DESIGN AND CONSTRUCTION OF A NOKIA 1200 CELL PHONE BATTERY CHARGER

BY

ABDULYEKEEN, ABDULGANIY O.

2004/18762EE

A THESIS WRITTEN IN PARTIAL FULFILLMENT OF BACHELOR OF ENGINEERING DEGREE AND SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA,

NIGER STATE, NIGERIA.

DECEMBER, 2009.

DECLARATION

I Abdulyekeen, Abdulganiy Olanrewaju declare that this work was done by me and has never been presented elsewhere for the award of a bachelor Degree.

....
Abdulyekeen A. O.

23/07/2010
....
Date

CERTIFICATION

This is to certify that the project work titled "Design and Construction of a Nokia 1200 Cell phone Battery Charger" was carried out by Abdulyekeen Abdulganiy O. with the Registration Number 2004/18762EE, under the supervision of Engr. (Dr) M. N. Nwohu and submitted to the Electrical and Computer Engineering Department, Federal University of Technology, Minna, in partial fulfillment for the award of Bachelor of Engineering (B. Eng.) degree in Electrical and Computer Engineering.

.... 15/3/2010
Engr. (Dr.) M. N. Nwohu. Date
(Supervisor)

.... May 6, 2010
Engr. Dr. A. Y. Adediran. Date
(Head of Department)

.... 09/03/10
External Examiner. Date

DEDICATION

I dedicate this project to my late mother, Hajia Rafat Abdul yekeen and sister, Kudirat Abdulyekeen who died on 25th January 1989 and 29th November 2007 respectively. May the almighty Allah grant both of them Al-janat Firdaus (Amen).

ACKNOWLEDGEMENT

I give thanks to the Almighty God for sparing my life till the successful completion y first degree. I also thank my guardian, Alhaji M.A. Alfanla for his full support in my emic activities to ensure I ended this programme and project successfully. May God save life and make your effort not to be in vain.

My profound gratitude also goes to my beloved father Malam Abdulyekeen S., may ighty Allah reward you abundantly.

hermore, I wish to express my sincere gratitude to my Supervisor, Engr (Dr.) M.N. ohu for his painstaking supervision and editorial work towards the success of my project k as well as his encouragement throughout the period of this project. May Almighty God ward him.

ABSTRACT

This project focuses on the design and construction of inexpensive mobile cell phone charger. The trends in mobile system are to increase functionality for the user, increase battery life and power efficiency. The charger is designed to charge a Nokia 1200 mobile cell phone batteries which was achieved using 555 timer IC as the main component for charging and monitoring the voltage level of the battery. This charger stops charging whenever the battery is full but continues to charge at low power supply. Of course it reduces the rigour faced in charging the battery frequently.

TABLE OF CONTENT

Pages

TITLE PAGE i

DECLARATION ii

CERTIFICATION iii

DEDICATION iv

ACKNOWLEDGEMENT v

ABSTRACT vi

TABLE OF CONTENTS...vii

LIST OF FIGURES x

CHAPTER ONE: INTRODUCTION

1.1 Introduction 1

1.2 Aims and Objectives ....,...........3

1.3 Motivations 4

CHAPTER TWO: LITERATURE REVIEW

2.1 Charging system 5

2.1.0 Constant-current system 5

2.1.1 Constant-voltage system...5

2.2 Types of battery chargers 6

4.4 Troubleshooting..27

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.0 Conclusion 28

5.1 Recommendations..28

REFERENCES

LIST OF FIGURES

Pages

1.0 Constant-current system 5

2.0 Constant voltage system 6

3.1 Block diagram of the circuit 15

3.2 Power unit diagram 16

3.3 Diagram of a voltage regulator 17

3.4 Series regulation circuit 18

3.5 Diagram of a reference voltage 19

3.6 Upper comparator of the 555 timer 20

3.7 Lower comparator of the 555 timer 21

3.8 State of charge indicator 22

CHAPTER ONE

1.1 INTRODUCTION

Today the advancement in technology has tremendously enhanced means of disseminating information and communication, telecommunication and others at affordable rates. Nowadays, the Mobile phone is one of the major means of communication commonly used by people. Throughout the world the mobile phone provide people avenue for quick business transactions, information dissemination among government agencies and fast transmission detective. Thus mobile phone is powered by an energy storage potential built into a densely packed battery, this batteries consist of different chemical compounds like NiMH, NiCd, $LiCoO_2$ and so on, for their better energy storage potential [1].

A mobile phone battery is a rechargeable battery in the sense that it produces an electric energy from a chemical reaction. It consists of two or more cells connected in series or parallel, but the term is generally used for a single cell. A cell consist of a negative electrode, an electrolyte, which conduct ions, a separator, also an ion conductor and a positive electrode, when the cell is connected to an external load, i.e. the circuit of a mobile phone, the negative electrode supplied a current of electrons that flow through the circuit or load and are accepted by the positive electrode. But after some time, it is found that the current flow into the circuit or load stops showing that the energy stored in the battery has been exhausted.

Therefore, it is necessary to replenish the lost of the stored energy or charges in the cell phone batteries after the time of operation which of course brought the quest for a battery charger.

A battery charger is a device used to restore the energy lost into the secondary cell or (rechargeable) battery by passing an electric current through it. This unit charges the batteries until it reach a specific voltage when the batteries are disconnected.

Therefore phone manufacturers build pretty smart charging and battery protection system into their phones package. The charging system built into a phone or its own charger is meant to work with the original family of batteries only. Ideally, don't fit NiMH batteries to an old phone designed only for NiCd. Similarly a phone which will work well with NiCd or NiMH will not work with Lithium batteries unless specifically designed for them. Usually a quick look into the instruction book had to be strictly adhered to [2].

