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Simulation of an Electrical Power Generation with the Help of PMSG in Rural Area

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Abstract: *This paper consists making a voltage and frequency constant of electrical power from wind power, even though wind speed varies. The friction losses and engagement losses of mechanical gearbox will be eliminated by using direct drive (DD) notion. That means turbine is directly connected to generator. And the voltage and frequency made constant by using power converters. Such as rectifier, boost converter and inverter. The generated voltage will be rectified by using diode bridge rectifier. The voltage is made constant by using boost converter. And this constant DC power is going to convert in the constant AC power with the help of single phase inverter.*

And such a whole system is to be assembled as per the framework arrangement in MATLAB and its simulation will be verified. Hence can be used for the areas where the electrical energy is not continuously available.

Keywords: *Framework arrangement, PMSG, Boost Converter, Full-Bridge Inverter, Simulating model.*

1. Introduction

Now days there is the lot of increment in energy demand from last so many years. And this demand is going to complete by using fossil fuels. So due to large demand, these fossil fuels are going to deplete. Hence as per as natural condition and policies of government concern to support the small scale generation by using green energy sources like wind, solar, tidal etc. But wind is the most viable one due to its large availability. In wind system, PM generators are most useful due to their low maintenance cost [1], [2].

As we know, there is the variation in voltage and frequency as the wind speed changes. So to overcome this problem, this paper is going to present [3]. In this paper, the generated electrical energy by wind turbine using green source like wind will be consumed by single phase RL load through power converters.

There is the use of direct drive notion which eliminates the losses of friction or engagement of mechanical gear box and the power converters are used to for making the constant voltage and frequency.

This paper shows that it is for standalone system. There is no availability of grid so it is most challengeable to make constant magnitude of voltage & frequency. The performance of whole system can be demonstrated in MATLAB.

2. Framework Arrangement

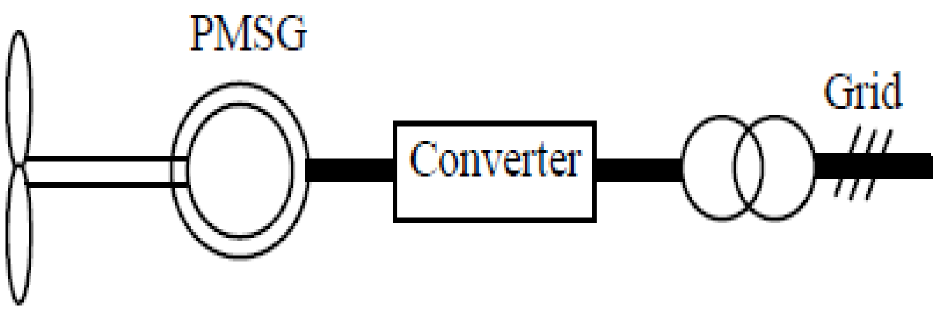

Fig1. *Schematic arrangement*

From schematic diagram, the first converter is a rectifier which consist three diodes in bridge manner. 2nd converter is boost converter and 3rd is an inverter.

The diode bridge rectifier converts the variable that is fluctuated AC power into DC power. The DC power also consist some fluctuation due to variation in the wind speeds. This fluctuated DC power can't be directly given to an inverter. So boost converter is provided with boost topology. This converter converts the fluctuated DC power into constant DC power over whole wind speed. It is also called as step up converter.

The steady DC power is converted into an AC power through inverter and it will be consumed by loads in such area where electricity is not continuously available.

3. PMSG

The stator of PMSG consist three phase winding and it produces almost sinusoidal. The magnets are placed on the surface of the motor core. Hence the excitation is provided by PM so it removes the losses regarding with field copper losses. But its drawback is too much expensive and there is the increment in the weight. Figure 2 shows the cross section of PMSG [4].

