DESIGN ANDCONSTRUCTION OF A MICROCONTROLLER BASED POWER ALERT SYSTEM

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DEDICATION

I dedicate this project to Almighty Allah, the most beneficent and most merciful who has always been there for me, and to my wonderful parents Mr. and Mrs. Ogeroju for their unending support. Daddy and mummy, you are the best. May God bless you and grant you long life to enjoy the fruit of your labour

DECLARATION

I, Ogeroju Motunrola Mutiat 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 copyright to the Federal University of Technology, Minna

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I also wish to express my profound gratitude to all my friends, colleagues and every other person who in one way or the other contributed to my stay in this school and the success of this work. God bless you all.

ABSTRACT

A microcontroller based power failure alert system is designed to notify users of when power fails and power is restored. Many forms of power failure alarms exist, but the scope of this project is mainly to alert users with an alarm sound and LED for a duration of ten seconds when power fails, and also to alert users with an alarm sound and LED different from the first for another duration of ten seconds when power is restored

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CHAPTER ONE

INTRODUCTION

1.1 GENERAL INTRODUCTION

A microcontroller based power alert system can be described as an alarm system that alerts users with two different alarm sounds of either chimes or sirens when there is a power failure from the main sources of power and when power has been restored in the case where alternative source of power such as inverters, generators, etc are being used.

In a country like Nigeria where there is incessant power failure and alternative sources of power supply are widely used, it is extremely necessary to have a power alert system in place to alert users of the present power situation so that necessary actions can be taken to rectify the situation by providing alternative power supply or relocating the installation. This will help in increasing the lifespan of devices as some devices can easily be damaged by sudden current surges due to the light speed of electronic switches.

It can be used for a whole lot of domestic, commercial or industrial purposes; for example, a failure in power supply to some people causes only an irritant, they may have to reset a clock, but to other people especially those in businesses, it can and does cause damages worth lots of money. These damages may be in the form of lost food in a fridge or freezer amounting to hundreds of kilograms of lost stock.

Generally, this power alert system will help to make life a whole lot easier.

1.2 Aims and objectives

The aim and objective of this project is to design and construct a micro – controller based power failure alert system that

- Will save money and prolong the lifespan of domestic, commercial and industrial based electronic appliances by notifying users of sudden current surges.
- Will be ideal for areas where high security is needed where it will alert users when a burglar cuts through power lines.
- Can be used to prevent damages when being used for domestic, commercial and industrial purposes which may be chemical and medical storage facilities, food storage rooms, hospitals, server rooms, computer rooms and general heating and cooling of an environment, etc

1.3 Methodology

The method employed in this work is to carry out the design of individual sub – circuit units, which are then synchronized into a system to satisfy the overall objective of this project

The sub – circuits involve:

i. The power unit
ii. The switching unit
iii. The control unit
iv. The alarm and indicator unit

he design methodology follows the block diagram as shown in figure 1.1 below. The design also onsiders the availability of suitable components at reasonable costs.

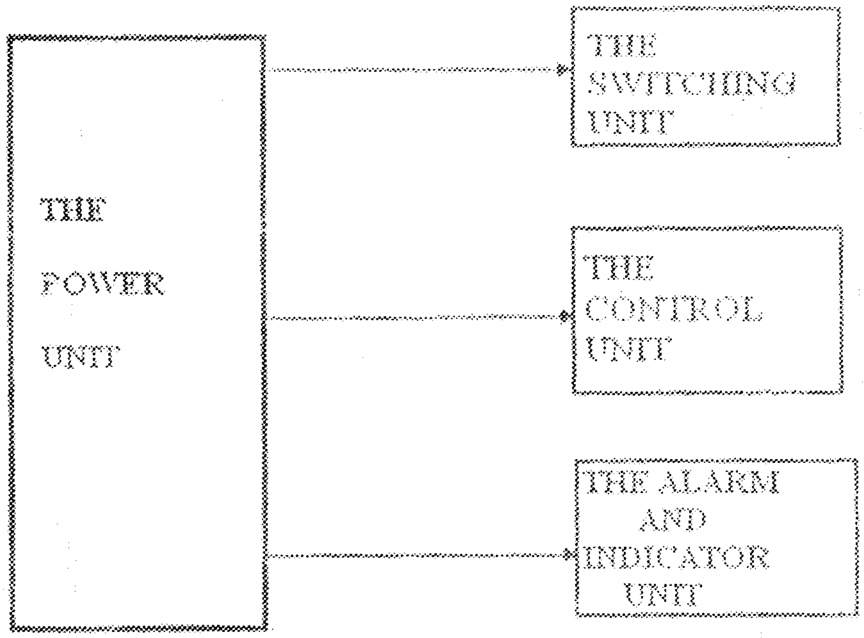

Fig. 1.1 Block diagram of a microcontroller based power failure alert system

The input AC voltage of 220V is rectified by the use of a full – wave bridge rectifier arrangement using four 1N4001A diodes. It is then filtered by the use of an electrolytic capacitor (1000μF × 35V). The AC ripple – free DC voltage is then regulated using a 7805 regulator to give a steady DC output voltage of 5V. Another 7805 regulator takes input from the capacitor terminals to power a relay. The relay takes care of disconnecting the battery when there is power from the mains.

output +5V terminal of the second 7805 regulator, while its collector is connected to the P1.0 of the microcontroller, and the emitter to the ground. This will enable the P1.0 to be pulled to the ground when power is supplied from the mains that is, PHCN, and to +5V if there is no power supply from PHCN. When there is PHCN supply, the microcontroller sounds the first alarm for duration of ten seconds, and at the same time lights a red L.E.D. When a power failure from PHCN occurs, the micro – controller sounds the second alarm for duration of ten seconds, and at the same time lights a green colored L.E.D.

However, there are two button switches present. Switch one will be used to reset the alarm, while switch two will be used to deactivate the alarm before the 10 seconds duration elapses.

1.4 Scope of the project

The construction of this power alert system will be carried out mainly to serve as an alarm to alert users of a power failure, accidental unplugging, turning off the power switch, a tripped circuit breaker or when power has been restored as the case may be. These occasions can happen without being noticeable as it is not uncommon for a motor driven appliance to fail and open the fuse or circuit breaker.

It is specifically designed to alert people for duration of ten seconds, after which it will automatically switch off. This device can be used for domestic, commercial and industrial uses.

1.5 Project layout

The chapter one of this project discusses the general introduction of the topic - micro – controller based power alert system, the scope of the project, the aims and objectives, and the methodology involved in achieving desired output.

Chapter two contains the literature review of this project, chapter three deals with the analysis of the design and calculations involved in this project, while chapter four deals with the construction, testing and results. Lastly, chapter five forms the conclusion of this project, recommendations are also discussed here.

CHAPTER TWO

LITERATURE REVIEW

2.1 HISTORY OF ELECTRIC POWER

Electricity is a form of energy involving the flow of electrons. All matter is made up of atoms, and an atom has a center, called a nucleus. The nucleus contains positively charged particles called protons and uncharged particles called neutrons. The nucleus of an atom is surrounded by negatively charged particles called electrons. The negative charge of an electron is equal to the positive charge of a proton, and the number of electrons in an atom is usually equal to the number of protons. When the balancing force between protons and electrons is upset by an outside force, an atom may gain or lose an electron. When electrons are "lost" from an atom, the free movement of these electrons constitutes an electric current.

