DESIGN AND CONSTRUCTION OF CARD ACTIVATED DIGITAL CODELOCK SYSTEM

BY

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(EE/06/1098)

A PROJECT REPORT SUBMITED TO THE DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNLOLOGY, MODIBBO ADAMA UNIVERSITY OF TECHNOLOGY YOLA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF ENGINEERING.

DECEMBER, 2012

DECLARATION

I hereby declare that this project report was written by me and it is a record of my own research work. It has not been presented before in any previous application for a bachelor's degree. References made to published literature have been duly acknowledged.

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The above declaration is confirmed

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CERTIFICATION

This project entitled "**Design and construction of card activated digital code lock system"** by **Jinkai, Haruna (EE/06/1098)** meets the regulations governing the award of the bachelor's degree of the Modibbo Adama University of Technology, Yola and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

To the Almighty God for His never-ending mercies and numerous blessings during the course of my study and in particular, His profound wisdom, great understanding and knowledge which has been without a doubt endless.

ACKNOWLEGDEMENTS

ABSTRACT

The design and construction of card activated digital code lock system using microcontroller (AT89C2051) technology was carried out herein. The system uses a smartcard to have access to the main system unit, where the user can type in the lock code (12345#) via a keypad, followed by the master code (1234567890#), the new code (5 digit), then # which will finally deactivate the lock. The user also have the option of bypassing (override) the main system unit through a switch, then slotting the smart card which will subsequently deactivate the lock.

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LIST OF ABBREVIATIONS AND SYMBOLS

D.C--------Direct current

A.C --------Alternating current

V_{min} ----------Minimum D.C output voltage

V_{max} ---------Maximum D.C output voltage

Vcc------------Supply Voltage

LCD----------Liquid Crystal Display

PEROM--------Programmable Erasable Read Only Memory

CMOS-----------Complementary Metal Oxide Semiconductor

CPU---------------Central Processing Unit

IC---------------Integrated Circuit

RAM-------------Random Access Memory

ALU---------------Arithmetic and Logical Unit

Ω-------------------Ohms

V--------------------Volt

μf--------------------micro Farad

k----------------------Kilo

QTY------------------Quantity

N----------------------Naira

CHAPTER ONE: INTRODUCTION

1.1   Background of Study

The oldest known lock was found by archeologist in the Khorsabad palace near Nineveh [1]. It was a forerunner to a pin tumbler type of lock used by the Egyptians in 1200AD. However, these locks require a lot of precise moving parts to function correctly. In the real world, code locks are used frequently to secure personal belongings. Conventionally, mechanical locks have being made using physical rotating discs or cams, which are specially crafted to interact with some type of locking mechanisms.

The development of science and technology, and the emergence of computers and programmable microchips have lead to the creation of digital programmable code locks which has many advantages over its mechanical predecessors. In mans search for maximum security, he developed several techniques so as to improve on the security access systems, which lead to the implementation of both electromechanical and digital locking devices.

1.2   Problem Statement

Security has been the prime concern in our daily life. Everyone wants to be as secured as possible because of the high rate of burglary activities and insecurity in the society. Code locks makes the task of access management more flexible and easy to configure. Mechanical locks require new keys to be manufactured every time a user compromises his personal keys or a user with access privileges is added. A lock also has to be replaced if any of the keys is lost. Situations like this may occur when people relocate from one house hold to another, or when they change offices. As we all know, even in this university, theft is especially rampant so much as that most of the students and lecturers have been a victim of lost properties due to theft at least

once or twice. For the aforementioned reasons, I have decided to undertake this project 'Card Activated Digital Code lock system' which have been undertaking with the aim of providing a solution to the incessant cases of theft and burglary in the society.

1.3   Objectives

The main aim of this project is to design and implement a Card Activated Digital Code Lock System using microcontroller (AT89C2051).The system will comprise of small electronic unit with a 4×3 numeric keypad and a 2×16 LCD. The objectives of the project are listed below;

❖ Design and simulate card activated code lock system.

❖ Implement a system that will add security to existing door lock systems.

❖ To use an access card to gain access to main system unit.

❖ To reduce the issue of burglary and insecurity to a minimum level.

❖ To usher the user the privilege to change password at any time needed, and

❖ To reduce the issue of carrying keys or losing them anyhow.

1.4   Significance of the Study

The beneficiary aspect of these findings is very versatile, the general public as whole will benefit from this project if only they can afford to buy it, because every individual is very cautious of his or her valuable belongings and would want to secure it by creating secrete access code to it. Apart from normal home use, commercial enterprise such as banks, hotels, investment house, private companies etc would benefits from this project.

There are many electronic door locking systems in the world. There are those that use electronic components including ICs and transistors, logic gates and/or other pre-made components. There is one that uses eight-position DIP switches and other components to make

the combination lock. There are others that use more complicated and more sophisticated components.

What set this project apart from the others is that it has memory and can interact with the user based on user inputs. The system allows for time outs if the user does not enter the combination fast enough and more importantly, locks out if an incorrect code combination is entered more than three times in a row. A mechanical lock has no memory so cannot lock out unauthorized user who is just guessing a large number of combinations.

Secondly, the programmable features of the system and presence of the card interfaced increase its security and offers room for code modification without making any physical modifications to the system. There are also many improvements that can be added to the system such as biometric identification devices.

1.5   Scope of the project

The extent to which this project will cover is to provide maximum security for valuable substances or materials as to what will be achieved is a card activated code lock system that will grant an authorized user to have access to the system. The lock is an electric latch that is protected by a password stored in a microcontroller. What will be achieved is as follows:

1. Create an electronic lock that has a 0-9 keypad for entering a password.
2. If the entered password is correct unlock the door.
3. Password will consist of only 5 digits.
4. Password can be changed by pressing a special button (#), then entering an old password, then a new password.
5. To be implemented using elements of digital design, microprocessors are not allowed.

6. To be simulated using a computer software (e.g. proteus circuit design software).

CHAPTER TWO: LITERATURE REVIEW

2.1   INTRODUCTION

Security systems nowadays are evolving rapidly. They cover most of the area of controlling and managing properties where safety issue is of top priority. The development of security system brought harmony to the advancement of technology. Considering today's economic context, the design of these control system is of great impact in terms of productivity cost.

There have been different types of security system, and there various modes and principle of operation. These systems that have been brought about through the trends and development of science and technology have one or two drawbacks which make them inefficient. Therefore, have taking these opportunity and challenge as an undergraduate to study or research on each system and its drawbacks in other to design a better security system with a high efficiency which can replace its predecessor, these system is called "Card Activated Digital Code lock System".

2.2   REVIEW OF RELEVANT WORK

There have been projects in the past that were done which posses several similarities to this particular project. These various security systems that were designed have various setbacks and disadvantage in their operation which makes them inefficient to tackle present security challenges faced in the society. Therefore, studies have been carried on this short comings and finding ways to eliminate such by carrying out several modification in the design of such systems. If possible, the concepts use in the designing of two or three systems can be harness in other to design or produce a single system which can now have a higher efficiency in its output.

These projects that were previously designed below are not actually the same, but the concept of designing several of these projects or systems is being utilized in other to develop and design this project called; " Card Activated Digital Code lock System".

2.3   TRENDS ON CODELOCK SYSTEMS

2.3.1   Combination lock system

A combination lock is a type of lock in which a sequence of numbers or symbols is used to open the lock. The sequence may be entered using a single rotating dial which interact with several disc or cams, by using a set of several rotating disc with inscribed numerals which directly interact with the locking mechanism, or through an electronic or mechanical keypad. A type ranges from inexpensive three-digit luggage locks to high security safes.

IMPROVEMENTS ON COMBINATION LOCK SYSTEMS.

Microcontroller Based Digital Combination Lock System.

The other project that has been developed is [2] Microcontroller Based Digital Combination Lock system. It is a password based door security system using microcontroller. The system comprises of a keypad connected to an 8 bit microcontroller AT89C2051. The microcontroller monitors the keypad such that if a user enters the password it will check the entered password and match it with the stored password in the memory and if the password corresponds with the stored one, the microcontroller will switch on the device.

