DESIGN AND CONSTRUCTION OF A UNIVERSAL DIGITAL MOBILE PHONE CHARGER

BY

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A THESIS SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

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DEDICATION

This project is dedicated to God Almighty who in His infinite mercy, has kept me to see this glorious and wonderful day come to pass in my life and also to my entire fellow electrical students, my parents; Mr. and Mrs. Benjamin Ogaji, to my brothers; Shedrach Benjamin, Marvelous Benjamin and Victor Ogaji.

DECLARATION

I Ogaji Ojonugwa John, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copy right to the Federal University of Technology Minna.

Ogaji Ojonugwa John
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Signature and date

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Name of external examiner

Signature and date

ACKNOWLEDGEMENT

My first appreciation goes to God Almighty who in His infinite mercy, has kept me to see that this project was successfully carried out and also to my parents; Mr. and Mrs. Benjamin Ogaji who supported me financially and morally towards the success of this project. My appreciation also goes to my supervisor; Engr. Y.A. Adediran who guided me all through this project. Also, my appreciation goes to all my friends; Ajibade Tunde, Ajibade Ibrahim, Akoje Jubril, to my brothers and sisters, and to all T.B.F. members; I love you all for your immense contributions towards the success of this project.

ABSTRACT

The objective of this project is to produce a device which is capable of charging some selected mobile phone batteries. Such a device will act as a charging device for mobile phone batteries. The device can be used in our homes, offices and in phone call business areas where a single charger is needed to charge so many types of batteries. A 240V A.C mains is needed to power the charging device. A very important feature of this project is its ability to display the type of phone that its battery is being charged and its ability to detect when the battery is fully charged.

To display the type of phone that its battery is being charged, a seven-segment display is interfaced with a microcontroller and to detect when the battery is fully charged; voltage comparator, digital-to-analogue converter were interfaced with the microcontroller.

/After the hectic process of design, construction and rigorous testing, a final product was reached which achieved all objectives.

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CHAPTER ONE

GENERAL INTRODUCTION

1.1 INTRODUCTION

Engineering is an art requiring the judgment necessary to adapt knowledge to practical purposes, the imagination to conceive original solution to problems and the ability to predict performance and cost of new devices or processes.

Unlike the scientist, the Engineer is not free to select the problem that interests him; he must solve problems as they arise; his solution must satisfy conflicting requirements. Usually efficiency costs money; safety adds to complexity; improved performance increases weight. The Engineering solution is the optimum solution; the end result that, takes many factors into account is the most desirable. It may be the cheapest for a specified level of performance, the most reliable within a given weight limit, the simplest that will satisfy certain safety requirements or the most efficient for a given cost. In many engineering problems, the social costs are significant [8].

The results of Engineering activities contribute to the welfare of man by furnishing food, shelter and comfort; by making transport and communication easier and safer; and by prolonging life and making it pleasant and satisfying[8].

On these bases, I decided to design a **DUAL POWER SOURCE (A.C AND D.C) UNIVESAL DIGITAL MOBILE PHONE BATTERY CHARGER.** A dual power source universal digital mobile phone battery charger is an electric device that is used for putting energy into a battery through a 240V A.C mains supply or 12V D.C supply. The charger changes the A.C from the power line into D.C suitable for the charger. However D.C generators and alternators are also used as charging sources for secondary batteries.

In general, a mains-operated battery charger consist of the following elements:

-A step down transformer for reducing the high A.C mains voltage to a low A.C voltage.

-A half-wave or full-wave rectifier for converting alternating current into direct current.

-A charge current limiting element for preventing the flow of excessive charging current into the battery under charge.

-A device for preventing the reversal of current i.e. discharging of the battery through the charging source when the source voltage happens to fall bellow the battery voltage. In addition to the above, a battery charger may also have circuitry to monitor the battery voltage and automatically adjust the charging current. It may also terminate the charging process when the battery becomes fully charged. However in many cases, the charging process is not totally terminated but only the charging rate is reduced so as to keep the battery on trickle charging[4]. Most of the modern battery chargers are fully protected against the following eventualities:

- They are able to operate into a short-circuit
- They are not damaged by a reverse connected battery
- They can operate into a totally flat battery
- They can be regulated both for current and voltage

1.2 AIMS AND OBJECTIVES.

1. To design and construct a small and a cheap Universal Mobile Phone Battery Charging device that could be alternatively powered from an A.C and a D.C source.

2. To design and construct an efficient and economical charging device; in the sense that it saves the money of owning more than one battery phone charger, since it could be used in the vehicle and at home.

3. To design and construct a Mobile Phone Battery Charger which contributes to the welfare and comfort of man; by making charging of Mobile Phone Batteries easier and safer [with the aid of indicators], and by prolonging the life of the battery and making it pleasant and satisfying for use.

1.3 METHODS OF CHARGING BATTERIES.

The methods of charge can be put into four categories:

- Trickle Charge,
- Constant Current,
- Constant Voltage &
- Floating System.

Trickle Charging :- A small current is passed through the battery for a long period of time.

Constant Current :- The charging current is held constant by a means of a variable resistance in the charging circuit.

Constant Voltage :- The voltage is held constant throughout the charge by means of variable resistance.

Floating System :- In this method used in charging (car charging systems) the D.C generators re-charges the battery when it falls below certain voltage. The charging current is automatically cut-out when a certain voltage is reached so that the battery does not feed back into the generator[9].

1.4 TYPES OF BATTERIES USED IN MOBILE PHONES.

The types of secondary or rechargeable batteries used in Mobile Phones include; Nickel - Cadmium (Ni-Cd) batteries, Nickel Manganese Hydride (NiMH) batteries & Lithium – ion (Li – ion) batteries.

The most common and widely used secondary batteries in Mobile Phones is the Lithium ion batteries. The Lithium ion battery is entirely different from the Lithium batteries. The practical different between them is that most Lithium batteries are not rechargeable but Li – ion batteries are rechargeable. From a chemical standpoint, lithium batteries use lithium in its pure metallic. Li - ion batteries use Lithium compounds which are much more stable than elemental Lithium used in Lithium batteries. A Lithium battery should never be recharged while Li – ion batteries are designed to be recharged hundreds of times[2],[3].

1.5 POSSIBLE PROBLEMS THAT COULD BE ENCOUNTERED

Since the universal digital mobile phone charger is an electronic device, one of the major constraints to achievable performance is power failure as this i.e. power failure, is a major constraint to achievable performance to all electronic devices. Human factor could also be a constraint to achievable performance of this device as humans can and frequently make mistakes, thus limiting the device's performance especially when not used a specified environment like plugging the device to an A.C. voltage above 240V or to an A.C voltage supply far below 240V.

