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Harmonic Reduction of Permanent magnet Synchronous Generator based Wind energy Conversion System with LC Filters

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Abstract: ***wind energy plays a very important role in generation of electrical power. Still it has some problems of distortions .This paper describes the Harmonic reduction of PMSG based wind energy conversion system with filters was proposed. Tank circuit is used to reduce the ripples at the load side. The proposed scheme was implemented in MATLAB/SimPowerSystems , the results are achieved experimentally.***

Keywords: permanent magnet synchronous Generator, ripple. Tank circuit

1. Introduction

The wind energy will play a major role to meet the renewable energy target worldwide, to reduce the dependency on fossil fuel, and to minimize the impact of climate change. Currently, variable speed wind turbine technologies dominate the world market share due to their advantages over fixed speed generation such as increased energy capture, operation at maximum power point, improved efficiency, and power quality Most of these wind turbines use doubly fed induction generator (DFIG) based variable speed wind turbines with gearbox This technology has an advantage of having power electronic converter with reduced power rating (30% of full rated power) as the converter is connected to the rotor circuit. However, the use of gearbox in these turbines to couple the generator with the turbine causes problems. Moreover, the gearbox requires regular maintenance as it suffers from faults and malfunctions [1].Permanent-magnet synchronous motors (PMSMs) have been receiving increasing attention in recent years.

The invention of high-performance magnets, such as samarium cobalt and neodymium–boron–iron, makes it possible to achieve motor performances that can surpass the conventional direct current (dc) or induction motors. The advantages of PMSMs are high efficiency and reliance, high power factor and power density, good dynamic performance with high torque/inertia ratio, etc. Equipped with a proper control strategy, PMSMs are preferable in many of industrial, commercial, or domestic variable speed drive applications.[2] The control of an inverter to present the customers with a balanced supply voltage is the main challenge in a standalone system. Moreover, voltage variations, flickers, harmonic generation, and load unbalance are the major power quality (PQ) problems that occur in the wind energy conversion system (WECS). The voltage variations are mainly due to the change in load.

Flicker or voltage fluctuations are primarily caused by variations in the power from WECS which comes into existence, owing to the fluctuations in the wind speed. Unwanted harmonics are generated due to the power electronics interface (rectifier, inverter and dc–dc converter) between the wind generator and the load. Those power quality problems may not be tolerated by the customers and hence require mitigation techniques.[3] ripple is a critical concern in many high-performance applications such as servo and traction drives, where low acoustic noise, high efficiency, or friendly human–machine interactions are highly demanded. The existence of torque ripple degrades the control accuracy of motor speed and makes the motor less stable. To overcome this problem, researchers have given great attention on reducing the ripple.[4].Hence the active LC filters are used to reduce the harmonics at the load side

2. Proposed Work

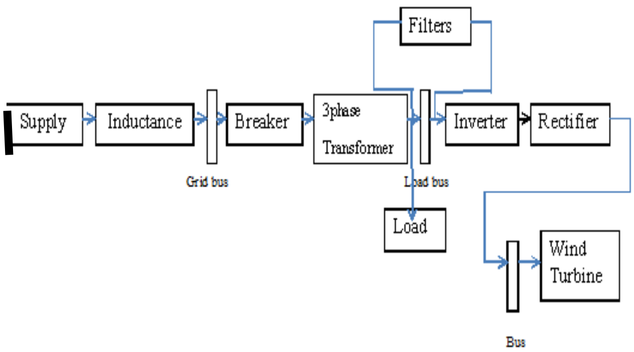

Figure 1: Block Diagram for proposed work

An **LC circuit**, also called a **resonant circuit**, **tank circuit**, or **tuned circuit**, is an electric circuit consisting of an inductor, represented by the letter L, and a capacitor, represented by the letter C, connected together. The circuit can act as an electrical resonator, an electrical analogue of a tuning fork, storing energy oscillating at the circuit's resonant frequency.

LC circuits are used either for generating signals at a particular frequency, or picking out a signal at a particular frequency from a more complex signal; this function is called a band pass filter. They are key components in many electronic devices, particularly radio equipment, used in circuits such as oscillators, filters, tuners and frequency mixers.

An LC circuit is an idealized model since it assumes there is no dissipation of energy due to resistance. Any practical implementation of an LC circuit will always include loss resulting from small but non-zero resistance within the components and connecting wires. The purpose of an LC circuit is usually to oscillate with minimal damping, so the resistance is made as low as possible. While no practical circuit is without losses, it is nonetheless instructive to study this ideal form of the circuit to gain understanding and physical intuition. The filter is connected in between the inverter and loads which as shown in fig1.

Resonance occurs when an LC circuit is driven from an external source at an angular frequency ω_0 at which the inductive and capacitive reactance are equal in magnitude. The frequency at which this equality holds for the particular circuit is called the resonant frequency. The resonant frequency of the LC circuit is

$$\omega_0 = 1/\sqrt{LC} \quad (1)$$

where L is the inductance in henrys, and C is the capacitance in farads. The angular frequency ω_0 has units of radians per second.

