ATTESTATION

I, Naziru Shu'aibu Reg No: 99/9065EE, hereby confirm that this project work implementation and report were both carried out by me solely.

....

Student's signature & date

Name of supervisor. Usman A-U ....

Signature...

Date...... 20/11/04 ....

Name of HOD... M. D. Abdullahi ....

Signature...

Date........ 31/01/2005 ....

Name of external examiner.......................

Signature...

Date...

ACKNOWLEDGEMENT

Praise is to the Almighty who saw me this far in my short academic career. Gratitude to my able supervisor, Engr. Abraham Usman, for making the project work worthy of presentation. The unconditional and unlimited support of all members of my family, especially my two parents-which words alone cannot express-is most appreciated. My special thanks to Engr. A. A. Ahmadu of Interactive Engineering Consult Kaduna, for encouraging me to implement the title in spite of the odds. This acknowledgement will not be complete if I don't mention our present H.O.D., Engr. M.D. Abdullahi, for his effective guidance and giving me unlimited access to himself, right from the on-set. My profound gratitude to Engr Abdullahi M. C. of NEPA district office Kaduna, for his moral support and interest in my academic career.

The moral support of all my friends especially Abdullahi Bamalli, Nasiruddeen Mora, Falalu Sa'idu, Abubakar Azare and Lawal Lamido is worth more than just mention. But thanks to them all the same. The last but by no means the least is my sweet girl friend for her encouragement, support and understanding throughout the period of this work. May the Almighty accordingly reward all those that contributed in one way or the other-mentioned above or not- in making the work a reality.

DEDICATION

To all struggling Nigerian students, who study under the most artificially rugged environment.

ABSTRACT

This project, 12V Solar Power Center (12V SPC), presents a simple model of how the abundant solar energy we receive from the sun, about 1kW per meter square in tropical areas, can be used to complement the conventional electrical energy sources we have. Owing to cost restrictions, the model presented here is of small power capacity that is to be used with 12V dc powered devices only.

The 12V SPC consists of a photovoltaic charge controller circuit; a battery bank and a low voltage disconnect circuit. Using the SPC for a solar powered device will ensure a long battery life.

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A PROJECT REPORT ON

DESIGN AND IMPLEMENTATION OF A 12V SOLAR POWER CENTRE

BY

NAZIRU SHU'AIBU
Reg No: 99/9065EE

SUBMITTED AS PART OF THE REQUIREMENTS FOR
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MINNA

NOVEMBER, 2004

CHAPTER ONE

GENERAL INTRODUCTION

1.0 OBJECTIVES

As part of the pre-requisites for acquiring first degree in any university, the final-year project is mandatory on every final-year student as stipulated by the National Universities Commission's syllabus for university undergraduates. One of the objectives is to encourage students to conceive an idea and consequently translate it practically, in their respective fields of studies. This is vitally important as regards engineering students. Basically, engineering is nothing but applied science. And project works, such as this, form the basis upon which the knowledge of engineering is developed. Hence, final year project works form the basic foundation upon which a sound first degree, in any engineering field, is obtained.

1.1 MOTIVATION

To this extent, the students would be made capable of making their own contributions to the world of technology with respect to technological inventions that is. It is generally believed that project designs are created out of local needs. Also, engineers throughout the whole world are encouraged by factors such as availability of raw materials, cost of the materials and, of course, marketability of the finished products. Therefore, this project work was borne out of the desire to diversify our sources of electrical power and thereby cater for our ever-growing need for electrical energy, especially here in the tropical area. Aside the urban cities, villages and satellite towns also stand to benefit a lot from the solar power supply system due to its portability, efficiency, environmental friendliness and ease of maintenance. Though solar panels are not as cheap in the market, the overall cost of a solar power generating station is cheaper than any equivalent hydro or thermal power generating stations we conventionally use. In fact, going by the aforementioned advantages of solar power stations, and many more, one may not be wrong to say that solar power stations will offer the best solution to our persistent problems of electrical power supply in this country.