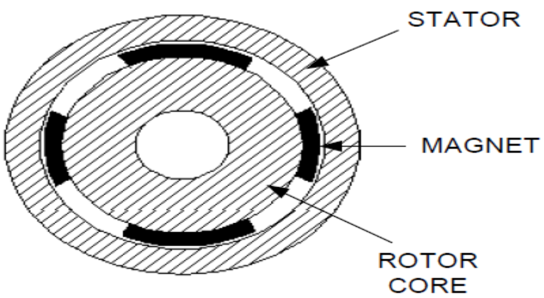

Fig2. *Cross section of PMSG.*

4. Boost Converter

This concept is used to convert the fluctuated DC power into constant DC power. This is also known as step up converter. Such configuration is to be made by using an inductor, capacitor, diode & an IGBT switch. The IGBT switch can be triggered by using PWM generator or pulse generator [5]. But here we are going to use current controller technique to trigger IGBT switch. In the current controller, reference voltage is compared with actual voltage through PID controller to generate an error signal. And this generated error signal is compared with an actual current. Hence we will get a signal to trigger the IGBT switch. Here the inductor L is 550μH and capacitor is 100μF. The following figure 3 shows the modeling of boost converter in MATLAB.

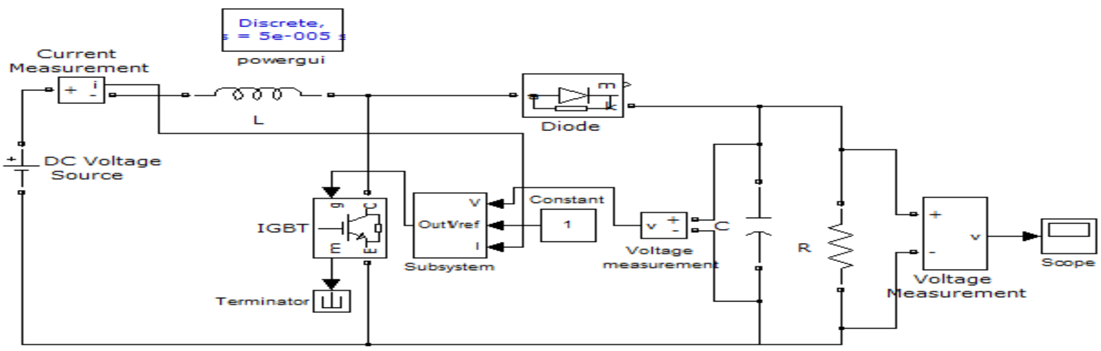

Fig3. *Modeling of boost converter*

5. Inverter

Here the four MOSET's are connected in bridge manner. The constant DC power from boost converter is given to bridge inverter to convert it into constant AC power for single phase RL load. The triggering to MOSFET's is provided from sub system in which square wave is generated. Here MOSFET's S1 and S2 are switched on alternately. That means firstly S1 and S4 conduct and after 180 degrees intervals S3 and S2 conducts. The following figure 4 shows the modeling of single phase bridge inverter in MATLAB/SIMULINK.

