A Hardware implementation of I9-Level Inverter with D-STATCOM Capability for Distributed Energy Systems

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Abstract

This paper presents a single phase multilevel inverter with D-STATCOM capability. The proposed inverter is located in between the source and distributed energy systems which increase the number of levels in inverter to improve the performance of system. The designed inverter armed with distributed static synchronous compensator to control the power factor of system and will reduce the use of extra capacitors and flexible Ac transmission system (FACTS) devices to control power factor of the distribution systems.

INTRODUCTION

The lack of energy is a big problem now days and to face those problems customers have to produce there required energy by using different renewable energy sources. There are some renewable energy sources are available such as wind energy, photovoltaic energy, hydrogen fuel cell, tidal energy and geothermal energy. This resource helps to economic condition and less human power but to produce new energy source related fossil fuels require large amount of resources. The power electronics devices are used in distribution systems. The power electronics devices are used for the conversion of renewable or non-conventional form of energy into power grids in the form of voltage and frequency. Power electronics converter is used to do the work with high efficiency and better power quality. There are different types of converters. Modular multilevel converter topology is used for high power reliability; eliminate harmonics and improving power factor. In this paper new idea is implemented for single phase renewable source like wind energy. In this AC transmission system used the FACTS devices for controlling and PF correction purpose or protection of our system and to regulate the active and reactive power. so that to design and implement the wind energy inverter to flexible AC transmission system with the help of FACT capability. The main aim of this system is to eliminate the use of capacitors and FACT devices to PF correction of distribution energy system. The designed inverter is placed in between the wind turbine and the grid same as regular wind energy inverter to regulate the active and reactive power of wind to grid by using this new technique. This desired technique is introduced to increase the use of maximum renewable energy in to the distribution systems. So this system is reduce the cost of renewable energy system by using this technique because not use this extra capacitor and FACT devices to reduce the cost of system. The main aim of this paper is to supply the active and reactive power of wind side to the grid side by using this inverter plus OSTATCOM system and regulate active power by adjusting the power angle and reactive power by modulation index .The general topology is used in this technique is MMC modular multilevel converter to collect the all information and record of this THO total harmonic distortion, efficiency and amount of whole system. The total system work steady and constant PF. software. The proposed designed inverter with OST A TCOM is connected with parallel to the system in between the wind turbine.

EXISTING SYSTEM

A multilevel voltage source inverter with separate dc sources for high power application or static var generation. The external dc source is used for the FACTS capability. These inverters or harmonic neutralizing magnetic equipment's are very expensive and also 40-50% power loss problem has occurred in system. Over voltage problems, saturation of transformers in transient condition and failure occurred in system.

