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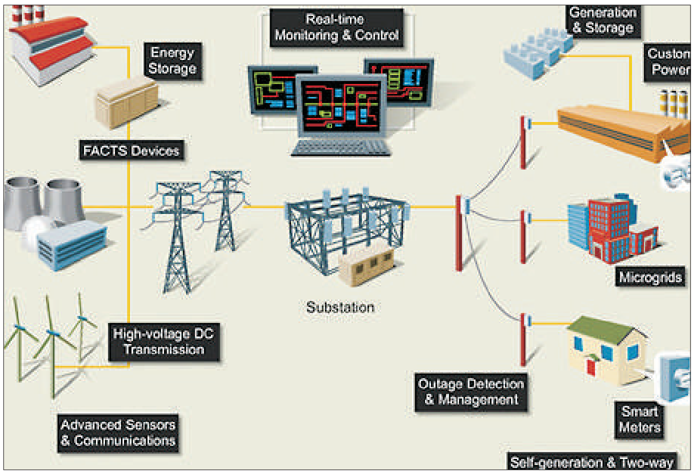
Design & implementation of 17 Level Inverter with FACTS technology for Distributed Energy System

[1]G.V Srinivas, [2]Md.Najeeb Ahmad
[1]AP.G Scholar Department of Electrical and Electronics Engineering, DMSSVH College of Engineering, Machilipatnam, India.
[2]Associate Professor



ABSTRACT

The thesis, deals with novel 1-phase wind energy multilevel inverters (WEI) with FACTS facility is given. The latest converter will be positioned in the middle of Wind turbine & the Grid, as usually, which is capable of regulating active & reactive-Powers transmitted to grid. The new flanged inverter has incorporated with D.STATCOM option to modify the Power Factor (PF) of general feeder. By this anticipated Inverter for small & average sized Wind applications will eliminates the utilization of Capacitor bank & FACTS requirements to manage the Pf of Distribution-line. The aspiration of the technique is to commence novel methods to augment access of renewable energy inventions in to Distribution system. It does support utility & consumers to act as provider of power also. This fresh kind of converter built with FACTS technology does minimize outlay of application. Here, Modular Multilevel Converter will be used as desired configuration to met all necessities of a 1-□ system i.e. compatibility of IEEE standard, Total Harmonic Distortion (THD), Efficiency, & total outlay of structure etc. control approach which we have used controls Active & Reactive-Power by power-angle & Modulation-Index techniques, respectively . The occupation of anticipated inverter is for conveying Active-power to Grid & maintenance of pf of power line at a mark Pf despite of coming Active-Power from Wind Turbine. The simulation for 17- level converter has done in MATLAB/ Simulink. To authenticate simulation consequences, the scaled example model of projected inverter has built & tested.

I***ndex Terms***—Distributed Energy Resources, Multi-Level Inverter, Harmonic Distortion, Power Quality.

I. INTRODUCTION

The objectives of the proposed inverter is to convert dc power coming from dc link to a suitable ac power to the main grid, and also to regulate the PF of the local grid at a target PF by injecting reactive power to the grid. The proposed control strategy permits the inverter to function as an inverter with DSTATCOM option when there is sufficient wind to produce active power, & to act like a DSTATCOM when there is no sufficient wind. The active power will be controlled by varying the power angle δ & reactive power is regulated by the modulation index 'm'. This source of generation is advantageous because the location is nearer to the loads when compared with other sources. Maximum power point tracking topology is

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designed to extract the maximum power from wind turbine.

Wind is abundant almost in any part of the world. Its existence in nature caused by uneven heating on the surface of the earth as well as the earth's rotation means that the wind resources will always be available. The cost of wind power that is connected to the grid is as cheap as the cost of generating electricity using coal and oil. The power extracted from wind is proportional to wind speed as shown below. The generated energy either can be connected to grid or can be connected load directly.

