POWER MANAGEMENT DEVICE FOR AUTOMOTIVE BATTERY

By

Mohd Sufiyan Bin Rani

Dissertation submitted in partial fulfillment
of the requirements for the
Bachelor of Engineering (Hons)
(Electrical and Electronics Engineering)

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CERTIFICATION OF APPROVAL

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SEPTEMBER 2011

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgement, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

MOHD

(MOHD SUFIYAN BIN RANI)

ABSTRACT

This project was basically represents the research and the job done so far base on this chosen topic, which is “Power Management Device for Automotive Battery”. Most of automotive in the world use battery to start up the engine. After the engine started, the engine will then generate back power to the battery. It happens that when an automotive is left for a long time, the battery was found dead even though the automotive does not turn on any devices in it. This problem was found due to parasitic drain. Thus, this project is carried to investigate the battery current drain (parasitic drain) on automotive batteries and proposing a device to overcome this problem. After carried on the study and data gathering about the project, simulation of circuit and analyzing it would be the main process in this project.

ACKNOWLEDGEMENT

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CHAPTER 1 INTRODUCTION

1.1 Background

Battery is the primary source of electrical energy in most of vehicles. From small vehicle like motorcycle till big vehicle such lorry or truck, need a battery to crank the engine and turn ON other electronic devices in the vehicle. The battery stores chemicals contains two different types of lead in an acid mixture to react and produce an electrical pressure. This electrochemical reaction changes chemical energy to electrical energy.

Basic battery function was to operate lighting and accessory systems during the engine OFF. While the engine was starting, the battery is used to operate the starter motor and provide current for the ignition system during cranking. After the engine running, the battery may be needed when vehicle electrical load requirement exceed the supply from the charging system.

Normally an automotive battery is a type of rechargeable battery. An Automotive battery usually lead-acid type, and are made of six galvanic cells in series to provide a 12 volt system. Each cell provides 2.1 volts for a total of 12.6 volt at full charge. Heavy vehicles such as highway trucks or tractors, often equipped with Diesel engines, may have two batteries in series for a 24 volt system, or may have parallel strings of batteries.

Lead-acid batteries are made up of plates of lead and separate plates of lead dioxide, which are submerged into an electrolyte solution of about 35% sulfuric acid and 65% water [2]. This causes a chemical reaction that releases electrons, allowing them to flow through conductors to produce electricity. As the battery discharges, the acid of the electrolyte reacts with the materials of the plates, changing their surface to lead sulfate. When the battery is recharged, the chemical reaction is reversed: the lead sulfate reforms into lead oxide and lead. With the plates restored to their original condition, the process may now be repeated.

Basically, the battery is used to crank-up the engine and supplying the power to other devices in an automotives. Once, the engine start, the battery will be recharged back by an alternator. Alternator is like a power generator in an automotive. The alternator uses the mechanical power from the engine and transfers the power into electrical power. During the engine was in running mode, all devices in car will use power supplied by the alternator.

1.2 Problem Statement

As the battery will only recharged when the engine was running, some time these situation might happen:

- The engine failed to be crank due to lack of power supplied from the battery.
- The engine suddenly stop running due to the lack power supply.

1.2.1 *Problem Identification*

Since most vehicles on the road today have built in computer programming as well as any number of electronic devices that draw power from the battery, parasitic drain can be a real problem for an automotive owners. Parasitic drain occurs when there is a load placed on your battery even when the automotive and its built in devices are turned off. Unfortunately, although turned off, the devices may still be drawing power from the battery for such things as the memory on your clock or radio. Even sometimes people forget to switch OFF the headlight. Excessive drain from these devices, it can easily lead to a dead battery that sometimes can seem quite a mystery.

Waking up in the morning and your battery is suddenly dead, and there is no evidence of having left the lights on or leaving a door partially open with the interior light on, then it is very likely that parasitic drain is the culprit.

Bad battery also could lead to excessive power drain as, bad battery could have short circuit and thus allow the current to drain. If this situation is prolonged, the battery could be damaged permanently.

1.2.2 *Significant of Project*

The significant of this project is to do study on the parasitic drain effects on automotive. With the study that had been carried out, a device would like to be introduced as a solution for this problem.

1.3 Objectives

The objective of this project would be to carry a study on parasitic effect on automotive battery and introduce a device that will be a solution for this problem.

1.4 Scope of Study

The scope of study will evolve around the automotive battery regarding its load, standard electrical layout for automotive and parasitic effects. The further of this project will cover on the simulation of a device to solve or minimize the problem. Thus for this part, the scope will cover on current measurement circuit, logic circuit and current limiter circuit.

1.4.1 *The Relevancy of the Project*

This project is relevant to the study of Power Electronics as well as the field of Instrumentation and Control. This project is also relevant to the recent technology of applying controller to various devices to optimize the performance of that device itself.

1.4.2 *Feasibility of the Project within the Scope and Time frame*

The project will start by collecting materials such as books, journals and technical papers specifically on automotive battery, parasitic drain, current measurement and power electronic controller. Research will be done from time to time as part of getting a better understanding on this issue. This project will then focus on simulating a prototype of a device that will control the current draw from the battery.

CHAPTER 2 LITERATURE REVIEW

2.1 Battery

A battery is a type of rechargeable battery that supplies electric energy to an automotive. [1] This usually refers to an SLI battery (starting, lighting, and ignition) to power the starter motor, the lights, and the ignition system of a vehicle's engine. An automotive battery may also be a traction battery used for the main power source of an electric vehicle.

Ampere-hours (A·h) is a measurement of electrical charge that a battery can deliver. This quantity is one indicator of the total amount of charge that a battery is able to store and deliver at its rated voltage. Its value is the product of the discharge-current (in amperes), multiplied by the duration (in hours) for which this discharge-current can be sustained by the battery. Generally, this value (or rating) varies widely with the duration of the discharge period. Therefore the value is typically only meaningful when the duration is specified. This rating is rarely stated for automotive batteries, except in Europe where it is required by law.

Peukert's law expresses the capacity of a lead-acid battery in terms of the rate at which it is discharged. Manufacturers rate the capacity of a battery with reference to a discharge time. Peukert's law is often stated as:

$$C_p = I^k t$$

Where:

C_p is the capacity at a one-ampere discharge rate, which must be expressed in A·h.

I is the actual discharge current relative to 1 ampere, which is then dimensionless.

t is the actual time to discharge the battery, which must be expressed in h [3].

The capacity at a one-ampere discharge rate is not usually given for practical cells. It is useful to reformulate the law to a known capacity and discharge rate:

$$t = H\left(\frac{C}{IH}\right)^{k}$$

Where:

H is the rated discharge time, in (hours).

C is the rated capacity at that discharge rate, in (Ampere-hours).

I is the actual discharge current, in (Amps).

k is the Peukert's constant, (dimensionless).

t is the actual time to discharge the battery, in (hours).