1.2 SCOPE OF WORK

In this particular project, a small capacity Solar Power Center (SPC) was considered. The SPC, which consists of a photovoltaic charge controller, a battery bank and a low voltage disconnect circuit, was meant to be an uninterruptible power supply (UPS). The aim of this project was therefore to demonstrate, using electronic circuitries, how solar energy can be conveniently used to power electrical appliances such as emergency lighting, portable radio sets, security/safety alarm systems and other 12V devices. To this extent, Mr. G. Forrest Cook (www.cirkits.com) and Engr. M.D. Abdullahi (www.musadaji.com), our current H.O.D., have helped me a lot.

1.3 CHALLENGES

This project work was a combined application of both the theory and the practical knowledge being thought in any modern-day university of technology. It therefore calls for hard work, dedication, high level of commitment and an effective supervision/supervisor in order to become a success. Most of all, it requires strict adherence to the basic rules and regulations guiding all electrical and electronic experiments. However, the project may pose some difficulties especially in sourcing components, soldering tools and testing apparatus. In the course of implementing this project, I am ready to face any possible constraints that may come up head-on, within my capacity that is. In the end I hope the work will further strengthen my dream to become a professional and practicing electrical engineer.

1.4 SOURCE OF COMPONENTS

The components used had been sourced both locally and internationally. All resistors, small signal diodes (excluding crow bar diode, zener diode, schottky diode and red/green dual color LED), capacitors, +5V regulators, toggle switches, fuses and connecting leads were sourced locally. But all other components were sourced from United States of America through a US based company, Digi-key Corporation (www.digikey.com). The mode of transaction used was online through a Nigeria-US based company, Hephzibah Computer Engineers (No. 14/15 Junction Road/Nassarawa Road) Kaduna-Nigeria. Table 1.0 below gives the list and cost of all the components ordered including handling charges, shipping charges and commissions.

S/No.	Component No. & Description	Qty Ordered	Unit price US$	Amount US$
1.	2N3906 PNP Transistor	4	.16	.64
2.	IRFZ34 N-Channel MOSFET	4	1.25	5.00
3.	4N35, 6-PIN Optoisolator IC	2	.44	.88
4.	80SQ035 Schottky Diode	2	1.45	2.90
5.	6A05 Crowbar Diode	2	.48	.96
6.	TLC2272, 8-PIN Op-amp IC	4	1.43	5.72

7.	Red/Green Dual Color LED	2	1.92	3.84
8.	3.3K NTC Thermistor	2	1.06	2.12
9.	1N5242, 12V Zener Diode	2	.21	.42
	Total Invoiced			22.48
	Handling Charges			6.00
	Shipping Charges (United Parcel Service, UPS)			8.00
	Commission (Hephzibah)			13.52
	Grand Total			**50.00**

Table 1.0 Price list of components ordered from US. Note: Exchange rate of US$ as at July, 2004 (N140 per Dollar)

CHAPTER TWO

LITERATURE REVIEW ON SOLAR POWER SYSTEM

2.0 THE SOLAR CELLS

First discovered by E. Becquered in 1839, solar cells convert light from sunlight into electrical energy. They are therefore referred to as photoelectric cells.

The light falling on the ultra thin n-doped layers of the solar cell destroys individual bonds, producing holes and free electrons. The holes and electrons move in various directions under the influence of the diffusion potential. In consequence, the n-layer is charged negatively and the p-layer positively, inducing a voltage between the contacts of the solar cell. The voltage and current in the cell depend on the intensity of illumination. In practice, solar cells, otherwise called photovoltaic array, are linked in the same way as voltaic cells to produce higher powers.

