# ENERGY CONSERVATION SYSTEMS:

(A CASE STUDY OF A REFRIGERATOR DOOR ALARM SYSTEM WITH AUTOMATIC RECLOSING)


BY

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## DECLARATION

I hereby delcare that this research work was done by me and it has not been presented anywhere else. The information in this work was derived from published and unpublished works which have been duly acknowledged and documented.

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## CERTIFICATION

I hereby certify that this project "**Energy Conservation System: a Case Study of Refrigerator Door Alarm System**" was carried out by Achimugu Franca .F. with matriculation number 2006/24271EE and meets the standard deemed acceptable by the department of Electrical Electronics Engineering, School of Engineering and Engineering Technology, Federal University of Technology, Minna, Niger State.

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# DEDICATION

This work is dedicated to my parents, my siblings, friends and my lecturers, for their various innumerable contributions on this work.

# ACKNOWLEDGEMENT

I acknowledge the Almighty God for being my source and bearing my daily burdens. On my own, it would have been impossible.

My sincere gratitude goes to my parents, Mr. and Mrs. Achimugu, for their unending love, support and prayers.

I will not forget to mention my siblings for their support: Jane, Juliet, Juliana, Victor, Godwin and Jenifer.

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In undertaking a research work of this magnitude, it is always nearly impossible to acknowledge all the many people who have been instrumental in its many phases leading to its successful completion. Be that as it may, with a deep sense of gratitude, I wish to acknowledge the contributions of my fellow colleagues for their support throughout this study.

I remain ever grateful to anyone and everyone who has assisted me in one way or another to the successful completion of this project. May almighty God bless you all.

# ABSTRACT

This project seeks to conserve energy using the refrigerator door alarm system as a case study. The refrigerator door alarm is designed to alert the energy consumer (user) to close the refrigerator door he/she forgets to close after a certain amount of set time. The design was carried out using a simple electronic circuit with the objective of constructing the power unit, a door monitoring unit, an alarm unit and a motor driver unit. The design uses a bump switch to detect if the door is open or closed. A delay is then introduced using a micro controller which counts for 30 seconds after which the alarm sounds. If the refrigerator door is not closed in 30 seconds after the alarm has sounded, the DC motor closes the refrigerator door automatically.

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# CHAPTER ONE

## 1.0 INTRODUCTION

Every day, we flip switches, start cars, work in busy factories all using energy at a rate which is growing daily. Energy has an important function. It is the central force behind our productivity, our leisure and our environment. There is a strong correlation between energy use per person and the standard of living in each economy.

Energy being an important element of Nigeria's infrastructure sector has to be ensured its availability on sustainable basis. On the other hand, the demand for energy is growing manifold and the energy sources are becoming scarce and costlier. Among the various strategies to be evolved for meeting energy demand, efficient use of energy and its conservation emerges out to be the least cost option in any given strategies, apart from being environmentally benign.

Energy conservation is the practice of decreasing the quantity of energy used [5]. It may be achieved through efficient energy use, in which case energy use is decreased while achieving a similar outcome, or by reduced consumption of energy services. Energy conservation may result in increase of financial capital, environmental value, national security, personal security, and human comfort.

Individuals and organizations that are direct consumers of energy may want to conserve energy in order to reduce energy costs and promote economic security. Industrial and commercial users may want to increase efficiency and thus maximize profit.

## 1.1 BACKGROUND TO THE STUDY

Energy is an indispensable component of industrial product, employment, economic growth environment and comfort, which has been abundant in the past but the 1973 oil embargo, produced an energy crisis which shocked the economy of the whole world. The subsequent increase in oil prices increased the energy cost in every sector, domestic commercial, industrial e.t.c, thus, causing all our energy resources are fast depleting, which makes energy saving essential in developed and developing countries.

It is important that any energy conservation plan should only try to eliminate wastage of energy without in anyway affecting productivity and growth rate.

## 1.2 STATEMENT OF THE PROBLEM

Energy can be conserved in industries, it can be conserved in electrical generation, transmission and distribution, it can be conserved in household and commercial sectors, it can be conserved in transport, it can be conserved in agriculture, and it can be conserved in legislation.

It is on this light that the conservation of energy at home and in commercial places is of great importance.

## 1.3 PURPOSE OF THE STUDY

In order to conserve energy at home and at work, it is very important to create and provide an alarm system that alerts the energy users on the conservation of energy.

This research seeks to conserve energy using the refrigerator door alarm system as a case study. This refrigerator door alarm system is designed to alert the energy consumer to close the refrigerator door he/she forgets to close, after a certain amount of time.

## 1.4 AIM AND OBJECTIVES

The aim of this project is to design and construct a refrigerator door alarm system using a simple electronics design circuit. It is designed to alert the energy consumer to close the refrigerator door he/she forgets to close, after a certain amount of time.

In pursuance of the aim of this project, the following objectives of the project have been specified:

i. Design and construction of a Power unit.
ii. Design and construction of a Door Monitoring unit
iii. Design and construction of an Alarm unit.
iv. Design and construction of a Motor Driver unit.

## 1.5 SIGNIFICANCE OF THE STUDY

It is difficult to imagine spending an entire day without using energy. Energy is used to light cities and homes, to power machinery in factories, cook food, play music, and operate televisions. In a home where electricity supplies all of the energy requirements, the average energy consumption is shown below [5]:

| | |
|---|---|
| Air conditioner and heater | = 50% |
| Water heater | = 20% |
| Lighting and small appliances | = 10% |
| Refrigerator | = 8% |
| Others | = 5% |
| Ovens and stoves | = 4% |
| Clothes dryer | = 3% |

Energy conservation is the reduction of quantity of energy used. Energy conservation supports the eco friendly lifestyle by providing energy, which saves money and at the same time saves the earth. When there is decrease in the amount of energy used, automatically efforts are made to reduce increasing global warming.

A refrigerator door alarm system will help in the reduction and conservation of energy that will be lost as a result of leaving the refrigerator door open when not in use.

## 1.6 SCOPE OF THE STUDY

The refrigerator door alarm system is a simple circuit that alerts the energy user when he/she forgets to close the fridge after a certain amount of time. The refrigerator door alarm has its limitations, despite its usefulness. This alarm system does not turn off the refrigerator or stop the compressor from working when energy is being wasted (when the door is left open). It only conserves energy by preventing undue waste by sounding an alarm when the refrigerator door is left open.

## 1.7 DESIGN METHODOLOGY

The refrigerator door alarm is designed to alert the energy user to close the refrigerator door he/she forgets to close, after a certain amount of time. This design uses a bump switch to detect if the door is open or closed. A delay is then introduced using a microcontroller, which counts for 30 seconds after which the alarm sounds. If the refrigerator door is not closed in 30 seconds after the alarm sounding, the DC motor closes the refrigerator door automatically.

## 1.8 PROJECT OUTLINE

Chapter one consists of introduction, background to the study, statement of the problem, purpose of the study, aim and objectives of the study, scope of the study, limitations of the study and the design methodology.

Chapter two consists of literature review and a brief theoretical background to the work.

Chapter three consists of the design analysis of the work.

Chapter four consists of tests carried out, results, discussion of the results and troubleshooting the design.

Chapter five consists of conclusions and recommendations made by the researcher.

# CHAPTER TWO

## LITERATURE REVIEW OF RELATED WORKS

### 2.1 ENERGY

Energy is defined as "the ability to do work" [13]. In this sense, examples of work include moving something, lifting something, warming something, or lighting something. The following is an example of the transformation of different types of energy into heat and power [5].

Oil burns to make heat -->

Heat boils water -->

Water turns to steam -->

Steam pressure turns a turbine -->

Turbine turns an electric generator -->

Generator produces electricity -->

Electricity powers light bulbs -->

Light bulbs give off light and heat.

People are greatly dependent upon energy. God gave us several forms of natural energy to help us live productively on earth. He gave man the intelligence to learn how to use different forms of energy in creative ways. God is the creator of the world and the producer of all its whole being or substances, including these energy types (Psalms 19:3-6). Everything that moves requires energy. Figure 2.1 shows the different types and forms of energy.