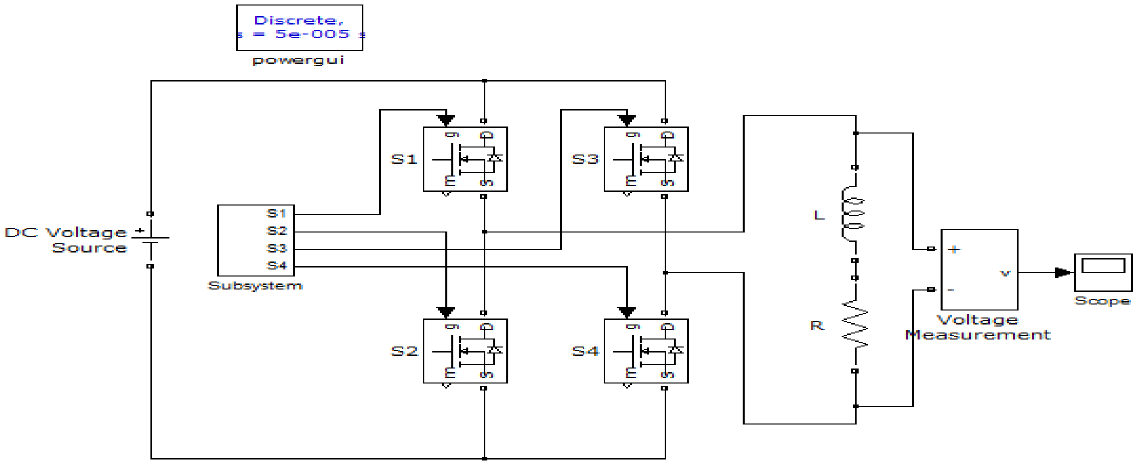

Fig4. *Modeling of inverter.*

The following figure 5 shows the generation of square wave from subsystem block. This wave is used to trigger the MOSFET's [5], [6]. Such waveform is to be generated by comparing the repeating sequence and sine wave. Figure 6 shows the o/p from subsystem.

