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HARDWARE IMPLEMENTATION OF HYBRID ENERGY SYSTEM BASED ULTRA SPARSE MATRIX CONVERTER

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Abstract*:*

The Closed loop implementation of the Ultra-Sparse Matrix Converter System along with a six-switch inverter for the generation of AC Output presented in the paper. The hardware implementation of the proposed matrix converter system developed for the verification of the Proposed Configuration. The improvements of the proposed converter system include the better shoot-through capability using the z-source inverter used in the AC-DC-AC converter configuration.

Keywords*:* Matrix based Hybrid Energy System, Peripheral Interface Controller, Space Vector Pulse Width Modulation, Soft Switching Converters, Electromagnetic Interference and Compatibility.

1. Introduction

Soft switching techniques used in the Converters to achieve lowered switching stress, Electromagnetic Interference and to extend the lifetime of the converter switches. The Reverse Blocking switches used to reduce the number of switches and to achieve maximum efficiency with reduced complexity. The Inductive Power Transfer also used for the AC-AC Matrix Converter Systems where it used for feeding AC Power Grid without Bulky Capacitor bank or an inverter section [1]. The Space Vector based modulation scheme used in the rectifier section along with scalar modulation scheme in the inverter section to control the independent loads. The power sharing between load 1 and load 2 adjusted using the Digital Scalar based Modulation Scheme for achieving low harmonic at the output load as well as to improve the system reliability to act with multiple loads [2]. The Indirect Matrix Converter used to merger the PV source to an AC grid System by placing PV instead of the DC Link Capacitor, thus the three-phase output of the PV array directly controlled using the suitable inverter configurations [3]. In these cases, the Sliding mode controller used for both series and the shunt converter stages.

Single Phase Buck Boost type Matrix Converters used to improve the voltage transfer ratio and to increase the flexibility of the input voltage source. The commutation problem also reduced in this kind of the matrix converters neglected as all the switches turned ON simultaneously without current overshoot problem[4].It also has the advantage of less requirements of the inductor and the negligence of the Bulky Transformer. The Matrix Converter Topologies are broadly classified into Direct and the Indirect type Matrix Converters.

2. Proposed Ultra Sparse Matrix Converter

The Proposed System consists of the Hybrid Energy System connected to the Ultra-Sparse Matrix Converter Circuit. There are several advantages in using the Ultra-Sparse Matrix Converters compared to the Very Sparse Matrix Converters due to the reduction in the Switching operation. Switching operation is performed between the upper and the lower switches using a 'OR' gate. Thus, the entire proposed system consists of the three switches in the rectifier side and the six switches in the inverter section. The Z-Source inverter connected before the DC Link Capacitor to provide the shoot-through capability for the inverter switching devices. The Rectifier switches triggered using the Sinusoidal Pulse Width nodulation while the SVPWM used for triggering the inverter switches.

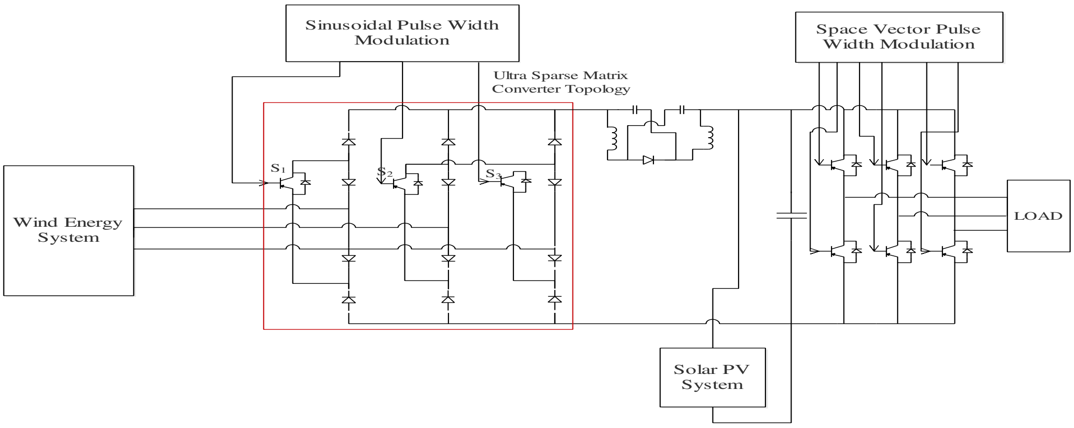

Fig.1 Proposed Hybrid Matrix Converter Topology with Photovoltaic and Wind Energy System.

2.1 Parameters of Proposed System

Table 1 shows the input voltage parameters of PV and Wind Energy Systems for the SVPWM based Ultra-Sparse Matrix Converter System and the Z-Source Parameters used in the Circuit Configuration. The table shows that the PV and Wind energy Systems maintained at Standard Test Conditions.