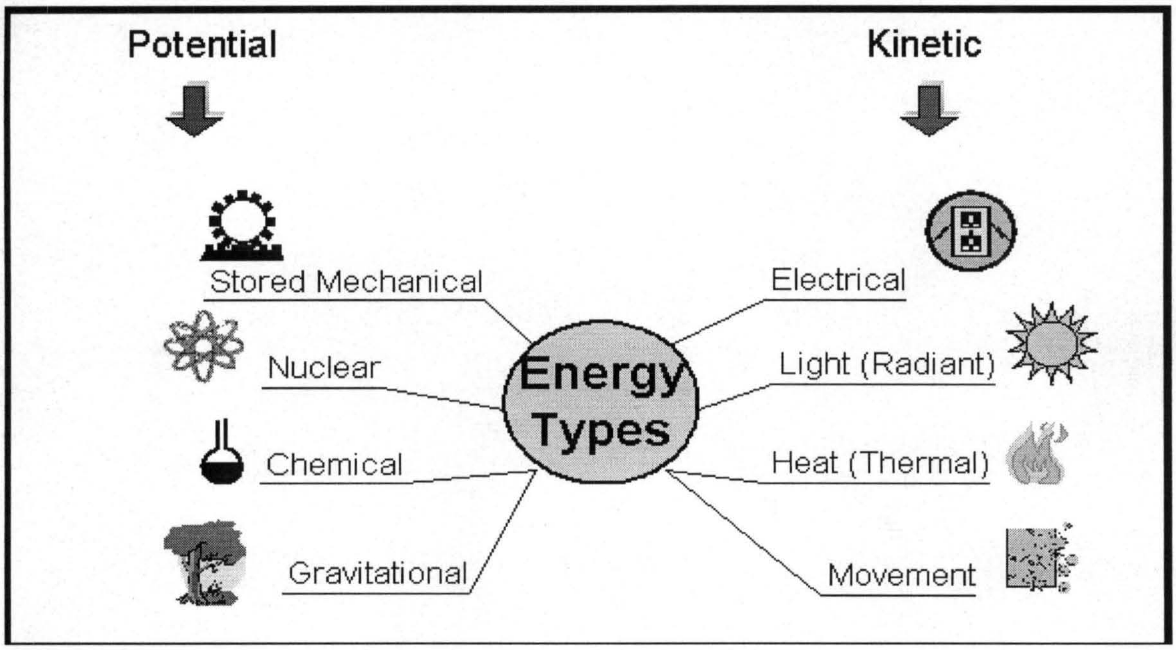


**Fig. 2.1 Types and forms of energy [11]**

Energy is defined as "the ability to do work" [5]. Work and energy may seem like very much the same thing. However, while they are similar, they are not the same. Work is a force that is acting by or through a distance. Energy is simply the ability to do that work. Almost everything done is connected to a form of energy. The sun produces light and the energy to make plants grow. Our bodies produce energy from food. Energy powers our vehicles, warms our homes, plays our music, lights our cities, and powers machinery in factories and farms.

The figure 2.1 divides the different forms of energy into two types: Potential and kinetic.

i. **Potential Energy:** Potential energy is stored energy. It is the energy that exists within an object. It is the stored energy of position possessed by an object.

ii. **Kinetic Energy:** Kinetic energy is the energy of motion. When you are walking or running, your body is exhibiting kinetic energy.

### 2.1.1 Different forms of energy

There are different types of energy. They include [12].

**a) Mechanical energy**, the kind of energy used by machines, lumps together kinetic energy and potential energy (that is, energy with levers, gears, and wheels that use kinetic or potential energy to convert into work). Examples of mechanical energy are the pendulum, a levered-up rock, and similar devices.

At the instant the pendulum is released, it has gravitational potential energy and no kinetic energy. At the bottom of the swing, it has kinetic energy but no potential energy. It just keeps going, trading energy back and forth between these two forms. A levered-up rock can fall, thereby doing work.

Other forms in which mechanical energy is seen include landslides, avalanches, and rain. To make rain, the Sun evaporates water, which condenses into clouds. This water then falls as rain. It does work if it can be captured behind a dam, after which its gravitational potential energy is converted to electrical energy as water falls through turbines in the dam.

Earthquakes, which release energy (stored as rock strain) along fractures, exhibit large-scale land motion. Tsunamis (so-called tidal waves) are water waves caused by underwater Earthquakes and are also forms of mechanical energy.

**b) Nuclear energy** becomes available when unstable nuclei spontaneously change by throwing off particles. The decay of the neutron into a proton, an electron, and an antineutrino is an illustration of the conversion of nuclear mass energy into kinetic energy.

**c) Thermal energy** is energy internal to the body, due to motion of the atoms making up the body. Hot springs such as those found all over Iceland, in Yellowstone Park, in the Geysers, California, region, and in the city of Klamath Falls, Oregon, are of high temperature because of contact with the hot rock making up the basement of the continent. Volcanoes, such as Mauna Loa, are reservoirs of thermal energy. The steam that drives the piston in a steam engine has thermal energy. The hot gases in the cylinder of an internal combustion have thermal energy.

**d) Electrical energy** is energy stored in the back-and-forth motion of electrons in electric utility lines. Lightning involves the transformation of electrical energy into thermal energy and light energy.

**e) Chemical energy** is energy that has been stored in chemical form, such as in fuels or sugars or as energy stored in car batteries. Gasoline is a chemical that combines with oxygen and a little thermal energy to release the great amount of thermal energy stored in the chemical structure of the gasoline. Other such chemicals include sucrose, methane, ethanol, and methanol.

**f) Radiant energy, or electromagnetic energy**, is simply the energy carried by electromagnetic radiation (we call this radiation light when it is visible or near the visible region). It is this energy that makes the chemical storage of photosynthesis possible. Chemical energy can be converted into radiant energy by phosphorescent organisms, some deep water fish, and fireflies.

Both work and heat, the transfer of thermal energy between objects at different temperatures, involve the interaction of two things. Work involves a force and a displacement. Heat is a transfer between two different objects. Heat is not a form of energy like those listed above. It is a designation for energy being transferred, not an amount contained in a body.

### 2.1.2 Sources of Energy

Energy sources are classified into two groups—**renewable** and **nonrenewable** [14].

#### 2.1.2.1 Renewable energy sources

These are energy which comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable (naturally replenished). In 2008, about 19% of global final energy consumption came from renewable energy source, with 13% coming from traditional biomass, which is mainly used for heating, and 3.2% from hydroelectricity. New renewable energy sources (small hydro, modern biomass, wind, solar, geothermal, and biofuels) accounted for another 2.7% and are growing very rapidly. The share of renewable energy sources in electricity generation is around 18%, with 15% of global electricity coming from hydroelectricity and 3% from others [14].

Sources of Renewable Energy include the followings:

i. **Wind power Energy** Airflows can be used to run wind turbines. Modern wind turbines range from around 600 kW to 5 MW of rated power, although turbines with rated output of 1.5–3 MW have become the most common for commercial use; The power output of a turbine is a function of the cube of the wind speed, so as wind speed increases, power output increases dramatically. Areas where winds are stronger and more constant, such as offshore and high altitude sites are preferred locations for wind farms.

ii. **Hydro power Energy** in water can be harnessed and used. Since water is about 800 times denser than air, even a slow flowing stream of water, or moderate sea swell, can yield considerable amounts of energy. There are many forms of water energy: Hydroelectric energy is a term usually reserved for large scale hydroelectric dams. Examples are the Grand Coulee Dam in Washington State and the Akosombo Dam in Ghana. Micro hydro systems are hydroelectric power installations that typically produce up to 100 kW of power. They are often used in water rich areas as a remote area power supply (RAPS). Run of the river hydroelectricity systems derive kinetic energy from rivers and oceans without using a dam. Ocean energy describes all the technologies to harness energy from the ocean and the sea. This includes marine current power, ocean thermal energy conversion, and tidal power.

**iii. Solar energy** is the energy derived from the sun through the form of solar radiation. It is the most important source of energy. Solar powered electrical generation relies on photovoltaics and heat engines. A partial list of other solar applications includes space heating and cooling through solar architecture, day lighting, solar hot water, solar cooking, and high temperature process heat for industrial purposes.