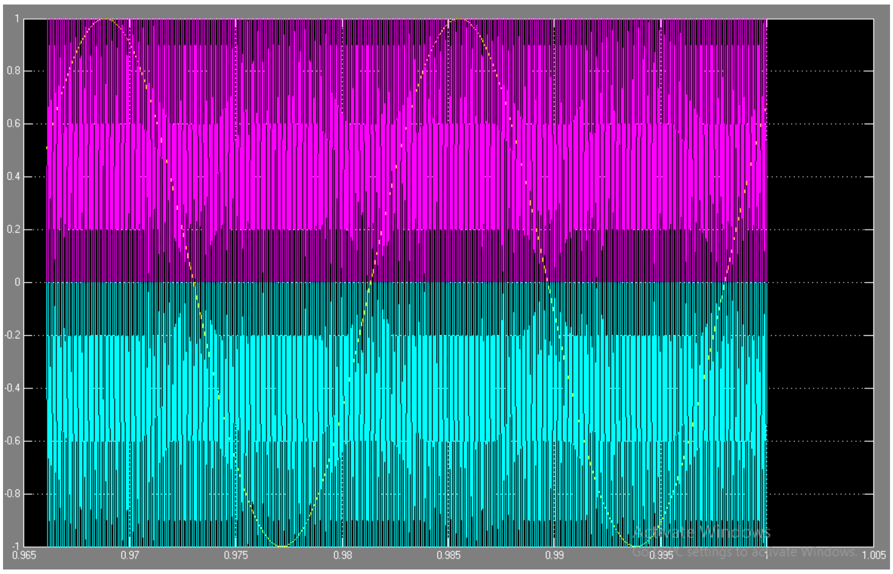

Fig5. *Comparison of repeating sequence and sine wave.*

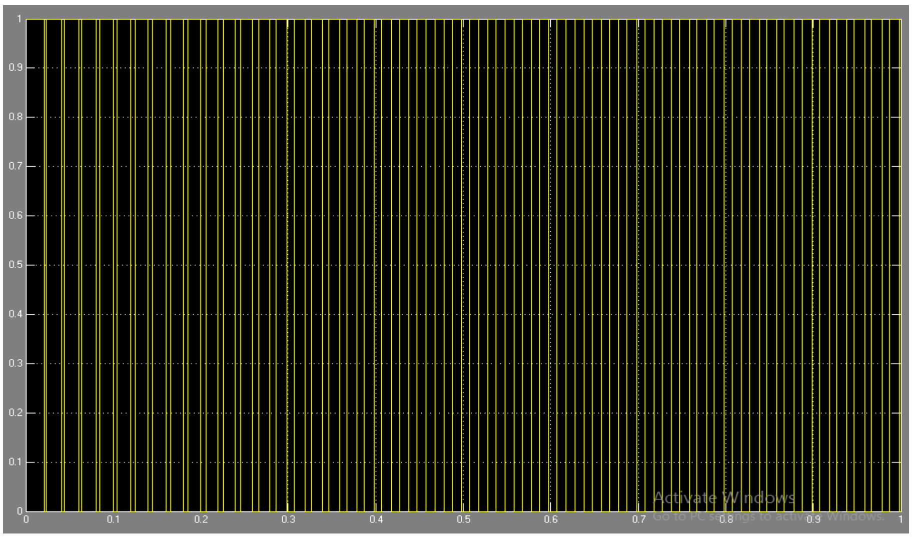

Fig6. *Output from subsystem***.**

6. Simulation Model

All models are connected as per the frame work arrangement in MATLAB/SIMULINK. And simulation results have been taken for single phase RL load with 50Ω and 20mH respectively. The following figure 7 shows the simulating model.

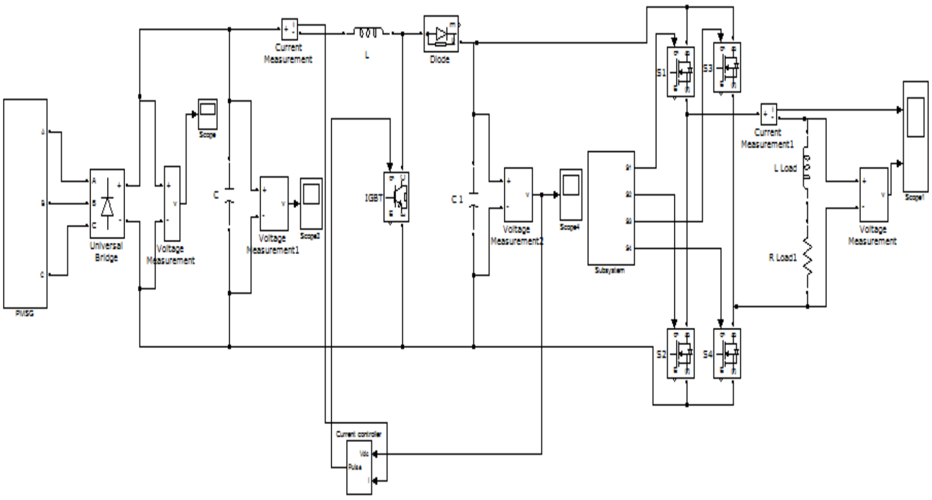

Fig7. *Simulation model of whole system.*

Figure 8 shows the generated voltage at various wind speed, hence it is distorted and figure 8 shows the rectified voltage by diode bridge rectifier.