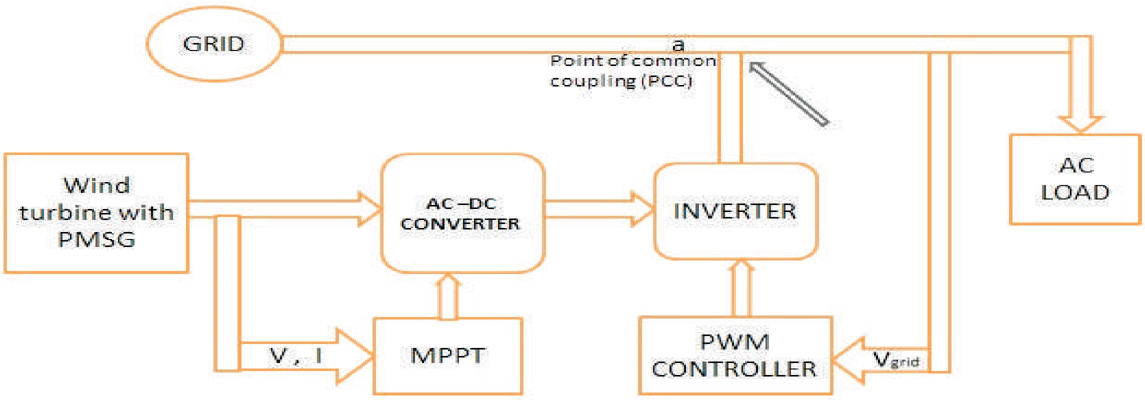

Fig. 1. Block diagram of Wind system integrated to grid

A DSTATCOM consists of coupling transformer, VSC & Energy storage device. It is connected in shunt to the distribution network through a coupling transformer.

The VSC converts the dc voltage across the storage device into a set of three-phase ac output voltages.

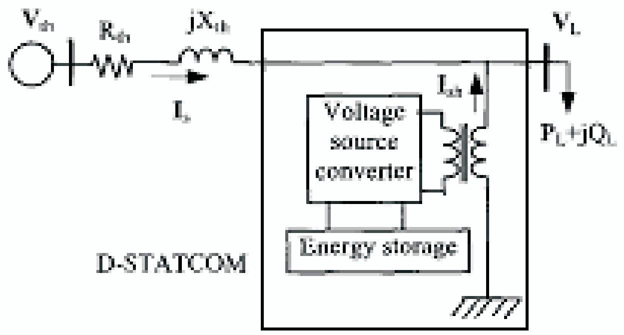

Fig. 2. Block diagram of DSTATCOM

STATCOM output voltages allows effective control of active and reactive power exchanges between the D-STATCOM and the ac system.

The VSC provides to three quite distinct purposes:

1. Voltage regulation and compensation of reactive power;
2. Correction of power factor; and
3. Elimination of current harmonics

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II. DESIGN METHODOLOGY

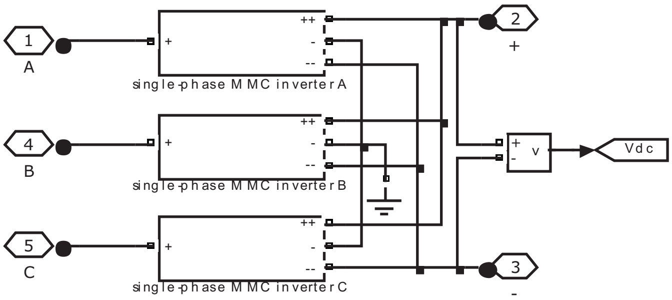

Fig. 3. Block diagram of 17 Level Inverter

Three phase MMC is constructed by using three single phase MMCs. Each single phase MMC consists of 8 full bridge or half modules in each arm i.e upper and lower. Number of output voltage levels L in cascaded inverter will be 'L' = 2s+1, where S is the number of separate dc sources. An example voltage waveform of a 17-level cascade H bridge inverter with 8 SDCSs & 8 full bridges phase voltage of van = va1 + va2 + va3 + va4 + va5 + va6 + va7 + va8.

