

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

WIRELESS POWER THEFT MONITORING SYSTEM



GROUP MEMBERS:-

MUHAMMAD REHAN AFZAL

091420-210

FARRUKH ZAMAN

091420-335

WASEEM AHMAD

091420-065

PROJECT ADVISOR:-

MUHAMMAD SALIK

DEPARTMENT OF ELECTRICAL ENGINEERING

UNIVERSITY OF MANAGEMENT AND TECHNOLOGY
LAHORE

WIRELESS POWER THEFT MONITORING SYSTEM
SESSION: 2009-13

This Project is to be submitted to the Department of Electrical Engineering, University of Management & Technology Lahore for the partial fulfillment of the requirement for the Bachelor's Degree in Electrical Engineering.

Approved on: _____

External Examiner

Signatures : _____

Name: _____

Head of department

Signatures: _____

Name: _____

Internal Examiner:

Signatures: _____

(Advisor) Name:

Muhammad Salik

DEPARTMENT OF ELECTRICAL ENGINEERING
UNIVERSITY OF MANAGEMENT & TECHNOLOGY LAHORE.



MESSAGE FROM QURAN

“O ye who believe! When it is said unto you, Make room! In assemblies, then make room; Allah will make way for you (Hereafter), and when it is said, come up higher! Go up higher; Allah will exalt those who believe among you, and those who have knowledge, to high ranks. Allah is informed of what ye do”

(SURAH AL-MUJADILA)

THE HOLY PROPHET MUHAMMAD (P.B.U.H)

“Let there be no envy, except in two things:

1- A man whom Allah gave a wealth and guided him to spend it in righteous way.

2- Or a man whom Allah gave wisdom and he acts wisely and Teaches it to others.”

(AL-BUKHARI)

DEDICATION

We dedicate our project work To Our respected Parents whose utmost love, care & Struggle against all odds brought us to this height of Knowledge With the guidance and help of The ALLAH Almighty.

ACKNOWLEDGMENTS

We express our total submission and eternal gratitude to **ALMIGHTY ALLAH**, The Most Gracious, The Most Merciful, without whose mercy and grace, this endeavor could not been possible even in its slightest. We bow before our compassionate endowments. Peace Be upon **HOLY PROPHET MUHAMMAD**(PBUH) who is ever a torch of guidance and knowledge for humanity as a whole.

We deem it an honor and privilege to pay our heartfelt thanks and gratitude to our **Project Advisor, Muhammad Salik**, for his guidance, advice and continuous encouragement and inspiration, especially during hard and desperate phases of our work. He helped us at every step of the way in completing this tedious task. No acknowledgement would ever adequately express our obligation to our parents who have always wished to see us flying high up at the skies of success. Without their prayers, sacrifices and encouragements the present study would have been our merry dreams.

Also, we would like to extend our whole hearted thanks to the University of Management & Technology Lahore and other faculty members of Electrical Department, for providing necessary help and guidance during this project. Once again we are thankful to our project advisor for working under his guidance. This is an asset which will really remain a light tower throughout our life.

AUTHORS

ABSTRACT

The demand for electrical energy is ever increasing and the power utilities are facing many universal problems like tampering, high person dependency, inability to monitor discrete loads, lack of knowledge of line losses and demand analysis etc. WAPDA's present meter reading system is based on meter readers in which risk of wrong and fake readings cannot be neglected and it's also very time consuming. In this Project Prepaid Energy metering has been introduced to recharge units instantly. In addition to this it is also capable of Power Theft control which is very efficient and can easily detect power theft. Central Base Station continuously monitor the system and whole system communicates using GSM technology.

