DESIGN AND CONSTRUCTION OF A SOLAR MOBILE PHONE CHARGER (CASE STUDY: LG B1300)

BY

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DECLARATION

I, NWAJAGU OBIORA hereby declare that this project was wholly conducted by me, under the able supervision of Mr. N. Salawu of the Department of Electrical / Computer Engineering, Federal University of Technology, Minna, Niger State.

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Special thanks to my colleagues (2005 set) 500 level Electrical/Computer Engineering Student.

Much love and respect to those whose names were not written here.

DEDICATION

This project work is dedicated to the Lord God Almighty for his love, mercy and favour over me. Also to all members of the Nwadinobi-Nwajagu family, Arc. O. C. Nwajagu, Mrs Josephine Nwajagu, Tobechukwu Nwajagu, and Ikenna Nwajagu.

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ABSTRACT

Sustainable development will require replacement of older technologies and increase the use of alternative power supply for the Global System for Mobile Communication (GSM) phone.

Findings are that the benefits clearly increase with the remoteness of areas with no power supply. Key parameters are solar panel, efficiency and a backup system.

The research also discusses future challenges and outstanding issues for solar mobile telephony and solar technology.

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Chapter One

1.0 Introduction

Photovoltaic offers the ability to generate electricity in a clean, quiet and reliable way. Photovoltaic systems are comprised of photovoltaic cells, devices that convert light energy directly into electricity. Because the source of light is usually the sun, they are often called solar cells.

Photovoltaic are gaining popularity around the world as their prices decline and efficiency increase.

1.1 The Basics of Photovoltaics

The photovoltaic effect is the process by which sunlight is converted directly into electricity. Photovoltaic cells or solar cells, are typically made of a thin wafer-like silicon semiconductor material that is treated with other elements to create a negative and positive field. A voltage potential of one-half volt (0.5v) is created between the positive and negative sides of the photovoltaic cell. When a photon of light strikes an atom of silicon in the solar cell, the transfer of energy fires an electron. The fired electrons flow in one direction from the force of the electric field, through a connection of wires to a load or some electrical device and returns to the positive layer after performing useful work. The cell acts as a current generator, as ore light strikes the cell, higher levels of current are generated with little effect on voltage. Also, the amount of current generated is proportional to the amount of surface area of the cell.

The output of a cell is affected by temperature, the higher the operating temperature, the lower the output power and efficiency along with a decrease in cell life. The cells are connected in series and parallel combinations to generate a desired voltage and current output. By connecting the cells in series, higher voltages are produced typically to match the load voltage. The array of cells is then connected, encapsulated, and sealed to form a module.

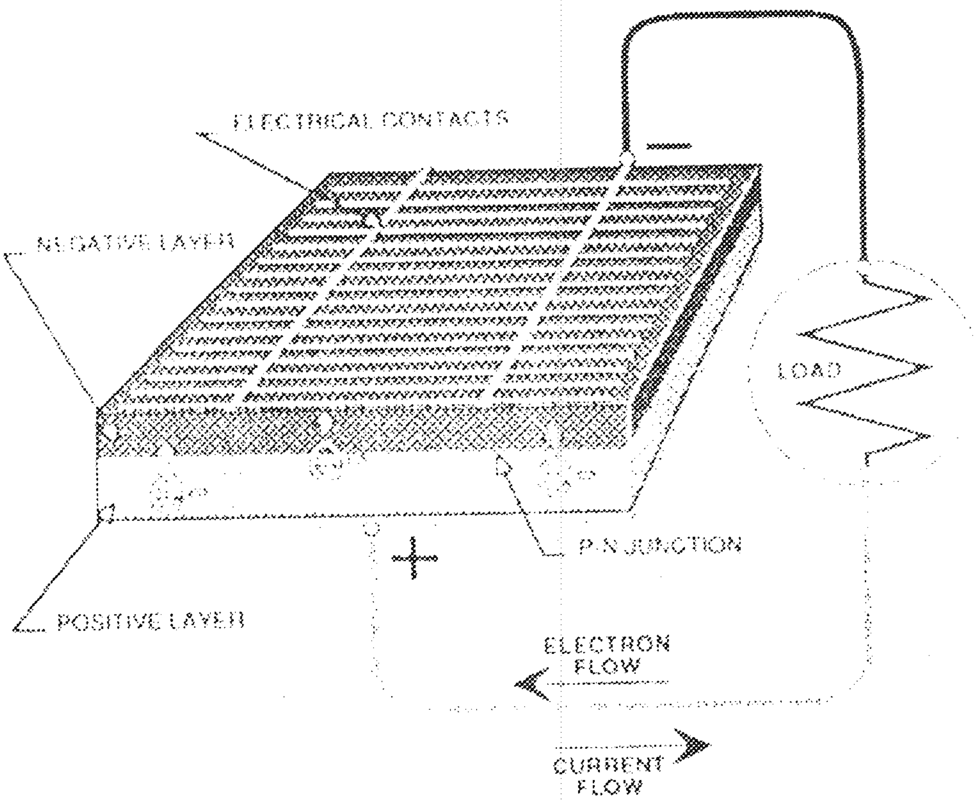


Figure 1: Photovoltaic cell creates negative and positive electric field

Communication systems are ideal for photovoltaic because mobile phone need only a small amount of energy to operate and require reliable power source. The use of photovoltaic systems is the only effective solution to establishin telecommunication network and keeping communication systems reliable

Photovoltaic systems are mobile, silent, durable, virtually maintenance free and easy to install.

In conclusion, it is "The most reliable source of electric power ever invented" and noted "cellular and photovoltaic technology go hand-in-hand"

1.2 Aim and Objectives

The aim of the study is to look at the viability of solar photovoltaic, as a source of power for mobile phones, and the objectives are:

1) To design an alternative method of powering the Global System for Mobile Communication (G.S.M.) phone.
2) To have an effective solution to establishing telecommunication network and keeping communication system (G. S. M.) reliable.