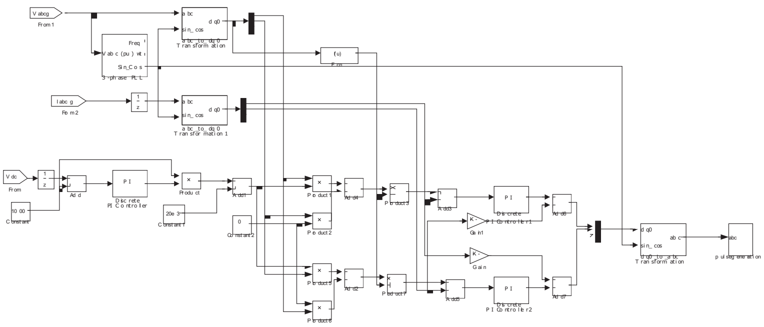

Fig. 4. Controller of 17 Level Inverter

III. EXPERIMENTAL AND SIMULATION RESULTS

The three-phase seventeen level inverter utilized is appeared as a part of fig. 5. The three-stage voltage source inverter shaping a DG or a smaller scale matrix subsystem. The consonant pay is finished by the consolidated framework operation [16] of inverter, adjustment plans and control calculation. The proposed framework utilizes PI sinusoidal PWM strategies for small scale matrix inverters. Results are appeared in taking after subsections.