2.3.2 Programmable Number Lock System for devices.

According to Programmable number lock system is a high security number lock system that can be used to lock electronics devices [3]. The present system is very user friendly. This

system is a combination of software and hardware at its best. Microcontroller 8051 is used for the interfacing of this system. In the present design, the system can activate or deactivate a device. Each device is locked using a 4 digit code (password), the code can be set as per the user's desire, hence the name "Programmable" for this device to be activated (unlocked), the user should enter the code that had been entered when the device was locked. In case the user enters the wrong code a silent alarm will be activated. The system has three units which are keypads, display units and control unit.

IMPROVEMENTS ON PROGRAMMING NUMBER LOCK SYSTEM   FOR DEVICES.

The improvements in programable number lock system for devices are:

Electronic Code Lock for devices Using (AT89C51).

With reference to an electronic lock or digital lock is a device which has an electronic control assembly attached to it [4]. They are provided with an access control system. This system allows the user to unlock the device with a password. The password is entered by making use of a keypad. The user can also set his password to ensure better protection. The major components include a keypad, LCD and the controller AT89C51 which belong to the 8051 series of microcontrollers. This article describes the making of an electronic code lock using the 8051 Microcontroller. This system can be used for both electronic devices and access doors.

The eight Digit Code lock for Appliances Switching

The code lock is useful for appliances using requiring exclusive or authorized use bi those who know the preset code [5]. The circuit doesn't require additional AND or NOT gate

operations at the output. It uses two pairs of 4-way DIP switches. The code is set using DIP switches, DIP3 and DIP4. Then these two switches are hidden inside the assembly. With DIP3 and DIP4, up to 256code combinations are possible. The unlocking code is set by the user using DIP switches. DIP1 andDIP2, which is compared with the preset code entered earlier via DIP3 and DIP4. If the two codes match, transistor T1 conducts.

The codes are compared using two cascaded 4-bit magnitude comparator IC's (IC1 and IC2). If the input nibble present at DIP1 matches with preset DIP3 nibble, output pin6 of IC1 (connected to input pin3 of IC2) goes high. Now if nibble present at DIP2 matches with the preset nibble at DIP4, pin6 of IC2 also goes high. This high output drives transistor T1 and the appliances turns on via relay contacts. The system does not make use of programmable chip.

2.3.3 Electronic Door Lock System.

An Electronic door lock (more precisely an electric lock) is a locking device which operates by means of electric current [5]. Electric locks are sometimes stand-alone with an electronic control assembly mounted directly to the lock. More often, electric lock is connected to an access control systems.

Advantages of electronic lock systems include:

➢ Key control: where keys can be added and removed without re-keying the lock cylinder.

➢ Fine access control: where the time and place are factors.

➢ Transaction logging: where activity is recorded

Design Operation:

Electric locks use either magnets, solenoids or motors to actuate the lock by either supplying or removing power. Operating the lock can be as simple as using a switch, for example an apartment intercom door release, or as complex as a biometric based access control system.

Few types of electric locks include:

i. Magnetic lock (mag lock)[6].

This is a large electro-magnet that is mounted on the door frame and a corresponding armature is mounted on the door. When the magnet is powered and the door is closed, the armature is held fast to the magnet. Mag locks are simple to install and are very attack resistant.

Disadvantages of mag lock include:

➢ Improperly installed or maintained mag lock can fall on people, and also one must unlock the mag lock to both enter and leave. This has caused fire marshals to impose strict codes on the use of mag locks and the access control practice in general.

➢ Lag time: lag time is the delay in releasing as the collapsing magnetic field is not instantaneous. These lag time can cause a user to walk into the door.

➢ Finally, mag locks by design fail unlocked, that is if power is removed they unlock. And these could be a serious problem where security is a prime concern.

➢ Additionally. Power outage could affect mag lock installed on fire listed doors, which are required to remain latched at all times

2.3.4 Card Activated Door Lock Systems:

Proximity Card Activated door Lock System

A proximity card or prox card is a smart card which can be "read" without inserting it into a reader device, as required by earlier magnetic stripe cards such as credit cards to use, the proximity card is held near an electronic reader unit for a moment [7]. The reader usually produces a "beep" or other sound to indicate the card has been read. Proximity card typically have a range of around 5cm (2 inches) for reading, so the user often leaves the card inside his or her wallet or purse, and simply holds the wallet or purse near the reader [8]. The term "Proximity Card" can refer to the older 125 kHz devices or the newer 13.56MHz.

Proximity cards can hold more data than a magnetic stripe cards for example an electronic funds balance, and so can be used for contactless payment systems. Many major banks are offering such cards.

Types of proximity card:

i. **Passive cards:** passive cards, the more widely used type which were described above, are powered by radio frequency signals from the reader device and so have a limited range and must be held close to the reader unit. They are used as keycards for access control doors in office buildings, library cards, contactless payment systems, and public transit fare cards.

ii. **Active Cards:** Active cards, sometimes called vicinity cards are powered by an internal lithium battery. They can have a greater range, up to 500ft, and are often used for applications where the card is read inside a vehicle such as security gates which open when a vehicle with the access card inside approaches, or automated toll collection. However, the battery eventually runs down, and the cards must be replaced after 5 to 7 years

How they works:

The cards and the reader unit communicate with each other through radio frequency fields of either 125 kHz, or 13.56MHz for the newer cards. By a process called resonant energy transfer.

Magnetic stripe Card door Lock system

A magnetic stripe card is a type of card capable of storing data by modifying the magnetism of tiny iron- based magnetic particles on a band of magnetic material on the card. The magnetic stripe, sometimes called swipe card or megastripe, is read by swiping past a magnetic reading head.

Magnetic recording on steel tape and wire was invented during World War II for recording audio. In 1950s, magnetic recording of digital computer data on plastic tape coated with iron oxide was invented. In 1960, IBM used the magnetic tape idea to develop a reliable way of securing magnetic stripes to plastic cards [9], under a contract with the US government for a security system. A number of international Organizations for Standardization standards, ISO/IEC7810, ISO/7811 and ISO/IEC 4909, now define the physical properties of the card, including size, flexibility, and location of the magstrip, magnetic characteristics, and data formats. They also provide the standards for financial cards, including the allocation of card numbers ranges to different card issuing institution.

In most magnetic stripe cards, the magnetic stripe is contained in a plastic-like film. The magnetic stripe is located 0.223 inches (5.56mm) from the edge of the card, and is 0.375 inches (9.52mm) wide. The magnetic stripe contains three tracks, each 0.110 inches (2.79mm) wide. Tracks one and three are typically recorded at 210 bits per inch (8.27 bits per mm), while tracks two typically has a recording density of 75 bits per inch (2.95 bits per mm). Each track can either contain 7-bit alphanumeric characters, or 5-bit numeric character.

All the projects mentioned above, use different types components, but they achieve the same purpose, i.e. preventing unauthorized users or intruders from getting access to valuable properties.

OTHER REVIEWS ON THE AUTHENTICATION TO ACCESS DOOR LOCK SYSTEM INCLUDES:

Security Tokens:

Another means of authenticating users is to require them to scan or "swipe" a security token such as a smart card or similar, or to interact a token with the lock [6]. For example, some locks can access some stored credentials on a personal digital assistant (PDA) using infrared data transfer methods.

Biometrics:

As biometrics become more and more prominent as a recognize means of positive identification, their use in security systems increases. Some new electronic locks takes advantage of technologies such as finger prints scanning, retina scanning and iris scanning and voiceprint identification to authenticate users.

So far, all these projects that are listed above has been the relevant reviews on related designs to the development of "card activated digital code lock system" as far as the present technology is concerned.

CHAPTER THREE: DESIGN AND CONSTRUCTION

3.1 INTRODUCTION

This chapter covers the design and construction of the entire system, the block diagram, theory of operation of the devices used and their implementation. The system is made up of various units and these units were designed separately.