CHAPTER TWO

LITERATURE REVIEW/THEORETICAL BACKGROUND

2.1 LITERATURE REVIEW

A battery charger is a device used to put energy into a cell or rechargeable battery by forcing electric current through it[1],[3].

The charging current depends upon the technology and capacity of the battery being charged. For example, the current that should be applied to recharge a 12V car battery will be different to the current for a mobile phone battery.

However, there are different types of battery chargers namely;

- Simple battery charger
- Timer-based battery charger
- Intelligent battery charger
- Fast battery charger
- USB-based battery charger
- Mobile phone battery charger
- Battery chargers for vehicles

* **Simple battery charger:** a simple battery charger works by connecting a constant DC power source to the battery being charged. The simple battery charger does not alter its output base on time or the charge on the battery. This simplicity means that a simple battery charger is inexpensive that is to say, it is cheap and affordable, but there is a trade-off in quality. Typically, a simple

battery charger takes longer time to charge a battery in order 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. The photographs below show the front and back view of a simple charger[1],[3]:

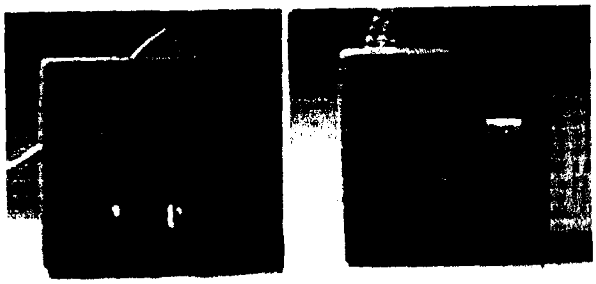


Fig. 2.1 A simple charger equivalent to a AC-DC wall adapter. It applies 300mA to the battery at all times, which damages the battery if left connected too long.

***Timer-based battery charger:** the output of a timer-based battery chager is terminated after a pre-determined time. Timer-based chargers were the most common type for Ni-Cd cells in the late 1990s.

Often, a timer-based battery charger and set of battries could be bought as a bundle and the charger time was set to suit those batteries. If batteries of lower capacity were charged, and if batteries of higher capacity were charged, they would be only partly charged. With the trend for battery technology to increase year by year, an old timer charger would only partly charge the newer batteries [1],[3].

The photograph below shows a timer-based battery charger:

Fig. 2.2 The timer-based charger charges the battery until it reaches a specific voltage and then it trickle charges the battery until it is removed.

*** Intelligent battery charger:** for an intelligent charger, output current depends upon the battery's state. An intelligent charger may monitor the battery's voltage, temperature and time undercharge to determine the optimum charge current at that instant. Charging is terminated when a combina tion of the voltage, temperature and time indicates that the battery is fully charged.

For the Ni-Cd and NiMH batteries, the voltage over the battery increases slowly during 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 labelled as ΔV chargers, indicating that they monitor the voltage change[1],[3].

***Fast battery charger:** fast chargers, made by VARTA, Lenmar and other companies, make use of control circuitry in the batteries being charged to rapidly charge the batteries without damaging the cell's 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 standard NiMH cells that do not have the special control circuitry. Some fast chargers, such as those made by Energizer, can fast-charge any NiMH cell if it does not have the control circuit [1],[3].

* **USB-based battery charger:** since the universal serial bus specification provides for a five-volts power supply, it is possible to use a USB cable as a power source for recharging batteries. Products based on this approach include chargers designed to charge standard NiMH cells, and custom NiMH battries with built-in USB plugs and circuitry which eliminate the need for a separate charger [1],[3].

* **Mobile phone battery charger:** battery charger for mobile phones and other devices are notable in that they come in different variety of connector-styles and voltages, most of which are not compatible with other manufacture's phones or even different models of phones from a single manufacturer. In many cases, although a connector may be the same for devices from the same brand or compatible with a device from another brand, the actual charging parameters may differ. Using a charger just because it has the "right" connector may result in an inadequate charge or even permanently damage the device.

Users of publicly accessible charging kiosks although charging kiosks not available in Nigeria must be able to cross-reference connectors with device brands/models and individual charge parameters. This ensures delivery of the correct charge for their mobile phones or mobile devices. A database-driven system is one solution and is being incoperated into some of the latest designs of charging kiosks.

China and other countries are making a national standard on mobile phone chargers using USB port [1],[3].

*** Battery charger for vehicles:** There are two main types of chargers for vehicles namely:

i To recharge petroleum that uses modulator charger.

ii To recharge battery electric vehicle. These vehicles include a battery pack, so generally, use series charger. The charger can be:

- Isolated i.e. they make no connection between the AC electrical mains and the batteries being charged.
- Non-isolated i.e. the battery negative terminal is attached to the AC outlet's neutral wire during charging

However, power factor correction chargers can more closely approach the maximum current the plug can deliver, shortening the charging time [1],[3].

Having talked about different types of battery chargers, this project focuses on mobile phone battery charger. It is aimed at the design and construction of universal digital mobile phone charger; universal in the sense that the device is capable of charging different, but not all types, of mobile phone battery.

The universal digital mobile phone battery charger is designed and constructed using a microcontroller with other components interfaced. These components include: voltage comparator, digital-to-analogue converter, seven-segment display e.t.c.

Details of circuit diagrams and circuit connections, operation overview, how the project is carried out and result of the universal digital mobile phone battery charger will be seen in subsequent chapters of the project.

2.2 HISTORY OF BATTERY CHARGER

The history of battery chargers cannot be talked about without the existence of batteries. Just like the inventor of battery charger, Nicholas McFadden said "there cannot be a rechargeable battery without a charging device". This statement prompted him to initiate the idea to design the first battery charger [2],[6].

However, Benjamin Franklin was the first to coin the term "battery" in reference to a set of linked Leyden jars, which was the earliest means of storing charge. At this time, experiments were limited to an electrical spark that lasted a mere fraction of a second, untill Alessandro Volta invented the first true battery in 1800. He invented what was referred to as the "electric pistol" by connecting an electrical wire to a jar filled with methane gas. By sending electric spark through the wire, the jar would explode. Through that discovery, he realized that certain fluids could be used as a way to transmit a chemical reaction between metals, resulting in in a continious flow of electrical force, thus resulting in the birth of the first battery.