Electricity is a basic part of nature and it is one of our most widely used forms of energy. We get electricity, which is a secondary energy source, from the conversion of other sources of energy, like coal, natural gas, oil, nuclear power and other natural sources, which are called primary sources. Many cities and towns were built alongside waterfalls (a primary source of mechanical energy) that turned water wheels to perform work. Before electricity generation began slightly over 100 years ago, houses were lit with kerosene lamps, food was cooled in iceboxes, and rooms were warmed by wood-burning or coal-burning stoves. Beginning with Benjamin Franklin's experiment with a kite one stormy night in Philadelphia, the principles of electricity gradually became understood. In the mid-1800s, everyone's life changed with the invention of the electric light bulb. Prior to 1879, electricity had been used in arc lights for outdoor lighting. The light

bulb's invention used electricity to bring indoor lighting to our homes. [1]

A key limitation distribution of electricity is that, with minor exceptions, electrical energy cannot be stored, and therefore it must be generated as it is needed. A sophisticated system of control is therefore required to ensure electric generation very closely matches the demand. If supply and demand are not in balance, generation plants and transmission equipment can shut down which, in the worst cases, can lead to a major regional blackout, such as occurred in California and the US Northwest in 1996 and in the US Northeast in 1965, 1977 and 2003 [2]

Sadly, this very important source of power is not constantly supplied especially in this part of the world and this has lead to the birth of power failure alarms.

2.2 History of micro – controller

In the year 1969, and a team of Japanese engineers from the BUSICOM Company arrived to the United States with a request that a few integrated circuits for calculators be made using their projects. The proposition was set to INTEL, and Marcian Hoff was responsible for the project. Since he had experience working with a computer (PC) PDP8, it occurred to him to suggest a fundamentally different solution instead of the suggested construction. This solution presumed that the function of the integrated circuit is determined by a program stored in it, which made the configuration simpler in the sense that it required far more memory than the initial project proposed by the Japanese engineers required. In transforming the idea into a readymade product, Frederico Faggin was a major help to INTEL, and in only

9months had succeeded in making a product from its first conception. INTEL and Texas instrument kept developing the microprocessor and in April of 1972, the first 8 – bit microprocessor appeared in the market. It was able to address 16kb of memory, and it had 45 instructions and a speed of 300,000 operations per second. That microprocessor is the predecessor of all today's microcontrollers.

2.3 BRIEF HISTORY ON POWER FAILURE ALARMS

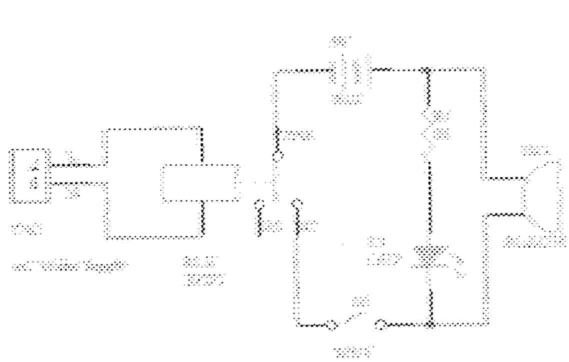

Fig 2.1 a circuit diagram of an existing power failure alarm

The first project under consideration is a power supply monitoring device that will trigger a buzzer when the mains supply cuts off. At the same time, the light emitting diode will be turned ON. The circuit shown above consists of an AC relay. If the mains input is 120V AC, a 120V AC relay will be recommended while a 240V AC relay will be recommended if the mains input is 120V AC. The relay is a Single Pole Double Throw (SPDT) type where the COM will be connected to NC terminal if it is not energized. Once energized, the COM terminal will be connected to the NO terminal. When the mains power supply is available, the relay will be energized, and the COM contact will be connected to the NO terminal, thus disconnecting the 9V power supply in the circuit. When the mains supply is cut off, the

COM will then be connected to the NC terminal, and a buzzer will sound. An LED will light up, and switch S1 will be used to enable or disable the buzzer and LED in the circuit.

The above project does not make use of a microcontroller; therefore, the alarm duration can not be timed. It goes on indefinitely, until it is manually turned off. Also, it only notifies users when there has been a power failure, it does not notify them when power has been restored.

My microcontroller power alert system is unique in that it employs the use of a microcontroller which helps to ensure the buzzer alerts people for a fixed duration of time that is, 10 seconds as employed in this project.

It also alerts people not only when there is a mains failure, but when power has been restored also. This is to enable the user to know when the main power supply has been restored, so that he or she can switch from generator, inverter or any other source of alternative power supply to the main power supply.

This project is also disability friendly, in that it makes use of both buzzer and LEDs. Therefore, a deaf person who can not hear the buzzer will see the LED and take appropriate actions, and a blind person who can not see the LED will hear the buzzer and also take appropriate actions.

CHAPTER THREE

DESIGN AND CALCULATION

The block diagram of this project is as shown in figure 1.1, and each unit is analyzed below

3.1 THE POWER UNIT

This unit supplies electrical energy to the switching unit. the control unit and the alarm and indicator unit. It also converts AC to DC, and the power supplied from this unit is regulated since it is held nearly constant despite load or current variations

It consists of the following:

- Transformer
- Rectifier
- Filtering capacitor
- Voltage regulator

3.1.1 TRANSFORMER

A transformer is a static electronic device by means of which electronic power in one circuit is transformed into electronic power of the same frequency in another circuit. It can raise or lower the voltage in a circuit but with corresponding decrease or increase in current. The physical basis of a transformer is mutual induction between two circuit linked by a common magnetic flux (D).

The coil through which electric energy is fed from the ac supply mains is called primary winding and the other from which energy is drawn out is called secondary winding.

There are two types of transformer:

i. Step up transformer

ii. Step down transformer

A step – up transformer is used to increase the generator output voltage for transmission while a step – down transformer is used to reduce the distribution voltage load for transmission and consumption [3]

The type of transformer used in this project is a step – down transformer. A step – down transformer is a transformer that changed electric power from high to low level, the primary winding is less than the secondary winding. The transformer rating used is 240/24V

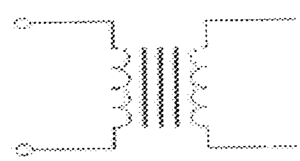

Fig 3.1 symbol of a transformer

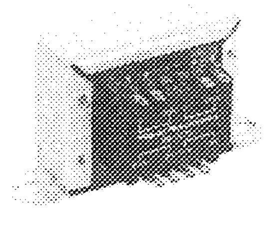

Plate 3.1 a transformer

3.1.2 RECTIFICATION

Rectification involves electronic circuit which converts an A.C voltage into pulsating D.C voltage. It can be achieved by the use of semiconductor diodes.

Rectification is classified into:

i. Half wave rectification

ii. Full wave rectification

iii. Full wave (Bridge) rectification

However, full wave Bridge rectification would be discussed as it is the type of rectification that is employed in the course of this project

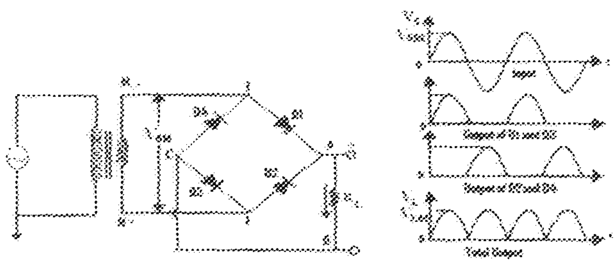

Fig 3.2 wave form of a bridge rectifier

In full rectification, both half cycles of the input are utilized with flux half of four diodes working alternatively. In this case, use of a transformer is essential.