1.3 Scope of Study

Due to the limitless amount of information that could be garnered on this research topic and the constraints that abounds in trying to achieve this project. The scope of this study is to provide an independent, reliable electrical power source to communication system (G.S.M.) phone.

1.4. Statement of Problem

Due to the various problems affecting conventional Alternating Curre power supply, which manifests in the form of expense, in efficiency in pow generation, transmission and supply, it is imperative that an alternative be found t proffer solutions in powering mobile phones.

1.5 Justification

The motivation for this study is quite clear, although numerous researc have been done on solar-photovoltaic as a source of renewable energy, none ha exhaustively treated the aspect of designing and construction of a solar mobil phone charger. Also to determine the viability of solar photovoltaic as a economically viable alternative to AC power supply, to assist facilitate nationa development. It will also improve the quality of life in Nigeria at the long.

1.6 Benefits of Study

Reliability and durability of the photovoltaic module. This system has th potential to become the 'best' method of power generation known for mobile phone

Chapter Two

2.0 Literature Review

2.1 Historical Background

Research into photovoltaic technology began over one hundred years ago. 1873, British scientist Willoughby Smith noticed the selenium was sensitive light. Smith concluded that selenium's ability to conduct electricity increased direct proportions to the degree of its exposure to light. This observation of t photovoltaic effect led many scientists to experiment with the relatively uncomm element with the hope of using the material to create electricity.

In 1880, Charles Fritts developed the first selenium based solar electric ce The cell produced electricity without consuming any material substance, a without generating heat.

Broader acceptance of photovoltaics as a power source didn't occur un 1905, when Albert Einstein offered his explanation of the photoelectric effe Einstein's theories led to a greater understanding of the physical process generating electricity from sunlight. Scientists continued limited research on t selenium solar cell through the 1930's despite its low efficiency and hi production costs.

In the early 1950's, Bell laboratories began a search for a dependable way power remote communication systems. Bell scientists discovered that silicon, t second most abundant element on earth was sensitive to light and, when treated wi certain impurities, generated a substantial voltage. By 1954, Bell laboratorie developed a silicon-based cell that achieved 6% efficiency.

The first non-laboratory use of photovoltaic technology was to power telephone repeater station in rural Georgia in the late 1950's. National Aeronautic and Space Administration (NASA) scientists, seeking a light weight, rugged an reliable energy source suitable for outer space, installed a photovoltaic syster consisting of 108 cells on the United States first satellite vanguard I. by the earl 1960's, photovoltaic systems were being installed on most satellites and spacecrafts

Today, homes in the United States use some type of photovoltaic technolog and also creating sustainable economic opportunities. The intense interest generate by current photovoltaic application provides promise for this rapidly developin technology.

2.2 Photovoltaic System Components

Photovoltaic systems are built from several important components. The tot components and subsystems that, in combination, convert solar energy int electrical energy suitable for connection to a utilisation load. Solar systems have t meet high standards of reliability and economic efficiency. This can only b guaranteed by the use of field-power quality components that are well-matched These components are:

2.2.1 Solar Cell

The basic unit photovoltaic device that generates DC electricity whe exposed to light. A typical silicon cell produces or generates a potential differenc of about 0.5 volts in normal operation and up to 6 amps and 3 watts for larger a cells. For this reason, solar cells are connected in series to bring the voltage up t useful level. For example 30-36 cells are normal enough to charge a 12 volt batte Several variety of silicon type solar cells and solar cell modules available are:

- **Mono-crystalline Cell Modules:**

  The highest cell efficiencies of around 15% are obtained with these modul The cells are cut from a mono-crystalline silicon crystal. They are chemica stable, so they last for a very long time is properly protected.

- **Multi-Poly Crystalline Cell Modules:**

  The cell manufacturing process is lower in cost but cell efficiencies of o around 12% are achieved. A multi-crystalline cell is cut from a cast-ingot multi-crystalline silicon and is generally square in shape.

- **Amorphous/Thin Film Silicon Modules:**

  These are made from thin films of amorphous silicon where efficiency is m lower (6-9%) but the process uses less material. The potential for cost reduct is greatest for this type and much work has been carried out in recent year develop amorphous silicon technology. Unlike mono-and multi-crystalline ce with amorphous silicon there is some degradation of power over time.

2.2.2 Photovoltaic Modules

A number of photovoltaic cells electrically interconnected and moun together, usually in a sealed unit of convenient size for handling and assembl into arrays. The term 'module' is often used interchangeably with the term 'panel

2.2.3 Photovoltaic Array

An electrical assembly of photovoltaic modules mounted together, t

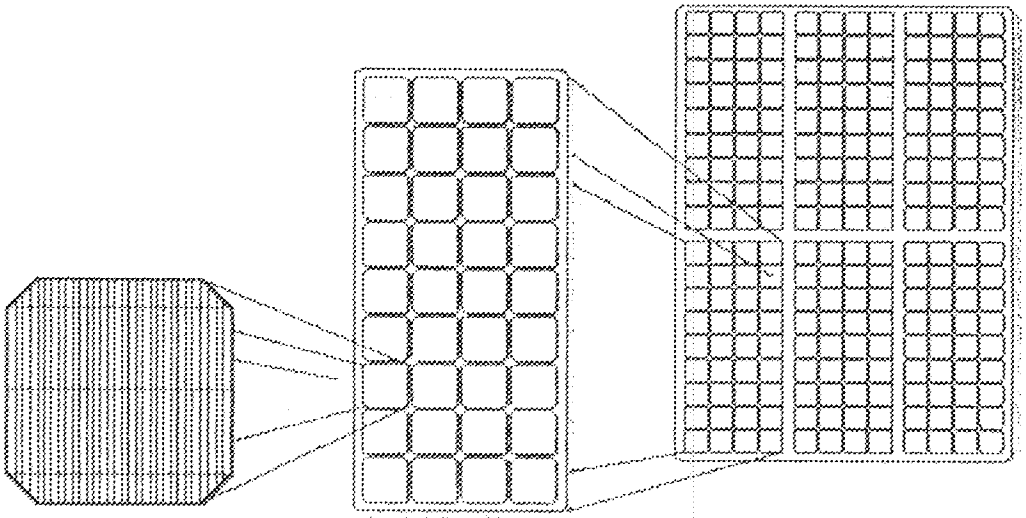


Fig 2: Photovoltaic cell module and array

The building blocks of solar electricity are modular in nature, allowing gr flexibility in applications.

