

Portable DC/AC Power Kit

by

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Final report in partial fulfilment of
the requirements for the
Bachelor of Engineering (Hons)
(Electrical & Electronic Engineering)

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CERTIFICATION OF APPROVAL

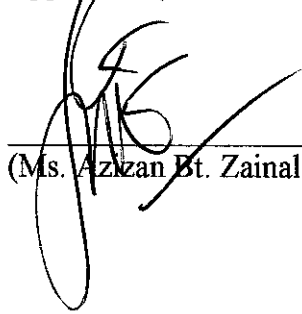
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A project final report submitted to the
Electrical & Electronic Engineering Programme
Universiti Teknologi PETRONAS
in partial fulfilment of the requirement for the
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Approved by,



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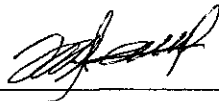
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TRONOH, PERAK

June 2009

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.



ZAINAL FARID BIN BURHANUDDIN

ABSTRACT

Due to the increasing demand of power usage nowadays, many kinds of power sources are available in the market. Usually these power sources are limited to indoor usage only. This will be a disadvantage for those with hobbies doing outdoor activities. The most important question is, "Are these power sources available in Alternating Current (AC)?" This is because most electrical equipment uses AC power to operate. The objective of this project is to design a new portable power kit that will supply an AC source by inverting a DC source from a battery as the main power source. To achieve the objectives of this study, information is gathered through internet, magazines, journal and etc. Followed by prototype model designing, testing and lastly finalizing the prototype. To do the prototyping successfully, a set of tools, equipment or software is needed in constructing the prototype. Pliers and hammer are examples of mechanical tools that will be used, whilst wire stripper and soldering iron are electrical tools needed to complete this project. PSPICE is used to simulate the circuit to make sure that there is no malfunction in the circuit. Before the completion of the hardware, the most important part is the circuit that will be used. Results from the simulation of the inverter circuit will be obtained. To support the need for this project, a set of questionnaire is distributed amongst colleagues and the general public residents. By knowing some feedback from the questionnaire subject, this portable power source can be built in the preferred feature such as low cost or lightweight. It is hoped that this project will achieve its objectives in providing an alternative source of energy especially for those who prefer outdoor activities.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Portable DC/AC power kit is defined as portable power source kit that can provide power to someone far from home or any other power sources. Physical appearance of this portable power kit is in a box. The box contains battery as the main power for this portable power source kit. This box is designed as a kit. This kit is designed so that it is user friendly, can be used anywhere under all circumstances. Although many types of power source are available in the market, not all these products are suitable for this purpose. For example, if a person likes to do the outdoor activities then he/she must need a power source to light up his/her bulb or anything else. Then, definitely he/she must prefer to have a portable power source that is simple and user friendly.

Portable DC/AC power kit is operating with 12V DC battery as the main power. An inverter circuit will then be used to invert the 12V DC to 220V~240V AC. The purpose of inverting DC voltage to AC voltage is because most of the electrical equipment that we used in daily life is using the AC voltage to operate. Then the equipment itself will do the rest and determine level of voltage required. To restore the battery power, a charging unit will be included to charge the battery.

Portable DC/AC power kit is designed compatible for many purposes. This portable power kit is designed to help people who are always in need of power anywhere and anytime. Besides, this new portable power source needs to provide an alternative to the less user-friendly ones that are currently available identified as a burden to the users.

1.2 Problem Statement

As the world moves on, energy demand in the developing countries is increasing. This situation had led global efforts in developing new technologies that use alternative energies such as wind, solar, hydro, biomass, etc. Amongst these alternative energies, solar energy is widely selected to be used. It is because this alternative energy is cheaper compared to the rest.

Due to this situation, we can see that many kinds of power sources are made available in the market. An example is the generator. Usually the generator is used by the hawker at the night market. The structure of the generator consists of a motor on the inside. It uses fuel or diesel to run the motor and the electricity power sources will be generated to light up bulbs and lamps. This fuel or diesel consumption makes it too costly to be used. Also this generator is difficult to handle. Because the generator is usually heavy and once it is damaged the maintenance fee will be costly. Many kinds of power sources are like this.

1.3 Objective

The objective of this project is to design a new portable power source kit that will be available in AC source. The main power bank is battery. The battery will supply 12V DC power. With the same supply, the voltage will be converted into AC by an inverter circuit. Target voltage converted is 240V AC. To charge the batteries, a solar panel will be used as the power source for the charging unit.

1.4 Scope of Study

This project is based on the study and implementation of knowledge in power system to design a new portable power kit and completed approximately within one year (phase 1 & phase 2).

The scope for phase 1 of the project is to research on the AC power. How will DC power source be converted to AC? With the appropriate circuit construction, the DC voltage will be inverted to AC. There are two methods of converting DC power to AC power. First method is by inverting 12V DC to AC and stepping up the voltage using a transformer. The second method is by boosting up the 12V DC first by using boost converter circuit and then inverting to AC by using the inverter circuit. This phase need to be completed in 1 semester (approximately 4 months).

Scope of phase 2 is the implementation of research material into the hardware. Phase 2 involves the design of the prototype of a portable kit that is user friendly. Once the implementation is completed, tests will be carried out to determine whether the objectives are achieved or not.

CHAPTER 2

LITERATURE REVIEW

2.1 Method Analysis/Identification

The demand of power is increasing and results indicate increasing demand of power consumption everywhere. As stated earlier, there are two possible methods for DC voltage to be converted into AC voltage. It is either by inverting directly from DC voltage to AC voltage and using transformer to step up the voltage or by using boost converter to step up the voltage and invert it to AC by using inverter circuit. Below is some information about the two circuits that may be used.

2.1.1 Method 1

Method 1 consists of two unit circuits. These made up of the inverter circuit and also the dc-dc converter circuit. Basically there are a few types of dc-dc converters. The one that will be used is a boost converter. The boost converter circuit is a dc-dc converter that converts dc-dc voltage from one DC level of source voltage to another level of DC voltage. It will convert the DC voltage to a higher level DC voltage compared to the input voltage. The operation of the circuit starts when the switch S (see Appendix A) is closed, resulting in an increase in the inductor current. In the off-state, the switch is opened and the only path offered to inductor current is through the flyback diode D, the capacitor C and the load R. This will result in transferring the energy accumulated during the on-state into the capacitor. Refer to Appendix A for example of Boost Converter circuit diagram [1].

2.1.2 Method 2

Method 2 consists of one circuit. The circuit that will be used is known as the inverter circuit. The inverter is a converter that changes a DC voltage to an alternating voltage (AC). The AC voltage will be produced once the DC supply is supplied at the input terminal +12V. Appendix B shows an example of inverter circuit diagram. The operation starts when Q1 and Q2 in the Appendix B diagram alternately function on/off. Q1 and Q2 also will determine the value of wattage that inverter can supply, and T1 will be a step up transformer to step up the voltage to required voltage value [2].

Table 1 shown below is the comparison between two methods that have been mentioned in terms of the advantages and disadvantages.

Table 1: Comparison between two methods.

Method 1	Method 2
<ol style="list-style-type: none">1. Required two types of circuit2. Lighter3. A bit complex since using two different circuits.	<ol style="list-style-type: none">1. Using one circuit only.2. A little heavy (using transformer)3. Simple construction when implement to hardware later.

