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**DESIGN REMOTE TERMINAL UNIT (RTU) VOLTAGE REGULATOR**

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**A report submitted in partial fulfillment of the requirements for the degree of  
Bachelor of Electrical Engineering (Control, Instrumentation and Automation)**

**Faculty of Electrical Engineering  
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**2016**

I declare that this report entitle “*Design Remote Terminal Unit (RTU) Voltage Regulator*” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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To my beloved father and mother

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## ABSTRACT

Power outages is always happened and its take a longer time for fault detection, isolation and restoration. This problem affects the manufacturing sectors and having an impact on residential areas. Therefore, the voltage regulator is implemented to ensure the problem of unsteady voltage can be controlled immediately. The purpose of this research is to design voltage regulator to regulate the voltage level in the load. The linear voltage regulator is the best selection as it can give fast response to input and output disturbances. At the same time, remote terminal unit (RTU) is employed at the load to monitor the voltage level in the load as well. The design of RTU including RTU hardware circuit board, the RTU using software algorithms, the interfacing for monitoring process and integrate software and hardware together to make the RTU as a complete system. In order to ensure the RTU system achieve its objectives, the methodology uses consists of Proteus software to design and develop the RTU circuit board, mikroC PRO software to program the microcontroller-base, Visual Basic software to create the GUI interfacing for the monitoring system and serial port as a communication media to connect RTU to the control unit in short distances. The findings of this research show that the problem of unstable voltage in the load can be detected quickly by RTU and the signals will be sent to the control unit for further action. The importance of design and development of RTU is being able to provide a system that can continuously collect, process, store data and operate independently through programming and save time and cost. The significance of this research is the improvement of the RTU system whereby the RTU designed is based on existing RTUs. The RTU has an industrial application potential which can be applied in TNB distribution automation and other industrial sectors to monitor weather, temperature, leakage current and others overcurrent. The proposed RTU is to monitor the voltage level and send the information in terms of type fault, the value of fault, substations status and locations, date and time to the monitoring unit.

## ABSTRAK

Gangguan kuasa sentiasa berlaku dan mengambil masa yang lebih lama untuk pengesanan kesalahan, pengasingan dan pemulihan. Masalah ini memberi kesan kepada sektor pembuatan dan mempunyai kesan ke atas kawasan perumahan. Oleh itu, pengatur voltan dilaksanakan bagi memastikan masalah ketidakstabilan voltan boleh dikawal dengan segera. Tujuan kajian ini adalah untuk mencipta bentuk pengatur voltan untuk mengawal selia tahap voltan dalam beban. Pengawal selia voltan linear adalah pilihan yang terbaik kerana ia boleh memberi tindak balas yang cepat untuk input dan output gangguan. Pada masa yang sama, unit terminal jauh (RTU) memainkan peranan penting untuk memantau tahap voltan dalam beban juga. Reka bentuk RTU termasuk perkakasan RTU papan litar, RTU menggunakan algoritma perisian, antara muka untuk proses pemantauan dan mengintegrasikan perisian dan perkakasan bersama-sama untuk membuat RTU sebagai sistem yang lengkap. Dalam usaha untuk memastikan sistem RTU mencapai objektifnya, kaedah yang menggunakan terdiri daripada perisian Proteus untuk mereka bentuk dan membangunkan papan litar RTU, perisian mikroC PRO untuk program mikro-asas, perisian Visual Basic untuk mewujudkan GUI antara muka bagi sistem pemantauan dan serial port sebagai media komunikasi untuk menyambung RTU kepada unit kawalan dalam jarak yang pendek. Hal ini menunjukkan kajian ini bahawa masalah voltan yang tidak stabil dalam beban boleh dikesan dengan cepat dengan RTU dan isyarat akan dihantar ke unit kawalan untuk tindakan lanjut. Kepentingan reka bentuk dan pembangunan RTU adalah dapat menyediakan satu sistem yang berterusan boleh mengumpul, memproses, menyimpan data dan beroperasi secara bebas melalui pengaturcaraan dan menjimatkan masa dan kos. Kepentingan kajian ini adalah peningkatan sistem RTU di mana RTU direka adalah berdasarkan RTU yang sedia ada. RTU mempunyai potensi aplikasi perindustrian yang boleh digunakan dalam sektor industri yang lain TNB pengagihan automasi dan untuk memantau cuaca, suhu, kebocoran arus semasa dan lain-lain. RTU yang



dicadangkan adalah untuk memantau tahap voltan dan menghantar maklumat dari segi jenis kesalahan, nilai kesalahan, status pencawang dan lokasi, tarikh dan masa untuk unit pemantauan.