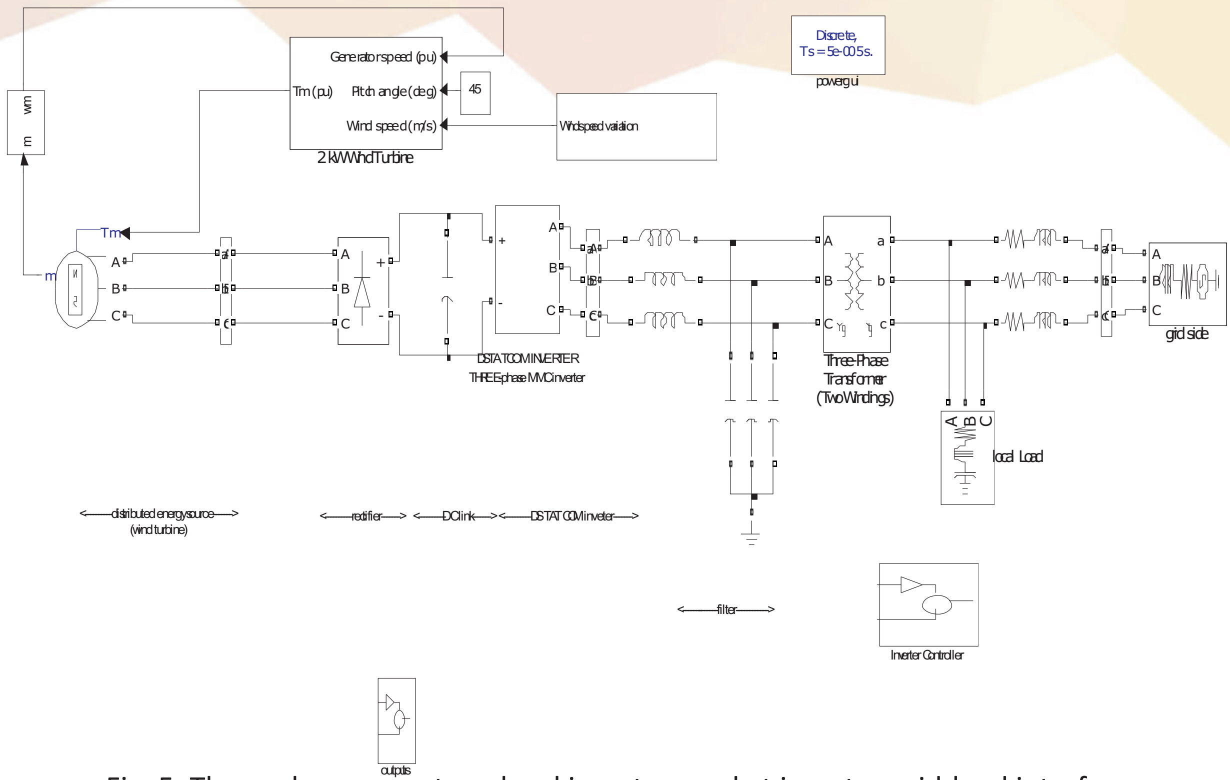

Fig. 5. Three-phase seventeen level inverter used at inverter-grid-load interface

PI controller - Sinusoidal Pulse Width Modulation based Micro-grid Inverter:

Pulse Width Modulation (PWM) is the most effective means to achieve constant voltage. It is not only used to control the output voltage but also to optimize the harmonics by performing multiple switching within the inverter with the constant dc input voltage.

fig: SPWM. The commonly used PWM techniques are: Single pulse width modulation, Multiple pulse width modulation, Sinusoidal pulse width modulation among these SPWM is used.

In sinusoidal pulse width modulation the reference signal is compared with carrier triangular signal which generatesthe switching pulses for solar inverter as shown in figure.

