LIGHTWEIGHT PORTABLE POWER SUPPLY WITH VARIABLE OUTPUT VOLTAGE

by

MUHAMMAD IZKAR BIN AHMAD SHOBRI

Dissertation report
submitted in partial fulfilment of
the requirements for the
Bachelor of Engineering (Hons)
(Electrical & Electronics Engineering)

May 2011

UniversitiTeknologi PETRONAS
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CERTIFICATION OF APPROVAL

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Approved:

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May 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 acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

MUHAMMAD IZKAR BIN AHMAD SHOBRI

ABSTRACT

Power supply is a device or system that supplies electrical power. Power supply is one of the main pieces of test equipment that is required to test any type of component or circuit in the lab. When we are looking at the test equipment in the market, it can be seen that bench top power supplies or lab power supplies are very necessary especially among the students or lecturer but the cost is too expensive. The power supplies those are available in the market currently also not portable and heavy in weight. Therefore, the main objective of this project is to produce a lightweight and portable power supply with a minimum cost, weight, size and circuit complexity while also reducing electrical stresses on the semiconductor devices. A new topology is proposed which combines the functions of rectifier, Buck-Boost converter or known as step-up and step-down converter into a single circuit reducing components used resulting in a unit that is compact, portable, lightweight and cheap. Using a rechargeable 1.2V batteries, the voltage can step up to 5V and 12V by apply the buck-boost method. Thus, with this 12V of voltage, this power supply is able to apply like the bench top power supply or lab power supply. There are many switch mode power supplies that can be used in the lab, but these types of power supplies are not portable and economical for students to purchase. There is a need in the industry for a portable power supply that can be used in various locations when AC is not available. This portable lightweight power supply is an alternative for the student who wants a portable power supply with an internal rechargeable battery to supply the output power. This system has a selling price of under RM100.So students can afford the test equipment which will last them throughout their college career and into their professional career. The weight is approximately 0.28g compared to bench top power supply which is approximately 6kg.

ACKNOWLEDGEMENTS

In the name of Allah, the Most Gracious, the Most Merciful.

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I am heartily thankful to my lovely mother, father and the whole family whose encouragement, guidance and support from the initial to the final level enable me to successfully finish this project.

Lastly, I offer my regards and blessings to all of those who supported me in any respect during the completion of the project.

TABLE OF CONTENTS

Content Page

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1
INTRODUCTION

1.1 Background of Study.

This project presents the development of a lightweight portable power supply. Using rechargeable battery as the primary power source, it will step up the voltage until approaching 5V and 12V and will remain the voltage at this stage. Nowadays, the application are becoming smaller and smaller and power efficient.

The purpose of using rechargeable battery is because of their ability to store a larger amount of energy (with longer changing period) and their decreasing in term of size. Different kinds of power supplies have various characteristics. Some of them transform from mechanical energy to electrical energy while some of them can transform heat to electrical and so on. Therefore, commonly names for power supply are electrical or mechanical power supply. The big issue is how much power they can supply, how good is their capability to produce stable output voltage and output current or how long the power supply can generate energy.

Recently, some of the power supply is using a renewable energy such as small hydro, modern biomass, wind, geothermal, biofuels and photovoltaic or solar cells. Although it can produce very large source of energy, but the output voltage and current is not stable. Hence, for this project, a lightweight and portable power supply can be produce with more stable output. A lightweight portable supply could have many uses. It will supply mains power to remote sites, for test equipment, lab purpose, building sites, radio masts, lock-up garages and garden sheds and running appliances such as electric drills, soldering irons and radio equipment.

This is because a long extension cord from a mains supply can be dangerous or inconvenient and a chemically fuelled generator might be too noisy, expensive and unreliable. Therefore for remote power operation, an electrical unit which is as cheap, light, compact and reliable as possible as it is highly desirable.

1.2 Problem Statement.

When we are looking through the test equipment market, it can be seen that bench top power supplies or lab power supplies are very necessary especially among the students or lecturer but the cost is too expensive. Nowadays, students in engineering streams are in need of cheap, lightweight and portable power supplies in order to finish their homework according to the time given, for class assignment or for the lab use. Most of the students especially from Electrical & Electronics Engineering need a personal power supply to complete their lab work in a specific time. Students only have at least 2 hours to do their lab experiment and mostly they can't finish it in 2 hours. Hence, they need to wait for other lab session to continue the experiment.

So, by using this power supply, it can help students by providing a portable, lightweight, rechargeable, and affordable power supply that allows students and hobbyist to power their various projects anywhere on their own convenience. Besides that, this power supply can be use for variety of application such as for testing equipment, class demonstration, powering many other electrical devices. University, such as Universiti Teknologi PETRONAS (UTP) has several laboratories with power supplies that are not portable. We can imagine when the students being able to take the power supply from one workspace to another without the concern of finding a power outlet, so this power supply will help make that a reality. This power supplies will have 5V and 12V of the outputs voltage same as the lab power supplies.

Therefore it will provide all the necessary and most common features of bench top power supplies on the market today but with added features that will possibly set the standard for future bench top testing supplies.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction.

The power supply is basically not only test equipment, but it is also widely used in powering many different types of electronic devices. Almost any type of electronic device will have some form of an internal power supply to supply the power to the components in the device. Today's world need power supply in order to power a device or test the electrical component. The linear power supply was one of the earliest forms used. In Malaysia, researches in portable power supply have gradually caught the interest of many industries. For the power supply research, there were several report has been published in the past few years. The research has been done using several sources and methods.

2.2 Past Research on Power Supply.

Basically, there are two types of power supply. One is linear power supply (conventional power supply unit) and the other one is switch mode power supply (SMPS). Switch Mode Power Supplies are the current state of the ability in high efficiency power supplies. Conventional series-regulated linear power supplies maintain a constant voltage by varying their resistance to manage with input voltage changes or load current demand changes. The linear regulator tends to be very inefficient. The switch mode power supply, however, uses a high frequency switch (in practice a transistor) with varying duty cycle to maintain the output voltage. The output voltage variations caused by the switching are filtered out by LC filter [1].

The source that have been use as a power supply are batteries, photovoltaic and Electric Double Layer Capacitor(EDLC)[2]. By using several types of batteries as a power supply, the comparison can be made to determine which is the most suitable battery to be used as a power supply for wireless sensor platform. The Batteries that have been tested are the Nickel Cadmium (NiCd) Battery, Nickel Metal Hydride (NiMH), Lithium Ion(Li-ion), and Lithium-Polymer (LiPo). From the test result, It shows some comparison between each batteries and their characteristics. NiCd cycle life is based on regular control and maintenance. On the contrary, NiMH, Li-ion and Polymer are developed technology and there is no need for such an accurate maintenance.[3]

For Electric Double Layer Capacitor (EDLC), during the past years, a pollution-free high performance electric energy storage device has been demanded. One of the best solutions is the electric or electrochemical double layer capacitor (EDLC), also known as the super capacitor or the ultra capacitor. A basic capacitor consists of conductive foils and dry separator. There are three types of electrode materials adequate for the EDLC. One of the most common is the high surface area activated carbon. It is also the cheapest to manufacture. The two other electrode materials are metal oxide and conducting polymers, but these last two are not as commonly used as the activated carbon. EDLC is a charge storage device, which utilizes a double layer formed on a large surface area of micro porous material such as activated carbon. EDLC stores the energy in the double layer formed near the carbon electrode surface. There are two layers, one layer of electrolyte molecules and a second layer is diffusion. In the first layer, the electrons cannot move at all and in the second layer the electrons can move around a little.

The others research on power supply is by using photovoltaic or solar system as a power source. Photovoltaic (PV) is a method of generating electrical power by converting radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. Photovoltaic power generation employs solar panels composed of a number of cells containing a photovoltaic material [4]. Due to the growing demand for renewable energy sources, the manufacturing of solar cells and photovoltaic arrays has higher considerably in recent years. A number of solar cells electrically connected to each other and mounted in a single support structure or frame is called a 'photovoltaic module'. Modules are designed to supply electricity at a certain voltage, such as a common 12 volt system. The current produced is directly dependent on the intensity of light reaching the module [5].From the research, photovoltaic are best known as a method for generating electric power by using solar cells to convert energy from the sun into electricity but the cost is to high and it is too depend on the weather because it needs a lot of intensity of light.