The French physicist, Gaston plantè invented the rechargeable battery nearly 60 years after. This was a lead acid battery that is still in use today. The nickel-cadmium cell was invented in 1899 but not until the late 1940s, with successful sealing of the cell, did the rechargeable battery become widely used. Both the lead acid and nickel-cadmium chemistries are used today, but they require maintenance every 60-90 days and contain toxins and acid that is very harmful to the environment.

It was on this note that the cells need to be maintained every 60-90 days that Nicholas McFadden invented the first battery charger around the early 1940s when the rechargeable batteries were fully put into use. He designed and constructed a device that was capable of putting energy into the rechargeable battery invented by the french physicist, Gaston plantè by forcing electric current through it by connecting the positive and negative terminal of the rechargeable battery to the positive and negative output terminal of the charging device respectively [2],[6].

However, with the ever-increasing technology, battery chargers did not just stop there. Today we have so many battery chargers serving the purpose of rejuvenating batteries for the comfort of man.

2.3 OPERATION PRINCIPLE OF A TYPICAL UNIVERSAL DIGITAL MOBILE PHONE CHARGER

The universal mobile phone charger is designed using an AT89C52 microcontroller which was programmed using assembly language with other components such as voltage comparator, digital-to-analogue converter, and seven-segment display e.t.c. interfaced to give the desired output.

The block diagram of the whole system is given below:

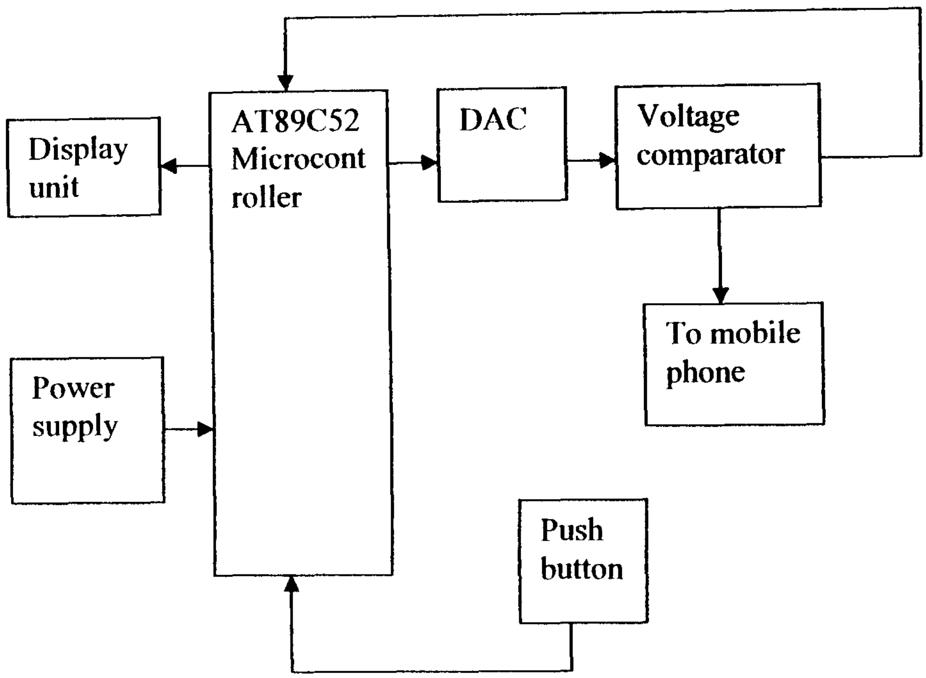


Fig.2.3 block diagram of a typical universal digital mobile phone charger

The power supply comprises dual power supply, a 5V and a 12V power supply. The 5V power supply is for the microcontroller while the 12V is for the digital-to-analogue (DAC) and the comparators. When the microcontroller is powered, the display unit, digital-to-analogue converter and the voltage comparator are powered simultaneously. The digital-to-analogue converter then converts the binary voltage to analogue voltage in the range of 0-7.2V DC. The display unit then displays the demo as programmed by the microcontroller. The mobile phone connector is then connected to the mobile phone and the push button is then used to select the type of phone as designed for the system and it appears on the display.

During charging, the voltage comparator which is there to detect when a battery is fully charged compares two voltages; the voltage of the charging battery and the required voltage of the battery. When they are both equal, it sends a feedback to the microcontroller. The microcontroller then sends signal to the digital-to-analogue converter to stop charging the battery.

CHAPTER THREE

DESIGN AND IMPLEMENTATION

3.1 BRIEF INTRODUCTION TO VARIOUS UNITS OF THE PROJECT

In the design and construction of the universal digital mobile phone charger, so many components were put together to bring about the simple device. These components are categorized into different units namely:

- Power supply unit
- The charging unit
- The display unit
- The digital-to-analogue conversion unit
- The control unit

It is the coming together of these various units that the universal digital mobile phone charger is able to carry out its function.

3.2 POWER UNIT

The power supply unit supplies the whole system with the appropriate and regulated biasing voltage. This is necessary because electronic circuits are very sensitive to fluctuations. The electronic system will not operate at all without this unit. This consists of a transformer, a bridge rectifier, a regulator and two wave smoothing capacitors.

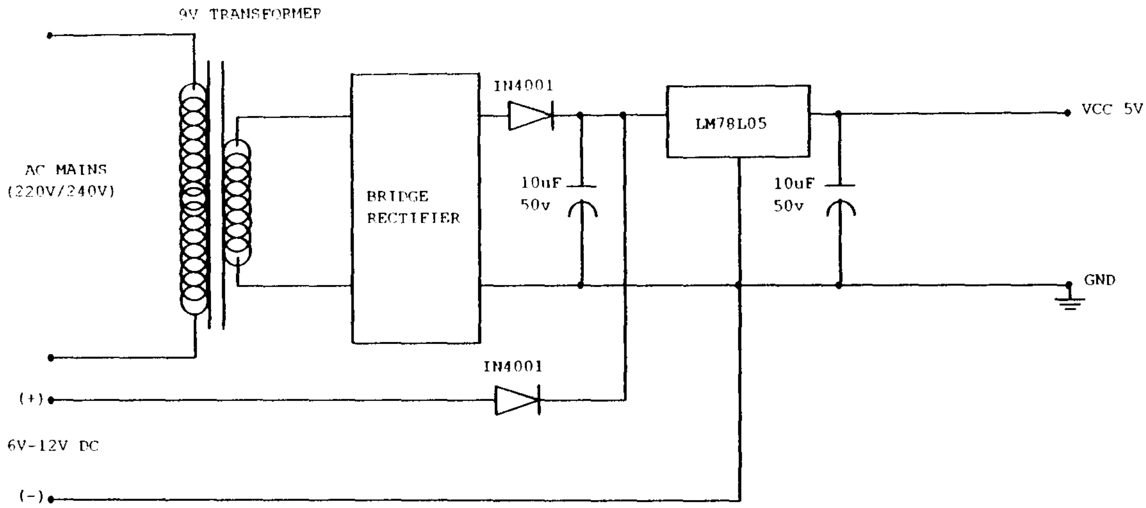


Fig.3.1 Circuit diagram of the Power Supply Unit

3.2.1 VOLTAGE TRANSFORMATION

The Voltage transformation was archived using a step-down transformer with specification given below:

