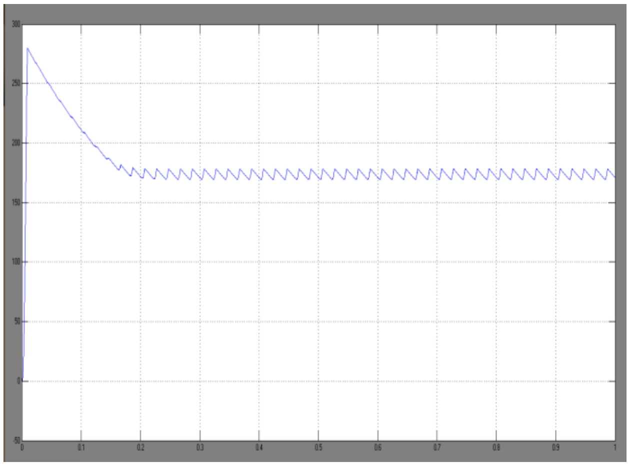

Fig.14. Simulated output voltage wave form of the Dc voltage form the SPMC.

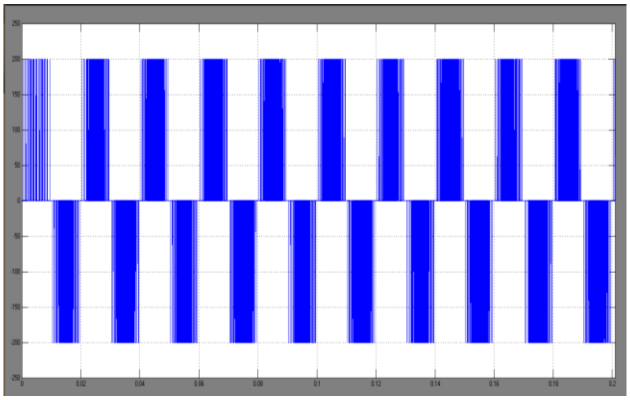

Fig.15. Simulated Ac voltage wave form of the inverter.

Fig.15 shows Simulated Ac voltage wave form of the inverter. Fig.16 shows Current wave form of the grid. Fig.17 shows Voltage wave form of the grid.

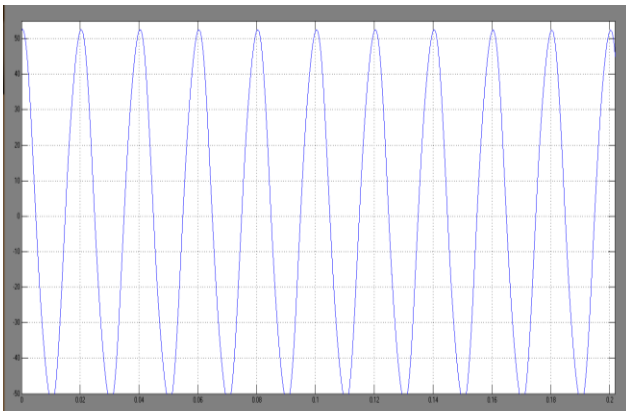

Fig.16. Current wave form of the grid.

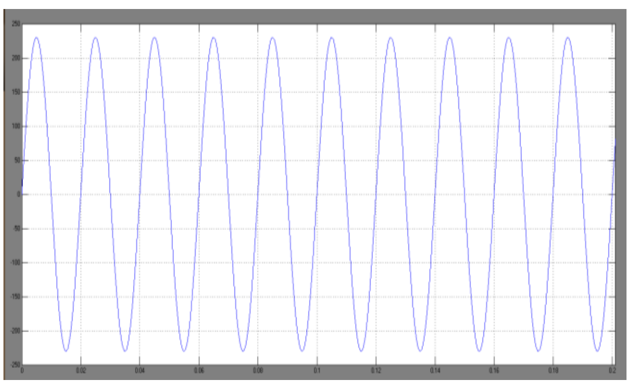

Fig.17. Voltage wave form of the grid.

VII.CONCLUSION

Power electronics devices are widely used in different fields and for different practical applications. The expansion of their field of applications is related to the knowledge of the device behaviour and of their performances. This paper briefly illustrates that the SPMC topology with reduced switch counts could operated as a boost rectifier. The implementation of SMPC with six switches converts ac-dc as well as Dc-Ac with Voltage Source Converter connected to grid. The dynamic evaluation of proposed converter module is evaluated using Matlab/Simulink model and results are conferred.

VIII. REFERENCES

[1] Gyugyi, L and Pelly, B.R, “Static Power Chargers, Theory, Performance and Application,” John Wiley & Son Inc, 1976.

[2] Alesina, A., Venturini, M., “Solid-State Power Conversion: A Fourier analysis Approach to Generalized Transformer Synthesis”, IEEE Transactions ON Circuits

[3] Alesina, A., Venturini, M., “Analysis and Design of Optimum Amplitude Nine-Switch Direct AC-AC Converters”, IEEE Transactions ON Power Electronics, January 1989, Vol. 4, No. 1, Page(s): 101-112.

[4] Zuckerberger, A., Weinstock, D., Alexandrovitz A., “Single-phase Matrix Converter,” IEE Proc. Electric Power App, Vol.144(4), Jul 1997 pp. 235-240

[5] Baharom R., A.S.A. Hasim, M.K.Hamzah and A.F Omar; “A New Single-Phase Controlled Rectifier Using Single-Phase Matrix Converter Topology”. Proceeding for IEEE First International Power and Energy Conference, PECON 2006.

[6] Baharom, R.; Hamzah, M.K.; Muhammad, K.S.; Hamzah, N.R.; “Boost rectifier using single-phase matrix converter”, 3rd IEEE Conference ON Industrial Electronics and Applications, 2008. ICIEA 2008. Page(s): 2205 – 2210

[7] “A High-Performance Single-Phase Rectifier with Input Power Factor Correction”. IEEE Transaction ON Power Electronics, Vol. 11, No. 2, March 1996.

[8] Baharom, R.; Hasim, A.S.A.; Hamzah, MK; Omar, M.F.; "A New Single-Phase Controlled Rectifier Using Single-Phase Matrix Converter", IEEE International Power and Energy Conference, 2006. PECon '06. 28-29 Nov. 2006 Page(s):453 -458.

[9] R. Baharom, A. Idris, N. R. Hamzah, M. K. Hamzah “Computer Simulation of Single –phase Matrix Converter with Reduced Switch Count”, IEEE Applied Power Electronics Colloquium IAPEC 2011, pp. 34-39.

[10] Baharom, R. and M.K. Hamzah, “A New Single-Phase Controlled Rectifier Using Single-Phase Matrix Converter Topology Incorporating Active Power Filter”. Proceeding for IEEE International Electric Machines and Drives Conference, 2007. IEMDC 07, 3-5 May. Antalya,, Turkey.