**iv. Biomass Energy** (plant material) is a renewable energy source because the energy it contains comes from the sun. Through the process of photosynthesis, plants capture the sun's energy. When the plants are burnt, they release the sun's energy they contain. In this way, biomass functions as a sort of natural battery for storing solar energy. As long as biomass is produced sustainably, with only as much used as is grown, the battery will last indefinitely. In general there are two main approaches to using plants for energy production: growing plants specifically for energy use, and using the residues from plants that are used for other things. The best approaches vary from region to region according to climate, soils and geography.

**v. Biofuels** include a wide range of fuels which are derived from biomass. The term covers solid biomass, liquid fuels and various biogases. Liquid biofuels include bioalcohols, such as bioethanol, and oils, such as biodiesel. Gaseous biofuels include biogas, landfill gas and synthetic gas. Bioethanol is an alcohol made by fermenting the sugar components of plant materials and it is made mostly from sugar and starch crops. Bioethanol is widely used in the USA and in Brazil. Biodiesel is produced from oils or fats using transesterification and is the most common biofuel in Europe. Biofuels provided 1.8% of the world's transport fuel in 2008. According to the International Energy Agency, biofuels have the potential to meet more than a quarter of world demand for transportation fuels by 2050.

**vi. Geothermal energy** is energy obtained by tapping the heat of the earth itself, both from kilometers deep into the Earth's crust. Ultimately, this energy derives from heat in the Earth's core. The geothermal energy from the core of the Earth is closer to the surface in some areas than in others. Where hot underground steam or water can be tapped and brought to the surface it may be used to generate electricity. Such geothermal power sources exist in certain geologically unstable parts of the world such as Chile, Iceland, New Zealand, United States, the Philippines and Italy. There is also the potential to generate geothermal energy from hot dry rocks. Holes at least 3 km deep are drilled into the earth. Some of these holes pump water into the earth, while other holes pump hot water out. The heat resource consists of hot underground radiogenic granite rocks, which heat up when there is enough sediment between the rock and the earth's surface. Several companies in Australia are exploring this technology.

### 2.1.2.2 Nonrenewable Energy

This is energy which cannot be produced, grown, generated, or used on a scale which can sustain its consumption rate, once used there is no more remaining. These resources often exist in a fixed amount and are consumed much faster than nature can create them. Fossil fuels (such as coal, petroleum and natural gas) and nuclear power (uranium) are examples. In contrast, resources such as timber (when harvested sustainably) or metals (which can be recycled) are considered renewable resources [14].

Sources of Nonrenewable Energy include;

**i. Fossil fuel**: As the plants and animals that inhabited the swamps died, they were buried under sand and mud which stopped them from decaying. Over time, more sediment covered the remains and pressure, together with heat, turned them into coal, oil and natural gas deposits. Fossil fuels are mostly found deep underground. To extract coal, mine shafts are dug into the ground. Drilling rigs are used to bore into the ground or seabed to obtain oil or natural gas. Natural resources such as coal, petroleum, oil and natural gas take thousands of years to form naturally and cannot be replaced as fast as they are being consumed. Eventually natural resources will become too costly to harvest and humanity will need to find other sources of energy. At present, the main energy source used by humans are nonrenewable fossil fuels, as a result of continual use since the first internal combustion engine in the 17th century, the fuel is still in high demand with conventional infrastructure fitted with the combustion engine.

**ii. Nuclear power:** Atoms are the building blocks of our world. Nuclear power comes from the energy stored in atoms – specifically from the atoms of the chemical element uranium, which is found in certain types of rock. The use of nuclear technology requires radioactive fuel. Uranium ore is present in the ground at relatively low concentrations and mined in 19 countries. The uranium resource is used to create plutonium; uranium 238 is fissionable and can be transmuted into fissile plutonium 239 in a nuclear reactor. Nuclear fuel is used for the production of nuclear weapons and in nuclear power stations to create electricity. Nuclear power provides about 6% of the world's energy and 13–14% of the world's electricity. Nuclear technology is a volatile and contaminating source of fuel production, with the expense of the nuclear industry predominantly reliant on subsidies. The radioactive waste the nuclear industry collects is highly hazardous, for a prolonged period and storage has risks of containment. Radioactive fuel continues to be controversial and unresolved industry.

#### 2.1.2.3 Advantages and disadvantages of non-renewable and renewable energy

The advantages of non-renewable energy are found in two areas: cost and availability. Most of the energy-consuming products that run off of non-renewable energy sources have very little real competition from similar or comparable products that utilize renewable sources. For example, it is difficult to find a car or truck that runs off of rechargeable battery power, solar power, or electricity. If you did find one, it would be less efficient (wouldn't go as fast, be as practical, etc.) and cost a LOT more. The disadvantages, of course, are that they are non-renewable, meaning that when they're gone, they're gone. You can't replace natural gas, oil, or coal. Also, mining for these sources at such an intense rate can have devastating environmental effects.

Renewable energy, on the other hand, provides for cleaner, environmentally friendlier power sources. Once fully developed, they have the potential to be much more cost efficient (consider solar power; it's not like the sun is a market-based commodity that can be over or under produced to obtain a better selling price). However, until this type of power source is fully integrated into the market, products utilizing it will remain more expensive, less readily available, and more of a unique alternative rather than viable competitor.

## 2.2 ENERGY CONSERVATION

The law of conservation of energy is an empirical law of physics. It states that the total amount of energy in an isolated system remains constant over time (is said to be conserved over time) [14]. A consequence of this law is that energy can neither be created nor destroyed: it can only be transformed from one state to another. The only thing that can happen to energy in a closed system is that it can change form: for instance chemical energy can become kinetic energy.

Albert Einstein's theory of relativity shows that mass is a form of energy, so they can transform one into another. So the distinction between "matter" particles (such as those constituting atoms) and energy particles (say photons of light) is not wide - they can turn one into other. However, this conversion does not affect the total energy of closed systems. So conservation of energy refers to the conservation of the total energy of an isolated system over time (including rest mass energy $mc^2$ associated with the rest mass of particles) and all other forms of energy (kinetic, potential, nuclear, chemical, thermal, etc) in the system together [14].

A consequence of the law of energy conservation is that perpetual motion machines can only work perpetually if they deliver no energy to their surroundings. Because of the limited amount of nonrenewable energy sources on Earth, it is important to conserve current supply or to use renewable sources so that natural resources will be available for future generations.

Energy conservation is also important because consumption of nonrenewable sources impacts the environment. Specifically, our use of fossil fuels contributes to air and water pollution. Saving energy and reducing utility expenses are major benefits of energy conservation though there are additional (often unreported) benefits from conserving energy. The financial and strategic benefits extend beyond the utility budget. The non-utility benefits contribute value worth an additional 18 to 50 percent of the energy savings. There are many ways to accomplish energy savings (via conservation, technologies, commissioning, process changes, etc.).

Therefore, any measure employed to conserve energy world over is a laudable one no matter how little the idea may be. Beyond illustrating these benefits, the goal of this project is to motivate change towards peoples' attitude towards saving more energy and money, while preserving more of our natural environment.

### 2.2.1 Benefits of energy conservation

"It's not the age… it's the mileage"… It is logical that a car driven 25% less each year will last longer. The same is true for most energy-consuming equipment, such as lights, motors and even digital equipment. By turning "off" energy-consuming equipment when it is not needed, an organization can find a financial jackpot, which extends beyond the utility budget. It doesn't matter how energy-efficient an organization/individual is, there are savings from turning equipment "off" when it is not needed.

Here are some benefits of energy conservation and these are benefits that can be attained without a negative impact on productivity [7].

**1. Efficient Net Income**: When energy is conserved, utility budgets are reduced. This is no secret, but what is noteworthy is that conservation savings impact a bottom line far more efficiently than many other investment initiatives.

**2. Extended Equipment Lives**: If assets are lasting longer (due to reduced operation per year), replacements are less frequent, thereby reducing capital budget requirements. For example- if a lighting system is operating 30% fewer hours per year, it could last up to 30% longer. A 15 year replacement policy could be changed to 20 years.

**3. Reduced Risk to Energy Supply Price Spikes**: For example- if less energy is consumed; the operational budget is less vulnerable when electric/gas/heating oil prices hit their seasonal spikes. The avoided costs can be worth millions to a large organization.

