

**Indiana University – Purdue University Fort Wayne**  
**Opus: Research & Creativity at IPFW**

---

Computer and Electrical Engineering Technology &  
Information Systems and Technology Senior Design  
Projects

School of Engineering, Technology and Computer  
Science Design Projects

---

4-26-2010

# Battery Power Monitoring for an Electric Scooter

Issakha Omar

*Indiana University - Purdue University Fort Wayne*

Follow this and additional works at: [http://opus.ipfw.edu/etcs\\_seniorproj](http://opus.ipfw.edu/etcs_seniorproj)



Part of the [Computer Sciences Commons](#), and the [Engineering Commons](#)

---

## Opus Citation

Issakha Omar (2010). Battery Power Monitoring for an Electric Scooter.  
[http://opus.ipfw.edu/etcs\\_seniorproj/891](http://opus.ipfw.edu/etcs_seniorproj/891)

This Senior Design Project is brought to you for free and open access by the School of Engineering, Technology and Computer Science Design Projects at Opus: Research & Creativity at IPFW. It has been accepted for inclusion in Computer and Electrical Engineering Technology & Information Systems and Technology Senior Design Projects by an authorized administrator of Opus: Research & Creativity at IPFW. For more information, please contact [admin@lib.ipfw.edu](mailto:admin@lib.ipfw.edu).

# **Battery Power Monitoring for an Electric Scooter**

**Final Project Report**

**Date: April 26, 2010**

**Issakha Omar**

Submitted to:

Paul Lin, Professor of ECET 491 Senior Design II

Stakeholders:

Senior Design Instructor: Professor Paul Lin  
Project Advisor: Professor Thomas Laverghetta

Department of Computer and Electrical Engineering Technology &  
Information System Technology  
College of Engineering, Technology, and Computer Science  
Indiana University-Purdue University Fort Wayne, Indiana

## TABLE OF CONTENT

Abstract	5
Executive Summary	5
Chapter 1: INTRODUCTION	6
1.1 Statement of Problem	6
1.2 Background	6
1.3 Statement of Solution	7
1.4 Methodology	7
1.5 Primary Purpose	8
1.6 Overview	8
Chapter 2: SYSTEM DESIGN OVERVIEW AND RESERCH	9
2.2 Market Analysis	9
2.3 Design Process	9
2.5 System Scope	10
Chapter 3: HARDWARE DESIGN	11
3.1 Battery Power Monitoring	12
3.2 Specifications	12
CHAPTER 4: SOFTWARE DESIGN	
4.1 Programming Language	17
4.2 Integrated Development Environment	18
4.3 Main Components	18
CHAPTER 5: UNIT TESTING AND SYSTEM INTERGRATION	19
5.1 Software Testing and Validation	20
5.2 Part 1: C Programming Language	21
5.3 Part 2: Testing Figures	24
CHAPTER 6: PROJECT MANAGEMENT	24
6.1 Schedule and Time Management	25
6.2 Resources and Cost Management	25
6.3 Trade-Off Study	27
6.4 Risk Management	24
References	24
CHAPTER 7: CONCLUSION	26

## LIST OF FIGURES

Figure 1 Current Sensing Resistor.....	11
Figure 2 Current Sensing Resistor Connected to DMM.....	11
Figure 3 Current Sensing Resistor Connected to Probe.....	11
Figure 4 Current Sensing Resistor Measuring.....	12
Figure 5 Hall Effect Sensing .....	14
Figure 6 Current Sensing Resistor Connected to Scooter Circuit.....	15
Figure 7 Breadboard Prototype Setup.....	16
Figure 8 Program Flow Chart.....	17
Figure 9 Flow Chart of Program Development.....	18
Figure 10 Program Code.....	21
Figure 11 Connecting System to the Scooter.....	22
Figure 12 Seven Segment Display Current.....	23
Figure 13 Main Test Diagram.....	23
Figure 14 Project Schedule for Project Phase 1.....	24
Figure 15 Project Schedule for Project Phase 2.....	24

## LIST OF TABLES

Table 1 Hall Effect Data Specification.....	13
Table 2 Voltage and Amps Data.....	14
Table 3 DC to DC Conversion.....	19
Table 4 AD Conversion.....	20
Table 5 Risk Management .....	26

## **ABSTRACT**

Battery power management (BPM) is a primary learning design for electrical engineering objective for portable systems. Traditionally, BPM has been implemented mainly by reducing average power consumption of system components. A careful analysis of charge and discharge characteristics and the adoption of accurate high-level battery models system-level design open new opportunities for battery life-time extension. In this paper, I introduce Sealed Lead Acid battery (SLAB) power management systems for an electric scooter. In the case of advanced SLAB, special features like safety management are necessary. Battery driven electric scooters strive to enhance life-time of the battery by automatically adapting discharge rate and current profiles to battery state-of-charge. The distinctive feature of these policies is the control of system operation based on the observation of battery output voltage. The effectiveness of the proposed policies and more generally, of the idea of accounting for battery behavior during system design, is proved by the experiments carried out on a realistic case study, namely on an electric scooter.

Current sensing resistors are the newest and fastest growing resistive product in the industry today. As with most passive products, the majority of new designs are surface mounted; these resistors are used to monitor the current in a circuit and translate the amount of current in that circuit into a voltage that can be easily measured and monitored. In this project I am using a  $5\text{m}\Omega$  sensor resistor with the power rating of  $3\text{W}$ ; I am able to measure  $17\text{A}$ s from a DC motor of  $400\text{W}$ .

The other important component I used was Hall Effect sensor; I chose to use ACS752SCA-050. The current sensor was supplied with 5 Volts DC from an on board regulator. I can see that when there is no current flowing through the large red wire, the sensor simply divides its supply voltage in half ( $5\text{V}$  divided by  $2 = 2.5\text{Volts}$  output).

## **Executive Summary**

Recently there has been high demand on battery power management (BPM) technologies in the electric vehicle, and solar energy technology. The battery is a fantastic but greatly misunderstood source of portable power. It is an electrical power accumulator that stores a specific amount of electrical energy, the amount being dependent on its electrical size, or capacity. The battery delivers a certain amount of amperes for a period of time depending on its size. This is called the ampere-hour (A.H.) capacity of a battery. So, my idea for this project is to effectively charge the batteries within a purely electric scooter. The initial system is designed to manage the Sealed Lead Acid Battery in the scooter; once the circuit for the battery is complete and functional, I will design the SLAB circuit and control the output information for the batteries, including voltage, current and time.