2.2 Parasitic Effects

Since most vehicles on the road today have built in computer programming as well as any number of electronic devices that suck power from your battery, parasitic drain can be a real problem for vehicle owners. Parasitic drain occurs when there is a load placed on the battery even when the vehicle and its built in devices are turned off. Unfortunately, although turned off, the devices may still be pulling power from the battery for such things as the memory on clock or radio. If this drain is excessive, it can easily lead to a dead battery that can seem quite a mystery.

Waking up in the morning and your battery is suddenly dead, and there is no evidence of having left the lights on or leaving a door partially open with the interior light on, then it is very likely that parasitic drain is the culprit. It is possible to test for parasitic drain, and to manually disconnect the devices that are primarily contributing to the problem [4].

Parasitic drain can sometimes be caused by the battery itself. If there is water or corrosion between the battery terminals, it could cause a current to drain between them. Battery terminals can, and should, be cleaned regularly with a solution of baking soda and water.

2.3 Current Transducer

A current transducer is a device that detects electrical current (AC or DC) in a wire, and generates a signal proportional to it. The generated signal could be in an analog voltage or current or even digital output. It can then be utilized to display the measured current in an ammeter or can be stored for further analysis in a data acquisition system or can be utilized for control purpose.

The sensed current and the output signal can be:

AC current input,

- analog output, which duplicates the wave shape of the sensed current
- bipolar output, which duplicates the wave shape of the sensed current
- unipolar output, which is proportional to the average or RMS value of the sensed current

DC current input,

- unipolar, with a unipolar output, which duplicates the wave shape of the sensed current
- digital output, which switches when the sensed current exceeds a certain threshold

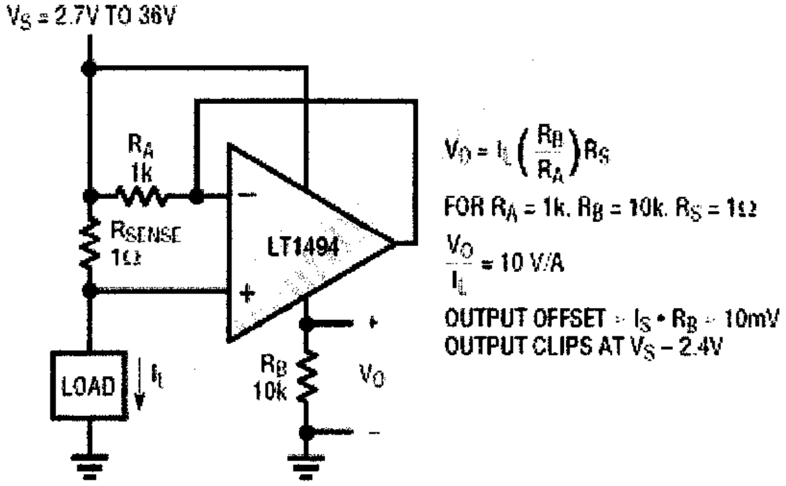
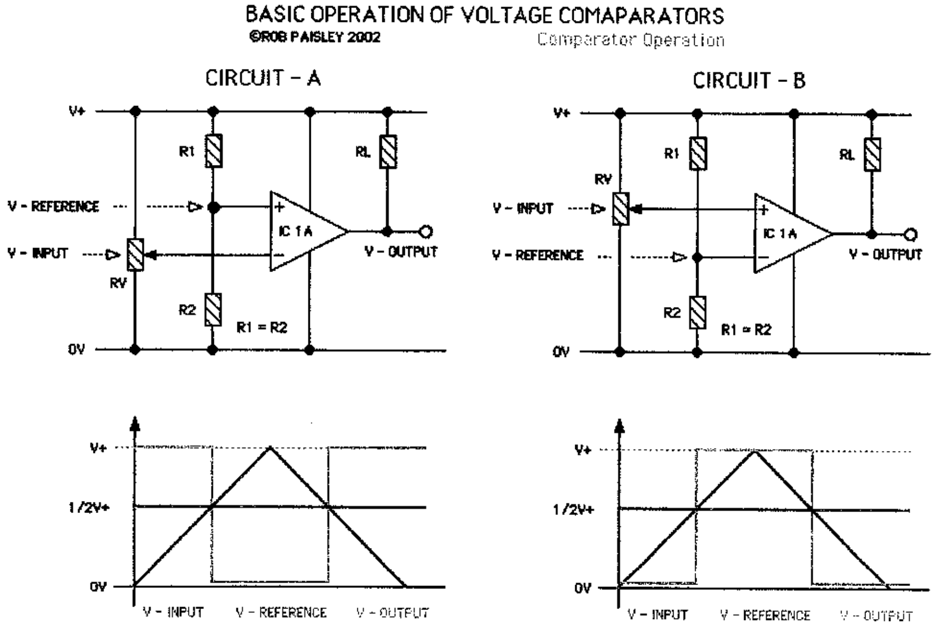


Figure 1: Example of current sensor

This current sensing circuit senses the current at the high side (between positive supply and load). The op-amp, the inverting input is connected directly to the output, and this negative feedback will keep the inverting input to be in the same level with the non-inverting input. This means that the voltage across R_A will be kept equal to the voltage across R_{SENSE}. This voltage make the current flows from the power source source to the output pin of the op-amp through R_A, and finally return to ground via R_B. Almost all of the current at R_B comes from R_A since the internal circuit draws only very small amount of current through V_{CC} pin, so the output at R_B is valid.

2.4 Voltage Comparator

In electronics, a **comparator** is a device that compares two voltages or currents and switches its output to indicate which is larger.



http://home.cogeco.ca/~rpaisley4/CircuitIndex.html

Figure 2: Example of voltage comparator

An operational amplifier (op-amp) has a well balanced difference input and a very high gain. This parallels the characteristics of comparators and can be substituted in applications with low-performance requirements [5].

In theory, a standard op-amp operating in open-loop configuration (without negative feedback) may be used as a low-performance comparator. When the non-inverting input (V+) is at a higher voltage than the inverting input (V-), the high gain of the op-amp causes the output to saturate at the highest positive voltage it can output. When the non-inverting input (V+) drops below the inverting input (V-), the output saturates at the most negative voltage it can output. The op-amp's output voltage is limited by the supply voltage. An op-amp operating in a linear mode with negative feedback, using a balanced, split-voltage power supply, (powered by ± V_S) its transfer function is typically written as: $V_{out} = A_o(V_1 - V_2)$. However, this equation may not be applicable to a comparator circuit which is non-linear and operates open-loop (no negative feedback).