3.2 Components and Material Selection

Several components were chosen based on their voltage capacity. These components and materials includes step down transformer, voltage regulator IC, filtering capacitors, resistors, rectifying diodes, keypad unit, smartcard slot, 16 X 2 LCD, microcontroller and an electric lock.

3.3 THE SYSTEM BLOCK DIAGRAM
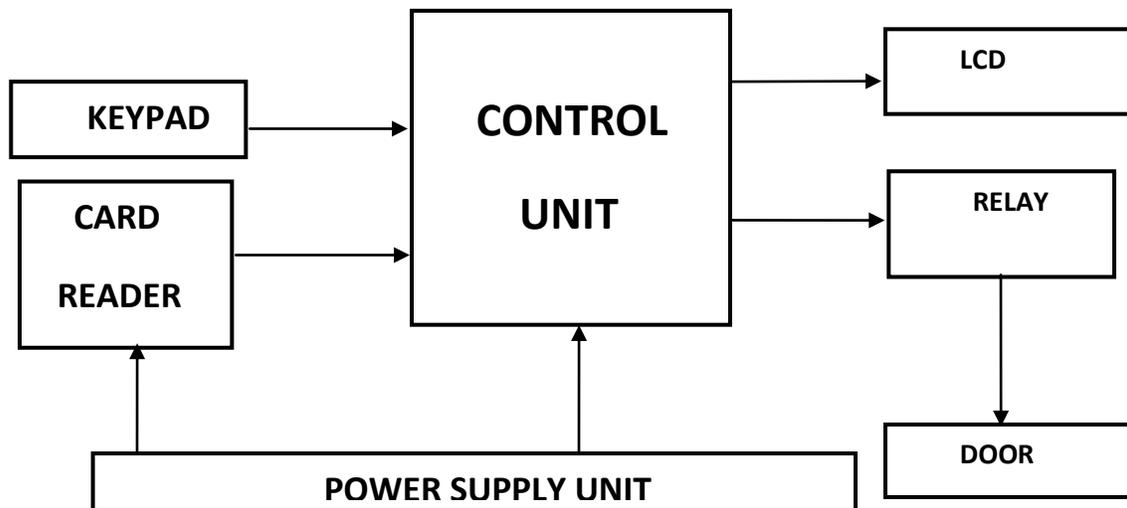
Figure 3.1 System block diagram

3.4   POWER SUPPLY UNIT

Most electronic devices require dc voltage supply to operate. Therefore, batteries are are verry useful in low power or portable devices but the operating time of such devices is limited unless the batteries are recharged or changed regularly. The whole sytem unit uses a 5volt DC. A voltage regulator had been incorporated in this unit in order to eliminate variation of voltage with changing input current and to supply each unit with the required power.

Figure 3.2 the power supply diagram

Various sections of the power supply unit:

i   Transformer unit:

A transformer is an electrical device by means of which electric power in one circuit is transformed into electric power of the same frequency in another circuit. It can raise or lower the voltage in a circuit with corresponding increase or decrease in current respectively in this design. The transformer used in this design is a step down transformer 230v AC to 12v DC. The output is given by

Peak voltage, $Vpeak = \sqrt{2} \times Vrms$ ……………………………………………………………………………3.1

$=\sqrt{2} \times 12v$

$=16.97v$

ii   Rectification unit

A rectifier is an electronic device that converts an alternating current (AC) into a direct current (DC) through rectification process. in this project, a rectifier had been deployed. A **diode bridge rectifier** is an arrangement of four diodes in a bridge configuration that provides the same polarity of output for each polarity of input. When used in its most common application, for conversion of an alternating current (AC) input into direct current a (DC) output, a bridge rectifier provides full-wave rectification from a two-wire AC input, resulting in lower cost and weight as compared to a rectifier with a 3-wire input from a transformer with a center-tapped secondary winding.[10]

There are two (2) major types of bridge rectifiers;

1   Full-wave rectifier

2   Half-wave rectifier

A full-wave rectifier converts the whole input voltage waveform into one of constant polarity (i.e. either positive or negative) at its output by reversing the negative or positive part of the alternating current waveform.

In a half-wave rectifier, the waveform is in one direction giving either positive or negative half waveform of the alternating current. The half-wave rectifier can be achieved by

using a single diode in a single phase power supply which sometimes seems to be inefficient for power transfer.[10]

A full wave bridge rectifier of 5A was chosen for the capacity to support a load of 2A using   IN4001 diodes due to its rating. The D.C voltage rectified is given by

$$Vdc = \left(\frac{2}{\pi}\right) \times Vpeak \ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(3.2)$$

$$Vdc = \left(\frac{2}{\pi}\right) \times 16.97$$

$$=10.80\text{V}$$

iii   The voltage regulator IC (LM 7805)

The LM7805 monolithic 3-terminal positive voltage regulators employ internal current-limiting, thermal shutdown and safe-area compensation, making them essentially indestructible. If adequate heat sinking is provided, they can deliver over 1.0A output current. They are intended as fixed voltage regulators in a wide range of applications including local (on-card) regulation for elimination of noise and distribution problems associated with single-point regulation. In addition to use as fixed voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents. Considerable effort was expended to make the entire series of regulators easy to use and minimize the number of external components. It is not necessary to bypass the output, although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.
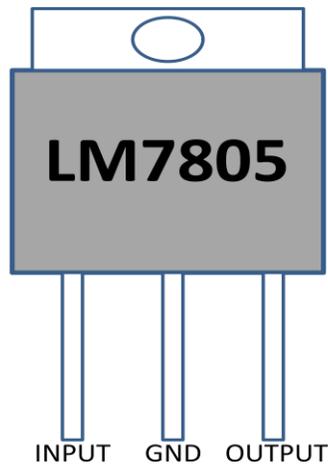
Figure 3.3 Regulator IC (LM7805)

To maintain a constant output level, the LM7805 is connected at the output of the filter. The percentage regulation of the power supply is given by:

$$\%\text{Regulation} = \left\{\frac{Vmax - Vmin}{Vmax}\right\} x \ 100 \ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \ (3.3)$$

Where,

V_{max} = maximum DC output voltage

V_{min} = minimum DC output voltage

Or can be put in this form:

$$\%\text{Regulation} = \left\{\frac{Vno \ load - V \ full \ load}{V \ full \ load}\right\} x \ 100 \ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \ (3.4)$$

iv   Filtering unit:

The main function of the filter is to minimize the ripple content in the rectifier output. The output of the rectifier circuit is pulsating. It has a d.c value and some a.c components called ripples. This output is not useful for driving sophisticated electric devices. These systems require a very steady d.c output. That is why the capacitor C_1 and C_2 are used in the power section.

The On-chip Oscillator

Pins XTAL1 and XTAL2 are provided for connecting a resonant network to form an oscillator. The crystal frequency is basic internal clock frequency. The maximum and minimum frequencies are specified from 1 to 24MHZ. Program instructions may require one, two or four machine cycles to be executed depending on type of instructions. To calculate the time any particular instructions will take to be executed, the number of cycles 'C', T = C*12d / Crystal frequency. Here, we chose frequency as 11.0592MHZ. This is because, baud= 2*clock frequency/ (32d. 12d [256d-TH1]). The oscillator is chosen to help generate both standard and nonstandard baud rates. If standard baud rates are desired, an 11.0592MHZ crystal should be selected. From our desired standard rate, TH1 can be calculated. The internally implemented value of capacitance is 33 pf.
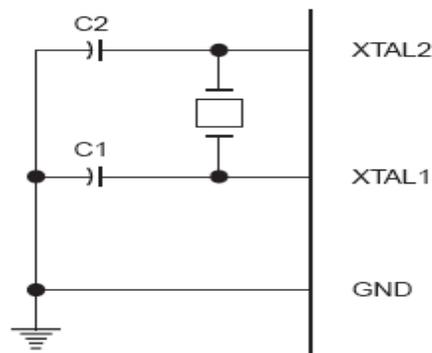

Figure 3.4   On-Chip Oscillators

There are some recommended values of resistors and capacitors for given set of frequency ranging from 4MHz to 12MHz gotten from the data sheet as shown in table 3.1

