DESIGN AND CONSTRUCTION OF SOLAR POWERED WASHING MACHINE

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DESING AND CONSTRUCTION OF SOLAR POWERED WASHING MACHINE.

SUBMITED BY:

ABASS USMAN AKOREDE

(19-05-0034)

BEING A PROJECT SUBMITTED TO DEPARTMENT OF ELECTRICAL ELECTRONICS ENGINEERING

SCHOOL OF ENGINEERING, ABRAHAM ADESANYA POLYTHENIC, IJEBU IGBO, OGUN STATE.

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TETFUND/THESIS DIGITIZATION/2017/22

CERTIFICATION

This is to certify that this project work was carried out under my supervision by **ABASS USMAN AKOREDE** with the Matriculation number **19-05-0034** from the Department of Electrical Electronics Engineering, School of Engineering, Abraham Adesanya Polytechnic, in partial fulfillment of the requirement for the award of National Diploma [ND]

MR. BANJO OLUGBENGA
Project Supervisor

1st Feb. 2022
DATE

HEAD OF DEPARTMENT

DATE

DEDICATION

This project is majorly dedicated to Almighty Allah for his greatness, keeping and providing for our needs before and throughout the compilation period. It is also dedicated to my mother Mrs. Abass Abisola and my lovely brothers for their financial and moral supports throughout the course of studies, I pray Almighty Allah stay with you and strengthen your ways.

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My profound gratitude goes to Almighty Allah for his unfailing love and kindness to me and his numerous blessings which we received throughout our staying in the institution.

I also express my sincere gratitude to my able supervisor: Mr. Banjo who out of his schedule time had contributed numerously, encouraged, support and fullness guidance towards the corrections to ensure that this project write up be a success work.

I want to sincerely appreciate my distinguished Director; Mr. Ariyo (a.k.a Baba Ariyo), my H.O.D; Mr. Odumosu, my Lecturers; Mr. Idris, Mr. Fowosere, Mr. Onaneye (a.k.a. Mr. Safety), Mr. Adewole (a.k.a. Atom), Mr. and Mrs. Banjo, Mrs. Olaojoyetan (a.ka. Mama Boyz), Mr. Bamidele, Mr. Oluwabiyi, and my School Officer; Mrs. Bello for all their parental roles, moral support and academical advice towards my success and to ensure I become successful person on earth. Thank you ALL.

I express my profound gratitude to my parent Mr. & Mrs. ABASS ABISOLA and Mr. OLANREWAJU ISMAIL for their financial and moral support throughout the course of studies.

Lastly, I must not forget to extend my warmth love to all my able friends both in School and at home mostly my troublesome friend, MUSA, EZEKIEL (a.k.a Easy-Moni), AKEEM ADENIYI (a.k.a. Balo), ABDULATEF (O-like me moo, gbemidebe), TOHEEB (a.k.a BARIKA), FATAI (a.k.a Prince Adewunmi), OPEOLUWA (a.k.a. upsmate), SAMMUEAL (a.k.a. Sam-Pori), May the Almighty Allah be with you all and to be frankly said, I will really miss you all.

ABSTRACT

This project is the design and construction of a Solar Powered Washing Machine, in which all solar panel, solar charge regulator, batteries, solar inverter and other (various) components are coupled together to convert a low voltage Direct Current (DC) into a high voltage Alternating Current (AC).

The objective of this project is to build a prototype device capable of washing clothes without the use of electricity but a solar system to hardness to us These are set to resolve some of the problems arising from the use of existing methods, including the difficulty of washing clothes with no electricity supply and the high electricity bill definition nowadays.

This project is mainly to help teach students the advanced use of solar energy which can help in improving our daily light consumption. Thus, Solar panel is used to receive energy from the sun.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF STUDY

The everyday needs of human have led to the recent discovery and development in both the field of industrial electronics and consumer's electronics. Different electronics devices with brilliant features have become part of our daily life as a result of this discovery and development in the world of electronics.

The installation used on this machine is very easy for spare parts conversion. Consumers today have done a lot of waste on monthly budgeting by paying excessive electricity bills when using regular washing machines where you do not have to wait for electricity before starting your operation. Therefore, we have innovated existing washing machines to reduce wastage on monthly expenses. The products we have invented are ideal for families with large households and limited electricity supply.

This project is based on the design and construction of a solar powered washing machine.

1.2 SCOPE OF STUDY

This project is carried out in an area with limited electricity supply. The scope of the study is to design and construct a workable solar washing machine of 1KVA that would ease clothing and provide alternative for electricity powered from NEPA based on the configuration of the proposed study. The charge controller, solar panel of 300watt and solar inverter are provided to improve the effectiveness and the strength of the washing machine whenever there is power failure. The essence of this study is to reduce man power in utilizing the washing machine for clothing and draining clothes.

1.3 AIM OF STUDY

The aim of this project is to design and construct a solar powered washing machine using 1KVA solar inverter regulator.

1.4 OBJECTIVE OF THE STUDY

Among the objectives of this study as follows:

i. To build a prototype capable of washing machine that would handle clothing without using electricity supply.

ii. To reduce man power efficiency while using this proposed project.

iii. To maximize the usage of solar energy resources available to power the washing machine.

iv. To save NEPA bills and prevent electricity interference (EMI)

1.5 SIGNIFICANT OF STUDY

This study of a Solar Powered Washing Machine will provide a means of trapping the greatly and cheaply available solar energy to generate adequate power supply for the washing machine via a solar panel that would power a washing machine with the help of a 100Ah battery and other components.

1.6 JUSTIFICATION OF STUDY

Nowadays, with the challenges faced by the economy interference of power supply, there is need to exploit on electricity source using solar power. Solar Powered Washing Machine is designed to make it easier for the community to be inland-controlled and allow the washing to be done at any time despite the absence of electricity supply. With the availability of this machine, the time to wash clothes will be saved in the absence of electricity supply. The cost of this maintenance is also low and easily maintained. The machine is adapted from the existing washing machine but it is improved efficiently by thinking about the ideas and innovations to add to the new design of the machine. This machine has solar panels to supply

energy for clothing washing. With the problems faced by consumers and the lack of efficiency of existing machines from survey results, there is need to produce a more efficient washing machine with the ability to do thorough washing despite the absence of electricity supply, which is better than existing type because the existing washing machine can only wash when there is electricity supply only.