2.5 Timer 555

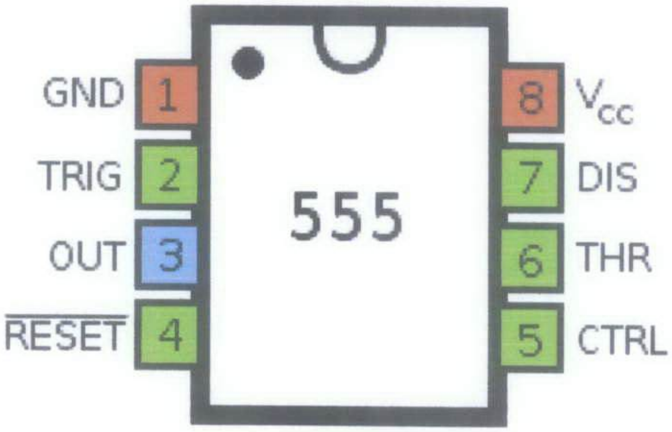


Figure 3: Timer 555 pinout

The 555 timer IC is an integrated circuit (chip) used in a variety of timer, pulse generation and oscillator applications. The 555 can be used to provide time delays, as an oscillator, and as a flip-flop element. Derivatives provide up to four timing circuits in one package.

The 555 has three operating modes:

2.5.1 Monostable mode

In this mode, the 555 functions as a "one-shot" pulse generator. Applications include timers, missing pulse detection, bounce-free switches, touch switches, frequency divider, capacitance measurement, pulse-width modulation (PWM) and so on.

2.5.2 Astable mode

The 555 can operate as an oscillator. It is used for LED and lamp flashers, pulse generation, logic clocks, tone generation, security alarms, and pulse position modulation and so on. Selecting a thermistor as timing resistor allows the use of the 555 in a temperature sensor: the period of the output pulse is determined by the temperature. The use of a microprocessor based circuit can then convert the pulse period to temperature, linearize it and even provide calibration means.

2.5.3 Bistable mode

the 555 can operate as a flip-flop, if the DIS (discharge) pin is not connected and no capacitor is used. Uses include bounce-free latched switches.

In the monostable mode, the 555 timer acts as a "one-shot" pulse generator. The pulse begins when the 555 timer receives a signal at the trigger input that falls below a third of the voltage supply. The width of the output pulse is determined by the time constant of an RC network, which consists of a capacitor (C) and a resistor (R). The output pulse ends when the voltage on the capacitor equals 2/3 of the supply voltage. The output pulse width can be lengthened or shortened to the need of the specific application by adjusting the values of R and C.[6]

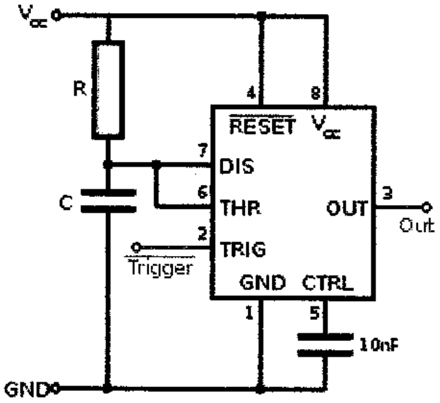


Figure 4: Monostable circuit configuration

The output pulse width of time *t*, which is the time it takes to charge C to 2/3 of the supply voltage, is given by:

$$t = RC\ln(3) \approx 1.1RC$$

Where t is in seconds, R is in ohms and C is in farads.
While using the timer IC in monostable mode, the main disadvantage is that the time span between the two triggering pulses must be greater than the RC time constant [7].

In bistable mode, the 555 timer acts as a basic flip-flop. The trigger and reset inputs (pins 2 and 4 respectively on a 555) are held high via Pull-up resistors while the threshold input (pin 6) is simply grounded. Thus configured, pulling the trigger momentarily to ground acts as a 'set' and transitions the output pin (pin 3) to Vcc (high state). Pulling the reset input to ground acts as a 'reset' and transitions the output pin to ground (low state). No capacitors are required in a bistable configuration. Pin 5 (control) is connected to ground via a small-value capacitor (usually 0.01 to 0.1 uF); pin 7 (discharge) is left floating.

In astable mode, the 555 timer puts out a continuous stream of rectangular pulses having a specified frequency. Resistor R_1 is connected between V_{CC} and the discharge pin (pin 7) and another resistor (R_2) is connected between the discharge pin (pin 7), and the trigger (pin 2) and threshold (pin 6) pins that share a common node. Hence the capacitor is charged through R_1 and R_2, and discharged only through R_2, since pin 7 has low impedance to ground during output low intervals of the cycle, therefore discharging the capacitor.

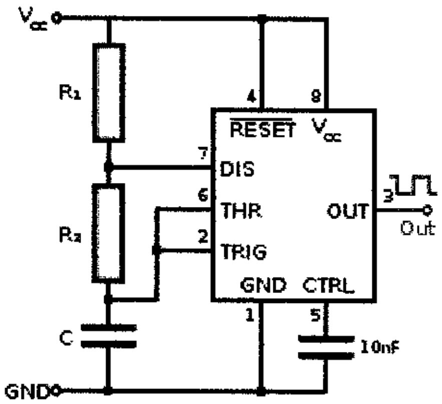


Figure 5: Astable circuit configuration

In the astable mode, the frequency of the pulse stream depends on the values of R_1, R_2 and C:

$$f = \frac{1}{\ln(2)\cdot C\cdot(R_1+2R_2)}$$ [8]

The high time from each pulse is given by:

$$\text{high} = \ln(2)\cdot(R_1+R_2)\cdot C$$

And the low time from each pulse is given by:

$$\text{low} = \ln(2)\cdot R_2\cdot C$$

Where R_1 and R_2 are the values of the resistors in ohms and C is the value of the capacitor in farads.

The power capability of R_1 must be greater than $\frac{V_{cc}^2}{R_1}$.

Particularly with bipolar 555s, low values of R1 must be avoided so that the output stays saturated near zero volts during discharge, as assumed by the above equation. Otherwise the output low time will be greater than calculated above.

To achieve a duty cycle of less than 50% a diode can be added in parallel with R_2 towards the capacitor. This bypasses R_2 during the high part of the cycle so that the high interval depends only on R_1 and C.

2.6 Relays

A relay is an electrically operated switch. Most relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are usually used where it is necessary to control a circuit by a low-power signal or where several circuits must be controlled by one signal. A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays-control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

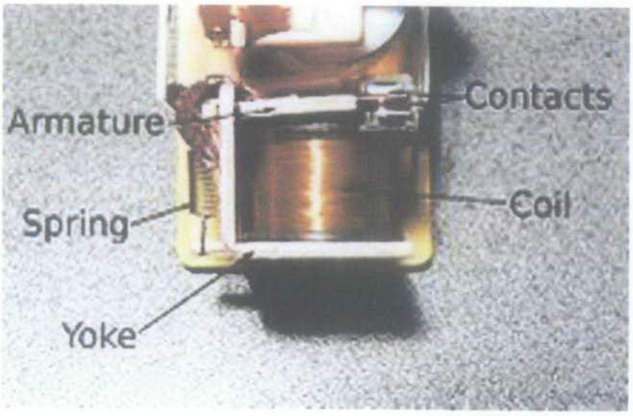


Figure 6: Relay elements

A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core, an iron yoke which provides a low reluctance path for magnetic flux, a movable iron armature, and one or more sets of contacts. The armature is hinged to the yoke and mechanically linked to one or more sets of moving contacts. It is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay pictured is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function.

