UNIVERSITI PUTRA MALAYSIA

MONITORING AND CONTROL OF AC POWER DISTRIBUTION BOARD THROUGH SOUND CARD-BASED SCADA SYSTEM

MUHAMMAD JABIR

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By

MUHAMMAD JABIR

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Master of Science

December 2014

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Do they say: 'He has invented this Book himself?' Say: 'If that is so, bring ten surahs the like of it of your composition, and call upon all (the deities or gods) you can other than Allah to your help. Do so if you are truthful **(Surah Houd, Ayat # 13)**

I dedicate this humble effort, the fruit of my thoughts & study to my Parents (Muhammad Ramzan&Sehnaz), my Brothers (Sabir, Babar, Bilawal and Tayyab), and to all those who love me for their support and encouragement they provided me to achieve this goal.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

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December 2014

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The concept of wide-area monitoring of each and every aspect of the electrical distribution system, its control and protection is the basic demand of this era. This is because of the electrical power demand is growing much faster which demands the more energy generating system like renewable sources which are cheap and easily available even at close to load and result complex electrical generating system. For safe and control electrical power from these complex electrical generating system to industrial and most important loads like telecommunication site load, the electrical energy is provide to system through AC power distribution board which pass electrical energy from these generating sources i.e. TNB and other sources like generator and renewable to load in control way. The present AC power distribution board can monitor and control only current and voltages of the coming electrical energy sources. Also there is no remote monitoring system that can check the coming AC power status even of voltage and current. The monitoring of voltage and current can monitor only by volt and ammeter that are presents on the AC power distribution boards (ACPDB).

This thesis explored the challenges and feasibility of the implementation of real-time system analysis features in order to monitor and control the AC electrical power distribution board (ACPDB) of the telecommunication sites. By using the sound card based SCADA system the signal of maximum range 2.1V that is get from potential and current transformers of the electrical system of telecommunication site has sent to computer or process device which integrates with the LabVIEW software. Sound card is the most cheapest and easily integrate to computer as data acquisition device rather than other acquisition cards which are expensive as well as demand separate software and software license in order to integrate hardware to computer software. LabVIEW is the one of the latest and efficient software that easily integrate with hardware by using sound card and receives the ACPDB signal with proper generated code. In this thesis ACPDB of type V4 has been used for monitoring and control. For V4 ACPDB the single phase voltage can measure upto 380V and current can measure up to 140A by using sound card SCADA.

The LabVIEW with the created design code electrical power distributed system of telecommunication site is monitored and controlled. Using sound card based SCADA system we are able to monitor any kind of aspect from fundamental quantity to distortion analysis. The values of monitored system store in the storage devices which are helpful for load forecasting and able to manage electrical sources. The protection of ACPDB is achieved by setting reference values in LabVIEW and LabVIEW send control signal to hardware in the event of fault.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia Sebagai memenuhi keperluan untuk ijazah Master Sains

PEMANTAUAN DAN KAWALAN AC LEMBAGA POWER PENGAGIHAN MELALUI SOUND CARD BERASASKAN SISTEM SCADA

Oleh

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Konsep Wide Area Network(WAN) memantau setiap aspek sistem pengagihan elektrik, kawalan dan perlindungan merupakan permintaan asas pada era ini. Ini kerana permintaan terhadap kuasa elektrik membangun dengan pantas dimana permintaan terhadap sistem penjanaan tenaga seperti sumber-sumber yang boleh diperbaharui dimana ia murah dan mudah didapati dan menyebabkan sistem penjanaan elektrik yang kompleks. Sebagai keselamatan dan kawalan kuasa elektrik dari sistem penjanaan elektrik yang kompleks kepada perindustrian dan paling utama kepada beban seperti tapak beban telekomunikasi, tenaga elektrik disalurkan kepada sistem melalui papan pengagihan kuasa AC dimana ia akan melepaskan tenaga elektrik melalui sumber penjanaan tersebut sebagai contoh, Tenaga Nasional Berhad (TNB) dan sumber-sumber lain seperti penjana dan memperbaharui beban secara terkawal. Kewujudan papan pengagihan kuasa AC hanya dapat memantau dan mengawal arus dan voltan yang datang melalui sumber – sumber tenaga elektrik. Selain daripada itu, tiada sistem pemantauan jarak jauh bagi menyemak status kuasa AC yang diterima daripada arus dan voltan. Pemantauan arus dan voltan hanya dapat dipantau dengan volt dan ammeter yang terdapat pada papan pengagihan kuasa AC (*ACPDB*).

