

Ben-Gurion University of the Negev Faculty of Engineering Science

Dept. of Electrical and Computer Engineering

Senior Project: Wind Turbine Emulator

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Students:

Zeev Rubinshtein 305806275

Eden Kidishman 040825655



Supervisor:

Prof. Shmuel Ben-Yaakov

Abstract

The modern world that we live in is dependent almost entirely on electrical energy which is growing each year. Along with the growth of electrical consuming has come the understanding that in order to keep our current life style and preventing an environmental damage we need to increase our use in renewable energy sources. This understanding has brought into a shift of the attention at finding new efficient and reliable ways of producing electrical energy from renewable energy sources.

Our project is a system of Wind Turbine Emulator for low power wind turbines. The system will emulate the torque that is being generated by the propeller from the wind turbine. The Emulator will allow lab experimentation that illuminate the need for outdoors experiments in order to test new approaches. Furthermore there is an importance of this system for researches in Ben-Gurion University due to climate conditions (low winds) in our area which do not allow the chance for testing the new approaches. In addition, lab conditions will allow us to reproduce the same "wind" over and over again as we wish for equaling the different approaches.

The system is built of: personal computer that operates as user interface, micro-controller that governs over DC motor (using DC-DC converter of buck topology) to emulate the real Torque of wind Turbine, through gear of 1:3 the system connects to Alternator that acts as SG of a real windmill and as a load for our system.

Parameter	Value	Units
Maximum Output Power	750	W
Nominal Power	390	W
Nominal Torque	7.4	Nm
Sys. Rotation Speed Range	400-1000	Rpm
Nominal Rotation Speed	500	Rpm
Input Voltage	220	Vrms
Motor Type	Brush DC Motor	
Driving Type	PWM	

System Specifications:



Micro-Controller Logic Blocks



Micro-Controllers logic is the system's heart. This logic has 3 inputs: wind velocity from the computer, generator rotation speed and motor current feedbacks. From these inputs the unit calculates the correct torque that the motor need to emulate. This data is then translated into PWM signal using PI control.

User Interface senior_project status ad data from vind turbine profile browse vind regim browse Armature Current log browse 0.5 sampled data browse oL 0.2 0.4 0.6 0.8 Shaft angular speed unning configuration ind regin data saving all points 0.5 repeat every points C constant after sec oL 0.2 0.4 0.6 0.8 run stop

To keep an easy use of the system a user interface was created. This user interface, which was developed in matlab environment, can work on personal computer where matlab installed. In this user interface no calculation is being done for controlling the system. Its only acts as a bridge between the user and the micro-controller. It sends wind and turbine profiles to the micro-controller and receives displays and saves experimental results.

System in Pictures

DC motor (left) and Alternator (right) connected through gear of ratio 1:3



Current saturated Transformer for Generators one phase load current sensing.



Micro-Controller Development board:



This board from Microchip allows fast and easy development with its micro-controllers. We used dsPIC30F2020 which was built for controlling PWM based Power Systems.

Electrical board:



This board as can be seen from next page schematics is build from two circuits:

- 1. Power Stage DC-DC Converter of Buck topology.
- 2. Digital circuit which responsibility to correlate between inputs and outputs of micro-controller voltage levels and the rest of the system.



Results

The system suffered from the noise generated by the power stage that corrupted the sampling signals. Without these samples the system couldn't make the needed calculations for correct emulation. The problem stems from the fact that the signals were connected in a single ended configuration without isolation. It is planned to redesign of this system to overcome this noise injection obstacle.

Electrical Board Schematic