When the A.C input supply is switched on, the M and N of the transformer secondary became +ve and –ve respectively. During the +ve input half-cycle, terminal M of the secondary is positive as N is – ve. Diodes D1 and D3 became forward – biased (ON) where as D2 and D4 are reversed biased (OFF). Hence the current flows along MEABCFN producing a drop across R_L. During the – ve half cycle, secondary terminal N becomes +ve and M –ve. Now D2 and D4 are forward – biased.

3.1.3 Filtering capacitor

A capacitor consists of a conductor separated by an insulator. The main feature of a capacitor is its ability to store electric charges, with a negative charge on one of its two conductors, and a positive charge on the other. [4]

By the analysis of fourier series,a rectified sine wave consist of a Dc components and harmonics of the supply frequency. These harmonics are responsible for the ripples and this is undesirable for smooth operation of our electronic circuits (the computer controlled switch). The process of removing these ripples is known as filtering.

A power supply filter reduces the amplitude of all alternating components in the rectified wave form, and passes the DC component. A measure of the effectiveness of a filter is given by the ripple factor `r` which is defined as the ratio of the r.m.s value of the AC component to the DC or average value that is, $r = \frac{V_{rms}}{V_{dc}}$.[5]

A ripple filter is basically a low pass filter that the DC component and alternatives the A.C compact as show in figure 3.3 below.

The five main types of filter circuit are:

i. Capacitor filter

ii. Resistance capacitance (RC) filter

iii. Inductance of choke – capacitance filter (LC)

iv. R-L-C filters

v. Series induction filter.

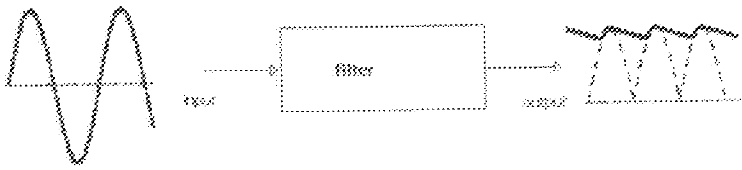

Fig. 3.3 filtered DC output

3.1.4 VOLTAGE REGULATOR

For most electronic equipment a DC power supply is generally preferred since, except for a start – up transient, the supply ideally does not introduce any timing dependence. However by and large electrical power is generated and distributed with a sinusoidal waveform. Thus a power supply typically begins with a rectifier to convert a sinusoidal input. The unidirectional but varying rectified waveform is filtered in various ways to reduce the variation (the 'ripple' voltage) to an acceptable level. Nevertheless, for many purposes, even the filtered supply voltage ripple variation often is unacceptably large, particularly within practical filtering limitations. Power line variations, for example, are passed on to the rectified output. Moreover the Thevenin equivalent circuit for the rectified and filtered power supply often involves a substantial 'internal' resistance, so that the terminal voltage of the supply varies with the amount of current drawn because of the voltage drop across this internal resistance. A 'voltage regulator' inserts additional electronics between the rectifier terminals and the load primarily to reduce this terminal voltage variation, but also to provide other associated benefits. [6]

The 7800 series will be considered in the course of this project. These series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications.

These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. Each of these regulators can deliver up to 1.5 A of output current. The internal current-limiting and thermal-shutdown features of these regulators essentially make them immune to overload.

In addition to use as fixed-voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents, and also can be used as the power-pass element in precision regulators. [7]

The voltage regulator determines the maximum current that can be drawn by the main circuit following the filtering capacitor, and they help to provide thermal overload protection and short circuit protection [8]

The 7805 regulator used in this project is to regulate the voltage from 24volts to a value of 5volts

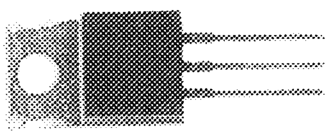

Plate 3.2 a voltage regulator

3.2 The switching unit

The switching unit enables the microcontroller to switch from the main to alternative source of power and back

It consists of the following

- Relay
- Diode
- Voltage regulator
- Battery source

3.2.1 RELAYS

A relay is an electrically operated switch, and it uses an electromagnet. This is a device consisting of a coil of wire wrapped around an iron core. When electricity is applied to the coil of wire it becomes magnetic, hence the term electromagnet. The terminals are SPDT switches controlled by the electromagnet, and when electricity is applied, the electromagnet acts upon the SPDT switch so that the No and C terminals are connected. When the electricity is disconnected, then the Nc and C terminals are connected. It is important to note that the electromagnet is magnetically linked to the switch but the two are NOT linked electrically.

Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and most have double throw (changeover) switch contacts as shown in diagram 3.5 below.

Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification but transistors cannot switch AC or high voltages (such as mains electricity) and they are not usually a good choice for switching large currents greater than 5A, in these cases a relay can be used

Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available. Most relays are designed for PCB mounting but wires can be soldered directly to the pins provided care is taken to avoid melting the plastic case of the relay. The coil will be obvious and it may be connected either way round. Relay coils produce brief high voltage 'spikes' when they are switched off and this can destroy transistors and ICs in the circuit. To prevent damage, a protection diode must be connected across the relay coil. [9]

In the course of this project, the relay assists in the automatic switching from the main to alternative source of power supply and vice – versa.

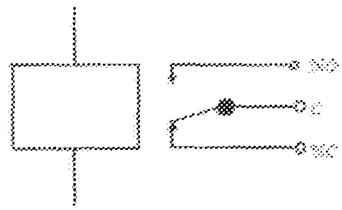

Fig 3.4 symbol of a relay

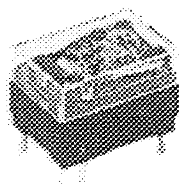

Plate 3.3 a relay

3.2.2 Diodes

A diode is a device that allows electricity to flow in one direction only. The arrow of the circuit symbol shows the direction in which the current can flow. Diodes are the electrical version of a valve and early diodes were actually called valves.

Electricity uses up a little energy pushing its way through the diode, rather like a person pushing through a door with a spring. This means that there is a small voltage across a conducting diode, it is called the forward voltage drop and is about 0.7V for all normal diodes which are made from silicon. The forward voltage drop of a diode is almost constant whatever the current passing through the diode so they have a very steep characteristic as shown in the current – voltage graph below

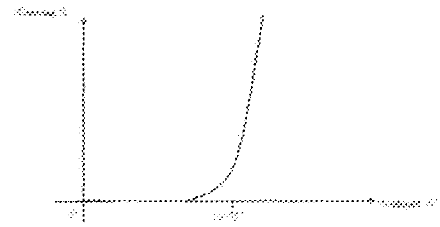

Fig 3.5 Characteristic diagram of a silicon diode

When a reverse voltage is applied, a perfect diode does not conduct, but all real diodes leak a very tiny current of a few µA or less. This can be ignored in most circuits because it will be very much smaller than the current flowing in the forward direction. However, all diodes have a maximum reverse voltage (usually 50V or more) and if this is exceeded the diode will fail and pass a large current in the reverse direction, this is called breakdown.

Ordinary diodes can be split into two types: Signal diodes which pass small currents of 100mA or less and Rectifier diodes which can pass large currents.

Diodes must be connected the correct way round, the diagram may be labeled 'a' or +ve for anode and 'k' or -ve for cathode. The cathode is marked by a line painted on the body.

Small signal diodes can be damaged by heat when soldering, but the risk is small unless a germanium diode is being used in which case a heat sink should be clipped to the lead between the joint and the diode body. A standard crocodile clip can be used as a heat sink.