From table above, it has been decided that Method 2 will be used for this project. The reason for choosing this method is because Method 2 consists of one circuit that will be used. By referring to the title of this project, it should be a simple design that is a portable. By having only one circuit in the portable power source, it should be cost effective. This is because less electronic component will be used that will reduce the construction costs.

2.2 Product Comparison

With the technology developing rapidly, there are many kinds of portable power sources that are available in the market. The availability of these power sources in the market is due to the increase in power demands. The product that will be described is available in the market, however the production such products has ceased for unknown reasons. The product that is available in the market is Coleman Portable Power Kit. The Coleman® Portable Power Kit is a combination of three products. The power kit also includes a battery backup power source and an AM/FM radio and LED light. The three products that include in this portable power kit are as shown in the Table 2 [3]:

Table 2: Components and description in Coleman Portable Power Kit

Components	Description
iSun Solar Charger	The Coleman® <u>iSun</u> is a complete portable solar charger. Use the power of the sun to recharge the Coleman® chargepak, as well as small electronics, using the included power adapters.
Light & Sound	The Coleman® light & sound is an all-in-one flashlight / ambient light / AM-FM radio portable accessory powered by the Coleman® chargepak. It will give you hours of bright light and clear listening. power
Chargepak	The Coleman® chargepak is a compact source for the light & sound that can also charge small electronics such cell phones, GPS units and digital cameras.

The availability of power source in this product is however limited to charging purposes. It does not include any sockets that provide power to the electrical components. The product is equipped with a light source, but what if the person wants to power up the external light or any other electrical equipment that uses AC or DC source?

2.3 Circuit Description

2.3.1 Inverter Circuit

An inverter is an electrical device that converts direct current (DC) to alternating current (AC). The AC voltage from the output of inverter circuit can be at any required voltage magnitude by using the appropriate transformer, switching circuit and control circuit. The DC power source can be from any sources such as batteries or solar panel. Earlier inverters were built with Silicon Control Rectifier (SCRs). Since the circuitry required to turn-off the SCR tends to be complex, other power semiconductor devices such as Bipolar Junction Transistors (BJT), power MOSFETs, Insulated Gate Bipolar Transistors (IGBT) and MOS-controlled thyristors (MCTs) are used nowadays. An inverter can be divided into three general categories [5]:

Table 3: Inverter Type and Description

Inverter Type	Description
Pulse-Width-Modulated (PWM) Inverter	For this inverter, the input DC voltage is essentially constant in magnitude. Therefore the inverter must control the magnitude and the frequency of the ac output voltages. Hence inverter called PWM inverters are used to achieve this.
Square-Wave Inverter	In this inverter, the input DC voltage is controlled in order to control the magnitude of the output ac voltage. The AC output voltage has a waveform similar to a square wave, and hence these inverters are called square wave inverter.

2.3.1.1 Operation of Inverter Circuit

All the dc-to-ac inverter topologies are derived from the basic circuit construction on Figure 1. To make easier understanding of inverter circuit operation,

let assume that the input DC voltage is constant and the inverter switches are pulse-width modulated to shape and control the output voltage.

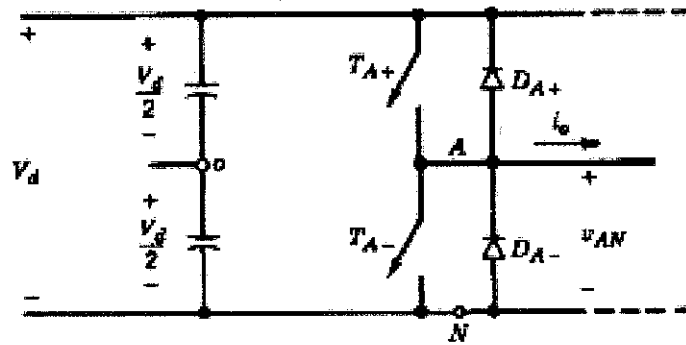


Figure 1: Basic Inverter Circuit

A. Pulse-Width-Modulated (PWM) Inverter

The good inverter circuit is the one that the ac output can be controlled. In order to produce a sinusoidal output voltage waveform at a desired frequency, a sinusoidal control signal at the desired frequency is compared with a triangular wave form as shown in Figure 2. The frequency of the triangular waveform establishes the inverter switching frequency and is generally kept constant along with its amplitude V_{tri} .

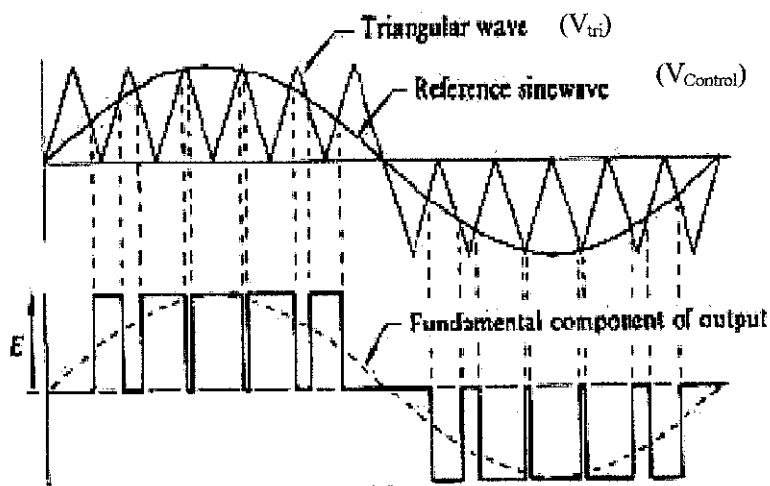


Figure 2: Control Signal and Triangular Wave

The basic concept of the PWM method is the division of the on-time into several on and off periods with varying duration. The value of the ac voltage is controlled by the on-time of the switches. The most frequently used PWM technique is Sinusoidal

Pulse Width Modulation. This approach requires a bridge converter with IGBT or MOSFET switches shunted by an anti-parallel connected diode. The diode allows current flow in the opposite direction when the switch is open. This diode also provides protection against transient over voltage, which may cause reverse breakdown of the IGBT and MOSFET switches. The typical circuit diagram is shown in Figure 3. During the positive cycle, S_1 and S_2 are switched on by the high frequency pulse train. During the negative cycle, the pulse train switches S_3 and S_4 are on state. The load inductance integrates the generated pulse train and produces a sinusoidal voltage (V_{ac}) and current wave. The switches in this converter are controlled by gate pulses. The gate signal contains several pulses distributed along the half-cycle.

