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A Single Phase Seven Level Inverter with MPPT Controller for Wind System

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ABSTRACT

In this paper a novel single phase seven level inverter with mppt technic for wind system is implemented. This proposed system consist of eight switch topology for seven level inverter instead of 12 switch required in conventional cascaded H-bridge inverter. The main objective of this project is to decrease the switches with increase in multilevel output which reduces the harmonics. To reduce the conventional losses and removing the transformer which leads to decrease the cost and size of inverter. The proposed inverter also consist of maximum power point tracking (MPPT) technology is used. In the mppt method the previous value and the present value is compared using P&O algorithm. The mppt can take the wind speed as reference speed which varies depend on the velocity of the wind. The maximum power the wind system is tracked by using this mppt method. The proposed inverter system for wind energy system is simulated in MATLAB/SIMULINK. The simulated seven level inverter topology offers several advantages such as improved output waveforms and reducing total harmonic distortion (THD). THD level is analysed using the MATLAB 7.14 simulation.

Keywords: Multilevel inverter, Maximum power point tracking and Wind Turbine.

1. INTRODUCTION

Microgrid studies is gaining increasingly more importance because of the need of financial usage of electrical electricity. Nowadays, fossil gas is the principle power dealer of the extensive economic system, but it's far a primary motive of ecological issues (such as global warming, air pollutants etc.). The need of producing extra power blended with the hobby in inexperienced power technologies consequences in an expanded improvement of power distribution structures using renewable power resources (RES) such as wind energy, solar, hydro, biomass, wave power, tidal energy and geo thermal power [1]. Further strain on the present electrical energy machine is additionally growing, due to the increase in power demand, hassle on power transport functionality of the grid, complications in constructing new transmission - distribution traces, and leading to blackouts [1].

Developments of energy digital converters in conjunction with its excessive-overall performance controllers make it viable to combine specific forms of renewable power resources to the microgrid. Different inverter topologies in addition to manipulate strategies to integrate renewable energies, i.e., wind power and solar electricity, and so on., in electricity grids are surveyed in details in [2]-[10].In the noted papers, it is able to be seen that good sized research is undertaken to connect renewable power resources to 1-phase grids using phase pulse-width-modulation (PWM) inverters. In case of medium power microgrid utility, single-phase inverters are gaining reputation [11]-[25]. The existing literature show that on one hand, the single-phase inverter is directly related (through an interfacing choke coil) to the point of commonplace coupling (PCC) [11] to facilitate energy flow to PCC. On the other hand, the grid (microgrid) and the loads also are related to the PCC. In a standard residential software, the renewable power is used to reduce the burden energy call for from the microgrid.

The power from the renewable/natural assets tends to differ during the day and subsequently optimizing the power seize is a need. For wind turbines (WT), the output power is determined through the wind velocity. Hence, the control of these systems desires to behave appropriately in step with the variant of these parameters. For example, the turbine pace for wind needs to be adjusted for distinctive wind speeds such that the generated power to be had is optimized and the gadget runs at Maximum Power Point (MPP).Similarly, the output DC voltage and modern of the PV array structures want to be adjusted in an effort to run them at MPP. Numerous sorts of converters had been used to provide grid connected renewable energy systems. A DC- AC converter is used to generate preferred voltage and frequency for the grid connection. Similarly, AC-DC-AC converter is vital for the WECS as wind energy is variable.

Due to the growing call for medium and high energy programs, multilevel inverters (MLI) have been attracting and developing attention in variable speed WT [3],[4]. Multilevel converters enable the output voltage to growth without growing the voltage score of the switching gadgets, in order that they offer the direct connection of renewable power systems to the grid voltage without using the high-priced and cumbersome transformers. Various topologies of multilevel inverter have been investigated inside the literature. The most commonplace sorts amongst them are the diode clamped [5], the flying capacitor [6] [7], the Cascaded H-bridge multilevel inverters (CHBMLI) [8] [9], changed H-bridge multilevel inverters [10] and the total bridge with cascaded transformers Among the numerous kinds of multilevel inverter, cascaded kind is more popular especially specifically for grid linked renewable power programs due to the following reasons,

1. Individual H bridge can be connected to a separate renewable power assets which include PV modules, Wind Turbines, Fuel Cell stacks and so on.