Primary Voltage	V_p,	-	-	240 V_{rms}
Secondary Voltage	V_s,	-	-	9 V_{rms}
Secondary Current	I_s,	-	-	500 mA

Using the transformer equation;

$(V_P/V_S) = (I_S/I_P)$ - - - - - 1.1

$I_P = (V_S * I_S)/ V_P$

$= (12 * 500 * 10^{-3})/ 240 = 25 * 10^{-3}\ A = 25\ mA$

Also,

$V_{peak} = \sqrt{2} * V_{rms}$ - - - - - 1.2

$= \sqrt{2} * 12 = 16.97\ V$

$$I_{peak} = \sqrt{2} * I_{rms} \quad - \quad - \quad - \quad - \quad - \qquad 1.3$$

$$= \sqrt{2} * 500 * 10^{-3}$$

$$= 707 \text{ mA} \approx 0.7 \text{ A}$$

3.2.2 VOLTAGE RECTIFICATION

A bridge rectifier with 2A rating was used in the design for the rectification of the ac mains. It converts an ac voltage level to a dc voltage level. It consists of four diodes connected in a bridge circuit. The dc voltage is calculated from the equation below

$$V_{dc} = (\sqrt{2} * V_{peak}) / \pi \quad - \quad - \quad - \quad - \qquad 1.4$$

$$= (\sqrt{2} * 16.97) / \pi$$

$$= 7.64 \text{ V}$$

3.1.2 VOLTAGE REGULATION

Voltage regulation is the process of ensuring that the output remains constant regardless of the loading conditions applied and is commonly achieved through the use of a zener diode . Since the microcontroller needs a stable voltage to operate properly, I used a 5V regulator (LM78L05) to regulate the output voltage from the bridge rectifier.

3.2.4 SMOOTHING THE WAVEFORM

The voltage obtained from the rectifier contains some ripples. To eliminate these ripples, I used two capacitors of 10μF 50V each.

3.3 THE CHARGING UNIT.

The charging unit consists of mainly of **resistors.**

3.2.1 RESISTOR.

Resistors are used to reduce or limit the amount of current flowing in a circuit. They oppose the flow of current. The opposition is called resistance and it is measured in ohms (Ω). Larger units of resistance are the kilo ohms (Ω) and the mega ohm (MΩ), where 1kΩ = 1000Ω and 1MΩ = 1000KΩ = 1000 000 Ω. A small resistance offers little resistance to the flow of current, whilst a larger resistor offers a larger resistance and thereby cause a smaller current to flow. All conductors have resistance which is given by ohm's law which states

$$\text{Resistance of a conductor in ohms} = \frac{\text{Voltage across the resistor (volts)}}{\text{Current through the resistor(amps)}}$$

i.e. **$R = V / I$. Or $V = I \times R$.**

Where V = p.d, I = current and R = resistance.

3.3.2 POWER OF A RESISTOR.

All resistors have power rating which is the rate at which heat energy can be given out without the resistor overheating. The power ratings is given in watts, where the watt is one joule of energy per second. In general, the larger the physical size of the resistor, the larger the power rating and in electronics the **0.125W, 0.25W**, and the **0.5W** are the most commonly used types. The energy released every second in a resistor is give by:

$$\mathbf{W = I^2 \times R \text{ or } W = V^2 / R.}$$

Where **W** is the energy per second in Watts, **I** is the current through the resistor in **amperes**, **V** is the voltage across the resistor in **volts** and **R** is the resistance in **ohms.** In addition, power is given by the formula

$$Power(watt) = {Energy(joules)}/{Time(seconds)}$$

3.3 DISPLAY UNIT

This unit is used to display the status of the system. It consists of 6 (six) seven segment displays (common anode), 6 control transistors (BC548) and 2 arrays of current limiting resistors (7 X 150 ohms and 6 X 4.2 k ohms respectively.) All the 6 segment display are tied together through a data bus, and are interfaced to PORT2 of the microcontroller which is configured in the out put mode. This cascading or multiplexing mode of operation of the seven segment displays does not also reduces the number of input/output interface line but also reduces the current requirement for operating the display unit.

