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Control Scheme for a Stand-Alone Wind Energy Conversion System

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Abstract: ***This paper proposes a control scheme for a stand –alone wind energy conversion system. Present energy need heavily depend on the conventional source. But the limited accessibility and steady increase within the value of standard supply's has shift the main focus to Renewable source of energy of the offered different sources of energy, wind energy is measured to be one in all the confirmed technologies with a competitive value for electricity generation, wind energy conversion system (WECS) is today deploy for meeting both grid-connected and complete load demands. we know that wind flow naturally is intermittent. so as to ensure continuous provider of power appropriate storage technology is used as backup. Rigorous testing is to be carried out in laboratory to develop efficient control strategy for wind energy conversion system (WECS). In this project the property of a hybrid of wind and battery is investigated for meeting the wants of complete dc load. A charge controller for battery bank supported turbine most point following electric battery state of charge is developed to confirm controlled charging and discharging of battery. The mechanical safety of the WECS is secure by means that of pitch management technique. each the management schemes are integrated and effectively is confirming by testing it with a spread of Load and wind profiles in MATLAB/SIMULINK. The resulting presentation development is usual experimentaly; hence our model reduces the cost and gives maximum efficiency.***

Keywords: Wind Energy, MPPT, WECS, Stand Alone System

1. Introduction

Energy is the measured to be the essential input for development. at the present due to the depletion of obtainable standard resources and anxiety relating to environmental deprivation, the renewable sources are being used to fulfill the ever rising energy needed. Because of a comparatively low value of electricity production wind energy is considered to be one in all the potential sources of fresh energy for the longer term. however the character of wind flow is random. Thus rigorous testing is to be accepted get into laboratory to extend economical management strategy for wind energy conversion system (WECS). The study of WECS and also the connected controllers are, thus, changing into additional and a lot of important with every passing day.

Nowadays, many standalone hundreds are powered by renewable supply of energy. With this revived interest in wind technology for separate applications, an excellent deal of study is being administered for selecting an appropriate generator for complete WECS. The main advantage of asynchronous machine is that the variable speed operation permits extracting most power from WECS and reducing the force fluctuations. Induction generator with a lower cost, inherent strength, and operational ease is measured because the most sensible choice as wind turbine generator (WTG) for off grid applications. However, the initiation generator need electrical device bank for excitation at isolated locations. The excitation development of self-excited induction generator (SEIG) is explained. the ability output of the SEIG depends on the wind flow that naturally is unreliable. Each amplitude and frequency of the SEIG voltage vary with wind speed. Such at random variable power once interfaced directly with the load will produce to flicker and instability at the load finish. So, the WECS are enclosed with the load by power electronic converters so as to confirm a regulated load voltage. Once more because of the alternating reasonably the wind generation, a WECS must have energy storage system.

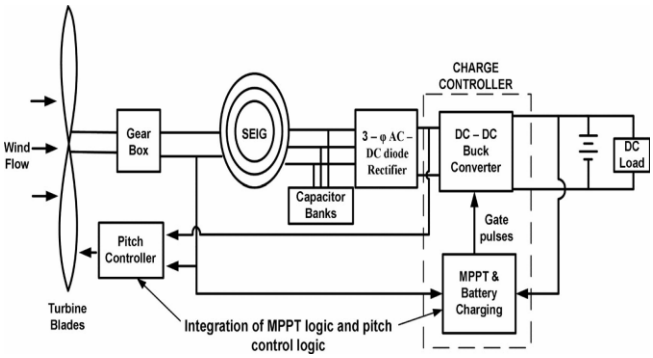

Figure 1: Layout of hybrid wind–battery system for a stand alone dc load.

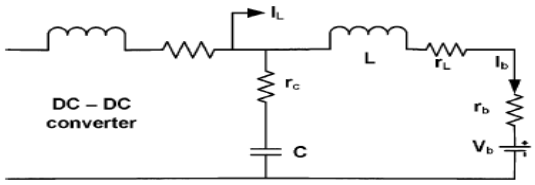

Figure 2: Circuit Buck Converter

2. Control Schemes

We know that the wind flow is erratic in nature. A WECS is integrated with the load by suggests that of ac-dc-dc device to stay faraway from voltage flicker and vocal generation. The management theme for a complete hybrid wind- battery system includes the charge Controller circuit for series banks and pitch management logic to confirm WT

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operations inside the rated price. The 5control logic ensures effective management of the wecs against all potential disturbances. Here we have following 2 types of control strategies.