Since the use of a rechargeable battery mostly power mobile equipment and increase in use of mobile technology have accounted for a large share of the mobile cell phone charger market in recent years. Batteries are a dependent commodity, useless without charger. There are different so-called mobile cellphone chargers in the market which are so inefficient, not reliable, and they actually destroy the batteries slowly or burn off after a short time of issue.

However, without a reliable battery charger, charging of the cellphone battery becomes a big problem while trading along distance as power supply source is not generally accessible. If the cellphone is switched on continuously, its battery potential goes down after a while making the cellphone ineffective. A fully charged battery becomes necessary especially when the distance from the nearest relay station increases. A well designed charger must be able to charge fast, ensure a long life and many circles before the battery becomes unserviceable.

An incompatible cellphone batteries and charger should also be avoided. Some web sites and second-hand dealers, not associated with reputable manufacturers and carrier, might be selling incompatible or even counterfeit batteries and chargers. A charger consumers should purchase manufacturer or carrier recommended products and accessories [3].

Battery chargers vary a great deal in intelligence, the types of batteries they can charge, how they maintain batteries, and how long they take to charge. As batteries are such a big investment when it comes to off grid solar power systems, it's important to get the right one for your off grid solar power system. A general rule of thumb is to charge a battery at about 10% of the amp hour capacity. For example, and 80th deep cycle battery should be changed at a rate of about 8A. Different types of batteries require different charging regions, for example, SLA (Sealed Lead Acid), AGM (Absorbent Glass Matt) and gel batteries are traditionally charged at a lower voltage than flooded lead acid batteries. This varies depending on the manufacturer and you should always check what charging voltage of a charger before using it [4].

In this project, the cell phone charger designed and constructed would be highly reliable, efficient, compact and relatively cheap for every mobile phone owner to have at home. Now, one can conveniently charge the phone once at anytime, anywhere, each time the charging level goes low and also save cost.

This project will also avert the burning of part of the commonly used Nokia charger as a result of the overheating caused by the excess current flows through its circuit component and consequently increase the life span of the use of the cell phone charger.

1.2 AIMS AND OBJECTIVES

The main aims of the project is to design and construct a Nokia mobile cell phone charger that is

- Capable of maximizing the use of the charger.
- Does not discharge the voltage in the cellphone battery whenever power supply goes off.
- Capable of stop charging whenever the battery is full
- Capable of continuous charging whenever the power supply goes low.

1.3 MOTIVATIONS

Considering the lapses common to Nokia 1200 cell phone battery charger commonly used by the commercial phone caller, this project was constructed to reduce the stresses faced in charging the battery frequently and in-turn reduces the cost and expenses of purchasing a new charger from time to time.

CHAPTER TWO

LITERATURE REVIEW

2.1 CHARGING SYSTEM

Batteries other than the 'floating' and 'system-governed' types, follows two general methods (through which other variation come to being) as employed.

1. Constant-current system and
2. Constant-voltage system

2.1.0 Constant Current System

In this method, the charging current is kept constant by varying the supply voltage to overcome the increased back e.m.f. of cells. If a charging booster (which is just a shunt dynamo directly driven by a motor) is used, the current supplied by it can be kept constant by adjusting its excitations. If charged on a dc supply, the current is controlled by varying the rheostat connected in the circuit. The value of charging current should be so chosen that there would be no excessive current during final state of charging and, also the cell temperature does not exceed 45^0C. This method takes a comparatively longer time but it is more efficient [5].

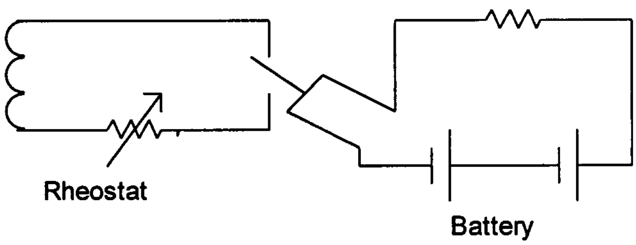

Figure 1.0: Constant-current system

1

2.1.1 Constant-Voltage System

With this method, time of charging is almost reduced to half. It increases the capacity by approximately 20% thereby reducing the efficiency of 100% to 50%.

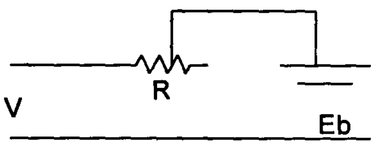

Figure 2: Constant voltage system

When a secondary cell or a battery of such cells is being charged, then the e.m.f. of the cells act in opposition to the applied voltage. If V is the supply voltage which send a charging current of I against the back e.m.f. E_b, then input power is VI but the power spent in overcoming the opposition i.e. E_bI. This power E_bI is converted into the chemical energy which is stored in the cell. The charging current can be found from the following equation:

$$I = \frac{V-Eb}{R} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

where: R = total resistance

I = charging current

By varying R, the charging current can be kept constant throughout. It is important to note the charging current and voltage of a particular charger before use. The charger current depends upon the technology and capacity of the battery being charged. For example, the current that should be applied to recharge a 3.7V cell phone battery will be different from the current of a 7.0V of another mobile phone battery. Charging with a simple charger equivalent to an AC-DC wall adapter that produces 300mA to the battery at all times will damage the battery if left connected too long.