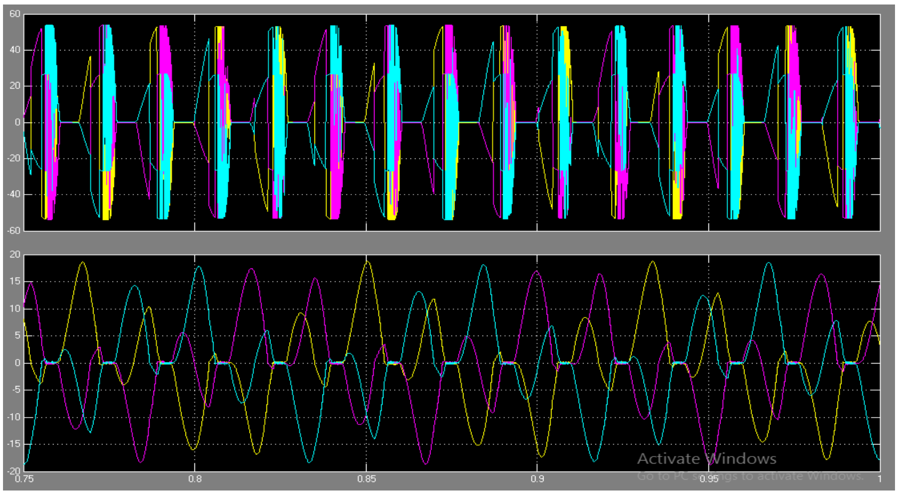

Fig8. *Generated voltage at wind speed disturbance.*

Fig9. *Rectified voltage*

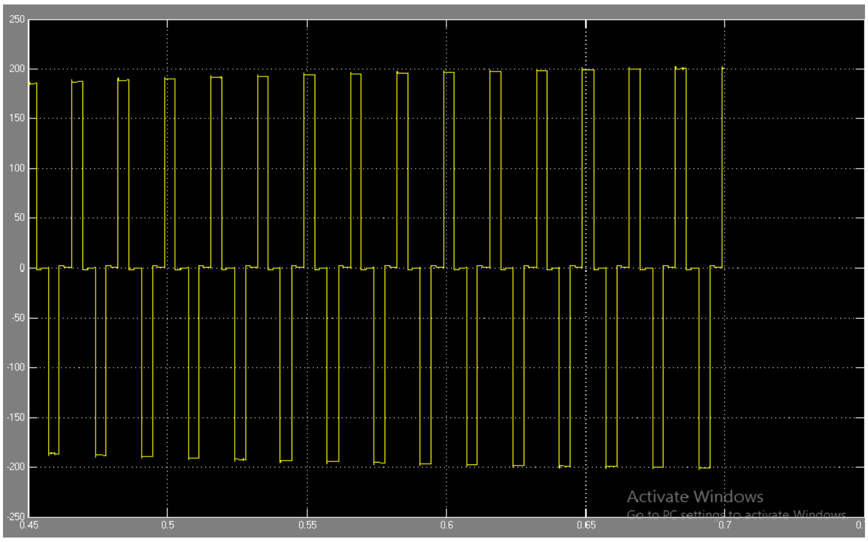

Fig10. *Load Voltage*

Figure 10 shows the voltage at the burden. This voltage is a regulated by the inverter. The information and yield extent will be steady for steady load even though wind speed progressions. Figure 11 shows the load current.

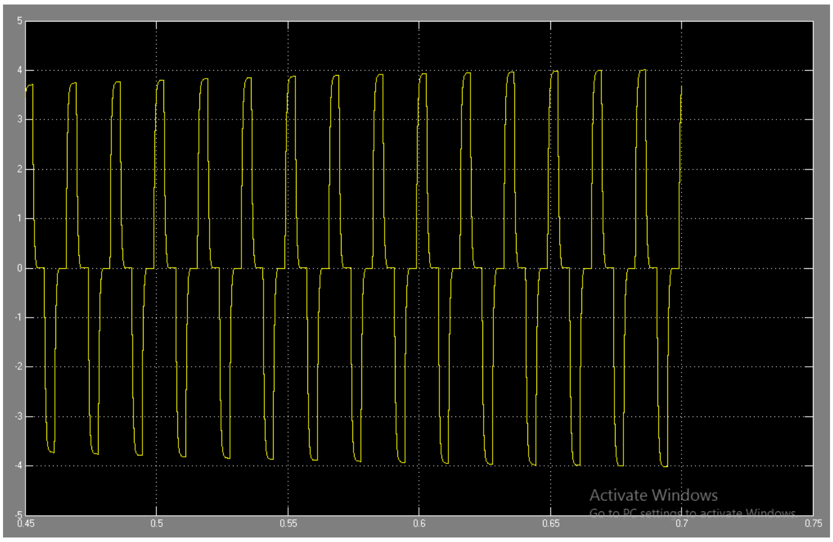

Fig11. *Load Current*

7. Conclusion

After simulating results we can conclude that, such a standalone wind energy conversion system is more useful in area, where the electricity is not continuously available or the area where most challenging work is to maintain voltage & frequency. Mostly it is suitable for rural area.

8. Parameters Used

PMSG

Rated Torque	27nm
Stator resistance	0.34Ω
Ld=Lq	8.89mh
Rotor inertia	7.041.10-3 kgm2
Rated Current	14.6A
Pole pairs	2
Max. Speed	3000 min-1

Boost Converter

L	550µH
C	100µF

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