CONTENTS

CHAPTER 1

INTRODUCTION	1
1.1 History of Electric power system.....	2
1.2 Motivation and Objectives	2
1.3 Features	3
1.3.1 Prepaid Energy Meter Features.....	3
1.3.2 Distribution Transformer`s Energy Meter Features.....	4
1.3.3 Base Station Features.....	4
1.4 Requirements	4
1.4.1 Software Requirements	4
1.4.2 Hardware Requirements.....	5
1.5 Methodology	6
1.6 Thesis Overview:	7

CHAPTER 2

EVOLUTION OF METERING SYSTEM.....	8
2.1 Introduction To Energy Meters.....	9
2.2 Postpaid Metering System	10
2.3 Digital Energy Meter	12
2.4. Automatic Meter Reading By Using Solid State Meters.....	13
2.5 Prepaid Energy Meter.....	15

CHAPTER 3

HARDWARE DESCRIPTION.....	18
3.1 Hardware Description.....	19
3.2 Microcontroller.....	19
3.3 Power Supply	28
3.4 Instrument Transformer.....	30
3.4.1 Current Transformer.....	30
3.4.2 Potential Transformer.....	32
3.5 Liquid Crystal Display.....	33
3.6 Leds, Buzzers, Capacitors & Resistors.....	35
3.7 Gsm Modem SIM300DZ.....	36

CHAPTER 4

WORKING OF HARDWARE CIRCUITRY.....	39
4.1 Prepaid Energy Meter (Module #1).....	40

4.1.1 Power Calculation Section.....	40
4.1.2 Energy (KWh) Calculations.....	41
4.1.3 Account Recharging Section.....	42
4.1.4 Simulations while Account being Recharged.....	44
4.1.5 Simulation while Unit Card Inserted.....	44
4.2 Distribution Transformer Meter (Module #2).....	45
4.2.1 Recharging of Customer Cards.....	45
4.3 Central Base Station (Module #3).....	46
4.4 I ² c Protocol (Inter Intricated Circuits).....	46
4.4.1.2 Wires and Signals.....	47
4.4.1.3 Wired and Connection.....	48
4.4.2 Communication.....	48

CHAPTER 5

POWER THEFT CONTROL.....	50
5.1 Problems Faced	51
5.2 Theft of Electricity.....	51
5.3 Common Methods of Theft Identification.....	52
5.4 Ways of Power Theft.....	53
5.5 Remedy Of The Above Dilemma.....	53

CHAPTER 6

SERIAL PORT INTERFACING.....	57
6.1 Serial Communications Basics.....	58
6.2 RS 232 Standard.....	60
6.3 RS 232 Data Transmission.....	61
6.4 RS-232 Level Converters	63
6.5 MAX232 Interfacing with Microcontroller.....	65
6.6 Common Applications for Serial Ports.....	65

CHAPTER 7

GRAPHICAL USER INTERFACE.....	67
7.1 Graphical User Interface.....	68
7.2 Future Enhancement In GUI.....	68
7.3 Screenshot Of GUI.....	69

CHAPTER 8

RESULTS & FUTURE DIRECTION	70
8.1 Results.....	71
8.2 Conclusion.....	71
8.2 Improvements and Recommended.....	71

CHAPTER 9

LEARNING THROUGH THE PROJECT.....	72
9.1 Learning Through the Project	73
9.2 New Technical Knowledge.....	73
9.3 Project Experience.....	73