**4. Reduced Maintenance Cost:** When equipment runs for fewer hours each year, maintenance, material/labour requirements are reduced. For example, if maintenance on a motor is done on a "run hour" basis and there are less "run hours" per year, there should be fewer. Thus, the energy conservation/efficiency program is an investment with less risk and quickly improves cash flow.

Further savings could result from considering that if equipment lasts longer, then staff/engineering/project management time is reduced for reviewing new equipment proposals, evaluating competing bids, overseeing installation efforts, coordinating invoices and payables with accounting, maintenance visits. Further, if the motor is part of ventilation system, air filter replacements, would occur less often, reducing material and labor costs.

## 2.3 COMPONENTS USED IN THIS WORK

The effective and efficient performance of a system, its functionality and maintainability largely depends on the various components, design and construction techniques employed in creating that system. Failure by any or all of the components used in this system will result in the failure and non performance of the entire system [9].

Components used for this system include:

i. **Diode:** The IN4148 is a high speed switching diode fabricated in planar technology. A diode and rectifier is any device through which electricity can flow in one direction.

ii. **Buzzer:** A buzzer is an audio signaling device which maybe electromechanical, mechanical or piezoelectric. They are used for alarm devices, timers and confirmation of user input such as mouse click or keystroke.

iii. **Transistor:** A transistor is a three terminal device. In a bipolar junction transistor (BJT), an electric current is fed into the base (B), and modulates the current flow between the other two terminals known as the emitter (E) and collector(C). A transistor acts like a switch or gate for electric signal.

Other components used are:

1. The micro processor (8051)
2. The DC motor
3. Voltage regulators
4. Bump switch
5. Relays
6. Transformers etc, which were all discussed extensively in the following chapter.

# CHAPTER THREE

## DESIGN AND IMPLEMENTATION

### 3.0 INTRODUCTION

In this section, the design analysis of various stages and steps undertaken to archive the project is presented.

The designed circuit was initially simulated on multism (an electronic work bench application soft ware) to ensure the designed circuit is working perfectly before proceeding to the breadboard work (temporary construction) to temporarily test the project and to be sure that all the component used are in good working condition and later proceed to the veroboarding work (the permanent construction).

### 3.1 METHODOLOGY

The refrigerator door alarm with automatic reclosing system comprises of different units which are all coupled together by a micro controller.

These units are;

i. The Power Supply Unit
ii. The Alarm Unit
iii. The Motor Driver Unit
iv. The DC Motor Unit

## 3.2 DESIGN ANALYSIS

This project is subdivided into six main units as shown in Fig 3.1. It consists of the power supply, the door monitoring unit, the micro controller unit, the alarm unit, the motor driver unit, and the DC motor.

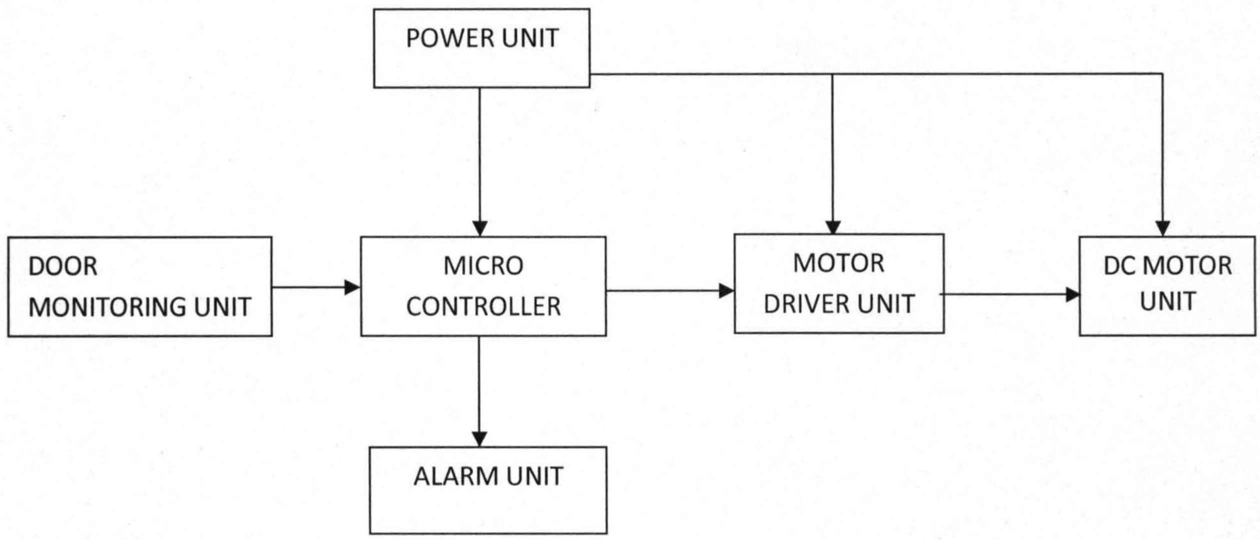


Fig 3.1 Block diagram of Refrigerator Door Alarm system

### 3.2.1 Power Supply Unit

Most electronic devices and circuits require a DC source for their proper operation, and a typical regulator to fix the voltage and make it constant for the load.

The power supply unit comprise of the following listed below:

i. Voltage regulator

ii. Battery

i. **Voltage Regulators**

A voltage regulator is an electrical regulator designed to automatically maintain design or may include negative feedback control loops. It may use an electromechanical mechanism or electronic components. Depending on the design, it could be used to regulate one or more AC or DC voltage.

Electronic voltage regulator is found in device such as computer power supplier where they stabilize the DC voltage used by the processor and other elements.

ii. **Battery**

This is a multiple of electrochemical cells of the same chemistry. Electrochemical energy storage in a cell is based on the conversion of chemical energy into electrical energy and vice versa. Each battery is characterized by a chemical reaction, which includes the exchange of electrical charges between ions. Electrical energy is gained through two separate electrode reactions; one electrode releases ions, the other electron absorbs them and current flows through the connected device [14].

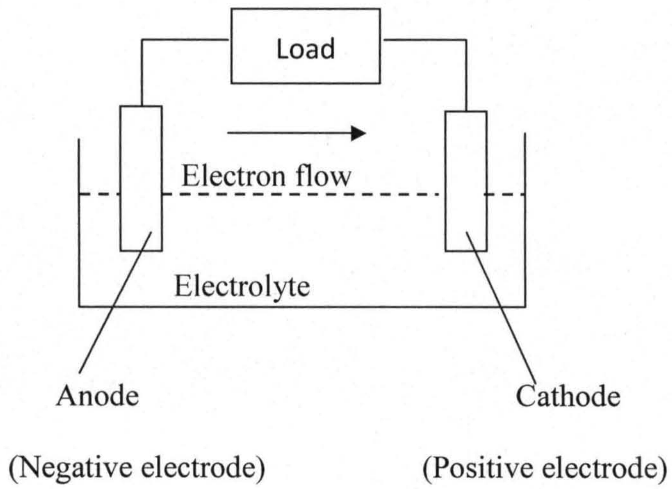


Fig 3.2: The schematic operation of an electrochemical cell

The basic components of a cell are the positive electrode, the negative electrode and the electrolyte. The electrodes consist of active materials that take part in the electrochemical reactions. During discharging, the negative electrode (e.g. a metal or an alloy) is called anode and is capable of being oxidized while the positive electrode (e.g. an oxide or a sulfide) is called cathode and is reduced. During charging, the positive electrode is oxidized and turns into the anode whereas the negative electrode is reduced and is turned into the cathode. The electrolyte must be a non-conductor for electrons in order to avoid self-discharge of the cell.

A battery consists of one or more cells that are electrically connected in series. The voltage of the battery is the individual cell voltage multiply by the number of the connected cells. When the battery is fully charged and in no-load condition, this voltage is called open-circuit voltage and is higher than the typical voltage during discharge (working voltage). The battery voltage at which the discharge is terminated is called end or cutoff voltage. Battery can be either primary or secondary.

i. **Primary Cell:** A primary battery is one that can convert its chemicals into electricity only once and then must be discarded. The most common form of the primary cell is the Leclanche cell, invented by the French chemist, Georges Leclanche in the 1860s. It is popularly called a dry cell or flashlight battery. The Leclanche cell produced about 1.5V. Another widely used primary cell is the Zinc-mercuric oxide cell, more commonly called a mercury battery [14].