2.2 TYPES OF BATTERY CHARGERS

2.2.1 Simple Charger

A simple charger works by supplying a constant DC power sources to a battery being charged. The simple charger does not alter its output based on time or the charge on the battery. A simple charger is inexpensive, but there is a trade off in quality. Typically, a simple charger takes longer time to charge a battery to prevent severe over-charging. Even so, a battery left in a simple charger for too long will be weakened or destroyed due to over-charging. These chargers can supply either a constant voltage or a constant current to the battery.

2.2.2 Trickle Charger

A trickle charger is a kind of a simple charger that charges the battery slowly, at the self-discharge rate. A trickle charger is the slowest kind of battery charger. A battery can be left in a trickle charger indefinitely, leaving a battery in a trickle charger keeps the battery "topped up" but never over charges. There are two main common types of trickle charger.

2.2.2.1 Constant Current Trickle Charger

The standard OEM (Original Equipment Manufacturer) or consumer – priced battery charger is a constant current trickle charger [4]. A trickle charger operates by delivering a steady, low level, positive current for as long as it is connected to a power supply. Ions are generated at one of the electrodes in the battery cell and must move to the other electrode. If current is sustained over an extended period, the ions concentrate on one side and create polarization which covers heat generation leading to inadequate charging capacity and short the life span of the battery.

This system of charging relies upon the user to stop the charger when the battery has reached its maximum capacity level. They generally charge battery fully in about ten hours. They are inexpensive and simple to design but they do not optimize the performance of the battery. In fact, they actually contribute to premature disposal of the batteries. The low charge rate allows the chemical reaction to be localized on the electrode surface leading to dendrite growth. There is high likelihood of over charging and in case of NiCd and NimH voltage depression or "memory effect" [6].

Memory effect is the great "imposter" that causes premature dismiss of batteries. When NiCd batteries are recharged before they are completely discharged, its electrodes passivity, decreasing the ability of the cell to accept a charge. When battery is repeatedly charged without being completely discharged, operating time and performance deteriorates and it appears due before its maximum life time.

Most OEMs upgraded fast chargers operate by increasing the constant current rate, charging the battery in only two or three hours. They either have rudimentary circuitry that terminates when the battery is fully charged or they decrease the charge current when the charge reaches a certain voltage level, usually about 80% - 90% charged. However, charging at a high constant current rate ignores the electrochemical process within the battery which over time causes significant deterioration.

2.2.2.2 Pulse Charger

Pulse-charging was introduced in the 1960s, it was the first improvement to the constant-current trickle charger. Pulse charging operates on the principle of surging power into the battery in pulses of electrical circuit. Interrupting the pulse current gives ions a chance to diffuse and distribute more evenly throughout the battery and returns to normal level routinely, thus reducing some of the negative effects of trickle charging. Although it was developed to address the chemical process of batteries, pulse charging still ignores the chemical reaction and physical phenomenon taking place in the battery. It provides short term fixes i.e. charged batteries, but the cost are heavy, shortened battery life and shorter charged cycles which translates into inadequate power to support equipment for the recommended duration.

The second generation of pulse charging emerged in the 1970s to counter the problem of recharging batteries that have not fully discharged. This method used only in selected commercial charger augments the rest period by adding a short negative discharge pulse interspersed with the positive charging pulse.

Podrazhansky, a Russian immigrant with a background in electrical and radio frequency engineering knowledge was busy searching for a solution to the problem plaguing his rechargeable batteries when he developed the design in electrochemical work (DEW) technology[6].Podrazhansky, advanced charger technologist of research discovered that the negative discharge in pulse charging can cause negative effect in the reverse direction. Single, high magnitude negative pulse cause an ion transportation problem in the negative direction as well as excessive discharge of battery, which increases charge time. Podrazhansky foundout that applying even shorter, multiple, negative pulses with a higher magnitude eliminates charging problems and enhance batteries chemical reactions.

2.2.3 Timer Based Charger

The output of a timer charger is terminated after a predetermined time. Timer chargers were the most common type for high capacity NiCd cells in the late 1990s, for example, low-capacity consumer Ni-Cd cell were typically charged with a simple charger.

Often a timer charger and set of batteries could be bought as a bundle and the charger timer was set to suit those batteries. If batteries of lower capacity were charged then they would be overcharged, and if batteries of higher capacity were charged, they would be only partly charged. With the trend for battery technology to increase capacity year by year, an old timer charger would only partly charge the newer batteries.

Timer based chargers also had the drawback that charging batteries that were not fully discharged, even if those batteries were of the correct capacity for the particular timer charger, would result in over-charging.

2.2.4 Intelligent Charger

The output current of intelligent charger depends upon the battery's state. An intelligent charger may monitor the battery's voltage, temperature and/or time under charge to determine the optimum charge current at that instant. Charging is terminated when a combination of the voltage, temperature and/or time indicates that the battery is fully charged.

For NiCd and NiMH batteries, the voltage across the battery increases slowly during the charging process, until the battery is fully charged. After that, the voltage decreases, which indicates to an intelligent charger that the battery is fully charged? Such chargers are often labeled as a DV "delta-V" or sometime "delta peak" charger indicating that they monitor the voltage change [7].

The problem is, the magnitude if (very) high capacity rechargeable batteries are recharged, this can cause even an intelligent battery charger never to sense that the batteries are actually already fully charged and continue charging. Overcharging of the batteries will result in some cases. However, many charger employ a combination of cut off systems, which should prevent overcharging in the vast majority of cases.

A typical intelligent charger fast charges a battery up to about 85% of its maximum capacity in less than an hour, then switches takes several hours to top off the battery to its full capacity [7].