Table 1 - PV and Wind Systems Parameter Specification.

Parameters	Value
PV Voltage	65-70 V
Wind Energy	25V

OutputVoltage	
Output AC Voltage	72 V
DC Link Voltage	110 V
Z-Source Capacitor	1000µF
Z-Source Inductor	2mH

2.2 Gate Pulse to the Proposed Matrix Converter Circuit

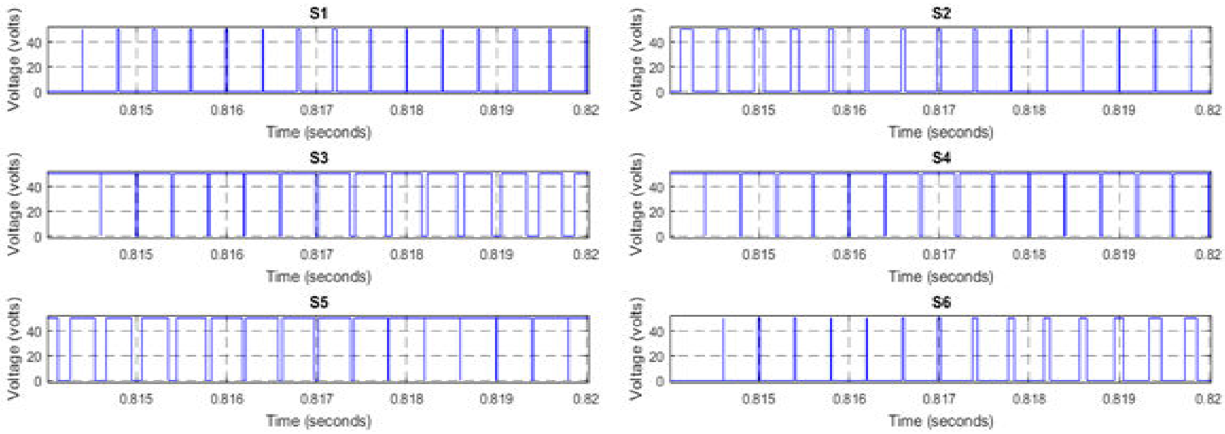

Fig. 2 Gate pulse generation for the Six Switches S_1 to S_6.

3. Simulation Results

Fig.2 represents the gate pulses to the six switch S_1 to $S_6$of Space Vector PWM based Ultra-Sparse Matrix type Converter. Figure 3 shows the AC output voltage waveform across the RL Load of Proposed Configuration.

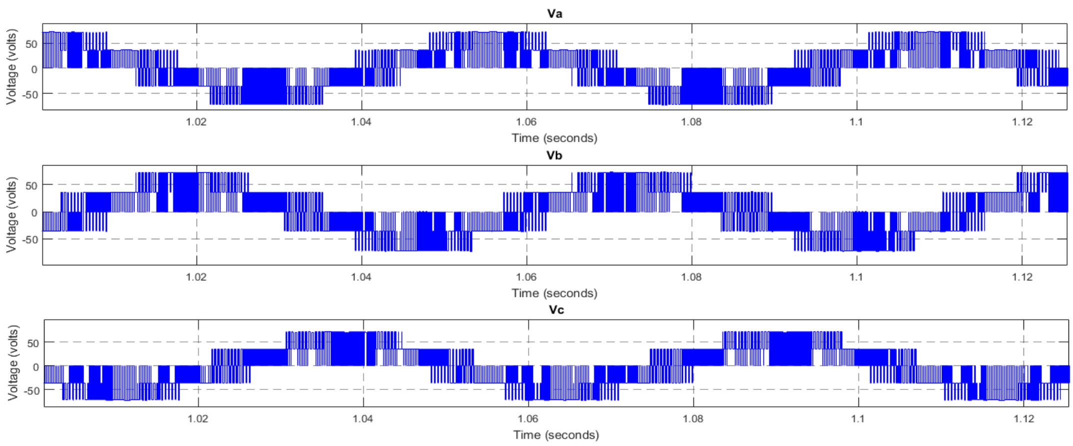

Fig. 3 Output AC Voltage across the Hybrid Matrix Converter System

From the Figure3 the output AC voltage displaced by 120° with each other. The AC voltage then fed back to the Matrix Converter System to convert it into the DC thus acting as AC to DC converter. The entire system acts as AC-DC-AC based Matrix Converter System. Here the conversion of the three phase quantities converted to the two-phase ('dq') quantities performed using Clarke's Transformation. The output voltage obtained at 110V while the power factor achieved up to 0.996 across the inverter section. In comparison to the existing system, the voltage transfer ratio obtained at 1.2%.The DC-AC voltage inversion ratio obtained at 0.76. It is possible to obtain the high voltage boost ratio of 6 times that of the input voltage by using the suitable DC-DC circuit topologies with reduced number of switching devices and less complex operation [5].