The relay in the picture also has a wire connecting the armature to the yoke. This ensures continuity of the circuit between the moving contacts on the armature, and the circuit track on the printed circuit board (PCB) via the yoke, which is soldered to the PCB.

When an electric current is passed through the coil it generates a magnetic field that activates the armature and the consequent movement of the movable contact either makes or breaks (depending upon construction) a connection with a fixed contact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Usually this force is provided by a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low-voltage application this reduces noise; in a high voltage or current application it reduces arcing.

When the coil is energized with direct current, a diode is often placed across the coil to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a voltage spike dangerous to semiconductor circuit components. Some automotive relays include a diode inside the relay case. Alternatively, a contact protection network consisting of a capacitor and resistor in series may absorb the surge. If the coil is designed to be energized with alternating current (AC), a small copper "shading ring" can be crimped to the end of the solenoid, creating a small out-of-phase current which increases the minimum pull on the armature during the AC cycle [9].

CHAPTER 3 METHODOLOGY

This project will be conducted according to this methodology to meet the objectives. The procedures and stages of the entire project are shown in the flowchart below:

3.1 Project Methodology

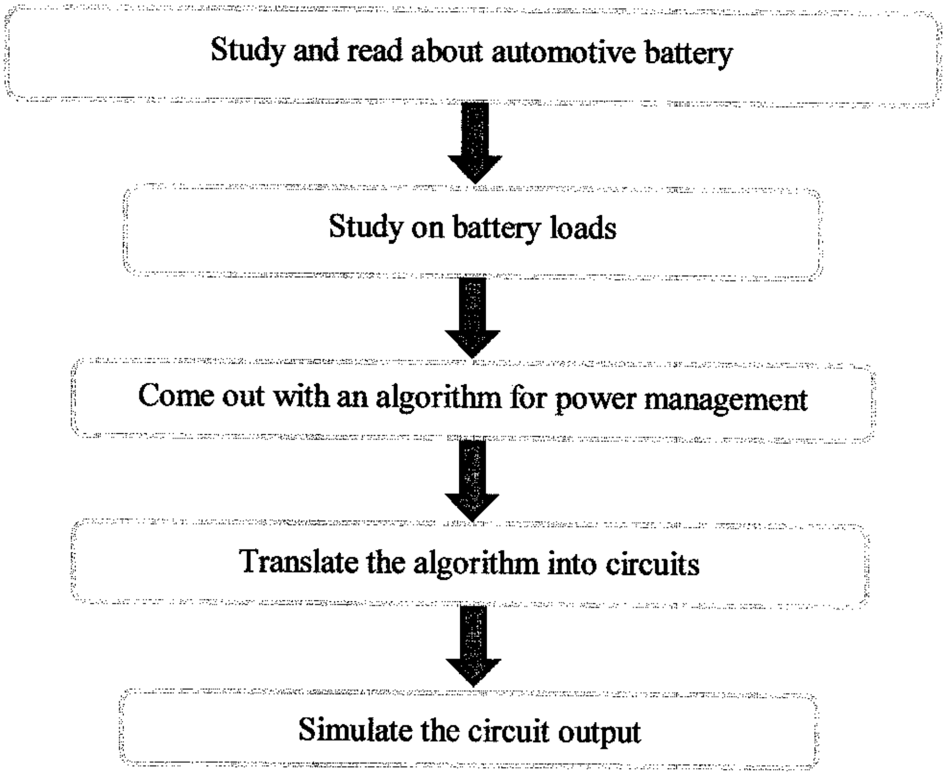


Figure 7: Methodology Chart

3.2 Project Activities

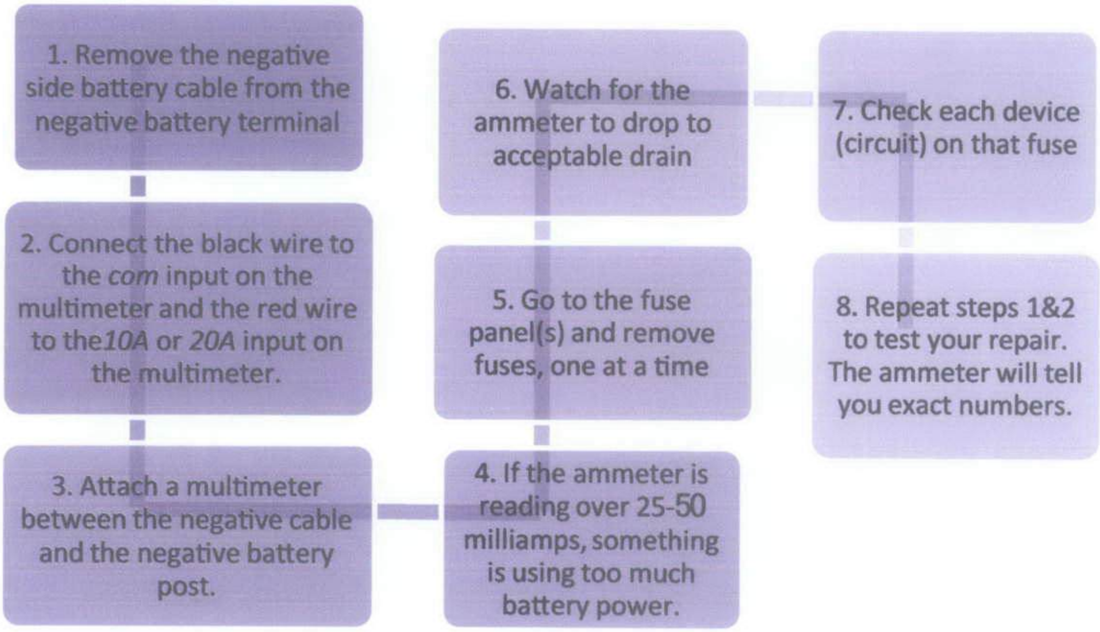
Project activities consist of reading and research material to expand the knowledge and gain more understanding about battery and parasitic drain on automotive battery. Besides, the project also include test for parasitic drain. From the data gathered, the project will proceed with the modeling and simulation of power management device. Last but not least, able to analyze the result obtained from simulation activity and implement the device on the real situation.

3.3 Tool / Equipment Required

This project is about modeling and simulation of power management device using Pspice. Pspice is an effective tool to analyze the simulation. Advantages of using Pspice are fast response.