PROPOSED SYSTEM

This proposed system is used to regulate active and reactive power at desire level. Concerning good power quality, minimum total harmonic distortion is one of the most important requirements from multilevel inverter. This paper presents the minimum total harmonic distortion in 19-level inverter with DSTATCOM capability and also keeping the constant power factor.
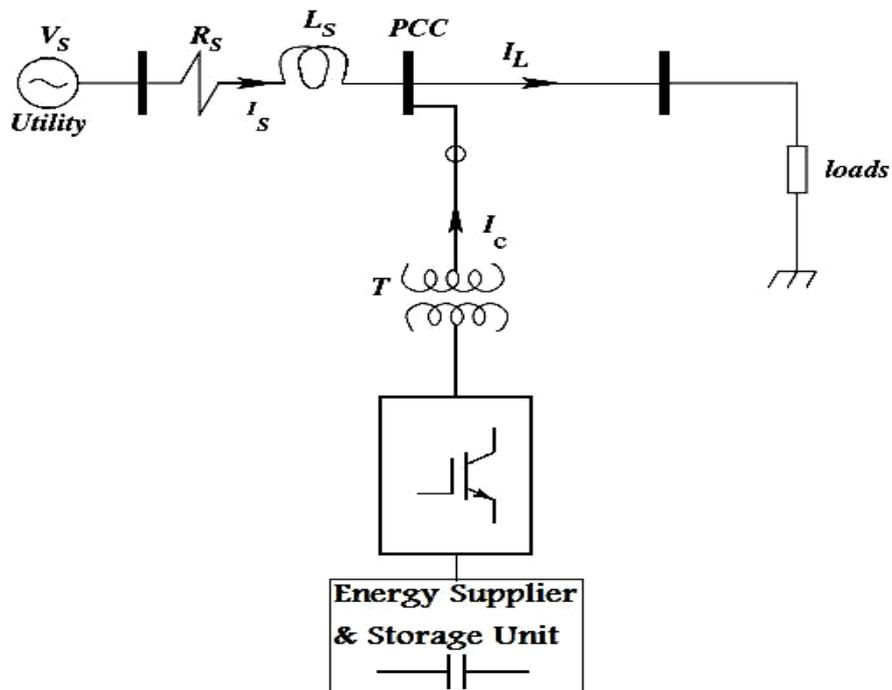
CIRCUIT DIAGRAM
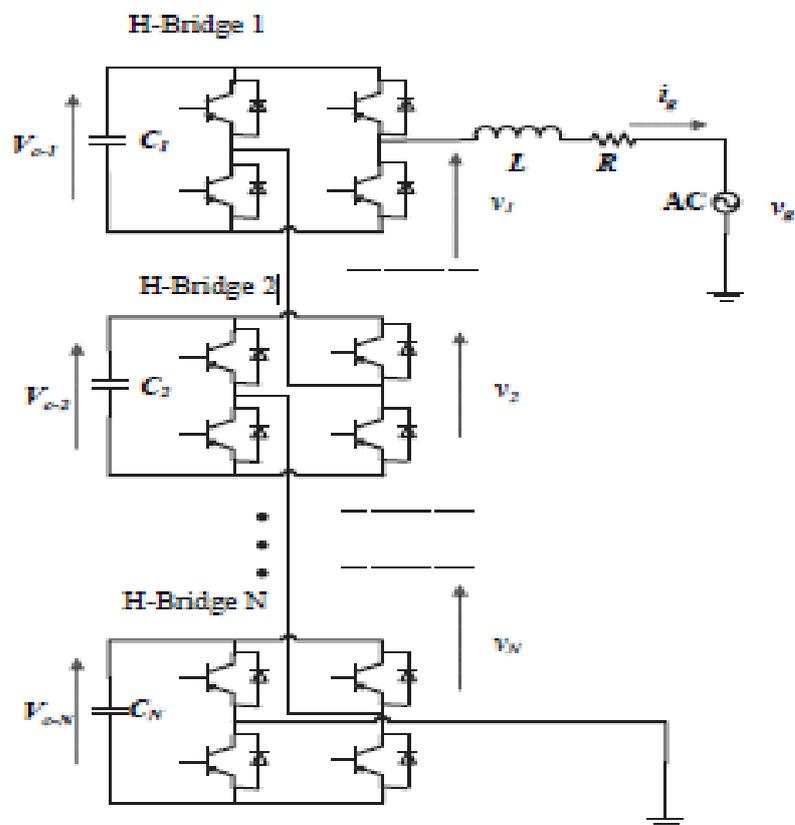