Z-Source Matrix Converters used in Buck-Boost Operations has the advantages of reduced cost and applicable for the high voltage applications [6]. The Hybrid Converter Topologies makes use of two different converters of main and auxiliary type. The Main converter used for the processing of the bulk power from the power source while the auxiliary used for processing fraction of the power input to the circuit [7]. By implementing the SVPWM of suitable strategies in the rectifier stage and the zero space vectors in the inverter side the Harmonics reduced in the inverter output resulting in the improved voltage transfer ratio without any additional requirement of hardware components and these modulated strategies find enormous applications in AC Motor Drive applications [8].In addition, the Direct Torque control strategies used for dividing the vector into master and the slave vectors as it improves the Flux Performance and archives the smooth torque and fast dynamic speed response for the PMSM drives [9]. 3x3 matrix converter topologies can be used for the Motor Drive Applications and to reduce the oscillations at the input to the motor loads [10].

4. Hardware Implementation

The Fig.4 shows entire configuration of the Proposed Ultra Sparse Matrix Converter Configuration with RL loads. The Pulse signals generated using a PIC16f874A microcontroller and the driver circuit implemented using the TLP250 Driver Configuration represented by the Fig.6 and Fig.7 respectively. Fig.5 shows the Circuit configuration of the Proposed Matrix Converter Configuration with Wind and the Photovoltaic Input Ports. Fig.8 presents the Phase-to-Phase output voltage waveform of the Proposed System. The Output voltage obtained at 72 Volts and the Total Harmonic Distortion obtained at 15.36 %.

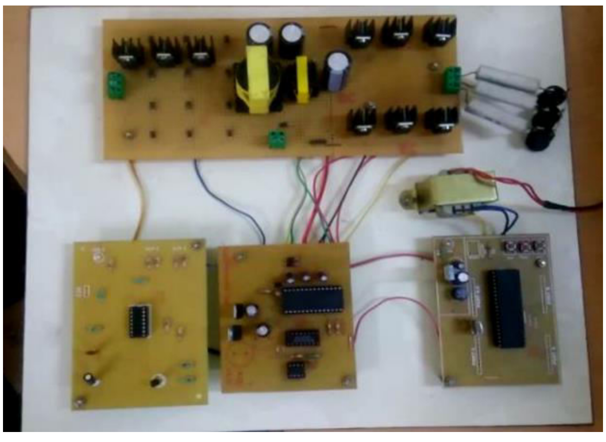

Fig.4. Setup of the Proposed Ultra Sparse Matrix Converter System with RL Loads.

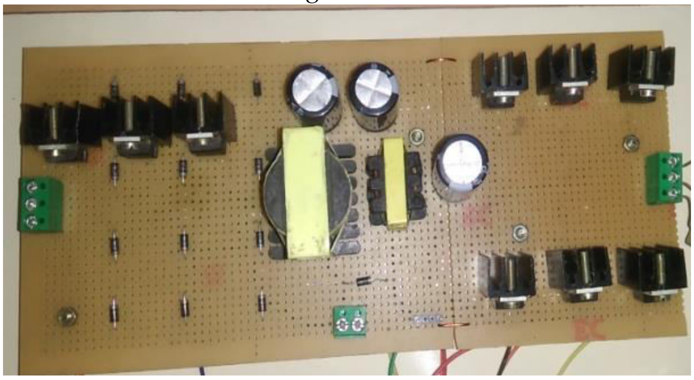

Fig.5. Ultra-Sparse Matrix Converter Circuit Configuration.

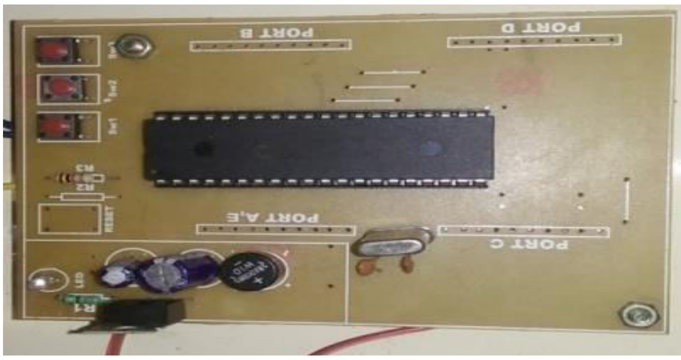

Fig.6. PIC16f874A Microcontroller used for the SVPWM pulse generation.

