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Simulating System for Technical Characteristic Analysis in Power Generation by Wind Turbine Generator

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***Abstract*— This paper describes the design of the controlling and monitoring system for electricity quality from wind turbine. The 4-RMUT (Rajamangala University of Technology) network joined in this research in order to apply for educational learning as well. This research proposes two objectives as follows: firstly, inventing the prototype of wind turbine for generating electricity including analyses to increase and monitor its efficiency; finally, demonstrating the prototype with our students in order to increase more understanding in a class than ever. The conclusion and developing of this research were also transferred the technical knowledge to the electrical engineering student by discussion in the class. Furthermore, the technical discussion in the class was also improved the teaching efficiency and given more vision to the engineering student as well.**

Keywords*— Wind turbine, STATCOM, SSCB, Monitoring, Transfer of knowledge.

I. Introduction

At the present, Thailand currently recognizes the importance of using more renewable energy as many as other countries which are developing the renewable energy usage. . Wind energy as defined a sustainable energy is not only friendly environment, it is also the clean energy and non-polluted. Wind turbine power generation has been established and installed in many areas o f T hailand with a varied capacity of power generation from 1 kW up to 2 MW.

Thailand is defined as tropical climate country, this is an effect to the power generation stability because of the wind speed and volume . The official results from wind-speed measurement is, sometimes only 1m/s, meanwhile sometimes increases to 1 4 m/s. Therefore, the electrical voltage power from wind turbine generator is, not sufficient to connect and synchronize to the grid of the electric power distribution which is the consequence problems to electronic devices in the household usage.

There are many solutions to solve the problem for the voltage fluctuation of electric power, in order to protect the electrical loads which are connected into the system.[1]

Therefore, the researcher groups from four RMUT has an interesting to find the solutions in order to solve the power quality problem by having an wind turbine power generation plant in Chonburi province to perform this project as shown in Fig 1.

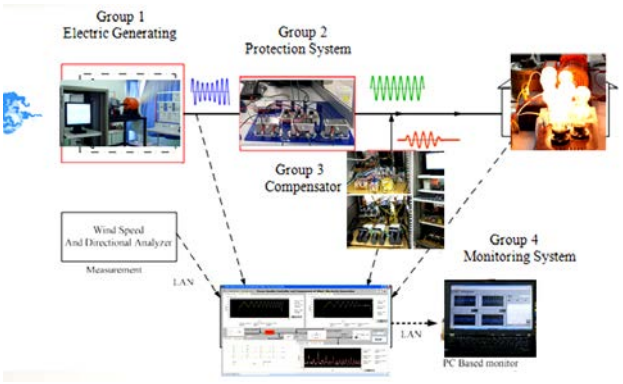


Fig. 1 The power quality controller system.

The topics for each researcher group are the following;

1. The voltage output analysis of magnetic generator performance of wind turbine power generator
2. Analysis and design of fault protection of power systems by using the solid state circuit breakers
3. The voltage fluctuation Controlling of Wind turbines via STATCOM
4. Development of Smart Monitoring System for Wind Energy System

II. Hardware and Experimentation Implement

2.1 Group 1 The analysis of voltage output of permanence magnet generator of wind turbine power generation. [2]

The purpose of this research was to increase the magnetic generator permanence at 1 kW. With 48 Voltage by installing a double-coils layer at 48 slot ,48 coil. The use of copper coil number 21 can make the stable current at 1.2 Amp. it also can generate the voltage between to 220-380 V.

by boosting the converter circuits and pass inverter circuit to the loads as shown in Fig. 2.

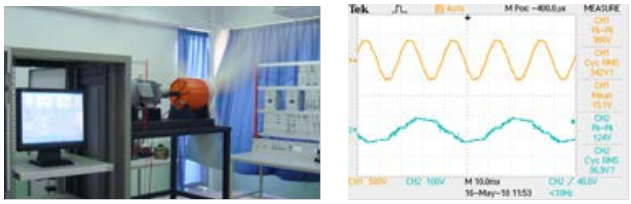
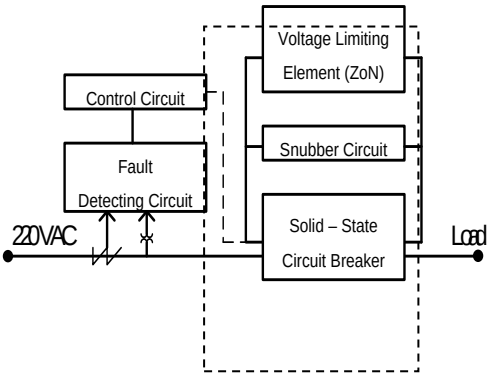


Fig.2 Signal output Voltage from electricity generation system.