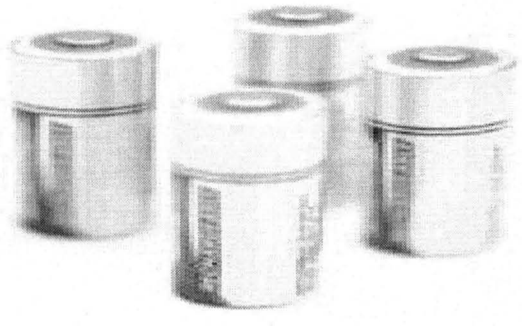

Fig 3.3: Primary Cell Battery

ii. **Secondary Cell:** A secondary battery has electrodes that can be reconstituted by passing electricity back through it; also called a storage or rechargeable battery, it can be reused many times. The storage battery or secondary cell, which can be recharged by reversing the chemical reaction, invented in 1859 by the French physicist Gaston Plante. Plante's cell was cell a lead-acid battery, the type widely used today. The lead-acid battery, which consists of three or six cells connected in series, is used in automobiles, trucks, aircraft, and other vehicles. Its chief advantage is that it can deliver a strong current of electricity for starting an engine; however, it runs down quickly. A lead-acid battery has a useful life of about four years; it produces about 2V per cell [14].

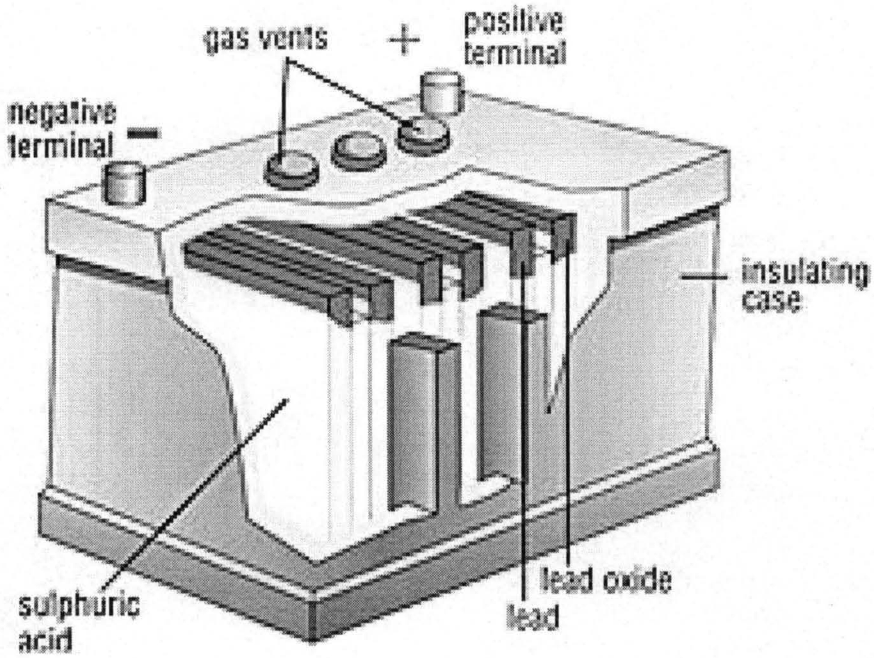


Fig 3.4: Secondary Cell Battery

The complete circuit of the power unit is shown Fig 3.5:

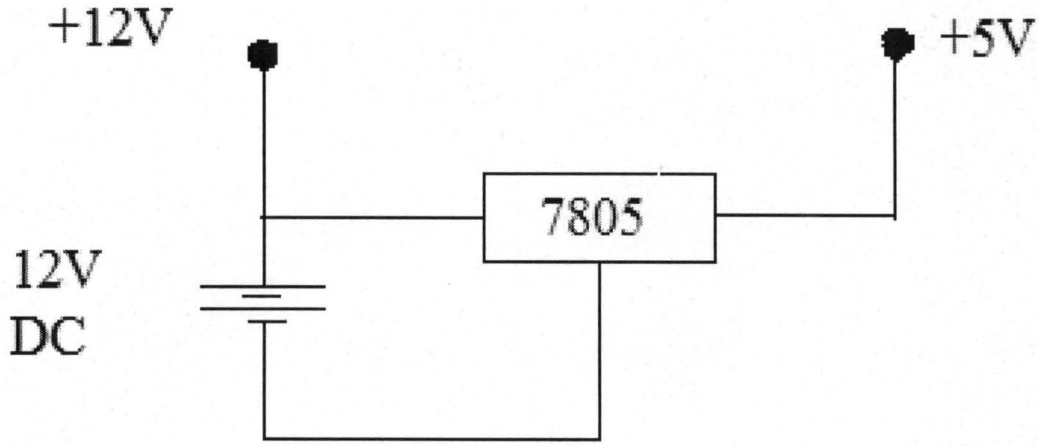


Fig 3.5 Power Supply

### 3.2.2 Microcontroller Unit

This unit is sub divided into two i.e. the software part and the hardware part:

#### i. Software Design

Keil Software was used to provide the software development tools for 8051 based microcontrollers. With the Keil tools, it was possible to generate an HEX file from an Assembly language commonly used in embedded applications for virtually every 8051 derivative. The supported microcontrollers are listed in the μ-vision as shown Fig 3.6.

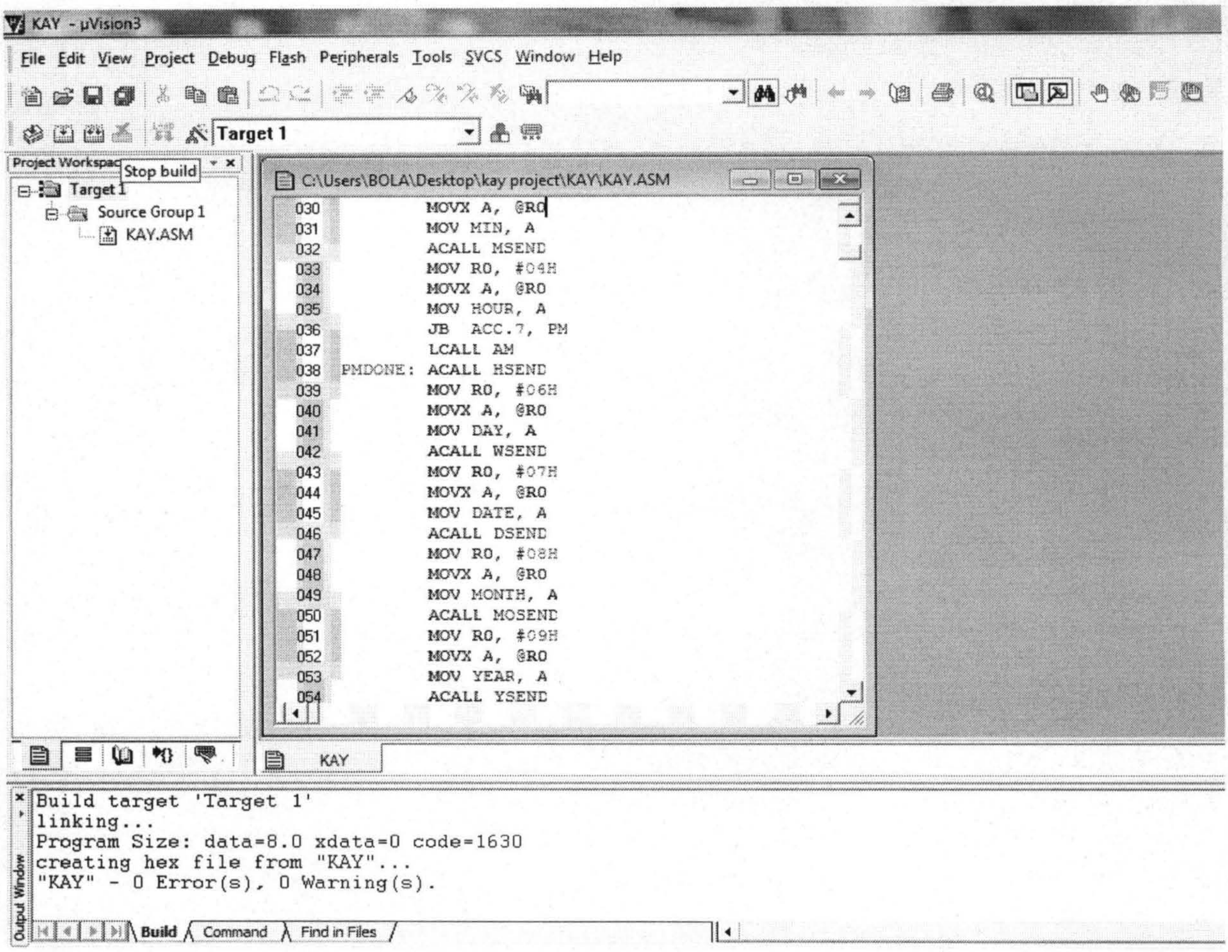


Fig 3.6 Keil Software program used to provide the software development tools for 8051 based microcontrollers.