2. Step up transformers are eliminated because the output voltage stage required for grid electricity injection may be executed via DC-DC boost converters and the cascaded connection of H Bridge outputs.

3. The CHBMLI has very much less general harmonic distortion (THD) whilst in comparison to three-stage primarily based inverters, which in turn reduces the output filter size for the compliance of grid harmonic standards [12].

4. Since this topology permits the relationship of independent renewable power sources each dc link voltages can be independently managed, the most energy extraction of a reduced number of PV modules may be executed with the help of Maximum Power Point Tracking (MPPT) algorithms [14].

Multilevel inverters are getting used in many commercial applications such as force device, static VAR reimbursement, FACT and UPS. It has been sub divided into 3 important sorts as Diode Clamped Multilevel inverter (DCMLI), Flying Clamped Multilevel inverter (FCMLI) and Cascaded multilevel inverter (CHBMLI) [1]. It has various advantages over stage inverter [2]. The strain on man or woman transfer is much less which enable MLI to use in excessive power application. It is free from Electromagnetic Interface (EMI) and switching losses are much less because of low switching frequency. These advantages make the MLI top-rated in lots of business packages. The first-class of power depends on the inverter output. The output ought to be unfastened from distortions, appropriate THD range and primary decrease order harmonic need to be removed. To gain the above satisfactory, many modulation techniques had been applied which include Sine Pulse Width Modulation (SPWM), Space Vector modulation (SVM) and Selective Harmonic Elimination (SHE) [3].

The SPWM is exceptional out of all due to it is easy and strong. But the switching frequencies for switches are very excessive which increases the switching losses. Due to the high switching losses, it's far constrained for high power utility. The satisfactory choice is the strategies for the reason that it's far operates at low switching frequencies. The specific undesirable harmonics can be removed effortlessly with the aid of solving mathematical equation and finding corresponding switching angles for lower THD. Various set of rules had been proposed with the aid of diverse researchers [4] in this paper, the mathematical equation (nonlinear) for the techniques are formulated. The nonlinear equation were solved using algorithms which include particle swarm optimization simulated an annealing, bat algorithm and Cuckoo seek set of rules. The codes are developed by means of MATLAB optimization tool field and M record environment. The received consequences were compared primarily based at the overall performance parameter along with THD, executing time, converge and memory area required. The simulated effects had been confirmed experimentally for seven stages. This paper proposes a novel single segment grid linked multilevel inverter fed from wind turbine coupled permanent magnet DC generator (PMDCG). In order to track the MPP of the wind turbine a novel sliding mode control method is used, that is more accurate and speedy in tracking the MPP for various environmental conditions. Inverter, in which as the lower inverter is the one mounted in [9]. This proposed inverter configuration has lot of blessings which include less number of electricity electronic devices, electricity diodes, capacitors and isolated DC resources while compared with different configurations and is quality proper for renewable power applications.

2. MPPT CONTROL TECHNICQUE

The MPPT technology is used to track the maximum power by comparing the previous and present values. The mppt method takes various speed as reference and then compare those speed with the present value and the maximum power is tracked and given as the output. The various characteristics are given in a table 1. The wind speed is taken into account and compare these speed and track the maximum power from the wind turbine. The wind turbine speed Vs power characteristics for various wind speed is shown in figure 1.

