
# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## BATTERY FLAT PREVENTER DEVICE DESIGN FOR CAR BASED ON BANG-BANG CONTROLLER OF CURRENT LIMITER

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Automation and Robotics) with Honours.

by

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# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Battery Flat Preventer Device Design For Car Based On Bang-Bang Controller of Current Limiter**

SESI PENGAJIAN: **2016/17 Semester 1**

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# APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Automation and Robotics) with Honours. The member of the supervisory is as follow:

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DR. MOHD BADRIL BIN NOR SHAH

# ABSTRAK

*Projek ini adalah mengenai pembangunan peranti yang mengehadkan penggunaan arus dari bateri kereta jika terdapat alat elektrik berkuasa sederhana dan tinggi (MHPEP) masih lagi berfungsi apabila pengguna/pemandu meninggalkan kereta. Situasi ini sering berlaku apabila pemandu kereta atau penumpang terlupa untuk mematikan MHPEP apabila meninggalkan kereta. Penggunaan MHPEP yang terlalu lama semasa keadaan enjin mati boleh menyebabkan bateri kehabisan kuasa seterusnya menyebabkan enjin tidak dapat dihidupkan. Peranti ini dibangunkan untuk mengatasi masalah ini dan berkebolehan untuk mengehad penggunaan bateri jika terdapat MHPEP yang masih berfungsi jika tiada pemandu atau penumpang di dalam kereta. Komponen utama peranti yang dibangunkan ini terdiri daripada pengawal mikro Arduino UNO, penderia arus, geganti dan pemban amaran. Pengawal buka-tutup digunakan untuk mengawal pengehad arus. Pada akhir projek ini, peranti yang dibangunkan boleh mengehadkan arus bateri apabila MHPEP masih lagi hidup semasa keadaan enjin mati seterusnya mengelakkan bateri kehabisan kuasa.*

# ABSTRACT

This project address the development of a device uses to limit the current from car battery if medium and high power electrical parts (MHPEP) is still switched on when driver leave their car. This situation always occurs when car driver or passenger forget to turn off a MHPEP when leaving the car. Long usage of MHPEP during engine off condition can cause car battery depletion or flat, thus lead to engine fail start. This device is developed to overcome the problem and it is capable to limit drawn current from the battery if the MHPEP is still switch on when there is no car driver or passenger in the car. The main components of the developed device are consists of Arduino UNO microcontroller, current sensor, relay and warning buzzer. A bang-bang controller is usd as a control of current limiter. In the end of this project, the developed device is able to limit the battery current when MHPEP is still switched on during engine-off conditions thus prevent battery flat.

# DEDICATION

Special dedication to
my beloved parents, siblings and my friends, who have encouraged, guided and supported me throughout my study.

# ACKNOWLEDGEMENT

I would like to take this opportunity to express my deepest gratitude to my project supervisor, Dr Mohd Badril Bin Nor Shah who has persistently and determinedly assisted me along the progress of the project. It would have been difficult to complete this first half of the project without enthusiastic support, insight and advice given by him.

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| | | |
|---|---|---|
| A | - | Ampere |
| Ah | - | Ampere hour |
| AC | - | Alternating Current |
| CHR | - | Chien Hrones Reswick |
| dB | - | Decibel |
| DC | - | Direct Current |
| GND | - | Ground |
| ICSP | - | In-Circuit Serial Programming |
| LCD | - | Liquid Crystal Display |
| LED | - | Light Emitting Diode |
| MHPEP | - | Medium and High Power Electrical Parts |
| MHz | - | Megahertz |
| PID | - | Proportional-Integral-Derivative |
| PWM | - | Pulse Width Modulation |
| SLA | - | Sealed Lead Acid |
| SSR | - | Solid State Relay |
| USB | - | Universal Serial Bus |
| V | - | Voltage |
| VAC | - | Volts of Alternating Current |
| VDC | - | Volts of Direct Current |

# CHAPTER 1

# INTRODUCTION

## 1.0 Project Background

Battery is among the most important parts in a car. It enables a car to perform crank start to activate the combustion process inside engine chamber. During engine-off condition, a car battery supplies electrical energy to some electric and electronic parts such as radio, alarm system, lamps, power windows, to name a few. The battery is charged by alternator during engine run condition. 12V sealed lead acid (SLA) battery type always used in a car since it can provide high current capacity at low cost.

Current limiter is a device in electrical or electronic circuits of imposing an upper limit on the current that may be delivered to a load for protection propose. Inappropriate high current may cause fire hazard, damage to other components or fast energy depletion. Current limiting operation can be performed either by using analog components or algorithm that is written into microcontroller.

The most basic algorithm that can be used to perform current limiter is bang-bang controller. Bang-bang controller is also known as on-off controller and it is the simplest and basic form of controller. It is widely used in many applications such as temperature and power supply control. The advantage of this controller is ease to design and robust to disturbance and parameter uncertainties.