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## CHAPTER 1

### INTRODUCTION

#### 1.0 Introduction

Energy interruption is the circumstance connected with damaging the energy with an area caused by problem that occurs with electric power stations, transmission, submission or maybe substations. Throughout Malaysia, typical reason behind electric power outage is actually split into 3 which can be coming from Tenaga Nasional Berhad (TNB) process or maybe alternative party participation in addition to client's office space. Regarding TNB process, the key reason why of the electric power outage is actually happened since the short circuit in TNB distribution process and underground line cable which has been dished up. And then, with regard to weather or third part participation incorporates accidents that include TNB installation for example poles and others, pilferage connected with TNB set up, extreme climate for example surges or maybe third party is effective outside of TNB's command for example road constructions. The necessity with regard to more efficient in addition to reliable electric power management improve annually because plenty of electricity created is actually misused by the wrong type of preparing brought on by the weaknesses of the electric power system itself. The particular customization may be produced on the technology in addition to transmission side that may enhance the active power is placed on the distribution side.

Electricity process employed to offer electricity in order to customers with electric power distribution process. The distribution industry connected with automation enables the particular tools in order to carry out variable control connected with distribution system to enhance efficiency, trustworthiness, as well as quality connected with electrical products and services. In order to make it a quality service, voltage regulator must be placed or



installed at a distribution system. Some sort of voltage regulator was created to automatically maintain consistent voltage stage. Within an electrical power distribution process, voltage regulators can be set up at a substation or alongside distribution lines so that almost all consumers obtain constant voltage regarding the amount of power can be driven from the line. Furthermore, a voltage regulator also can be tested at the load to maintain the voltage in the load. At the same time, the voltage level in the load can be monitored through a far distance by placing the remote terminal unit (RTU) at the load.

The remote terminal unit (RTU) is really a standalone information acquisition as well as control unit. The main operation of RTU is to control and acquire information coming from process equipment on the remote area as well as transfer which information returning to the main unit. This kind of remote terminal model (RTU) system was created to inform in case of failing about the small voltage source 400/240V process only. The principle job on this RTU is to find errors due to over voltages along with miss-setting voltages in the Taps at the transformers. It is usually to accomplish the method involving monitoring along with repair in case of errors. The malfunction repair functions is going to be clean and easy to control. This kind of works by using automation strategy in creating of the intelligent RTU as a result of adjustment as well as innovative developments.

## **1.1 Motivation**

The aim of this project is to design the Remote Terminal Unit (RTU) that can stabilize the voltage level that controlled by voltage regulator. As we know, RTU can collect, process, and send the information to the master station for monitoring system. After fully considering all these matters, the non-expensive RTU that can be operated independently is designed and developed. In terms of performance, an RTU can only operate at low voltage 400/230V and has a short distance communication medium. An RTU can contribute equality in terms of monitoring and controlling the data and sending the information to the master station. By interfacing the RTU at the load, the current value in the load can be monitored through a short distance communication. The data will send

to the operator to inform the load condition in the load. Furthermore, voltage regulator is made to keep the voltage level at the steady state in the RTU. The steady voltage level has to be controlled to provide sufficient voltage supply for the RTU.

## **1.2 Problem Statement**

The unsteady voltage level usually occurs at load are defective wiring system and short circuit in the load. When this happen, control room operator have to analyse the load mechanism to recognize what the problem occur in the load before carry any selection to be able to actions. Normally, the process will take long delay to analyse the voltage level in the load. Therefore, it is necessary to create and develop a Remote Terminal Unit (RTU) and voltage regulator which can be interfaced with the load. At the same time, RTU is a flexible system that can process and control the data. It can easily interface with the load. The data from the load will send to the master station by RTU for monitoring system. The data will be visualised using GUI in Visual Basic software. Hence, the operator can easily be informed that the voltage level in the load is being regulated smoothly.

