DESIGN AND CONSTRUCTION OF HOME AUTOMATION SYSTEM WITH THE USE OF MOBILE PHONE

BY

BAMIGBELE, ADEMOLA EVANS

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
FEDERAL UNIVERSITY, OYE-EKITI

SEPTEMBER, 2016

DESIGN AND CONSTRUCTION OF HOME AUTOMATION SYSTEM WITH THE USE OF MOBILE PHONE

BY

BAMIGBELE, ADEMOLA EVANS

EEE/11/0387

A REPORT SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING OF FEDERAL UNIVERSITY OYE-EKITI, IKOLE EKITI CAMPUS.

IN PARTIAL FULFILMENT FOR THE ACQUISITION OF THE AWARD OF BACHELOR OF ENGINEERING IN ELECTRICAL AND ELECTRONICS ENGINEERING (B.ENG)

SEPTEMBER, 2016.

DECLARATION

I declare that this project was carried out by me under the supervision of Engr. T. Ofusori of the Department of Electrical and Electronics Engineering, Federal University, Oye - Ekiti, as part of the requirement for the award of Bachelor Degree of Electrical and Electronics Engineering. Sources of Information are specifically acknowledged by means of reference. I solemnly declare that this work has not been submitted elsewhere for the award of any Degree.

.... 24/10/2016

BAMIGBELE ADEMOLA E. **DATE**

(EEE/11/0387)

CERTIFICATION

This is to certify that **BAMIGBELE ADEMOLA EVANS** of the department of ELECTRICAL AND ELECTRONICS ENGINEERING carried out this project work. Federal University Oye-Ekiti, Ikole Ekiti Campus.

______________________________ ______________________________

ENGR. OFUSORI .T. **DATE**

(Project supervisor)

______________________________ 24/10/2016

ENGR. DR. AKINSANMI .O. **DATE**

(Head of Department)

______________________________ ______________________________

EXTERNAL EXAMINER **DATE**

ACKNOWLEDGMENT

With Sincerity, I acknowledge God Almighty for seeing me through my period of study in FEDERAL UNIVERSITY OYE EKITI, EKITI STATE. It has been by his grace and mercy.

I am deeply grateful to Engr. Ofusori my supervisor for his assistance and fatherly advice towards the success of this project. Am indeed grateful Sir.

My gratitude also goes to all my amiable and competent lecturers. My thanks go to Prof. Y.A Adediran, Ass. Prof. Akinsanmi .O., Engr. G.K. Ijemaru, Engr. Ezea, Engr. Obikoya, Engr. Babarinde, Engr. Olusuyi, Engr. Opeyemi, Engr. Taiwo Omoleye

I whole heartedly appreciate my Parents Mr. and Mrs. Bamigbele and Siblings, Bamigbele Adebayo, Bamigbele Adebowale, Bamigbele Mary, Bamigbele Adebukola. I say thanks for been there for me at all time, you are the best family members in the world. I love you all.

I would like to appreciate the laboratory Personnel, Mr. Owoeye and Mr. Olowokeere for their moral and technical support, I say God bless you. I also say a big thank you to my good friend Adetiba Opeyemi. I also say a big thank you to my house mate Ichie, Chukwumaobi Ichie, Aduloju Oluwatobi and James Paul for their support for the success of this project, indeed you are a brother from another mother. I love you all.

To all my well-wishers and course mates, especially Mr & Mrs Oyebola, Miss. Abe Blessing, Miss. Adu Mercy, Miss Taiwo Akisanmi, Mr. Olabisi Michael and Mr. Ololade Hassan. You people have been wonderful.

DEDICATION

This project is dedicated to God Almighty for His mercy, grace and guidance over me.

My gratitude also goes to my beloved parents Mr. and Mrs. BAMIGBELE for their love, care and encouragement, also for their financial and moral support given to me. My greeting also extends to all member of my family,

Mrs. Aarinola Oti, Mr. Bamigbele Adebayo, Mr. Adebowale, Mrs Mary Oladosu, Miss Bamigbele Bukola who in one way or the other have positively contributed to the success of my academic pursuit.

ABSTRACT

This project presents the design and construction of a home automation system using Dual-Tone Multi Frequency (DTMF) called ATMEGA16, and a microcontroller (MT8870D-1). This system uses the Dual-Tone Multi Frequency (DTMF) technique used in touch tone telephones to control multi electronic devices from long distances using the mobile phone. The DTMF IC was interfaced with a microcontroller connected to a ULN2803 transistor array supported by five different 12V relay to switch OFF and ON any electrical household appliance. The appliances are controlled by the ON switch for switching on any appliance and the OFF switch for switching off any appliance. This project finds application in switching off and on large number of home appliances, indoor and outdoor lamps and lights, landscape sprinkler timers and so on using their mobile phones. The result of this project shows that a microcontroller is a very powerful device for building smart electronic devices that can automatically control electrical appliances, with little circuitry complexities and components.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ABBREVIATIONS

DTMF	Dual Tone Multi-frequency
GPRS	General Packet Radio Service
RFID	Radio Frequency Identification
BAS	Building Automation System
SCADA................	Supervisory Control and Data Acquisition
AC......................	Alternating Current
DC.......................	Direct Current
RAM......................	Read Access Memory
LED	Light Emitting Diode
ROM	Read Only Memory
I/O	Input/ Output
RISC........................	Reduced Instruction Set Computing
DDR........................	Data Direction Register
EEPROM	Erasable Electrical Programming Read Only Memory