Thesis ini meneroka cabaran-cabaran dan ciri kebolehlaksanaan sistem analisis masa nyata untuk memantau dan mengawal papan pengagihan kuasa AC (*ACPDB*) ke tapak-tapak telekomunikasi. Dengan menggunakan kad bunyi berasaskan sistem SCADA berisyarat julat maksimum 2.1*V* yang diperolehi daripada potensi dan tapak pengubah sistem arus elektrik telekomunikasi telah dihantar ke komputer atau alat pemproses yang telah disepadukan dengan perisian LabVIEW. Kad bunyi adalah termurah dan mudah disepadukan ke komputer sebagai alat perolehan data berbanding kad-kad perolehan data yang lain dimana ia mahal dan juga memerlukan perisian berasingan dan lesen perisian untuk menyepadukan perisian keras ke perisian lembut komputer. LabVIEW merupakan perisian terkini dan berkesan serta mudah disepadukan dengan perisian keras dengan menggunakan kad bunyi dan menerima isyarat ACPDB dengan kod yang dijana dengan betul. Dalam thesis ini,

ACPDB jenis V4 telah digunakan bagi pemantauan dan pengawalan. Bagi ACPDB jenis V4, fasa tunggal voltan boleh mengukur sehingga 380V dan arus boleh diukur sehingga 140A dengan menggunakan kad bunyi SCADA.

LabVIEW dengan sistem kod reka bentuk yang dicipta kuasa elektrik yang diedarkan ke tapak telekomunikasi kini telah apat dipantau dan dikawal. Dengan menggunakan kad bunyi berasaskan sistem SCADA kita kini boleh memantau apa-apa jenis aspek daripada kuantiti asas hingga ke herotan analisis. Nilai sistem yang dipantau disimpan ke dalam peranti simpanan dimana sangat membantu meramal beban dan mampu mengurus sumber-sumber elektrik.

Perlindungan ACPDB dicapai dengan menetapkan nilai-nilai rujukan dalam LabVIEW dan LabVIEW akan menghantar isyarat kawalan ke perisian keras sekiranya berlaku kerosakan.

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This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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I hereby confirm that:

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CHAPTER 1

INTRODUCTION

1.1 Brief Introduction

Electrical energy is the basic of human life. Now a day the energy demand is increasing day by day. In order to fulfil the current requirement different types of electrical energy sources has been brought to electrical system. By enlarging the electrical system to get more electrical power it is also very important to focus towards managing the system. To manually manage the electrical system even small distribution system is not very easy as the new electrical power sources like renewable brings new uncertainties (Dong, 2009 and Zhao & Wu, 2013). Also there are other challenges what will the behaviour of Power system load under faulty condition, how to monitor the whole system in easy and efficient way and how to protect under fault. Figure 1.1 shows the most important challenges that have to tackle in order normal operation of electrical systems.

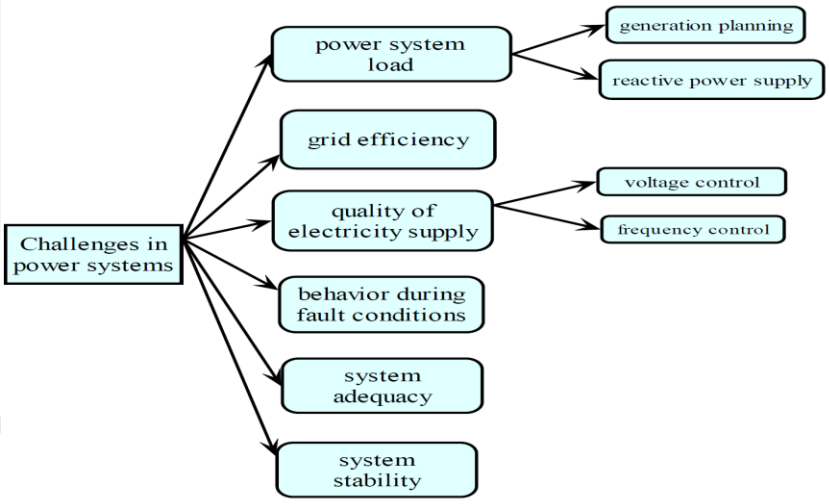


Figure 1.1 Challenges in Power Systems (Zhao & Wu, 2013)

Telecom Sites are usually powered through various sources which include – AC utility, Diesel generator and renewable sources etc. This topology provides fault tolerance and redundancy in case of failures. The focus has been shifted to some renewable sources like solar that can provide electrical energy to telecom site even within telecom compound in low cost and less maintenance as compare to generators (Zhao & Wu, 2013) but this has made more complex system. The complexity of the AC power supply empathies for precise monitoring and notification of any failures. This makes Power Supply Monitoring board an integral part of the telecom shelter unit. Normally to control power from these electrical sources TNB, generator and renewable the AC power distribution board are used and can monitor system voltage and current only.