- Pitch control Scheme.
- MPPT technique.

2.1. Pitch Control

In general the cut-off wind speed of a recent WT is way higher compared to the rated wind speed. If the wt is allowed to activate over the complete vary of wind speed while not performance of any management mechanism , the angular speed of the shaft exceed its rate price which can cause break of the blades. So, it's considerably essential to manage the speed and power at wind speeds higher than rated wind speed. this can be achieved by dynamic the pitch angle of the blade such a technique is mentioned because the pitch management of WT. So, the pitch control mechanism controls the power output by dropping the power coefficient at high wind speeds. The pitch controller changes the pitch command due to variation in rotary engine rotation speed, power, and output voltage of rectifier that ensures safe operation of the WECS.

The p.u value of each input is compared with 1 to calculate the error. The errors are tuned by PI controller. The MAX block chooses the maximum output from each PI controller which is then passed on to a limiter to generate the pitch command for the WT. The actual pitch command is compared with the limited value. The lower limit of the pitch command is set to zero. There arises an error when the actual pitch command goes above or below the specified limit. This is multiplied with the error obtained from each of the comparator. The product is compared with zero to determine the switching logic for integrator. This technique is carried out to avoid integrator saturation.

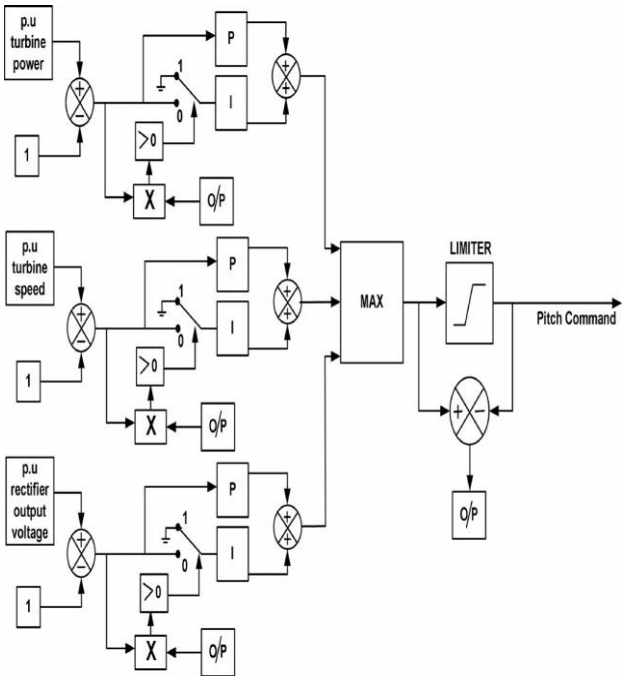

Figure 3: Pitch control scheme for a stand-alone WECS

2.2. MPPT Technique

Maximum Power Point track, commonly referred to as MPPT, is associate electronic system that operates the electrical phenomenon (PV) module in a very manner that permits the modules to get all the ability they're capable of. MPPT isn't a mechanical following technique that ―physically moves" the module to construct them purpose additional directly at the sun. MPPT is totally electronic systems that change the electrical operating purpose of the modules so the modules are able to deliver most accessible power. Additional power harvested from the modules is then created offered as increased battery charge current. MPPT may be used at the same time with a automatic following system, however the 2 systems are fully completely different. to acknowledge however MPPT works, let's initial decide the operation of a standard (nonMPPT) charge controller. once a standard controller is charge a discharged battery, it essentially connects the modules on to the battery. This forces the modules to control at battery voltage, sometimes not the perfect operating voltage at that the modules are able to manufacture their most offered power output. MPPT or most electric receptacle following is algorithmic rule that enclosed responsible controllers used for extracting most offered power from wind module below bound conditions. The voltage at that wind module will generate most power is termed ‗maximum power point' (or peak power voltage). most power varies with wind module produces power with most power voltage. A MPPT or maximum electric receptacle hunter is associate electronic DC to DC device that optimizes the equivalent between the star vary (PV panels), and also the battery bank or utility grid. to place it merely, they modify a better voltage DC output beginning star panels (and some wind generators) right down to the lower voltage required to charge batteries.