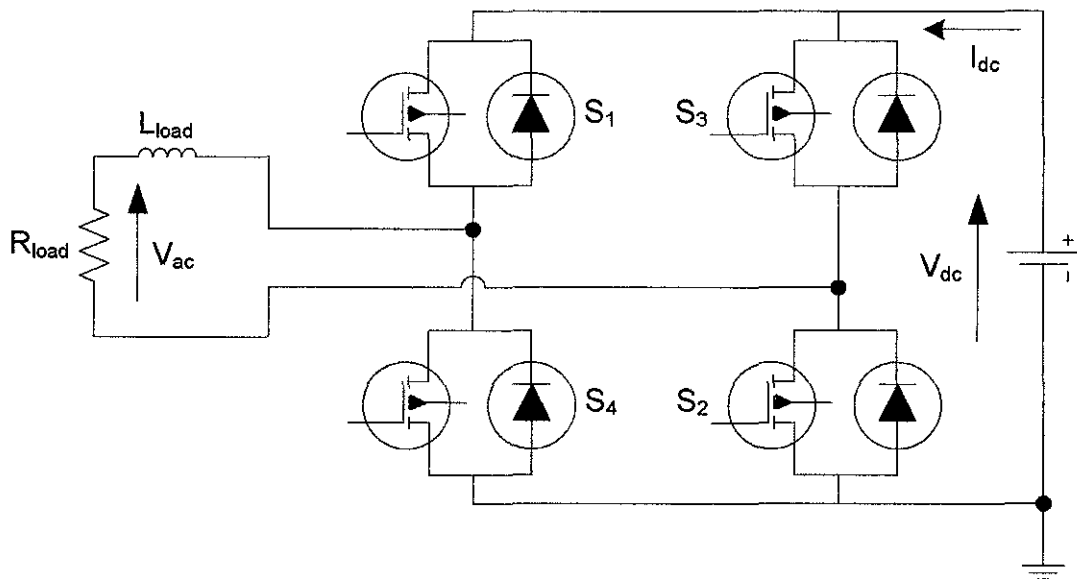


Figure 3: Typical PWM Circuit Diagram

B. Square-Wave Inverter

This type of inverter produces a square wave waveform at the output side. This square wave output voltage can be obtained from a simple switching scheme. According to Figure 4, the first half cycle of the circuit operation is conducted when switches S_1 and S_2 are closed. And the output voltage waveform corresponding to this cycle is according to Figure 5 from time 0 to $T/2$. While the other half cycle are conducted when switches S_3 and S_4 are closed. And result from this operation is according to Figure 5 vary from time period of $T/2$ to T . The periodic switching of the load voltage between $+V_{dc}$ and $-V_{dc}$ produces a square-wave voltage across the

load. The output is alternating but non-sinusoidal. But, note that switches S_1 & S_4 or S_2 & S_3 should not be closed at the same time.

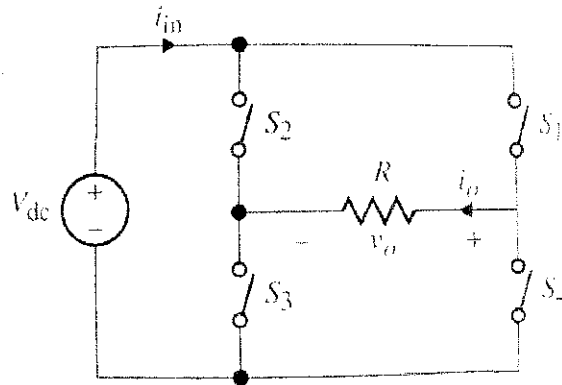


Figure 4: Square-Wave Inverter Circuit

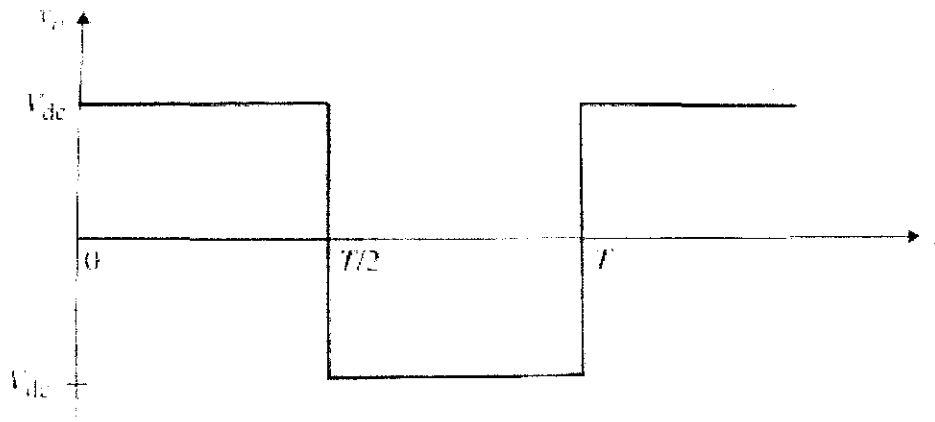


Figure 5: Square-Wave Inverter Output Waveform [5]

2.3.2 Boost Converter Circuit

Boost converter is one of the dc-dc converters that convert DC voltage from low level to high level dc voltage. The basic topology of this circuit is shown in Figure 6.

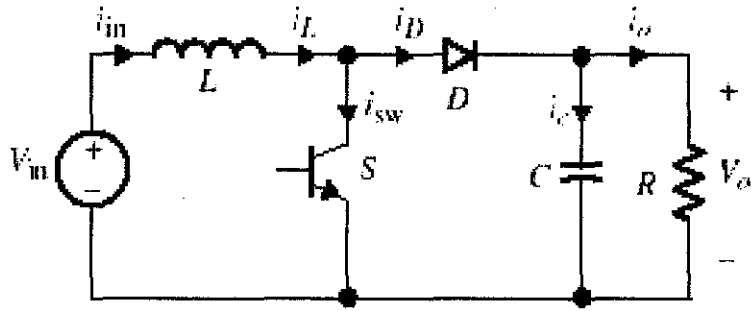


Figure 6: Basic Topology of Boost Converter Circuit

The operation of this circuit (Figure 6) starts when switch S turn on and off alternately. During the on-state, the current in the inductor is recharging. The circuit diagram during this state can be seen as in Figure 7.

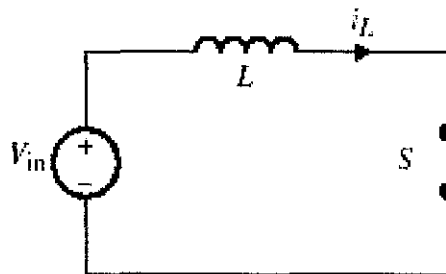


Figure 7: Circuit Condition during On-State

When the operation of the circuit in Figure 6 comes to the off-state of switch S, the current stored earlier in the inductor, L during the on-state start to discharging and flow in the circuit. The circuit during this off-state can be referred to Figure 8.

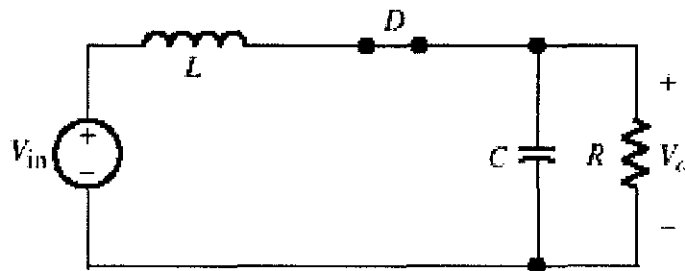


Figure 8: Circuit Condition during Off-State

For the waveform of current and voltage in the circuit during these two states referred to Figure 9 [6].