The others design on the power supply is by using based on an LTC1325 [6] microprocessor-controlled battery management system [7].For this power supply, it consists of two battery pack. One battery pack supplies power to the embedded application while the other pack is charged. When the pack supplying power to the application is discharged, the two packs are switched. The second pack then supplies power while the first pack is recharged. Temperature and voltage of the battery packs are monitored by the LTC1325 during system operation in order to maximize the health and longevity of the battery packs. System parameters may be changed to optimize performance depending on the type of batteries being used (*e.g.* NiMH, NiCd, or Li-Ion).The objective of this power supply is basically to be used on portable mobile charger and to operate wireless sensor. Hence, this project will develop a telemetry application where a portable, rechargeable battery-based power supply was required. The power supply needed to provide continuous power to the embedded telemetry controller, while maintaining the standards of long life and high reliability. The application was not going to be physically accessible for connecting a power supply, so the power supply would have to be inductively charged as well.

During the last few decades, only moderate improvements concerning rechargeable batteries have been made in terms of higher capacity and smaller size. Compared with advancement in areas such as microelectronics, the lack of progress in battery technology is apparent. Consider a computer memory core of the sixties and compare it with a modern microchip of the same byte count. What once measured a cubic foot now sits on a tiny chip.

The consumer market, for example, demands high energy densities and smaller size. This has to be done to maintain adequate runtime of portable devices that are becoming increasingly more powerful and power hungry. Downsizing of the portable equipment has pressured manufacturers to invent smallest battery.

CHAPTER 3
METHODOLOGY

3.1 Procedure Identification

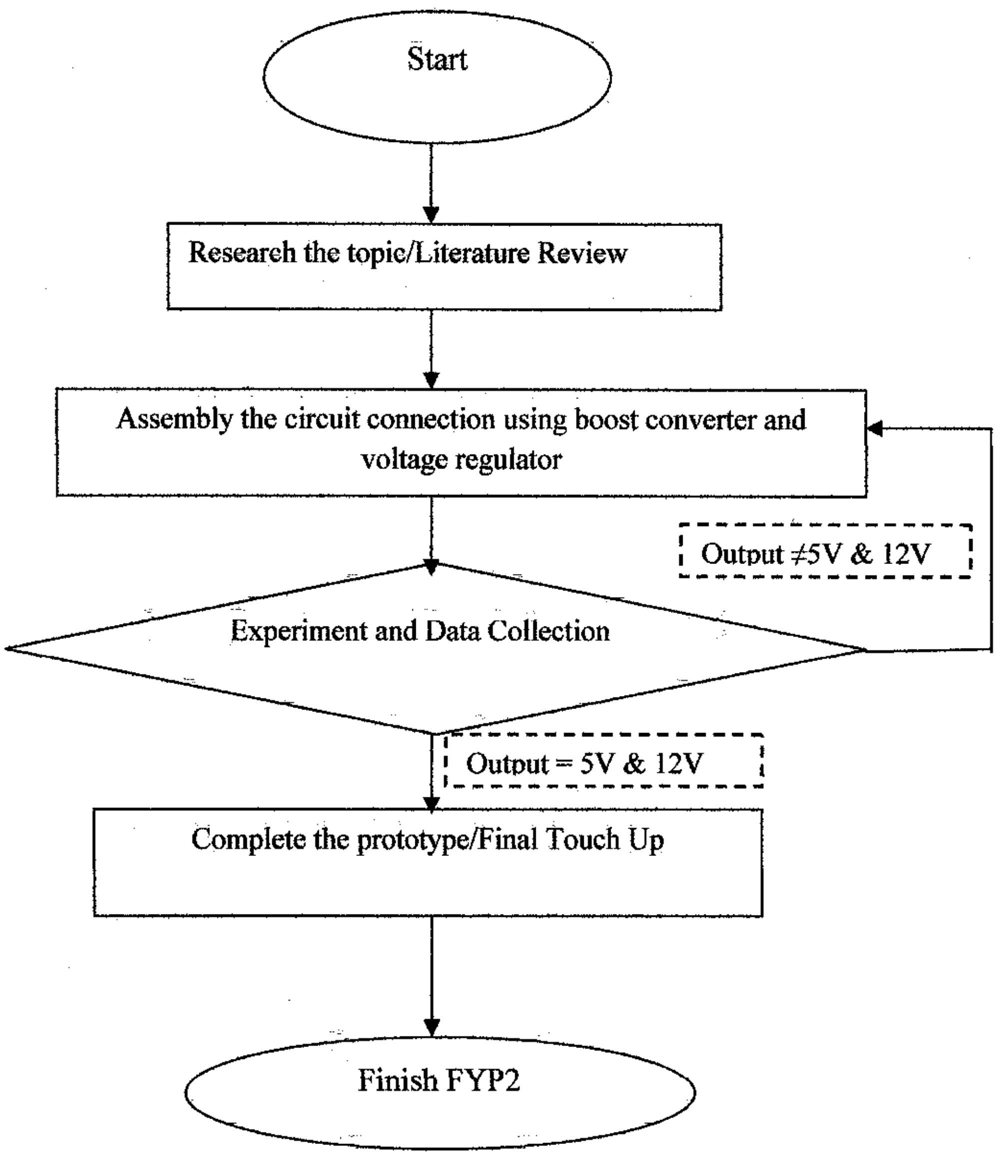

Figure 1: Project Flow Chart

This chapter discuss about the flow of this project from the beginning until the end of this semester .There are some steps to be applied in designing a lightweight portable power supply. This project will be divided by two parts which is first part is final year project 1 and another part is final year project 2. For this semester which is final year project 2, the main focus is to complete the project and get full of experimental results.

In this methodology, I have separated into two elements. Among of the elements are:

i. **Simulation Design**

PSpice is chosen to simulate the circuit designed. In this simulation, it will show the simulated output results. This simulation is very essential to keep all theoretical design and calculation is suitable to the project designed. Besides that, it can give clear view of the project according the obtained simulation output. AutoCAD 2007 is used to design the prototype of the product.

ii. **Hardware Design**

During this semester, I expect to finish up until get a prototype of this project.

3.2 Procedure of Project

1. **Identify need**
   - Construct and design a prototype of Lightweight Portable Power Supply that can convert low input voltage from the rechargeable battery to high output voltage using booster.
2. **Define problem**
   - Nowadays, students in engineering streams are in need of cheap, lightweight and portable power supplies in order to finish their homework according to the time given, for class assignment or for the lab use. Most of the students especially from electrical electronics engineering need a personal power supply to complete their lab work in a specific time.
3. **Research**
   - Conduct a research by surfing the internet the about power supply unit. Understand the concept of DC-DC converter (boost converter) and voltage regulator that will use in this project.
4. **Set constraint**
   - Set main priorities which should begin with time (within 10 weeks), level of knowledge and followed by the cost needed to achieve targeted outcome of this project.
5. **Set criteria**
   - Cost effective, portable, power produced, reliable, practical, marketable, and safe for usage.
6. **Analysis**
   - All pros and cons of the proposed ideas are considered. The general idea must be clear understand and know how to construct the prototype. Alternative ideas are analyze as back-up plans if problems would arise unexpectedly in the future.

7. **Decision**

- A final decision made by choosing the most practical considering the objective and other constraint to make it achievable.

8. **Specification**

- Specification of the prototype made for detailed project report once everything has finalized and confirmed. Points to consider for specification are as follows :

  Size → Handy

  Design → Attractive

  Quality → Lasting

  Material → Affordable

  Performance → Efficient

Table 1: Software

No.	Type of Software	Description
1	Microsoft Word	To write the reports and other text documents
2	Microsoft Excel	To perform data analysis and calculations

Table 2: Tools

No.	Fabrication Process
1	Cutting (body)
2	Drilling machine
3	Joining (Welding, Rivet, Adhesive)
4	Soldering
5	Setting electrical system