This project will also need several tool such ammeter with adapter as we need to measure actual current draw from the battery.

3.4 Checking for Parasitic Drain



1. Remove the negative side battery cable from the negative battery terminal
2. Connect the black wire to the *com* input on the multimeter and the red wire to the*10A* or *20A* input on the multimeter.
3. Attach a multimeter between the negative cable and the negative battery post.
4. If the ammeter is reading over 25-50 milliamps, something is using too much battery power.
5. Go to the fuse panel(s) and remove fuses, one at a time
6. Watch for the ammeter to drop to acceptable drain
7. Check each device (circuit) on that fuse
8. Repeat steps 1&2 to test your repair. The ammeter will tell you exact numbers.

Figure 8: Step for checking the parasitic drain from the battery

3.5 Gant Chart and Key Milestone

Gantt chart is a project schedule to illustrate the start and finish date of a project in duration 28 weeks. Gantt chart is provided to ensure that the project ordering is consistent and all milestones in Gant Chart color-corded to distinguish upcoming, overdue and complete task.

Final Year Project I																
No.	**Detail/Week**	**1**	**2**	**3**	**4**	**5**	**6**	**7**		**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	Selection of Project Topic	🟧	🟧													
2	Study about Automotive Battery and parasitic effects			🟧	🟧	🟧	🟧	🟧								
3	Submission of Extended Proposal						●									
4	Proposal Defense									🟧	🟧					
5	Study about power management devices											🟧	🟧	🟧		
6	Submission of Interim Draft Report														●	
7	Submission of Interim Report															●

🟧 Process
● Suggested Milestone

Table 1: FYP I Gantt Chart

Final Year Project II																		
No.	Detail/Week	1	2	3	4	5	6	7		8	9	10	11	12	13	14	15
1	Project Work Continues	▨	▨	▨	▨	▨	▨	▨									
2	Submission of Progress Report									●							
3	Project Work Continues									▨	▨	▨	▨	▨			
4	Pre-EDX												●				
5	Submission of Draft Report													●			
6	Submission of Dissertation (soft bound)														●		
7	Submission of Technical Paper														●		
8	Oral Presentation															●	
9	Submission of Project Dissertation (Hard Bound)																●

▨ Process

● Suggested Milestone

Table 2: FYP II Gantt Chart

3.6 Block Diagram

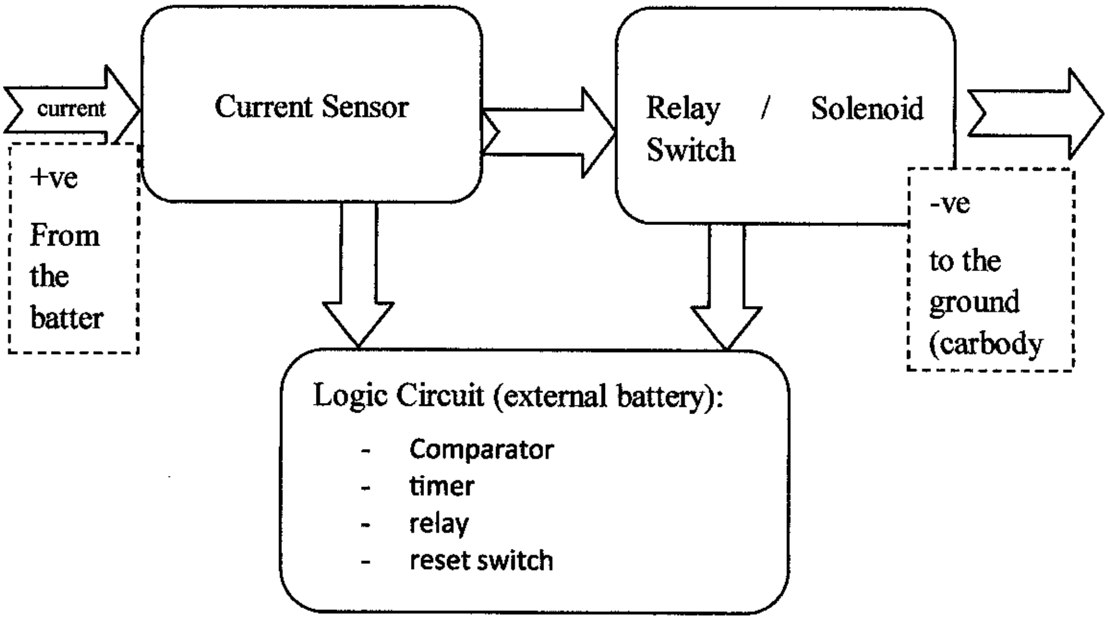


Figure 9: Block Diagram

The block diagram show the overview of the project, indicating what should be in the controlling circuit. From the positive (+ve) terminal of the battery, the current will be checked by the current sensor. The output of current sensor will then be channeled to voltage comparator.

The voltage comparator will then check whether there are current leak from the battery as excessive current leak would lead to battery damage and that was the unwanted condition. As soon as the voltage comparator detect the over current drawn from the battery it will then sent the high input to relay which then will triggered the "cut off" switch.

The “cut off” was put into action as it will not allowed any current flow from the battery. With this, the device saves current inside the battery. The problem could come when the user would like to start the engine again. Before the user start the engine, he/she need to reset the device first so that the device will reconnect back the main connection from the battery to other connection (starter, lighting, radio and etc.).