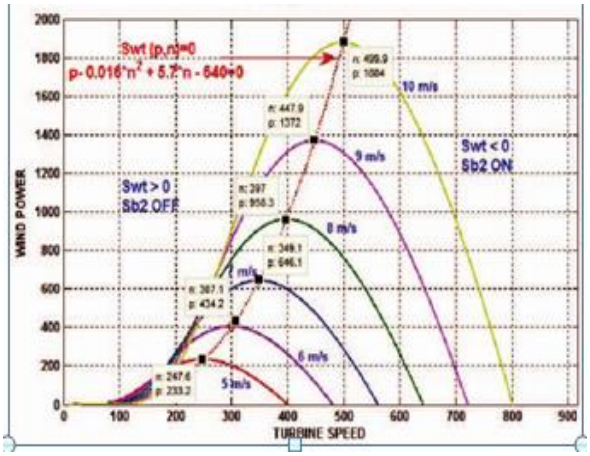

Fig.1. Wind turbine speed Vs Power characteristics for various wind speed

Table 1
PARAMETERS OF WT AND PMSG

Wind Turbine Parameters		PMSG Parameters	
Rated Power (KW)	2	Rated Power (KW)	5
Rated wind speed (m/s)	10	Stator resistance (Ohms)	1.5
Radius (m)	1.525	Stator inductance (mH)	0.01
Gear Ratio	5	Pole Pairs	2
Air density m3/Kg	1.08	Flux (Wb)	0.2194
Height (m)	5	Moment of Inertia (kg m)	2

The main aim of the proposed topology is to reduce the number of switches and reduces the multilevel output meanwhile reducing the harmonics. The existing seven level inverter can consist of 12 switch topology. When the number of switches increases the switching losses and also harmonic level should be increased. The seven level inverter with high losses is the existing system. The proposed system can consist of eight switch topology and maximum power point tracking technology also present to get more output. The boost converter is used which boost the input voltage and the other

seven switches are used to get seven level output. The three switches are connected parallel and other four switches can connect as bridge type. The switches are reduced to get low losses and also the total harmonic distortion level should be decreased by using this topology. The main advantage of using these inverter is to decrease the filter and also the switches number. The existing system has more switching losses then the proposed system.

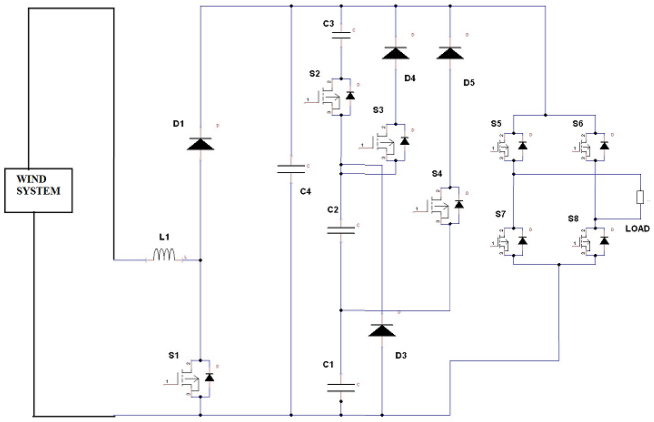

Fig.2. Circuit diagram of proposed 7-level inverter

3. MODE OF OPERATION

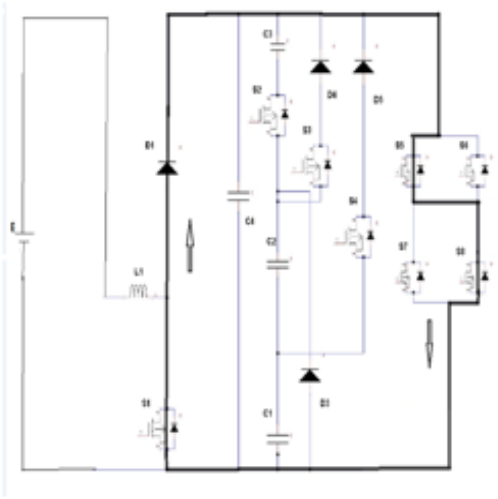

Fig.3. Operation at Mode

MODE 1:

In the mode 1 operation three switches can conduct and produces the output which is Vdc/6. The conducting switches are S1, S5, S8. The switch S1 can conduct first and then the switches from the bridge circuit S5 and S8 can conduct. The switch S5 can conduct for positive half cycle and the switch S8 can conduct for the negative half cycle.

MODE 2:

In the mode 2 operation three switches can conduct and produces the output which is Vdc/4. The conducting switches are S2, S6, S7. The switch S2 can conduct first and then the switches from the bridge circuit S6 and S7 can conduct. The switch S6 can conduct for positive half cycle and the switch S7 can conduct for the negative half cycle.