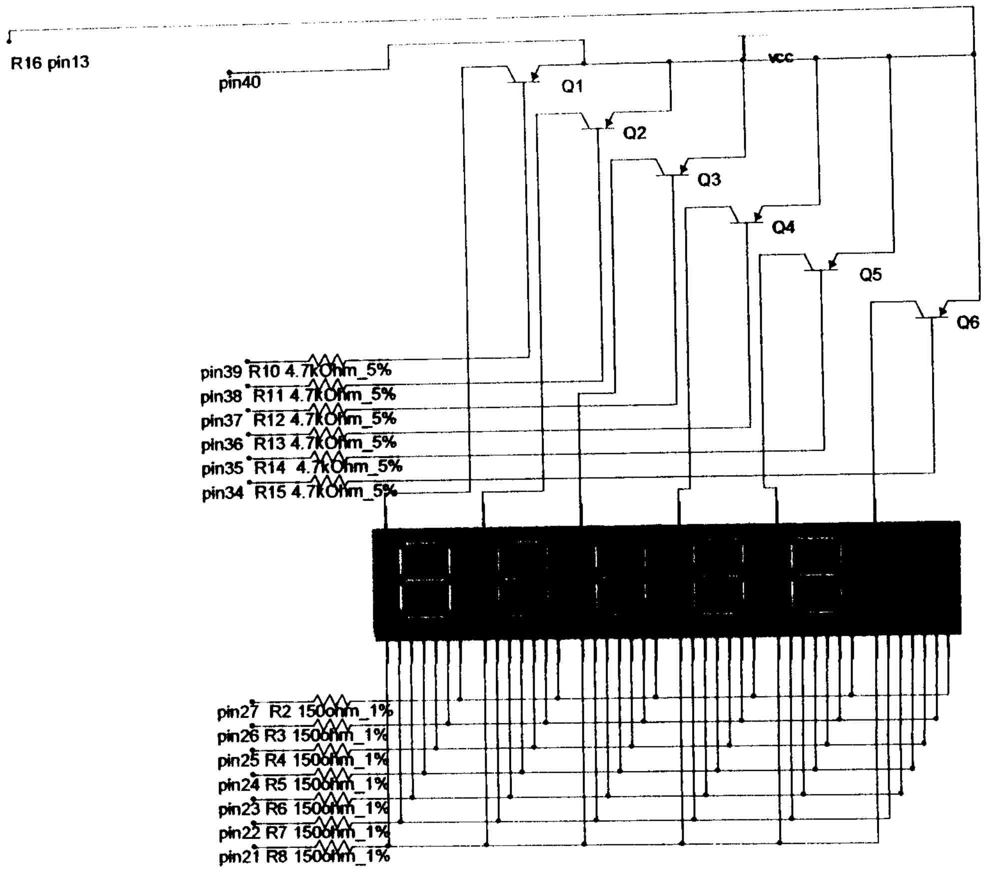


Fig.3.2 Interface between the display unit and the microcontroller

3.4.1 MULTIPLEXING

Multiplexing is a technique used in communications and input/output operations for transmitting a number of separate signals simultaneously over a single channel or line. To maintain the integrity of each signal on the channel, multiplexing can separate the signals by time, space, or frequency. The device used to combine the signals is a multiplexer.

Each seven segment of the display is controlled via its own respective transistor. When a desired data is to be displayed, that particular seven-segment display is enabled by switching on its respective control transistor. The control transistors are interfaced to

PORT3 via a control bus. The entire process of displaying the data is controlled with the help of the software burned into the microcontroller. The software does the control in such s manner that it will display the data without any flickering.

3.4.2 DATA LINE

A bus is essentially a shared highway that connects different parts of a system. In case of computer these parts could include the microprocessor, disk drive controller, etc and enable them to transfer information. Since the seven segment display has only seven lines, I decided to use a seven bit data bus.

The microcontroller uses this 7 bit data bus to communicate or transfer data to each of the seven segment display in the display unit.

3.4.2 ADDRESS LINE

This is a 6-bit address bus or line. The microcontroller uses the address bus to control the way or manner in which each of the seven segments accepts data on the data line. Each of the seven segments has a unique address. If a data is to be written to a particular seven–segment display, the data is first put on the data line, while the address of that seven segment display is put on the address line, so that only the seven-segment with that address sees the data.

3.5 DIGITAL-TO-ANALOG CONVERTION UNIT

I used a DAC0808 DAC (Digital-to-Analog Converter). The pin out is given below:

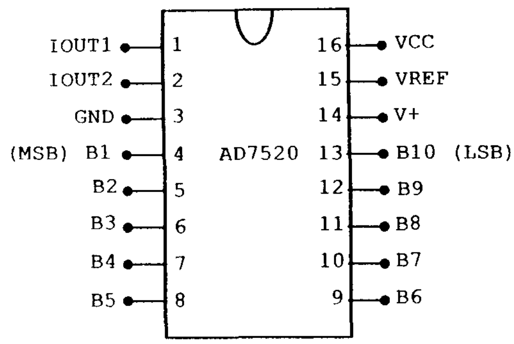


Fig.3.3 DAC0808 pin out

The DAC0808 is a 10 bit DAC, meaning that it has a resolution of:

$$\begin{aligned} Resolution &= VCC/1024 \\ &= 5/1024 \\ &= 0.005 \text{ approx} \end{aligned}$$

This unit converts digital data from the microcontroller into voltage analogs that is used for charging the cell phone. The figure shown below shows the interface between the digital-to-analogue conversion unit and the microcontroller:

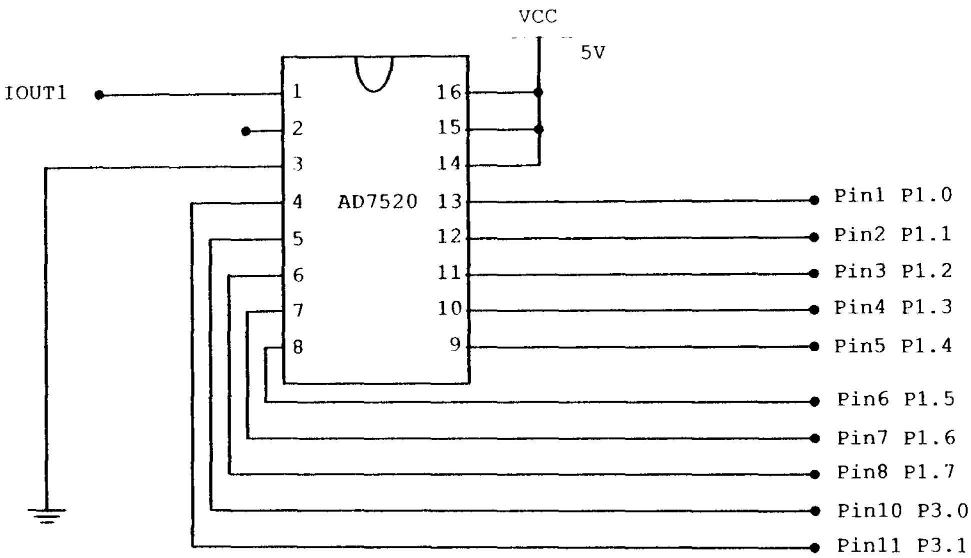


Fig.3.4 Interface between the DAC unit and the microcontroller

3.6 CONTROL UNIT

This unit is responsible for controlling the system through software written in assembly language. The unit consists of a MCU (microcontroller), 2 push buttons and a clock source.