APPENDICES

LIST OF FIGURES

Fig 2.1: Electromechanical Energy Meter
Fig 2.2: Digital Energy Meter
Fig. 2.3 Solid State Meters
Fig. 2.3 Prepayment Meters
Fig 3.1: Microcontroller's Fundamental Components
Fig 3.2: Basic Microcontroller Architecture
Fig 3.3: Inside a Microcontroller
Fig 3.4: PIC 18F452
Fig 3.5: Pin outs of PIC 18F452
Fig 3.6: Basic Microcontroller Connectivity
Fig.3.7: 5V Regulated Power Supply
Fig.3.8: 7805 Regulator IC
Fig 3.9: Current Transformer
Fig 3.10: Transformer Principle
Fig 3.11: Step-down Transformer
Fig 3.12: Interfacing LCD with Power Supply
Fig 3.13: Interfacing LCD with Microcontroller
Fig 3.14: Electrolytic Capacitor
Fig 3.15: Ceramic Capacitor
Fig 3.16: GSM Module (Courtesy of Simon)
Fig 4.1: Power Measurement and Display Circuitry of Prepaid Energy Meter
Fig 4.2: Customer Card
Fig 4.3: Circuit Diagram of Customer Card
Fig 4.4: EEPROM Connected to the Microcontroller
Fig 4.5: Simulation While Account is Being Recharged
Fig 4.6: Simulation While Used Card is Inserted
Fig 4.7: Circuit Diagram of Relay Circuit
Fig 4.8: I ² C Data and Clock waves

Fig 4.9:I²C Protocol
Fig 4.10:I²C Protocol Data Transfer Bits
Fig 4.11:Framing
Fig 4.12:Framing
Fig 5.1:Meter Tempering
Fig 5.2:Kunda System
Fig 5.3:Block Diagram
Fig 6.1:Serial Communications
Fig 6.1:Simplex,Half-, Full-Duplex Transfer
Fig 6.3: Framing ASCII "A" (41H)
Fig 6.4:RS232 Transmission.
Fig 6.5:Data Transmission on RS232 line
Fig 6.6:How the Receiver receives the Data on RS232 RX
Fig 6.7: DB-9 Pin Connector
Fig 6.8:Schematic for RS232 level Converter.
Fig 6.9:MAX 232**Fig 6.10**
Internal Hardware of MAX 232
Fig 6.11: Block Diagram of RS 232 level Converters
Fig 6.12:Interfacing MAX 232 with Serial Port
Fig 7.1: Snapshot of Graphical User Interface
Fig.A.1: Prepaid Energy Meter And Distribution Transformer`s Energy Meter
Fig.A.2:Central Base Station
Fig.A.3: Prepaid Energy Meter
Fig.A.4: Meter With Distribution Transformer and Central Base Station

LIST OF TABLES

Table 1.1:Software Requirements

Table 6.1:IBM PC DB-9 Signals

CHAPTER 1

INTRODUCTION

This chapter includes:

1.1. HISTORY OF ELECTRIC POWER SYSTEM

1.2. MOTIVATION AND OBJECTIVES

1.3 FEATURES

1.3.1 PREPAID ENERGY METER FEATURES

1.3.2 DISTRIBUTION TRANSFORMERS ENERGY METER FEATURES

1.3.3 BASE STATION FEATURES

1.4. REQUIREMENTS

1.4.1. SOFTWARE REQUIREMENTS

1.4.2. HARDWARE REQUIREMENTS

1.5. METHODOLOGY

1.6. THESIS OVERVIEW

INTRODUCTION

1.1 History of Electric Power System

In the year 1878, Thomas A. Edison began his incredible work on the research of electric light and formulated the concept of the lighting in the surrounding area, which was driven by a centrally located power station. Realization of the research came in the year of 1879 and by 1882, September 4, he set up a historic Pearl Street Station in New York City, making him the pioneer batch of scientist in the World of Electric Utility Industry.

In the beginning, the generator that supplied the electricity to the surrounding could only support the initial load of 30kW for a 110V incandescent lighting. Due to the introduction of the *DC* motor by Frank J. Sprague in 1884 and the development of the three wire 220V DC system, this allowed the loads to increase. As the demand of electricity and transmission distances started to increase, voltage problems were experienced. By the year of 1885, William Stanley solved the problems with the development and design of the transformer, which has the ability of transmit power at a high AC voltage and low current, minimizing the voltage drops on the transmission lines; making AC source more attractive than DC source. Growth of the AC systems started in the year of 1888, when Nikola Tesla discovered two-phase induction and *synchronous motors*. This discovery added to the advantages of the poly phase versus the single – phase systems, leading to an expansion in the usage of three-phase line in Germany and United States of America. Making the three-phase Synchronous generator the workhorse of the industry.