This software was used to simulate the code and be sure the code is free from syntax error and logic error and finally help in generating the HEX file which was burn on the microcontroller chip to perform the control function in this project e.g. timing for both the buzzer and the DC motor.

### ii. Hard ware Design

A microcontroller is a single chip that contains the processor (the CPU), non-volatile memory for the program (ROM or flash), volatile memory for input and output (RAM), a clock and an I/O control unit. Also called a "computer on a chip," billions of microcontroller units (MCUs) are embedded each year in a myriad of products from toys to appliances to automobiles. [2, 3] For example, a single vehicle can use 70 or more microcontrollers. Fig 3.7 depicts a general block diagram of microcontroller.

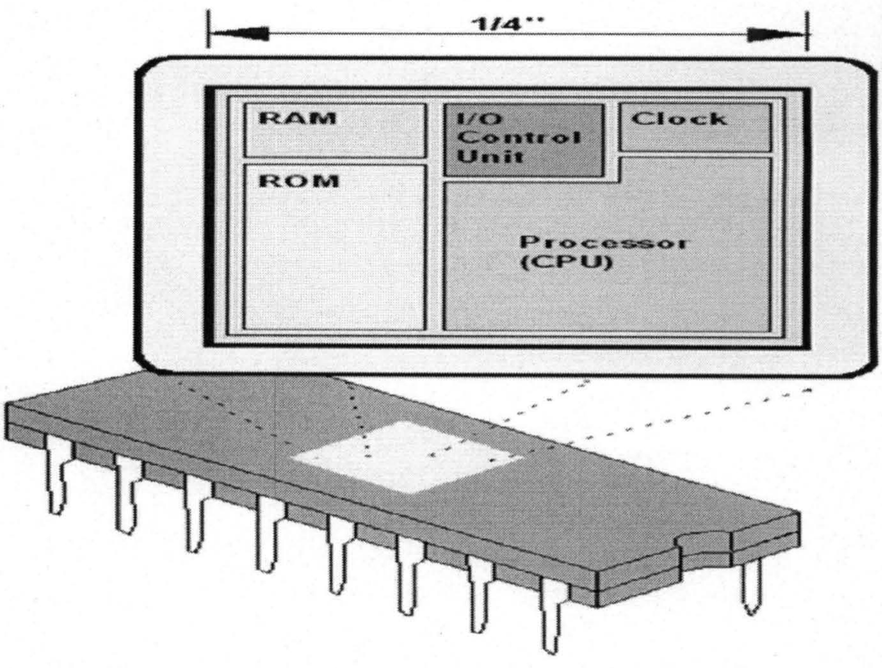


Fig 3.7 the Microchip

- **AT 89S52 Microcontroller**

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 8051 instruction set and pin out [2, 3]. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller, which provides a highly flexible and cost-effective solution to many, embedded control applications. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry [2,3]. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes.

The hardware is driven by a set of program instructions, or software. Once familiar with hardware and software, the user can then apply the microcontroller to the problems easily. The pin diagram of the 8051 shows all of the input/output pins unique to microcontrollers:

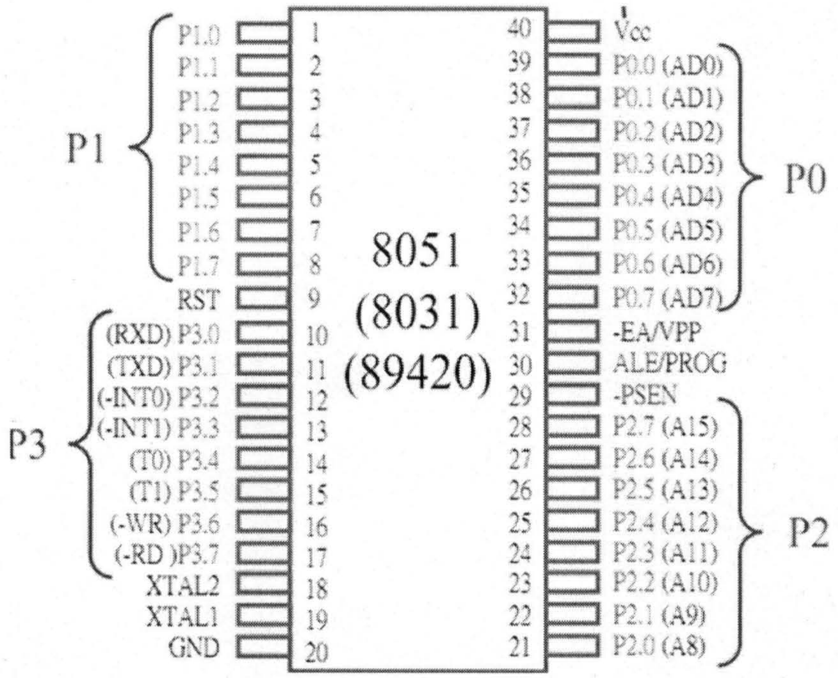


Fig 3.8: 8051 Microcontroller and its pins

The following are some of the capabilities of 8051 microcontroller.

1. Internal ROM and RAM
2. I/O ports with programmable pins
3. Timers and counters
4. Serial data communication

The 8051 architecture consists of these specific features:

1. 16 bit PC & data pointer (DPTR)
2. 8 bit program status word (PSW)
3. 8 bit stack pointer (SP)
4. Internal ROM 4k
5. Internal RAM of 128 bytes.

6. 4 register banks, each containing 8 registers
7. 80 bits of general purpose data memory
8. 32 input/output pins arranged as four 8 bit ports: P0-P3
9. Two 16 bit timer/counters: T0-T1
10. Two external and three internal interrupt sources Oscillator and clock circuits.

The assembly language program written for this project was to:

1. Start timing to 30 seconds when it senses that the refrigerator is being left open.
2. Start timing to 30 seconds again after the alarm sounds and the refrigerator is still open.

Fig 3.9 indicates the flow chart of the micro processor activity.