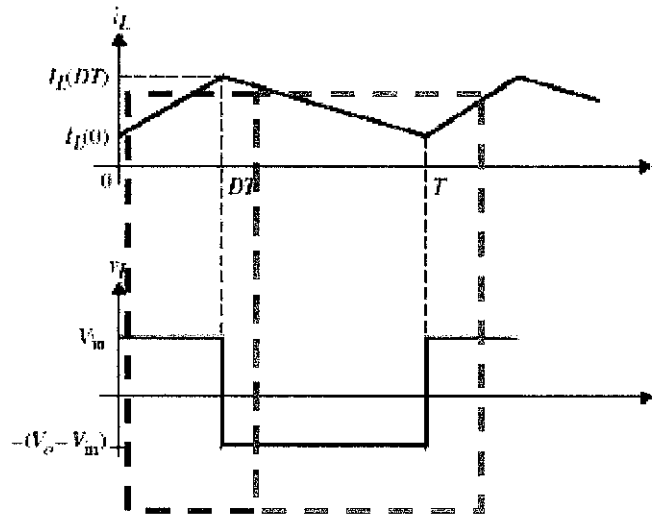


Figure 9: Current and Voltage Output Boost Converter

2.4 AC vs DC

Both AC and DC have its own advantages and disadvantages. But the common used as a main power to generate the power to power up the electrical equipments is AC. Compared AC with DC, AC have its own advantages why it have been chosen as the main power. The advantages of AC over DC are:

- 1) AC is safer than DC.
- 2) AC has less loss compared to DC when transmitted over a long distance.
- 3) AC is more efficient.

2.4.1 AC Safer Than DC

When we are talking about safety, more people tend to ask which one of these two currents is safer. Both of these current is lethal if you are getting a shock by it. But in term of safer, AC is safer compare to DC. It is because AC voltage

varies from 0 to its maximum value. So the person gets a time to remove his part of the body from the source. While for DC is smooth and invariable voltage. There is no interval time for the voltage to go to zero.

2.4.2 AC Less Power Loss

One of the reasons why AC has been chosen as the main power to transport over a long distance is because it has less power loss compared to DC. This is because when we transfer the voltage a long distance it's the best to transfer with high voltage capacity. AC is easier to transform into high or low voltage with less loss. The transportation of electrical energy through a long distance has a resistance, R for a conductor. The power lost in the conductor is $P = I \cdot V$, but $V = I \cdot R$. So, the earlier equation become $P = I^2 \cdot R$. When I is held with small value, therefore the voltage must be really high related to I and P. At the end of the transmission, the voltage will be stepped down and the current, I will be increased to meet the user requirement. This can be done because AC can be easily converted and can work with transformer while for DC cannot work with transformer and it is hard to converted DC into another form.

2.4.3 AC Is More Efficient

Due to the less power loss in AC, AC voltage is more efficient. To compute the efficiency, $\eta = \frac{P_o}{P_{in}} \times 100\%$. P_o refers to the output power and P_{in} refers to input power. The more the losses occurred, the less power will be obtained on the output side. According to the efficiency equation, the lesser the output power, the less efficient is the system.

CHAPTER 3

METHODOLOGY

3.1 Design procedure

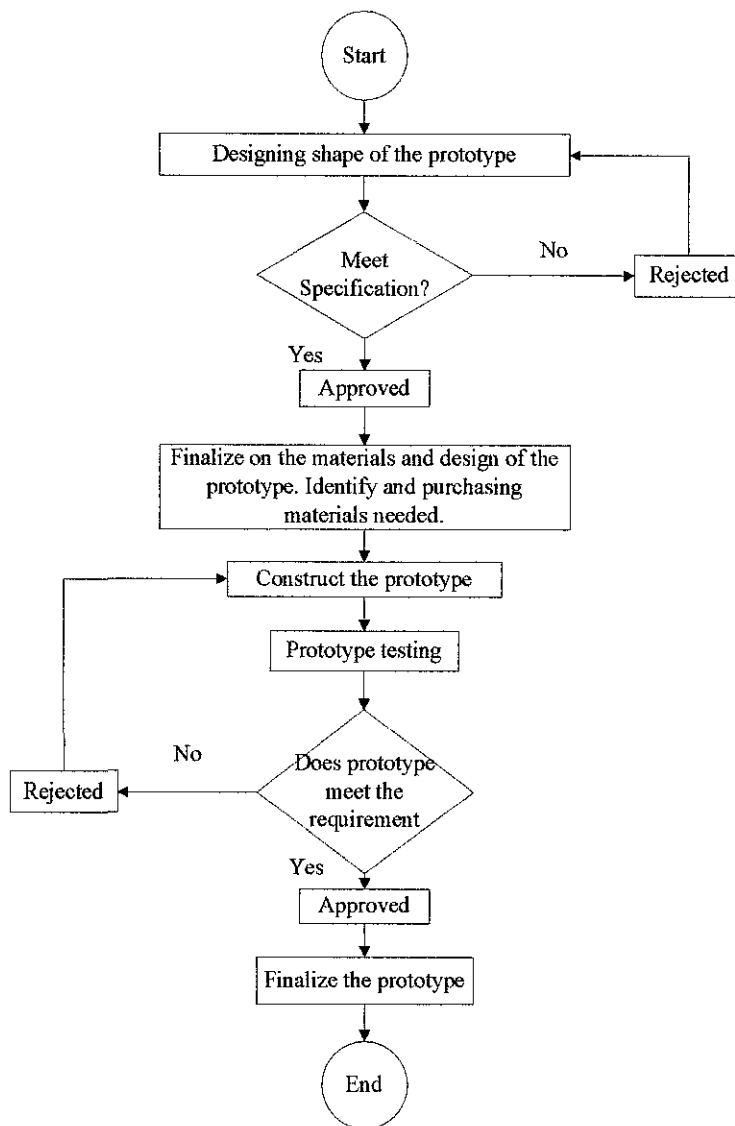


Figure 10: Flowchart of the project

3.2 Project Activities

Project activities for the project are doing some circuit simulation and designing a set of questionnaire, the priority given to the circuit simulation. By doing the simulation, the output of the circuit can be predicted. The simulation involves the circuit that will be used for this portable power source. The circuit is known as the inverter circuit. Expectation of the output is AC voltage range 220V ~ 240V. This high value voltage is obtained from the step up transformer. The transformer will be placed at the output of the inverter circuit. The DC voltage itself is converted to AC voltage by the circuit.

A questionnaire is used to support the need for the project. The purpose of this questionnaire is to survey the need for the portable power source due to the situation of increasing power demand. Secondly is to survey the important features by public demand that should be considered when dealing with the portable power source. The main subjects of this questionnaire are students on the UTP campus and some local residents in the campus vicinity. Discussions of the results are found in Chapter 4.

The third activities of the project, is to design the portable power kit. This is the first step to make a prototype. Raw design of the portable power kit is to ensure that the real design is fit to the design requirements and also can fit all the equipments that will be used such as battery, circuit and etc. The material used to construct the prototype is wood. Raw design of the portable power kit will be displayed under Chapter 4. Under the same section, figure of the prototype also will be displayed.

3.3 Tools and Software

PSPICE will be used to estimate the output of the circuit. The prototype must be designed to meet the specifications. Besides that, PSPICE, mechanical and electrical tools are used to make the prototype as designed and described as follows:

A. PSPICE

For this kind of software, it is for viewing the output of electronic circuit in any conditions. It also can do almost every basic principal and concepts of electronic circuits. It can be predicted what will be the output of circuit that we want to see. Below are some of the functions that PSPICE is capable of,

- i. Simulate the circuit.
- ii. View the output of the circuit using graph as the main medium to show the outcome from the circuit.
- iii. Detect if there are any mistakes in the circuit.