2.2.5 Fast Chargers

Fast chargers make use of control circuitry in the batteries being charged to rapidly charge the batteries without damaging cells' elements. Most such chargers have a cooling fan to help keep the temperature of the cells under control. Most are also capable of acting as a ssstandard overnight charger. If used with standard NiMH cells that do not have the special control circuitry. Some fast charger, such as those made by energizer, can fast-charge any NiMH battery even if it does not have the control circuit.

2.6 Inductive Charger

An inductive battery charger use electromagnetic induction to charge batteries. A charging station sends electromagnetic energy through inductors coupling to an electrical device, which stores the energy in the batteries. This is achieved without the need, for metal contacts between the charger and the battery. It is commonly used in electric foothbrushes and other devices used in bathrooms. Because there are no open electrical contacts, there is no risk of electrocution.

2.7 USB-based charger

Since the Universal serial Bus specification provides for a five-volt power supply, it's possible to use a USB cable as a power source for recharging batteries. Products based on this approach include charger for cellular phones and portable digital audio player. They may be fully compliant USB peripheral devices adhering to USB power discipline, or uncontrolled in the manner of USB decorations.

2.8 Next Generation Battery Charger

Through years of advanced research in battery electronics and electrochemistry, CTEK has developed battery charger with superior technology that save time, money and aggregation by maximizing battery life and performance. CTEK does this by using a patented multi-step charging process.

1. Desulphation
2. Bulk
3. Absorption
4. What this means is that CTEK will efficiently bring the battery up to charge then shut down completely.

The charger then monitors the battery and kicks in more charge when needed. This method is proven more efficient than a typical trickle charge.In addition, CTEK has many built-in safety features that can not only save the battery charger but also the phone user and the batteries. These chargers are splash proof and weather-proof, so they can be left in any where, it can be used indoor and outdoor without any problem. The patented technology protects it against sparks. All of these features make CTEK the most recommended charger in the world [8].

China and other countries are now making a national standard of mobile phone chargers using the universal serial bus USB so as to meeting with next generation battery chargers. On October 22, 2009, the International Telecommunication Union announced a standard for a universal charger for mobile handset. Starting in 2010, Apple, Nokia, Motorola, Samsung and RIM will begin to make handset with a standard phone charger based on the micro-USB connector for effective, reliable and efficient charge [7].

On August 26, 2005, therewerecautions that "don't answer your phone when it's plugged into its charger". A Nigerian was reported dead when he answered his phone while it was plugged in the electricity tocharge. The man answered his phone, then after a few seconds electricity flowed into the cell phone unrestrained and the young man was thrown to the ground with a heavy thud, resulting in a weak heartbeat and burnt fingers, and he was dead on arrival at a hospital [9]. Nonetheless, this story should be considered as warning that while mobile phones are useful, they can also be an instrument to death.

Some mobile phone chargers nowadays are not really chargers, only adapters that provide a power source for the charging circuitry which is almost always contained within the mobile phone [7]. Mobile phone can usually accept relatively wide range of voltages, as long as it is sufficiently above the phone battery's voltage. However, if the voltage is too high, it can damage the phone. Mostly, the voltage is 5 Volts or slightly higher, but it can sometimes vary up to 12 Volts when the power source is not loaded.

Battery charger for mobile phones and other devices are portable in that they come in a wide variety of DC connector styles and voltages, most of which are not compatible with other manufacturer's phone or even different models of phones from a single manufacturer. It is not advisable to use incompatible cell phone batteries and chargers. There are many web sites and second-hand dealers, not associated with reputable manufacturers and might be selling incompatible or even counterfeit batteries charger. Phone user should purchase manufacturer or carrier recommended products and accessories. If unsure about whether a replacement battery or charger is compatible, contact the manufacturer of the charger.

In order to avoid a short-circuit resulting in overheating of a battery while charging is in progress, the following points have to strictly be adhered to:

1. Do not permit a battery out of the phone to come in contact with metal objects, such as coins, keys or jewelry.
2. Do not crush, puncture or put a high degree of pressure on the battery as this can cause an internal injure to it.
3. Do not place the phone or battery in an area that may get very hot, such as on or near a cooking surface, cooking appliance, iron or radiator.
4. Do not get your phone batteries or charger wet. Even though they will dry and appear to operate normally, the circuitry could slowly corrode and pose a safety hazard.

The charger user should try and follow its usage, storage and appliance guidelines found in the user's guide so as to maximize the usage of the charger.

CHAPTER THREE

3.1 DESIGN AND IMPLEMENTATION

The design procedure of this project work first begins with the basic charging requirement of Nokia 1200 cell phones, the charging voltage and the charging current whose critical and statistical analysis form the basis of this work. The figure in the next subheading shows the different unit of the block diagram used in this project work to achieve the desired result.