2.1 SOLAR ENERGY AROUND THE WORLD

In the past, different scientists have done a lot of work, at different times, to put solar power into use. In India for example, thousands of solar stoves were produced with solar heat to increase the supply of food. Research, on solar power, is going on in more than thirty countries, helped by an organization called the Association for Applied Solar Energy. Formed in 1954, this group held the first world symposium on solar energy in Arizona, United States of America. The theme was 'The Sun at Work', and solar devices of all kinds from all over the world were displayed. The many displays made lived up to that title.

The sun powered radios, telephones, clocks, furnaces and solar machines that produced ice. The sun has long heated homes. Solar 'batteries' have powered telephone lines, radios, and television equipment in space satellites and even driven electric cars. There is the prospect of using the solar power to provide electricity for driving the train.

2.2 SOLAR ENERGY IN NIGERIA

Several hundreds of other experiments and applications of solar energy have been made over the centuries. Today, the sun has been found to be of inestimable importance in the energy requirements of industries, commerce, transportation, down to the household cooking, and a host of other applications. This is to such an extent that a solar motor company exists in Boston in the United States. While it is acknowledged that advancements in solar power utilization in industrialized countries had already, in the 1930s, reached the stage of devising solar facilities to send rockets to the moon, the focus on solar power in developing counties, including Nigeria, is on water heating, irrigation, solar distillation of sea water, solar crop drying, water pumping, cooking etcetera. In order not to be left out in harnessing the infinite store of solar energy, efforts are being made by the Nigerian government in the area of solar energy research. An Energy Research Centre was established, in 1982, at the Usman Danfodio University, Sokoto State. In this centre, solar energy research has been taking place more than a decade before the enabling law came to being in 1993.

CHAPTER THREE

BLOCK DIAGRAM, DESIGN THEORIES AND DESIGN ANALYSIS

3.10 BLOCK DIAGRAM

Below is a block diagram of the 12V-SPC. It consists of a photovoltaic charge controller: a battery bank and a low voltage disconnect circuit.

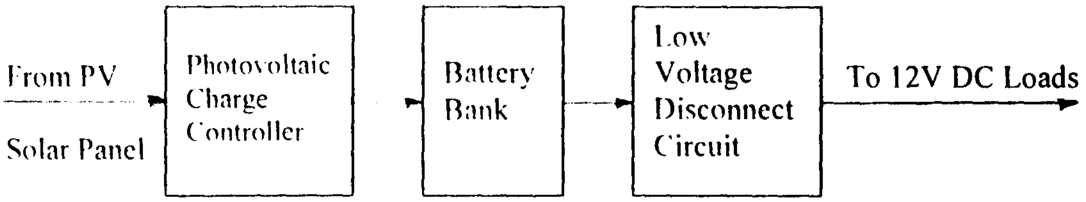

Figure 3.0 12V Solar Power Centre Block diagram

3.12 PHOTOVOLTAIC CHARGE CONTROLLER

The charge controller receives the dc power voltage generated by the solar panel. Its main function is to maintain the battery at the proper charge level and protect it from overcharging.

3.13 BATTERY BANK

The battery bank contains a deep-cycle (rechargeable) battery. The battery stores the power produced by the solar panel and discharges it when needed.

3.14 LOW VOLTAGE DISCONNECT CIRCUIT

The low voltage disconnect circuit contains a load on-off switch and battery low voltage indicator. Its function is to prevent deep discharge of the battery when the battery voltage drops to shutoff point.

3.20 DESIGN THEORIES

3.21 SOLAR POWER CENTRE

The circuit diagram for the solar power center is as shown below.