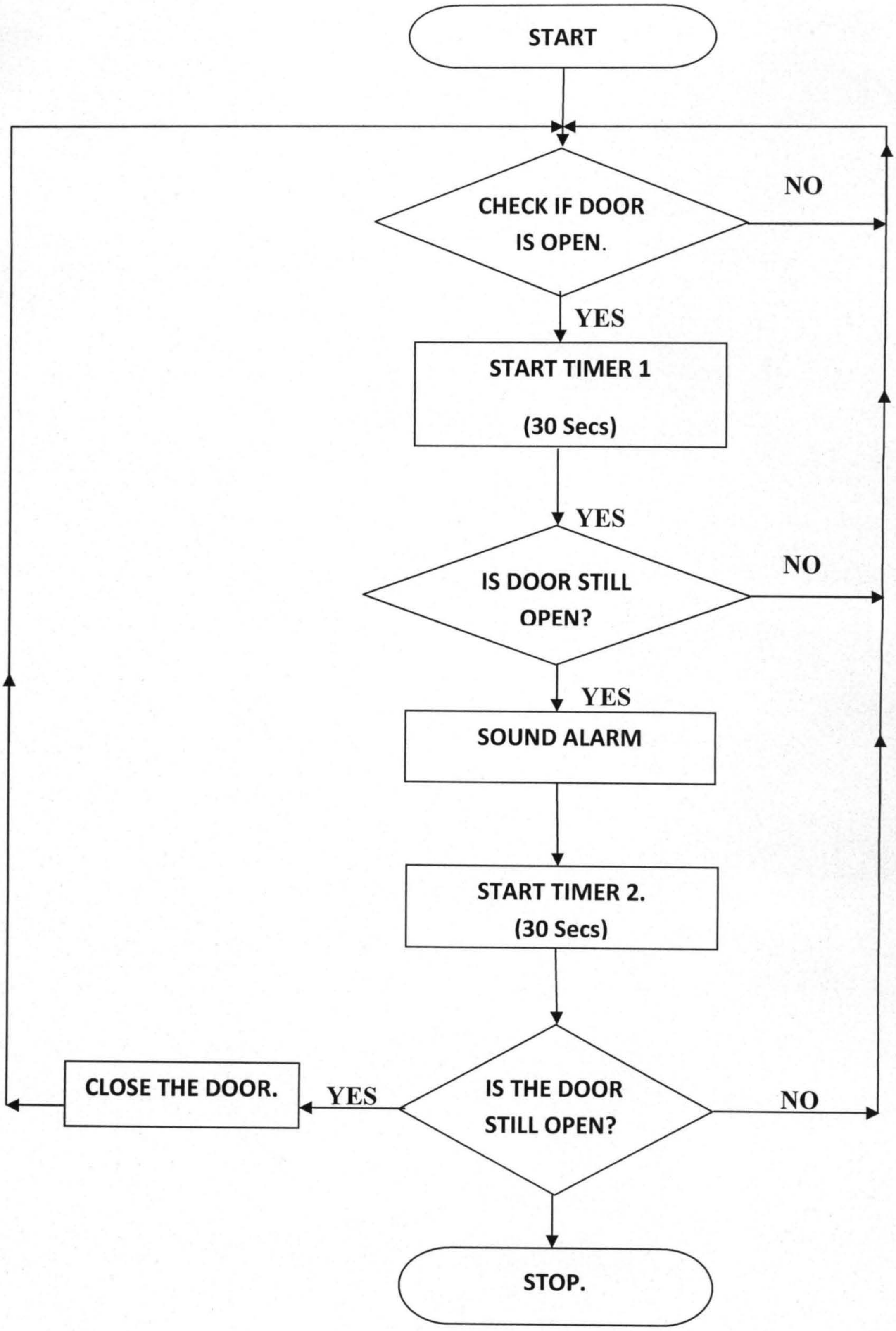


Fig 3.9 showing the flow chart of the micro processor activity

### 3.2.3 Door Monitoring Unit

The primary component in this unit is the bump switch. The bump switch has three terminals; the common, normally open and normally closed. When the switch is in-activated, the common is connected to the normally closed and when the switch is activated, it is connected to the normally open and the normally open is interfaced with the micro controller which will indicate if the refrigerator door is left open or close.

### 3.2.4 Motor Driver Unit

This unit consists of the electromagnetic relays and switching transistors.

#### i. Principle of a relay

A relay is an electromagnetic device that when current flow through the coil a magnetic field is generated at the knob and attracts the terminal of the common to itself, it has five terminals as illustrated below:

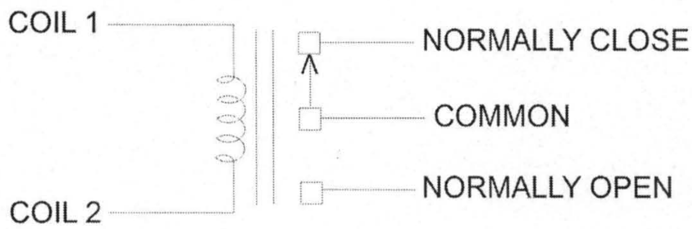


Fig 3.10 the Relay Circuitry

The common is usually connected to the normally close and only when current flows through the coil the common disconnect from the normally close and connect to the normally open and the switching time is around 300 milliseconds that the changes can hardly be notice.

### ii. Switching transistors

The coil of a relay have about 100 ohms resistance and 12V there by requiring a current of about 150mA which a switching transistor cannot allow, there is a need to cascade two transistors, when the 2N3906 is on the base of the D882 is pull high with the aid of the 10K resistor which will disallow current from flowing through the coil of the relay and when the transistor is off the base of D882 is pulled to the ground which allow current to flow through the coil of the relay, the two condition are determine by the microcontroller and the circuit diagram is shown in fig 3.11.

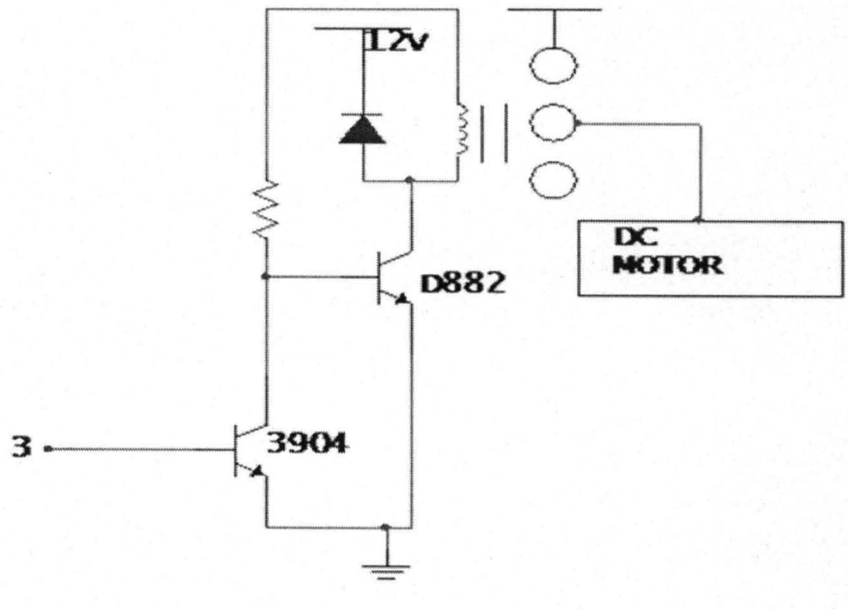


Fig 3.11 switching transistors in a cascade (3 representing Pin 3)

### 3.2.5 Motor Unit

Considering the operation of this device, bidirectional DC motor was used. A bidirectional DC motor is a motor that has the ability to rotate in both direction i.e.in clockwise direction and also in anti clockwise direction, this is done by reversing the polarity of the supply voltage which was achieved using the electromagnetic relay. Fig 3.12 shows the complete circuit diagram of the entire design.