Supervisory controls and data acquisition (SCADA) is the system that can monitor and manage the complex electrical system. In SCADA system data from electrical system send to computer or processing device by using sensors, data acquisition devices and communication lines. On the base of system data computer monitor the whole complex system, store the monitored values, and can make decision and send to control signal to protect system during fault (Baqer & Sikder, 2012 and Zhang & Xiang, 2014). Following Figure 1.2 shows the block diagram of SCADA system.

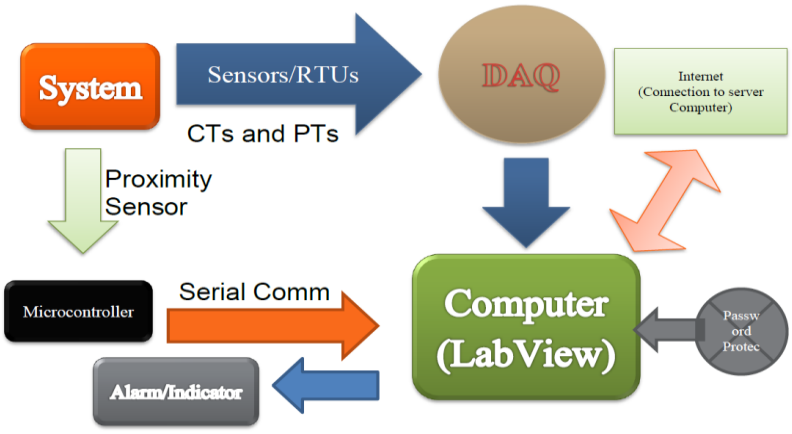
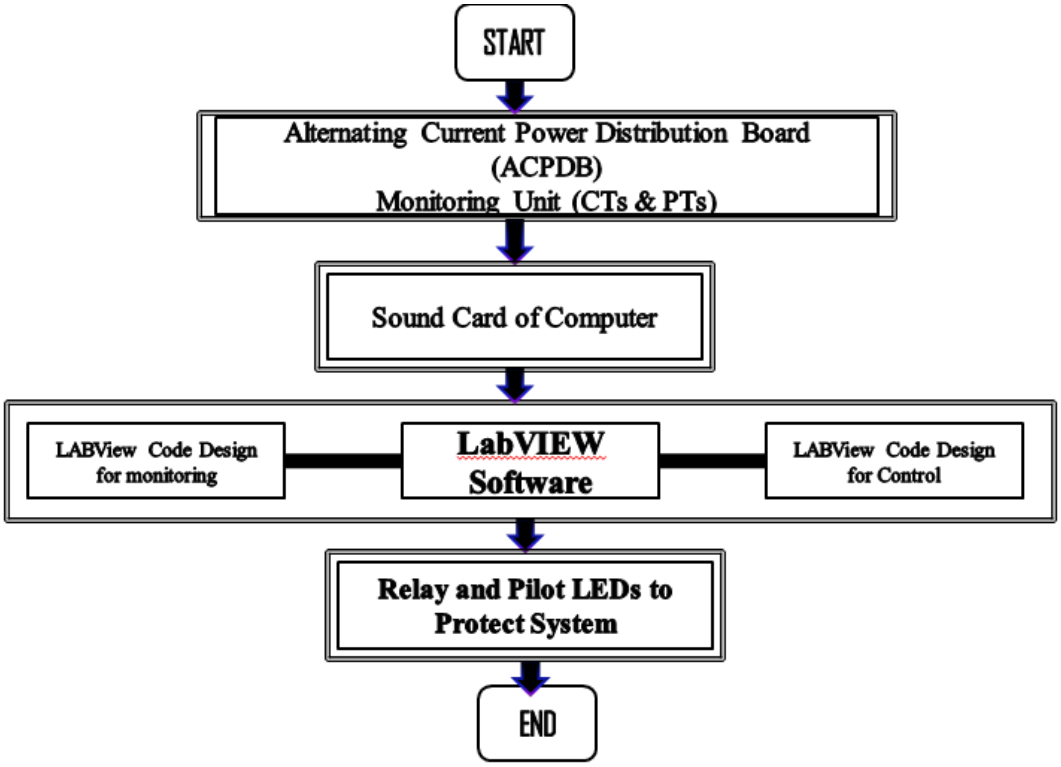