Fig.4. Operation at Mode2

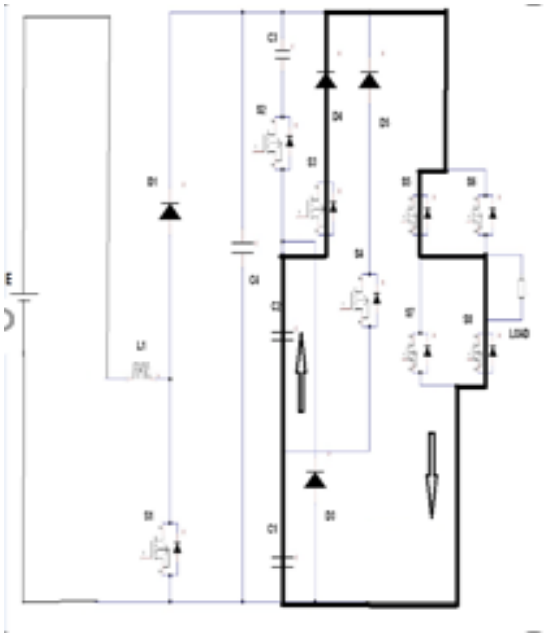

Fig.5. Operation at Mode 3

MODE 3:

In the mode 3 operation three switches can conduct and produces the output which is Vdc/2. The conducting switches are S3, S5, S8. The switch S3 can conduct first and then the switches from the bridge circuit S5 and S8 can conduct. The switch S5 can conduct for positive half cycle and the switch S8 can conduct for the negative half cycle.

MODE 4:

In the mode 4 operation three switches can conduct and produces the output which is 0. The conducting switches are S4, S6, S7. The switch S4 can conduct first and then the switches from the bridge circuit S6 and S7 can conduct. The switch S6 can conduct for positive half cycle and the switch S7 can conduct for the negative half cycle.