3.2 ANALYSIS OF THE BLOCK DIAGRAM.

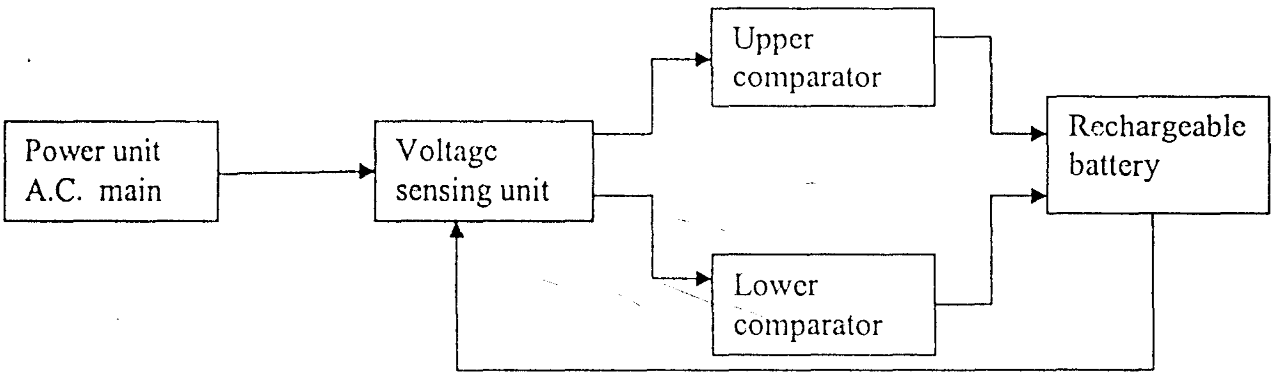

Figure 3.1: Block diagram of the circuit

A block diagram is a flow chart representation of different stages of the design of the project work. This can be segmented into the following unit.

1. The power unit
2. Voltage sensing unit
3. Upper comparator unit
4. Lower comparator unit
5. Output unit

3.2.1 POWER UNIT

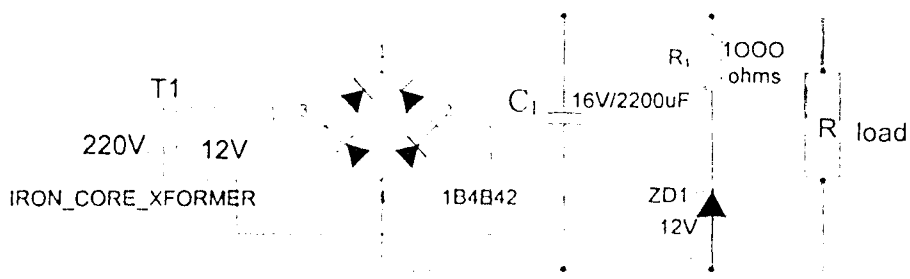

Figure 3.2: Power unit diagram

The power unit is made of transformation of voltage through the use transformer, rectification through the use of diode and filtering through the use of capacitor.

3.2.1.1 TRANSFORMER

A transformer can easily be defined as an electrical device that is used for the conversion of energy from one voltage level to another at the same frequency (voltage transformer). There are other types of transformer use for different purposes e.g. current transformer. For the purpose of this project a 220-12V, 300mA transformer was used without centre tap. The primary job of the transformer is to step down the supply voltage to suit the requirement of the solid state electronic devices and circuit fed by the DC power supply. It also provides isolation from the supply line which is an important safety consideration [2].

3.2.1.2 BRIDGE RECTIFIER (BR)

This is a device having four terminals. It consists of four diodes connected together to form bridge rectifying unit which convert A.C voltage from the transformer to a D.C pulsating voltage. The reason why the full wave bridge rectifier was selected is that it utilizes the transformer output voltage continuously. It also has high reliability and no center tap transformer is required [2].

3.2.1.3 FILTER

The filtering circuit performs the operation of removing fluctuation or pulsation (called ripple) that might be present in the output voltage from the rectifier. Though, there has not been any filter that can completely remove the ripple associated with the rectifier as that of dc battery but it approaches so closely that the power supply performed as well. Therefore, a 16V, 2200μF capacitor was used to remove any possible traces of pulsating voltage from the power supply.

3.2.1.4 VOLTAGE REGULATOR

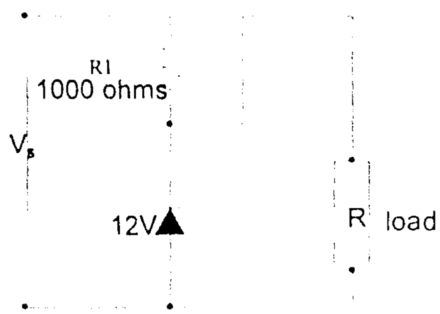

Figure 3.3: Diagram of a voltage regulator

Voltage regulator is a measure of a circuit ability to maintain a constant output voltage even when either input voltage or load current varies. The figure above shows how a zener diode can be used as a voltage regulator to provide constant voltage of about 12V from the source whose voltage may vary appreciably. A resistor, R_1 is to limit the reverse current through the diode to a safer value and its value could be calculated from the formula below.

$$R_1 = \frac{V_S - V_Z}{I_Z} \quad \text{.................................... (2)}$$

i.e. $R_1 = \frac{13-12}{1\times10^{-3}} = 1000\Omega$

where, V_S = source voltage

V_Z = output voltage

I_Z = Zener diode current

3.2.1.5 Series regulation

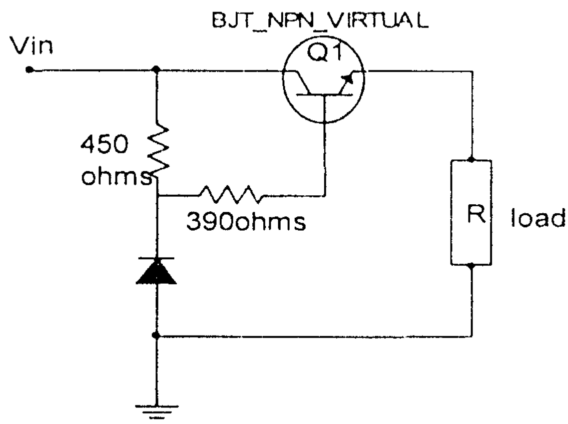

Figure 3.4: Series regulation circuit

The above is a series regulator. The base voltage is maintained at fixed voltage by the voltage drop across the Zener diode. If the load current increases for some reason, there will be an increase in voltage across the transistor, causing it to conduct harder and tending to maintain the output voltage at a constant value.