1.2 Motivation and Objectives

Electricity is one of the basic needs of mankind now a day. As the demand of electricity is increasing day by day the demand of its stability, security, quality, proper control and measurement is also crossing bounds. Human interaction in every field especially in measurement and control may not be error and corruption free. Whereas the machines are free of these problems if properly designed and controlled. The present system of energy billing is error prone and also time and labor consuming. Errors get introduced at the stage of energy billing like.

- Errors with electro-mechanical meters.
- Human errors while noting down the meter reading.
- Processing the paid bills and the due bills.

WAPDA's present meter reading system is based on meter readers, who go house to house and read meters once in a month. **We cannot neglect risk of wrong and fake readings.** So there was a need of such measurement and controlling system which must be free from all errors and corruption. There are many cases where the bill is paid and then is shown as a due amount in the next bill. There is no proper way to know

- The consumer's maximum demand.
- Usage details.
- Losses in the lines.
- Power theft.

The major drawback of a post paid system is that there is no control of usage from the Consumer's side. There is a lot of wastage of power due to the consumer's lack of planning of electrical consumption in an efficient way. Since the supply of power is limited, as a responsible citizen, there is a need to utilize electricity in a better and efficient way. The distribution company has to receive huge amounts in the form of pending bills which results in substantial revenue losses and also hurdles to modernization because of lack of funds. The remedy for this drawback is prepaid energy billing, which could be titled "Pay first and then use". There are clear results from many countries where a prepaid system has reduced the usage (wastage) by a large amount. Another advantage of the prepaid system is that the human errors made reading meters and processing bills can be reduced to a large extent .

The Government despite its all claimed efforts to decrease line losses of WAPDA has failed to do so as these losses are still standing at a figure of more than 30 percent. The line losses of every type were transferred to the consumers. Karachi Electric Supply Company (KESC) and Hyderabad Electric Supply Company (HESCO) are facing the worst state of electricity theft. In HESCO, line losses are more than 40 percent and KESC is also competing the figure closely. The situation is also not very good in Punjab as in Lahore many industry-owners and consumers are stealing electricity with the connivance of line men of WAPDA .The billing system is minimally able to detect power theft and even when it does it is at the end of the month. Also, the distribution company is facing many problems in terms of losses. The distribution company is unable to keep track of the changing maximum demand for domestic consumers. The consumer is facing problems like receiving due bills for bills that have already been paid as well as poor reliability of electricity supply and quality even if bills are paid regularly.

The remedy for all these problems is to keep track of the consumers load on a timely basis, which will help assure accurate billing, track maximum demand, and detect online theft. These are all the features to be taken into account for designing an efficient energy billing system. The present project "**Prepaid Energy Metering System with Power Theft Control**" incorporates these features to address the problems faced by both the consumers and the Distribution companies.

1.3 Features

There are three modules in our project

1. Prepaid energy meter
2. Distribution transformer energy meter
3. Base station

1.3.1 Prepaid Energy Meter Features

The energy meter has following features:

1. Sensing the system parameters:
 - a) Load Current
 - b) Voltage

2. Calculation of power.
3. Monitoring of neutral and phase currents for power theft control and tripping the circuit in case of imbalance current flow.
4. Digital display using LCD.
5. Recharging via prepaid card.
6. Sending power reading to central base station by GSM after regular intervals.
7. Low balance alert.

1.3.2 Distribution transformer energy meter features

1. Measuring of voltage and current
2. Calculation of power
3. Sending the power data to central base station

1.3.3 Base station Features

1. Receiving of data from energy meters and distribution transformers
2. Comparing the data of distribution transformer with the sum of the data received from energy meter
3. Displaying the received data and the calculated losses
4. GUI
5. Power theft indication

1.4 Requirements

Design and Implementation of Prepaid energy metering System with power theft control is hardware as well as a software project. As this project is based on microcontrollers, it is important to check whether codes work well as required. So, for development of this project, it can be said that this project is both software and hardware based. Hence the requirements of the project are of two types.