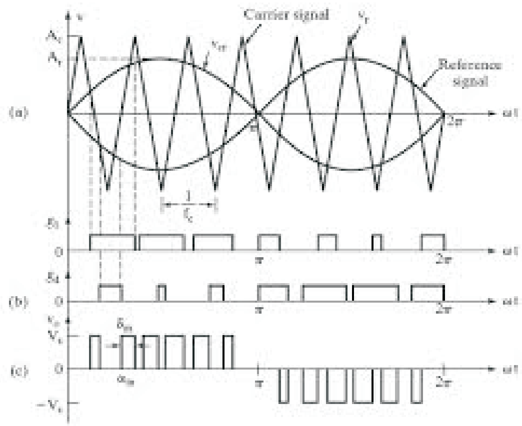

Fig.6. Sinusoidal Pulse Width Modulation

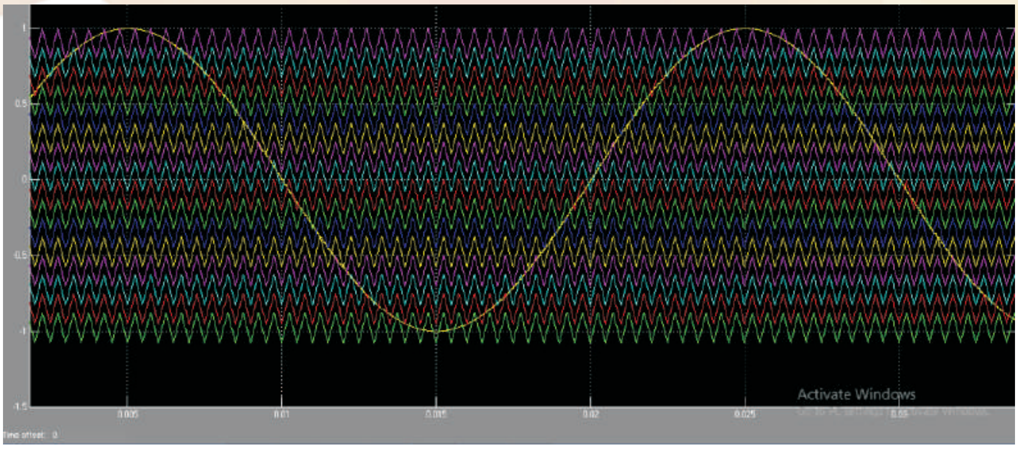

Fig.7. Sinusoidal Pulse Width Modulation for 17 level Inverter

Sinusoidal Pulse Width Modulation uses (at a much higher frequency) many more square waves to mimic the shape of a sine wave. Sinusoidal Pulse Width Modulation technique, output wave form is pure sinusoidal, so very small energy has to be used and released later during the higher frequency signal cycles. So that less inductors and capacitors are required for much cleaner output.Simulation parameters used for DER inverter are shown in table 1.Voltage and current waveforms including line-line voltage, line-neutral voltages and phase currents of SPWM based micro-grid inverter are shown in fig. 6