3.3 Design Concept

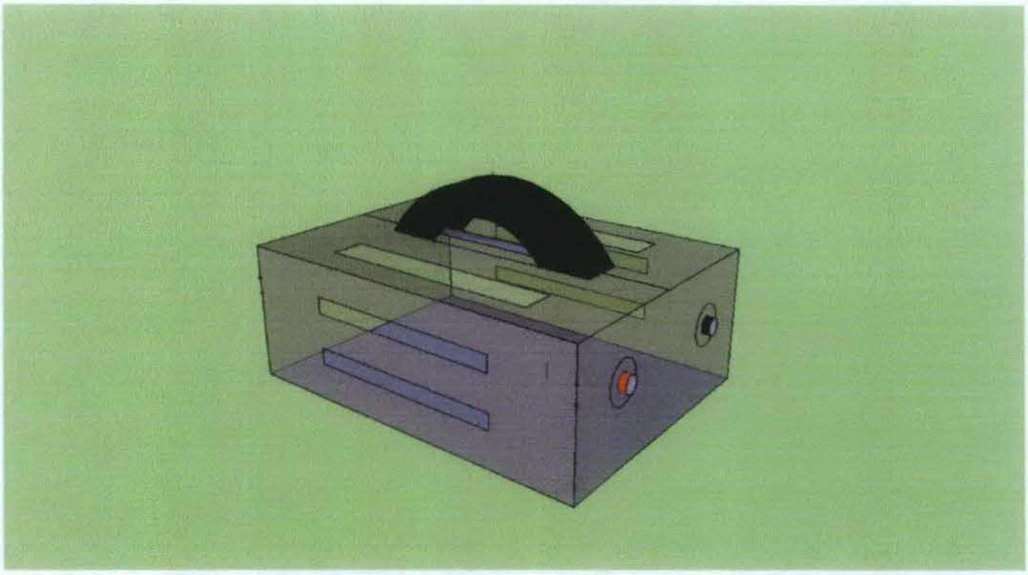

Figure 2: Schematic Drawing

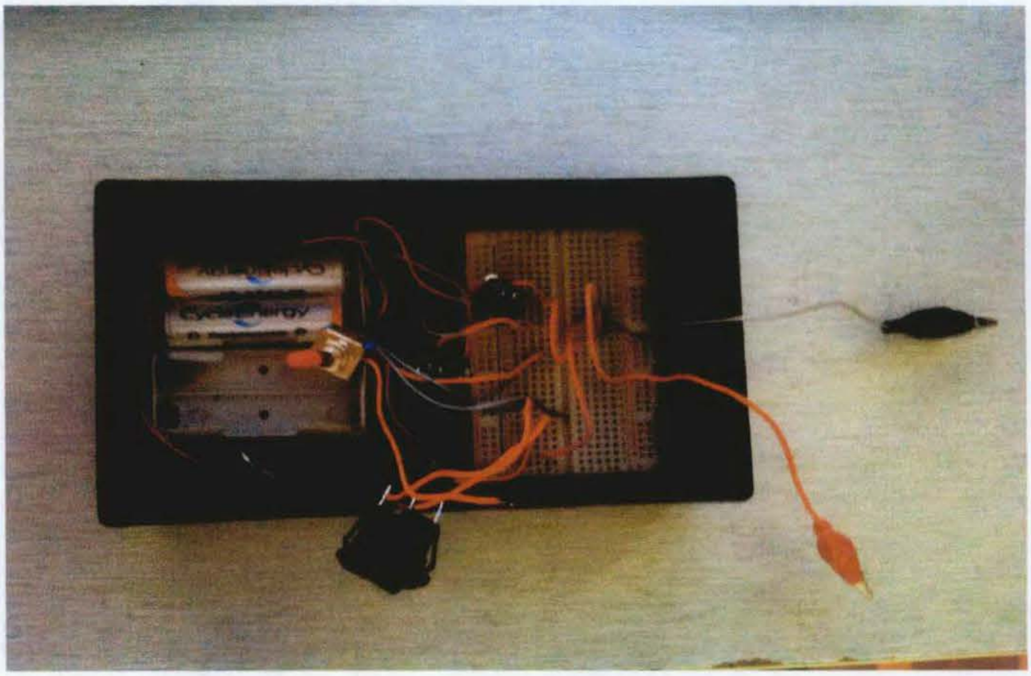

Figure 3: Lightweight Portable Power Supply

Lightweight Portable Power Supply is basically an innovation from the power supply that have been used nowadays where the output are 5V and 12V.In this project, the application of boost converter is applied in order to get the larger output. Basically, boost converter is a step up converter. As the name implies, the output voltage is always greater than the input voltage. Using 1.5V battery, the battery is connected to the booster circuit. The positive terminal of the battery is connected to the positive terminal of the boost converter and also for the negative terminal. After the connection is completed, it will produced 5V of output which is the first aim output. The output is measured using a multi meter. The second aim is to produce 12V of output. So, in order to accomplish 12V of output, 3 batteries will be use with all have the same connection. Then the 3 sets of connection will connect together in series connection on the breadboard. The output will show 15V of output voltage and we need to use 12V voltage regulator to stabilize the output to 12V. We need the voltage regulator to be able to accept of an input voltage range of 10.5V to 14.1V and be able to produce a constant voltage for the DC cooling fan. The switch is added to the circuit so as to control the power supply to two major outputs.

3.4 Circuit Design

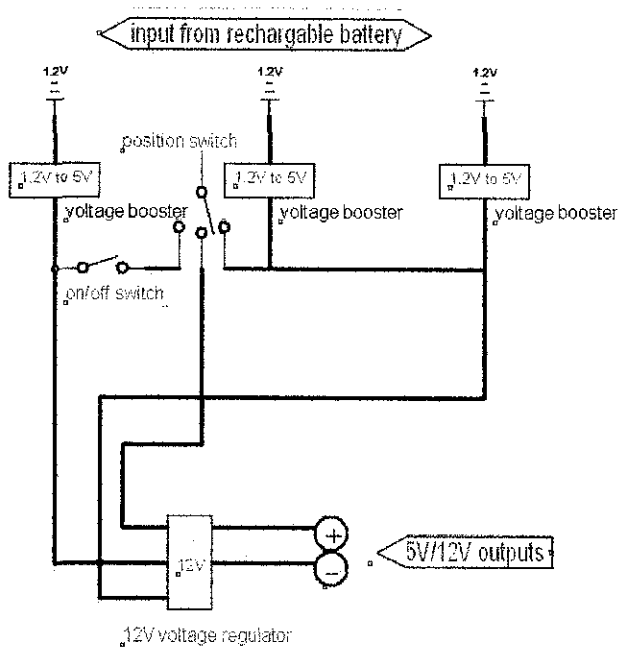

Figure 4: Circuit design

From the above circuit, the input source of this circuit design is using three 1.2V batteries. Each of these batteries is connected to the voltage booster and will produce 5V of output voltage for each connection. There are 2 switches added between the two connections as we can see above that is on/off switch to control on/off of this power supply and the other is position switch to control how much voltage the uses need. When we turn on the switch and the circuit is closed, current will flow from the first connection to the second and third connection based on the position switch. If we toggle the switch to the right direction, then the circuit will have 5V of outputs because the first connection is not connected to the second connection. But when we toggle to the left direction, then it will connect to the full connection of this circuit and will produce 15V of output. In order to get 12V of output, 12V voltage regulator is added and the final voltage that will produce is 12V.

3.5 Justification in Choosing Design

The design of this project consists of 1.2V rechargeable batteries, boost converter and 12V voltage regulator. During the research, two designs were proposed. The first design is using three 1.2V batteries and boost converter without using voltage regulator. So, when the connection has been done, the output voltage has show 15V of output. So, to make sure the output is constantly at 12V, some circuit design need to be done using additional components such as resistors, inductors and capacitors. For the second design, batteries, boost converter and 12V voltage regulator need to be used. This connection will produce 12V of output constantly. So, the seconds design has been choose as a part of connection to achieve the target of this project. This is because when we are using voltage regulator, it is easier to get the output of 12V because the component have already set to produce 12V of output. Besides that, the output is more stable and easy to connect. For this entire semester, I will try to make variable output of my power supply and while using a switch, we can change the output that the users need to use whether it is 5V or 12V.So, it will be easy for the users to choose the supply voltage from this portable power supply by only toggle the switch.

3.51 Power Source in Portable Application

During the last few decades, only moderate improvements concerning rechargeable batteries have been made in terms of higher capacity and smaller size. Compared with advancement in areas such as microelectronics, the lack of progress in battery technology is apparent. Consider a computer memory core of the sixties and compare it with a modern microchip of the same byte count. What once measured a cubic foot now sits on a tiny chip.

Research has brought about a variety of batteries chemistries, each offering distinct advantages, but none providing a fully satisfactory solution. With today's increased selection, however, better choices can be applied to suit specific user application.

The consumer market, for example, demands high energy densities and smaller size. This has to be done to maintain adequate runtime of portable devices that are becoming increasingly more powerful and power hungry. Downsizing of the portable equipment has pressured manufacturers to invent smallest battery.

Table 3: Battery characteristics

Battery type	NiCd	NiMH	Li-ion	Li-polymer
Gravimetric Energy Density[Wh/kg]	45-80	60-120	110-160	100-130
Cycle Life	1500	500-800	500-1000	300-500
Overcharge Tolerance	moderate	low	Very low	low
Self-discharge/Month	20%	30%	10%	~10%
Cell Voltage[V,nominal]	1.25	1.25	3.6	3.6
Load Current[As]	1	0.5 or lower	1 or lower	1 or lower
Maintenance Requirement	30 to 60	60 to 90	Not required	Not required
Cost per cycle	0.03	0.09	0.11	0.22
In commercial use since	1950	1990	1991	1999

http://batteryuniversity.com/learn/article/whats_the_best_battery

CHAPTER 4
RESULT AND DISCUSSION

4.1 Data Gathering and Analysis

After some of the experiments have been done, all the data are kept and some analysis has been made. The connection of are based on the circuit diagram. Using 1.2V of battery, here is some procedure and result that produce:

1) While using single **1.2V** battery, then the battery is directly connected to boost converter. By using a multi meter to measure the output voltage, the value is **5.8V**.