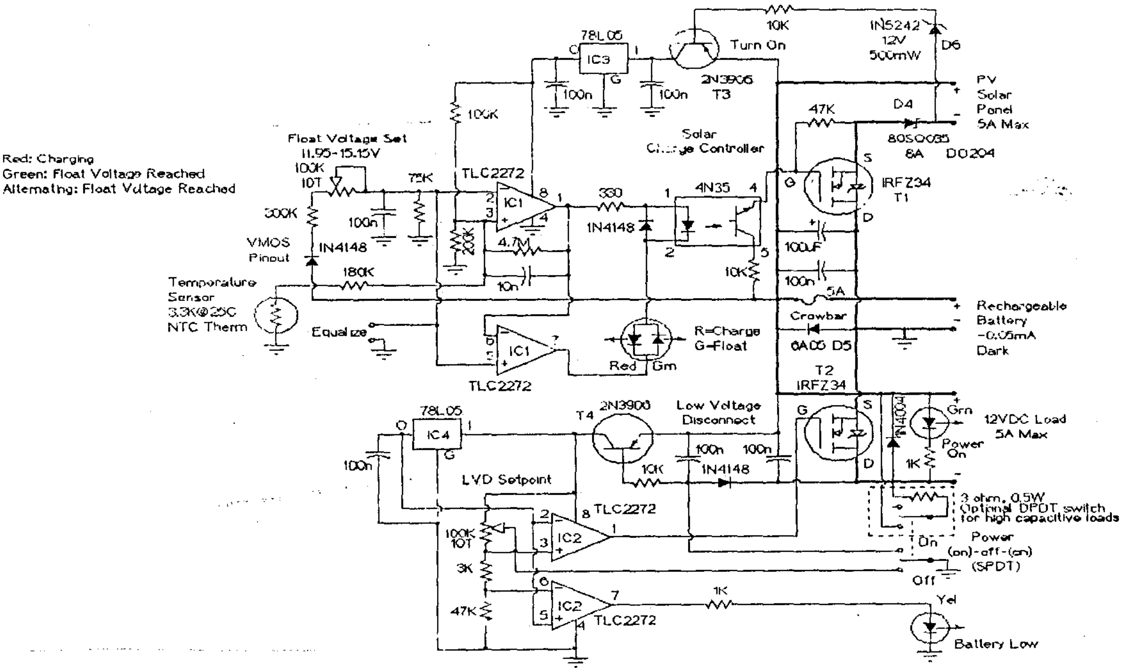

Figure 3.1 solar power centre circuit diagram

3.22 SPECIFICATIONS: the circuit has the following specifications;

Nominal battery voltage, 12V

Maximum solar panel current, 6A

Maximum load current, 6A

3.23 CHARGE CONTROLLER CIRCUIT (CCC)

The circuit is made up of diodes, transistors, voltage regulators, integrated circuits (ICs), resistors, indicators, and other electronic components as shown above. The charge controller is shown in the upper half of the schematic. Transistor T3 turns on power to the rest of the charge controller circuitry when the photovoltaic (PV) panel input exceeds 12V. Regulator IC3 provides 5volts to run the rest of the circuit.

The upper half of IC1 is the heart of the charge controller. It acts as a combine comparator/signal conditioning circuit. When the battery voltage is well below the float voltage setting, IC1 turns on, this causes the red/green light emitting diode (LED) to turn red and the 4N35 activates field effect transistor (FET) T1, which connects the solar panel power to the battery. When the float voltage is reached, the circuit swings above and below the float voltage setting as the charging current gets switched on and off the battery. The battery charging characteristics and the current that is available from the solar panel mainly sets the rate of swinging above and below the float voltage setting. The 10nF capacitor across the upper half of IC1 limits the maximum rate of swinging. The 4.7-MΩ resistor across IC1 causes the circuit to have some hysterisis, separating the charge/float switch points.

The thermistor modulates the float voltage setting slightly, the full voltage set point rises in colder temperatures. The lower half of IC1 always produces the opposite output from the upper half of IC1 for driving the bipolar LED. Shorting the equalize terminals causes the circuit to stay in the charging state, this is useful for occasionally overcharging (equalizing) a battery.

Diode D4 prevents the battery from draining back into the solar panel at night. Diode D5 is a crowbar, if the battery is connected in reverse; it causes the fuse to blow. This saves the rest of the circuitry from destruction.