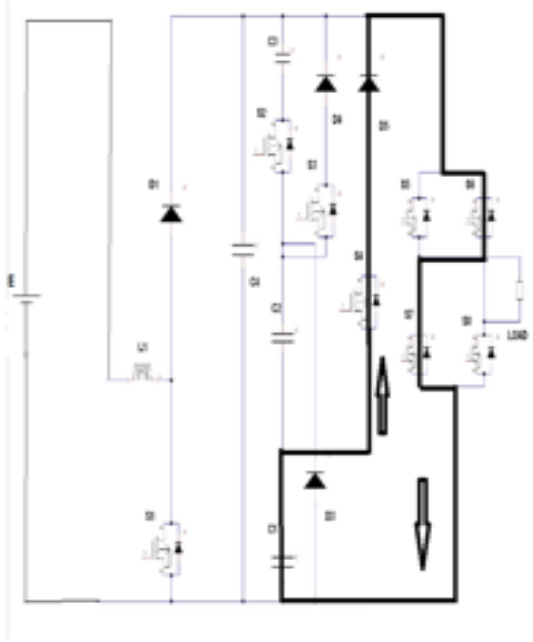

Fig.6. Operation at mode 4

4. SIMULATION RESULTS

The simulation results for the proposed system can be shown in below figures

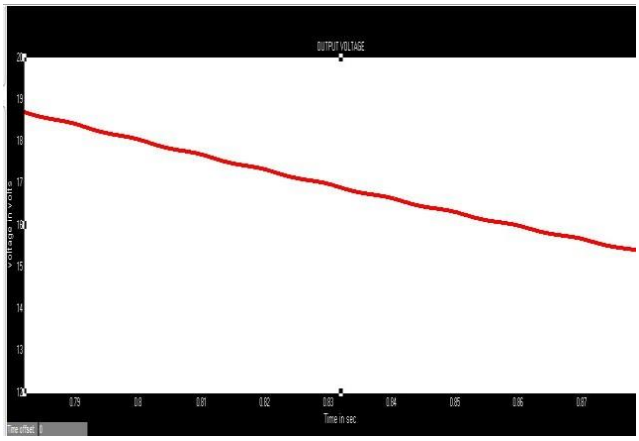

Fig.7. Wind waveform

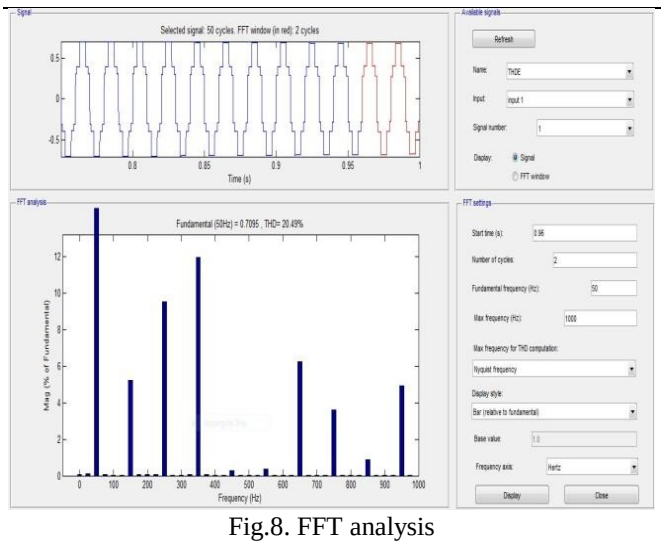

Fig.8. FFT analysis

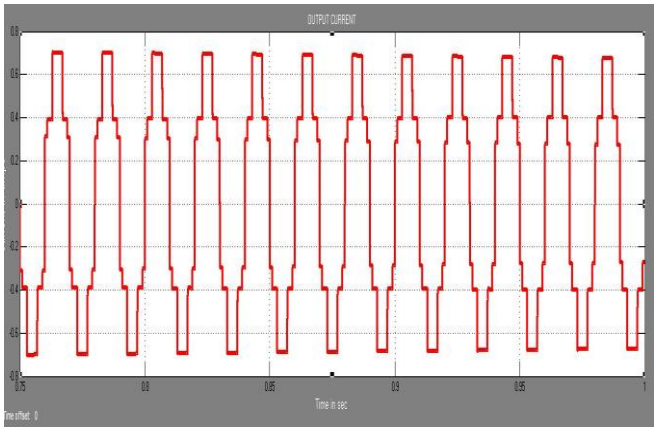

Fig.9. Output voltage

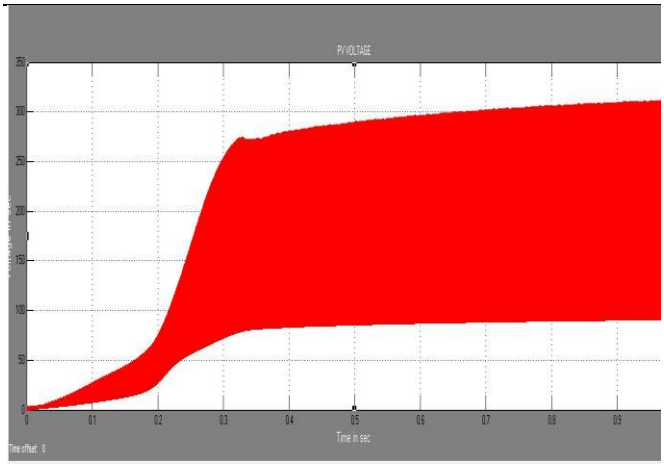

Fig.10. Wind output voltage

5. CONCLUSION

A novel seven level inverter topology with maximum power point tracking (mppt) controller for wind system is proposed in this project. There are several new topology for multilevel inverter is invented regularly catering to different needs of different applications. The multilevel inverters designed for drive applications are very specific about the THD value. As already specified this multilevel inverter can be used for renewable energy applications as well as for drives, house hold power inverter. This report explains about seven level inverter used with mppt technique for wind system. The proposed inverter circuit reduces the harmonic level and switching losses when compared to the other seven level inverter. The similarities between the simulated software results and observed output from the hardware circuit shows clearly that the new topology for wind energy conversion system works as expected result.

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