B. Tools

- Mechanical part
 - Pliers
 - Hammer
 - Steel saw
 - Power driller or hand drill
 - Screwdriver
 - Cutter machine
- Electric & Electronic Part
 - Soldering iron and solder sucker
 - Wire stripper
 - Circuit board

Besides using the stated tools and software mentioned, there is another software that will be used for the circuit simulation purpose which is Multisim. Multisim is a software of schematic capture capabilities, integrated with full analog/digital simulation and can be transferred to PCB layout. It offers a single,

easy-to-use graphical interface for all your design and analysis needs. The difference between Multisim and PSPICE is that Multisim contains all the equipment that is used as the test equipment in one window. Some examples of this test equipment are oscilloscope, multimeter, function generator and etc. So by using Multisim, the user can place the required equipment directly on to the circuit that have been constructed earlier on.

CHAPTER 4

RESULTS & DISCUSSION

4.1 Results

4.1.1 Circuit Simulation

The inverter circuit is simulated using the mentioned software. This step is to ensure that the circuit is working and the output from the circuit is accurate. The expectation output of the circuit is a sine wave. Figure 11 below shows the example of a sine wave [4].

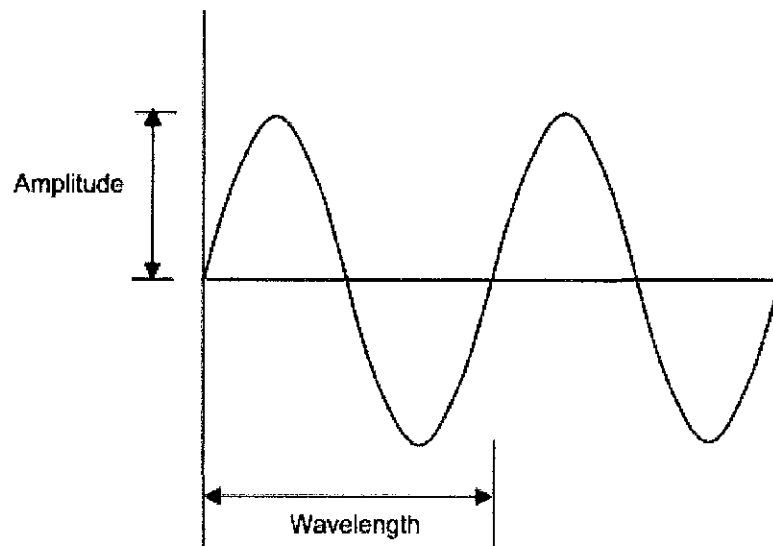


Figure 11: Sine Wave (Expected Output)

The steps done for the simulation are by constructing the circuit in the layout page of the software used. Then, appropriate connections between the components for the complete circuit are made. Next, is to ensure that there is no short circuit between two components that have no connection. The connection between two points is indicated by the red dot (•). The circuit is run by hitting the 'Run' button to

start the circuit simulation. And the output of the circuit simulation is represented in discussion section by graph shown in Figure 14.

4.1.2 Questionnaire/Survey

The second part of the activities is carrying out a survey. This activity was successfully done. The objective was to find out the need of users and to make sure that this project is worth doing. In the future, anyone would not hesitate to have one unit of this portable power kit. Subjects for this questionnaire are among the colleagues in the campus and local residents around the campus. A total of seventy five random persons were chosen to do this survey. From seventy five persons, fifty are UTP colleagues and another twenty five are the local residents around the campus. Results and analysis of this survey are as described in the discussion section.

4.1.3 Circuit Testing

The real circuit have been construct and tested. With the appropriate components identical to the circuit simulation, the constructed circuit being tested and the result have been recorded. The result obtained from working on the real unit is as follows:

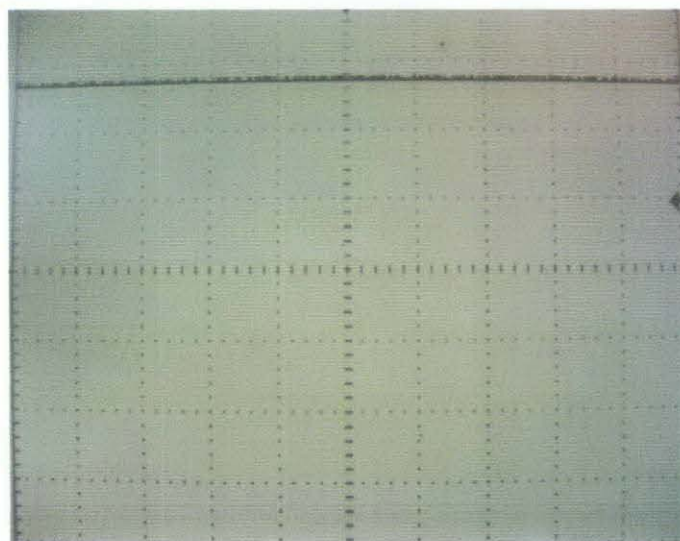


Figure 12: Input from Working Unit



Figure 13: Output from Working Unit

Details of this working part are as described in the discussion section.

4.1.4 Prototype Design

Below is the respective figure for the draft design and real unit of prototype.

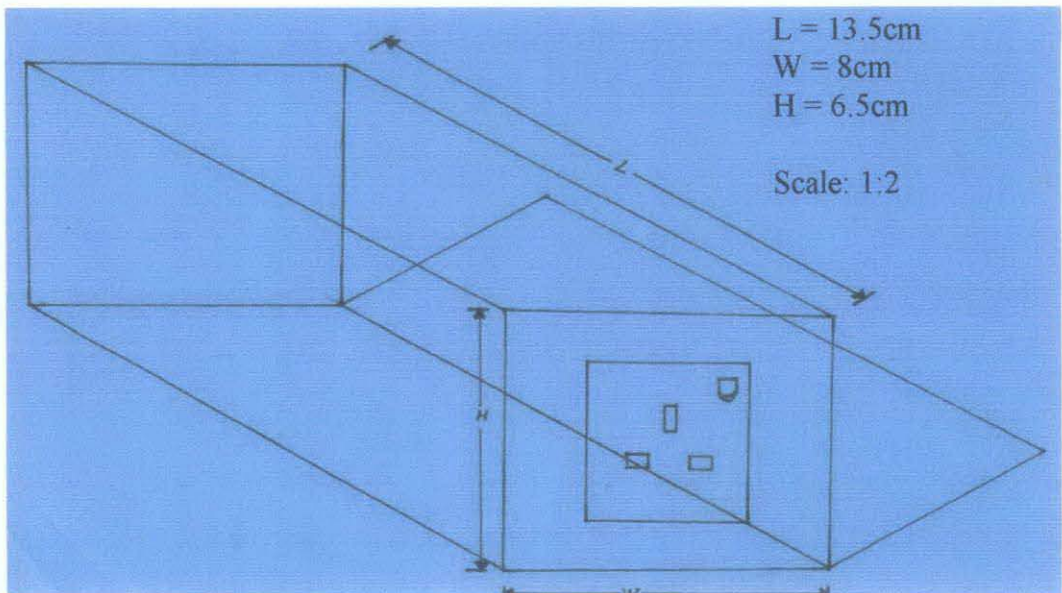


Figure 14: Draft Design of Prototype



Figure 15: Prototype Design (I)



Figure 16: Prototype Design (II)

By referring to Figure 14, Figure 15 and Figure 16, Figure 14 shows the raw design of prototype while Figure 15 and Figure 16 show the real unit design of prototype. For this project, the material used for construction of prototype is wood. The reason why wood have been chosen is because it categorized as a bad conductor. This project involving high voltage and safety must be place at first place. The existence of battery as a main supply increases the risk that a person will get a shock. The dimension if this prototype is $27cm \times 16cm \times 13cm$ ($L \times W \times H$). The dimension is excluding width of wood.