DC-Link Voltage	**Vdc=800 V**
Fundamental Frequency	**f=50 Hz**
Switching Frequency	**fs=1 MHz**
Sampling Time	**$Tz=10^{-6}$ sec**
Modulation Index	**a=0.85**
Cut-off Frequency	**fo=500 Hz**

Table 1. Simulation parameters for SPWM based micro-grid inverter

SIMULATION RESULTS OF 11 LEVEL AND 17 LEVEL INVERTERS:

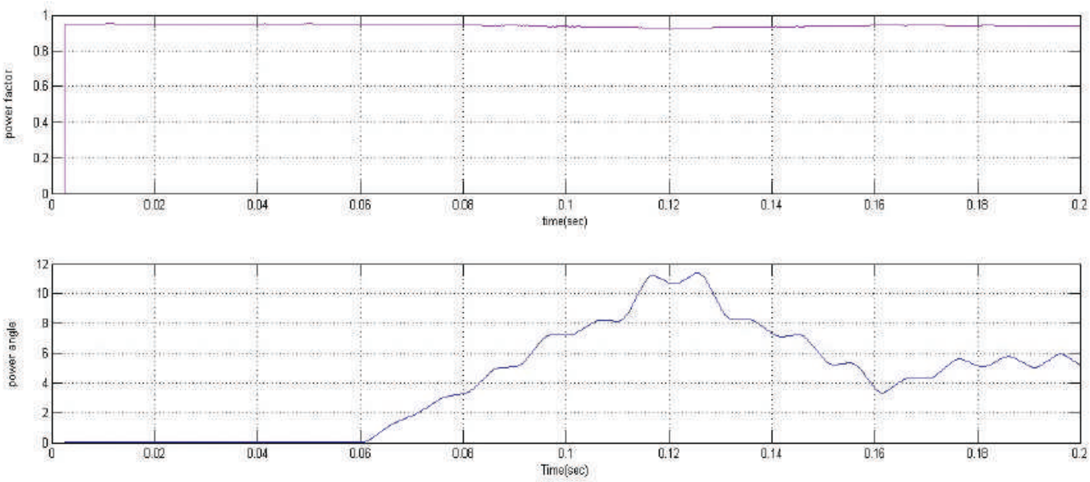

Fig. 8.Power Factor Comparison between 11 Level & 17 Level Inverter

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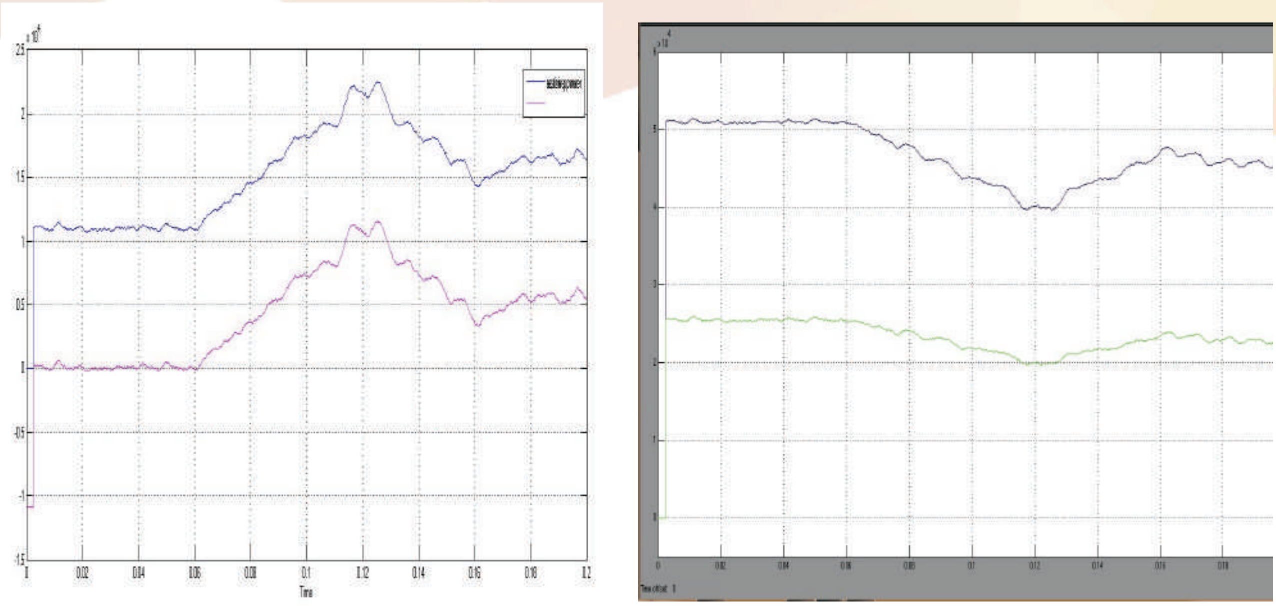