1.7 PROBLEM OF STUDY

We are in the spite of a difficult place to find electricity as in the interior. Most people spend hours washing clothes by hand. People soaked up their clothes and then hit them on a rock to remove the dirt. Solar Powered Washing Machine is an innovation from an existing washing machine. This is due to the fact that existing washing machines cannot be used without electricity supply intake. Moreover, in the absence of a washing machine most of them have wasted time washing shirts using hands. Therefore, the idea of developing this innovation project so as to help in making washing fast and easy.

1.8 METHODOLOGY

The methodology to be adopted for this study as follows:

1. Get a solar panel that would harvest solar energy.
2. Get a solar charge controller that will automatically control the charging of the batteries via the harvest solar energy.
3. Get a working washing machine that could wash any dirty or stained clothes.
4. Get a battery of 100Ah that will store energy from the incoming solar panel.
5. Test the constructed electronic system to ensure the above listed objectives are duly met.

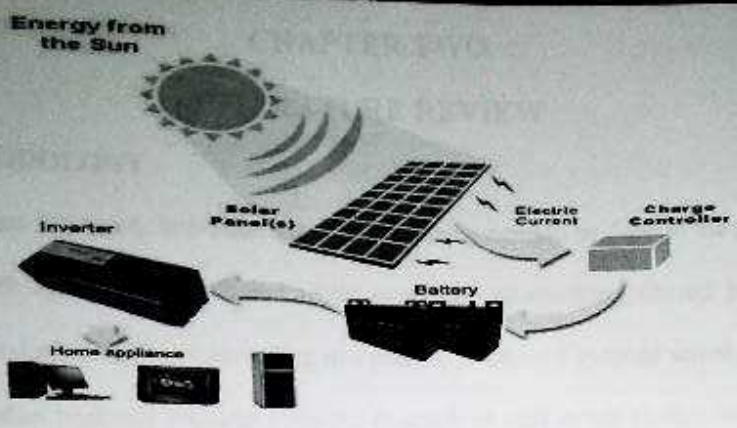

Figure 1.0: Block diagram of a proposed designed system.

1.9 PROJECT DESCRIPTION

This describes the organization of the study adopted below:

1. **Chapter One** is the introduction, aims and objectives, scope of study, significant, justification and problems of study.
2. **Chapter Two** is about the literary review that disclosed the importance and existence of new study over present study. It enlightens all the components involves for the story
3. **Chapter Three** is the construction of the study. This gives out the methodology to be taken in achieving the objectives of study.
4. **Chapter Four** is Result and Analysis of study. This shows the output result of the study and how the objective could be achieved.
5. **Chapter Five** is the summary and Recommendation of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 METHODOLOGY

Literacy studies are a very important aspect. Necessarily need to be done in the production of a project. With thorough research and all the necessary information gathered, project can be done easily and systematically according to a predetermined and planned schedule.

Cleaning clothes basically requires someone to scroll as well as rub clothes sebum to break down solid stains to allow the soap solution to penetrate it. Originally it was done by scratching or crashing clothes on a rock in the river, until the epilate of the touch boards lingered. During the Roman times, humans whitened the dress by scratching it on a rock while letting the soap be informed of it. At that time, soap was made of animal fat. Washing machine technology was developed as a way to reduce manpower consumption as a result of the process of scrubbing by providing an open tab or covered container with a radius to wash the dress automatically. Since the electricity supply was yet to be widely available until the earliest of the 1930s, some of these washing machine models used low-speed single-speed cylinder gasoline engines. Since water should be heated to wash, hot soapy water is valuable and will be used repeatedly; first to wash clothes that were not dirty, followed by more dirty clothes. While the earliest models were made of wood, the newer salty was made of metal to allow the fire loops to be installed under the washing tab to heat water during the day's washing. The process of urinating soap from clothing after washing is originally a separate process. The wet clothes were originally slit with hands to defecate. To reduce this workforce, roller machines were created using two tense rollers to defecate from clothing. Nevertheless, only a piece of clothing can be swanked at any one time. The earliest rollers used hands before using electric motors. Modern methods for urination through rotation only begin to be used after an electric motor was created. The dry rotation process requires high-

powered and high-speed electric motors. Originally this process is done separately on a dry spin tab. Upon completion of washing, users need to transfer their own clothes from the washing tab to the dry spin tab before the clothes could be rotated to defecate. Such washing machines are known as semi-automatic washing machines and gradually improved in order to meet up the new technology devices due to their present compare to automatic washing machines.

Many efforts have been made to reduce tremors due to unbalanced loads, such as installing an absorbent system as well as a machine turning switch automatically as it roars out loud to allow users to rearrange clothing in a dry spin tab. Most modern machines come with a liquid-covered bracelet to deal with a stretch of imbalance.

2.2 EXISTING WASHING MACHINE

Refers to existing products in the market. Undoubtedly, this existing machine type benefit consumers. However, the product is still unsatisfactory. This is because in the absence of electricity, the product cannot work efficiently due to absence of power supply. The washing machine takes time as a result the maker due to its specification and composition.

2.3 CONSTRUCTION PROCEDURES

This new study is to design a workable and durable washing machine that could be hardness to remove any stains or dirty path which gives a new product. It covers various aspects that should be taken into consideration both physically, science, as well as the environment. This is important because the production of new products must meet the characteristics that suit the needs of the needs. Research should also be done in terms of safety, attractions, etc. According to Manahar, Lotia in 1999, several types of additional components and tools were adopted to complement this design for easy operation. These additional tools have been selected according to the appropriate characteristics and specifications in line with the construction of this design. Aesthetic values are inducted into this project according to

consumer demand such as designing simpler and smaller products. Moreover, it was emphasized on the weight of tools that have a lifespan such as solar panels. Users are often more likely to choose products that have affordable prices, have privilege features, and are easy to use. Thus, the research work done covers the following area:

i. **Cost:** Selection of materials used to obtain low product manufacturing capital costs. Apart from conscious capital used, the quantity of materials should also be emphasized in order to avoid any future difficulties. Simple use of design colors can also save on capital production theme being a new products.

ii. **Safety:** Safety features are necessary on each product produced. If security features are not highlighted, products may not be accepted by consumers nor the authorities who approve the results of the product creation. Each security feature should be highlighted on the manual.

iii. **Color:** This also plays a vital important role in making choices to create a product invention. In order to gain attractiveness from consumers, the featured products are colored according to the concept of dark color for the products to have a longer lifespan.