3. Proposed Model Specification.

a) Wind turbine system specification

- Rated power - 1.5kw
- Rated wind speed– 10 m/s.

b) Permanent magnet synchronous machine :

- Phases – 3
- Input – torque
- Stator resistance -1.875(ohm)
- Armature inductance -0.0008 h
- Rated power – 1.5 kw

c) Battery specifications :

- Rated capacity – 1.5Ah
- Nominal voltage – 50 v
- Full charge voltage -29 v
- Soc – 60 %
- Buck converter :
- Inductor – 1mh
- Capacitor- 1mf
- Resistive load -1000(ohm)

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4. Simulation Model

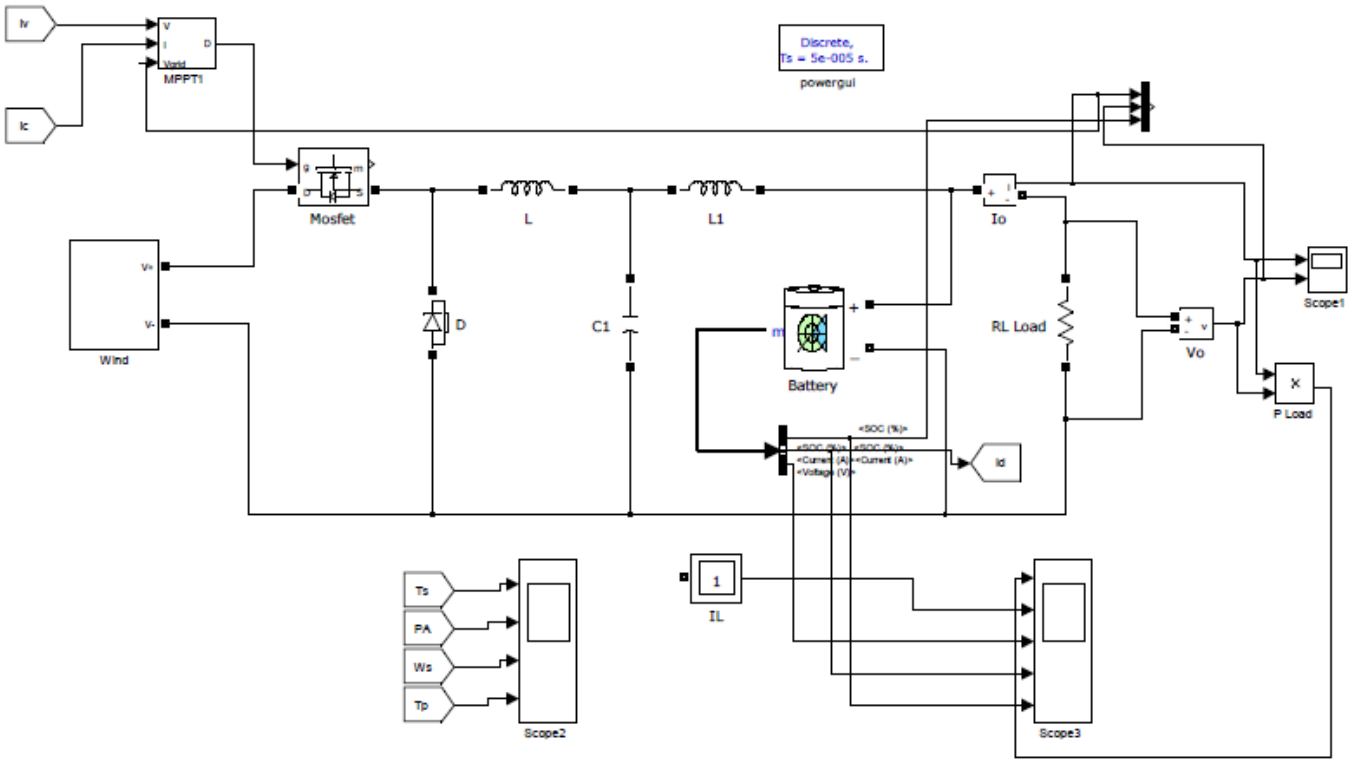

Figure 4.1: final mppt model.