2.2 Group 2 Analysis and design the faults protection of power system by using the Solid state Circuit Breaker (SSCB) [3]

This research presents the design of electrical system protection by using power electronic devices. In case of the abnormal situations, for example, short circuit, under voltage, over voltage, over current, surge and interruption, the main function of the protection device will quickly switch the circuit off in order to reduce the sparking at contact of the circuit breaker, solving symmetrical fault and asymmetrical fault in a system.

The implementation of power electronic properties is used instead of mechanical parts which is called "Solid-State Beaker". This research used method of solid-state breaker to simulate based on the mathematical analysis via MATLAB/ Simulink program, in the cases of fault occurs in an electrical system. The simulation is used as a comparison when it is brought into the system. The fault voltage is detected by RMS Method which is implemented in LAB View program. The detection signal will be sent to the solid-state breaker and control it to cut off all three lines simultaneously to confirm the efficient running of solid state breaker. However, this paper has not yet considered the effect of harmonic.



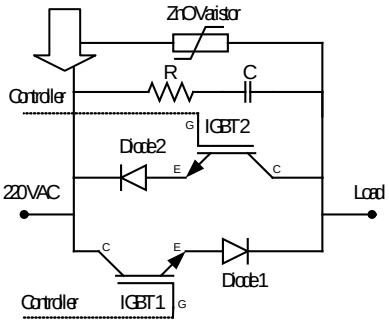


Fig.3 Control Structure and IGBT solid-stage circuit breakers circuit

The results of this research show that Solid State Circuit Breaker can switch off the electrical circuit faster than the IEC 60898 standard in case of over current instantaneous tripping. It can trip the whole circuit within 1 second.

2.3 Group 3 Voltage Fluctuation Control for Wind turbines via STATCOM [4]

This research presents the analysis and design of static compensator (STATCOM) for the voltage fluctuation by compensation to wind turbine electricity generation. In order to control the output power and maintain the stability of voltage loading, the normal control technique of the output voltage is carried-out by using DSP board with the C++ language.

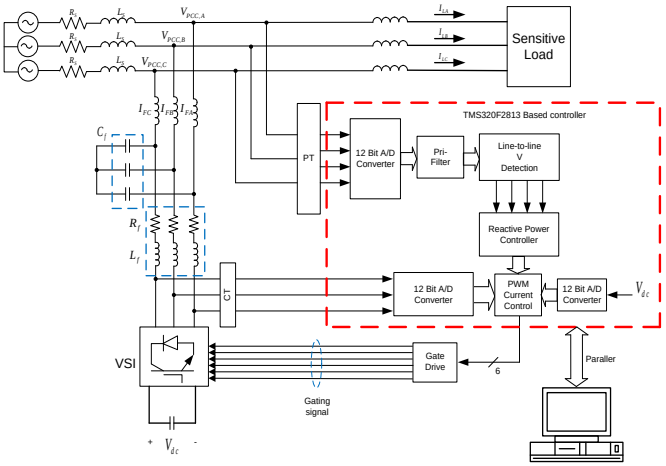


Fig. 4 Diagram of STATCOM control

Firstly, the execution program of the controller is developed in the host computer with a mixed form with C language and assembly language. Secondly, the completed execution file was downloaded to the target DSP via data link. A simple rating is 10 kHz. The execution time is fast enough for the real time control of the DSTATCOM.

The STATCOM was connected to the wind turbine system and there was a three phase resistance load; 400 W at 400V.

The result of this experiment of the voltage fluctuation can be compensated by using STATCOM under the power quality standard (IEEE 1159) STATCOM. It also can compensate the 10% voltage sag and voltage swell compared with voltage normal. STATCOM can also resolve the ripple output voltage of the wind turbine.

2.4 Group 4 D evelopment of Smart Monitoring System for Wind Energy System [5] This Sub-Research presents the development of the monitoring system for a prototype wind turbine system. The proposed of the monitoring system was developed under L abview environment.