The strength of new build depends on the circumstances or manner of the connected structure. The selection of each of these connections depends on the form of structure, functions, design, surrounding conditions etc.

Other Factors To Be Taken Into Consideration:

I. **Size:** The size considered for this prototype is medium which is moderate to carry and easier to utilized.

II. **Structure and Stability:** The connectivity structure for this study is strong because it uses welding techniques to couple most of the components that need to be pact together. The iron used is also strong and the iron selection type is also considered according to the iron capacity that bears the burden.

III. **Quality:** The quality of goods and equipment implored is of high quality in order to extend the life span of the machine.

IV. **Texture and Color:** The textures and colors selection must be in accordance with the use of machines and look beautiful and attractive to purchase.

2.4 PHOTOVOLTAIC SYSTEM COMPONENTS

A basis photovoltaic system consists of four main components: Solar panel of 300W, Battery of 100Ah, 12V of solar charger, solar inverter and the load which is the washing machine. The panel are responsible for collecting the energy from the sun and generating electricity. The battery stores energy for later use. The inverter ensures the panel and battery are working together and convert the energy of the sun to a DC supply. The load refers to any device that requires electrical power. It is important to remember that solar panels and batter are direct current (DC).

2.4.1 Washing Machine

A washing machine is designed to wash clothes including shirts, towels and sheets. The term refers to machines using water and detergent as a major source of washing items, unlike dry cleanings that use alternative detergents as shown in figure 2.1.

Figure 2.1: A washing machine diagram

There are various types of washing machine available for use as follows:

2.4.1.1 Upper Load Washer: The top load washer places the clothes loaded through the cover at the top into a vertical stacked tab as well as having a rotator on the essential part. Such machines are popular in Asia, Australia, Australia USA, America, New Zealand, Canada and Malaysia. During the washing cycle, the clothing-filled tab is filled with much of water to support clothing and rotational movements pulling clothing into the central base section towards the rotation. Thereafter, the dress moves towards the side of the tab and the recurring process for the opposite direction of rotational wheel until washing time ends. After the washing process ends, some water is discarded and the rotates the clothes in a very short period of time to crowd the clothes to balance the clothes payload before the intermediary dry rotation process. The next process is repeated for the first and last rinse, and after the last rinse cycle ends, the last dry rotation cycle lasts about 6 minutes to dry the dress completely as shown in figure 2.2.

Figure 2.2: A top load washing machine diagram

2.4.1.2 Front Load Washer Machine: Washing load front machine require a user to enter clothing into the tab through door front via silly water. Thus, the effect is felt and touched before being produced through movement tab and action gravity. Movement tab id used to lift the clothing to a part on tab before clothing fall to the policy tab as shown in figure 2.3.

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Figure 2.3: A front load Washing Machine diagram

2.4.2 Solar Panel

Solar panel of 300W is to absorb sunlight as an energy source for producing electricity or heat. It is used as one of the major components in a larger photo voltage system to generate electricity for commercial and residential use. Mono crystalline-type solar panel was adopted because more efficiently than solar panels in turning sunlight into electricity, solar panels with the same watt will be larger physically as shown in figure 2.4.

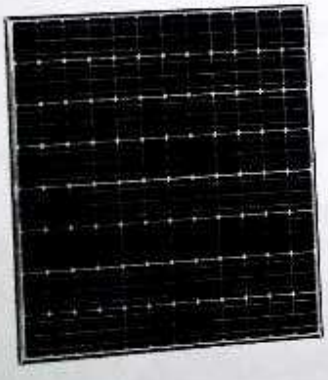

Figure 2.4 A front view of Solar Panel of 300Watt diagram

2.4.3 Solar Charge Controller

Some functions of solar Charger Controller are arranging current for filling to batteries, avoiding excessive filling and excessive tensile, managing discharged/relieved current from the battery until the battery is not fully exhausted, and the advantages of load and monitoring of battery temperature. The charge controller can include other features that add valuable information and security control to the

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equipment. These features include ammeters, voltmeters, measurement of ampere-hour, timers, and alarms etc. For conveniency, none of these features are required for a working photovoltaic system as shown in figure 2.5.

Figure 2.5 A solar charge controller

2.4.4 Inverter

A solar Inverter as an electronic device that converts DC voltage from batteries or solar panels into standard household AC voltage for use to power common tools and appliances. Basically, not only has a direct AC conversion function, but also has functions that maximize solar cell function and system error maintenance function. It works actively and functions of power closure, maximum power tracking control function, anti-free operation function (for grid-related systems), active voltage adjustment functions (for grid connection systems), DC detection functions (for grid-related systems), DC base detection functions (for grid-related systems) as depicts in figure 2.6.

Figure 2.6: A diagram of a solar inverter

2.4.4.1 Classification of Inverter Circuits

Inverter are classified into groups based on their commutation principle. The external commutated inverter which operates on external commutation can be classified as line

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commutation or load commutation. The self-commutating inverter as a commutating capability in their own circuits or device and can generate independent AC power. These are classified into three groups:

i. The rectangular inverter circuits.

ii. The pulse with modulated inverter circuits.

iii. The resonant inverter circuits.

2.4.4.2 Types of inverters

i. Multivibrator driven inverters.

ii. SCR driven inverters

iii. Resistive-couple transistor inverter.

iv. Two transistor type using one or two transformers.

v. Single transistor with single transformer driven

2.4.4.3 Factors determining the choice of inverter

In building and selecting the type of inverter to be used, the following conditions needs to be considered:

- The efficiency stability of the output voltage.
- The power capacity of the loads to carry.
- The efficiency of DC to AC power conversion.
- Overload protection of the inverter.

2.4.5 The battery

The battery stores energy produced by the solar panel that is not consumed by the load, whenever the battery supplies electricity, its positive terminal acts as cathode and the negative terminal as anode. This stored energy can then be used during period of low solar irradiation when the battery is connected to an outdoor circuit, the electrolytes are able to move like ions in it and allow the chemical reaction to be completed on a separate terminal which in return transmits energy to the external circuit. The movement of ion in the battery is

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what allows the current to move out of the battery and provide its function as shown in figure 2.7.