Fig. 9.Active & Reactive Power Comparison between 11 Level & 17 Level Inverter

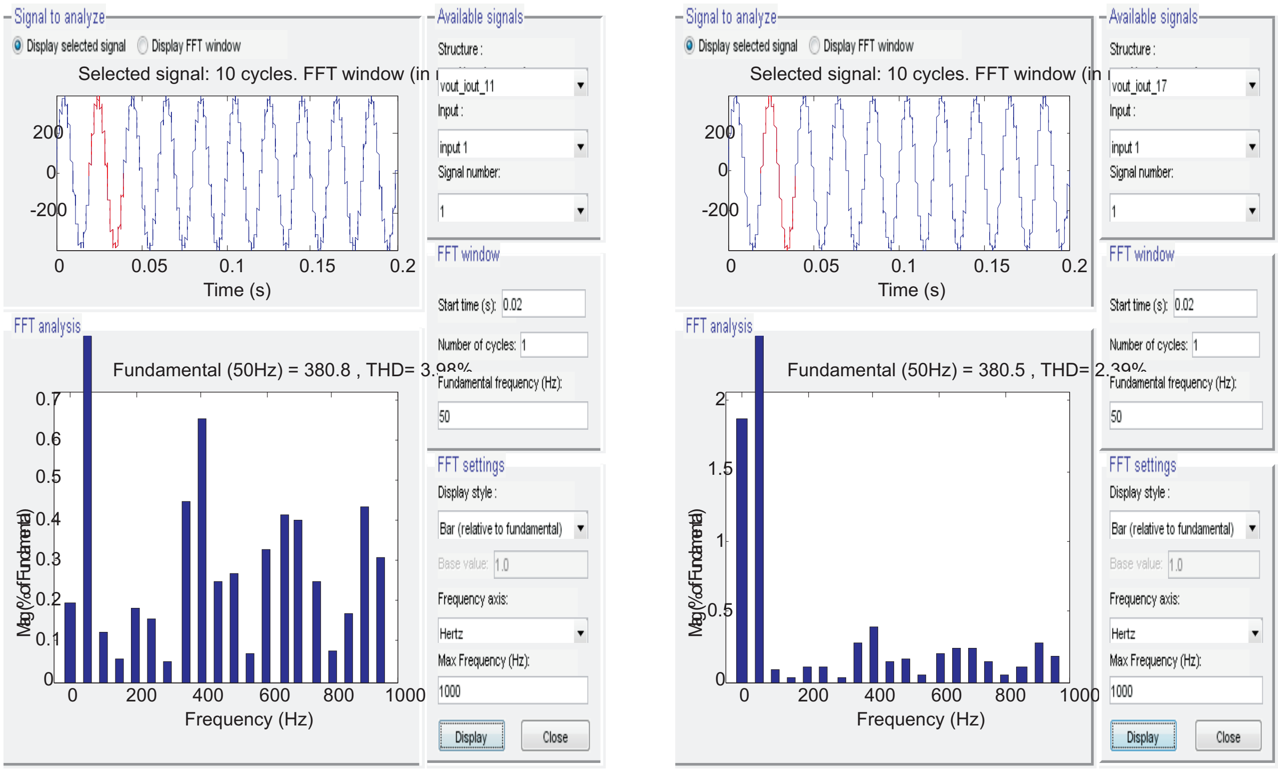

Fig. 10 .THD Comparison between 11 Level & 17 Level Inverter

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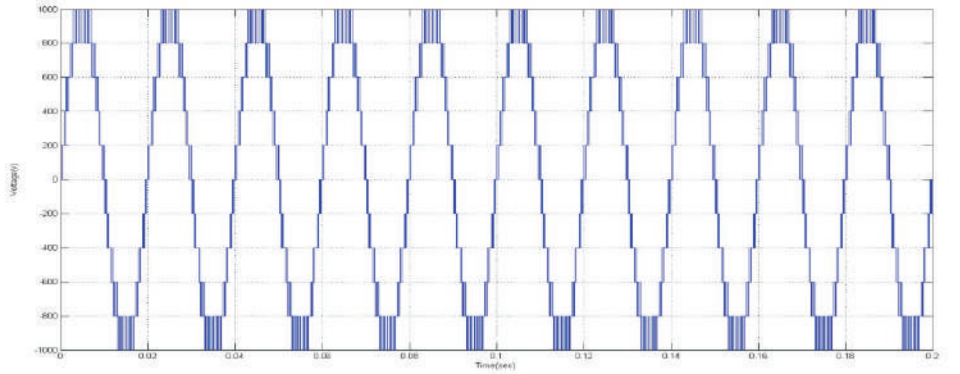

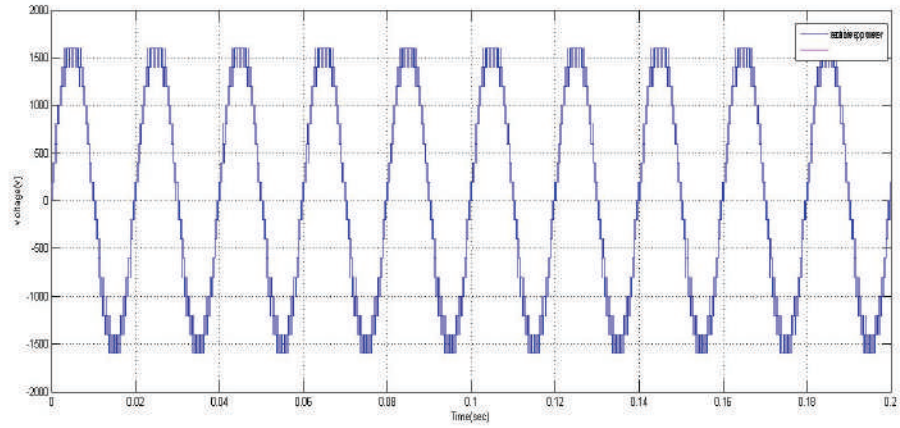

Fig r

IV. CONCLUSION

In this thesis modular multilevel inverter with FACTS ability for small and medium sized wind turbines are presented. Replacing the existing renewable energy inverters eliminates requirement of separate FACTS devices to control the PF of the grid. This shows a new technique in which DG sources could be used to provide control & support in distribution system. The proposed control strategy could control the Active Power by altering the power angle (delta) & reactive power by modulation index 'm'. The simulation results of 17-level inverter are implemented in MATLAB/Simulink and compared with 11 level inverter. Results showed good performance of the projected control strategy.

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