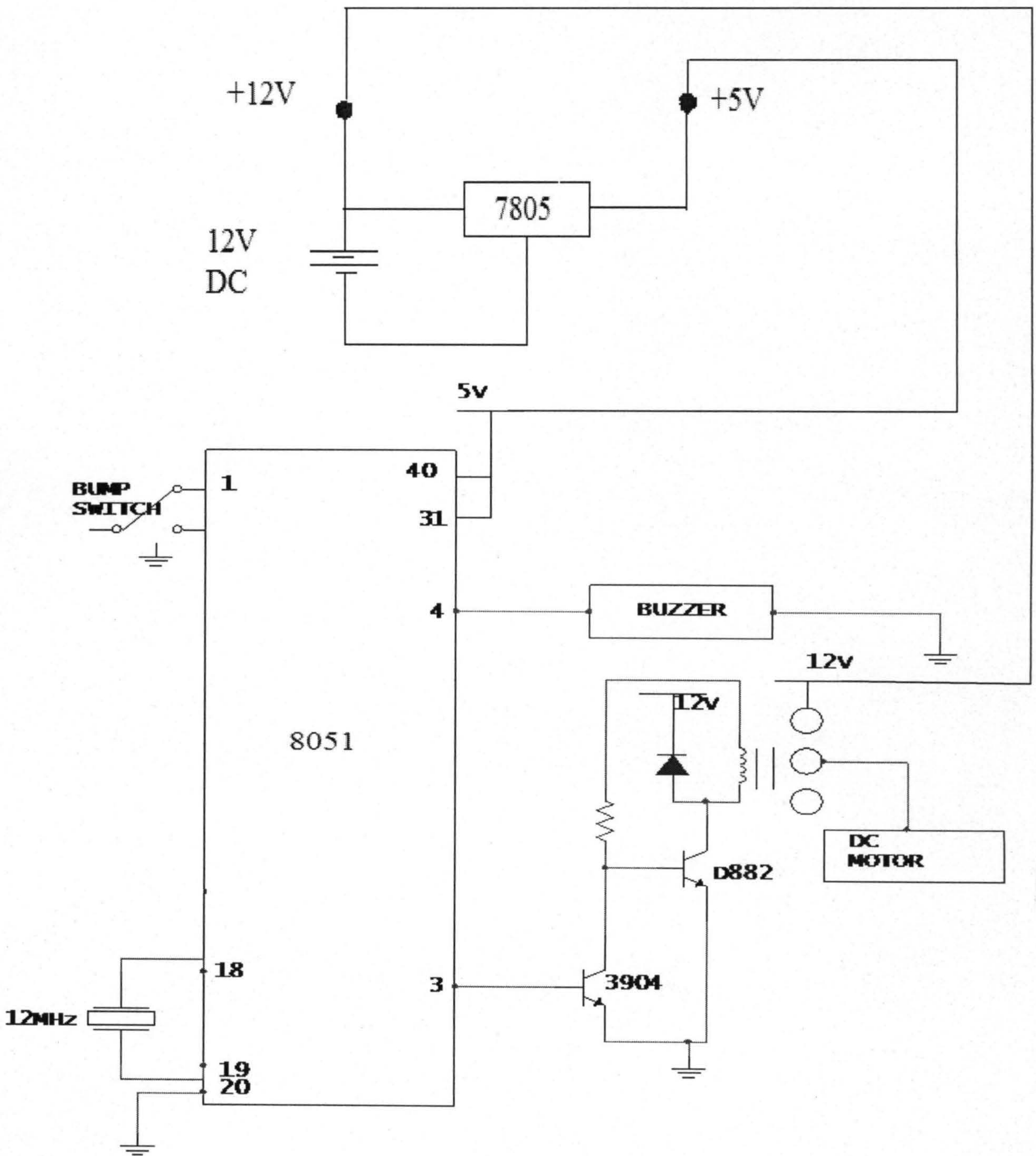


Fig 3.12 the Complete Circuit System of the Refrigerator Door Alarm System

# CHAPTER FOUR

## TESTING

### 4.0 CONSTRUCTION

The project was first design on a breadboard and later transferred to a veroboard (permanent construction) achieving the desired aims and objectives, construction testing and accuracy were also tested on each section. During the construction process each section was tested with a multimeter and was found in a good working condition.

### 4.1 PRECAUTIONS

#### 4.1.1 Soldering Precautions

The construction was carried out with care. The precautions taken during the soldering were:

i. The tip of soldering iron was kept clean with the help of a file from time to time.
ii. The solder wire was of smaller thickness.
iii. Extra solder was not used in order to avoid and prevent component damage as a result of excessive heat on the components due to the heat from the soldering iron.
iv. The leads of the components were kept clean before soldering, with the use of sand paper.

### 4.1.2 Components Precaution

i. I.C should not be heated much while soldering; too much heat can destroy the I.C. For safety and ease of replacement, the use of I.C socket is suggested.

ii. While placing the I.C pin no 1 should be made sure at right hole.

iii. Opposite polarity of power can destroy I.C so, check the polarity before switching ON the circuit. One should use diode in series with switch for safety since diode allows flowing current in one direction only.

## 4.2 TESTING

At every stage of construction of the project, there was constant need for measurement of certain quantities to ensure that they conformed to the required/expected values, starting from the power supply, the bump switch, the microcontroller and the motor.

For the testing of the project the most indispensable tool used was the multi-meter. A digital multi-meter (DMM) was used for measurement of voltages resistances and continuity to be sure of perfect connection.

The refrigerator was open and left for 30 seconds, the alarm sounded and after another 30 seconds, the refrigerator automatically closed itself. This was done severally and the prototype proved to be in a good working condition.

The power supply was tested to ensure accurate supply of 12V and 5V voltage. The output of the voltage regulator was also tested and a value of 12.01V and 4.99V respectively was read.

## 4.3 DISCUSSION OF RESULTS

It was noticed that some trials were smooth while some were not (in the process of automatically closing the refrigerator), this is as a result of fluctuation of power supply which in turn vary the current flowing in the circuit and also the tolerance due to component and also some construction error such as soldering packaging etc.

# CHAPTER FIVE

## 5.1 CONCLUSION

An energy saving device has been designed, constructed and tested. The final prototype meets all specifications as described in this report. This project provides useful information on energy wastage minimization and control in a refrigerator provided that it is used properly and only when the components are in optimal condition.

The product design is low maintenance and very compact. The project was designed within the specific time line set initially.

## 5.2 RECOMMENDATION

In light of the successful design, construction and testing of an energy device, the research recommends the following:

i. The energy conservation device should be adopted for use in homes and any environment deemed fit for its use.
ii. More energy conservation devices should be designed for use in other appliances and applications where energy conservation is of great need and benefit.
iii. There is room for further improvement to achieve better performance.

## REFERENCES


1. Digital Logic Design, B. Holswortu and Ric Wood, 4th Edition, Oxford Newnes, 2002, pp 287.
2. The 8051 micro controller, Kenneth .J. Ayala.
3. The 8051 micro controller and embedded systems, Muhammad Ali Mazidi.
4. Engineering Design: A material and processing approach, George E. Dieter, 3rd Edition, Mc Graw-Hill, Boston, pp 123, 2000.
5. United States Environmental Protection agency, 1997. Energy conservation
6. Engineering Design: A material and processing approach, George E. Dieter, 3rd Edition, Mc Graw-Hill, Boston, 2000.
7. Energy Focus!: http://www.learnaboutenergy.org/focus/part1.htm
8. Energy Quest: http://www.energyquest.ca.gov
9. Energy Resource Materials for K-12:http://www.need.org/guides.htm
10. Introduction to Energy: http://id.mind.net/~zona/mstm/physics/mechanics/energy/introduction/introduction.html
11. The Physics Zone: Work, Energy and Power: http://www.sciencejoywagon.com/physicszone/lesson/05work/workpower.htm
12. Types of Energy: http://redding.apogee.net/kids/allabout/kctype.htm
13. What is Energy?: http://www.eia.doe.gov/kids/whatsenergy.html
14. Wikipedia.org Online Encyclopedia 2011

APPENDIX

```
DOOR EQU P1.0
MOTOR EQU P2.1
ORG MAIN
ORG 000BH
                 DJNZ RO, CCA
                 SETB BUZZER
                 CLR MOTOR
                 JNB DOOR,    $
                 ETB MOTOR
                 RETI
CCA:             MOV TLO, #00H
                 MOV TH0, #00H
                 SETB TRO
                 RETI
MAIN    : MOV TMOD, #00000001B
                     MOV TL0, #00H
                     MOV THO, #00H
                     MOV IE,     #10000010B
MAIN 1: CLR DOOR
                     JB DOOR,  $
                     ACALL DELAY
                    JB DOOR, MAIN1
                    CLR BUZER
                    MOV RO, #255
                    SET B    TRO
                    JNB DOOR, $
                   SET B BUZZER
                   AJMP MAIN1
DELAY:      PUSH 00H
                   PUSH O1H
                   PUSH 02H
                   MOV 00H, #255
BOLA2:      MOV 01H, #255
BOLA 1:     MOV 02H  #255
DJNZ 02H, $
                   DJNZ 01H  BOLA1
                   DJNZ  00H, BOLA 2
                   POP 02H
                   POP 01H
                   POP 00H
                   RET
DELAY 1:  PUSH 00H
                    PUSH  01H
                     PUSH  02H
                     MOV   00H, #05
FRANCA2:MOV  01H, #255
FRANCA1:MOV  02H #255
                   DJNZ 02H, $
                   DJNZ 01H,  FRANCA1
                    DJNZ 00H,      FRANCA2
                    POP  02H
                    POP  01H
                     POP OOH
                     RET
                     END
```