Table 3.1   Recommended values of R and C to run an oscillator

FREQUENCY	R	C
455KHz	3.0K	22 µF
2.0MHz	3.0K	25 µF
4.0MHz	3.3K	25 – 29 µF
8.0MHz	4.7K	30 – 33 µF
10 – 12 MHz	5.6K	33 – 35 µF

3.5   THE CONTROL UNIT

The control unit comprises mainly of an Atmel family microcontroller AT89C2051. The 8051 family of microcontrollers is based on an architecture which is highly optimized for embedded control systems. It is used in a wide variety of applications from military equipment to automobiles. The 8051 family of microcontrollers is available in a wide array of variations from manufacturers such as Intel, Philips, and Siemens. These manufacturers have added numerous features and peripherals to the 8051 such as I2C interfaces, analog to digital converters, watchdog timers, and pulse width modulated outputs. Variations of the 8051 with clock speeds up to 40MHz and voltage requirements down to 1.5 volts are available. This wide range of parts based on one core makes the 8051 family an excellent choice as the base architecture for a company's entire line of products since it can perform many functions and developers will only have to learn this one platform (Atmel data sheet).

The AT89C2051 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pinout. 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 Flash on a monolithic chip, the Atmel AT89C2051 is a powerful microcomputer, which provides a highly-flexible and cost-effective solution to many embedded control applications.

The basic architecture of AT89C2051 consists of the following features:

❖ An 8-bit ALU

❖ 32 discrete I/O pins (4 groups of 8) which can be individually accessed

❖ Two 16 bit timer/counters

❖ Full duplex UART

❖ 6 interrupt sources with 2 priority levels

❖ 128 bytes of on board RAM

❖ Separate 64K byte address spaces for DATA and CODE memory

One 8051 processor cycle consists of twelve oscillator periods. Each of the twelve oscillator periods is used for a special function by the 8051 core. The time required for any 8051 instruction can be computed by dividing the clock frequency by 12, inverting that result and multiplying it by the number of processor cycles required by the instruction in question. Therefore, if you have a system which is using an 11.059MHz clock, you can compute the number of instructions per second by dividing this value by 12. This gives an instruction frequency of 921583 instructions per second. Inverting this will provide the amount of time taken by each instruction cycle (1.085 microseconds).

3.5.1 Pin configuration
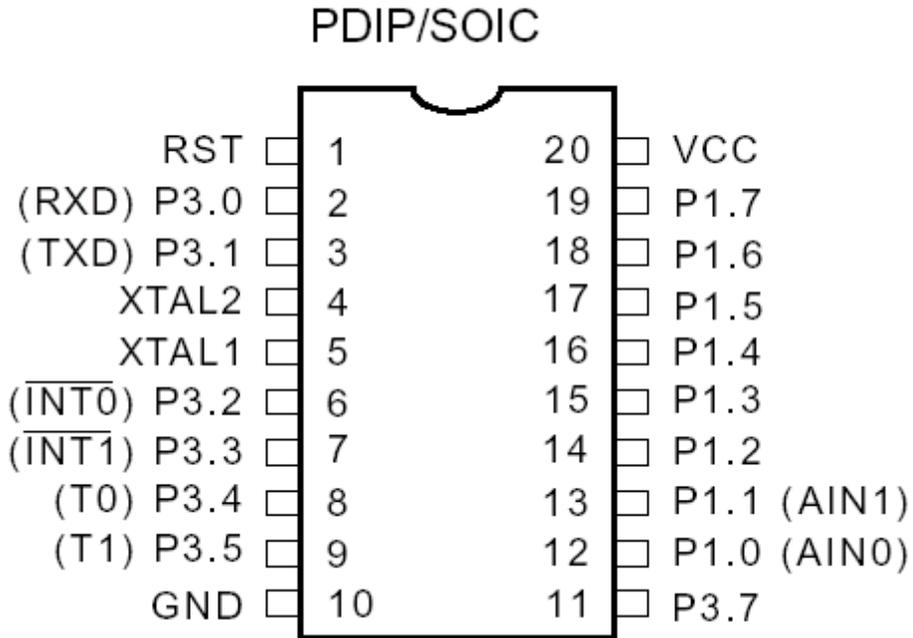
Figure 3.5 AT89C2051 Pin configuration

3.5.2 Pin description of AT89C2051

Table 3.2   AT89C2051 pin description

PIN	DESCRIPTION
VCC	Supply voltage.
GND	Ground.
Port 1	Port 1 is an 8-bit bidirectional I/O port. Port pins P1.2 to P1.7 provide Internal pullups. P1.0 and P1.1 require external pullups. P1.0 and P1.1 also serve as the positive input (AIN0) and the negative input (AIN1), respectively, of the on-chip

	precision analog comparator. The Port 1 output buffers can sink 20 mA and can drive LED displays directly. When 1s are written to Port 1 pins, they can be used as inputs. When pins P1.2 to P1.7 are used as inputs and are externally pulled low, they will source current (IIL) because of the internal pull-ups. Port 1 also Receives code data during Flash programming and program verification.
Port 3	Port 3 pins P3.0 to P3.5, P3.7 are seven bidirectional I/O pins with internal pullups. P3.6 is hard-wired as an input to the output of the onchip comparator and is not accessible as a general purpose I/O pin. The Port 3 output buffers can sink 20 mA. When 1s are written to Port 3 pins they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pullups. Port 3 also serves the functions of various special features of the AT89C2051 as listed below. Port 3 also receives some control signals for Flash programming and programming verification.
RST	Reset input. All I/O pins are reset to 1s as soon as RST goes high. Holding the RST pin high for two machine cycles while the oscillator is running resets the device. Each machine cycle takes 12 oscillator or clock cycles.
XTAL1	Input to the inverting oscillator amplifier and internal clock operating circuit.
XTAL2	Output from the inverting oscillator amplifier.

3.6 INTERFACING THE MICROCONTROLLER WITH THE LCD

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It uses very small amounts of electric power, and is therefore suitable for use in battery powered electronic devices. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. Without the liquid crystals between them, light passing through one would be blocked by the other. The liquid crystal twists the polarization of light entering one filter to allow it to pass through the other (LCD Data sheet,).

More microcontroller devices are using 'smart LCD' displays to output visual information. LCD displays designed around Hitachi's LCD HD44780 module, are inexpensive, easy to use, and it is even possible to produce a readout using the 8x80 pixels of the display. Hitachi LCD displays have a standard ASCII set of characters plus Japanese, Greek and mathematical symbols.

For an 8-bit data bus, the display requires a +5V supply plus 11 I/O lines. For a 4-bit data bus it only requires the supply lines plus seven extra lines. When the LCD display is not enabled, data lines are tri-state which means they are in a state of high impendence (as though they are disconnected) and this means they do not interfere with the operation of the microcontroller when the display is not being addressed.

3.6.1 The LCD requires 3 control lines from the microcontroller:

❖ **Enable (E):** This line allows access to the display through R/W and RS lines. When this line is low, the LCD is disabled and ignores signals from R/W and RS. When (E) line is high, the LCD checks the state of the two control lines and responds accordingly.

❖ **Read/Write (R/W):** This line determines the direction of data between the LCD and microcontroller. When it is low, data is written to the LCD. When it is high, data is read from the LCD.

❖ **Register select (RS):** With the help of this line, the LCD interprets the type of data on data lines. When it is low, an instruction is being written to the LCD. When it is high, a character is being written to the LCD.