2.2.4 Output of Solar Cell Modules

The power output of a module depends on the number of cells in t module, the types of cells, and the total surface area of the cells.

The output of a module changes depends on:

- The amount of solar radiation
- The angle of the module with respect to the sun
- The temperature of the module
- The voltage at which the load (or battery) is drawing power from the module

The output of a solar cell is temperature dependent. Higher cell temperatures lead to lower output, and hence to lower efficiency. The level of efficiency indicates how much of the radiated quality of light is converted into useable electrical energy. Solar cell module output is very much governed by the intensity of the solar radiation on a module. Higher intensity of solar radiation increases the module output while lower radiation lowers the voltage at which current is produced.

2.2.5 Photovoltaic Module Performance

To insure compatibility with storage batteries or load, it is necessary to know the electrical characteristics of photovoltaic modules. Each solar cell and module has its own particular set of operating characteristics that can be described by the current-voltage curve, which is better known as the I-V curve. I-V curve are used to compare solar cell modules, and to determine their performance at various levels of insulation and temperatures.

A photovoltaic module will produce its maximum current when there is essentially no resistance in the circuit. This would be a short-circuit between its positive and negative terminals.

This maximum current is called the short circuit current, abbreviated I(sc). When the module is shorted, the voltage in the circuit is zero.

Conversely, the maximum voltage is produced when there is a break in the circuit. This is called the open circuit voltage, abbreviated V(oc). Under this condition the resistance is infinitely high and there is no current, since the circuit is incomplete. These two extremes in load resistance, and the whole range of conditions in between them, are depicted on a graph called a I-V (current-voltage) curve. Current expressed in amps, is on the vertical y-axis. Voltage, in volts, is on the horizontal x-axis.

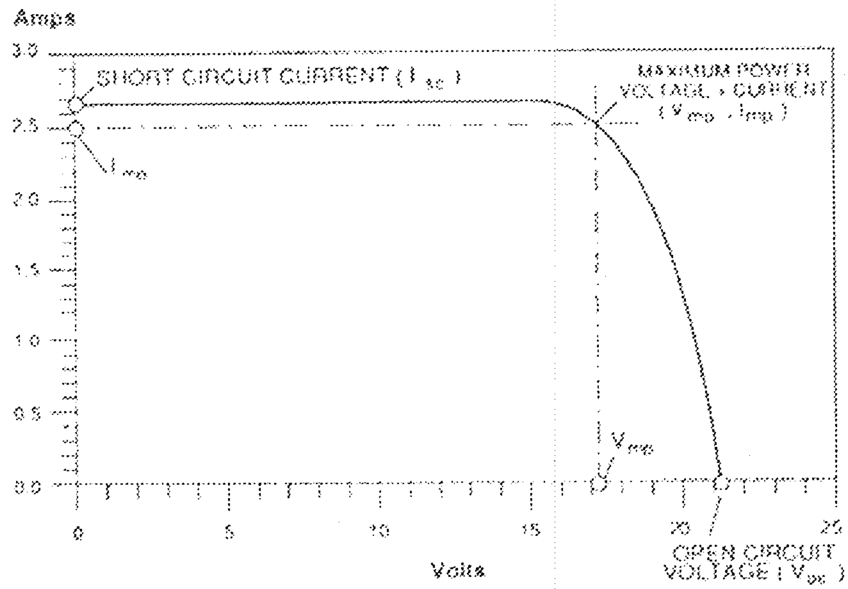


Fig 3: A typical current-voltage curve

The power available from a photovoltaic module at any point along the curve is expressed in watts. Watts are calculated by multiplying the voltage times the current. (watts = volt x amps, or W= VA).

The maximum power is the point on the I-V curve where the module produces the greatest power. The maximum power point is always found at the place where the curve begins to bend steep by downward.

2.2.6 **Photovoltaic Battery**

Batteries are group of electrochemical cells devices that convert chemical energy into electrical energy. The two common types of battery systems are "Lead acid" and "Nickel Cadmium" batteries.

NICAD BATTERIES

Sometimes called 'Alkaline' storage batteries in which the positive active material is nickel oxide and the negative contains cadmium.

CHARACTERISTICS

- The are more expensive
- They are less efficient per unit of storage than lead-acid batteries (low efficiency: 65-80%)
- Very expensive to dispose of-cadmium is considered very hazardous
- Have longer life compared to most lead-acid types
- Requires less maintenance than most lead-acid batteries
- Can be completely discharged without damage to the cells, and the can be left for long periods in a low state of charge. In very small systems without charge controllers, this is an important advantage.

LEAD-ACID BATTERIES

Lead-acid batteries have plates made of lead, mixed with other materials, submerged in a sulphuric acid solution. The lead-acid battery is still the battery of choice for 99% of solar and backup power systems. They are the most common in photovoltaic system and readily available nearly everywhere in the world.

There are types of lead-acid batteries, that fall into two general categories:

1. Deep cycle batteries
2. Shallow cycle batteries

DEEP-CYCLE BATTERIES

These batteries are designed to be repeatedly discharged by as much as 80% of their capacity so they are a good choice for power systems. Even though they are designed to withstand deep cycling, these batteries will have a longer life if the cycles are shallower. All lead-acid batteries will fail prematurely if they are not recharged completely after each cycle. Letting a lead-acid battery stay in a discharged condition for many days at a time will cause sulfation of the positive plate and a permanent loss of capacity.