3.6.1 SWITCHES

The two push buttons use for this project are for the **Phone Select** and **Enter.** The push buttons were connected in such a way that, when it is pressed, it pulls the pin on the microcontroller where it is connected to the ground. The figure shown below shows the interface between the switches and the microcontroller:

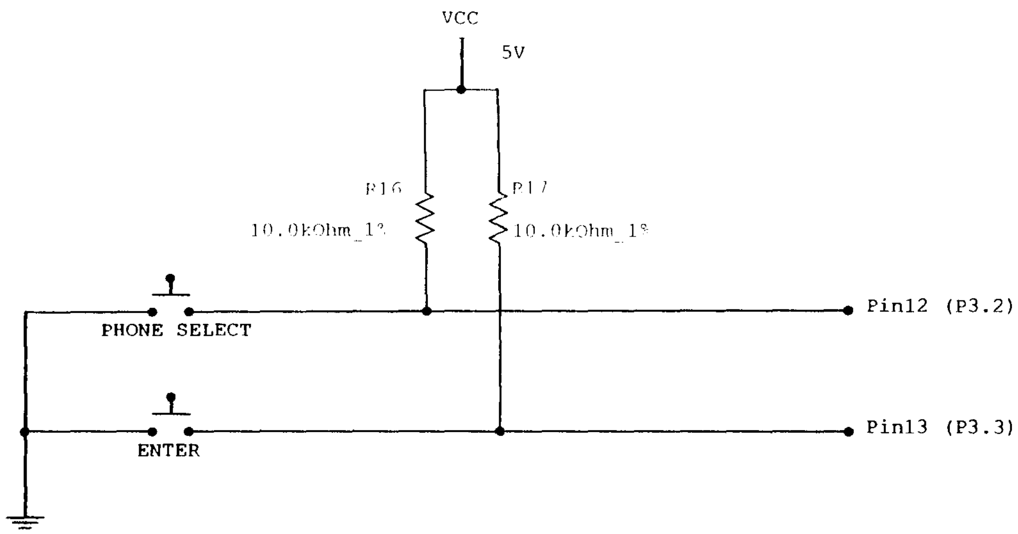


Fig.3.5 Interface between the switches an the microcontroller

3.6.2 MICROCONTROLLER

No modern electrical system in today's world is complete without a microcontroller or microprocessor. In the scope of this project a microcontroller is used to capture, save and display digital data.

The microcontroller used in this project is AT89C52 from Atmel 89 Series microcontrollers. The AT89C52 is a low power- high performance CMOS 8-bit Microcomputer with the following features:

* Compactable with MCS-51 products.
* 8K bytes of In-system Reprogrammable flash memory.
* Endurance; 1000 write\ Erase cycles.
* Full static Operation; 0 Hz to 24 MHz.
* Three level program memory lock.
* 128x 8 bit internal RAM

* 32 programmable I \ O (Input\ Output) lines

* Two 16-bit Timer\counters

* Eight interrupt sources

* Programmable serial channels

* Low – power Idle and Power-down Mode

*3.0V to 6.0V Operating Range

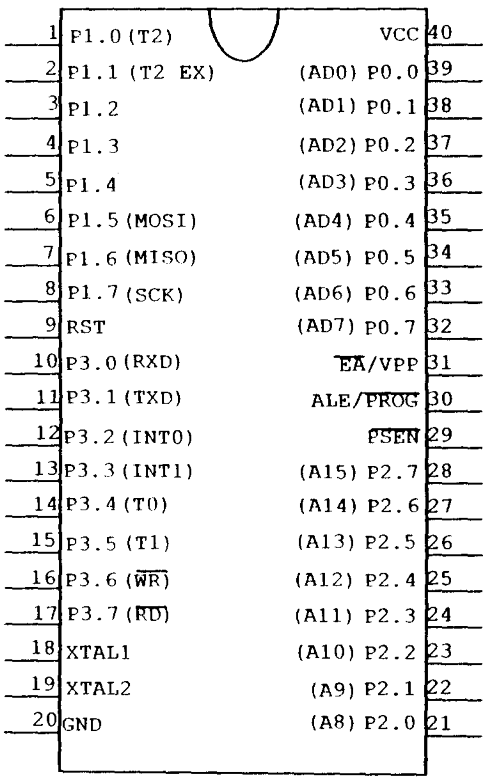


Fig.3.6 AT89C52 pin out.

The system is controlled by the AT89C52 via a software (HYVE110) written in assembly languages.

3.6.3 CLOCK SOURCE

The clock source unit is made up off two basic components, two 30pf capacitors and one 12MHz crystal. This unit generates the clock pulse for the microcontroller to execrate its instruction.

The interface between the clock source unit and the microcontroller is shown below:

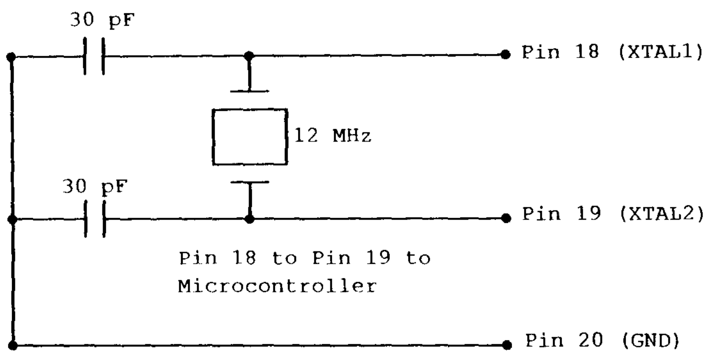
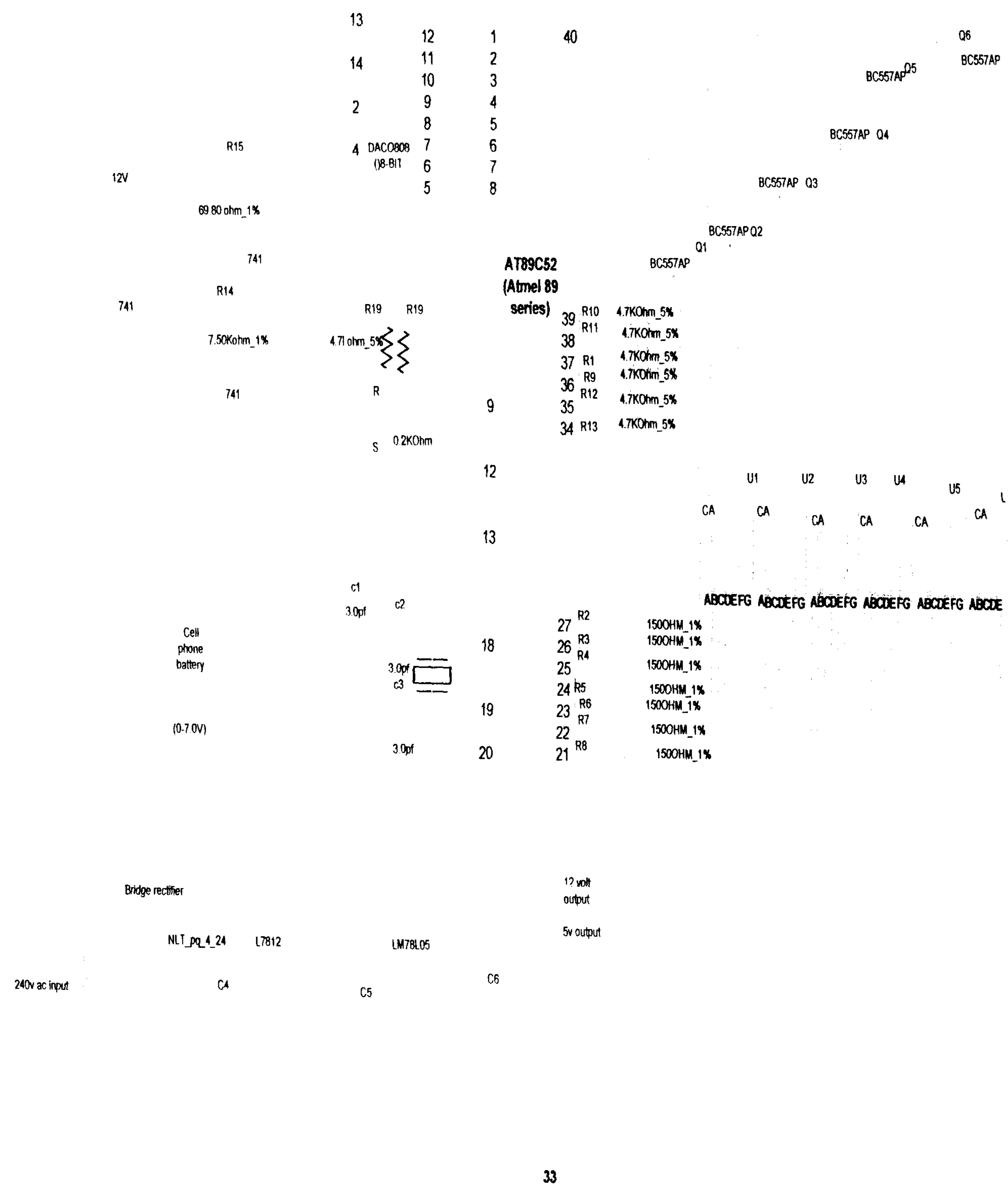