## 1.1 Problem Statement

A modern car commonly equipped with medium and high power electrical parts (MHPEP) such as head lamp, fog lamp, radio and amplifier. The MHPEP consume quite significant amount of electrical current. During engine run condition, MHPEP obtain the electrical power from the alternator, but during engine off condition, the power of MHPEP is supplied by car battery.

Long usage of MHPEP during engine off condition can cause car battery depletion or flat, thus lead to engine start problem. This situation always occurs when car driver or passenger forget to turn off the MHPEP when leaving the car. Besides that, fault current due to short circuit of wiring or electrical equipment can lead to same problem. To prevent such problem, a potential device that capable to give warning can be developed to indicate the MHPEP is still functioning once car driver or passenger leaving their car. The device also capable to limit drawn current from the battery if the MHPEP is still switch on when there is no car driver or passenger in the car.

## 1.2 Objective

The aims of this project are:

a) To design a circuit that capable to give warning if MHPEP is still switch on when car driver or passenger leaving their car.
b) To design closed loop control current of current limiter circuit to limit the drawn current from car battery that is consumed by MHPEP.

A battery flat preventer device for car is successfully developed if these objectives are achieved.

## 1.3 Scope of Work

The scopes of the project are:

a) Circuit design

Microcontroller based circuit will be designed where it will be designed where it will be connected to human detector sensor. Solid-state relay (SSR) will be connected to the circuit as interfacing between car battery to electrical systems.

b) Controller Design

Closed loop control is required to enable adjustable current limiter operation for car battery

c) Simulation

The performance of the designed circuit and controller will be evaluated through simulation.

d) Hardware prototype

To verify the efficiency of the designed circuit and controller, a hardware prototype will be developed.

## 1.4 Report Outline

This report is organized into 5 chapters and the outline of each chapter is briefly explained as follows.

In Chapter 1 explains the introduction of the project, which includes the background, problem statements, objectives and the work scope of the project.

In Chapter 2, the chapter briefly explains the review of theories, experimental works and some findings that had been done during the past research that is related to the current project.

In Chapter 3, methodology and strategy to achieve the objectives is explained in detail. The working procedure, materials and apparatus are well also covered.

Chapter 4 shows the results and discussion. The results analysis is also included.

Finally, in Chapter 5, the conclusion for this project is presented. The suggestion for future work is also covered in this chapter.

# CHAPTER 2

## Literature Review

### 2.0 Introduction

In this chapter, all components and all information that related to this project are describe. This chapter review created to get an idea about the specification, project design, conception and any information that related to this project. The flows of the system are based on the reviews made from research on car problem.

### 2.1 Battery Draining Prevention Device

In the online market for the car, there are device that can prevent battery to flat out that is BlackVue Power Magic Pro 'Battery Draining Prevention Device'. BlackVue Power Magic Pro have same application with the 'Battery Prevention for Car' but this device only work for the dashboard camera and not with all MHPEP in the car. This product is a little control box that ties car's electrical system and gives new devoted outlet to connect to the dashboard camera (out of view underneath the dashboard).

At the time when the car has the dashboard camera running in parking mode, there is a hazard that it will in the end deplete the battery if abandon it running too long. While maybe a couple days won't be an issue if the battery is good shape, if leave the dash cam running for an extended period run a real hazard that it might deplete the battery.

The Battery Draining Prevention Device enables the “parking mode", where the dashboard camera can keep watch over car while it is parked. While in parking mode, the dashboard camera draws power from the vehicle battery, however users don't have to worry returning to discover car not able to start because of a drain battery, since it is always monitoring the car battery and will turn off the dashboard camera when the battery level fall underneath a specific (adjustable) limit.

It will automatically cut off the power to dashboard camera when voltage drops below the minimum voltage setting. Moreover, it also acts as a countdown timer where user can set the preferable duration to have the dashboard camera operates when parked. It helps to prevent further draining of battery voltage when vehicle is parked for longer period.

Therefore, some dashboard camera manufacturers offer battery discharge prevention devices. A good setting for a discharge prevention device would be to cut off power if the battery’s voltage drops below 12V, and additionally set a timeout of 1-2 days. The reason why need a timer is that at 12V, the battery will already be partially depleted. And while that’s not a huge problem by itself, users should not let this happen too often, because it could significantly reduce your battery’s overall life span. It also lets users select a timeout between 6 and 120 hours, or can set it to infinity.


Figure 2.1: Battery draining prevention device

## 2.2 Solid-State Relay (SSR)

A solid-state relay is a control relay with an isolated input and out-put, whose functions are achieved by means of electronic components without the use of moving parts such as those found in electromechanical relays. These solid-state electrical relays are ideal for applications that have many contact closures, since solid state relay switches offer a greatly extended life compared to electromechanical relays.