SHALLOW CYCLE BATTERIES

Shallow cycle batteries, like the type used as starting batteries in automobile, are designed to supply a large amount of current for a short-time and stand mild over charge without losing electrolyte. Unfortunately, they cannot tolerate being deeply discharged. If they are repeatedly discharged more than 20% their life will be very short. These batteries are not a good choice for a photovoltaic system.

2.2.7 Charge Controllers

Charge controllers are used to regulate the flow of electricity from the photovoltaic panels to the batteries.

Charge controllers prevent array from overcharging the battery and automatically disconnects load from the battery during deep discharge.

The major classes of charge controller are as follows:

- One and two stage
- Three stage PWM (pulse width modulation)type
- Three stage MPPT (maximum power point tracking) type

One and two stage charger were the best available units, but now have no proper place in a well-designed photo-voltaic system. They will dramatically reduce the life of the batteries, and decrease power input from the photovoltaic panels.

Three state chargers accomplish all three charge stages. The third stage requires that the current slowly decrease while the voltage remains the same. However, the input to the controller is from a photovoltaic panel that does not automatically do this. In order to achieve the third stage charge, the PWM portion of the controller rapidly switches the current on and off. By adjusting the width of the pulses (pulses width modulation) the current that the battery "sees" can be adjusted. Thus, the controller is able to provide fine control MPPT chargers use all the tricks of the PWM charges, (MPPT squeezes more power from the photovoltaic panels by making them operate at their most efficient voltage).

Additionally, most of the MPPT controllers can also perform DC voltage conversion. This means the photovoltaic panels can operate at a different voltage than the batteries. This is a major advantage for long wire runs, since the higher voltage power from the photovoltaic panels can be brought in on a smaller wire.

2.3 Types of Photovoltaic System

1) **Standalone Photovoltaic Systems**

- Direct current systems with no storage (Day use systems)
- Direct current systems with storage batteries
- Direct current systems powering alternating current loads

2) **Utility Grid Interconnected Systems**

STANDALONE PHOTOVOLTAIC SYSTEM

Standalone photovoltaic systems can be configured in many ways which are:

(i) **Direct Current with no storage (day use system)**

The simplest and least expensive photovoltaic systems are designed for day use only. These systems easiest of modules wired directly to a DC appliance, with no storage device. When the sun shines on the modules, the appliance consumes the electricity they generate. Higher insulation (sunshine) levels result in increased power output and greater load capacity.

Examples:- Calculators, toys, remote water pump

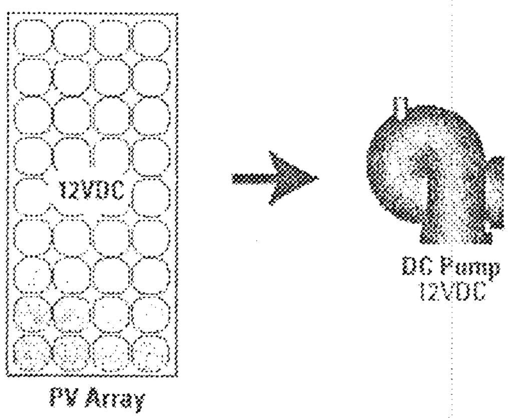


Fig 4 Direct Current with no storage (day use system)

(ii) **Direct Current Systems with storage batteries**

To operate loads at night or during cloudy weather, photovoltaic systems must include a means of starting electrical energy. Batteries are the most common solution. System loads can be powered from the batteries during the day or night, continuously or intermittently, regardless of weather. In addition, a battery bank has the capacity to supply high-surge currents for a brief period, giving the system the ability to perform difficult tasks.

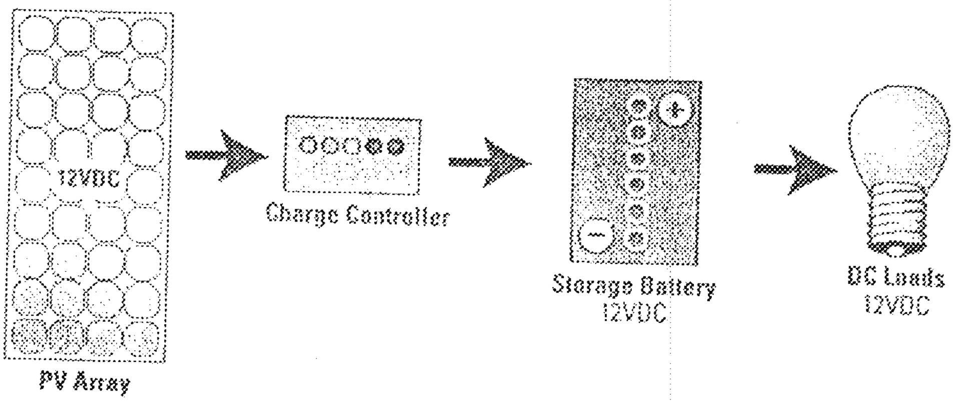


Fig 5: Direct Current Systems with storage batteries

This system's basic components include a photovoltaic module, charge controllers, storage batteries and appliances (the system's electrical load). A battery bank can range from small flash light size batteries to dozens of heavy-duty industrial batteries. Deep-cycle batteries are designed to withstand being deeply discharged and then fully recharged when the sun shines. (Conventional automobile batteries are not well suited for use in photovoltaic systems and will have short effective lives). The size and configuration of the battery bank depends on the operating voltage of the system and the amount of night time usage. In addition, local weather conditions must be considered in sizing a battery bank. The number of modules must be chosen to adequately recharge the batteries during the day. Batteries must not be allowed to discharge too deeply or be overcharged-either situation will damage them severely. A charge controller will prevent the battery from overcharging by automatically disconnecting the module from the battery bank when it is fully loaded. Most charge controllers also prevent batteries from reading dangerously low charge levels by stopping the supply of power to the DC loads, providing charge control is critical to maintaining battery performance in all but the simplest of photovoltaic systems.

(iii) **Direct Current Systems Powering Alternating Current loads**

Photovoltaic modules easily produce DC electrical power, but many common appliances require Ac power. Direct current systems that power AC loads must use an inverter to convert DC electricity to AC.