3.7 Circuit Flow Chart

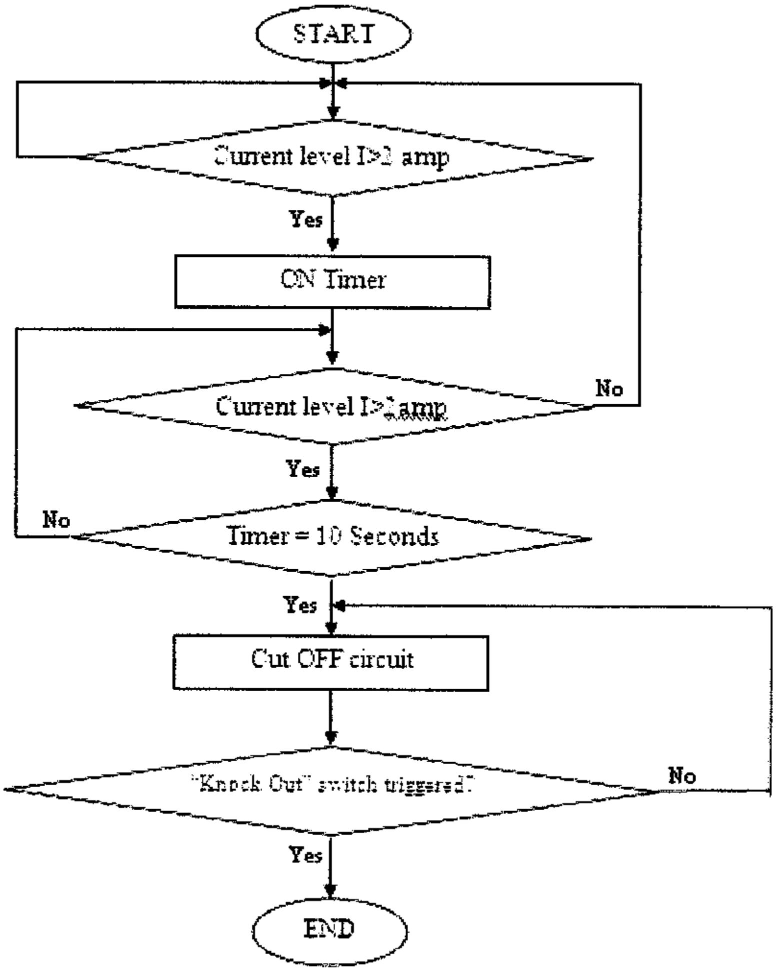


Figure 10: Flow Chart (sequences)

This is the suggested flow chart of the device that would be simulating and designed. The device will "On" once the user leave the engine off and take out the keys. The device will then start to check for current draw from the battery. If the current level draw from the battery was over 2A (2A is the minimum current draw for lighting), it will triggered the Timer. The timer will start counting till 10 seconds. During the 10 seconds counts, if the the current suddenly drop below 2A the timer will off and the device will be back to measure the current level.

When the 10 seconds reached, the device will cut off the main circuit (from the battery and other device). Next is the device will check whether the reset circuit was triggered or not. If the reset circuit is not triggered, the device will still cut off the main circuit. As soon as the reset circuit was triggered, the device will reconnect back the main connection.

CHAPTER 4 RESULT DAN DISCUSSIONS

From the readings, the most common battery rating is the AMP-HOUR RATING. This is a unit of measurement for battery capacity, obtained by multiplying a current flow in amperes by the time in hours of discharge.

For example:

A battery which delivers 5 amperes for 20 hours delivers, thus 5 amperes times 20 hours which equal to 100 Ampere-Hours.

Normally, an automotive with a low power engine 1000cc and below use less power thus require less Ampere-Hours rated battery which is usually 40Amp-Hours. For the more powerfull engine (1000cc and above) will require higher rated battery which usually 60Amp-Hours to 70Amp-Hours or higher.

Calculation: **Hour(s) of operating time, Based on fully charged batteries.**

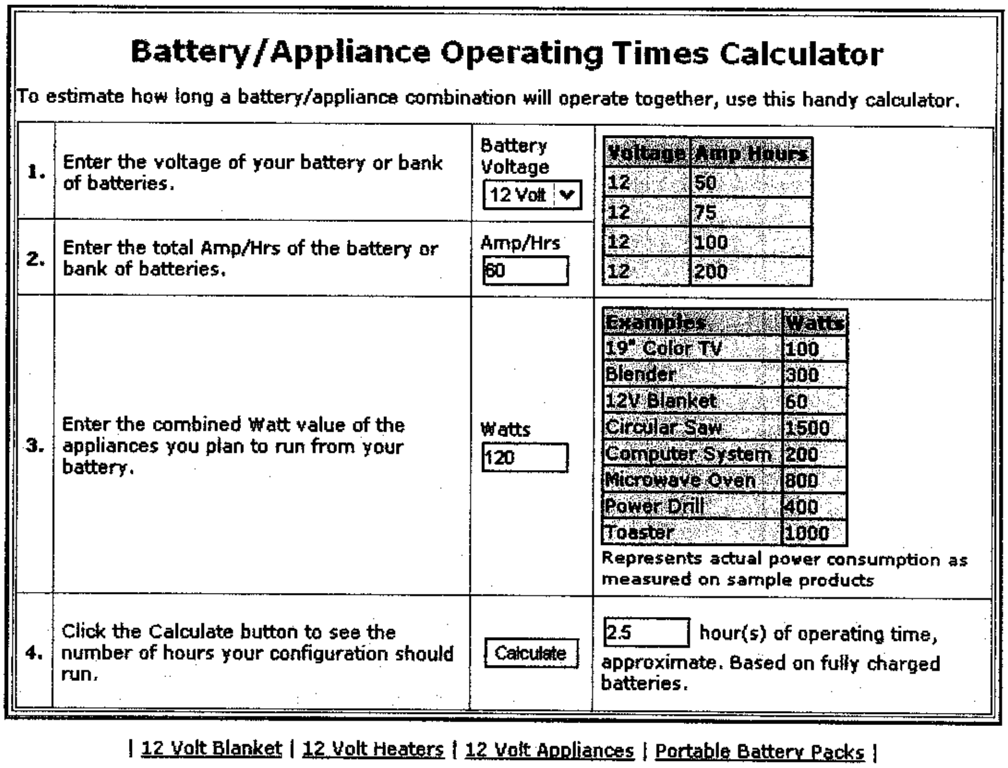
e.g.:

Automotive Battery: **12 Volts**

Amp/Hrs of the battery: **60Amp-Hours** (taking the medium value)

Watt value of the appliances: **120Watts** (Current draw from a appliances in automotive times 12Volts)

Hour(s) of operating time: 120Watts/60Amp-Hours = 2 Hours



Battery/Appliance Operating Times Calculator

To estimate how long a battery/appliance combination will operate together, use this handy calculator.

1.	Enter the voltage of your battery or bank of batteries.	Battery Voltage 12 Volt ▾
2.	Enter the total Amp/Hrs of the battery or bank of batteries.	Amp/Hrs 60
3.	Enter the combined Watt value of the appliances you plan to run from your battery.	Watts 120
4.	Click the Calculate button to see the number of hours your configuration should run.	Calculate

Voltage	Amp Hours
12	50
12	75
12	100
12	200

Examples	Watts
19" Color TV	100
Blender	300
12V Blanket	60
Circular Saw	1500
Computer System	200
Microwave Oven	800
Power Drill	400
Toaster	1000

Represents actual power consumption as measured on sample products

2.5 hour(s) of operating time, approximate. Based on fully charged batteries.