Rectifier diodes are quite robust and no special precautions are needed for soldering them. A multimeter or a simple tester such as a battery, resistor and LED can be used to check if a diode conducts in one direction and not the other. A lamp may be used to test a rectifier diode, but cannot be used to test a signal diode because the large current passed by the lamp will destroy the diode.

Signal diodes are used to process electrical signals in circuits, so they are only required to pass small currents of up to 100mA. General purpose signal diodes such as the 1N4148 are made from silicon and have a forward voltage drop of 0.7V while Germanium diodes such as the OA90 have a lower forward voltage drop of 0.2V and this makes them suitable to use in radio circuits as detectors which extract the audio signal from the weak radio signal.

For general use, where the size of the forward voltage drop is less important, silicon diodes are better because they are less easily damaged by heat when soldering, they have a lower resistance when conducting, and they have very low leakage currents when a reverse voltage is applied.

Signal diodes are also used to protect transistors and ICs from the brief high voltage produced when a relay coil is switched off.

Rectifier diodes are used in power supplies to convert alternating current (AC) to direct current (DC), a process called rectification. They are also used in circuits where a large current must pass through the diode. All rectifier diodes are made from silicon and therefore have a forward voltage drop of 0.7V. The 1N4001 is suitable for most low voltage circuits with a current of less than 1A.

Zener diodes are used to maintain a fixed voltage, and they are designed to breakdown in a reliable and non-destructive way so that they can be used in reverse to maintain a fixed voltage across their terminals. They can be distinguished from ordinary diodes by their code and breakdown voltage which are printed on them. They have a minimum voltage of 2.4V and power ratings of 400mW and 1.3W are common [11]

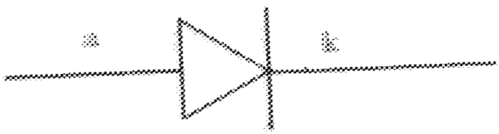

Fig 3.6 symbol of a diode

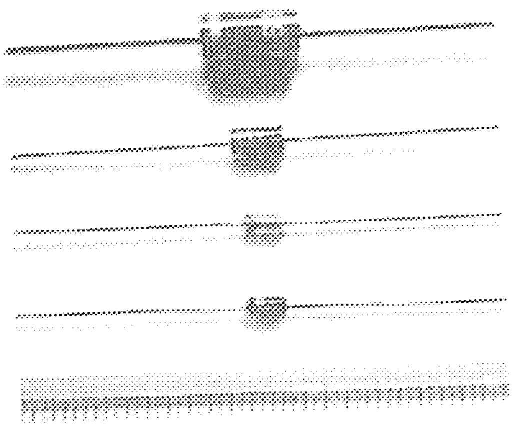

Plate 3.4 Diodes

3.2.3 Voltage regulator

This is as shown in section 2.2.4 above

3.2.4 Battery source

An electrical battery is one or more electrochemical cells that convert stored chemical energy into electrical energy. Since the invention of the first battery (or "voltaic pile") in 1800 by Alessandro Volta, batteries have become a common power source for many household and industrial applications.

A battery is a device that converts chemical energy directly to electrical energy, and they are classified two categories, namely primary batteries and secondary batteries.

The type of battery used in this project is the primary battery, and it used to power the circuit when there is a power failure.

Primary batteries irreversibly transform chemical energy to electrical energy. When the initial supply of reactants is exhausted, energy cannot be readily restored to the battery by electrical means.

Primary batteries can produce current immediately on assembly. Disposable batteries are intended to be used once and discarded. These are most commonly used in portable devices that have low current drain, are only used intermittently, or are used well away from an alternative power source, such as in alarm and communication circuits where other electric power is only intermittently available. Disposable primary cells cannot be reliably recharged, since the chemical reactions are not easily reversible and active materials may not return to their original forms. Battery manufacturers recommend against recharging primary cells.

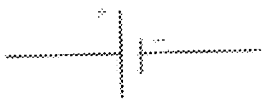

Fig 3.7 symbol of a battery

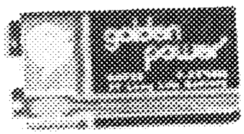

Plate 3.5 a battery

3.3 Control unit

The major component of this unit is the microcontroller, which had its beginnings in the development of technology of integrated circuits. This development has made it possible to store hundreds of thousands of transistors into one micro chip. That was a prerequisite for production of microprocessors, and the first computers were made by adding external peripherals such as memory, input – output lines, timers and others. The further increase in the volume of the package led to the creation of integrated circuits which contain both processor and peripherals. That is how the first chip containing a microcomputer or what would be later known as a micro – controller came into existence.

In the course of this project, an INTEL 8051 micro – controller will be considered, and it is as shown in figure 2.8 below

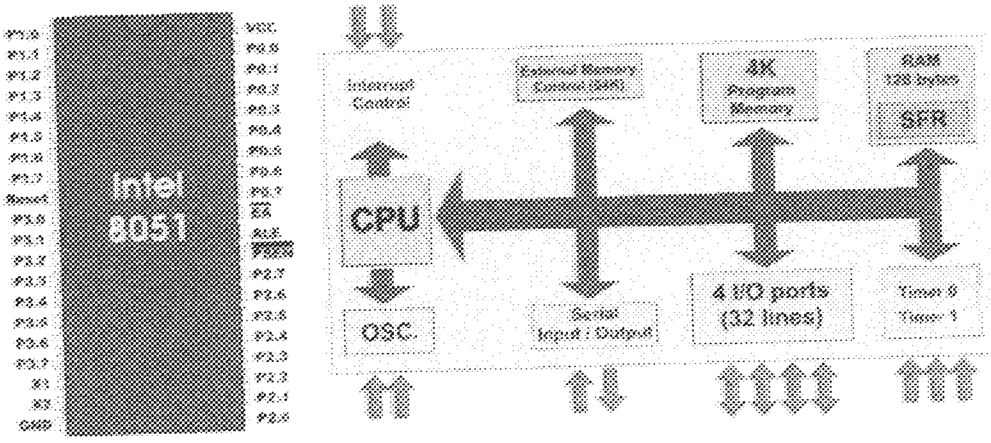

Plate 3.6 schematic diagram of an INTEL 8081 microcontroller

As seen in figure above, the 8051 microcontroller has nothing impressive in appearance, but it consists of the following

- 4 Kb of ROM
- 128Kb of RAM (including SFRs) which satisfies the user's basic needs.
- 4 ports having in total of 32 input/output lines are in most cases sufficient to make all necessary connections to peripheral environment.

The whole configuration is obviously thought of as to satisfy the needs of most programmers working on development of automation devices. One of its advantages is that nothing is missing and nothing is too much. In other words, it is created exactly in accordance to the average user's taste and needs. Another advantage is RAM organization, the operation of Central Processor Unit (CPU) and ports which completely use all recourses and enable further upgrade.

3.3.1 Microcontroller Pin descriptions

The pins used in the course of this project are described as shown below:

Pins 1: serves as the power input of the micro – controller.

Pin 5: serves as the switch used to turn off the alarm and LED before the ten second duration elapses.

Pins 9: serves as the micro – controller reset switch.

Pins 18 and 19: serve as the internal oscillator input and output. A quartz crystal oscillator which specifies operating frequency is usually connected to these pins.

Pin 20: is connected to the ground.

Pins 21 and 22: are general inputs or output pins. They are connected to the output of this project which is the buzzer and LEDs in this case

Pin 24: serves as the power input to the buzzer

Pin 31: is connected to VCC when an external memory is being used, otherwise, it is connected to ground. It executes instructions from external to internal memory

Pin 40: is connected to the +5V power supply which is the VCC.