Figure 1. Schematic diagram of statcom

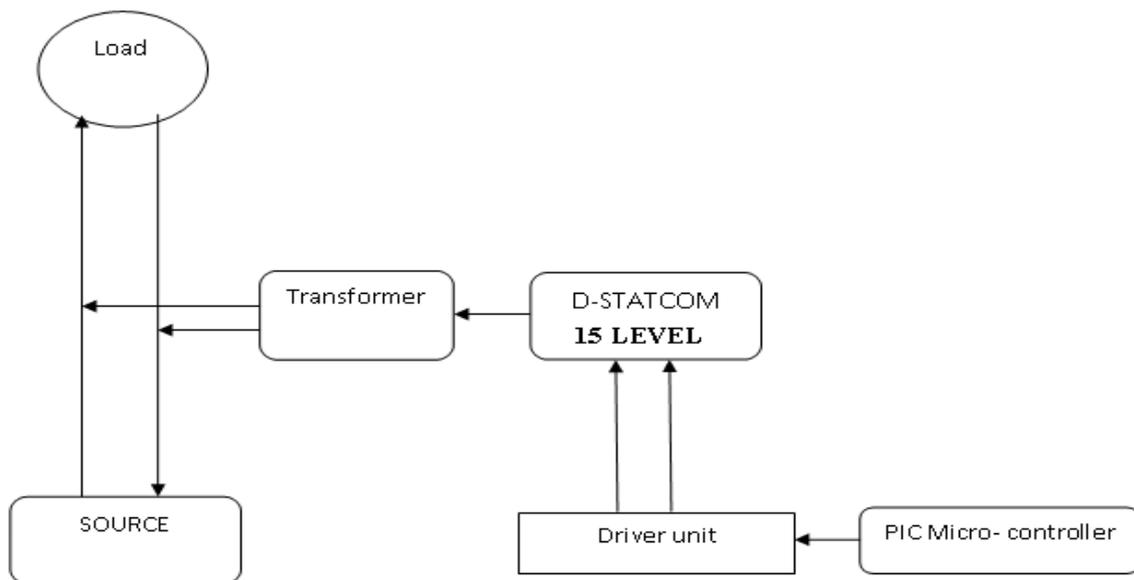**Figure 2.** Multi level topology

Block diagram:

Figure 3. Block diagram of proposed system

LITERATURE SURVEY

Decoupled and Modular Harmonic Compensation for Multilevel STATCOMs

Among the multilevel STATCOM topologies the most extended is the H-bridge based configuration, where several H-bridge modules are connected in cascade to generate a multilevel voltage [8]. Some of the relevant features of this topology are that higher equivalent switching frequencies can be achieved and the total power is shared among all modules. Taking advantage of the modular nature of the H-bridge based STATCOM; an extra feature is explored to achieve both reactive power compensation and harmonic cancellation. Indeed, two types of modules can be included in the configuration, the first type will compensate reactive power at fundamental frequency and the other one will cancel out the load current harmonics. Similar approaches have been proposed in [9], [10], where preliminary simulated results were presented. The aim of this paper is to prove the feasibility of the modular harmonic compensation. That is, each H-bridge module is controlled to compensate a specific harmonic separately from the fundamental reactive power compensation. The main characteristics of this approach will be explained along the document and they will be confirmed with experimental results.

Cascaded Two-Level Inverter-Based Multilevel STATCOM for High-Power Applications

In this paper, a static var compensation scheme is proposed for a cascaded two-level inverter-based multilevel inverter. The topology uses standard two-level inverters to achieve multilevel operation. The dc-link voltages of the inverters are regulated at asymmetrical levels to obtain four-level operation. To verify the efficacy of the proposed control strategy, the simulation study is carried out for balanced and unbalanced supply-voltage conditions. A laboratory prototype is also developed to validate the simulation results. From the detailed simulation and experimentation by the authors, it is found that the dc-link voltages of two inverters collapse for certain operating conditions when there is a sudden change in reference current. In order to investigate the behavior of the converter, the complete dynamic model of the system is developed from the equivalent circuit. The model is linearized and transfer functions are derived. Using the transfer functions, system behavior is analyzed for different operating conditions. Static var compensation by cascading conventional multilevel/ two level inverters is an attractive solution for high-power applications. The topology consists of standard multilevel/two level inverters connected in cascade through open-end windings of a three-phase transformer. Such topologies are popular in high-power drives. One of the advantages of this topology is that by maintaining asymmetric voltages at the dc links of the inverters, the number of levels in the output voltage waveform can be increased. Therefore, overall control is simple compared to conventional multilevel inverters. In, a three-level inverter and two level inverter are connected on either side of the transformer low-voltage winding. The dc-link voltages are maintained by separate converters. In [11], three-level operation is obtained by using standard two-level inverters. The dc-link voltage balance between the inverters is affected by the reactive power supplied to the grid.