- Software Requirements
- Hardware Requirements

1.4.1 Software Requirements

The software's needed for different purposes are described next:

- **MIKRO C**

MikroC for PIC is a full-featured ANSI C compiler for PIC devices. It is used for developing code for PIC devices. It is a powerful compiler with advanced optimizations, lots of hardware and software libraries, and additional tools that will help you in your work. Compiler comes with comprehensive Help file and lots of ready-to-use examples designed to get started.

- **Proteus ISIS**

This software is used to simulate the whole project. The Proteus Design Suite is wholly unique in offering the ability to co-simulate both high and low-level micro-controller code in the context of a mixed-mode SPICE circuit simulation. With this Virtual System Modeling facility, you can transform your product design cycle, reaping huge rewards in terms of reduced time to market and lower costs of development. All sort of hardware is present in the software to check the simulation with microcontroller.

➤ **Express PCB**

It forms a complete platform to design, validate and layout printed circuit boards (PCB). Its interface enables efficient layout and routing of PCB designs. Some features of the software are:

- Intuitive, user-friendly design environment.
- Integrated spreadsheet view for managing design constraints, part placement, and copper routing.
- Easy-to-use design tools optimized for speed or precise control.

➤ **Hyper Terminal**

Hyper Terminal is a built-in windows program that can be used to connect to other computers, online services, and host computers and other devices using either modem or a serial DB-9 cable.

Software requirements are summarized here:

Sr. Software #	Purpose
1 MikroC	hex files generation
2 Microchip 2	Dumping .hex file to microcontroller
3 Proteus ISIS	Simulations
4 Express PCB	PCB designing

Table 1.1: Software Requirements

1.4.2 Hardware Requirements

- Circuit Designing for prepaid energy meter, distribution transformer energy meter
- Circuit designing for prepaid recharging card (smart card)
- Programming of PIC microcontroller.
- Designing PCB for each module.
- Making circuit hardware of modules.
- Finalize checking of the working of all circuit modules.
- Following are the hardware components requirements for project:

- PIC Microcontroller
- Current Transformer (split core CT)
- LCD (4*20)
- Step-down AC transformer (220V-12V)
- Buzzer (Beep Type)
- Push switches
- MAX 232
- Voltage Regulator 7805
- DB-9 connectors
- Breadboards
- Vero Boards
- Crystal Oscillators (12MHz)
- Resistors
- Capacitors
- Power Supply
- Printed Circuit Board (PCB)

1.5 Methodology

Following Methodology is followed for completion of this project:

1.5.1 Analysis:

In the starting phase of our project following data was required for design of the project:

- Functions of present metering systems
- Previous solution and related problems
- Statistical data of power theft and line losses
- Shortcomings in the present metering system

1.5.2 Designing Flow charts

After analysis of the problems, flow charts had to be designed. These flow charts were designed and verified from the engineers working on the projects of automatic metering system.

1.5.3 Writing and developing codes and simulating the circuits

Codes were written and developed according to the flow charts. All the codes were divided into short modules for each operation.

1.5.4 Hardware implementation

All the Circuits from software were implemented on hardware, at first on breadboard their PCB were designed.

1.5.5 Testing and troubleshooting

Finally, the design is tested and troubleshooting is done. The designs are altered due to results to give accuracy in controlling.

1.6 Thesis overview

This thesis is organized as:

Chapter 2 Evolution of Energy Metering System

Chapter 3 Hardware Description

Chapter 4 Working of Hardware Circuitry

Chapter 5 Power Theft Control

Chapter 6 Serial Port Interfacing

Chapter 7 Graphical User Interface

Chapter 8 Results & Future Directions