Inverters provide convenience and flexibility in a photovoltaic system, but add complexity and cost. Because AC appliances are mass-produced, they are generally offered in a wider selection, at lower cost, and with higher reliability than DC appliances. High quality inverters are commercially available in a wide range of capacitors.

UTILITY GRID INTERCONNECTED SYSTEMS

Photovoltaic systems that are connected to the utility grid (utility-connected, grid – tie, line-tie systems) do not need battery storage in their design because the utility grid acts as a power reserve. Instead of storing surplus energy that is not used during the day, the homeowners sell the excess energy to a local utility through a specially designed inverter. When homeowners need more electricity than the photovoltaic system produces, they can draw power from the utility grid.

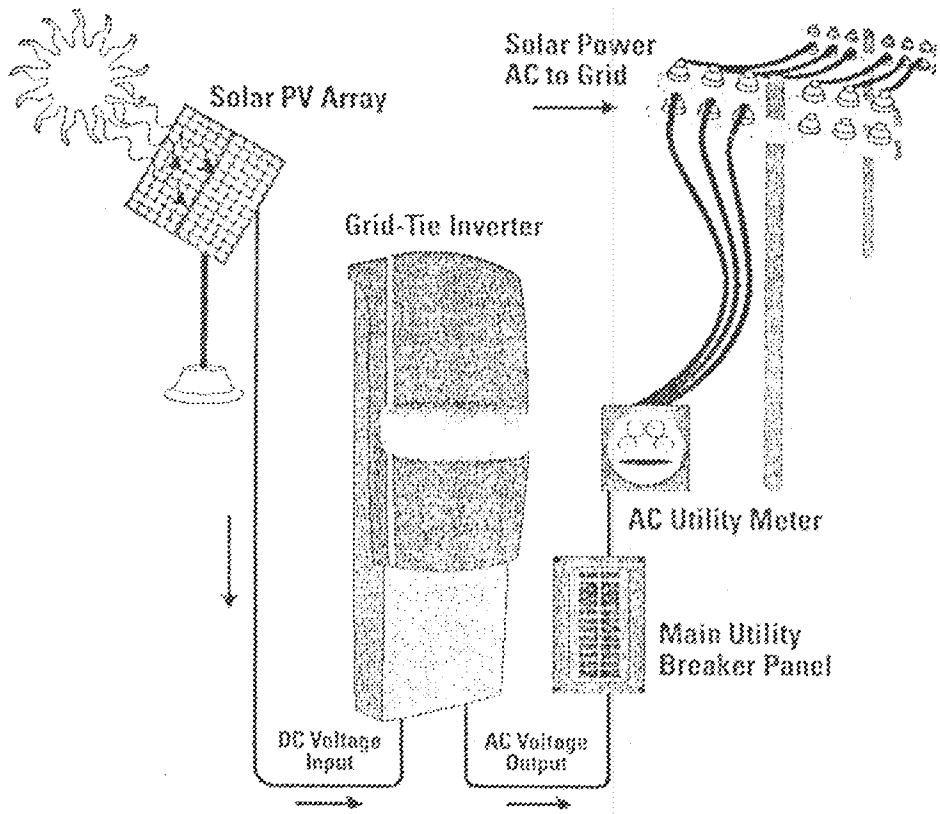


Fig 6 : Utility Grid Interconnected Systems

An advantage of this system is the buffering due to the grid which results in all of the energy in all of the energy operated by the photovoltaic system being utilised.

Conversely, a disadvantage of this system is the need for the presence of the grid for the inverter to function. If the grid fails then no energy in generated even at times of high irradiance.

A grid connected backup system combines the grid connected array with a battery back up for standalone operation in the event of grid failure. This type of system suffers the disadvantage of stand-alone photovoltaic systems (expensive battery storage) but overcomes the disadvantage of the grid connected system which fails when the grid is lost. The advantages are that all the photovoltaic power is utilised and power always available for the load. The added expense of these dual systems limits their use to remote but grid connected consumers who require a high security of supply.

2.4 Benefits of Photovoltaic Technology

Photovoltaic system offer substantial advantages over conventional power sources.

- **Reliability:** Even in harsh conditions, photovoltaic systems have proven their reliability. Photovoltaic arrays prevent costly power failure in situations where continuous operation is critical.
- **Durability**: Most photovoltaic available today show no degradation after ten years of use. It is likely that future modules will produce power for 25 years or more.
- **No fuel cost:** Since no fuel source is required, there are no costs associated with purchasing, storing, or transporting fuel.

- **Photovoltaic Modularity:** photovoltaic systems are more cost effective then bulky conventional system. Modules may be added incrementally to a photovoltaic system to increase available power.
- **Lower Maintenance Cost:** Transporting materials and personnel to remote area for equipment maintenance or service work is expensive. Since photovoltaic systems require only periodic inspection and occasional maintenance, these costs are usually less than with conventionally fuelled systems
- **Reduced Sound Pollution:** Photovoltaic systems operate silently and with minimal movement
- **Electrical Grid Decentralisation:** Small-scale decentralised power stations reduce the possibility of outages on the electric grid.
- **Safety:** Photovoltaic systems do not require the use of combustible fuels and are very safe when properly designed and installed.
- **High Altitude Performance:** Increased insulation at high altitudes makes using photovoltaics advantages, since power output is optimised. In contrast, a diesel generator at higher altitudes must be rated because of losses in efficiency and power output.
- Independence: Many residential photovoltaic users cite energy independence from utilities as their primary motivation for adapting the new technology.

2.5 Disadvantages of Photovoltaic Technology

Photovoltaics have some disadvantages when compared to conventional power system.