Figure 2.7 A diagram of a Dry cell battery

2.5 DESIGN SPECIFICATIONS

This design specification specifies the configuration and the benefit of the proposed product that gives alternative to existing product problems which are listed below:

a) This product can be best used in hostel, laundry and home.

b) This product is able to save electricity and regulate the amount of input and output voltage needed by the study.

c) This product does not require extensive space or large space before it can be installed and is easy to store energy.

2.5.1 ELECTRONICS COMPONENT USED

The theoretical basis of this study is the characteristics and the principle of operation of the component used in the design and construction of this system which will be discussed in this section.

2.5.1.1 RESISTOR

A resistor is used to resist the flow of current flowing through in a circuit, provide voltage drop and dissipate electric energy. Its ability to resist is known as resistance which is measured in ohms. The voltage drop between its terminals is proportional to the electric current and this is done in accordance with ohm's law (i.e. V=IR)

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Types of resistors

1 Fixed Resistor

They are made from carbon and have a power rating of 1/8 to 10watts. Larger resistor are able to dissipate more heat than small ones.

Figure 2.8a: Symbol of a fixed resistor

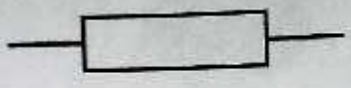

Figure 2.8b: circuit symbol of a fixed resistor

Resistor colour code

Some resistors have their resistance boldly written on them. These resistors are called choke resistors. Other resistors, however, are called coded. Colour coded resistor have four band on them.

Table 2.1: colour coding resistor.

Colour	Digit value
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9
Gold	±5%
Silver	±10%

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2 Variable resistor

They are used to vary the volume, speed, intensity and voltage in circuits.

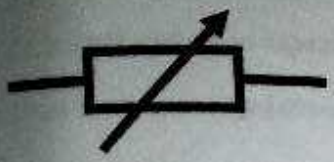

Figure 2.9a: Symbol of a variable resistor

figure 2.9b: Diagram of a variable resistor

2.5.1.2 CAPACITORS

A capacitor is a device or component that has two led sticking out of it and use in storing and filtering charged. Capacitors is a measure of a capacitor's ability to store charge. A large capacitance means that more charge can be stored. Capacitance is measured in farads(F)

Function

Capacitors store electric charge which are used with resistors in timing circuit because it takes time for a capacitor to get fully charged. They are used to smooth varying DC supplies by acting as a reservoir of charge. They are also use in filter circuit because capacitors easily allow AC (changing) signals but the block DC signals.

Types of Capacitors

1 Electrolytric capacitor

This type of capacitor is polarized i.e. it has both positive and negative terminals. They are not damaged by heat when soldering. It is easy to know the capacitance of electrolytic capacitors because it is clearly printed with the voltage rating on their body.

Figure 2.10a: Electrolytic capacitor diagram

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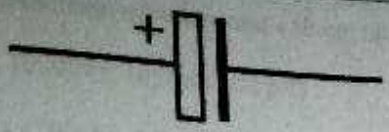

Figure 2.10b: Symbol of an electrolytic capacitor

2 Ceramic and mica capacitor

These types are not polarized i.e they have neither positive nor negative terminals and may be connected either way round. They are not damaged by heat when soldering, except foe one unusual type (polystyrene). They have high voltage ratings of at least 50v, usually 250 also. It can be difficult to finds the values of these small capacitors because there are many types of them and several different labelling system! Many small value capacitors have their value printed but without a multiplier, so you need to use experience to work out what the multiplier should be! For example 0.1 means 0.1uf 100nf. Sometime the multiplier is used in place of the decimal point: for example: 4n7 means 4.7nf as shown in figure 2.11

Figure 2.11a: Symbol of a ceramic and mica capacitor

Figure 2.11b: A picture diagram of a ceramic and mica capacitor

Capacitor number code

A number code is often used on small capacitors where printings is difficult

The 1st number is the first digit

The 2nd number is the second digit

The 3rd number is the number of zero to give the capacitance in PF

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Ignore any latter-they just indicate tolerance and voltage rating.

For example, 102 means 1000Pf = 1nf (not 102 pf!)

For example, 472j means 4700pf = 4.7nf (J means 5% tolerance).

2.5.1.3 DIODE

It is unidirectional component.it allows electrons to flow through easily in one way but oppose flow of electrons in the opposite direction

Types of Diodes

1 Common silicon or germanium diode

They are used in rectification of current (i.e to convert alternative current (AC) to direct current (DC) and they are also called general purpose signal diode eg. The IN series which are made from silicon and have a forward voltage drop of 0.7v.

Germanium diode such as the 0A90 have a lower forward voltage drop of 0.2volt and this make them suitable for use in radio circuit as detectors which extract audio signal from the weak radio signal. For general use, where the size of the forward voltage drop is less important, silicon diode are better because they are less easily damaged by heat when soldering they have a lower resistant when conducting, and they have very low leakage current when a reverse voltage is applied as shown in figure 2.12a and figure 2.12b.

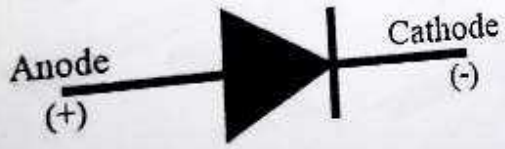

Figure 2.12a: Symbol of a common silicon diode

Figure 2.12b: Diagram of a common silicon diode

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Bridge Rectifiers

There are several ways of connecting diode to make a rectifier which convert AC to DC. The bridge rectifier is one of them and it is available in special packages containing the four diodes required. Bridge rectifier are rated by their maximum current and maximum reserved voltage. They have four leads or terminals: the two DC output are labeled + and -, the two AC inputs are labeled! As shown below

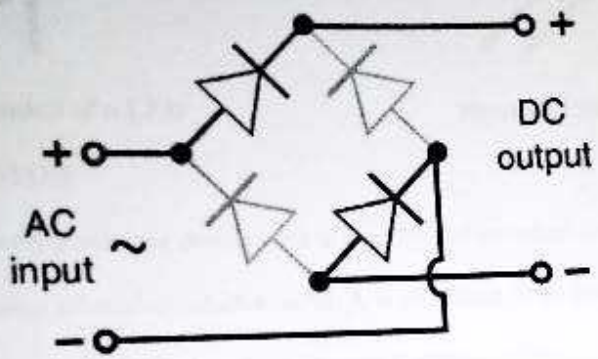

Figure 2.13: A Bridge Rectifier

The diagram shows the operation of a bridge rectifier as it converts AC to DC. Notice how alternative pairs of diodes conduct as shown in figure 2.13.