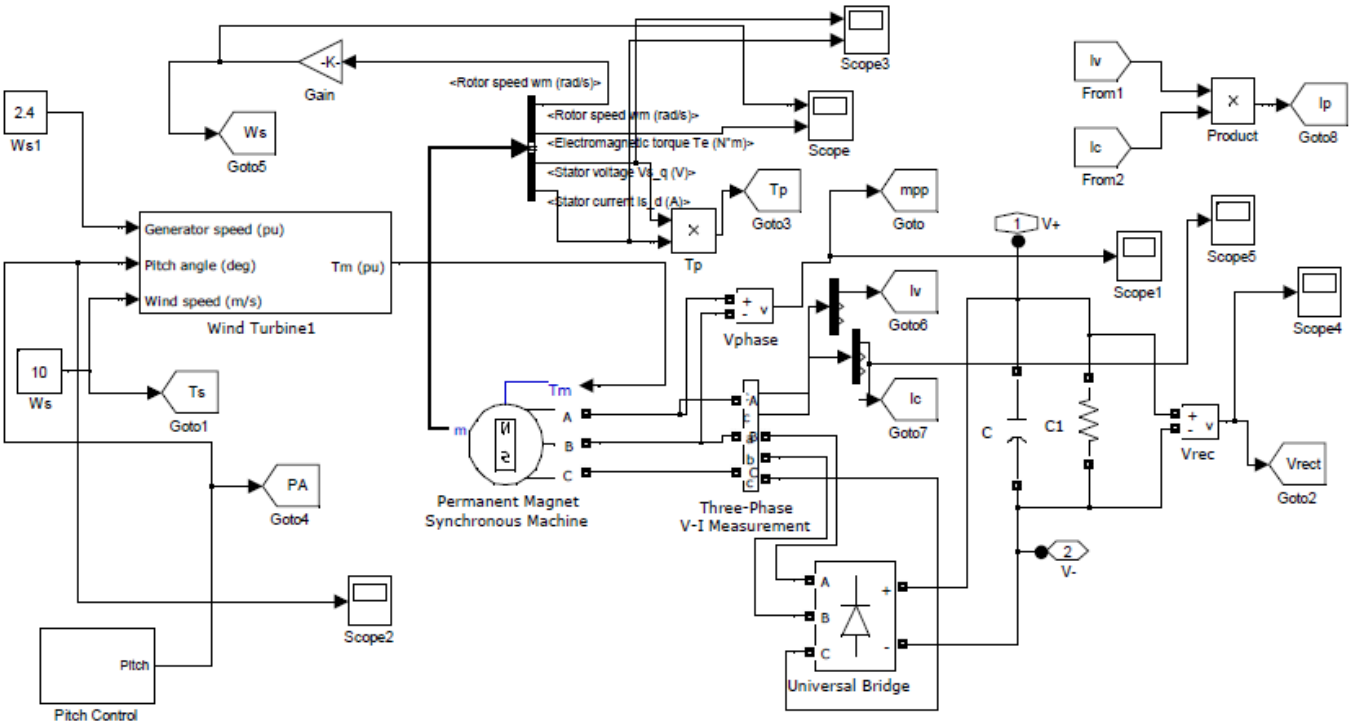

Figure 4.2: wind model.

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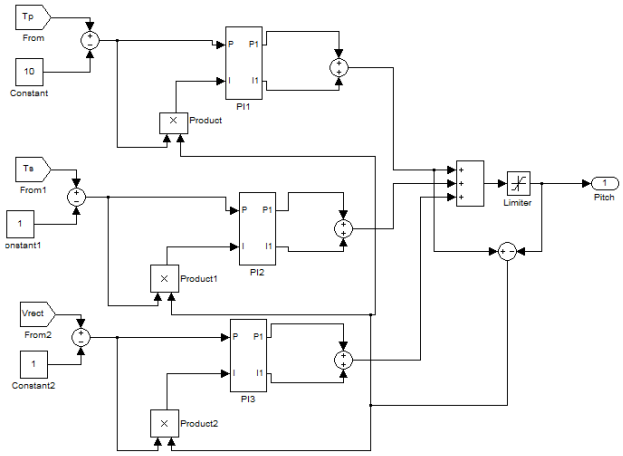

Figure 4.3: Pitch control scheme.