Writing data to the LCD is done in several steps:

1. Set R/W bit to low

2. Set RS bit to logic 0 or 1 (instruction or character)

3. Set data to data lines (if it is writing)

4. Set E line to high

5. Set E line to low

Reading data from data lines (if it is reading)

1. Set R/W bit to high

2. Set RS bit to logic 0 or 1 (instruction or character)

3. Set data to data lines (if it is writing)

4. Set E line to high

5. Set E line to low
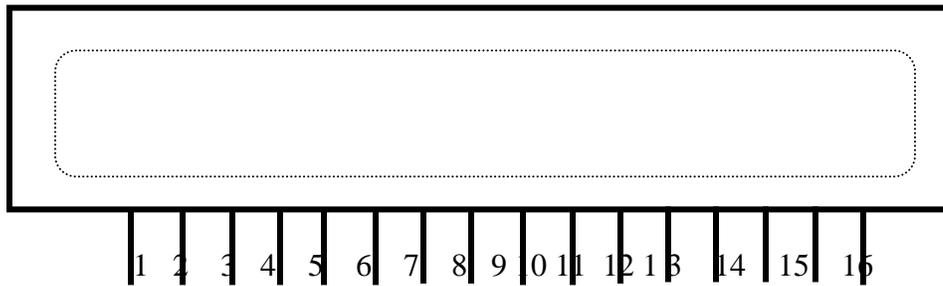
3.6.2 LCD Pin Description

Figure 3.6 LCD pin configuration.

3.6.3 LCD Pin Description

Table 3.3   LCD pin description

PIN	SYMBOL	FUNCTION
1	Vss	Power Supply(GND)
2	Vdd	Power Supply(+5V)
3	Vo	Contrast Adjust
4	RS	Instruction/Data Register Select
5	R/W	Data Bus Line
6	E	Enable Signal
7-14	DB0-DB7	Data Bus Line
15	A	Power Supply for LED B/L(+)
16	K	Power Supply for LED B/L(-)

In table 3.1, Vcc and Vss are supply pins and VEE (Pin no.3) is used for controlling LCD contrast. Pin No.4 is Rs pin for selecting the register, there are two very important registers inside the LCD. The RS pin is used for their selection as follows; If RS=0, the instruction command code register is selected, allowing the user to send data to be displayed on the LCD.

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R/W is a read or writes Pin, which allows the user to write information to the LCD or read information from it. R/W=1 when reading R/W=0 when writing. The LCD to latch information presented to its data pins uses the enable (E) pin. The 8-bit data pins, D0-D7, are used to send information to the LCD or read the contents of the LCD's internal registers. To display letters and numbers, we must send ASCII codes for the letters A-Z, and number 0 -9 to these pins while making RS=1.

3.7   INTERFACING MICROCONTROLLER WITH THE CARD SLOT (The Card Reader)

The card reader is an electronic access device that reads the data on a chip or data card specially designed to serve a given purpose. There are different types of card readers; these are magnetic stripe card reader, bar code reader, punched card reader and smart card reader. The card reader is part of the front end user interface. The card reader together with the card can be reconfigured to the to overide the data and to serve as a bridge between the user and the security system so as to increase the system's security.

This unit is made up of a smart card reader purposely reconfigured to suit the function to which it will perform. The unit gives a user access to the whole control unit. The role of the card reader is to create an interface between the user and the entire system. The card configuration is given in the figure below;
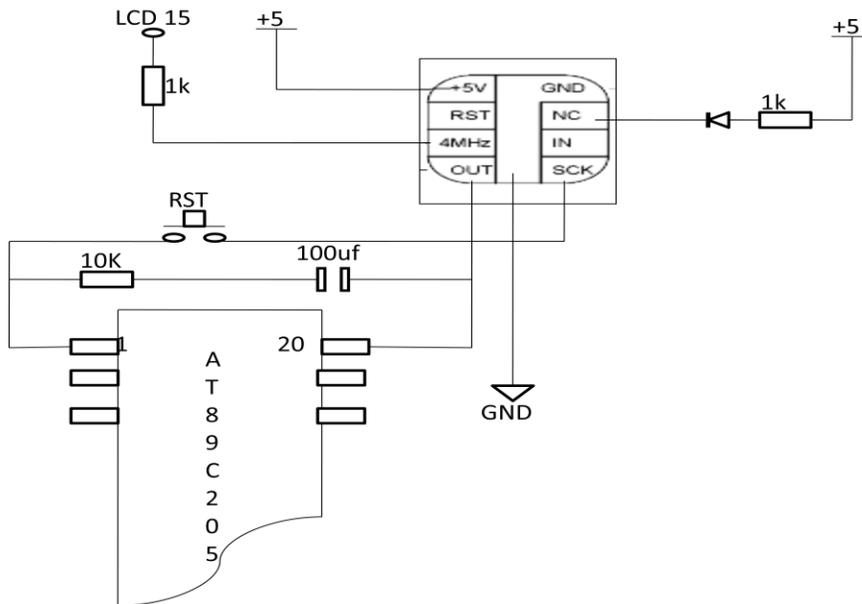
Figure 3.7 Card reader configurations

3.8 INTERFACING MICROCONTROLLER WITH THE KEYPAD (The 3×4 Keypad)

Key pads are part of HMI (Human Machine Interface) and they play important role in small embedded systems where human interaction or human input is needed. Matrix keypads are well known for their simple architecture and easy interfacing with any microcontroller. At the lowest levels, keyboards are organized in a matrix of rows and columns.
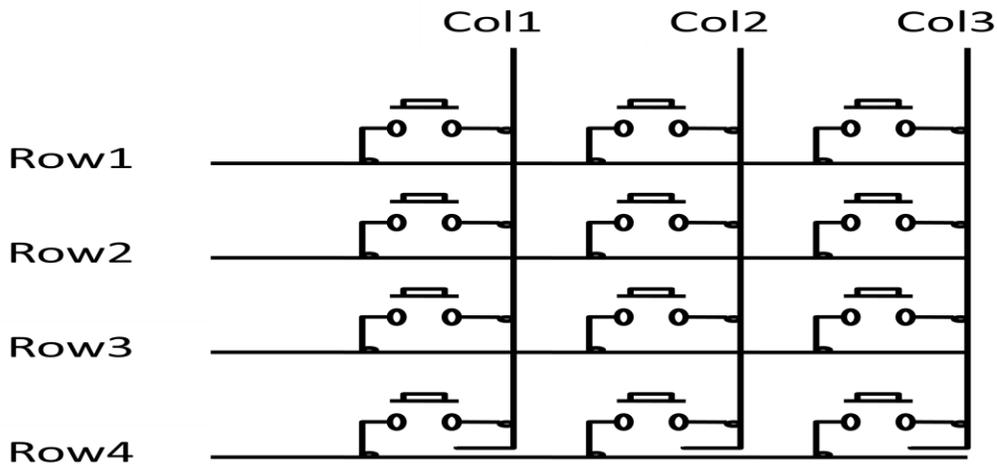
Figure 3.8 3x4 keypad architecture

The CPU accesses both the rows and columns through ports, therefore, with two 8-bit ports; an 8×8 matrix of keys can be connected to the microcontroller. When a key is pressed, a row and a column make a contact, otherwise, there is no connection between rows and columns (all data sheet.com).The detection of the key varies from scanning of the key to grounding the rows and columns.

3.8.1 Scanning and identifying the key

A 4×3 matrix connected to two ports. The rows are connected to an output port and the columns are connected to an input port. If no key has been pressed, reading the input port will yield 1s for all the columns since they are connected to high (V_{CC}). If all the rows are grounded and a key is pressed, one of all the columns will have 0 since the key pressed provides the path to ground. It is the function of the microcontroller to scan the keyboard continuously to detect and identify the key pressed.