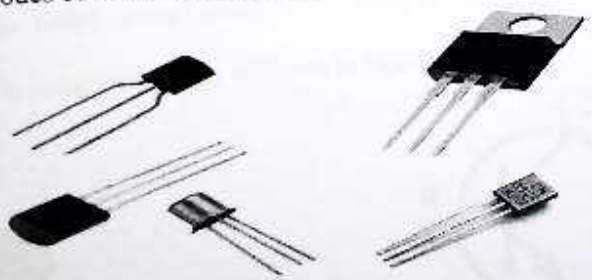

Figure 2.14: Diagram showing various type of bridge rectifier

2 Light Emitting Diodes (LEDs)

This also called LED, is a type of diode which lights up when the current flows in the forward direction. It has a forward voltage drop in the range of 1.5 to 3volt. There are the 7-segment numeric LED displays mostly use for familiar LED display boards\signs which are package of many LEDs arranged in a pattern (e.g for showing number\digit 0-9). There are

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also infrared LEDs which emits infrared radiation when current flows through it in the forward direction. LEDs are used as indicators, digital displays, digital signboard, matrix signboards etc as shown in figure 2.14.

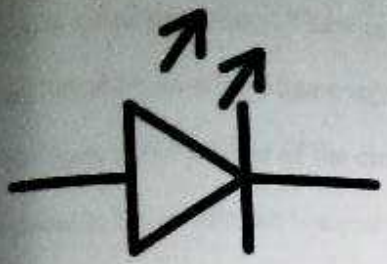

Figure 2.15a: Symbol of a LED

Figure 2.15b: Diagram of a LED

2.5.1.4 TRANSISTOR

A transistor is a semi-conductor device used to amplify and switched electronic signals. It is made of a solid piece of semi-conductor material, with at least three terminals for connection to an external circuit as in fig 8. A voltage or current applied to one pair of the transistors terminals changes the current flowing through another pair of terminals. Because the control power can be much more than the controlling (input) power, the transistor provides amplification of signal. Today, some transistors are packaged individually, but many more are found embedded in integrated circuit as shown in figure 2.15.

Figure 2.16a: Diagram of a BJT

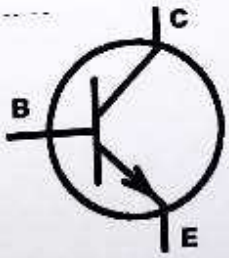

Figure 2.16b: symbol of an NPN transistor

2.5.1.5 TRANSFORMER

Transformers convert AC electricity from one voltage to another with little loss of power. Transformer works only with AC and this is one of the reasons why main electricity is AC.

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ıp transformer increases voltage, while step-down transformer reduce voltage. Most
r supplies use a step-down transformer to reduce the dangerous high voltage (i.e.
/ or 230V in UK) to a safer low voltage. The input coil is called primary and the output
is called secondary. There is no electrical connection between the two coil instead, they
inked by an alternating magnetic field created in soft iron core of the transformer. The
lines in the middle of the circuit symbol represent the core. Transformer waste vary little
ver so the power out is equal to the power in. Note that as the voltage is stepping down,
current is stepping up. The ratio of the number of turns on each coil, is called 'turns ratio',
termine the ratio of the voltage. A step-down transformer has a large number of turns on it
imary coil which is connected to the high voltage main supply, and a small number of turns
ı a secondary coil to give low output voltage.

'urns ratio = vp/vs= Np/Ns

'ower output = power input

Vs x Is = Vp x Is

Where:

VP = primary voltage

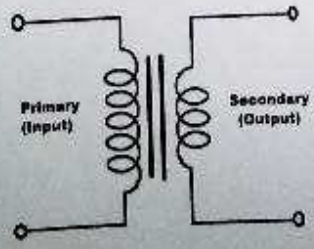
Np = number of turns on primary coil

Ip = primary current

Vs = secondary voltage

Ns = number of turns on secondary coil

Is = secondary current



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re 2.17a: Circuit symbol of a transformer

re 2.17b: Picture of a step-down transformer

ERGONOMIC

study is designed for comfort and to maximize fatigue as listed below:

. Machines should be able to be used by less skilled users.

i. Storage weight and methods should correspond to the user's ability.

iii. Any signs of safety should be clear and understood by the user.

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CHAPTER THREE

DESIGN AND ANALYSIS

his chapter described the operation of each segment of the 12V solar inverter system and the lculation involved. All the calculation ideals were extracted from [inverter] textbook and ternet. The proposed system are sub-divided into various parts:

1. Solar inverter power
2. Solar charge invertor
3. Oscillator circuit
4. Low battery cut off circuit
5. Battery monitor circuit
6. Driver (MOSFET) circuit

3.1 SOLAR INVERTER CIRCUIT

The solar inverter power is 1KVA but in watt rating = 0.8 x 1000VA.

=800watt

Since the household equipment are mostly rated in watt. Then a household equipment of 750watt can only be handed by this inverter.

3.2 OSCILLATOR CIRCUIT

This is the heart of solar panel inverter and is the system that convert direct current into high frequency {50 Hz} alternating current. Different oscillator circuit can be used but we adopt SG3524 oscillator circuit in this project which has provision for output feedback. The feedback allows us to generate a stable voltage of 220VA.C no matter the battery voltage.

3.2.1 THE BUFFER CIRCUIT

The circuit consists of two NPN BC548-transistor connected in the emitter follower mode. This is needed because the output signals of the oscillator are not powerful enough to drive the output driver [MOSFETS]. Those signals are given to the driver transistor [NPN, BC548] to amplify them to a level that can be able to drive the MOSFETS.

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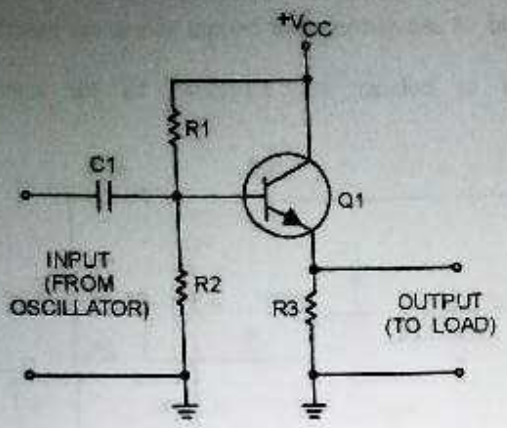

igure 3.1: Schematic diagram of the buffer circuit

his is needed because the output signal of the oscillator are not powerful enough to drive the utput driver {MOSFET}. Those are given to the driver transistor {NPN, BC548} to amplify hem to a level that can be able to drive the MOSFETS.