2) The other **1.2V** battery is connected with the same connection as above and the output is testing using same multi meter and the result is **5.8V**.

3) Then, the 2 sets of connection will be connect together using breadboard by series connection method.

4) The circuit has been tested again using the multi meter and now the output value shows **10.8V**.

At this level, when one extra connection is connected to the circuit with the same connection, then it will produce approximately **15V** of output. In order to get **12V** of output constantly, the voltage regulator of 12V need be connected to the circuit. The type of voltage regulator that I have used in this project is *L7812CV WCC1A0222 MOROCCO.* For this experiment, the objective is to produce double outputs which is 5V and 12V but not at the same time. The reason of 5V and 12V has been chosen for the outputs are because many lab applications are using this range of voltage as a power supply. So, in order to achieve this objective, two switches have been used in this project which is on/off switch and position switch. In electronics, a switch is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another. Each set of contacts can be in one of two states, either 'closed' meaning the contacts are touching and electricity can flow between them, or 'open', meaning the contacts are separated and none conducting. So, in this project, this switch is usually to control the on and off of the power supply. So, it can save much power compare without using a switch. The other switch is a position switch. This switch is to control whether the users want to use a 5V or 12V of the supply power. By only toggle the direction of the switch, the users can get the supply power from this power supply.

Here is the summarization of the experimental and theory value of the output voltage and current:

Table 4: Output Voltage

No	**No of batteries that been used**	**Output Voltage/V**	
		Experimental	Theory
1.	1	5.8	5.0
2.	2	10.8	10.0
3.	3	15.6	15.0
4.	After using voltage regulator	12.0	12.0

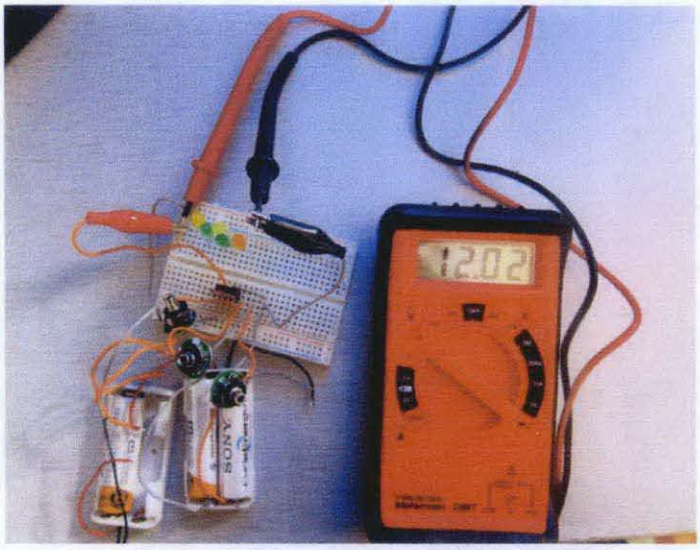

Figure 5: Measurement of Output Voltage

When I am working on the experiment, all the batteries are in fully charging condition. When the experiment is done using LED and 12V DC Cooling Fan as a load, the result is showing as below. The purpose of this experiment is to determine how long the batteries can maintain before it needs to recharge. So, as a traveler, when they want to bring along this power supply, they can budget the approximate time to use it.

Table 5: Duration of the batteries

No	Load	Duration
1	LED	7 Hours
2	12V DC Cooling Fan	4 Hours

This experiment used PASCO Data Studio which is software for collecting and analyzing data by using sensor system. Using this tool, it can measure voltage, current and temperature versus time. All this data will display at computer in table and graph. The positive and negative terminals of the power supply prototype is connected to the positive and negative terminals of PASCO and it will show the result of voltage and current output for every seconds based on user setting.

Table 6: Prototype experiment result for 5V output

time (s)	current	voltage
5	0.5	4.78
10	0.49	4.78
15	0.49	4.78
20	0.49	4.81
25	0.5	4.82
30	0.5	4.86
35	0.51	4.89
40	0.53	4.89
45	0.51	4.91
50	0.51	4.91
55	0.52	4.94
60	0.54	4.96
65	0.56	4.98
70	0.53	4.99
75	0.55	4.98
80	0.55	5.01
85	0.55	5.01
90	0.56	5
95	0.56	5.02
100	0.55	5.01
105	0.56	5.02
110	0.56	5.02
115	0.54	5.03
120	0.54	5.02
125	0.55	5.02
130	0.56	5
135	0.56	5.01
140	0.57	5
145	0.56	5
150	0.58	5.01
155	0.58	5.03
160	0.58	5.04

165	0.56	5.04
170	0.56	5.06
175	0.54	5.07
180	0.55	5.06
185	0.54	5.06
190	0.55	5.06
195	0.54	5.05
200	0.54	5.06
205	0.55	5.06
210	0.56	5.08
215	0.56	5.08
220	0.56	5.07
225	0.56	5.04
230	0.54	5.05
235	0.55	5.05
240	0.54	5.04
245	0.55	5.06
250	0.56	5
255	0.56	5.02
260	0.56	5.04
265	0.55	5.03
270	0.53	5.04
275	0.55	5.04
280	0.55	5.04
285	0.54	5.03
290	0.54	5.04
295	0.56	5.04
300	0.56	5.05
305	0.56	5.07
310	0.54	5.05
315	0.55	5.04
320	0.57	5.05
325	0.56	5.05
330	0.56	5.05
335	0.57	5.05
340	0.59	5.04
345	0.57	5.05
350	0.57	5.05