3.8.2 Grounding the rows and columns

To detect a pressed key, the microcontroller grounds all rows by providing 0 to the output latch, and then read its columns. If the data read from the columns is D3-D0 =1111, no key is pressed and the process continues until a key is press is detected. However, if one of the column bits has a zero, this means that a key in D1 column has been pressed. After a key pressed is detected, the microcontroller will go through the process of identifying the key. Starting with the top row; the microcontroller grounds it by providing a low to row D0 only; then it reads the columns. If the data read is all 1s, no key in that row is activated and the process is moved to the next row. It grounds the next row, reads the columns, and checks for any zero. This process continues until the row is identified. After identification of the row in which the key is pressed, the next task is to find out which column the pressed key belongs to.
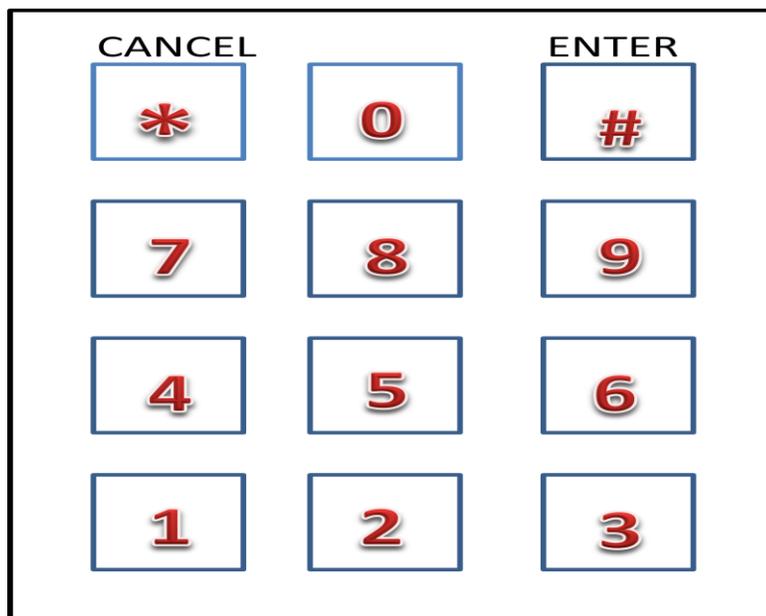

Figure 3.9 4×3 Keypad layout

The key pad unit as earlier mentioned is a collection of push buttons arranged in the required matrix format, the keypad serves as a human machine interface. The keypad is interfaced with the microcontroller giving room for user to enter his password. The push buttons are arranged in 3 x 4 matrix format with 3 columns and 4 rows respectively. The columns are connected to pins 12 through 14 while the rows are connected to pins 16 through 19. The matrix format is used to minimize the number of ports to be consumed. The keypad interface with the controller is shown in figure 3.
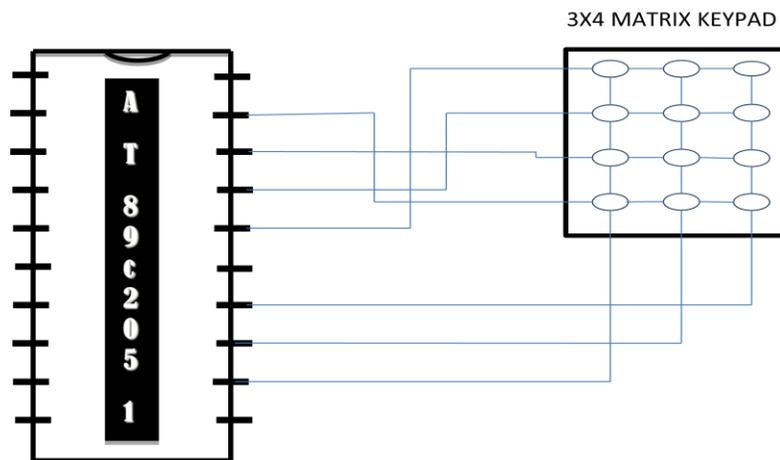

Figure 3.10 Keypad configuration

Plate1: keypad, LCD, Microcontroller, power supply all interfaced and tested.

3.9   THE INDICATING UNIT

As the name implies, it is as indicator used to indicate that the lock has been deactivated that is the lock is opened. This unit comprises of a light emitting diode (LED) and a limiting resistor. The value of the resistor can be calculated as follows:

$$R = 2 \times (V - V_d) / I \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(3.5)$$

$I = 50\text{mA}, V = 9\text{V}, V_d = 0.7\text{V}$

$R = 2 \times (9 - 0.7)/0.05$

$R = 332\Omega$

Therefore, the value used is 330Ω.

3.10 IMPLEMENTATION:

The overall components put together gives the resulting circuit diagram for card activated code lock system as shown in fig12. The user of the device has two options, which are to use the personal 5 digits code or the default code. The default code is 12345 followed by the (#) key. The (×) key is used for cancelling back the codes. The user also has the option to bypass or override the main system when there is error in the keypad and LCD section by making use of the two way switch in other to open the lock. The code lock system is designed to reduce the rate at which unauthorized persons gain access to some restricted areas of a building. The system can also function as a door control switch. It has a card slot interface which serves as a switch to the main system. When used for doors, the lock opens from the inside without authentication for compliance with fire code and for an acceptable level of usability. The card used in this system activates the entire system and put into operating mode.

