

ECE SENIOR DESIGN PROJECT 2005-2006

FINAL REPORT

Wireless Device for Power Consumption Measurement

Submitted to Dr. Dagmar Niebur & Dr. Basavaiah

Electrical and Computer Engineering Department

Drexel University

Team Number: ECE-034

Team Members:

Kamil Javaid	Electrical Engineering
Pritesh Patel	Electrical Engineering
Vimal Patel	Electrical Engineering
Siby Varghese	Electrical Engineering

Submitted in partial fulfillment of the requirements for the Senior Design Project

Wednesday, August 09, 2006

Abstract

Due to recent changes in Pennsylvania and other state laws, it is now possible for consumers to choose their utility providers. Electricity accounts for 50% or more of residential utilities budget and consumers need to be aware of the alternatives in reducing their energy costs [6] [7]. According to a recent article by Exelon Corporation, residential consumers can lower their energy costs when consuming most of the energy during off-peak hours [1]. Most consumers have already experienced that their appliances contribute to 50% or more on their energy bill each month. Therefore, providing consumers with the option to monitor their energy usage will ultimately assist them in reducing their costs.

It is the objective of this project to design and build a power monitoring device that will measure the actual power consumption of appliances in kWh, and provide the consumers with a consumption profile available on a PC. The power monitoring device will integrate three components: the power monitoring unit (PMU), the wireless communication unit (WCU) and the graphical user interface (GUI). The power monitoring unit connects in parallel with the appliance, measures the actual power consumed by the appliance, and converts the analog signals into digital data. It consists of an external circuitry that steps down the voltage and current signals. The external circuitry is attached to the power measuring integrated circuit (I.C.) that measures the power consumed and outputs digital pulses. The wireless communication unit consists of two XEMICS XM1201A transceiver modules, one connected to PMU and other connected to PC through NI6009 DAQ card. The GUI displays the processed data including the average power data in KWh and the operating cost.

The project includes a working PMU, functional wireless unit and GUI. During the testing phase of our product the one of the wireless transceiver was shorted and damaged. Due to the time constraints we will not be able to order the wireless transceiver in time to complete testing of the product and receive it before the final presentation. The power consumption project is within the actual budget proposed in the budget limits.

Table of Contents

Problem Description	4
Statement of Work	5
Method of Solution	5
Product Specifications and Design Constraints	6
Functional Specifications	6
Non-Functional Specifications	6
Design Constraints	6
Progress towards the Solution	7
Power Measurement Unit	7
External circuitry to power measuring I.C.	7
Microcontroller	8
Data Acquisition Card	9
Wireless Communication Unit	10
Graphical User Interface	12
Project Management Timeline	14
Economic Analysis	14
Sociological and Environmental Impact Analysis	15
Conclusion	15
References	17

Appendices

Appendix-A – Power Measurement Circuit	18
Appendix-A-1 – Circuit Specifications	18
Appendix-A-2 – Parts List for External Circuitry of ADE7757	18
Appendix-A-3 – External Circuit Diagram and PSpice Simulation Results	19
Appendix-B – Microcontroller	21
Appendix - B1 – Microcontroller Alternatives	21
Appendix – B2 – Process Flow chart of the MCU	22
Appendix – B3 – ‘C’ code for the MCU to count pulses	23
Appendix – B3 – ‘C’ code for the MCU to keep track of the real time.	25
Appendix - C – Wireless Communication Unit	27
Appendix – C1 – Data Sheet of XM1201A Transceiver Module	27
Appendix - D – Graphical User Interface	29
Appendix-E – Economic Analysis	32
Appendix-F – Gantt chart	36
Appendix-G – Resumes	38

List of Figures

Figure-1: Prototype of the Wireless Device for Power Consumption Measurement	6
Figure 2: Block Diagram of Analog Circuit	7
Figure-3: Flow Diagram for the MCU Unit	9
Figure-4: Wireless Communication Unit Circuit Connection Diagram.	11
Figure-5: Wireless Communication Unit Real Picture	11
Figure-6: Wireless Communication Unit Flow Diagram	12
Figure-7: Graphical User Interface testing- Real Picture	13
Figure-8: Graphical User Interface Front Panel	14
Figure 9: Overall input circuit diagram to pins V1 and V2.	20
Figure 10: Circuit design for pin V2 input of ADE7757	20
Figure 11: Output voltage of the V2 step down circuit vs. time	20
Figure 12: Circuit design for V1	20
Figure 13: Output voltage of the V1 step down circuit vs. time	20
Figure-14: Process Flow Chart of the MCU	22
Figure-15: Graphical User Interface Block Diagram	29
Figure-16: Graphical User Interface Front panel prompting users to save data	30
Figure-17: Graphical User Interface Front panel in running mode	30
Figure-18: Screen shot of data saved on the computer	31