3.24 LOW VOLTAGE DISCONNECT (LVD) CIRCUIT

The LVD circuit is shown in the lower half of the schematic. Unlike simple under-voltage shutoff devices, when the LVD circuit shuts off, it stays off until it is manually turned back on. This prevents the load from oscillating off and on due to the rise in battery voltage after the load is disconnected.

When the momentary switch is turned on, transistor T4 is turned on. This activates the comparator circuits formed by the two halves of IC2. As long as the battery voltage is above the LVD set point, the upper IC2 comparator goes high and FET T2 is switched on. Once the LVD circuit has been turned on, T4 continues to stay on via the current through the 1N4148 diode.

The IC4 regulator provides a reference voltage to compare the battery voltage to. The voltage on IC2 pin 8 tracks the battery voltage. When the battery drops near the shut off point, the lower half of IC2 turns on, causing the yellow low voltage warning LED to light. When the battery voltage drops further, to the cut off point, the upper half of IC2 goes low, causing FET T2 to turn off, and cutting power to the load. The bias current through the 1N4148 diode also shuts off, T1 turns off, and the rest of the battery circuitry loses power.

If the LVD circuit is on, switching the momentary switch to off causes the upper half of IC2 to produce a low output, shutting down the LVD circuit as described above. High capacitance loads, above several thousand microfarads, will tend to keep the circuit on for a while when the off switch is pressed. Adding the circuit shown in the dashed box will help to speed up the discharge of the capacitance.

3.30 DESIGN ANALYSIS

3.31 2N3906 PNP TRANSISTOR

With base resistor, Rb = 10k & Vin = 12V (for the CBconfiguration),

base current, Ib = 12/10k

= 1.2 mA

the dc current gain, hfe = Ic/Ib

hence collector current, Ic = hfe x Ib

the value of hfe is 100, minimum and 300, maximum from 2N3906 manufacturer's data sheet. 100 was chosen so that Ic cannot exceed its absolute maximum value of 200 mA (from data sheet).

Therefore, Ic = 100 x 1.2

= 120 mA

power dissipated in the transistor, Pd = Ic x Vce

= 120 x 1.0 (Vce = 1.0 from the data sheet)

= 120 mW

BJT: some of the advantages of BJTs as current-controlled switches are; their ability to switch very rapidly, typically in a small fraction of a microsecond, and can be used to switch many different circuits with a single control signal.

3.32 IRFZ34 N-CHANNEL POWER MOSFET

Threshold voltage, Vgs(th) = 4V maximum, and on-drain current, Id(on) = 250 μA: from IRFZ34 manufacturer's data sheet.

From the relation, Id(on) = K(Vgs – Vgs(th))

where K is a constant dependant on Vgs(th), Id(on) & Vgs. Vgs is the gate-sorce voltage & Vgs = Vds (Vds = drain-source voltage = 12 V in this case)

therefore, $K = Id(on)/(Vgs - Vgs(th))^2$

$= 250\ \mu A/(12 - 4)^2$

$= 3.91\ \mu A/V^2$

whence the drain current, Id, is obtained from, $Id = K(Vgs - Vgs(th))^2$

$= 3.91(12 - 4)^2$

$= 250\ \mu A$

this is the transistor's switching current, it should not be mistaken for the load current which is 6 A, maximum.

MOSFETs: MOSFETs are commonly used as analog switches because their low ON resistance, extremely high OFF resistance, low leakage currents and capacitance make them ideal voltage-controlled switch elements for any signals.

3.33 TLC2272 DUAL SUPPLY OP-AMP IC

This +5V rail-to-rail voltage feedback amplifier was chosen because of its applicability in battery powered systems and signal conditioning. The TLC2272 is a dual supply, 8-pin amplifier. Pins 4 & 8 respectively serve as its negative and positive inputs. It consists of two op-amps. Pins 1, 2 & 3 of this IC form one op-amp (op-amp1) and pins 5, 6 & 7 form another (op-amp2). Pin 1 serves as output1 while pins 2 & 3 serve as negative and positive inputs1 of op-amp1 respectively. Pin 7 forms output2 while pins 5 & 6 form the positive and negative inputs of op-amp2 respectively.