$V_L = Vz - V_{BE}$ .... (8)

The load voltage for charging the battery is 4.6 -0.7 = 3.9V, where 0.7 is the V_{BE}. The voltage is sufficient to charge Nokia phone whose charging voltage is about 3.9V. For other products like Motorola, Samsung and sagem, the Zener diode has to be replaced with a suitable one. In this design, only one voltage is apparent. This voltage includes 3.9 volts for products whose charging voltage are around these values only.

3.2.2 VOLTAGE SENSOR

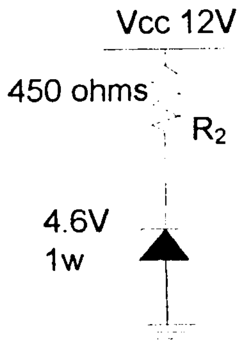

Figure 3.5: Diagram of a reference voltage

This arrangement provides a reference voltage for the upper comparator of the 555 timer and is directly connected to the 2/3V point of the voltage divider network Zener diode sas the voltage reference simply provides approximately constant voltage which is done with a resistor from a higher supply voltage forming the most primitive kind of regulated supply. The 4.6V Zener diode is used to achieve the highest output voltage. The current drawn by the 555 timer input is 1mA. The value of the resistor could be calculated from this formula.

$$R_2 = \frac{V_s - V_d}{I_d + I_t} \quad \text{........................} (3)$$

$$R_2 = \frac{12 - 4.6}{(15+1)mA}$$

$$R_2 = \frac{7.1}{16 \times 10^{-3}} = 463\Omega$$

where, V_S = voltage supply

V_d = diode voltage

I_d= diode current

I_t = current drawn by the 555 timer.

450 ohms value resistor was chosen and used because it is the nearest value to 463ohms in the market. R_2 is connected with Zener diode so as to hold back excessive current or limit the current to a prescribed value and prevent the Zener diode from overheating.

3.2.3 Upper comparator of the 555 timer

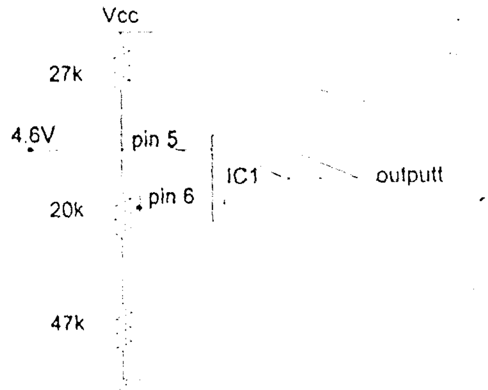

Figure 3.6: Upper comparator of the 555 timer

The diagram above is the upper comparator of the internal structure of the 555timer. The output sets the flip flop in the 555 timer. This arrangement senses the output terminal voltage of the battery and compares it with the reference voltage 4.6V. The voltage at pin 5 makes it possible to vary the threshold comparator `s trip point above or below the 2/3 of Vcc depending on the preset value of the 20k variable resistor.

The minimum input when the terminal voltage is 12V can be based on the voltage divider theorem.

Minimum voltage, V_{min} = $\frac{R_1}{R_1 + R_2 + R_3}$ ……………………………………… (4)

$$\frac{27}{27+47+20} \times 12V = 3.5V$$

while maximum voltage, V_{max} = $\frac{27+20}{27+47+20} \times 12V = 6V$

When a flat battery is connected across the charging terminals, then the output terminal voltage (of the battery charger) drops. Normally the input through pin6 of the upper comparator which senses the terminal voltage drops below the reference voltage of pin5. The output voltage of the 555timer is low when the reference pin5 is higher than the terminal voltage of the battery. Also, when the voltage has appreciated and has gone above the reference voltage i.e 8.6V, the output voltage now becomes high.

3.2.4 Lower comparator of the 555 timer

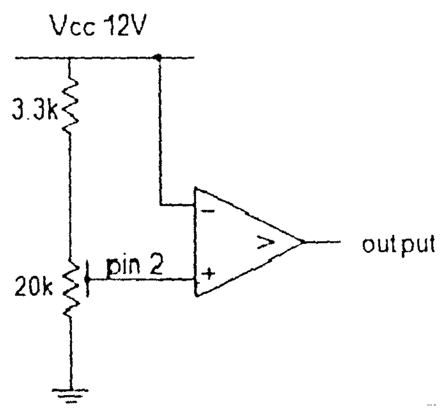

Figure 3.7: Lower comparator of the 555 timer

The network above also senses the terminal voltage and compares it to ½ of the reference voltage.

$1/2V_{ref} = 1/2 \times 4.6V = 2.8V$. .... (5)

Pin 2 can be varied through 20K variable resistor from

$$0 \text{ To } \frac{20}{20+3.3} \times 12 = \frac{20}{23.3} \times 12 = 10.3V$$

It senses the lower level of the voltage when a pin 2 input has dropped below 2.8V depending on the preset value or point. The flip flop is set, thereby, raising the output high.

In summary, the upper comparator reset the output to end charging process while the lower comparator sets the circuit to commence the charging process.

3.2.5 Light indicator configuration

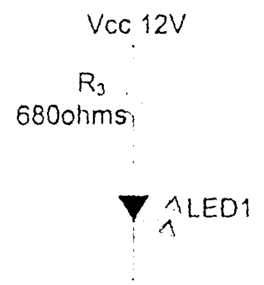

Figure 3.8: State of charge indicator

An LED must have a resistor connected in series to limit the current flowing through the LED otherwise, it will burn instantly. The output is the normal 555 timer output which is approximately Vcc=12V.