Fig12a   CIRCUIT DIAGRAM

Fig. 12b

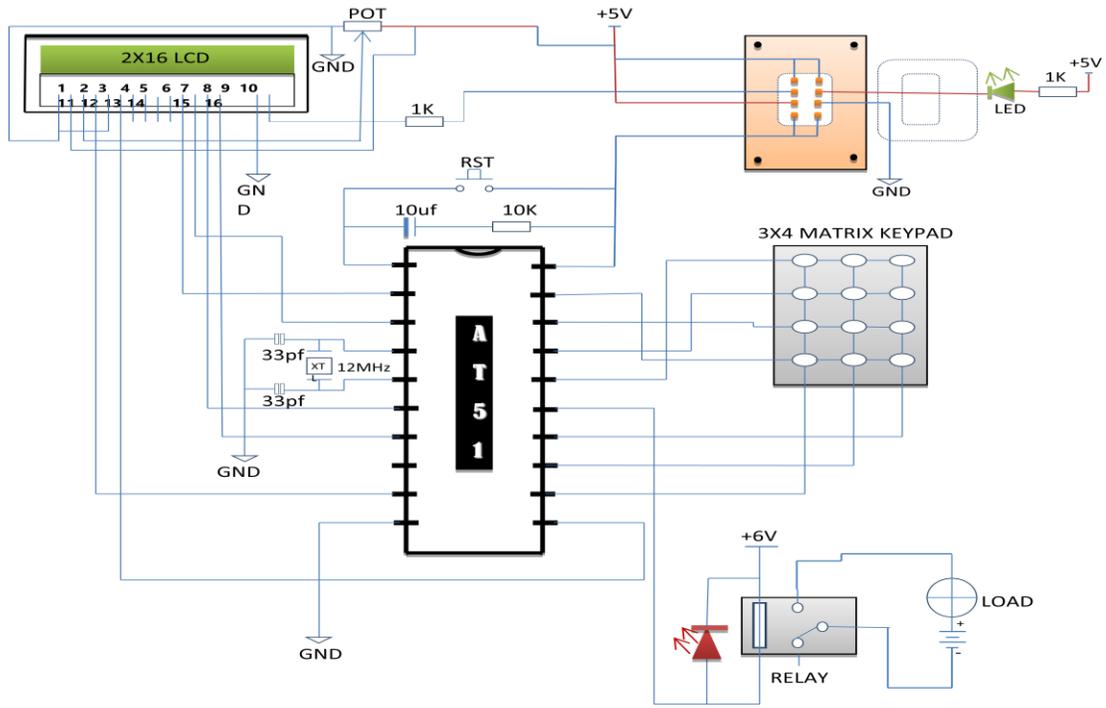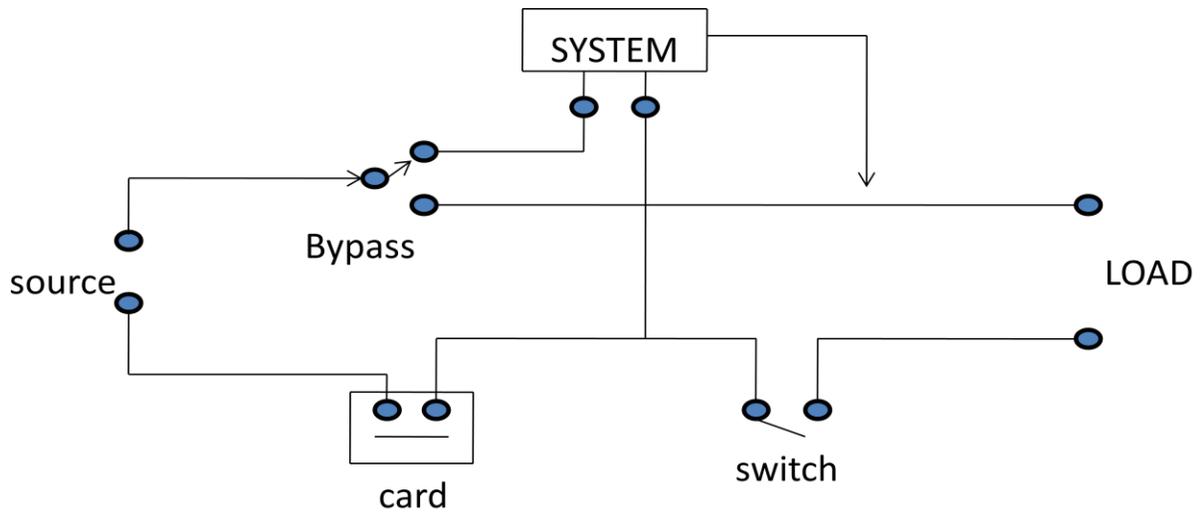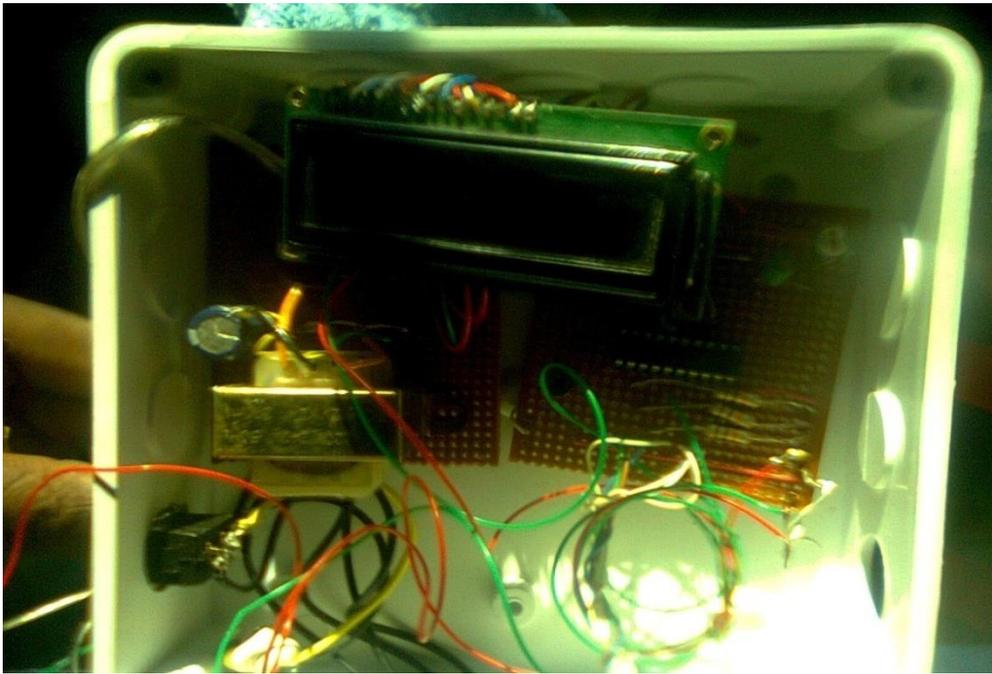**Plate2: LCD, Microcontroller, power supply all placed in the casing**

3.11   CASING:

The choice of casing of the entire design and construction was a plastic and soft wooden material, and this was due to the following reasons;

- ➢ It's lighter in weight.
- ➢ It's durable and long lasting.
- ➢ Its looks more beautiful and colorful.
- ➢ It's cheap
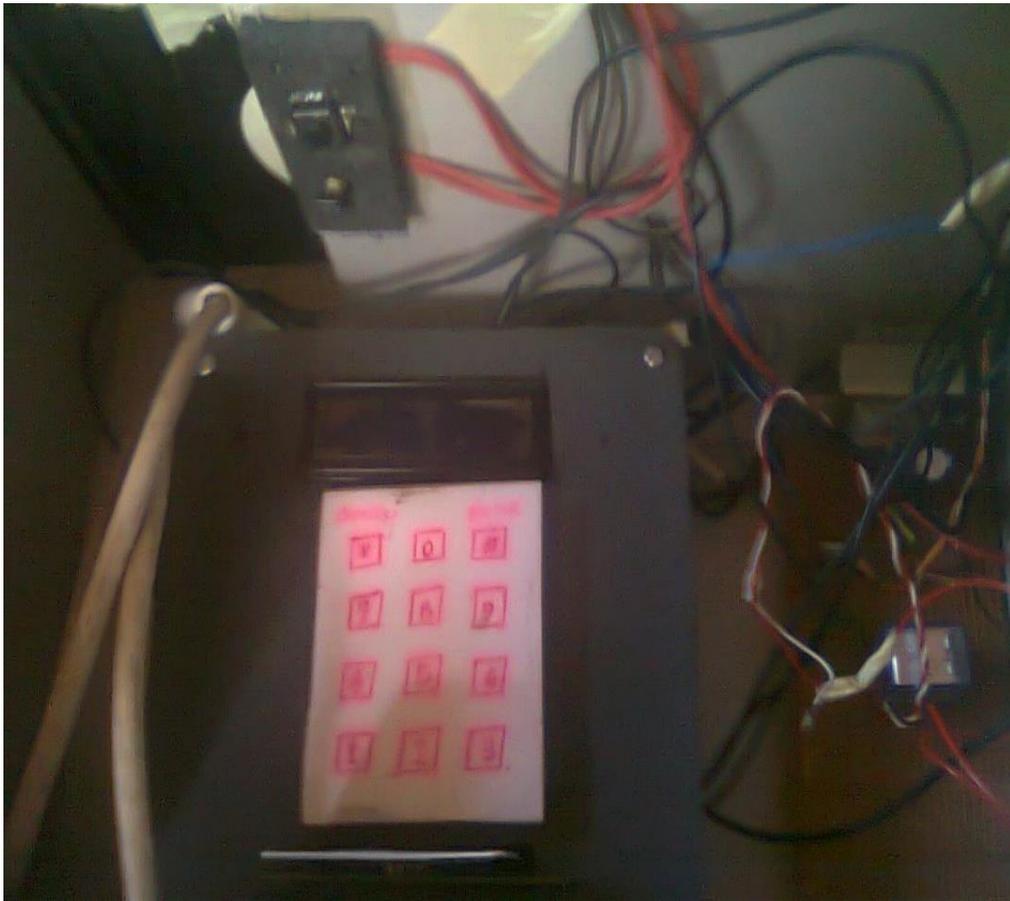- ➢ Ease of construction.

Plate3: casing of the design

CHAPTER FOUR: PERFORMANCE AND COST EVALUATION

4.1   BACKGROUND

This chapter covers the various tests, results and cost evaluation gotten from the complete project design. The chapter rounds up the entire procedure for the design and construction of the Card Activated Digital Code lock system.

4.2   PERFORMANCE EVALUATION

After the construction of the entire system, the program was written and burned into the microcontroller chip. Satisfaction in operation is obtained from the very moment the card is slot in, which activates power into the whole system; afterwards, the right code is entered via the keypad into the microcontroller. The microcontroller interpret this code and matched it with the saved code, if is the correct code, a signal is sent to the switching unit to activate the door to open.

4.3   TEST:

During the design and implementation of this system, the following tests were carried out:

❖ The components were tested first using a digital multi-meter so as to make sure that the components were working perfectly. After their confirmation, they are being put to use.

❖ The circuit software aspect was designed and simulated using Proteus design software. The program was coded compiled and assembled after which it was burned into the microcontroller. The simulation result was carried out and the output was gotten as expected.