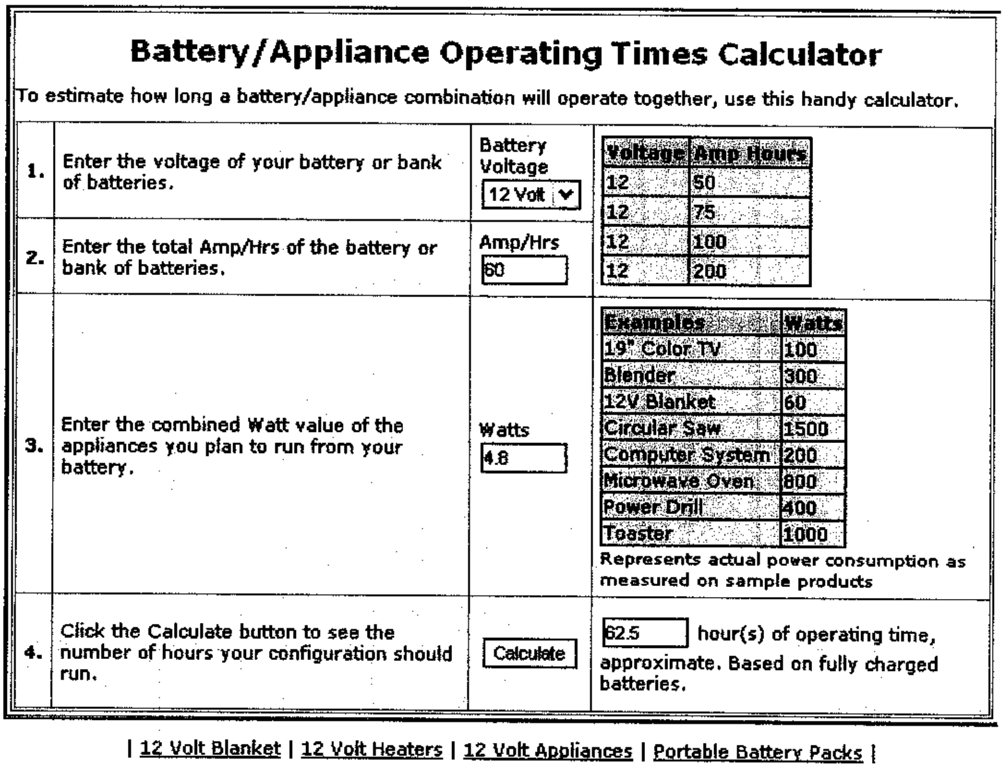
| 12 Volt Blanket | 12 Volt Heaters | 12 Volt Appliances | Portable Battery Packs |

Figure 11: Battery operating time calculator (120 Watts)

The standard minimum current draw from battery during engine was OFF, was around 40mA. This current draw is due to some electronics devices and parasitic drains.

40mA times 12 Volts = **4.8 Watts**

Using the calculation above : 4.8Watts/60Amp-Hours = 62.5 Hours



Battery/Appliance Operating Times Calculator

To estimate how long a battery/appliance combination will operate together, use this handy calculator.

1.	Enter the voltage of your battery or bank of batteries.	Battery Voltage 12 Volt	
2.	Enter the total Amp/Hrs of the battery or bank of batteries.	Amp/Hrs 60	
3.	Enter the combined Watt value of the appliances you plan to run from your battery.	Watts 4.8	Represents actual power consumption as measured on sample products
4.	Click the Calculate button to see the number of hours your configuration should run.	Calculate	62.5 hour(s) of operating time, approximate. Based on fully charged batteries.

Voltage	Amp Hours
12	50
12	75
12	100
12	200

Examples	Watts
19" Color TV	100
Blender	300
12V Blanket	60
Circular Saw	1500
Computer System	200
Microwave Oven	800
Power Drill	400
Toaster	1000

| 12 Volt Blanket | 12 Volt Heaters | 12 Volt Appliances | Portable Battery Packs |

Figure 12: Battery operating time calculator (4.8 Watts)

From the result above, the proposed solution for this problem was to cut-off the power supply (battery) to the automotive. As stated before in the methodology, the flow of this device was clear. Firstly, the device needs to sense the current level draw from the battery. Using the current sensor this will achieve the goal.

Figure 13: Current sensor

Figure 10 show a current sensor. This current sensor will detect current draw from the battery as per electromagnetic law say that, when current passing through a coil, thus it will create electromagnetic force. From the force created, the sensor will generate output which can vary from 0-5 Volts. This current sensor also has a very high range of input which can vary from 0-300 Amps.

As far as simulation of the device is concern, so far the simulations on the voltage comparator had being simulated.