The value of the component used in both channel of buffer circuit must be the same, so that the voltage level of both channels remains same, otherwise the MOSFET could get damaged.

3.3 DRIVER CIRCUIT

Tis is the MOSFET circuit that uses the low voltage, low current signal produced by the oscillator circuit for the buffer circuit to drive a very high current and voltage for the transformer.

The driver circuit is made up of metal-oxide semiconductor field effect transistor. Each MOSFET has current holding capacity of 40Ampares at 50V.

Now each MOSFET power = IV = 15x50 = 750w----------equation 1

Solar inverter power = 1000VA at 12V

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The solar inverter operates on center tapped transformer has to be switched in two sides alternatively. Then two set of MOSFET are needed to drive the transformer.

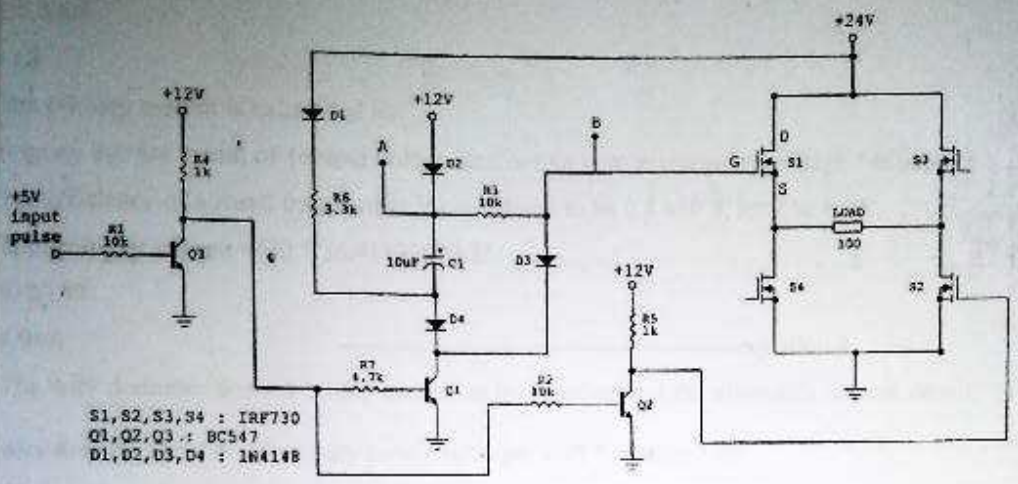

Figure 3.2: Schematic diagram of MOSFET driver

3.4 DESIGN OF INVERTER TRANSFORMER

This is an inverting transformer used for the output.

Transformer power = 1000VA

Primary voltage (Vp) = 220V

Secondary voltage (Vs) =12-0-12V = 24V center tapped

Secondary current (Is) = 10Amp

This cross-sectional area of the core is given by:

Core area = 1.152 x secondary volt. x secondary current

1.152* Vs*Is

=1.152 * 24 * 50

=1.152 * 1000

=39.9cm ---------- equation 2

For deciding the number of winding in primary and secondary, we calculate the turns per volt which is given by:

Turn per volt = 1/[4.44 * 10 * frequency core area * flux density] ----------equation 3

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The frequency used in Nigeria

Flux density is about 1.0wb/m for ordinary steel stamping.

This turn per volt = 1/4.44*10^-4*50*39.9*1.0

1/0.8008

11.3

The primary current is calculated by:

Primary current = sum of {output voltage and output current}/primary voltage * efficiency.

The efficiency of a small transformer is considered to be 0.8 to 0.9, let it be 0.85

Thus primary current =(20 * 36.4)/(220*0.85)

938/187

4.96A ----------equation 4

The wire diameter depend on the current to be supplied and the allowable current density of wire thus the number of primary turns= turns per volt * primary volt:

11.3*220

=263 turns.

The space taken by winding depend on the thickness of the winding and diameter of wire. From winding data on enameled copper wire, we estimate the turns per 5gcm by selecting the suitable SWG of 21.

The primary winding area= primary turns / turns per sq cm ----------equation 5

=264/242

=1.09sqcm

As we have specified the secondary current (10A), we can directly refer to the table and selected the wire size of 11-SWG:

Secondary current=10A

The number of secondary turns can be calculated by:

The number of the secondary turns=1.03(turns/volt*secondary volt)

=1.03(1.2*40)

= 24.72turns ----------equation 6

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The secondary window area is found from the table by selecting the suitable value of 11-SWG. Secondary window=secondary turns/turns per sq cm

=24.72/16.1=1.54cm

Some extra area is required for the former and the insulation between the winding this extra area is considered to be 30%. The space area is given by;

Space for insulation=30% 0f (primary winding area+ secondary winding area)

30/100(1.727+2.43)

1.2474

The total winding area is given by;

Total window area= primary winding area + sum of secondary winding + space for insulation.

=1.727+2.43+1.2474

= 5.40cm ----------equation 7

The gross core area is calculated by considering the gap between lamination stacking. The core stacking factor is taken as /0.9

= 51.52/0.9= 57.244cm

Usually, the core of Efficient (E) and Inverse (I) shape are preferred and the tongue width is given by;

Tongue width = gross core area:

= 24.48

95cm ----------equation 8

From the table of dimension of transformer stampings we select the suitable core type and number by the approximately tongue we got; type number of 7(E-1).

The stack height of the core is given by;

Stack height=gross core area/actual tongue width

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23.48/4.95

4.95cm

Thus for step down transformer having of 220V and output of 15V with 10A secondary current

The number of turns is the primary winding is 264 of 21-SWG

The number of turns in the secondary winding is 24.72, 11-SWG.

With the core size of 7(E-1) and the stake height of 4.95cm.----------equation 9

3.5 THE BATTERY MONITOR

This is the circuit that displays the state of the battery. LM339 is used as the comparator here which has four operational amplifier. LED (light emitting diode) bar / dot display are solid state light device that were used as analog indicating meter.