## **1.3 Objectives**

The objectives of this project are:

1. To design and develop a Remote Terminal Unit for hardware and software.
2. To create a voltage regulator that is suitable for the RTU
3. To develop GUI software for distribution automation using RTU models with Visual Basic (VB) interface for monitoring system.

## **1.4 Scopes**

The scopes of this project are:

1. For low voltage devices.
2. The GUI interfacing using Visual Basic (VB).
3. The RTU used is based on microcontroller with PIC16F877A.
4. The communication protocol is based on wireless protocol using serial communication.
5. The simple voltage regulator that is suitable for the RTU

## **1.5 Significance**

After the completion of this project, there are several features can be obtained. The simple voltage regulator can be interfaced with the RTU and regulates the voltage level in the RTU smoothly. The data from the load can be collected by RTU. The project can provide a RTU that can collect data, can process and store data and can send the data to the master station for monitoring. The current voltage level in the load can be informed frequently. Lastly, the RTU equipment can easily be integrated and designed to be repairable.

## **1.6 Report Outline**

This report contains five chapters. Chapter 1 is an overview of Remote Terminal Unit, voltage regulator, Graphic User Interface (GUI) and the communication system, including the problem statement, motivation, objectives, and scope of work. Chapter 2 is a Literature Review presents an explanation of design and development of the remote terminal unit (RTU). This includes the past and current RTU design and development circuit. The other research about the voltage control applied in RTU also has been studied. Chapter 3 is about the methodology of the whole project. This chapter describes the hardware and software designing. The Proteus software is used to design the RTU board, mikroC PRO is used to program the RTU function and the Visual Basic (VB) is used to

create the interface for the monitoring system. Chapter 4 shows the result and discussion which presents the complete RTU circuit as a voltage regulator sent to the monitoring system via Serial communication. Finally Chapter 5 presents the general conclusions.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.0 Introduction**

This part studies the past research result and information which is related to development and design remote terminal unit (RTU) and voltage regulator. The past research discovered on how to design new modelling for the remote terminal unit (RTU) and voltage regulator.

#### **2.1 Design and development of remote terminal unit (RTU)**

Pattern and also development connected with Wise Remote Incurable Unit (RTU) can be demand for managing the particular voltage downstream connected with 400/240V. The dsign as well as development associated with out of the way RTU signal as well as hardware execution which often manifested inside distribution automation system(DAS). Distribution Automation System (DAS) allows the utilities to practice accommodating handle regarding submitting program to provide proficiency along with top quality regarding electric powered services. The design determined by microcontroller making use of PIC16F877A along with Orcad software package to development world for the RTU. [1][2].

Remote Terminal Unit (RTU) is a standalone data acquisition and control unit. It might oversee and also manage gear on some distant area on the central section of which utilizes inside the Distribution Automation Program (DAS) [3]. The master of this system is RTU and the slaves are digital input and output modules. An inlined Ethernet controller is employed to produce RTU work as a converter regarding Human Machine Software (HMI) and to software together with digital input and output modules. There are computer software methods widely-used to build criteria for that controller in addition to HMI for monitoring in addition to handling operations for that owner. [2]. RTU will be assigned the task for digital input and output modules to work on [4]. The RTU could track down wrong functioning, controlling operations as well as facts selection for examination. RTU can be a major part intended for sensing fault in addition to issue in order to provide information speedily from the management room. That functioning will involve the actual recognition of failing linked with the actual microcontroller (PIC18F77A) which suggests the actual sensor can send the actual signals to the present microcontroller if the fault occurs. RTU is able to detect and control under voltage and overcurrent fault [3].