3.34 4N35 OPTOCOUPLER IC

This is a 6-pin, dual in-line phototransistor optocoupler. It consists of a gallium arsenide infrared emitting diode driving a silicon phototransistor. Pins 1 & 2 respectively form the anode and cathode of the infrared emitting diode. Pin 3 has no connection. Pins 4, 5 & 6 are the emitter, collector and base of the phototransistor respectively. This IC chip is commonly used as power supply regulator. It is otherwise called optoisolator.

CHAPTER FOUR

PARTS EXPLANATION

4.0 INTRODUCTION

The various electronic parts used to implement this project, 12V Solar Power Center (SPC), have been discussed in this chapter. The explanations given were limited to their uses in the 12V SPC circuit and, some of their, absolute maximum ratings as provided in their respective data sheets. Parts schematics were not included here: the circuit diagram (pp--) was considered sufficient.

4.1 1N5242

This is a 12V, 500mW small signal zener diode used to provide a constant 12V for driving 2N3906 in the Charge Controller Circuit (CCC). It has minimum and maximum zener voltages of 11.4V and 12.6V.

4.2 2N3906

This pnp general-purpose transistor is used as the switching device for powering the CCC. It does the same in the Low Voltage Disconnect (LVD) circuit. This transistor has a continuous collector current of 200 mA, power dissipation of 625 mW and a switching time of 35 ns.

4.3 78L05

This regulator IC is used to make stable +5V from +12V input in both the CCC and the LVD circuit. It has output voltage range of 4.8V-5.2.

4.4 TLC2272

This is a dual input voltage feedback amplifier. This op-amp is used to drive 4N35 as well as the red/green LED in the CCC. However, in the LVD circuit, the TLC2272 is used to drive IRFZ34 and the yellow LED. This op-amp has a dc power supply rejection ratio of 63dB and an open loop gain of 76dB.

4.5 4N35

This is an optocoupler IC used to activate IRFZ34 in the CCC. This device has an average dc input forward current of 100 mA and power dissipation of 250 mW at room temperature.

4.6 IRFZ34

This N-Channel power MOSFET is used as the main switching device of the 12V SPC. In the CCC, it is used to connect power to the load. At room temperature, this power MOSFET has a continuous drain current up to 30A and power dissipation up to 88W. The IRFZ34 has turn-on (switching) delay time of 13 ns and turn-off delay time of 29 ns respectively.

4.7 80SQ035

This schottky diode is used as a guard against power from the battery draining back into the solar panel at night. This diode has a forward voltage of 0.55V. This feature, very low forward voltage drop, is its major advantage.

4.8 6A05 & 5A FUSE

The 6A05 is a crowbar diode. It was used as a protection against causing damage to the CCC in case the battery is connected in reverse. The 5A glass-type fuse is used along with the 6A05. It will blow whenever the battery is connected in reverse.

4.9 THE 3.3K THERMISTOR

This is a negative temperature coefficient (NTC) semiconductor device. It is used as a temperature sensor in the CCC. It has a large coefficient of resistance change and it is easy to use.

4.10 SMALL SIGNAL DIODES & LEDS

The small signal diodes used in the 12V SPC were 1N4148. They were used to ensure unidirectional current flow in both the CCC and the LVD circuit. This diode has an average rectified forward current of 200 mA and power dissipation of 500 mW.

The red/green dual colour LED used in the CCC is to indicate battery status: red when charging and green when fully charged. The green LED. across the load terminal, is used to indicate when power is connected to the load while the yellow LED, in the LVD circuit, is used to indicate that the battery voltage has dropped to near shut off point.

4.11 RESISTORS

Various resistance values were used in the 12V SPC mainly as current limiters. The values range from 330Ω-300kΩ and 300kΩ-4.7MΩ. The resistors were of 0.25 W and 0.5 W. power dissipation. The 100 kΩ variable resistor used in the CCC was for setting the battery float voltage point. And the other 100 kΩ variable resistor in the LVD circuitry was for setting the Low Voltage Disconnect point of the battery.