The equivalent frequency in units of hertz is

$$f_0 = \omega_0/2\pi \quad (2)$$

$$=1/2\pi\sqrt{LC}$$

LC circuits are often used as filters; the L/C ratio is one of the factors that determines their "Q" and so selectivity. For a series resonant circuit with a given resistance, the higher the inductance and the lower the capacitance, the narrower the filter bandwidth. For a parallel resonant circuit the opposite applies. Positive feedback around the tuned circuit ("regeneration") can also increase selectivity.

Stagger tuning can provide an acceptably wide audio bandwidth, yet good selectivity

3. Simulation Model

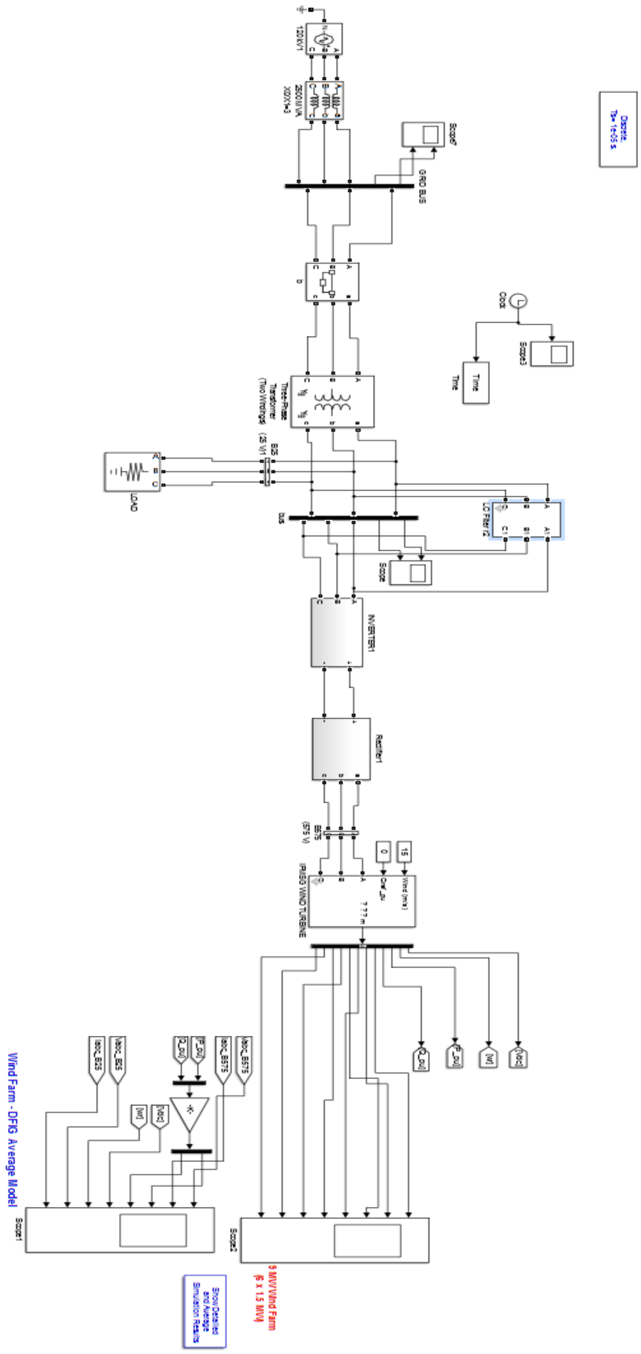

Figure 2: Simulation model of Harmonic reduction of Permanent magnet synchronous generator based wind energy conversion system with filters

Implementation is designed as per the above block diagram. In MATLAB wind turbine block is there so we put that block in the corresponding designed model file after that we design the diode rectifier using of diodes. Output of the Diode Rectifier is fed into the DC link capacitor. Here we measured the voltage across the link and current through that link. That current and voltage is fed into MPPT algorithm here that algorithm is developed in MATLAB function file in that algorithm is produce duty cycle after that duty cycle is fed into the PWM generator, output is fed to the Inverter .The Filters are connected between the load side bus and the inverter output side which as shown in fig.3.