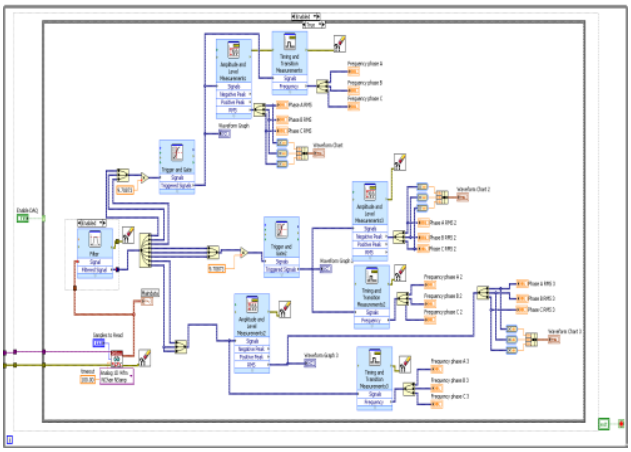


Fig. 5 Circuit of data monitoring in Lab view program

The implementation of the system is simulated by selecting wind profile. After input the wind profile parameters to the generator, the PQ unit will control the quality of the power and supply to the load via converter. The monitoring system provided the visual display which can immediately observe the power quality of the system. The monitoring system provided very useful graphic windows for the operator. The graph showed at the point of monitoring. The operator can just open the program then the data will be immediately displayed.

From the implantation as shown in Fig. 5 the results show that the wind prototype works properly and the monitoring system can provide the correct data, the operator can investigate the characteristic of the system in order to analyze in order for future applications.

The results of the monitoring system indicate that the monitoring system is able to work properly, the data can be used to investigate the wind turbine for system analysis. This is very important for wind turbine in order to supply the stable energy to the consumers.

III. Results of Integrade System Experiments

Wind turbine power generation system type permanence magnet generator could increase the voltage from 48 V , 5 A as throughout the fluctuation frequency can be 380 V, 0.6 A with boot converter circuits. STATCOM could be regulated the coming voltage from the network distributor to the wind turbine. The STATCOM can compensate the 10% voltage sag and voltage swell compared with voltage normal under the power quality standard (IEEE 1159).

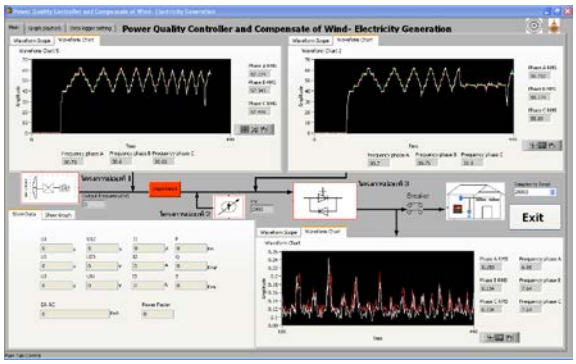


Fig. 6 The monitoring system display of real-time monitoring investigation with internet

The system has safety when faults occur in distribution by SSCB. It can switch off the electrical circuit faster than the IEC 60898 standard in case of over current instantaneous tripping. Moreover, the system can monitoring by the internet and measure current, voltage and power v alue as accuracy as electric instruments.

IV. Knowledge Transfer from Research for University Students

To transfer and the technical knowledge and increase engineering skill for the undergraduate engineering students, the development of teaching technique is required. In this presentation work , applied research work in class was selected as the teaching technique to improve the technical knowledge to the electrical engineering students. The questionnaires were used to determine the knowledge and satisfaction from students before and after learning. From the data of four groups of engineering students from four universities (40 students per group), the difference value between before and after studied by using applied research work in class technique was 0.01 and the satisfaction was in excellent level. Thus this technique can improve the teaching efficiency in engineering level.

Fig. **7** Invention from research for university education

V. Knowledge Transfer from Research for University Students

The results from four research group shows that the control and monitoring systems can increase the efficiency of wind turbine power generation. For example, control system can increase voltage value and maintain power quality by compensation system., The electronic devices equipment can protect and monitor the system from remote area and command with online mode .Moreover, this result and collected data from this research can be used and discussed with engineering student in the class in order to transfer and increase the technical knowledge. It also, improves and increases the communication and corporation between the RMUT researchers groups as well.

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