3.4 The alarm and indicator unit

This unit serves as the output of this project. It indicates with the use of varying alarm sounds and LEDs the status of the circuit at that point in time.

It consists mainly of

- Transistors
- Resistors
- Light emitting diodes

- Buzzer

3.4.1 Transistors

There are two types of standard transistors, NPN and PNP with different circuit symbols. The letters refer to the layers of semiconductor material used to make the transistor. Most transistors used today are NPN because this is the easiest type to make from silicon

NPN is one of the two types of bipolar transistors, in which the letters "N" (negative) and "P" (positive) refer to the majority charge carriers inside the different regions of the transistor. Most bipolar transistors used today are NPN, because electron mobility is higher than hole mobility in semiconductors, allowing greater currents and faster operation.

NPN transistors consist of a layer of P – doped semiconductor (the "base") between two N-doped layers. A small current entering the base in common-emitter mode is amplified in the collector output. In other terms, an NPN transistor is "on" when its base is pulled high relative to the emitter.

The arrow in the NPN transistor symbol is on the emitter leg and points in the direction of the conventional current flow when the device is in forward active mode.

The other type of BJT is the PNP with the letters "P" and "N" referring to the majority charge carriers inside the different regions of the transistor.

PNP transistors consist of a layer of N-doped semiconductor between two layers of P-doped material. A small current leaving the base in common-emitter mode is amplified in the collector output. In other terms, a PNP transisior is "on" when its base is pulled low relative to the emitter.

The arrow in the PNP transistor symbol is on the emitter leg and points in the direction of the conventional current flow when the device is in forward active mode.

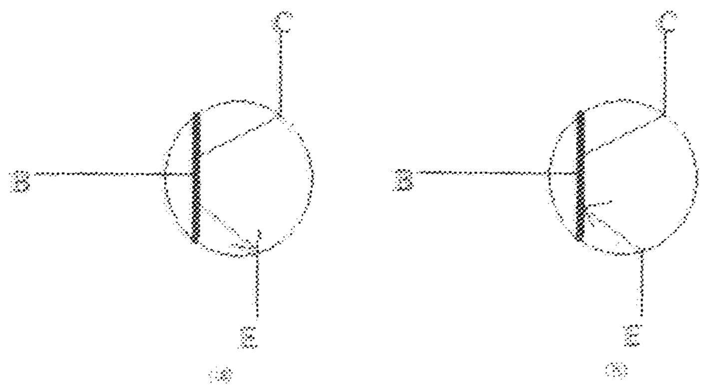

Fig.3.8 (a) symbol of an npn transistor (b) symbol of a pnp transistor

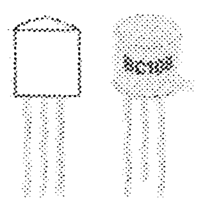

Plate 3.7 transistors

3.4.2 Resistors

A resistor is a two – terminal electronic component that produces a voltage across its terminals that is proportional to the electric current passing through it in accordance with Ohm's law:

$$V = IR$$

Resistors are elements of electrical networks and electronic circuits and are ubiquitous in most electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel/chrome).

A resistor can either be linear or non – linear, and every resistor has a power rating also known as the wattage rating which signifies the maximum power that the resistor can withstand without over heating to a destructive temperature [12]

The primary characteristics of a resistor are the resistance, the tolerance, maximum working voltage and the power rating. Other characteristics include temperature coefficient, noise, and inductance. Less well-known is critical resistance, the value below which power dissipation limits the maximum permitted current flow, and above which the limit is applied voltage. Critical resistance is determined by the design, materials and dimensions of the resistor.

Resistors can be integrated into hybrid and printed circuits, as well as integrated circuits. Size, and position of leads (or terminals) are relevant to equipment designers; resistors must be physically large enough not to overheat when dissipating their power. [13]

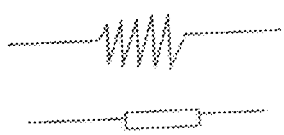

Fig. 3.9 symbols of a resistor

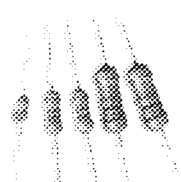

Plate 3.8 Resistors

3.4.3 Light emitting diodes

A light-emitting diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices, and are increasingly used for lighting. Introduced as a practical electronic component in 1962, early LEDs emitted low-intensity red light, but modern versions are available across the visible, ultraviolet and infrared wavelengths, with very high brightness.

When a light-emitting diode is forward biased (switched on), electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the color of the light (corresponding to the energy of the photon) is determined by the energy gap of the semiconductor. An LED is usually small in area (less than 1 mm^2), and integrated optical components are used to shape its radiation pattern and assist in reflection. LEDs present many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved robustness, smaller size, faster switching, and greater durability and reliability. LEDs powerful enough for room lighting are relatively expensive and require more precise current and heat management than compact fluorescent lamp sources of comparable output.

Light-emitting diodes are used in applications as diverse as replacements for aviation lighting, automotive lighting (particularly indicators) and in traffic signals. The compact size of LEDs has allowed new text and video displays and sensors to be developed, while their high switching rates are useful in advanced communications technology. Infrared LEDs are also used in the remote control units of many commercial products including televisions, DVD players, and other domestic appliances. [14]

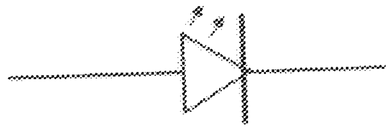

Fig. 3.10 symbol of LED

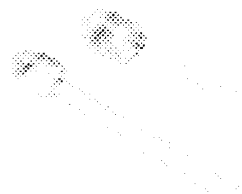

Plate 3.9 LEDs

3.4.4 Buzzers

A buzzer is a transducer which converts electrical energy into sound. It is also an audio signaling device, which may be mechanical, electromechanical, or electronic, and used for alarms, timers and confirmation of user input such as a mouse click or keystroke. Early devices were based on an electromechanical system identical to an electric bell without the metal gong. Similarly, a relay may be connected to interrupt its own actuating current, causing the contacts to buzz. Often these units were anchored to a wall or ceiling to use it as a sounding board. The word "buzzer" comes from the rasping noise that electromechanical buzzers made.

A joy buzzer is an example of a purely mechanical buzzer. [15]

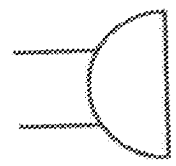

Fig. 3.11 diagram of a buzzer

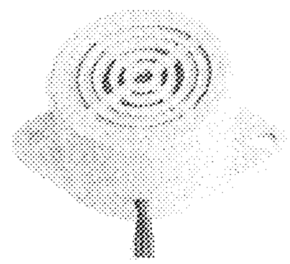

Plate 3.10 Buzzer

3.5 DESIGN OF POWER SUPPLY UNIT

Most electronic devices and circuits require a DC source for their proper operation, and a typical dc power supply consists of five components which include transformer, rectifier, filter, voltage regulation and load. The complete circuit diagram of the power supply unit is as shown below