All the inverting pins of the comparators (LM339) are fed with −5v reference from regulator output pins _16 of 5G3524(oscillator IC). The inverting pins of the LM339 {comparator}were supplied through a voltage divider of network resistor 12kohm,220ohm,7.5kohm, and 2kohmVR.The network outputs are more than +5v when the battery is full (100%)to give negative outputs at each of the op_ amp where fed to each cathode [-]pin of the LED bar.

The anode of the LEDs are connected together and supplied with positive voltage through 1kohm as series resistor (Rs)

Rs [Vcc VD]/10Ma series resistor

Vcc = supply voltage (12v)

VD = voltage drop across the diode (2v)

Rs = 12-2/10AM=10/0.01=100ohm ----------equation 10

As the battery discharge the LED bar also goes down at the rate of 100%, 75%, and 25%.

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t 10.5v which is the minimum voltage that the battery can be drained to, all the LED should ave gone off.

/oltage divider formula use

/olt (R2/R1+R2) Vin

√in =12v ----------equation 11

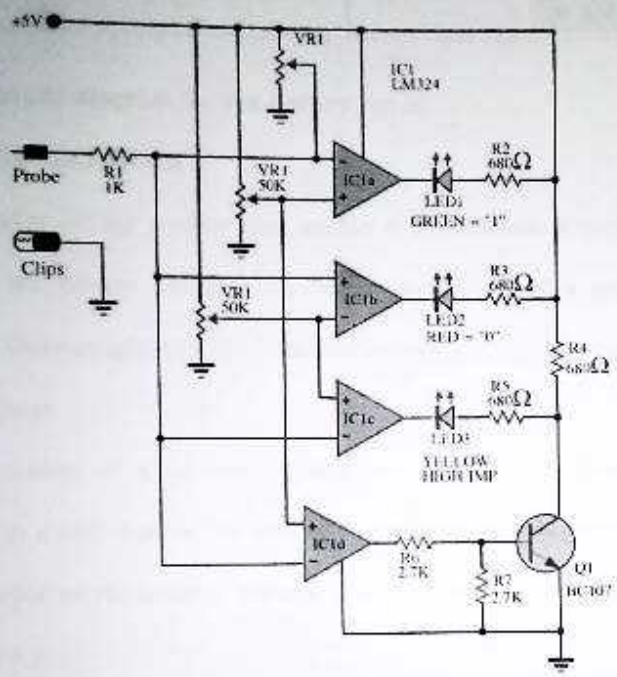

Figure 3.3: Schematic diagram of the inverter battery monitor

3.6 LOW BATTERY CUT-OFF

This is the circuit used to prevent over drain of the battery. Here operational amplifier was used as voltage comparator. With the non-inverter input was supplied with 5V reference, and the inverting input with a voltage divider network of resistor (47k +4.7) RI and 47k as R2. Having shut-down all other system of the inverter will also shut down, and then the battery is saved as shown below in figure 3.4

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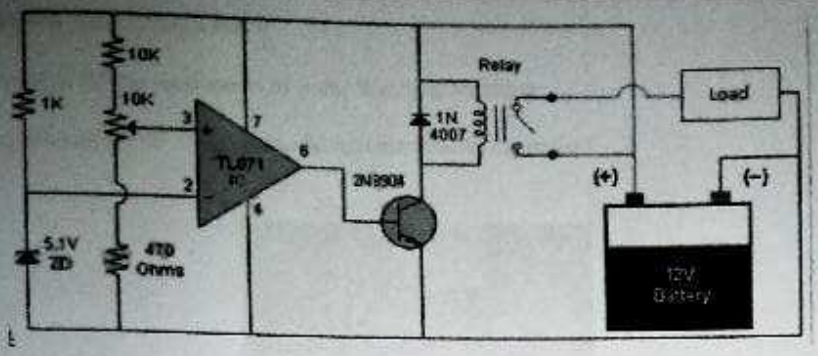

Figure 3.4 schematic diagram for low battery cut-off

3.7 INVERTING FEEDBACK

This is the section of the inverter that enable it to maintain a constant output voltage irrespective of the battery voltage. The section comprises of a general purpose 6-pin phototransistor: Opto-coupler (4N35), 100kilo-ohms resistor, and a bridge rectifier circuit.

The general purpose

Opto-coupler consists of a gallium arsenide infra-red emitting diode driving a silicon phototransistor in a 6pin dual in line package. The bridge rectifier tapped their supply from about 300V output of the inverter through a 220kilo-ohms 1w resistor and rectified it as shown in figure 3.5.

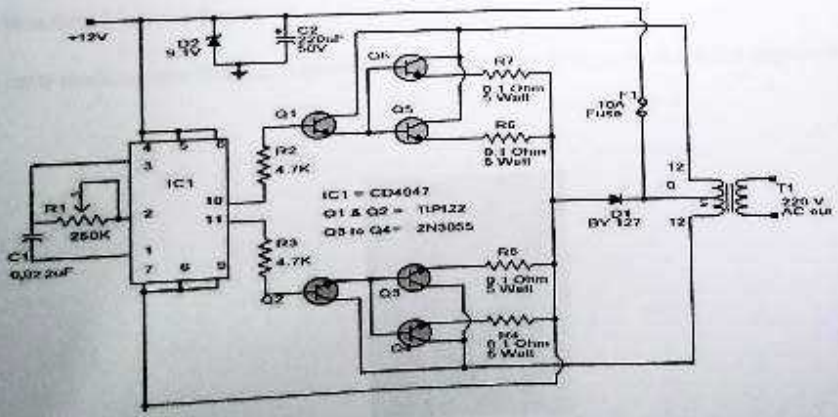

Figure 3.5 Circuit diagram of the inverter system

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8 PRODUCT PRODUCTION

ere are the ways for the production of Solar Washing Machine:

. Ensure equipment goods sufficient to launch manufacturing project

Figure 3.6: Components Solar Washing Machine Components

2. Make test at circuit project with connect all materials.

Figure 3.7: All materials connectivity

3. Measure the height, width and size of the washing machine to innovate the existing amplifier as a Solar Washing Machine frame.

4. Perform clothing washing on amplifiers to test stability while projects run for improvement

Figure 3.8: Washing clothing

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Installation of each material on the framework of the project (ample) and makes wiring to form a complete solar circuit.