4.2 Discussion

4.2.1 Circuit Simulation

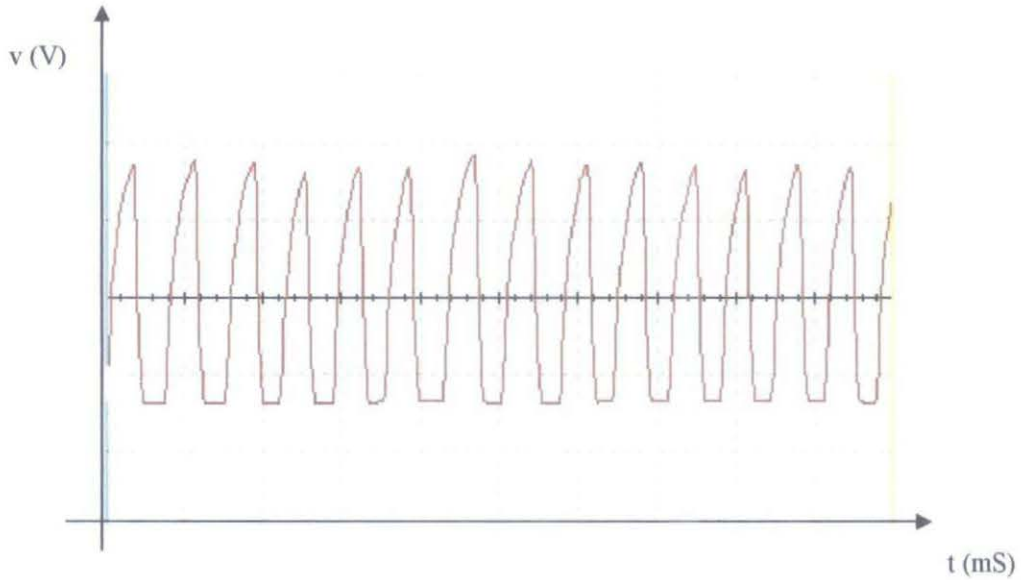


Figure 17: Simulation Output

By referring to Figure 17, the waveform shown is the output from the simulation circuit. The waveform is quite similar to the sine wave. It can be said that the output obtained from the circuit is not purely a sine wave. It can be said that the constructed inverter circuit in the simulation is not a purely sine wave inverter. The inverter can be called a Square Wave Inverter. This is because the output from the simulation looks like a square wave. Even though the inverter is not a purely sine wave, the output from this circuit still can be considered as an AC voltage. Beside from the mention reason why the output is as in the figure, another reason is probably due to the component used in the simulation. The components that have been used are not the real components as in the circuit. The components used in the simulation are the equivalent component to the original one that should be used in the circuit. What does it mean by the word equivalent is the technical specification of the component. There are two components that have been replaced for the simulation purpose: transistor 2N3906 equivalent to transistor 2N2905 and transistor 2N2222A equivalent to transistor 2N3055.

4.2.2 Questionnaire/Survey

The represents following pie charts are the results of the questionnaire that have been done. From seven questions that have been asked, three questions have been chosen for the analysis and discussion for the feedback and to support the project itself. These three questions are:

- i. Is portable power source need for the outdoor activities?
- ii. What is the most preferred feature for this portable power kit?
- iii. Agree or not if AC and DC voltage is available in one portable power kit?

From the earlier observation, the results of this questionnaire give a positive feedback to the project.

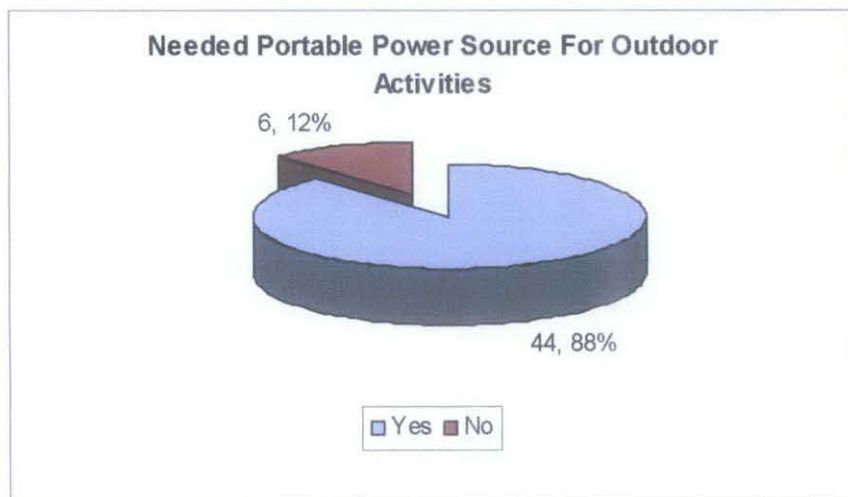


Figure 18: Needed Portable Power Source for Outdoor Activities (UTP students)

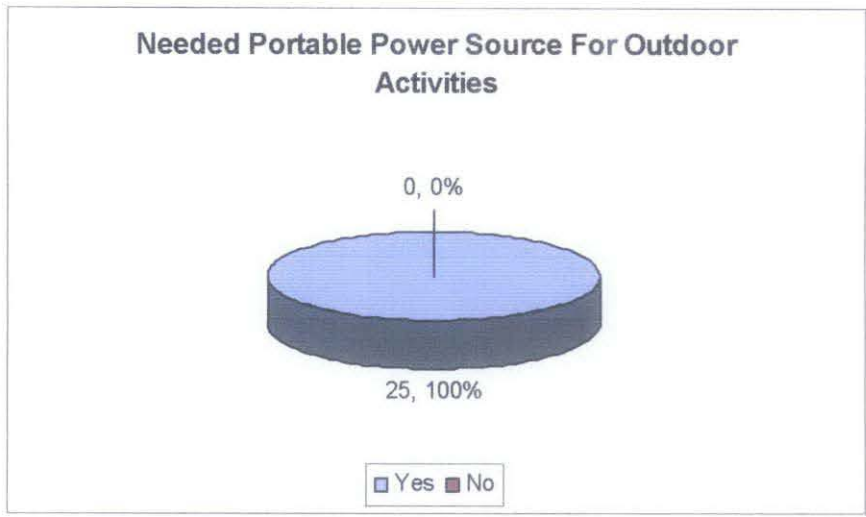


Figure 19: Needed Portable Power Source for Outdoor Activities (Local residents)

From Figure 18 and Figure 19, almost all the subject preferred to bring along the portable power source when doing outdoor activities. Referring to Figure 18, only six persons or 12% from fifty persons of UTP students choose not to bring along any portable power source when doing outdoor activities while the rest choose to bring along portable power source with them when doing any outdoor activities. Amongst the local residents, (refer to Figure 19), all of them choose to bring portable power source together with them for any kind of outdoor activities. It would make life easier if there is a product that can be used as an external power source for outdoor activities away from home.