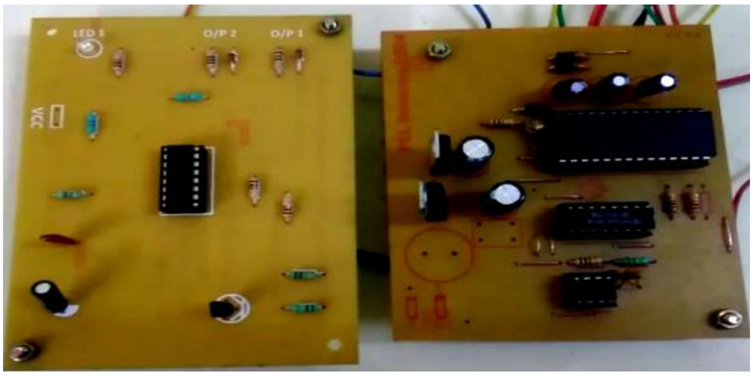

Fig.7. TLP250 Gate Driver.

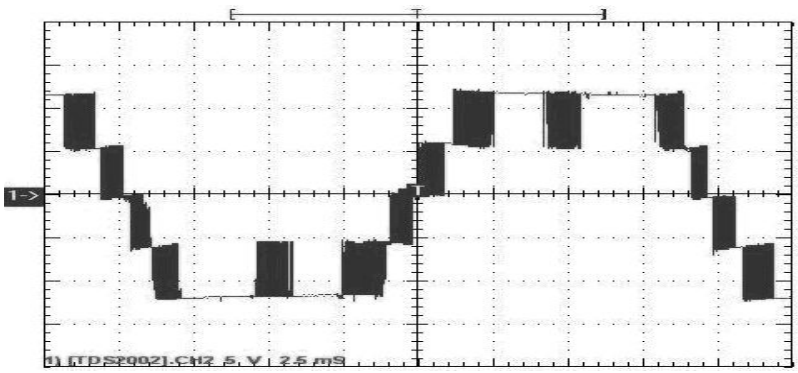

Fig.8. Phase-to-Phase Output Voltage Waveform.

5. Conclusion

The Proposed type of SVPWM based closed loop Matrix Converter System has the improved voltage transfer ratio and the DC to AC voltage inversion ratio compared to the existing ultra-sparse matrix converter systems for Hybrid

Energy Systems. Moreover, the Hardware Prototype implemented and the output of the proposed system verified accordingly. The Proposed type of converter is useful for integrating it with the AC power grids and used to power the AC loads.

References

1. M. Moghaddami, A. Anzalchi and A. I. Sarwat, "Single-Stage Three-Phase AC–AC Matrix Converter for Inductive Power Transfer Systems," in IEEE Transactions on Industrial Electronics, vol. 63, no. 10, pp. 6613-6622, Oct. 2016.
2. M. Hamouda, H. F. Blanchette and K. Al-Haddad, "A Hybrid Modulation Scheme for Dual-Output Five-Leg Indirect Matrix Converter," in IEEE Transactions on Industrial Electronics, vol. 63, no. 12, pp. 7299-7309, Dec. 2016.
3. T. Geury, S. Pinto and J. Gyselinck, "Direct control method for a PV system integrated in an Indirect Matrix Converter-based UPQC," 2016 IEEE Smart Energy Grid Engineering (SEGE), Oshawa, ON, 2016, pp. 117-122.
4. H. F. Ahmed, H. Cha, A. A. Khan, J. Kim and J. Cho, "A Single-Phase Buck–Boost Matrix Converter With Only Six Switches and Without Commutation Problem," in IEEE Transactions on Power Electronics, vol. 32, no. 2, pp. 1232-1244, Feb. 2017.
5. C.K.Kishore and Ramesh G.P., “Hybrid Energy System using ThreePort Converter,” International Journal of control theory and applications, (IJCTA), Vol.9, Issue. 5 (2016), pp 399-406.
6. B. Ge, Q. Lei, W. Qian and F. Z. Peng, "A Family of Z-Source Matrix Converters," in IEEE Transactions on Industrial Electronics, vol. 59, no. 1, pp. 35-46, Jan. 2012.
7. C. Klumpner and C. Pitic, "Hybrid matrix converter topologies: An exploration of benefits," 2008 IEEE Power Electronics Specialists Conference, Rhodes, 2008, pp. 2-8.
8. T. Shi, X. Zhang, S. An, Y. Yan and C. Xia, "Harmonic suppression modulation strategy for ultra-sparse matrix converter," in IET Power Electronics, vol. 9, no. 3, pp. 589-599, March, 2016.
9. Y. Yan, J. Zhao, C. Xia and T. Shi, "Direct torque control of matrix converter-fed permanent magnet synchronous motor drives based on master and slave vectors," in IET Power Electronics, vol. 8, no. 2, pp. 288-296, 2 2015.
10. Lekshmi K. R., K. Shankaranarayana and Abhishek P. R, "3??3 matrix converter for motor drive application," 2015 International Conference on Control Communication & Computing India (ICCC), Trivandrum, 2015, pp. 176-181.