- **Initial cost:** Each photovoltaic installation must be evaluated from an economic perspective and compared to existing alternatives. As the initial cost of photovoltaic systems decreases and the cost of conventional fuel sources increases, these systems will become more economically completive.
- **Efficiency Improvement:** A cost-effective use of photovoltaics requires a high efficiency approach to energy consumption. This often
- **Viability of available solar radiation:** Weather can greatly affect the power output of any solar-based energy system. Variations in climate or site conditions require modifications in system design.
- **Education:** Photovoltaic systems present a new and unfamiliar technology. Few people understand their value and feasibility. This lack of information slows market and technological growth.
- **Energy storage:** Some photovoltaic systems use batteries for storing energy increasing the size, cost and complexity of a system.

2.6 Maintenance and Troubleshooting of a Photovoltaic System

Purpose of Section

This section describes the steps necessary to take care of the photovoltaic systems after it has been installed. This includes regular maintenance and the troubleshooting of system problems in order to keep the system running through its intended lifetime. Much of the maintenance of photovoltaic systems is composed of clearing, checking connections, and maintaining performance.

2.6.1 Maintenance of System

Maintenance the photovoltaic system properly will ensure its functionality throughout its intended lifetime. The tasks associated with maintaining the system should be carried out on a regular basis. A system that is adequately maintained should operate correctly for the lifetime of the components. The maintenance of PV system components are:

- Visually check the controller for any loose wires or connections. The location in which its is installed should be cool and dry, and not near the battery ventilation area, as sparks could cause the hydrogen gas normally released by the batteries to ignite.
- Visually inspect all of the system wiring. Look for loose, broken, or corroded wiring, terminals or connections pull firmly on all connections to make sure they are tight.
- The single cell are not to be shaded, it may cause the entire module to fail.
- Keep your batteries clean, always take them for boosting when they have been deeply discharged.
- Don't mix battery types in your bank. All batteries should be of the same type and about the same age. Lower quality batteries decrease the performance of those to which they are connected.
- Lead-acid batteries should not be left standing uncharged for long periods of time.

- Regular checking of state of change by using either the voltmeter, to ensure that the battery is performing well. Keeping state of charge records may help to defect when a battery is getting too old to use, or when a cell has gone bad.
- Clean terminals and contacts: cleaning the terminals ensures a good electrical contact with the solar array and load
- Use a soft cloth and either plain water or mild dish washing detergent and water to wash the surface of the photovoltaic modules at least once a year
- Check and tighten al mounting system fasteners. The frames should be straight with no serious corrosion.

2.6.2 Troubleshooting Problems

Troubleshooting must be performed when the user knows there is something wrong with the photovoltaic system, but they don't know what the cause is. The bulk of troubleshooting relies on the user checking the connections between components. Everything must be checked since it is possible that more than one component is malfunctioning. Regular maintenance can cut down on the need for troubleshooting, but unforeseeable circumstances can lead to component failure. Proper identification of these problems at an early stage will allow the use to repair or replace the faulty components, and keep the other components from being damaged in the process.

There are two main types of troubleshooting. The first relies on interpreting visual observations of the system. The other is based on a digital multimeter, which gives you readings on what the parts of the system are actually doing. Comparing these numbers to what the system is designed to be doing can help in determining what may be wrong.

2.7 Applications of Photovoltaic Systems

1) **Equipment**

- Water purification
- Refrigerators
- Portable pumping station

2) **Generators**

- Photovoltaic generators
- Small generators
- Small battery chargers
- Ups/Backup power

3) **Communications**

- Call boxes
- Portable AM/FM radios
- Radio Cellular phones
- Radio base stations
- Portable hand-held radios

4 **Healthcare System**

- Lighting in rural clinics
- Vaccine refrigeration
- Sterilizers
- Blood storage refrigerators

5. **Lighting**

- Street lighting
- Security lighting
- Personnel lights/Residential lighting
- Billboards and highway signs

6. **Transportation**

- Highway changeable message sign
- Road markers
- Hazard and warning lights

Chapter 3

3.0 Design and Construction

This chapter deals with the actual construction of the solar mobile phone charger and all the necessary tests carried out during the implementation of the circuit.

3.1 Circuit Components and their Functions

I. **Power Supply System:** Electronic power supply provides the energy for the circuit to work:

There are two types of power supply namely:

(i) Direct Current (DC) Battery

(ii) Solar Panel

Direct Current (DC) Battery

The battery is a device capable of providing direct current voltage to an electronic circuit. The lead-acid battery has plates made of lead, submerged in a sulphuric acid solution. The lead-acid battery is still the battery of choice for 99% of solar and backup power system. They are most common in photovoltaic system. A 12v 7AH battery was used for the project.

The symbol for a direct current (DC) battery is shown below:

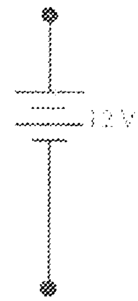


Fig 7: A direct current battery

Solar Panel:

Solar panels convert energy in the form of light from the sun into electrical energy. Only between 2 and 22% of the energy that falls on a panel is converted to usable electrical energy. The remaining energy is reflected or transformed into heat. Solar panel consists of a number of cells, which work together to create a high voltage to give off sufficient energy. Energy from the sunlight beats down on the solar panel crystals within these cells, knocking some electrons loose. This action creates electricity. A solar panel made up of 30-36 connecting cells, produces 15 to 18 volts.

In this project, a number of 36 photovoltaic cells are electrically interconnected and mounted together to produce a voltage of 18v.

II **Filtering:**

The capacitor (1000μF, 25v) is required if the Integrated Circuit(IC) regulator is located more than several inches from the battery.

Capacitor:

The capacitor stores electrical energy by electrostatic stress in the dielectric. It is also widely used to filter signals from a variety of circuits.

A capacitor`s capacity to store energy is called its capacitance, C, which is measured in Farads. It can be any value from pF to mF. The current through the capacitor is equal to C multiplied by the rate of change in voltage across the capacitor, that is (mathematically)

$i = C\, dv/dt$

-i is the current

- dv/dt is the rate of change of voltage with respect to time

- C is the capacitance

The symbol for a capacitor is shown below:

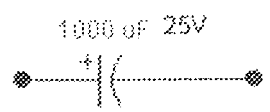


Fig 8: A capacitor

III Voltage Regulation

Voltage regulation is one of the most important regulated power supply components. It is the measure of a supply's ability to maintain a constant output voltage. In this project, voltage regulator(LM 7806) and a zener diode (5.1v) are provided for regulating the supplies.