Supervisory Control and Data Acquisition (SCADA) system is a central station which could communicate with some other circle using the communication process. Simply Smart RTU alongside the SCADA is usually capable to conduct clever selections around the syndication automation responsibilities. The intention of developing a very good Microcontroller based RTU with regard to supply automation technique should be to innovate the downstream area of the energy supply technique such as conversation social networking technique [5]. Basically, the particular types of cpa networks depend on the particular seven layers involving wide open system interconnection (OSI) as well as International Standard Organization (ISO). The protocol is made to check the particular reputation of all the so-called feedback in addition to end result subject devices in addition to send the particular report in accordance with in which reputation. The actual matching protocol and also transmission parameters between attaching devices will be included in developing a difficult SCADA system. The obtainable methods to build up the conversation regarding RTU tend to be Modbus/ASCII, allocated community protocol (DNP3), controller region community (CAN), Overseas Electro-technical Commission (IEC 60870), and also indication handle protocol/internet protocol (TCP/IP). [6]. Planning a system with regard to supervising in addition to curbing machine in addition to

equipment within rural spots for example RTU may be utilized by having a several associated with marketing and sales communications alternatives for example wifi LAN engineering, dial-up modems, private radio sites, Satellite tv conversation, in addition to mobile community. The particular RTU provides a couple places connected with RS485 transmission process and something TCP/IP port along with 10Mbps swiftness for that communication part [2]. Regular RS-232, RS-422, RS-485 along with Ethernet solutions usually are recognized simply by Modbus protocol which in turn consists of ASCII, RTU, along with TCP transmitting method. Though ASCII mode or even RTU mode uses serial dock Modbus system, Modbus/TCP manner uses Ethernet system. The interface parameters and transmission setting should be the same to all devices in Modbus network [6]. The particular main computer handle acquired the information by means of verbal exchanges project by way of example IEC 61850 as well as DNP3. Actually the only received information may processed and also exhibited by Graphic User interface (GUI) for the interconnection involving submitting, command and also transmission technique [4].

The design planned based on Global System for Mobile (GSM) conversation shows an intelligent design for distribution automation system. GSM Short Message Services (SMS) providers regarding computerized determination making along with steady overseeing regarding deliver on system ingredients instantly by means of overseeing along with controlling of the relays. GSM will probably send out the particular concept for the command area operators attentive these people around the recent scenario via cell phone whenever files acquired by RTU [4]. This PIC16F877A need to be associated with the actual GSM modem through RS232 cable television having MAX232 converter so as to transfer signal to GSM modem. The technique functionalities GSM modem name Wavecom fastrack and controlled via in command regarding many people connected with operations. RTU will record three kinds connected with details which can be analog, digital and control. RTU measure facts via kV, MWatt, MVar, Hz and Amps plus the analog input offers the other people just like 4-20mA, 0-10V, 2.5 to 2.5V, 1-5V. The data versions with regard to digital can be within status, alarm or indication and also data type with regard to control are usually open and also close, raise or maybe decrease. In addition, it may reset [5].

The design along with the development regarding RTU with small remote telemetry unit designed for different application form inside low voltage technique. It operates in line with PIC16F877 device functioning from 20MHz and also runs via a good 9-24V AC/DC provide. The microcontroller PIC16f877A will be belonging for the class connected with 8-bit microcontrollers involving RISC architecture. The CPU as well as microcontroller will be the core components regarding microcomputers demand current external components most of these ROM, RAM along with I/Os pertaining to perform its purposes. PIC will be operating making use of 5V DC voltage. It is DIP layout and sufficient for its overall project. The digital output of a PIC is 5V to help provide the signal 1 with 0 due to the 0 signal. Whenever the PIC pins are usually set as digital inputs, it will detect input voltage 5V. PIC features 40 pins, but sole 33 I/O pins is usually designated in the same way digital input or perhaps output [6]. The crystal oscillator taken is usually 20MHz of which carry out every process line for the system. 20MHz is usually taken considering that it is the maximum frequency the PIC will probably support. The software design consists of MPLAB software development using C programming in addition hardware assembly [3]. For software design, the program to be able to detect faults uses MPLAB software and the program incorporates commands round the given I/O pin, given ports for its timekeeping chip and also analog digital converter, cycle associated with collecting input if genuine line, data location for info writing and memory [3].

## **2.2 Voltage control in distribution automation system and voltage regulator**

A novel coordinated voltage control scheme is usually proposed to enable voltage regulator to efficiently regulate the voltage involving multiple feeders at the presence of DGs in accordance with placing a remote terminal unit (RTUs) from each DG into each line capacitor. These kinds of RTUs coordinate together through communication and application a multi agent system [7]. As real time voltage control is known as a legacy system that can uses method for real time voltage control, based on emergency demand