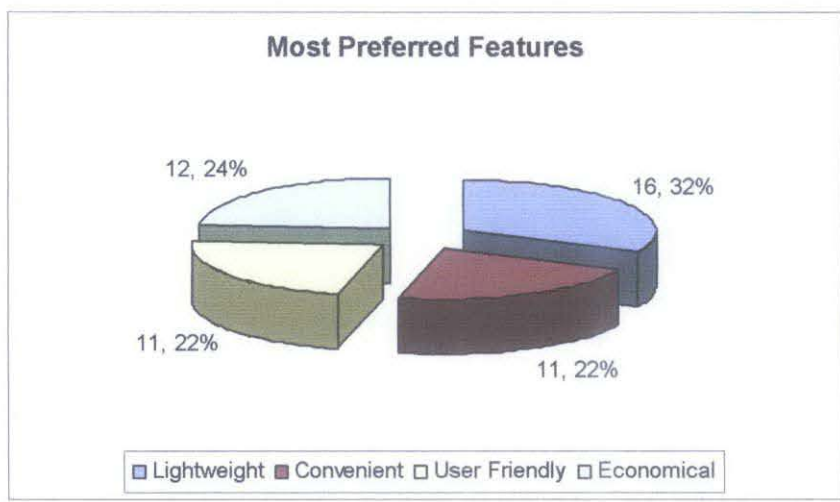


Figure 20: Most Preferred Features (UTP students)

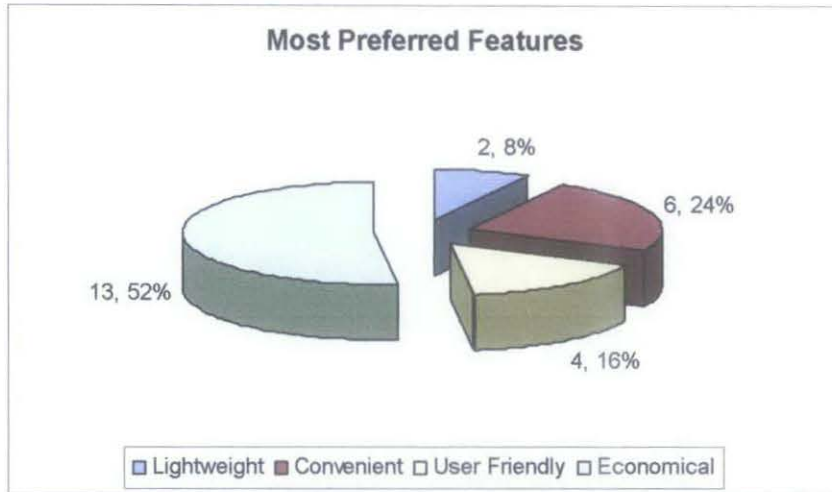


Figure 21: Most Preferred Features (Local residents)

Second question of this questionnaire that has been taken for the analysis is the feature of portable power source. There are four main features that have been considered, i.e. lightweight, convenience, user friendly and economical. However which of these are the most important features that should be considered if a new portable power source is going to be invented. By referring to Figure 20, the most preferred features for the portable power source by UTP students are lightweight. Sixteen from fifty persons or 32% choose this feature, followed by economical aspect chosen by twelve persons or 24%, and 11 persons or 22% for convenience and user friendly. While the most preferred feature for local residents is economical aspect by thirteen out of twenty five persons or 52%, followed by convenience chosen by six persons or 24%, user friendly chose by four persons or 16% and lightweight chose by two out of twenty five persons or 8%. Since most of the local residents are hawkers, they consider that an economical portable power source should be the best feature. It would help them save the cost of their business. And for the students they would rather choose a lightweight power source. It would make their life easier if they want to do any outdoor activities for relaxation.

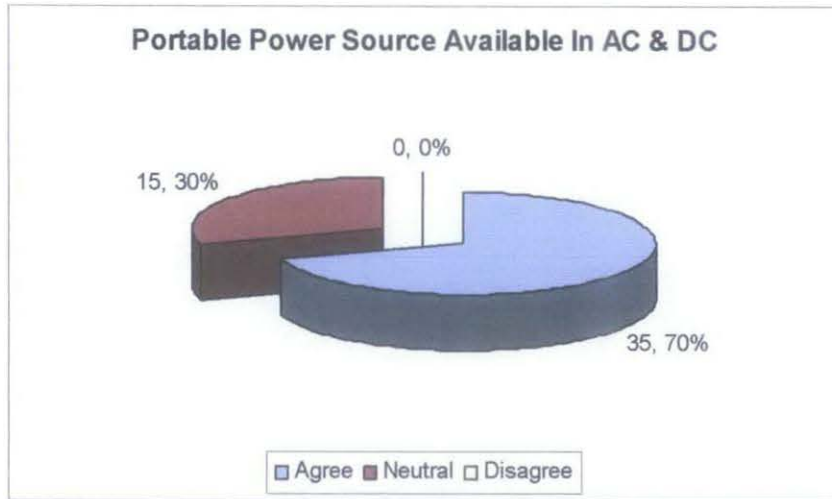


Figure 22: Portable Power Source Available in AC & DC (UTP students)

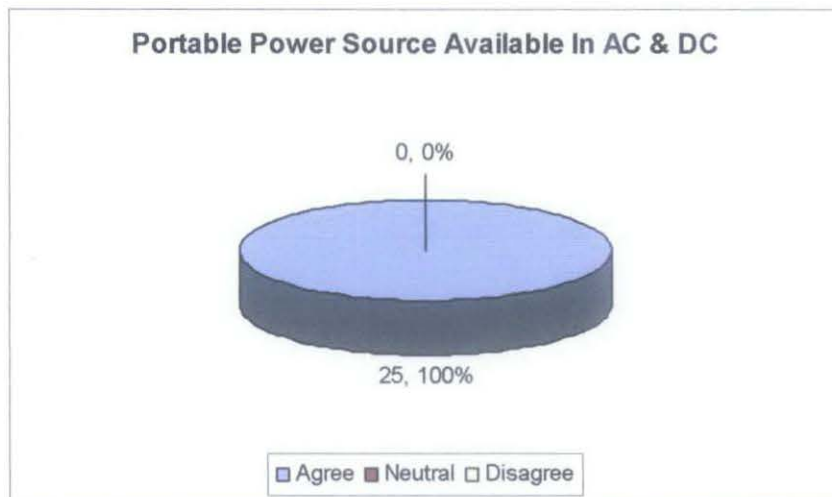


Figure 23: Portable Power Source Available in AC & DC (Local residents)

The third part taken from the questionnaire is about availability of AC and DC power source in one unit portable power source. As we can see, the available power source right now is not two sources in one unit. The user needs to buy two separate units of power sources if they want to use AC and DC source at the same time. One question from the questionnaire asks about this matter. Is it necessary for a portable power source to be available in AC and DC? By referring to Figure 19, thirty five of fifty persons or 70% of UTP students agree to have a portable power source that consists of AC and DC power source. While fifteen persons or 30% of UTP students decided to choose neutral about this matter. And 0% of person chooses

to disagree on the availability of AC and DC source in one unit of portable power source. And by referring to Figure 23, 100% of local residents agree to have a portable power source that available in AC and DC. The results should give a positive feedback on the project.