❖ The circuit was first of all connected on a project board and was discovered that it was working as needed, and then it was transferred to a Vero board for permanent soldering.

❖ The output of each unit was tested with a meter to ensure that the required output is gotten.

❖ The voltages across the supply unit was tested using digital multi-meter and the results gotten are shown in table 4.1

Table 4.1: voltage test and result carried across power supply unit.

TEST	RESULT
Voltage Before Transformer	180 to 220V AC
Voltage Before Rectification	16.97V
Voltage After Rectification	10.8V
Voltage with 5V Regulator	5V

4.4   EXPERIMENTAL RESULT

Result with main system

When the card is slotted and the right codes for default code, master code, and new code is entered, then the # button pressed, the following result was obtained:

Table 4.2:   Experimental result with main system unit (right code entered)

DESCRIPTION OF RESULT	OUTPUT
Logic level is high (5V)	Door opens

When the card is slotted and the wrong codes was entered, the following result was obtained

Table 4.3:   Experimental result with main system unit (wrong code entered)

DESCRIPTION OF RESULT	OUTPUT
Logic level is low (0V)	Door remain closed

Result with Bypass system

When the card was slotted and the switch turned ON, the following result was obtained:

Table 4.4:   Experimental result with bypass system.

DESCRIPTION OF RESULT	OUTPUT
Logic level is high (5V)	Door opens

4.5   PRECAUTIONS

The following precaution were taken during the construction and implementation stages

❖ Components data sheets were consulted so as to ensure correct pin connections.

❖ The connection board was thoroughly inspected to check for continuity

❖ All connections were done with care.

❖ Soldering was carefully carried out.

4.6   COST EVALUATION

The cost evaluation is the cost estimate of each components used in the entire design and implementation.

The table below is the part list and cost of each components used in the entire design.

Table 4.5 Cost Evaluation

S/N	COMPONENTS	QTY	COST (N)
1	Liquid Crystal Display (LCD)	1	3,500
2	Microcontroller (AT89C2051)	1	1,200
3	Crystal Oscillator	1	300
4	Capacitor (33pF)	2	100
	,, ,, $(10\,\mu\,F)$	1	30
	,, ,, $(2,200\,\mu\,F)$	1	50
5	Transformer	1	200
6	Diode	4	200
7	Voltage Regulator (LM7805)	1	150
8	Resistor (10k Ω)	4	40
	,, ,, (330 Ω)	1	10
	,, ,, (220k Ω)	1	10
9	Keypad Press Button	12	240
10	Solid Switch	1	100
11	Light Emitting Diode (LED)	2	60

12	Vero Board	1	50
13	Card Reader	1	3,500
14	Casing (Plastic)	1	700
15	Load Mechanism	1	1,500
GRAND TOTAL			11,940

CHAPTER FIVE: CONCLUSIONS

5.1 Summary

The main aim of the project is to design and implement a card activated digital code lock system that can be used to protect valuable properties and items from unauthorized users. Having carefully followed the required design guidelines and principles and also the suitable choice of components involved in this design, the realization of "card activated digital code lock system" had been fully achieved.

Different units and their relationships were thoroughly surveyed throughout the work. The design methodology had been given to the maximum level, the theory of operation of most of the components used were given accordingly.

5.2 Conclusions

The software simulation of the card activated code lock was successfully carried out and the hardware implementation functions as expected even though there are few challenges. Also with accurate design procedures and principles, the design of "card activated digital code lock system" was successfully carried out and accomplished.

5.3 Recommendations

The following recommendations will serve as a launching pad for further work on this challenging and yet fascinating project.

There should be a buzzer to give a sound when the user entered the wrong code more than three times, the load signal(voltage) for the microcontroller should be sufficient enough to

drive the load physically, it is also recommended that printed circuit board(PCB) should be used

to promote simplicity and multiplicity.

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APPENDICES

SOURCE CODE OF THE PROGRAM

```
' pass = 1 4 2 8 bin ( 1324) decimal
$crystal = 6000000
$regfile = "89c2051.dat"
Dim I As Byte
Dim K(4) As Byte
Dim Pass(4) As Byte
Dim Key As Byte
Dim Invalid_pass As Bit
Dim Sec_count As Byte
Dim Clock_word As Word
Dim Passtime As Byte
Dim Attempts As Byte
Dim Maxattempts As Byte
Ready_led Alias P1.0
Relay_out Alias P1.1
For I = 1 To 4
K(i) = 0
Next I
Pass(1) = 1
Pass(2) = 3
Pass(3) = 2
Pass(4) = 4
Sec_count = 0
Passtime = 5
Attempts = 0
Maxattempts = 3
Config Lcd = 16 * 2
Config Lcdpin = Pin , Db4 = P1.4 , Db5 = P1.5 , Db6 =
P1.6 , Db7 = P1.7 , E = P1.3 , Rs = P1.2
'port 1
P1 = 0
P3 = 255
Config Timer0 = Timer , Gate = Internal , Mode = 2
'Timer0 use timer 0
'Gate = Internal no external interrupt
```

```
'Mode = 2 8 bit auto reload
' set t0 internal interrupt 2000 times a sec
On Timer0 Timer_0_overflow_int
Load Timer0 , 250
Priority Set Timer0
Enable Interrupts
Enable Timer0
Begin:
If Attempts >= Maxattempts Then
Locate 0 , 0 : Lcd Maxattempts ; " attempts over"
Locate 2 , 0 : Lcd "try after 10 seconds"
Attempts = 0
Gosub Trylater
End If
Sec_count = 0
For I = 1 To 4
K(i) = 0
Next I
Cls
Cursor On Blink
'clear the LCD display
Lcd "Enter Pass:"
'display this at the top line
Ready_led = 1
For I = 1 To 4
While 1 = 1
If Sec_count > Passtime Then
Exit For
End If
If P3 <> 255 Then
' some key pressed - check it
If I = 1 Then
' start timer0 on first keystroke
Sec_count = 0
Start Timer0
End If
Key = P3
' wait for key release
While Key = P3
Wend
K(i) = 255 - Key
If K(i) = 1 Then
Goto Lcd_out
End If
If K(i) = 2 Then
Goto Lcd_out
End If
If K(i) = 4 Then
```

```
K(i) = 3
Goto Lcd_out
End If
If K(i) = 8 Then
K(i) = 4
Goto Lcd_out
End If
If K(i) = 16 Then
K(i) = 5
Goto Lcd_out
End If
If K(i) = 32 Then
K(i) = 6
Goto Lcd_out
End If
If K(i) = 128 Then
K(i) = 7
Goto Lcd_out
End If
' invalid key combination
Key(i) = 0
Lcd_out:
Lcd K(i)
Waitms 30
Exit While
End If
Wend
Next I
Ready_led = 0
Stop Timer0
' check if time over
If Sec_count > Passtime Then
Locate 2 , 0 : Lcd "time over"
Incr Attempts
Gosub Error_flash
Wait 1
Goto Begin
End If
' check valdity
Invalid_pass = 0
For I = 1 To 4
If K(i) <> Pass(i) Then
Invalid_pass = 1
End If
Next I
If Invalid_pass = 1 Then
Goto Invalid
End If
```

```
Valid:
Locate 2 , 0 : Lcd "valid password"
Relay_out = 1
Wait 3
Relay_out = 0
Goto Begin
Invalid:
Locate 2 , 0 : Lcd "invalid"
Gosub Error_flash
Incr Attempts
Wait 1
Goto Begin
Trylater:
' wait for 10 seconds
For I = 1 To 10
Wait 1
Key = P3
Key = 255 - Key
If Key = 3 Then
Exit For
End If
Next I
Wait 2
Return
Error_flash:
For I = 1 To 10
Ready_led = Ready_led Xor 1
Waitms 100
Next I
Ready_led = 0
Return
' interrupt subroutine ————————————
Timer_0_overflow_int:
' program comes here 2000 times a sec with a 6mhz
xtal
Incr Clock_word
If Clock_word > 2000 Then
Clock_word = 0
Incr Sec_count
End If
Return
End
```