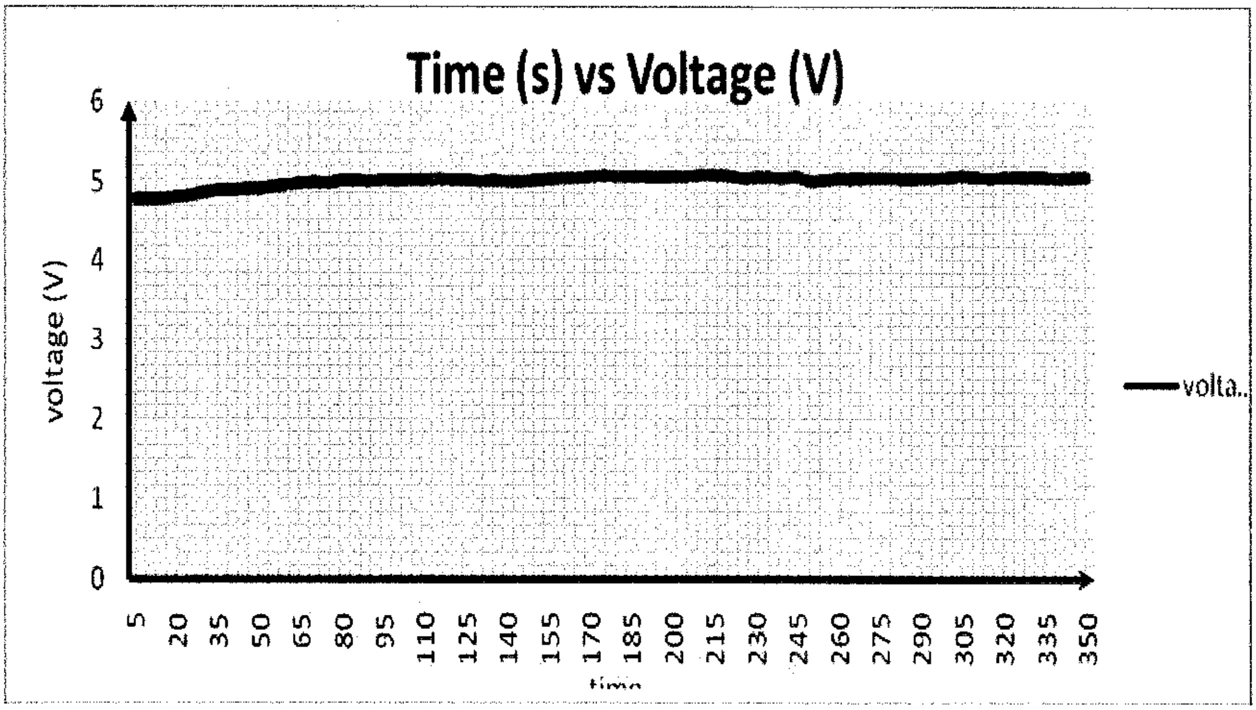

Figure 6: Graph voltage vs. time

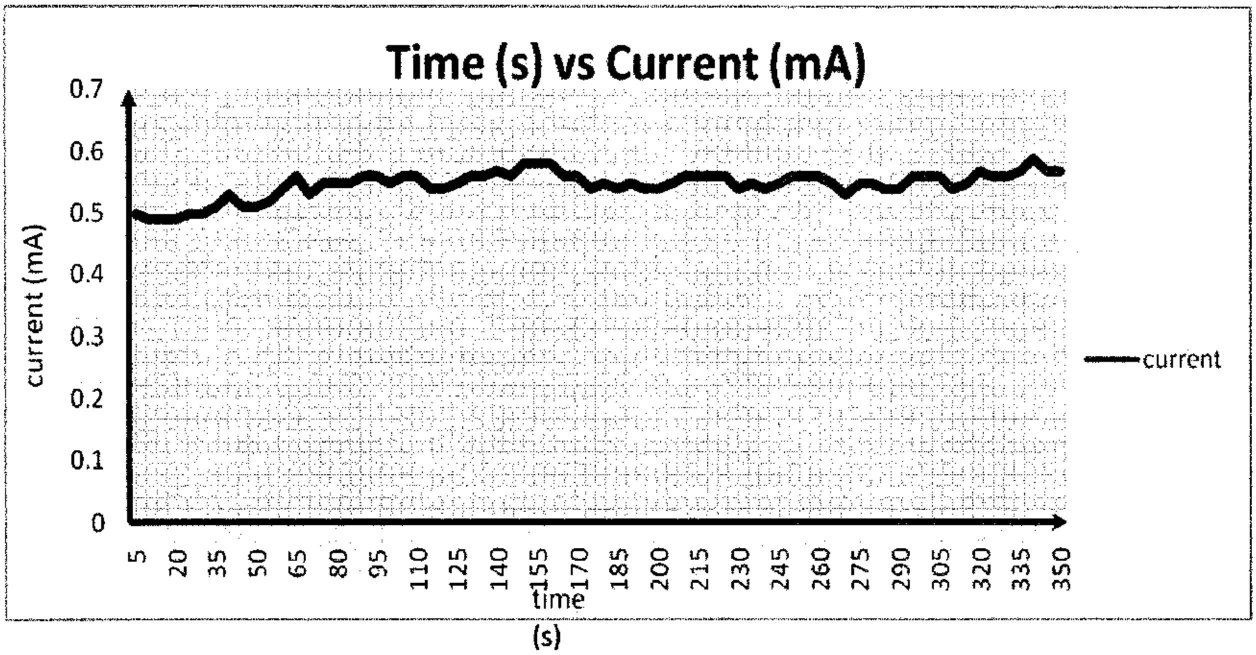

Figure 7: Graph current vs. time

Table 7: Prototype experiment result for 12V output

time (s)	current (A)	voltage (V)	time (s)	current (A)	voltage (V)
5	0.356	11.73	180	0.3562	12.08
10	0.3558	11.87	185	0.356	12.07
15	0.3552	11.98	190	0.3558	12.05
20	0.3546	12.11	195	0.3556	12.02
25	0.3541	12.14	200	0.3554	12
30	0.3538	12.2	205	0.3552	12.1
35	0.3534	12.18	210	0.3551	12
40	0.353	12.21	215	0.3548	12.03
45	0.353	12.24	220	0.3546	12.03
50	0.3532	12.2	225	0.3544	12.07
55	0.3535	12.2	230	0.3542	12.06
60	0.3538	12.14	235	0.354	12.08
65	0.3542	12.12	240	0.3538	12.09
70	0.3546	12.14	245	0.3536	12.11
75	0.3549	12.12	250	0.3534	12.11
80	0.3553	12.06	255	0.3532	12.1
85	0.3557	12.06	260	0.353	12.09
90	0.3562	12.01	265	0.3528	12.08
95	0.3568	12.08	270	0.3526	12.08
100	0.3573	12.11	275	0.3526	12.04
105	0.3577	12.12	280	0.3528	12.03
110	0.3583	12.09	285	0.3534	12.03
115	0.3585	12.09	290	0.3539	12
120	0.3585	12.07	295	0.3542	12.01
125	0.3584	12.05	300	0.3548	12.03
130	0.3583	12.07	305	0.3552	12.04
135	0.3582	12.09	310	0.3557	12.06
140	0.358	12.13	315	0.3563	12.05
145	0.3577	12.13	320	0.3565	12.03
150	0.3574	12.14	325	0.3568	12.07
155	0.3572	12.14	330	0.3569	12.11
160	0.3572	12.14	335	0.357	12.11
165	0.3568	12.11	340	0.357	12.12
170	0.3566	12.1	345	0.3569	12.12
175	0.3564	12.08	350	0.3568	12.13