4.2.3 Circuit Testing

By referring to Figure 12 and Figure 13, Figure 12 represents the input of the circuit from the battery source. While, Figure 13 represents output of the circuit after inverting operations. From the observation of Figure 12, the straight line represents the DC voltage of the battery. The magnitude of the line should be 12V from the centre line. The magnitude of the line should be same as the voltage of the battery used. This straight line is obtained because of the criteria of DC voltage. DC voltage is linear and invariant. The DC voltage can only move in one way in a particular time. Meanwhile, from the observations of Figure 13, a square wave is obtained from the output of the circuit. From a straight line at the input, the internal circuit inverted this DC voltage to an AC voltage. This inverter circuit can be classified as a square wave inverter. From the output of this inverter, its still can be considered as an AC output. It is still alternating but non sinusoidal.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

As a conclusion, a new portable power kit has been successfully design. With this new invented portable power kit design, it is hope that it can meet the increasing power demand in the world. With this new kit also, it can be used as an alternative power source when there are people that usually really like to do the outdoor activities. Form the construction of the prototype, this portable power kit is comparatively low cost compare to the others. With some positive feedback from the questionnaire, this project can be improved by considering the recommendation made form the observations through out the project work.

5.2 Recommendation

As a recommendation for this project, the availability of DC source in the unit can be fully utilized by expanding the usage of DC source in the unit. Referring to the objective of this project, the DC source can only be used as a main power supply converted to AC source for this project. And also provide more and variety power outlets for the usage of DC electrical equipments. This will make the portable power kit more reliable and user friendly.

Second recommendation is to make the portable power kit be able to supply power to the high voltage demanding electrical equipment. By doing this, the user

can supply the electricity to the equipment they like and the portable power kit capabilities will not be doubtful.

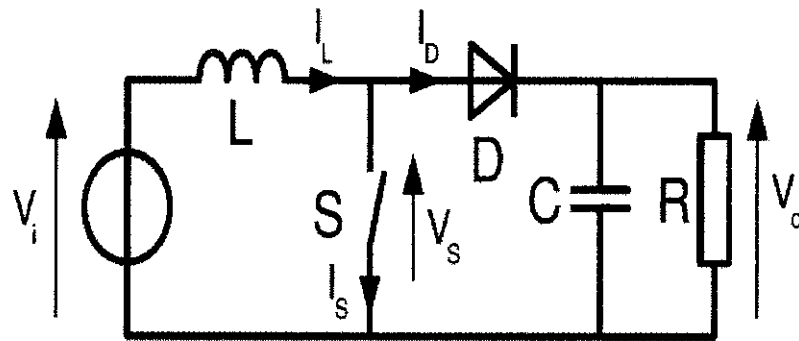
For third recommendation, the material used to construct the prototype should be change to other material. The material must also a bad conductor. The suggested material is fibre, because it is lighter than wood.

REFERENCE

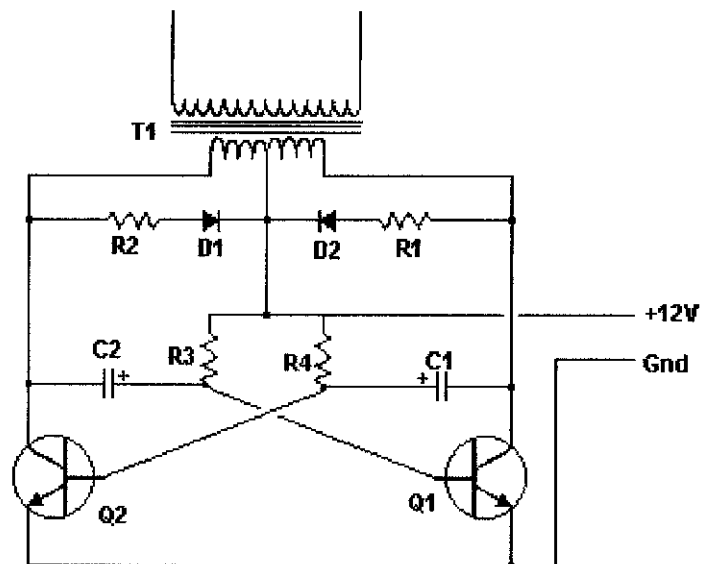
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APPENDICES

Appendix A: Boost Converter Circuit Diagram



Appendix B: Inverter Circuit Diagram



Appendix C: Gantt Chart

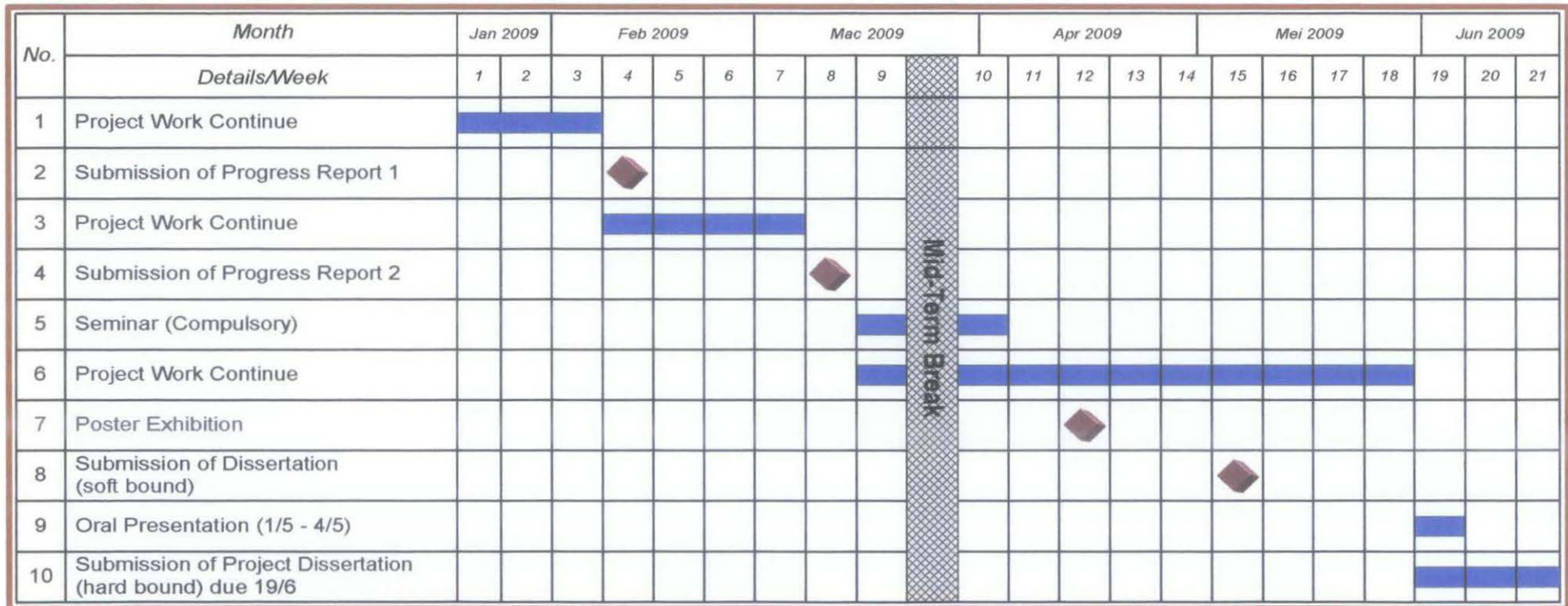
Suggested Milestone for the First Semester of 2-Semester Final Year Project



◆ Suggested milestone
 ■ Process

Appendix D: Gantt Chart

Suggested Milestone for the Second Semester of 2-Semester Final Year Project



◆ Suggested milestone

[Process] Process

Appendix E: Simulation Circuit