Zener Diode

The zener diode is designed to operate in the reverse breakdown, or zener region, beyond the peak inverse voltage rating of normal diodes.

Zener diodes are used primarily for voltage regulation because they maintain constant output voltage despite changes in current.

The schematic symbol of a zener diode is shown below:

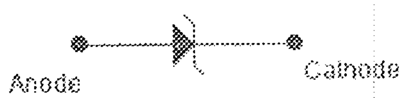


Fig 9: A zener diode

LM7806 (IC) Regulator:

This is a 3-terminal positive voltage regulator with an output voltage of +6v. It is designed with built in internal current limiting, thermal shutdown and safe area compensation for maximum flexibility and safety.

It is not necessary to bypass the output, although this further improves transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.

IV **Supply Indicator Network**

This network has two components viz; a limiting resistor and a Light Emitting Diode (LED).

A Limiting Resistor

It is a colour code resistor. The range of current for the LED (light emitting diode) to be protected is 10 to 50mA. Its function is to limit the current (current regulator) that has to flow in the LED. But if the value of the resistor is not enough to limit the current, the LED can be destroyed. LED is to indicate that power supply is on.

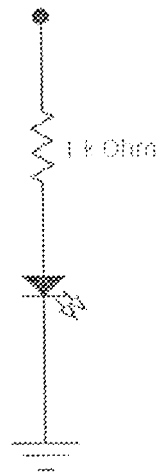


Fig10: Showing The circuit of power supply indicator

Light Emitting Diode (LED)

This is a diode which emits light in a variety of colours when conducting. LEDs are constructed of gallium arsenide or gallium arsenide phosphide. While efficiency can be obtained when conducting as little as 2 milliampere of current, the usual design goal is in the vicinity of 10mA. During conduction, there is a voltage drop across the diode of about 2 volts.

Resistor

The purpose of the resistor is to crate specified values of current and voltages in a circuit. They come in a variety of sizes, depending on the power they can safely dissipate. A resistor's resistance, R, is measured in ohms (Ω), colour-coded stripes on a real-world resistor specify its resistance and tolerance.

The symbol for a resistor is shown below:

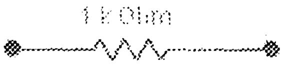


Fig 11: A resistor

V. **Diode (IN4001-IN4007)**

It is a two-terminal device consisting of a P-N junction formed from either germanium or silicon crystal. The diode allows current to flow in only one direction. Terminal A is called the anode and terminal K is called the cathode. The arrow head indicates the conventional direction of current flow when forward-biased. It is the same direction in which hole-flow takes place. The circuit symbol is shown below:

Fig 12: A diode

3.2 Specification of Components

Listed below are list of components used in the course of carrying out this project.

Table 1.0 List of Components

QUANTITY	COMPONENTS	RATING
3	Diode	IN4001 – IN4007
3	LED	
2	Resistor	47 Ω

1	Solar panel	18v 170mA 3 watts
1	Lead rechargeable battery	12v 7AH
1	Capacitor	1000µF 25v
1	Voltage regulator	LM 7806
1	Zener diode	5.1v
1	Resistor	100 Ω
1	Resistor	1k Ω

3.2.1 **Supported Mobile Phones:**

Specification:

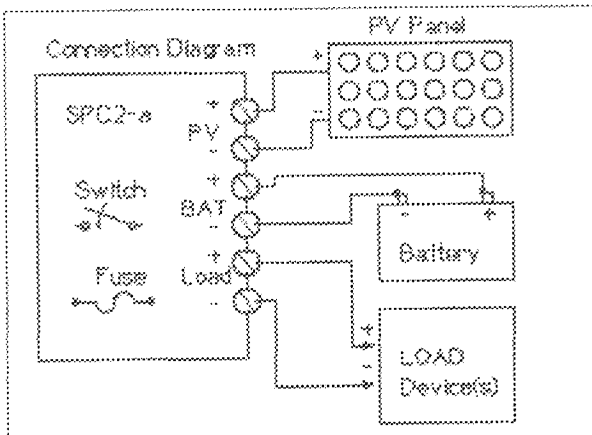
Product: LG B1300

Voltage rating: 5.0v

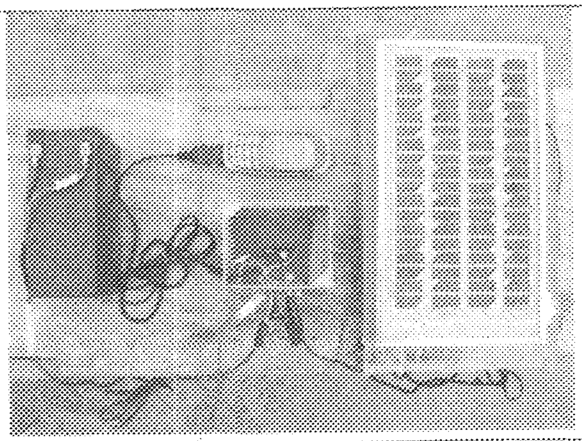
Current rating: 650mA

Manufacturer: LG

3.3 Schematic Diagram



(a)Block Diagram of the solar mobile phone



(b)Photo of the solar mobile phone charger using the solar panel,12v-7AH battery and the LGB1300 phone charging.

Fig A: Block diagram of the solar mobile phone

Fig B: Photo of the solar mobile phone charger using the solar panel ,battery and cellphone

3.4 Circuit Operation

The circuit presented here as an alternative to charge mobile phone (LG B1300) with a rating of 5.0 volts 650mA. Each of the solar cells develop about 0.5 volts across itself when in full sunlight. The string of 36 solar cells put out around 18v with no load, whereby the positive DC supply is connected through D_1 (prevent current flowing back to the solar panel) to the chargers output contact, while the negative terminal is connected through current limiting resistor R_2 (47 Ω).