SIMULATION RESULTS:

The MATLAB/Simulink simulation for 19-level inverter with DSTATCOM capability system is presented in fig 5 and required data for simulation of system is represented. The simulation result of this design inverter by using MMC structure is finding by MA TLAB software. So that results is carried out by various Simulink model design. The following

waveform of wind turbine output how much power is develop and the output of wind turbine is 10KWto 12KW. This waveform shows that the active and reactive power of the wind turbine to regulate the active power from the wind to grid by after the compensation of reactive power to maintain the PF 0.82 to 0.90 after the inverter starts. After the time 6 sec the output of the wind increases and the decreases the feeder line active power. The following waveform shows output of multilevel inverter for 19- level inverter i.e. step wise output of upper and lower level of output. This is main aim of the design inverter to get grid PF is constant 0.90 despite the active power of the wind turbine. The output voltage of dc link is 2000V and the RMS voltage of ac is 600V. The next fig.9.is shows that the FFT analysis of 13-level inverter and it shows that thetotal harmonic distortion is reduces as per the IEEE standard.
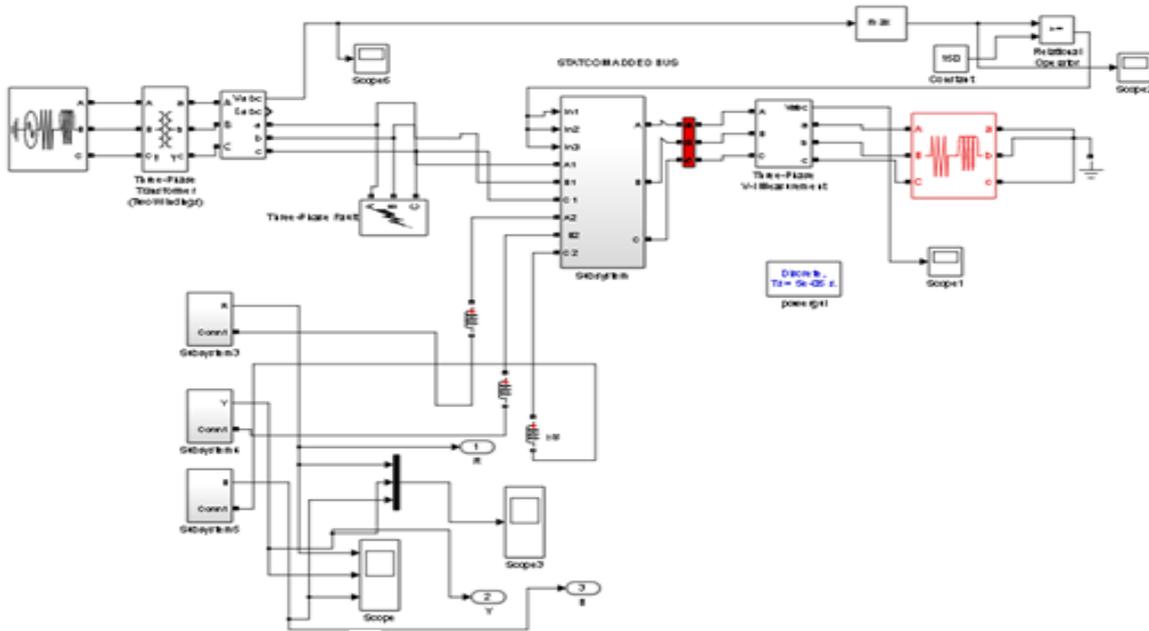