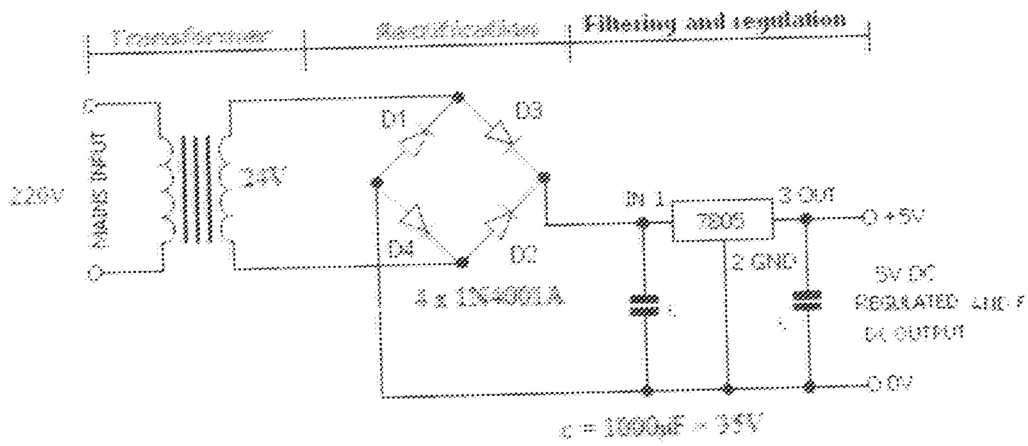

Fig. 3.12 circuit diagram of a power supply unit

The main voltage of 220V is stepped down by a 220V/24V transformer, it is then rectified by the use of a full – wave bridge diode rectifier using four 1N4001A diodes. It is then filtered by the use of an electrolytic capacitor of value 1000µF × 35V. The AC ripple free DC voltage is regulated using a 7805 regulator, to give a steady DC output voltage of 5V.

Another 7805 regulator then takes its input from the capacitor terminals to power a relay

$$C = I^{dt}/_{dv}$$

Generally, dv which is the ripple voltage is chosen to be 30% of V_p, where V_p is the peak voltage.

$$\text{Therefore, } V_p = V_{rms}\sqrt{2}$$

Where V_{rms} = 24V, since a transformer of 220V/24V is being used.

$$V_p = 24 \times \sqrt{2}$$

$$= 33.94V$$

For bridge rectifier,

$$V_{p(out)} = V_{p(in)} - 1.4V$$

Since 0.7V drops across a diode whenever it conducts, only two diodes will conduct at a time. Therefore,

$$V_{p(out)} = 33.94V - 1.4V$$

$$= 32.54V$$

$$dv = (^{30}/_{100}) \times 32.54V$$

$$= 10.84V$$

Therefore,

$$C = \frac{1 \times 0.01}{10.84}$$

$$= 0.000922F$$

$$= 922\mu F$$

So, the commercial values of 1000μF, 35V will be used in order to reduce the ripple to the nearest minimum. Then, the expected ripple voltage using this value of capacitor is

$$dv = \frac{1 \times 0.01}{1000 \times 10^{-6}}$$

$$= 10V$$

This means that the output waveform goes from a peak value of 32.54V to

$$(32.54 - 10)V = 22.54V$$

It maybe noted that the input voltage to the IC regulator must be at least 2V above the output voltage in order to maintain regulation. Therefore, the peak value of 32.54V to 22.54V is acceptable, since the output voltage is 5V. The ripple is regulated by the 7805 regulator, to a negligible value.

The average voltage going to 7805 is calculated by

$$V_p - 0.5dv$$

$$= 32.54 - (0.5 \times 10)\ V$$

$$= 32.54 - 5$$

$$= 27.54V$$

3.6 Design of the switching unit

The output from regulator 2 is used to power the battery driver (relay). The relay used is a 6V, 10A relay with a minimum operating voltage of 4.5V, and maximum of 7V. The positive terminal of the battery is connected to the normally closed (NC) terminal of the relay, and a conductor was used to connect the common terminal to the input of REG1. The diode D_5 prevents backflow of current to the rectifying unit when the battery is supplying REG1. The figure below illustrates the above explanation

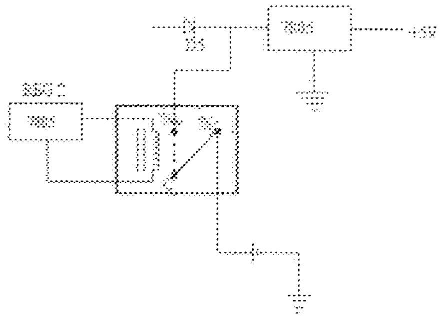

Fig 3.13 circuit diagram of the switching unit

3.6.1 Design of input drivers

This is made up of just one NPN – transistor, BC 639 which indicates the status of power. It works on the fact that as long as there is no supply from the mains, REG2 is inactive. The base of the transistor was connected to the output of REG2, and is thus driven to saturation when there is power from the mains. The collector was connected to P1.0 of the microcontroller and the emitter to the ground. A logic level 1 on the pin indicates power from PHCN, while a logic level 0 indicates a generator. The below diagram illustrates the above explanation. The 1kΩ resistor limits the base current.

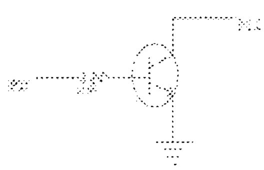

Fig 3.14 diagram of the input driver

3.7 Design of the control unit

The major component of the control unit which also forms the major component of the project is the AT89C52 micro – controller which controls, co – ordinates and directs all the activities and behaviors of this design. Most controlled applications require extensive I/O and need to work with individual bits. This AT89C52 addresses both of these needs by having 32 I/O, bit manipulation and checking. The input from the input driver units to the micro – controller automatically causes the micro – controller to carry out the specified functions as programmed within the micro – controller chip. The output of this goes to the alarm and indicator unit. The below diagram 3.17 below shows the circuit diagram of this unit, while diagram 3.18 shoes the system flow chart