LED 2 works as a power indicator with resistor R_1 serving as the current limiter and LED 3 indicates the charging state. During the charging period, 3 volts drop occurs across resistor R_2, which turns on LED 3 through resistor R5.

An external DC supply source can also be used to energise the charger where resistor R4, after polarity protection diode D2, limits the input current to a safe value. The 3-terminal positive voltage regulator LM7806 (IC1) provides a constant voltage output of 7.8 v DC. Since LED 1 connected between the common terminal (PIN 2) and ground rail of IC1 raises the output voltage of 7.8 v DC. LED 1 also serves as a power indicator for the external direct current (DC) supply. Diode D1 and D3 act as a gate, which selects the highest out of the two voltage sources.

Finally, it is preferably advisable a small heat sink is recommended for IC1 7806.

3.5 Circuit Diagram

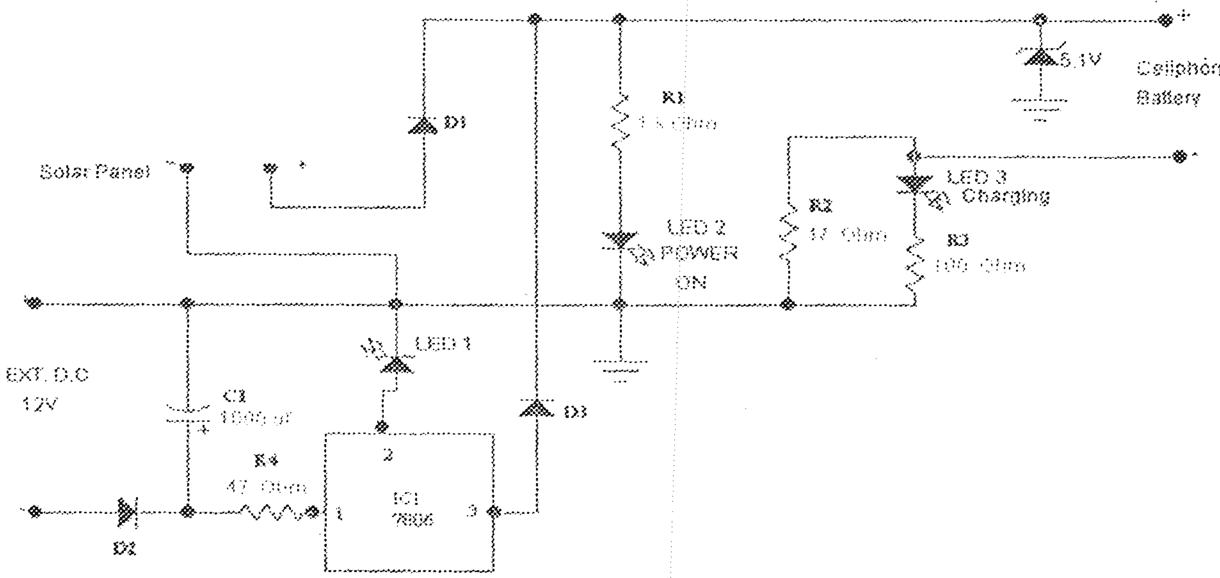


Fig 13: Circuit diagram of the solar mobile phone charger

3.6 Discussion of Results

Test and Observation

Measured output voltage = 5.23v

Measured output current = 150 mA

Research has shown that for better charging results the voltage of the power supply should be greater than the voltage requirements of the cell phone battery.

A charging chart is provided for easy reference.

Table 2.0 Charging chart

SOLAR OUTPUT	MEASURED OUTPUT VOLTAGE/CURRENT	RECHARGEABLE CELL PHONE BATTERY	CHARGING TIME IN SUNLIGHT
12 V 170mA	5.23v/150mA	650mA	4.33 hours

Charging times will vary depending upon the following conditions

1. Capacity of the battery
2. Intensity of the sunlight
3. Level of battery discharge

Charging time can be calculated as follows:

$$\text{Time} = \frac{\text{Battery capacity of } 650mA}{\text{Measured output current in } 150mA} = 4.33 \text{ hours}$$

3.7 Observation

The problem with charging the mobile phone battery from solar panel is the SUN. It doesn't shine all the time and clouds get in the way! Our eyes adjust to the variations in the strength of the sun but a solar panel behaves differently.

As soon as the sun loses its intensity, the output from a solar panel drops enormously. Not only does the output current fall, but the output voltage also decreases.

Chapter 4

Conclusion and Recommendation

4.1 Conclusion

Due to the inadequate supply of electricity for domestic use from the primary source (Power Holding Company of Nigeria, PHCN) it has become an imperative and necessary task to produce or source for a secondary source of power generation that is independent of the primary source.

The objective of this project is to design and construct accurately a "SOLAR MOBILE PHONE CHARGER" operating an output voltage/current at 5.23v/150mA to charge the LG B1300 at a maximum of 4.33hours. The performance of the project after test met design specification and hence can be said to be satisfactory.

Furthermore, stated below are the achievements:

(i) Developing an alternative source of power generation for the LG B1300 mobile phone.

(ii) Creating an awareness of solar technology.

Finally, like every aspect of Engineering there is still room for improvement and further research on the project as suggested in the recommendation below.

4.2 Recommendation

Though the design and construction of this project was a success, there are components which could still be put into the design to make it more efficient and easily controllable. This could have been carried out in this project if not for financial constraint.

Enumerated below are the various things that has to be put in place for future construction of this project.

First and foremost, I will recommend that a solar panel having a higher current ampere be used, to enhance the charging time of the mobile phone. Secondly, I also recommend that both the mobile phone and the lead acid rechargeable battery be charged simultaneously using the solar panel.

Finally, to develop a universal charger, which is able to charge other mobile phones.

4.3 References

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