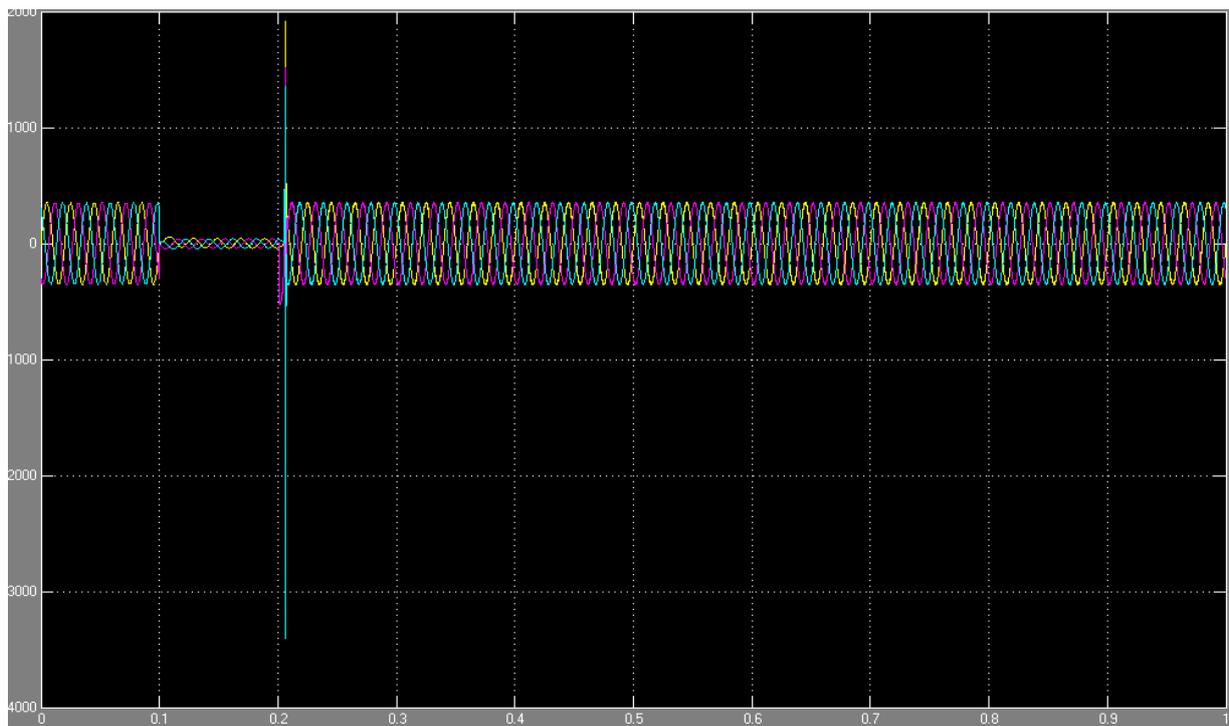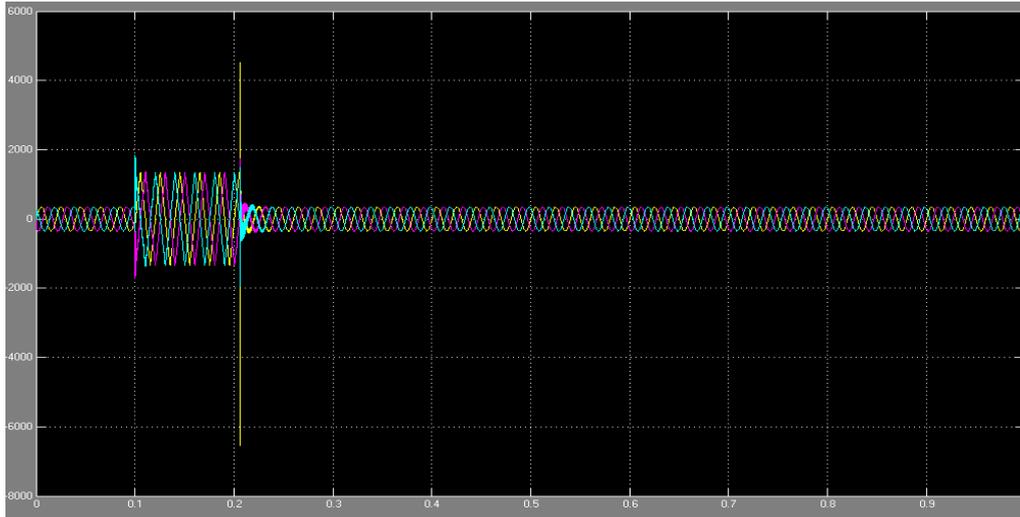
Figure 4. Simulation diagram