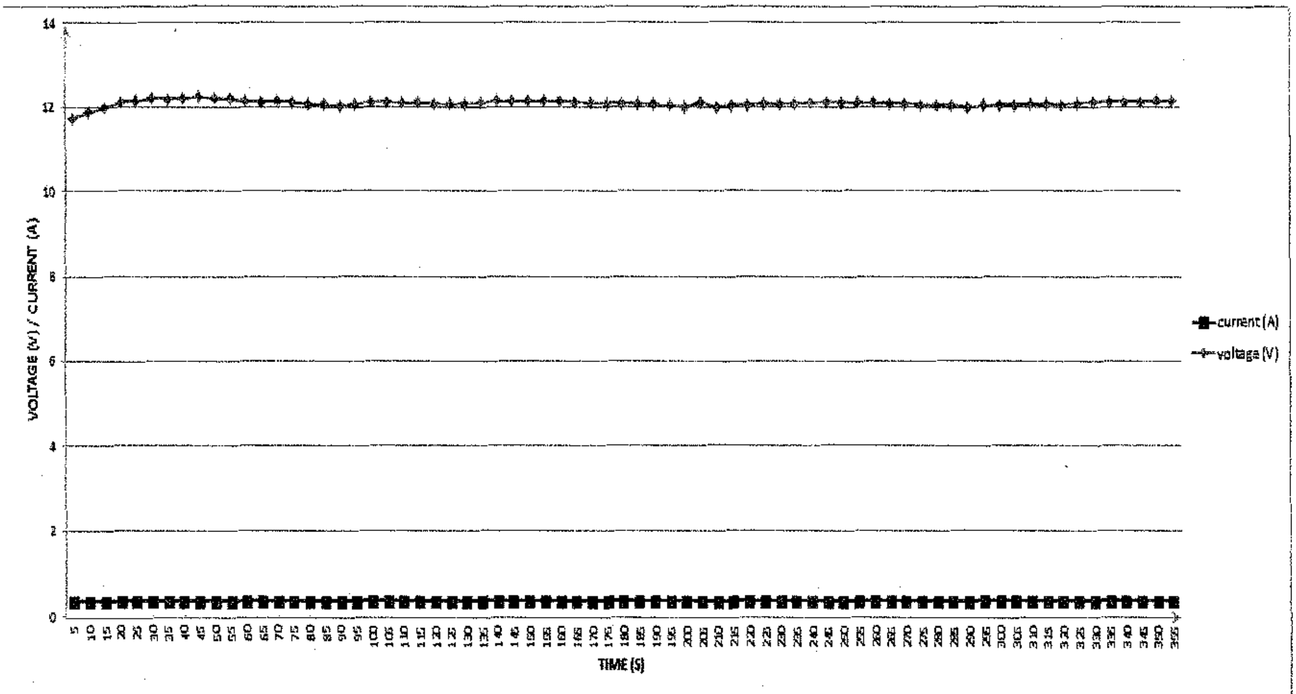

Figure 8: Graph voltage and current vs. time

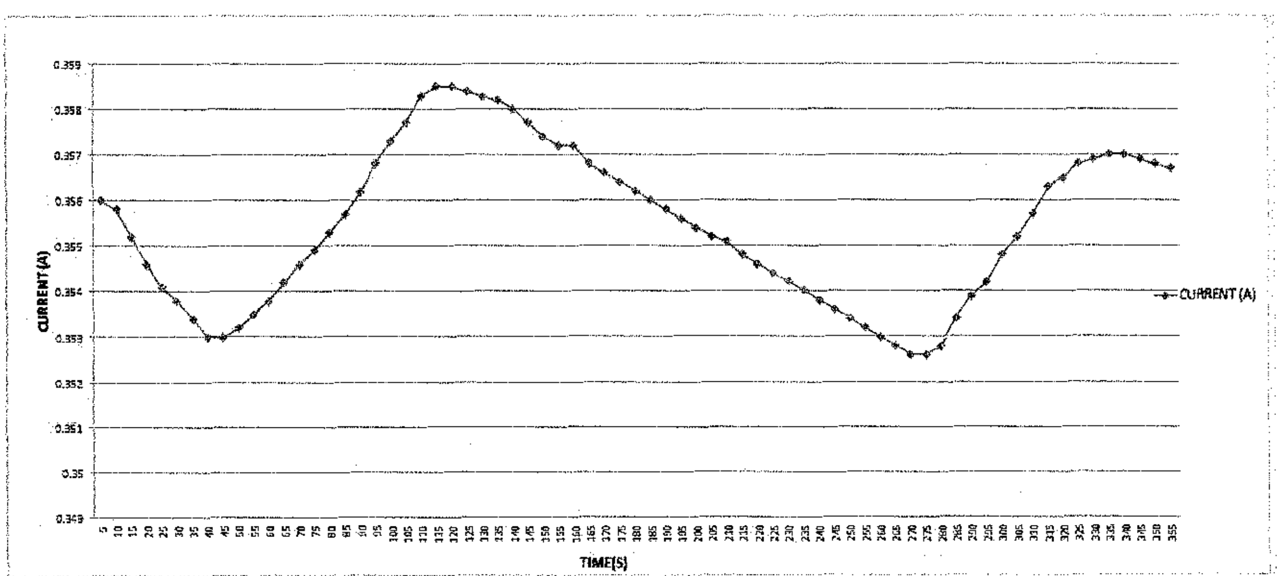

Figure 9: Graph current vs. time

4.2 Calculation of Duty Ratio and Output Current

In order to calculate the duty ratio, D:

Vout = Vin/(1-D)

Vin= 1.2V

Vout=5V

So,

5=1.2/(1-D)

The duty ratio, D=0.76 or 76%

(Time that a system is in an "active“state)

In order to calculate the output current, Io:

Output Current, Io= (1-D) Id

Io= (1-0.76) (1)

Io=0.24A

4.3 Project Specification and Analysis

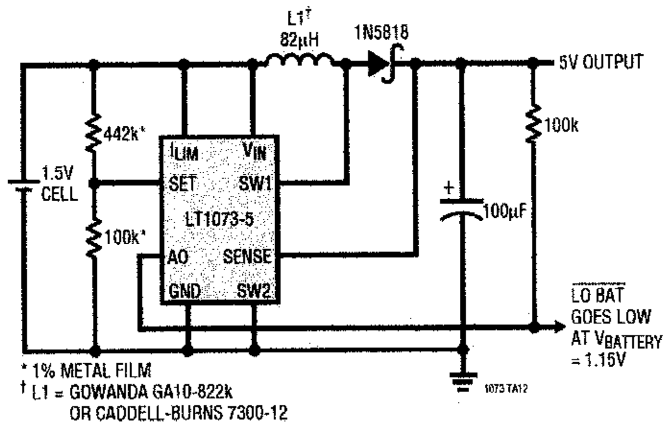

Figure 10: Boost converter circuit

This booster circuit is constructed using LT1073 which is a versatile micro power DC/DC converter that can easily be configured as a step-up or step-down converter and in this project, it is basically being used to step up 1.5V of voltage that was produced by the battery to achieve minimum of 5V of output. When the switch is ON, the diode is reversed biased, thus isolating the output stage. The input supplies energy to the inductor. When the switch is OFF, the output stage receives energy from the inductor as well as from the input. In the steady-state analysis, the output filter capacitor is assumed to be very large to ensure a constant output voltage. The oscillator is set internally for 38ms ON time and 15ms OFF time, optimizing the device for step-up circuits where VOUT » 3VIN, e.g., 1.5V to 5V. Other step-up ratios as well as step-down (buck) converters are possible at slight losses in maximum achievable power output[8].

4.4 Material to Build Power Supply Box.

4.41 Perspex

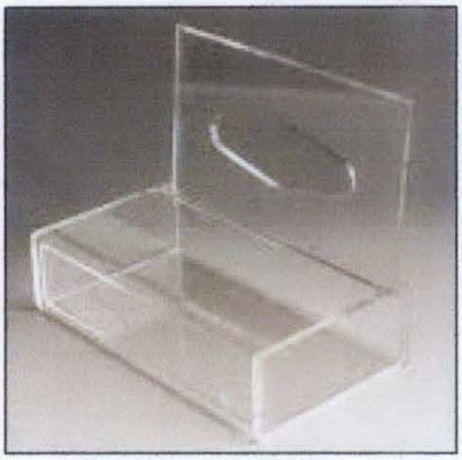

Figure 11: Perspex

Perspex is a trade name of Lucite International and is polymethyl methacrylate (PMMA) acrylic sheet which is manufactured from methyl methacrylate monomer (MMA) [9].

Properties:

- Low water absorption
- Low density 1.19 g/cm3
- Low flammability
- High weathering resistance
- Excellent weather and UV resistance
- Excellent optical clarity

4.42 Plywood

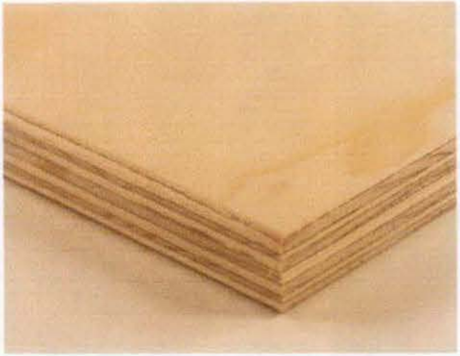

Figure 12: Plywood

Plywood is a type of manufactured wood made from thin sheets of wood. The layers are glued together so that adjacent plies have their wood grain at right angles to each other for greater strength.

Properties:

- Symmetry, so it makes the board less prone to warping.
- Lightweight
- Flammable but flexible
- Cheap in cost.
- High degree of strength (Hardness surface).
- Most widely use for construction and industrial purpose.

4.43 Aluminium

Figure 13: Aluminium

Aluminium is a silvery white member of the boron group of chemical elements.

Properties:

- It can be melted, cast and formed.
- Highly corrosion resistant
- Density 3.80 g/cc
- Hardness, Mohs 9.00
- Tensile Strength, Ultimate 200 MPa
- Compressive Strength 2400 MPa
- Specific Heat Capacity 0.880 J/g-°C
- Thermal Conductivity 25.0 W/-K
- Melting point 660.25°C

4.44 ON OFF SWITCH KCD1-105B1

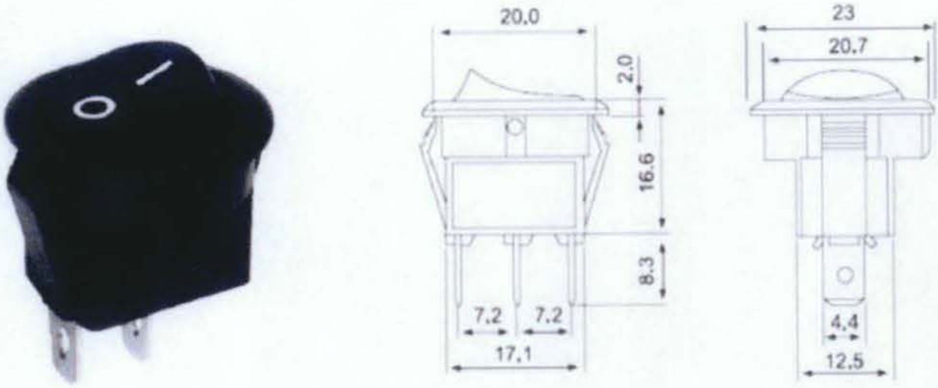

Figure 14: On Off Switch

6A 250VAC

CE, CQC

Mounting size is 20mm

Properties[10]:

1.Rating: 6A 250V, 10A 125VAC

2. Dielectric Intensity: 1500VAC/1min

3. Life: >10000 Cycles

4. Environmental Temperature: -25+85

5. Contact Resistance: <50mΩ

6. Insulation Resistance: >100mΩ

7. Mounting size is 20mm

4.45 Position switch (30 Amp Toggle Switch DPDT 3 Position On-Off-On)

Figure 15: Position Switch

Description:

30 amp, Double Pole Double Throw On-Off- On Toggle Switch. This is a maintained switch meaning it stays locked in the selected position. This heavy duty switch mounts in a .48 diameter hole and it has 1/4 quick connect terminals.

Specification:

DPDT

30A 12VDC, 15A 125VAC, 10A 250VAC,

Mounts in a .48 diameter hole and it has 1/4 quick connect terminals.

UL & CSA Approved.

4.5 Justification for material chosen.

4.51 Perspex

After all the specifications have been considered, the best material to build the power supply box is Perspex instead of aluminum and plywood. The first reason Perspex have been choose as a material is because it is lightweight and low density which is only 1.19 g/cm3.This is the most important criteria to build this power supply box because this is a portable power supply as well as to make the person who have use it easy to carry anywhere and anytime. Furthermore, Perspex is low water absorption. Perspex is also cheap as well as easy to find, abundantly available in the lab or can buy it at any hardware shop. Besides that, it has a high degree of strength because of the hard surface. This is also important to make sure it safe to use for a long time. We can bring along this power supply where ever we want to go, so as a reason, it must have a high degree of strength .Last but not list, Perspex made from insulator material. So, it cannot conduct the electricity through it and surely it save for users. Hence, the surface of this power supply is also no to hot and easy to hold on.