Figure 3.9: installation of each material on the project frame work

5. Perform tests at the end of project production.

Figure 3.10: final project production

7. Updating projects to attract buyer's attention when marketed later.

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CHAPTER FOUR

1 CONSTRUCTION OF THE CIRCUIT

harge circuit reserves electrical energy generated by solar panel in the battery. All the omponents were tested to confirm this project. When the panel charges the battery ompletely, charging is stopped and battery color on washing machine LCD will be green. Turning on the machine, energy in the battery is converted to AC 220v by the solar inverter and finally it reaches the machine memory to turn on the machine and start working.

The solar panel receives energy from the sun, and with the help of 6mm cables the energy is transferred to the solar regulator and charge up the battery (3rd stage). The solar inverter converts the energy of the battery (4th stage) and later gives energy to the load (last stage) in AC.

Both electrical and mechanical tools were used for the construction. Examples are: pliers, soldering iron, paper-tape, set of screw driver, etc.

The main advantage of this study is as follows:

1. Increasing washing and machine rating
2. Renewable energy and environment protection
3. Reduce costs and energy consumptions
4. Possibility to turn on other kitchen tools and charging cell phone and lap top
5. An independent domestic supply for emergencies
6. Wash 5kg of clothes every 3 days without the need of man power
7. Power supply display and washing with smart phone
8. With regard to high costs of establishing solar power stations for the states, implementing this design and producing more than 200,000 solar washing machines, a power station with annual capacity of 10,000MW electrical energy can be set up in people home without any maintenance cost and requirements for fund and a place to

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construct. For any solar washing machine more than 50kW is saved. Therefore, production of 200,000 ones can save annularly 10,000MW.

.2: OPERATION OF THE INVERTER

The operation of this inverter can be explained stage by stage as shown be in this block diagram below.

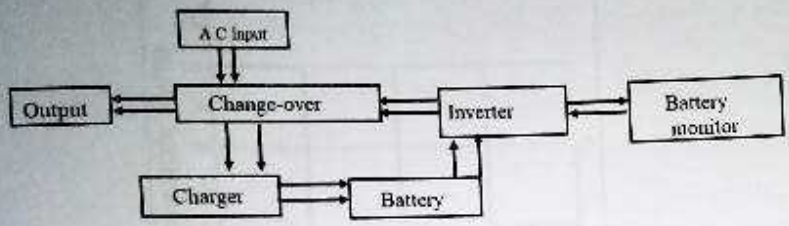

Figure 4.1: The block diagram of the Inverter System

The inverter with all control such as low battery cut off, battery monitor, output regulation, are the heart of the system. The inverter dose the work of conversion from direct voltage (DC) from the battery to the alternating current voltage of 12VA.C.

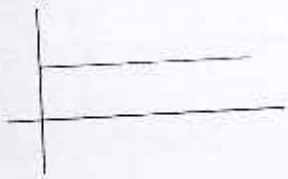

Figure 4.2: D.C signal

The D.C from battery was oscillated (alternated) by oscillator circuit. The oscillating signal from the oscillator is of 12V, 300W, duty cycle and micro current and was boosted to 12VA.C by the buffer circuit but also low current. This buffer signal was fed to the Driver circuit which require relative no current but low voltage drive a very high current of about 50V at 12VD.C from battery.

The driver circuit is a high current switching device. In the inverter, it switches the battery negative to the positive connected to the centre of the inverting transformer.

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As the transformer primary is been switches by this pulsating D.C the secondary will be producing a certain high voltage say by 300VA.C which will be corrected {regulated} by feeding it back to the opto-coupler in the oscillator circuit for the pulse width modulation. This feedback was to adjust the high voltage back to 12Va.c, 300W, 100AH duty cycle. This signal is a square wave signal

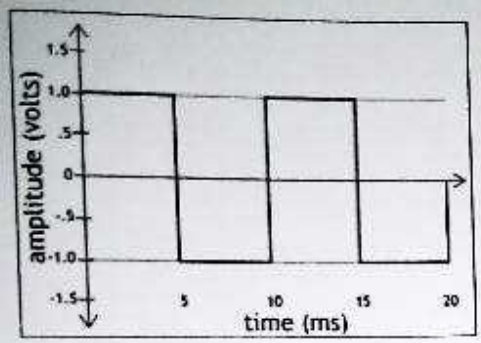

Figure 4.3: square wave signal

With the use of 2.5NF 400V A.C capacitor the signal was modified sine wave.

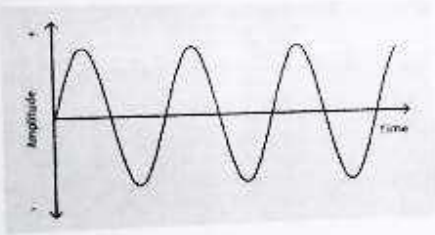

Figure 4.4: Modified sine-wave signal

This signal is at least good to handle any inductive, capacitive or resistive loads. This modified sine wave output was supplied to through fuse of 3A 220va.c to the final normally closed of the charger-over relay and to be used at the common of the big charger-over relay.

4.3 TEST, DISCUSSION AND RESULT

From the above study, it was discovered that the solar inverter system was able to perform desired operations with the listed components and available devices. The solar panel was able to charge appropriately with the connection of solar charger and the solar controller. Though it can be upgraded to increase and acquire more voltage based on the needs of the consumers.

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rom the assessment, the overall solar panels installed on the washing machine are effective nd meet the design features set and require low cost in the maintenance of the washing achine. Besides that, the workforce required in the manufacturing process of this product is hree. Solar Washing Machine is able to wash clothing without electricity.

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CHAPTER FIVE

SUMMARY AND RECOMMENDATION

5.1 SUMMARY CONCLUSION

The design and construction of this 12V, 300W, 100Ah duty cycle was a gradual process of selecting materials and components. The relevant matters relate to the objectives of the study as well as recommendations on the studies carried out in which all the components were tested to confirm its workability of this project. The duration of this proposed working inverter depends on the type of battery used and power of the load consumed from the panel at a particular time.

5.2 RECOMMENDATION

In the course of making this project work different from the existing ones to make improvement for the usage.

As a result of the experiments conducted, i can recommend this prototype system for use in homes, schools, hotels and in various house power consumption.

It is also recommended that the school management can invest more on this project in order maximize the usage in campuses to power electrical appliances and to look for better alternative to NEPA rather than keeping the whole places in darkness of duties.

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