Figure 5. Source voltage
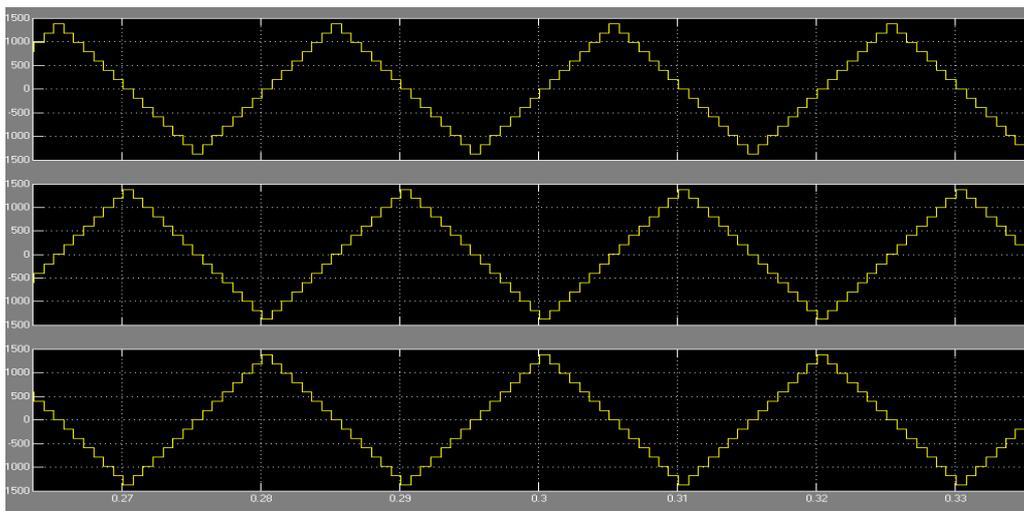
Figure 6. Load voltage

Figure 7. R,Y,B phase voltages
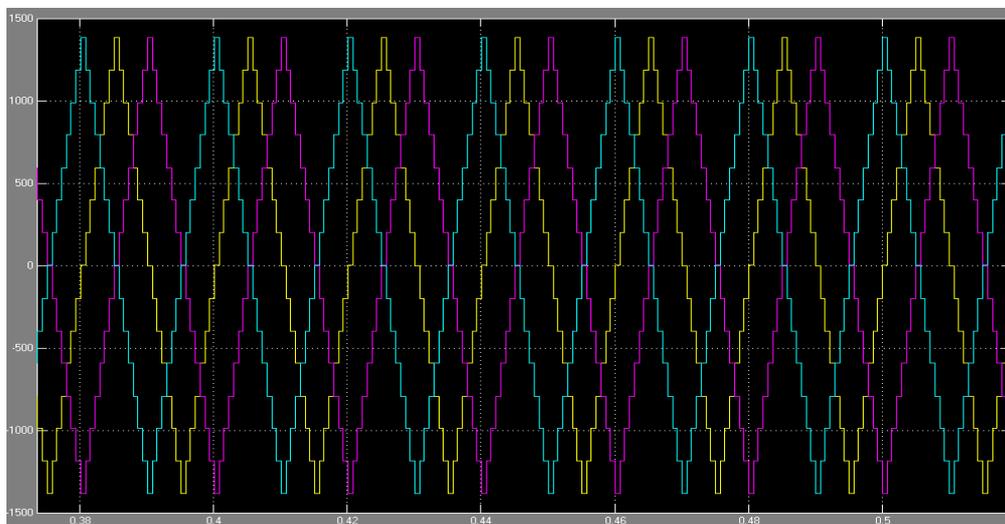

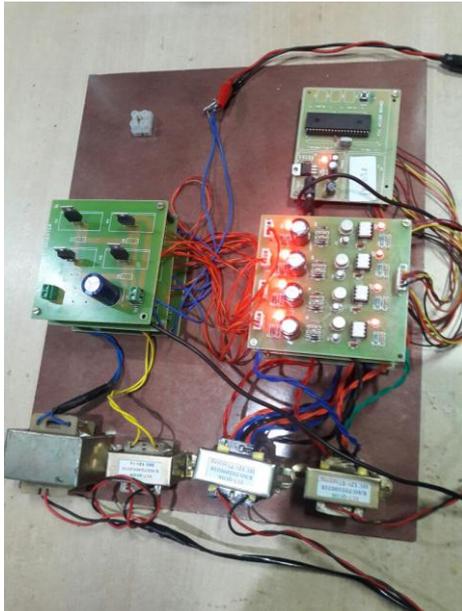**Figure 8.** Proposed 19 level voltage waveform
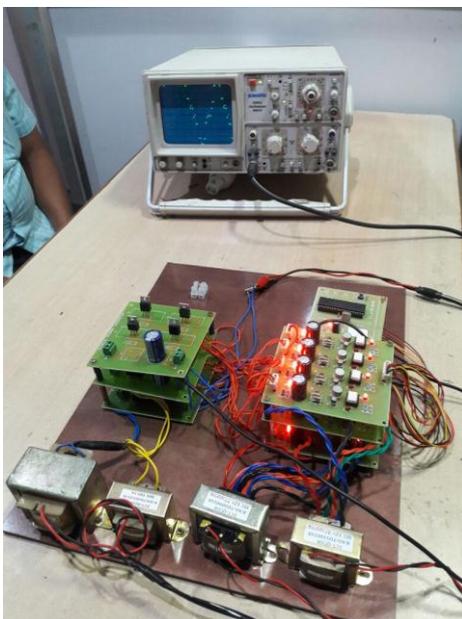
Figure 8.1. Hardware Model.