V_{out} = 10.3V.

$$R_3 = \frac{V_{out} - V_{led}}{I} \quad \ldots\ldots (6)$$

$$\frac{10.3V - 2V}{15mA} = \frac{8.3V}{15mA} = 553.3\Omega$$

A resistor of 680Ω is chosen because it is the nearest standard resistor value. It is also chosen in order to increase the battery life.

3.3 MODE OF OPERATION

When a cell phone was connected across the output terminals, the lower and upper comparator of the IC senses the output terminal voltage of the battery and compares it with the reference voltage 4.6V provided by the reference zener diode (D2). The trigger input pin drops below 1/3Vcc depending on the present value, thereby taking the output pin3 high, at this point charging commences (The led illuminates indicating that the battery is charging). When the voltage has appreciated and goes above 2/3Vcc, the output becomes low and set the flip-flip to zero, thereby terminating the charging process (the LED goes off indicating that the charging process has ended. It should be noted here that after multi usage of the charger, the voltage goes low and may not charge effectively. The charger batteries would hence require charging. The charging process for mobile phone charger batteries follows a similar pattern. When the outlet of the mobile charger is connected to the A.C mains, the transformer unit step down the voltage from 220V to 9V which is suitable for the circuit in charging the mobile batteries.

3.4 CONSTRUCTION

In the construction of the project, certain things were put into use such as breadboard/ project board, and finally Vero-board.

The essence of the breadboard is to assemble whatever the design is and carryout anything possible and ascertain the practicability of the project with necessary adjustment made before it is transferred to a Vero-board where soldering is finally being done.

3.5 FUNCTIONS OF EACH COMPONENT USED IN THE CIRCUIT.

Resistor (R_2, R_3, R_4 and R_5): are current limiting resistors. Current limiting resistors are series resistor inserted in a circuit to limit the current to the prescribed value.

Resistor R_2 (450ohms) is a current limiting resistor connected in series with a Zener diode. This is necessary to prevent the current from exceeding maximum allowable value which when surpassed, would cause the Zener diode to conduct excessively, thereby overheating. It simply holds back excessive current.

Resistor R_3 (680ohms). This resistor is also a current limiting resistor connected in series with the LED to limit the current through LED so as to avoid instant burn out of the LED

Resistor R_4 (39ohms) – it critically provides the required current to the base of the transistor to turn it on and conduct the current for charging.

Resistor R_5 (100ohms) – it also limits the current flowing in to the transistor. Uncontrolled current in to the transistor can damage it.

Resistor R_6, R_7, R_8 (27k, 47k and 3.3k) ohms – form a divider network for pin 2

Variable resistor VR_1 and VR_2 (20kohms each) – are resistors whose value can be varied either continuously or in steps. It sets the voltage needed by pin 2 and pin 6 to a pre-determined level.

Capacitor C_2 (0.01μF) – this capacitor remove spikes generated in the circuit especially during switching operation which is carried out in the 555timer.

Capacitor C_1 (16V, 2200μF) – it is a smoothing capacitor; it removes any possible AC traces. It also filters any possible glitch created by a standard 555timer.

Zener diode Zd1 (12V) – the diode provides a constant voltage Vcc to the entire circuit irrespective of either low voltage supply or variable low current.

Zenerdiode Zd2 (4.6) – this provides pin5 with reference voltage and regulated charging voltage due to varying current produced by the variable resistors. It also prevents back flow of current.

Transistor (BC 547) – it is used to enhance the charging current.

IC NE 555timer – it is used to charge and monitor the voltage level of the battery.

CHAPTER FOUR

TESTING, RESULTS AND DISCUSSION

4.0 TESTING

Testing started right from the point of acquiring and purchasing of components, each component was tested by either checking for continuity using multi-meter or by connecting it to a.c. supply. Each module on the Vero board was also tested for continuity or to get the desired output.

An external connector was connected to the output terminal so that N1200 mobile phone batteries can be charged without removing the battery.

4.1 RESULTS

Input voltage into the rectifier	=	12V
Input voltage into the regulator	=	15.5V
Output voltage from the regulator	=	12V
Circuit current rating	=	180mA
Voltage from output of the circuit	=	3.9V

4.2 DISCUSSION OF RESULT

Basically, the charger is a current-limited voltage source. Generally, cell phone battery packs requires 3.6V DC and 180 – 200mA current for charging. These usually contain three NiCd cells, each having 1.2 rating current of 100mA sufficient for charging the cell phone battery at a low rate. A 12V battery containing eight cells gives sufficient current (1.8A) to charge the battery connected across the output terminals. The circuit also monitors the voltage level of the battery. It automatically cut off the charging process when its output terminal voltage increased more than the predetermined voltage level.

The NE555 was used to charge and monitor the voltage level of the battery. Pin 5 of the IC provide the reference voltage 4.6V by Zener diode ZD2. Threshold pin 6 was supplied with a voltage set by VR_1 and trigger pin 2 was supplied with a voltage set by VR_2.

A completely discharged cell phone battery was connected to the circuit, the voltage given to pin 2 of IC was below 1/3Vcc then the IC was switched on to take output pin3 high. When the battery is fully charged, the output terminal voltage increases at pin2 above the trigger point. This switched off the IC and the output goes low to terminate the charging process. About 180mA charging current of the battery was enhanced by transistor T_1 and resistor R_4.