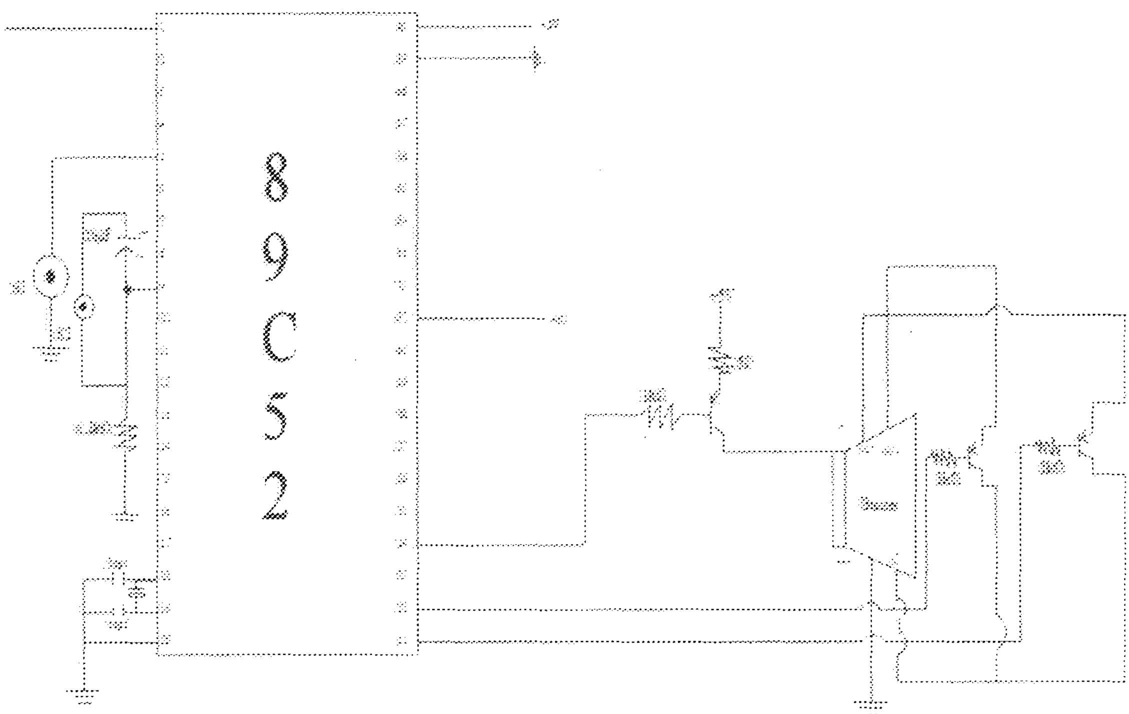

Fig. 3.15 circuit diagram of the control unit

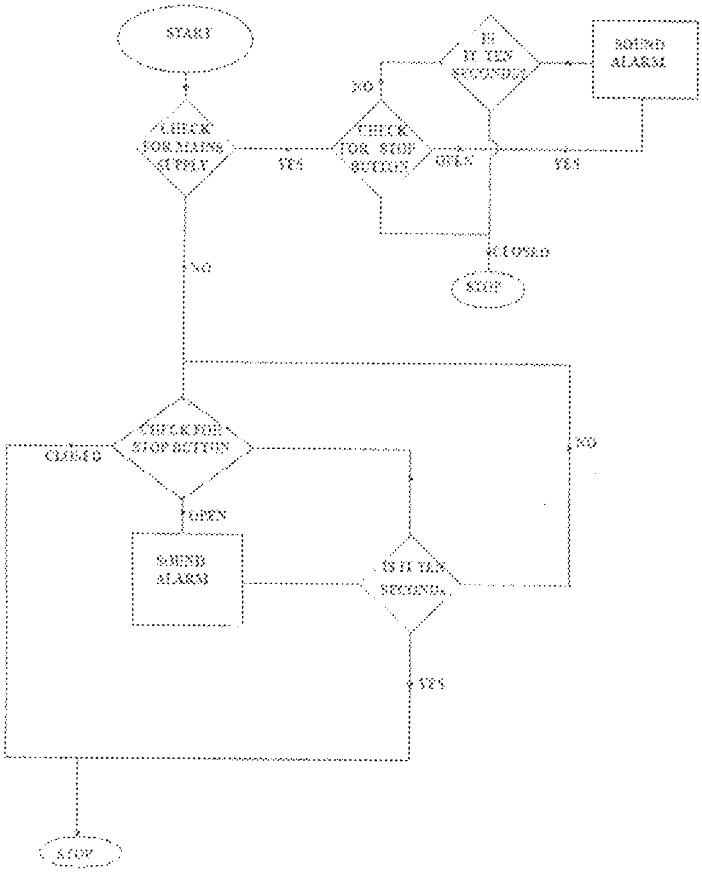

Fig 3.16 diagram of the system flow chart

3.8 Design of alarm and indicator unit

The alarm was controlled using three PNP transistors, BC638. The first transistor switches the alarm supply and the outer two control the two different sounds produced.

The alarm is rated 3V, 250mA. In order to use a 5V supply, a current limiting resistor R_{lim} was connected. The value was calculated as follows:

From Ohm's law,

$$V = IR_A$$

Where R_A = Resistance of alarm

$$3V = 250mA \times R_A$$

$$R_A = \frac{3}{0.25}$$

$$= 12\Omega$$

For 5V supply,

$$V_N = I\,(R_A + R_{IN})$$

$$5 = 250mA\,(12 + R_{IN})$$

$$\frac{5}{0.25} = 12 + R_{IN}$$

$$20 = 12 + R_{IN}$$

$$R_{IN} = 20 - 12$$

$$= 8\Omega$$

A resistor value of 8.2Ω was used because 8Ω was not available. The first and second sounds were switched in a similar way, and the illustrations are shown in the below figure

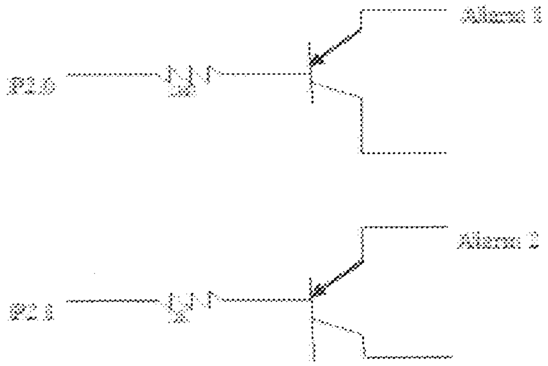

Fig. 3.17 circuit diagram of the alarm unit

Each light emitting diode was connected as shown below

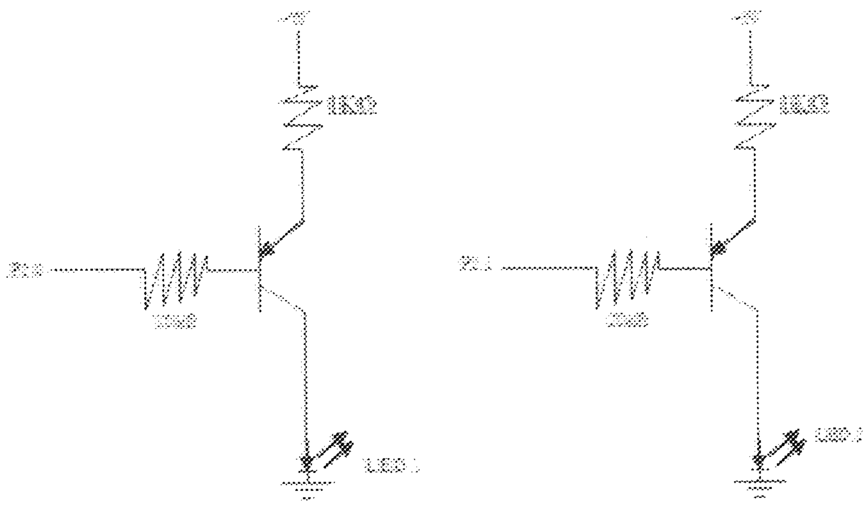

Fig. 3.18 circuit diagram of the indicator unit

After the design of each unit, the whole circuit was merged together to give the circuit diagram shown in fig. 3.19 below