4.6 Justification for power source chosen.

4.61 Nickel-metal hydride battery

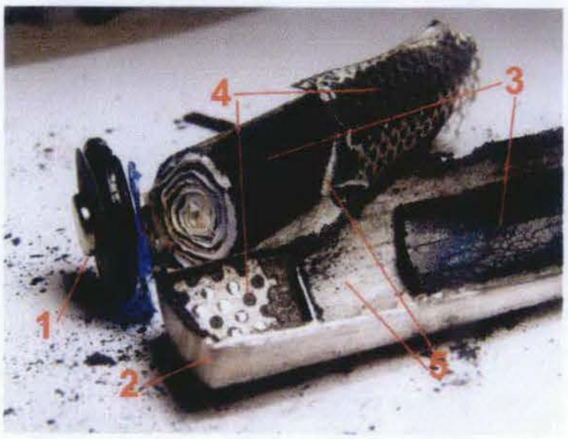

Figure 16: Disassembled NiMH AA cell

1 - Positive terminal

2 - Outer metal casing (also negative terminal)

3 - Positive electrode

4 - Negative electrode with current collector (metal grid, connected to metal casing)

5 - Separator (between electrodes).

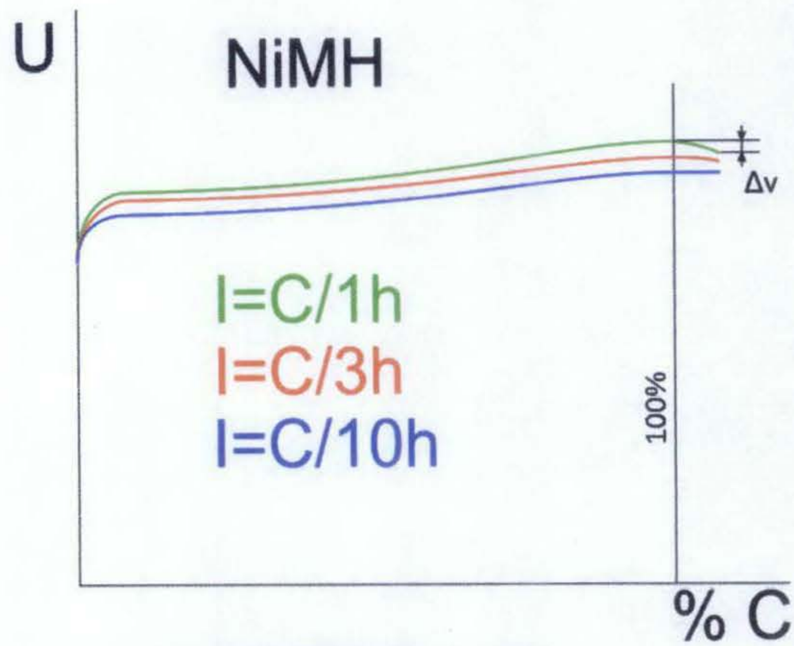

Figure 17: NiMH Charge curve

NiMH cells are not expensive, and the voltage and performance is similar to primary alkaline cells in those sizes. They can be substituted for most purposes. Although alkaline cells are rated at 1.5 volts and NiMH cells at 1.2 volts, during discharge the alkaline voltage eventually drops below that of NiMH. NiMH batteries offer a flatter discharge curve, particularly at higher current draw.

NiMH cells are often used in high drain devices, where over the duration of single charge use they outperform primary (such as alkaline) batteries. Applications that require frequent replacement of the battery, such as toys or video game controllers, also benefit from use of rechargeable batteries. With the development of low self-discharge NiMHs, many occasional-use and very low-power applications are now candidates for NiMH cells.

NiMH cells are particularly advantageous for high current drain applications, due in large part to their low internal resistance. Alkaline batteries, which might have approximately 3000 mA·h capacity at low current demand (200 mA), will have about 700 mA·h capacity with a 1000 mA load. Digital cameras with LCDs and flashlights can draw over 1000 mA, quickly depleting alkaline batteries. NiMH cells can deliver these current levels and maintain their full capacity[11].

Certain devices that were designed to operate using primary alkaline chemistry (or zinc-carbon/chloride) cells will not function when one uses NiMH cells as substitutes. However, this is rare, as most devices compensate for the voltage drop of an alkaline as it discharges down to about 1 volt. A good-quality freshly charged NiMH cell delivers 1.4–1.45 V, very close to the 1.5 V that these devices expect. Such devices would also likely have an extremely short runtime as the voltage from an alkaline falls to 1.4 V quite quickly from the 1.5 V starting voltage. Low internal resistance allows NiMH cells to deliver a near-constant voltage until they are almost completely discharged. This will cause a battery level indicator to overstate the remaining charge if it was designed to read only the voltage curve of alkaline cells. The voltage of alkaline cells decreases steadily during most of the discharge cycle. [12] .So by using the rechargeable battery, this power supply will provide long life use and high reliability.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From the results obtained, the portable power supply produces enough power up many electrical devices and also as test equipment. This invention can be used at anyplace because it is portable and lightweight. This product is practical and beneficial device, environmentally friendly, not require high operating cost and convenient installation. The objective of this project is fully achieved which is to produce 5V and 12V and also suitable for outdoor use because it is portable. The size also compact and lightweight compare to the bench top power supply.

Obviously, I will be creating a power supply that will meet all the student criteria. Realistically I need to decide which requirements can I meet and which will be impossible to meet or maybe I can meet all the requirements. This power supply will meet all the requirements that I have specified. The advantages of this power supply are that it will be low cost as well as efficient and durable. The fact that it is essential to design a power supply that has to be low cost can be a disadvantage to me. I need to take into consideration how cost affects the efficiency and durability of a circuit. In my minds, I think the more money I pay the more quality I get.

5.2 Recommendation

The objective of this project is fully achieved and several improvements shall be made;

- Develop large capacity storage element such as ultra capacitor so that this product can power up appliances for longer duration; which at the same time is light enough.
- Using renewable energy for the input power-large source of energy.
- Variable output of voltage.

This enhancement is important since it will enlarge product's application in daily life.

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APPENDIX

APPENDIX A

GANTT CHART

Table 8: Gantt chart

WEEK	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
TITLE														
Circuit Design														
Progress Report														
Material Selection/Design														
Data Analysis														
Fabrication														
Circuit														
Cutting/ Joining														
Assembling														
Testing														
Finishing														
Final Touch Up														
Report/Posters														