Figure 1.2 Block Diagram for whole SCADA System (Zhang & Xiang, 2014)

In SCADA system firstly get two basic electrical quantity i.e. voltage and current in real time monitoring by using PT and CT. After this these analogue quantities through data acquisition device (DAQ) by National Instrument Company send to computer in digital form. However DAQ through this device is relative expensive and needs separate configuration. Moreover, its design is based on industrial safety standard. Therefore, this is inconvenient for generalization. Another system for this purpose is sound card. Sound card has ability for data acquisition because it has ability of both conversions i.e. analogue to digital and digital to analogue. Moreover, data acquisition through sound card is cheaper, better compatibility, stable performance, flexible applications and easy update for drivers. General sound card can reach an accuracy of 16 bit or 32 bit degree of A/D conversion accuracy, higher than a usual 12 bit A/D card.

After acquisition, the signal is ready for electrical system monitoring by using software LabVIEW and electrical power unit can control through with communication of LabVIEW software and external control unit. The research follow chart that is given as:



1.2 Problem Statement

The current technique for monitoring the AC power distribution board of the telecom site is the usage of volt and ammeter that are usually attached to the monitoring board of the ACPDB. The problem of this technique is that it can only monitor the voltage and current of the incoming supply of electrical power. By using this technique other electrical parameters like electrical power and distortion parameters (THD, SIND) etc. cannot monitor and record the data of AC supply either it is from TNB or other sources. Monitoring and control of Alternating Electrical Power Distribution board of telecommunication system at remote station through computer is not available and the current technique to monitor the ACPDB of site to look at the values of volt and ammeter on ACPDB panel. Quality of system monitoring of the electrical power distribution system depend on the data acquisition of the electrical current and voltage. In sound card technology, the method of choice for achieving a real-time system with low-cost, high sampling accuracy, great flexibility, friendly interference, and convenient data store. After process through sound card, electrical quantities comes in computer where can easily record and control them fast and efficient.

1.3 Aim and Objective

The aim and objective of this research are:

- To enhance sound card acquisition based SCADA system which has to monitor and protect the alternative electrical power distribution unit with low-cost, high sampling accuracy, great flexibility, and friendly interference.
- To enhance monitoring system by displaying the 8 different monitoring parameters (voltage, current, frequency, active power, reactive power, apparent power, THD and SIND) of ACPDB on LabVIEW front Panel.

1.4 Scope of Work

The Sound Card SCADA can monitor the important electric parameters of telecommunication electric load which is controlled by ACPDB. These important parameters are voltage, current, frequency, active power, reactive power, apparent power, THD and TND. Recently, the volt meter and ammeter placed on ACPDB has been used for monitoring of the AC electric voltage and current. Other SCADA system like by using DAQ devices can also be used as Sound Card SCADA in telecommunication load but these are expensive and company controlled DAQ cards. One of the cheapest method applied in many industrial applications is based on sound card based SCADA.

One most important motivation of this work is that it can use personal computer for monitoring and control of electrical power distribution system, industrial systems (heat, air and water flow) and for bio medical purpose like ECG of human body and heart beat rate calculation etc.

1.5Thesis Layout

This thesis is composed of five chapters. The first chapter 1 is the introductory chapter and it provides basic background of the study, problem statement, objectives, and scope of the work.

Chapter 2 gives the review and analysis of several previous research works on electrical system monitoring and different types of method used for electrical system monitoring and protection. Moreover, it provides different techniques used for data acquisition. At the end of the chapter there is explanation Sound card acquisition.

Chapter 3 presents the methodology to integration of the ACPDB through sound to computer software. And software code design for getting data, monitoring electrical fundamental quantities, electrical power, distortion analysis and control of electrical voltage and current through LabVIEW software.

Chapter 4 includes the detailed discussions on results and findings electrical data in computer for analysis. The result of the monitoring value of the electrical voltage, current, power and distortion analysis has been showed on the computer LabVIEW software front panel (graphical display). The results of SCADA are verified and compared with volt and ammeter of the ACPDB monitoring system. A final discussion is also made to present the importance of this work.

Finally, in chapter 5 a conclusion for this work is presented. Sound card based SCADA is the most suitable when to monitor electrical system due to its high sampling rate, cheapest and design simplicity. SCADA system is convenient way to monitor and control the ACPDB of telecom site. Contributions from this work are also stated and ideas for future development of the SCADA system.

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