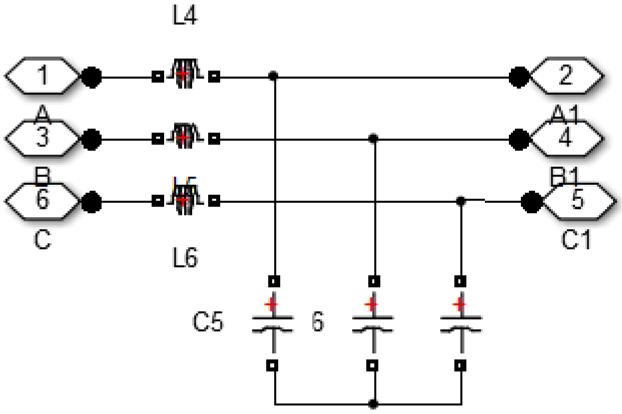

Figure 3: simulation model of the LC Filter

4. Result and Discussions

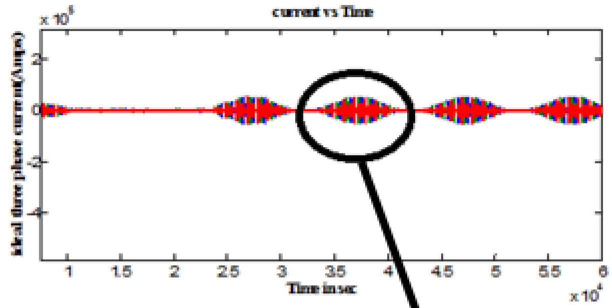

Figure 4: simulation results of ideal three phase currents

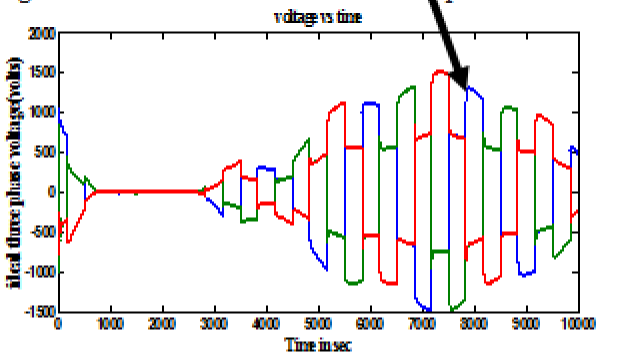

Figure 5: simulation results of the ideal three phase voltages

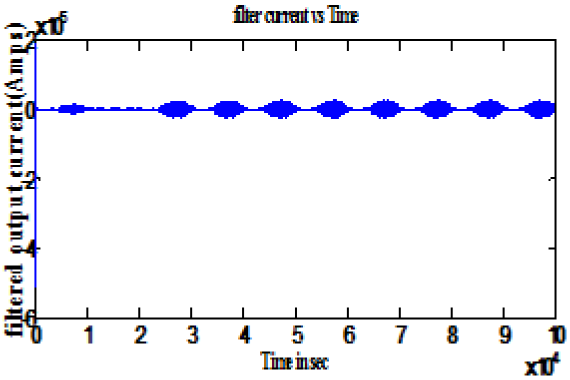

Figure 6: simulation results of output current with filter

The above results are obtained after adding filter for the PMSG wind turbine circuit. The ideal three phase currents and voltages are shown in fig(4)&(5).respectively. Ripples at the load side bus is reduced by filters ,the simulated results are shown in fig(6).inverter voltages are shown in fig(7).the multiplier output is obtained by the inverter currents and voltages are multiplied with product block which are available at the MATLAB library. Its performance curve is as shown in the fig (8)

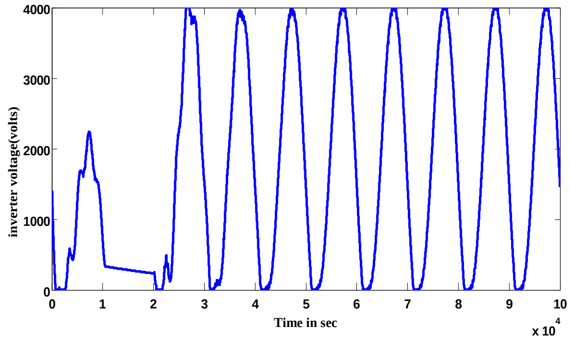

Figure 7: performance curve of the inverter voltage

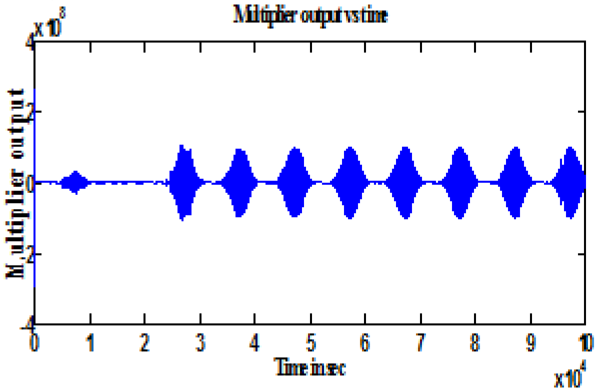

Figure 8: performance curve of the multiplier output

5. Conclusion

In this Paper Harmonic reduction of Permanent magnet synchronous generator based wind energy conversion system with filters were implemented. Tank circuit is used to reduce the ripples at load side. The proposed scheme was implemented in MATLAB/SimPowerSystems , the results are achieved experimentally.

Specifications:
inductor-10e05Henri, capacitor-10e06 Farads.

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