APPENDIX B

SCHEMATIC DRAWING

LIGHTWEIGHT PORTABLE POWER SUPPLY SCHEMATIC DRAWING

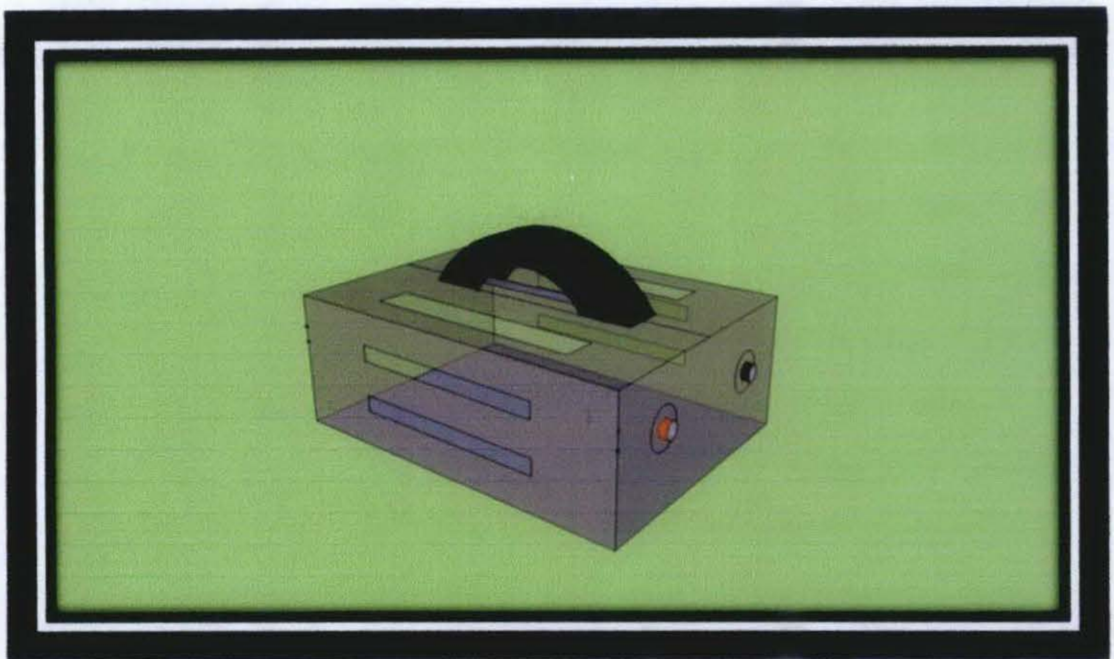

Figure 18: 3D VIEW

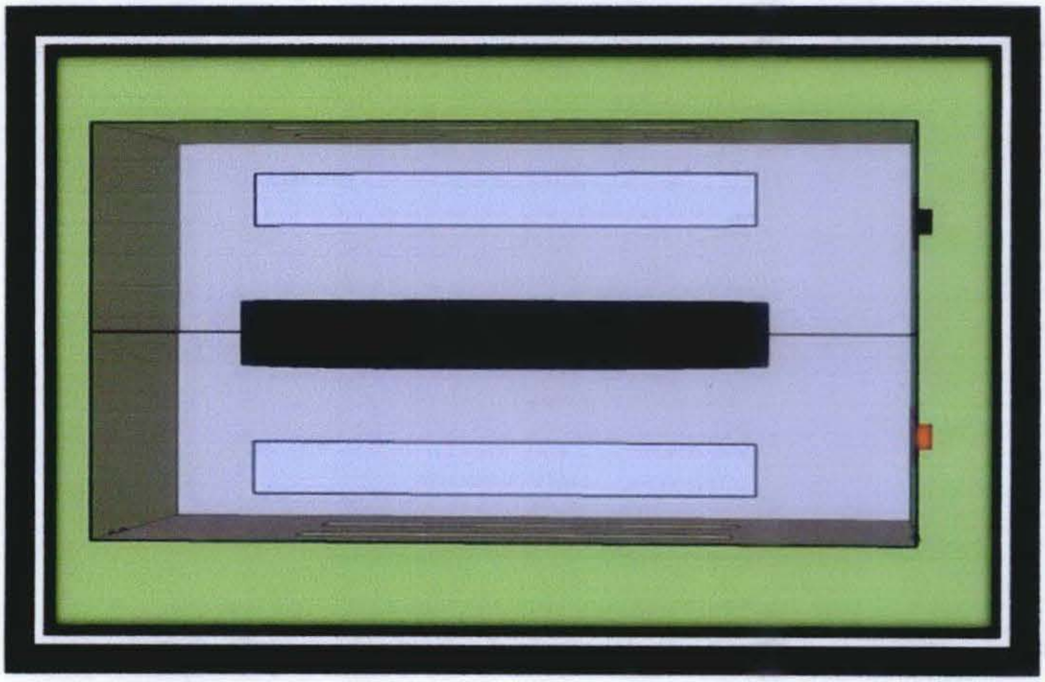

Figure 19: UPPER VIEW

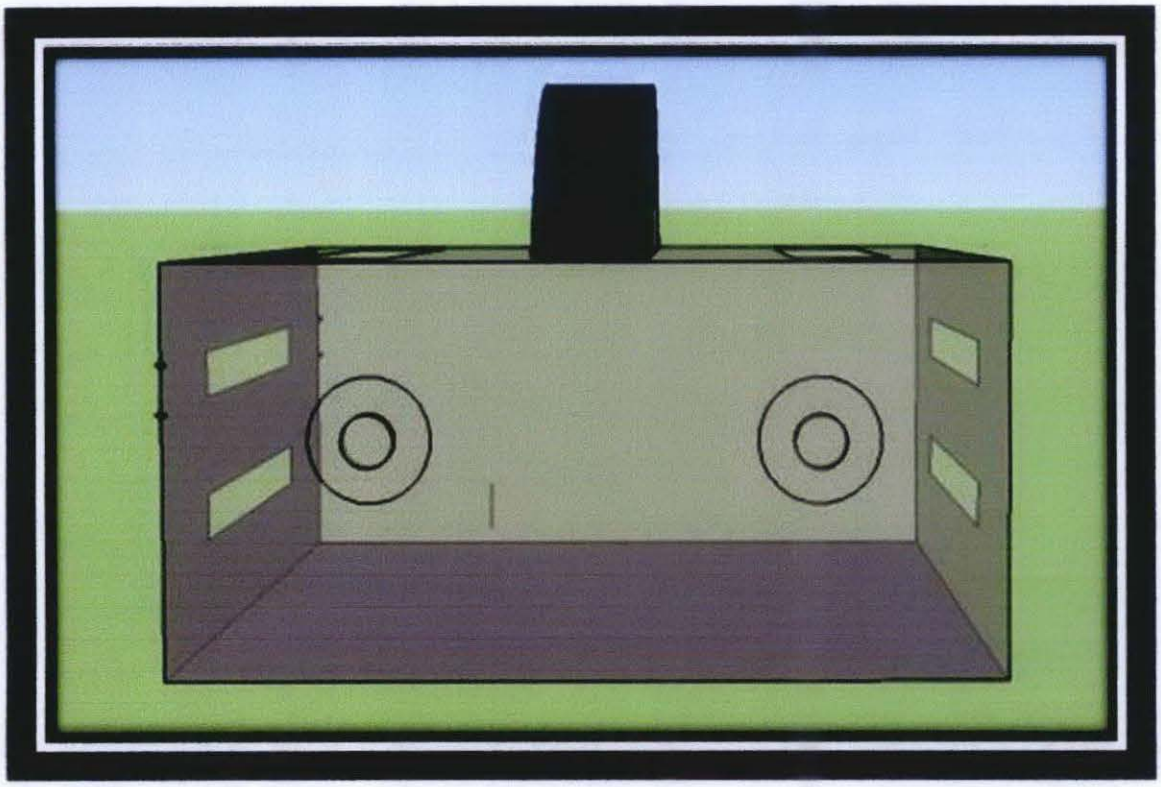

Figure 20: SIDE VIEW 1

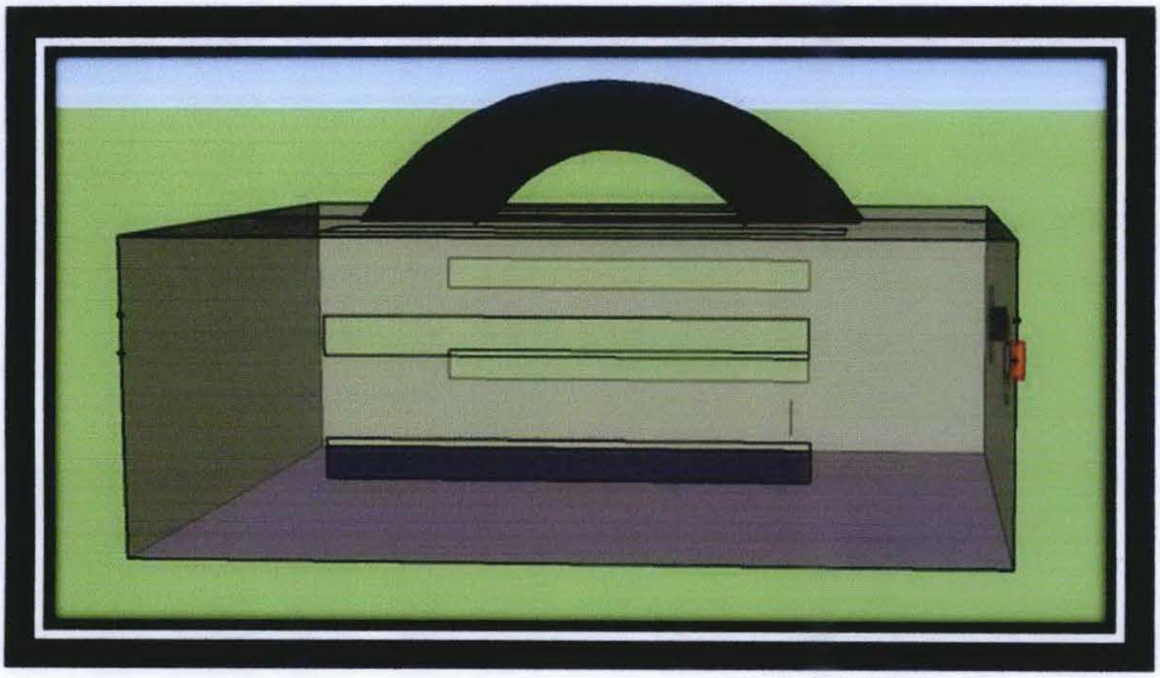

Figure 21: SIDE VIEW 2