4.3. LIMITATIONS TO THE WORK

The main shortcomings to the execution of this project work are as follows

1. Some of the circuit components got damaged during the construction due to probably high voltage, high current or miss-use of the component.
2. Identification of the component polarity was not as easy as supposed. Most of the components calibrations and signs were done wrongly by the manufacturers.
3. The soldering of the circuit component posed much problem as most of the leads were not soft enough and caused short circuit, which made the entire work to malfunction.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

IC555 timer was use as the main component of this project so as to charge and monitor the battery voltage level which is the primary aim and objective of this project. Also, a portable, inexpensive N1200 cell phone charger capable of charging cellphone without removing the battery was achieved. It is also capable of charging the battery within the range of two to three hours depending on the state of the battery before charging.

5.2 RECOMMENDATION

It is more fantastic to include a digital display which may involve the use of microcontroller chip and programming so that the output voltage can be easily seen rather than imagined. I also recommend that this work should be made potable for easy movement from place to place.

I highly recommend that engineering department should start macro manufacturing of projects designed by the students with the view to motivating them

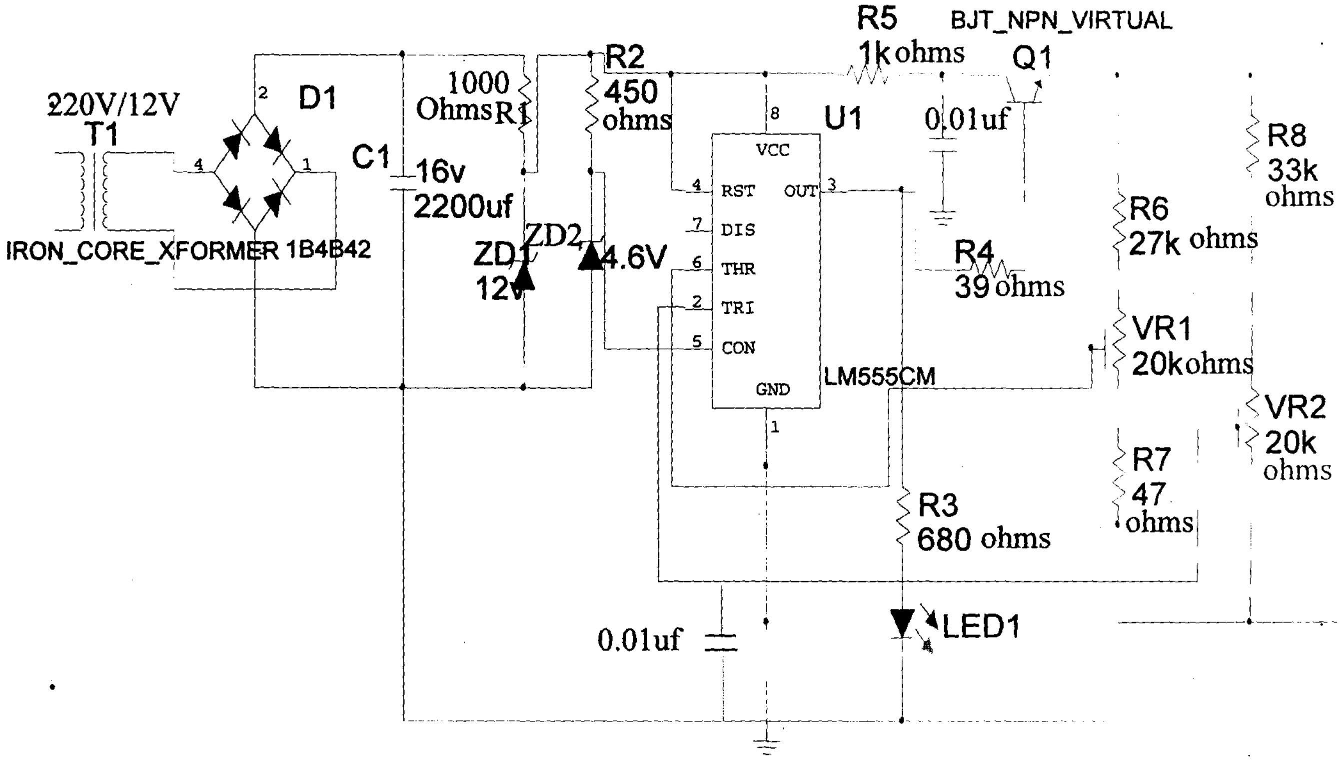

Fig. 3.9: Complete circuit diagram of a Nokia 1200 cell phone battery charger

REFERENCES

[1] "Introduction to battery charger", http//www.electronicsforu.com/circutilab.asp.

[2] Theraja B.L and Theraja A.K.(2005), "Electrical Technology", Published by S. Chand and Company Limited, pp-1278-1279.

[3] "Energy efficiency", http//www.Istockphoto.com/kmitu.

[4] "Great battery charger shootout", http//www.Ezineartices.com/expart-Micheal Bloch.

[5] Daniel R. Tomal and David V.Godson (1999), "Principle and Practice of Electrical and Electronics Troubleshooting", Published by TABBOOS Inc, pp-132-135.

[6] "Standard Battery Charger", http//www.freepatentonline.com.

[7] "Battery Charger", http//www.wapedia-Wiki.com.

[8] "Charging System", http//www.Ctek.Com.

[9] "Generation of battery charger" http//www.Textually.orgltextually/arhives.

[10] J.B Gupta (2003), "Electronic Devices and Circuit", published by Sanjeev Kumar Kataria. 4424/6, pp 861-865.