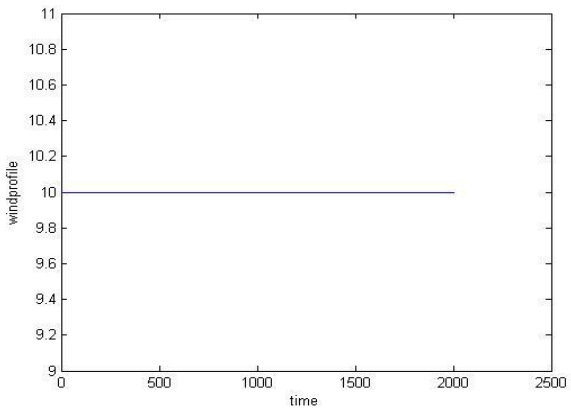

Figure 5.3: Wind profile vs time.

5. Simulation Results

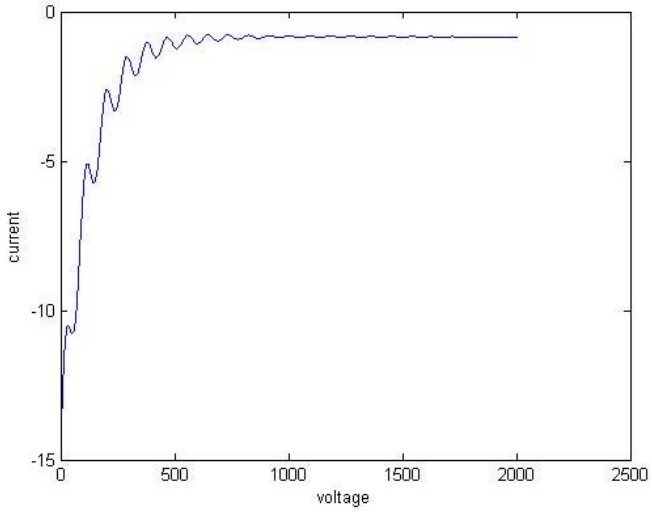

Figure 5.1: Current vs voltage graph

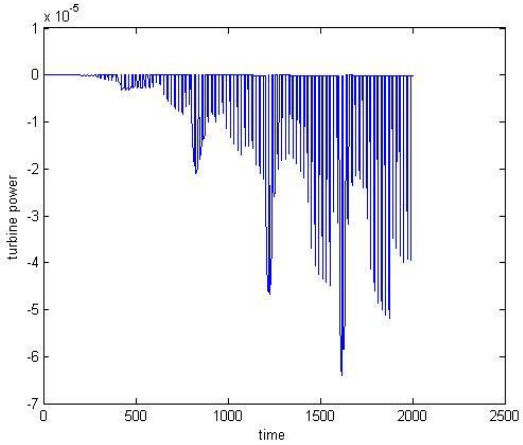

Figure 5.4: Turbine power vs time graph

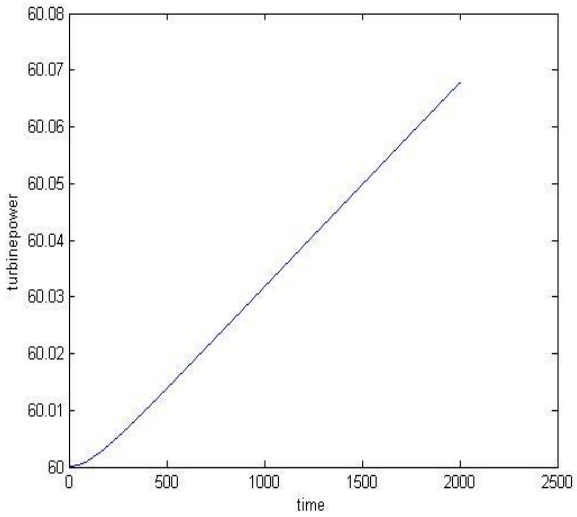

Figure 5.2: Turbine power vs time graph

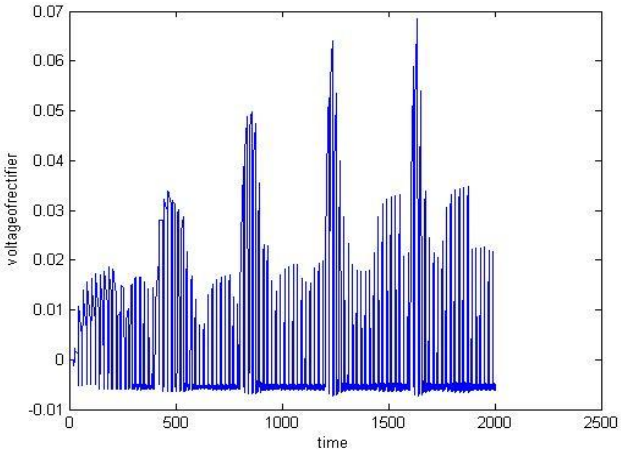

Figure 5.5: Rectifier vol vs time graph.

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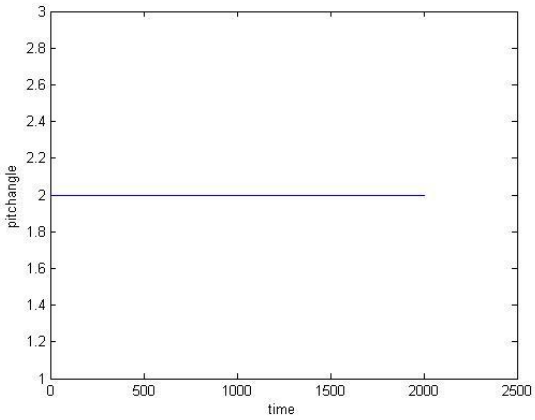

Figure 5.6: Pitch angle vs time

6. Result and Discussion

Proposed simulation model is basically based on renewable energy. It has three parent sections. Section 1st is wind, second is MPPT and last is the battery block. In wind basic focus is on pitch angle and wind speed. This wind model basically generates power, current and voltage with reference speed. Reference speed is basically used for pitch angle. The pitch controller change the pitch command due to variation in turbine rotation speed, power, and output voltage of rectifier, for ensuring safe operation of WECS.

From the pitch control model we have following specifications:-
Tp – per unit turbine power – 3KW.
Ts – per unit turbine speed – 10 m/s.
Vrect- per unit output voltage. 22 pu.

Vrec is rectifier voltage and Vphase is phase voltage. Here we use permanent magnet synchronous motor for power generation. Our system here is based on MPPT P&O method which tracks maximum power and hence maximum power is obtained. Its basic use in proposed model is to control wind power and generate maximum efficiency.

7. Conclusion and Future Scope

Wind energy conversion system (WECS) is currently deployed for meeting both grid-connected and stand-alone load demands. So, a WECS cannot make sure continuous power flow to the load. so as to satisfy the load demand the least bit instances, appropriate device is required. Therefore, planned model may be a hybrid wind-battery system that's chosen to provide the required load power. The management logic enforced within the hybrid established includes the charge management of battery bank exploitation MPPT and pitch management. The charge controller tracks the most power offered to charge the battery bank during a controlled manner. During the power mismatch conditions, the pitch action can regulate the pitch angle to reduce the WT output powers in accord with the total require. The MPPT and pitch control of the WT for assuring Electrical and mechanical safety. The current programmed control technique inherently protects the cuk converter from over current situation. Hybrid wind-battery system along side its management logic is developed in MATLAB/SIMULINK and is tested with numerous wind profiles.

This model reduces the cost and gives maximum efficiency. Wind power has unique ability to provide even greater source of distributed energy production. This model will give maximum output with minimum source of utilization. Research is also being carried out on ways to score large quantities of surplus electricity, particularly through the uses of batteries.

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