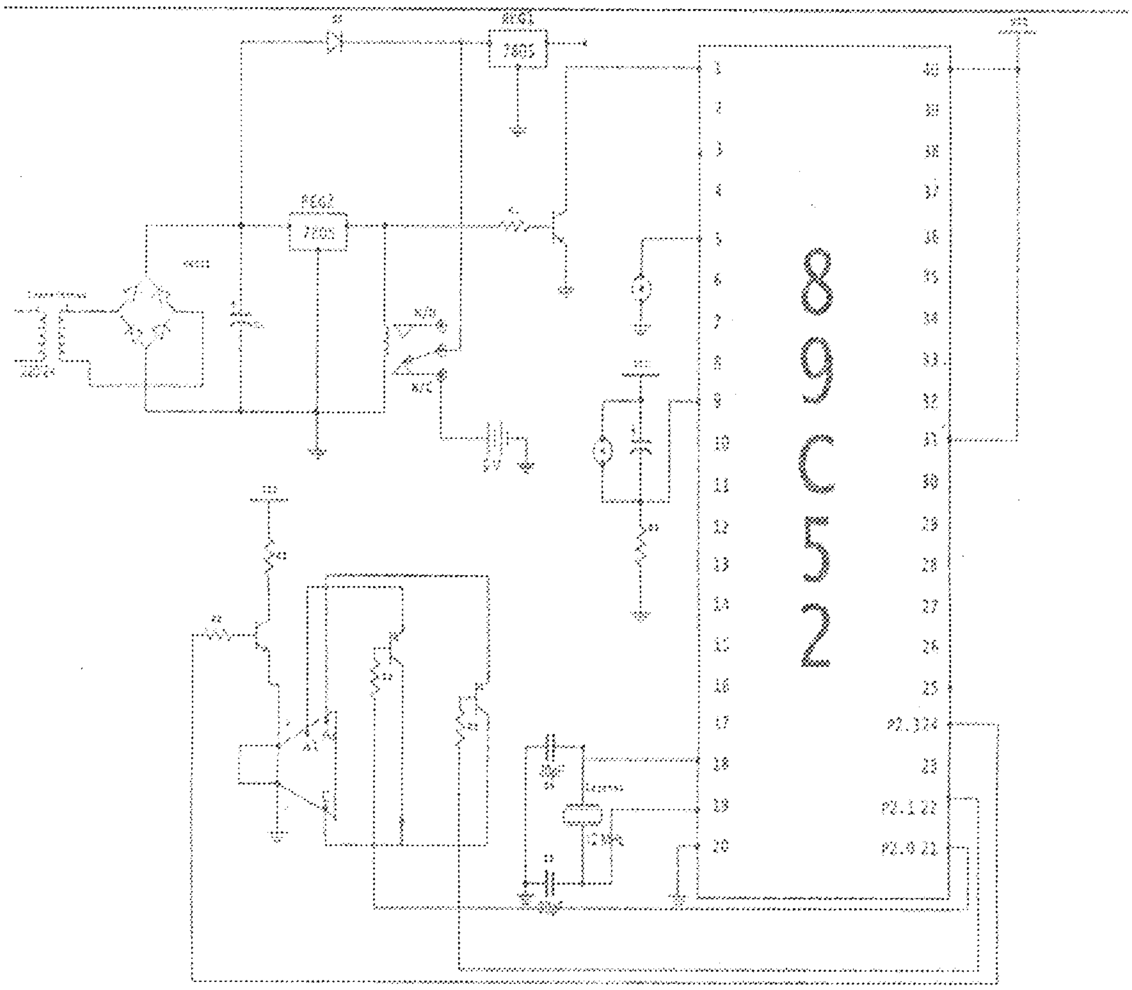

Fig 3.19 Complete circuit diagram

CHAPTER FOUR

TESTING AND RESULTS

4.1 Testing

It is one thing to construct, but the effectiveness of all construction works is for them to pass all tests and work to specification. This project was physically and functionally realized. After the paper design and analysis, the different stages of the circuit was constructed and tested to ensure an error free system, and it was finally coupled together to meet the desired specifications. The process of testing and trouble shooting required the frequent use a digital multimeter which basically measures voltages, resistance, continuity, current, frequency, temperature and transistors. The process of implementation of the design on the Vero board required the measurements of parameters like voltages, continuity, resistance values of the components. It was also used to check the voltage drop at all stages of the project. It served as the most useful tool for troubleshooting during construction and coupling

The design of this project was first carried out on a piece of paper in the form of block diagram, after which each block was developed into individual circuit diagrams, which were later merged to make a whole. Upon getting the desired circuit diagram, the specified components were obtained, and a test was carried out on a bread board. When it became fully functional on the bread board within the specified circuit designs, the entire components were then transferred onto a Vero board. The strip lines of the Vero board were cleaned with methylated spirit in order to remove any form of dirt or conductor on it before the components were soldered onto it

4.2 Result analysis

After the project was implemented on a bread board to test its operation, it worked perfectly. When the transformer was plugged to the mains supply, a red colored L. E. D was lit, as well as an alarm sound from the buzzer. This indicated that power was being supplied from the mains. The alarm and L.E.D were on for ten seconds, after which they switched themselves off. The transformer was then disconnected from the mains, and the green colored L.E.D came on, with the alarm giving a different sound from the first. This went on for another ten seconds, after which they also switched themselves off.

This project consists of two switches, the first is used to reset the alarm, while the second switch is used to put off the light and L.E.D before the normal ten second duration elapsed.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The aim and objective of this project was achieved, and the microcontroller based power alert system was successfully designed, implemented and tested.

In this era of power instability, where lots can be lost or damaged due to sudden current surges, this project is best for all household, commercial and industrial based applications.

This project is going to stand the test of time because of its simplicity, the low cost of materials, and the readily availability of components used.

5.2 Recommendation

An improvement that can be made on this project is the strategic positioning of the alarm since its aim is to notify and not scare users or disturb neighbors.

Another future improvement that can be made is the incorporation of an automatic switch into the project. This will automatically change over from the main to alternative source of power supply and vice – versa as the case maybe

Also, for future implementation of this project, a rechargeable battery that will be charged when the main power supply is on will be recommended. A signal should also be included to indicate when the battery is low, and when the alarm fails

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[13] http://en.wikipedia.org/wiki/Light-emitting_diode 12/08/2010

[14] http://en.wikipedia.org/wiki/Buzzer 12/08/2010

Appendix I

```
ORG 0000H

CLR A
        MOV R0,#00H
        MOV R1,#00H
  MOV R2,#00H
        MOV R3,#00H
  MOV R4,#00H
  MOV R5,#00H
  MOV R6,#00H
  MOV R7,#00H
 LJMP MOTUN

 OJAY:LCALL OJ
    CJNE R1,#0,JIYA
    CJNE R5,#0,JIYA
    INC R0
    CJNE R0,#14H, OJAY
    MOV R0,#00H
 JIYA:RET

 OJ:MOV TMOD,#01
   MOV TL0,#0H
   MOV TH0,#3CH
   SETB TR0
   JNB TF0,$
   CLR TF0
   CLR TR0
   JB P1.4,AMI
   MOV R1,#3
   SJMP NOAMI
   AMI:JB P1.0,NOAMI
      MOV R5,#12
 NOAMI:RET

  OJAYE:LCALL OJE
     CJNE R1,#0,JIYAE
     CJNE R4,#0,JIYAE
     INC R0
     CJNE R0,#14H, OJAYE
```

```
    MOV R0,#00H
JIYAE:RET

OJE:MOV TMOD,#01
   MOV TL0,#0H
   MOV TH0,#3CH
   SETB TR0
   JNB TF0,$
   CLR TF0
   CLR TR0
   JB P1.4,NO
   MOV R1,#3
   SJMP NOAMIE
 NO:JNB P1.0,NOAMIE
   MOV R4,#5
 NOAMIE:RET


 MOTUN:LCALL OJAY
     JB P1.0,GENERATOR
 NEPA:CLR P2.3
    CLR P2.0
 MICE:LCALL OJAYE
    CJNE R1,#0,LANRE
    CJNE R4,#0,LANRE
    INC R2
    CJNE R2,#10,MICE
    MOV R2,#0
 LANRE:MOV R1,#0
     MOV R4,#0
    SETB P2.0
    SETB P2.3
    SJMP GCHECK
 GENERATOR:CLR P2.3
        CLR P2.1
     RICE:LCALL OJAY
        CJNE R1,#0,TOMI
        CJNE R5,#0,TOMI
        INC R3
        CJNE R3,#10,RICE
        MOV R3,#0
     TOMI:MOV R1,#0
        MOV R5,#0
        SETB P2.1
        SETB P2.3
```

```
        SJMP NCHECK
NCHECK:JB P1.0,$
      SJMP NEPA
GCHECK:JNB P1.0,$
      SJMP GENERATOR
END
```