Fig.3.7 Interface between the clock source unit and the microcontroller.

The crystal used is a 12 MHz crystal, that is, it will generate 12,000,000 pulses in one second. Normally an 8051 compactable microcontroller executes one instruction in 12 clock pulses. Therefore the microcontroller will be able to perform 12,000,000 divided by 12 instructions in one second (1 MIPS i.e. million instruction per second)

The circuit diagram of the whole system is shown below:

CIRCUIT DIAGRAM OF THE DIGITAL UNIVERSAL MOBILE PHONE CHARGER



CHAPTER FOUR

RESULT AND DISCUSSION

4.1 TEST

Testing is a necessity in any design. It is important to test and try to meet specifications, and if they are not met, corrections are made accordingly. The testing of the whole design was based on software (Computer Aided Design) and hardware (Project Board Testing)

4.2 COMPUTER AIDED DESIGN SIMULATION

The test procedure required a test circuit in order to obtain readings that would be more accurate than readings from a project board (breadboard). The design was tested on Computer Aided Design (CAD). A Software for designing schematics and laying out PCBs. The test was done on two units, which are the display unit and the power supply unit.

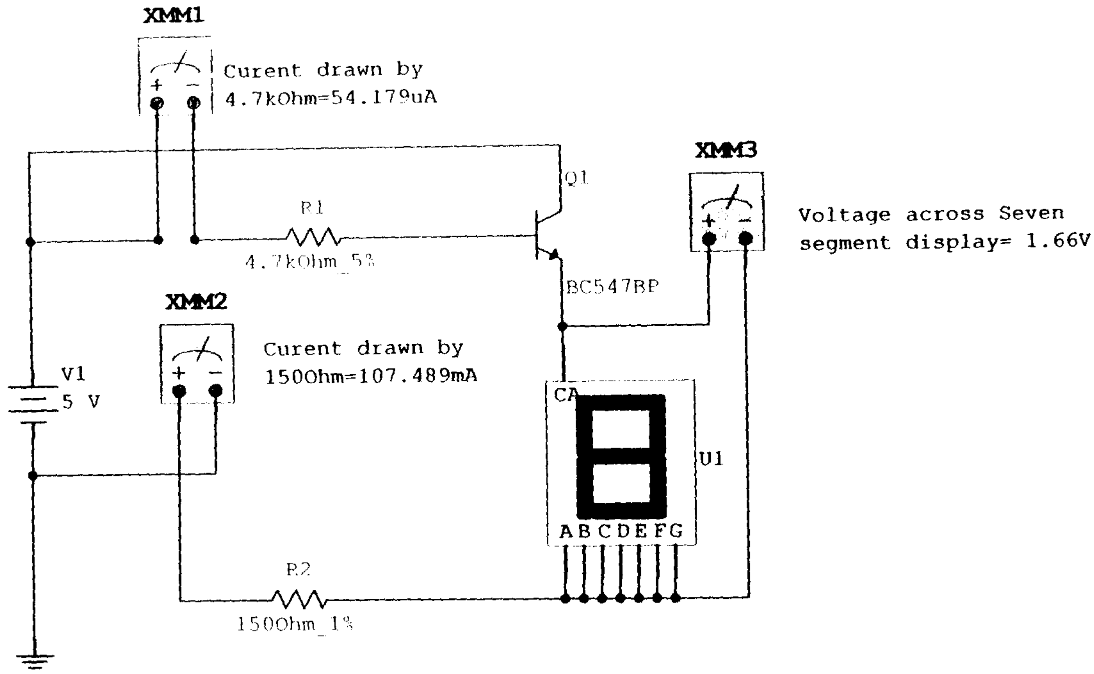
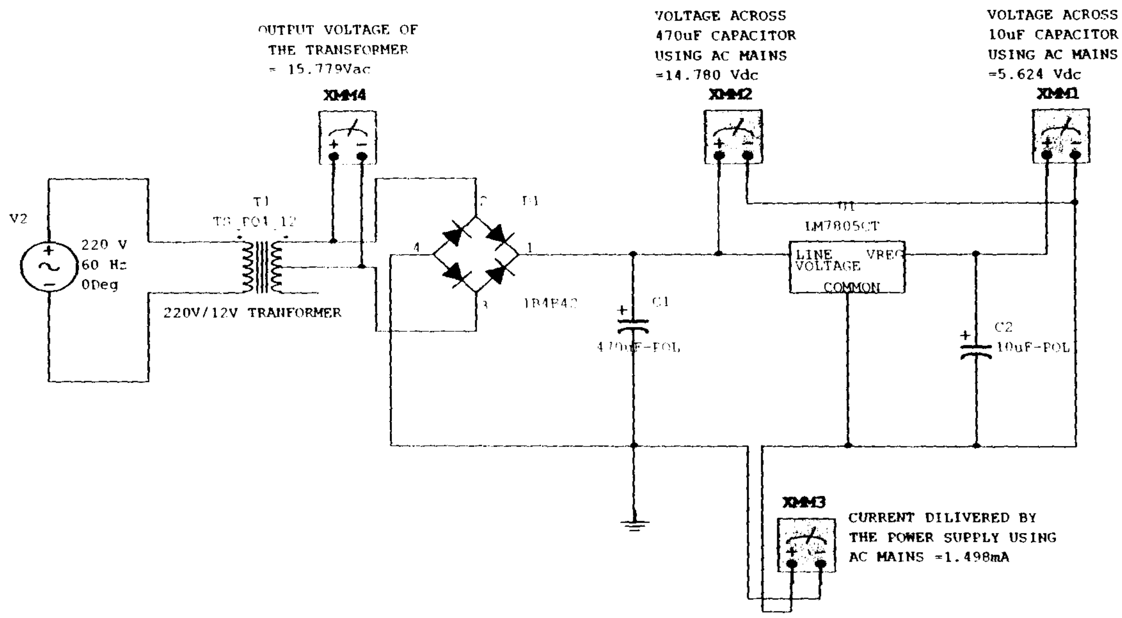
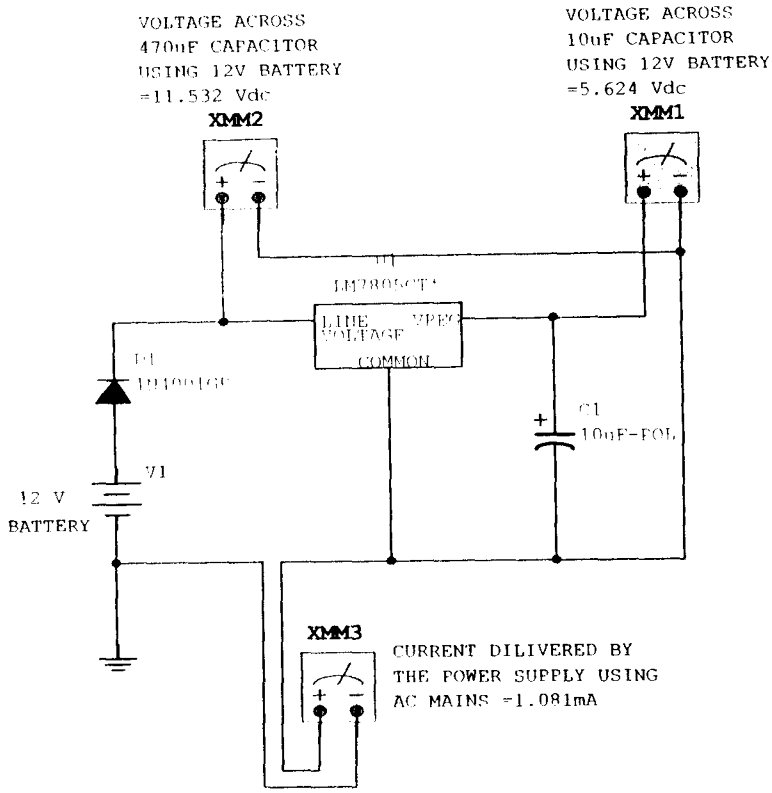


Fig.4.1 Display unit test using CAD



(a)



(b)

Fig.4.2 Power supply unit test using CAD (a) using ac mains (b) using a battery

Table 4.1 Table of values from CAD simulation

Components	**Readings**
Current Through 150Ohm Resistor	107.489 mA
Current Through 4.7KOhm Resistor	54.179uA
Voltage across seven segment display	1.660Vdc
AC voltage	240.000Vac
Transformer output voltage	15.779Vac
Voltage across 470uf capacitor using ac mains	14.780Vdc
Voltage across 10uf capacitor using ac mains	5.624Vdc
Current delivered by the power supply using ac mains	1.498mA
Voltage across 470uf capacitor using a 12V battery	11.532Vdc
Voltage across 10uf capacitor using a 12V battery	5.624Vdc
Current delivered by the power supply using a 12V battery	1.081mA

4.1.2 PROJECT BOARD TESTING

The whole system was assembled on a project board as shown on the circuit page. Readings were taken, tabulated and compared with those gotten using CAD simulation.

Table 4.2 Table of values from project board testing

Components	**Readings**