Figure 8.2. Hardware Output

CONCLUSION

In this paper the concept of multilevel inverter by increasing the number of level reduces the total harmonic distortion of the system and improving the power quality. This paper presents new technique to eliminate the use of extra capacitor and FACTS devices. The design and implementation of the multi- level inverter with DSTATCOM capability is new concept to reduce the cost of capacitor bank to improve the PF by reactive power compensation. The use of this inverter is to regulate the active power by adjusting the power angle delta and the reactive power by adjusting the modulation index. Simulation result is found on MA TLAB software.

REFERENCES

[1]   S. Solar Market Insight, 2010 Year End Review Executive Summary, SEIA, Washington, DC, USA, 20 I I.

[2]   A WEA U.S. Wind Industry Annual Market Report Year Ending 2010, A WEA, Washington, DC, USA, 201l.

[3]   S. A. Rahman, R. K. Varma, and W. H. Litzenberger, "Bibliography of FACTS applications for grid integration of wind and PV solar power systems: 1995-2010 IEEE working group report, " in Proc. IEEE Power Energy Soc. General Meeting, Jul. 2011, pp. 17.

[4]   A. Beekmann, J. Marques, E. Quitmann, and S. Wachtel, "Wind energy converters with FACTS capabilities for optimized integration of wind power into transmission and distribution systems, " in Proc. CIGRE/IEEE PES Joint Symp. Integr. Wide, Scale Renew. Resour. Power Del. Syst., Jul. 2009, pp. 1-9.

[5]   J. Rodriguez, J. S. Lai, and F. Z. Peng, "Multilevel inverters: Survey of topologies, controls, and applications, " IEEE Trans. Ind. Appl., vol. 49, no. 4, pp. 724-738, Aug. 2002.

[6]   F. Z. Peng, J. S. Lai, J. W. McKeever, and J. VanCoevering, "A multilevel voltage-source inverter with separate DC sources for static V Ar generation, " IEEE Trans. Ind. Appl., vol. 32, no. 5, pp.1130-1138, Oct. 1996.

[7]   B. Gultekin and M. Ermis, "Cascaded multilevel converterbasedtransmission ST ATCOM: System design methodology anddevelopment of a 12 kV ± 12 MV Ar power stage, " I EEE Trans. Power Electron., vol. 28, no. 11, pp. 4930--4950, Nov. 2013.

[8]   K. Varma, S. A. Rahman, A. C. Mahendra, R. Seethapathy,and T. Vanderheide, "Novel nighttime application of PV solar farmsasSTATCOM (PV-STATCOM), " in Proc. IEEE Power Energy Soc.General Meeting, Jul. 2012, pp. 1-8.

[9]   R. K. Varma, E. M. Siavashi, B. Das, and V. Sharma, "Realtimedigital simulation of a PV solar system as ST A TCOM (PVSTA TCOM) for voltage regulation and power factor correction, " in Proc. EPEC, Oct. 2012, pp. 197-163. 978

[10]   P.Avirajamanjula, P.Palanivel, **"**Normalized Least Mean Square based selective Current Harmonic Elimination in Voltage Source Inverters", *International Review on Modelling and Simulations (IREMOS),*Vol.7 No.3, June 2014,pp-394-400.

[11]   P.Avirajamanjula, P.Palanivel, "Corroboration of Normalized Least Mean Square Based Adaptive Selective Current Harmonic Elimination in Voltage Source Inverter Using DSP Processor", *International Journal of Power Electronics and Drives Systems,*Vol.6, No.1, March 2015,pp-178-184.