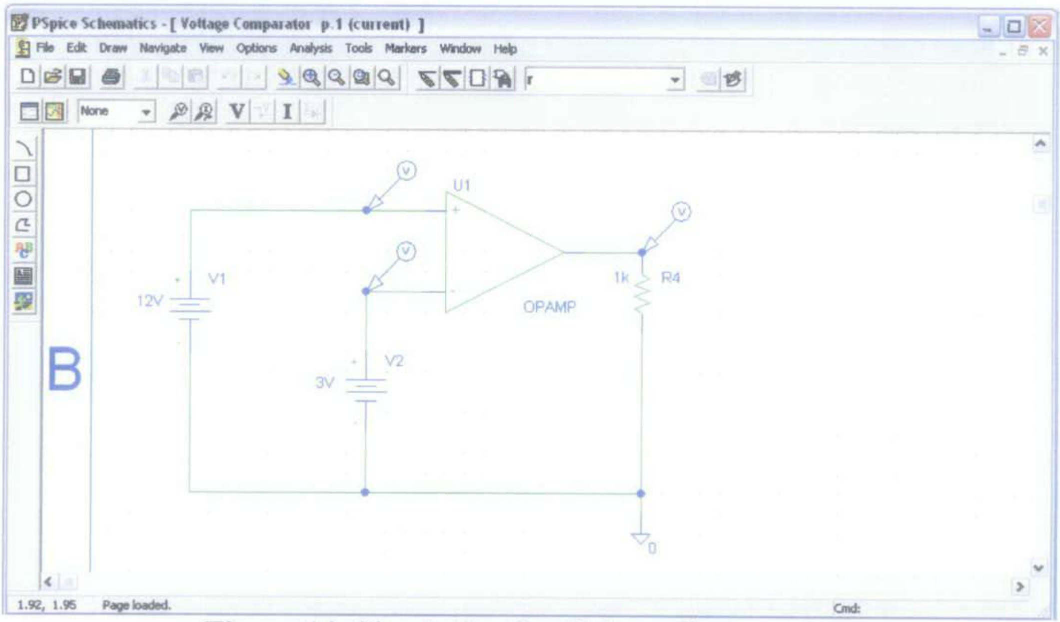


Figure 14: Simulation for Voltage Comparator

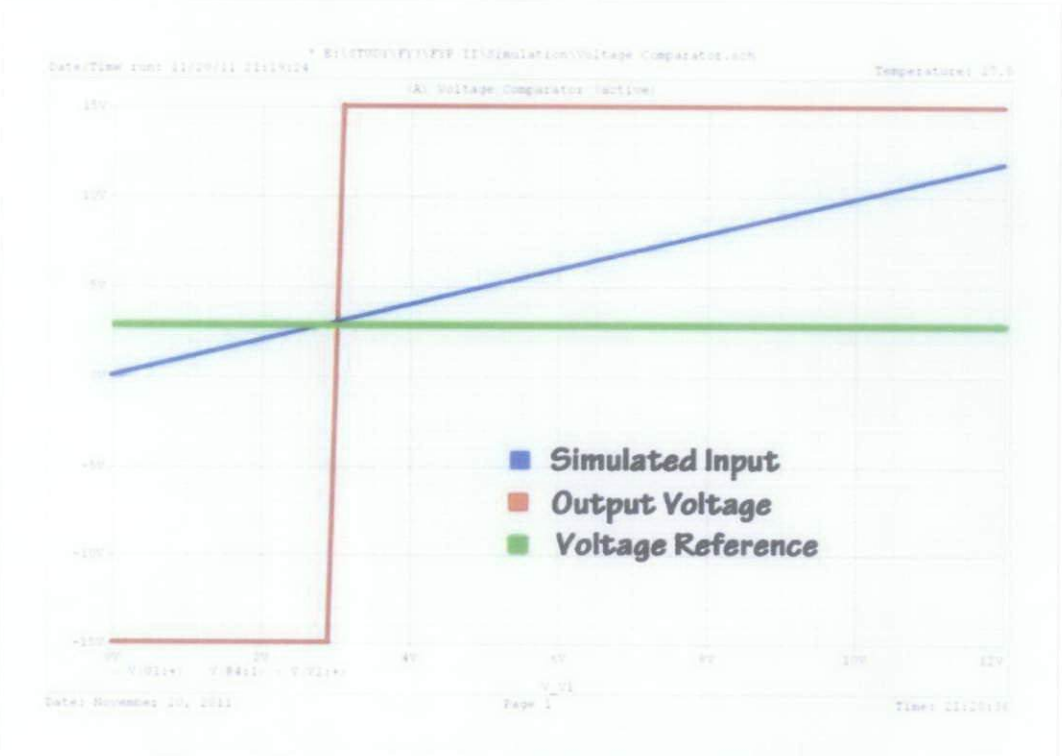


Figure 15: Simulation Result for Voltage Comparator

The setting was to simulate input voltage, V1 as in the **Figure 8** to be the simulated or manipulated voltage. We also set the voltage, V2 as in the **Figure 8** to be fixed and we consider it to be the reference voltage. For simulation wise the V2 was set to 3 Volts.

From the **Figure 9** we could see that as the input voltage was below the reference voltage which is 3 Volts, the output voltage was -15 Volts, and when the simulated voltage was above 3 Volts, the output was +15 Volts.

From the result above we can say that that voltage comparator works as we expected.

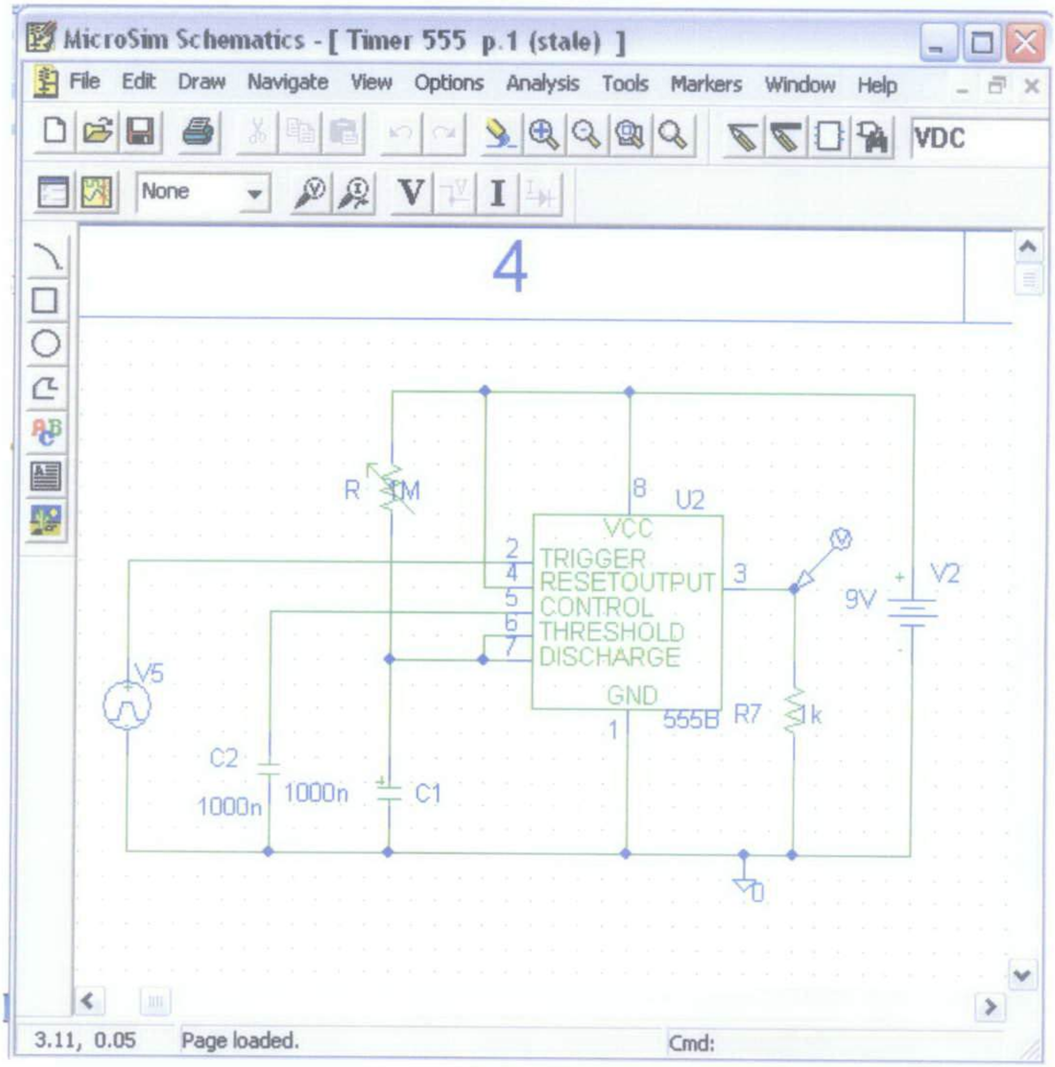


Figure 16: Simulation for Timer

CHAPTER 5 CONCLUSION AND RECOMMENDATION

The main objectives of this project are to carry a study on parasitic effect on automotive battery and introduce a device that will be a solution for this problem. The study of the parasitic drains was carried out with various ways including reading materials and testing for parasitic drains.

As far the result for the device that would be the solution is still on progress. More improvement can be made to make the device more power efficiencies and user friendly such as came up with circuitry that would not use much power. External power source for the device would be a good solution but still it will consume power. Having a power saving circuitry would be the main challenge for this project. It is quite irony if the device that would be build consume more power that the normal current drain from others device in automotive.

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