4.12 CAPACITORS

A number of electrolytic capacitors were used in the 12V SPC commonly as filters: that is, to store or discharge dc power as may be required to ensure smooth dc power flow. The capacitors used range from 0.1μF to 100μF.

4.13 CONTROL SWITCHES

Two sliding switches were used. One for the CCC equalize terminal and the other as the LVD momentary switch. Three toggle switches were used: one for connecting the solar panel to the 12V SPC, another for connecting the battery to the SPC circuit and the last one for connecting the load.

4.14 OTHERS

Other parts used include a 10cm X 24cm circuit board, IC sockets, soldering lead, a number of connecting wires and a suitable wooden case.

CHAPTER FIVE

CIRCUIT IMPLEMENTATION, PERFORMANCE EVALUATION AND CASING

5.0 INTRODUCTION

This chapter contains step-by-step explanations of the procedures followed to implement the 12V SPC circuit physically. Obviously, this was one of the most critical stages of the project. Every care was taken to ensure that no component was damaged, either by high solder temperature or by human body electrostatic charges, during test on project board and during final mount on circuit board. Final test and test results were treated under performance evaluation. This part explained how the two circuits, CCC and LVD, could be aligned/set for optimum performance. The type of casing used for the project was explained in the last part of this chapter.

5.1 CIRCUIT IMPLEMENTATION

The various electronic components that form the 12V SPC circuit, as shown on page 8, were carefully assembled on a project (bread) board one after the other. Connecting wires were used as jumpers throughout. That way, the complete SPC circuit was built on the project board. After that, a test was conducted using a 12V, 50Ah rechargeable (car) battery and a 0-30V, 0-20A variable dc power supply in the laboratory. The assembled circuit was found to be working. See section 5.2 for details of the test. Thereafter, the circuit assembly was, using the same care, transferred to the circuit (Vero) board accordingly. That is, each component was mounted and soldered on the

Vero board. The same thing was done to the jumpers that connected the individual components together.

All precautions necessary for handling semiconductors, especially MOSFETs, were observed. The workstation, including myself, was fully grounded during the work. See appendix one for the completed circuit assembly on the circuit board (pp27).

5.2 PERFORMANCE EVALUATION

Upon completion of the Vero board mounting of the SPC circuit, a test was carried out to evaluate its performance. The output power was measured by measuring the output voltage and current using a voltmeter and an ammeter. The test was carried out with a 0-30V, 0-20A variable dc power supply connected as the source, depicting daylight operation of the SPC, and without the variable power supply, depicting night operation of the SPC. A 12V, 50Ah rechargeable battery was used as the battery bank. The 0-30V, 0-20A variable dc power source was used as the input power unit instead of a 12V solar panel module. This was due to the unavailability of the solar panel in the laboratory. Table 5.1 gives the output voltage and current readings obtained. The measurement was carried out four times in each case.

The Charge Controller Circuit was first of all aligned. The dc power supply, which served as the solar panel, was connected to the circuit. The float voltage setting was turned fully clockwise. The dual colour LED turned red, indicating that the battery voltage was low and hence being charged. The circuit was left connected until the battery was fully charged. The float voltage setting was then turned counter clockwise until the LED alternated red and green. The setting was adjusted until the LED blinked and the battery voltage was set to 14.0V. This had effectively set the fully charged voltage level of the battery and therefore, the float voltage point of the CCC. It should however be noted that the float voltage point can be adjusted accordingly.