Solid-state relays (SSR) are like electromechanical relays, in that both use a control circuit and a separate circuit for switching the load. When voltage is applied to the input of the SSR, the relay switch is energized by a light emitting diode. The light from the diode is beamed into a light sensitive semiconductor which, in the case of zero voltage crossover control relays, conditions the control circuit to turn on the output of the solid-state switch at the next zero voltage crossover.

In the case of non-zero voltage crossover relays, the output of the solid-state switch is turned on at the precise voltage occurring at the time. Removal of the input power disables the control circuit, and the solid-state relay switch is turned off when the load current passes through the zero point of its cycle.

Solid-state relays have features which electromechanical relays do not such as:

- Long life
- Shock and vibration resistance
- Generation of RFI, EMI
- No contact bounce
- Arc less switching
- Acoustic noise
- Zero voltage switching
- IC compatibility
- Immunity to humidity, salty environment and dirt

## 2.3 Hall-Effect Current Sensor

The hall-effect current sensor is an electronic device that indirectly senses current by measuring the strength of the magnetic field produced by the current flow. The probe simply clamps around the outside of the insulated conductor carrying the current. A distinct advantage of the hall-effect device is that no electrical contact is required with the power circuit. The hall-effect current sensor is significantly more expensive than the current shunt.

## 2.4 The Arduino Microcontroller

The Arduino UNO is a microcontroller board with 14 digital input/output pins (6 of it can use as PWM output), 6 analogue input, USB connection, 16Mhz crystal oscillator, a power jack, a reset button and ICSP header. Figure 2.2 show the Arduino UNO board.

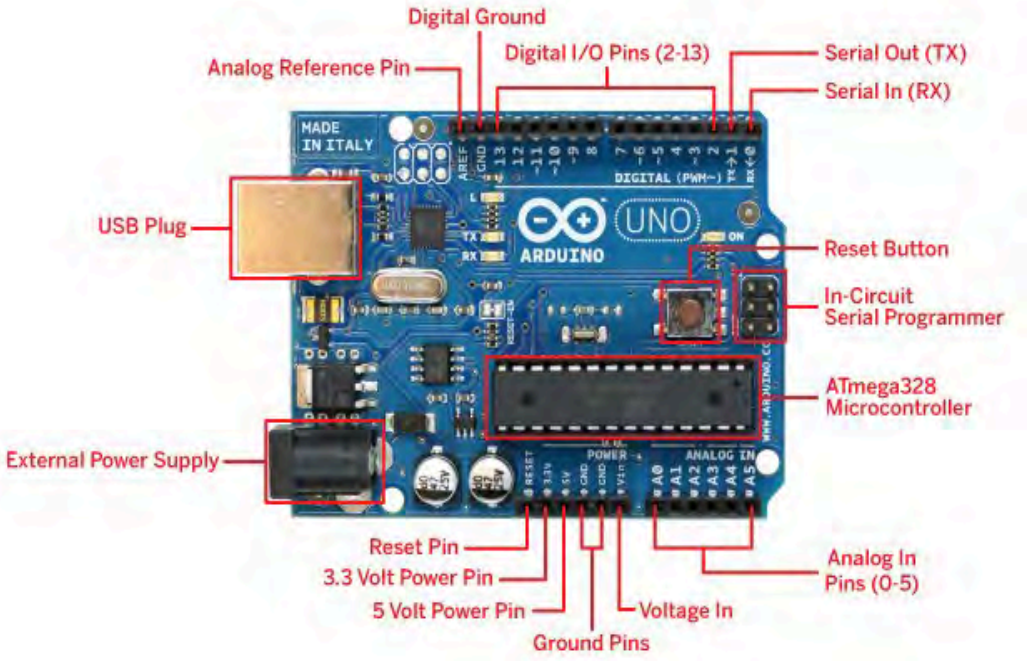


Figure 2.2: The Arduino UNO board

The Arduino UNO is different than all preceding boards in that it does not have the FTDI USB-to-serial driver chip. Table 2.1 shows the technical specification for Arduino UNO. The Arduino UNO can be powered via the USB connection or with external power supply.

Technical Specification

Table 2.1: The technical specification of Arduino UNO

| Features of Arduino Board | |
|---|---|
| Operating Voltage | 5V |
| Input Voltage (recommended) | 7-12V |
| Input Voltage (limits) | 6-20V |
| Digital I/O Pins | 14 (6pin for PWM output) |
| Analog Input Pins | 40mA |
| DC Current for 3.3V Pin | 50mA |

Table 2.2: The power pins of Arduino UNO board

| Power Pins | |
|---|---|
| 5V | The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator or be supplied by USB or another regulated 5V supply. |
| 3V3 | 3.3 V supply generated by the on-board regulator. Maximum current draw is 50mA. |
| GND | Ground pins |
| VIN | The input voltage to the Arduino UNO board when it using an external power source. Can supply the voltage through this pin or supplying voltage via the power jack, access it through this pin. |