Current Through 150Ohm Resistor	100.500 mA
Current Through 4.7KOhm Resistor	49.000uA
Voltage across seven segment display	1.550Vdc
AC voltage	200.000Vac
Transformer output voltage	12.500Vac
Voltage across 470uf capacitor using ac mains	11.500Vdc
Voltage across 10uf capacitor using ac mains	5.050Vdc
Current delivered by the power supply using ac mains	1.500mA
Voltage across 470uf capacitor using a 12V battery	11.050Vdc
Voltage across 10uf capacitor using a 12V battery	5.000Vdc
Current delivered by the power supply using a 12V battery	1.0001mA

The values obtained when the circuit was simulated and those obtained when the circuit was setup on a project board differs, which were within the limit of experimental error. The error could be as a result of one of the following:

* The varying AC supply
* Change in temperature, which can affect the component values
* The tolerance of the component used.
* Human error which can not be avoided

CHAPTER FIVE

CONCLUSION

The aim of this project right from conception stage is to produce a universal digital mobile phone battery charger using an AT89C52 microcontroller, seven-segment display, digital-to-analogue converter, voltage comparator e.t.c.

After considerable time spent on analysis, design, and construction a final product was reached which was tested using computer aided design simulation. The results are shown in table 1 and 2 above. From the results gotten, it can be concluded that:

The entire project is a huge success.

5.2 PROBLEMS ENCOUTERED

In the course of this project, the following setbacks or problems were encountered:

1. Unavailability of components at close proximity.
2. Constant power failure, which considerably slowed down the pace at which the work was carried out.
3. Due to time and financial constraint, some attractive features could not be added to the project.
4. Getting the connector for the various phones posed a problem

5.3 RECOMMENDATION

This project like every other engineering project is opened to improvements. Other mobile phone batteries that are not included in this design can be added. A digital clock can also be incorporated in the display unit to show time when the device is not in use. One major limitation this project has is that it can charge just one phone at a time. For the purpose of improvement, this can be improved upon.

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