In turn, the Low Voltage Disconnect circuit was aligned. A variable dc voltage source was set to 11.0V and connected across the battery terminals. The LVD set point was fully turned counter clockwise. The battery power switch was then turned on and hence, the green LED went on. The LVD set point was turned clockwise until the yellow low voltage LED turned on. The set point was further turned clockwise, slowly, until the yellow and green LEDs both turned off. The dc voltage source was set to 12V and the power switch was again turned on. Gradually, the dc voltage source was turned down until the LVD cut out at 11.5V. This effectively set the LVD point to 11.5V. The LVD point can also be adjusted accordingly.

Test	Day/Night time test	Voltage (V)	Current (A)	Power (W)
	Day time (dc power supply connected)			
1.	Test number one	12.56	6.00	75.36
2.	Test number two	12.56	6.00	75.36
3.	Test number three	12.56	6.00	75.36
4.	Test number four	12.56	6.00	75.36
	Average power			75.36

	Night time (dc power supply disconnected)			
1.	Test number one	12.54	6.00	75.24
2.	Test number two	12.54	6.00	75.24
3.	Test number three	12.52	6.00	75.12
4.	Test number four	12.52	6.00	75.12
	Average power			~~60.18~~ 75.18

Table 5.1 test results

5.3 CASING

A wooden case of 11cm length, 11cm width and 8cm depth was designed and constructed to house the 12V SPC that was built on the 10cm x 24cm circuit board. Five 2mm∅ holes were drilled on the circuit board for accommodating screws to fasten the board onto the wooden case. Holes were made on one face (11cm) of the case through which power and battery control switches, including their respective indicators, were respectively fixed. Another set of holes was made on the 26cm face of the wooden case. Load control switch, equalize terminal switch and LVD momentary switch, together with their respective indicators, were fixed through these holes. The base of the wooden case carries two more holes. These holes were meant for the SPC unit to be hanged on a wall, a pillar etcetera. See appendix two for the wooden case (pp27).

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.0 SUMMARY

This project work, titled, 12V Solar Power Center (SPC), which started as a proposal was finally, not without some troubles, realized. Like any other project of this nature, the report was divided into, specifically six, chapters. Chapter one, the introductory chapter, covered objectives, motivation, scope of the work, challenges met and sources of the components used. Chapter two was the literature review chapter on solar power system. The chapter discussed solar cells, solar energy around the world and solar energy in Nigeria. In Chapter three, block diagram of the project, design theories and design analysis were presented.

Chapter four explained each and every electronic component used in constructing the 12V SPC. Chapter five treated the construction of the 12V SPC on a circuit board. It also dealt with the test carried out to evaluate performance of the completed work. The chapter finally treated the type of casing used for the project work. Lastly, chapter six covered summary, conclusion and the recommendations given upon successful completion of the work.

6.1 CONCLUSION

In spite of all the odds, the design and implementation of the12V SPC, a mere conceived idea in the first place, was successfully translated into reality. Hence, the main objective of the project was achieved. However, as emphasized under the scope of work (section 1.2 of chapter one), this project work was presented as a prototype mainly due to cost of materials needed to develop a medium capacity solar power center, like 600W or even 1000W. In any case, the recommendations given in the next section covered that.

6.2 RECOMMENDATIONS

Having successfully presented a small capacity 12V SPC as a prototype, the following points are hereby recommended with a view to developing a higher capacity SPC, up to 1000W or there about.

- The circuit can be made to operate on higher voltages and currents of the solar power input by arranging a number of 12V, 6A solar panel modules in series and in parallel.
- Some of the components like 12V zener diode, positive voltage regulator, 5A fuse, a number of resistors and capacitors may need to be replaced accordingly. However, IRFZ34 power MOSFET may not be replaced. In any case, extensive use of the components' data sheets will be highly needed.
- A suitable inverter may be incorporated to the SPC to give an equivalent ac power output for powering some household ac appliances.
- The university authorities should take it upon themselves to look for organizations, especially industries, to sponsor these types of projects with a view to making mass productions. In this way, local talents will not only be encouraged, but will also be appreciated both nationally and internationally. On the economic part,

more jobs will be created thereby improving the Gross Domestic Product (GDP) and hence, the overall economy of the country.

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