CHAPTER ONE

1.1 INTRODUCTION

Home automation is not a new concept in today's world, it is used to provide convenience for users to remotely control and monitor appliances as well as better power management. The efficient use of electricity makes the Home automation play an important role in our daily life. Mobile phones are getting more advanced which allow people to develop applications that run on them. Currently mobile phones are gradually replacing Personal Computers (PC) because of their ability to do almost all computers can do. Remote management and control of devices is one of the areas where an application can be developed to make our life easier. Different approaches can be followed to develop remote management or control systems, some use DTMF (Dual Tone Multi Frequency) technology which involves using mobile phones tone to perform an action, while some use Short Message Service technology (SMS) to send the command for a particular action, some also use GPRS (General Packet Radio Service) technology to directly interface mobile phone and the computer. Imagine how helpful it will be to be able to switch on your air conditioning system ten minutes before you get home on a hot afternoon in January. This is what home automation is about and there is no end to its application. In fact, sophisticated home automation systems are now being developed that can maintain an inventory of household items, record their usage through an RFID (Radio Frequency Identification) tag, and prepare a shopping list or automatically order replacements. Home automation has made it possible to have what is often referred to as a smart home, a home where you can switch on the security lights at night and switch them off in the morning, heat water for bathe and tea, stream to you anywhere in the world via the internet a live video of what is happening in and around your house. It makes it possible to link lighting, entertainment, security, telecommunications, heating, and air conditioning into one centrally controlled system. This allows you to make your house an active partner in managing your busy life. Nowadays, you can hardly find a house without a home automation system which can range from the remote for the television, burglar alarm and hi-tech security gates, to an automated air conditioning system that maintains the temperature at a predefined value.

1.2 AUTOMATION

Automation is the use of control systems and information technology to control equipment, industrial machinery and processes, reducing the need for human intervention. In the scope of industrialization, Automation is a step beyond mechanization. Mechanization provided human operators with machinery to assist them with the physical requirements of work while automation greatly reduces the need for human sensory and mental requirements as well. Automation plays an increasingly important role in the global economy and in daily experience. Engineers strive to combine automated devices with mathematical and organizational tools to create complex systems for a rapidly expanding range of applications and human activities. Many roles for human in industrial processes presently lie beyond the scope of automation. Human-level pattern recognition, language recognition, and language production ability are well beyond the capabilities of modern mechanical and computer systems. Tasks requiring subjective assessment or synthesis of complex sensory data, such as scents and sounds, as well as high-level tasks such as strategic planning, currently require human expertise. Automation has had a notable impact in a wide range of highly visible industries beyond manufacturing. Medical processes such as primary screening in electrocardiograph or radiography and laboratory analysis of human genes, blood plasmas, cells, and tissues are carried out at much greater speed and accuracy by automated systems. Automated teller machines have reduced the need for bank visits to obtain cash and carry out transactions. In general, automation has been responsible for the shift in the world economy from agrarian to industrial in the 19th century and from industrial to services in the 21st century Office automation Office automation refers to the varied computer machinery and software used to digitally create, collect, store, manipulate, and relay office information needed for accomplishing basic tasks and goals. Raw data storage, electronic transfer, and the management of electronic business information comprise the basic activities of an office automation system, office automation helps in optimizing or automating existing office procedures. Building automation describes the functionality provided by the control of a building. The control system is a computerized, intelligent network of electronic devices, designed to monitor and control the mechanical and lighting systems of a building. A building automation system is an example of a distributed control system. The building automation system (BAS) core functionality keeps the building climate within a specific range, provides lighting based on an occupancy schedule, and monitors system performance and device failures and provides email and/or text notifications to building engineering staff.

The BAS functionality reduces building energy and maintenance costs when compared to a non-controlled building.

Power automation is the automated control and monitoring of power plants, substations and transformers for effectiveness, efficiency and fault detection. It has made it possible to have a reliable municipal or national electricity system, which often comprises remote and hard-to-reach transformers and power sub-system units. It makes it possible to monitor different power units, relay their status and health information, and even carry out fault detection and correction without human interference. Example of power automation system is the Supervisory Control and Data Acquisition (SCADA) system. Home automation may designate an emerging practice of increased automation of household appliances and features in residential dwellings, particularly through electronic means that allow for things impracticable, overly expensive or simply not possible in recent decades. Home automation includes all that a building automation provides like climate controls, door and window controls, and in addition control of multimedia home theatres, pet feeding, plant watering and so on. There exists a difference in that home automation emphasizes more on comforts through ergonomics and ease of operation.

1.3 PROJECT AIM

The aim of this project is to design and construct a home automation system that will remotely switch on or off any household appliance connected to it, with the use of a mobile phone.

1.4 PROJECT OBJECTIVES

The objectives of this project are;

(i) To implement a low cost, reliable and scalable home automation system

(ii) To construct a circuit that can be used to remotely switch on or off any household appliance, using a microcontroller to achieve hardware simplicity, from any phone to toggle the switch state.

1.5 PROJECT SCOPE

The scope of this project includes the hardware design (designing, modelling and testing) of Home Automated controlled system. The project controls multiple appliances by switching it on or off as required.

1.6 SIGNIFICANCE OF THE PROJECT

This project is designed so as to be able to control all your electrical home appliances with the use of your mobile phone.

In a situation where by because of the epileptic power supply in the country, you forget to off any of your home appliances before going out, only for one of your neighbours to call you that your Television set is disturbing the peace of the environment. Instead of you wasting time coming back home and risking so many things, you can easily switch off the Television set from the office with the help of this project. All you need is your phone.

1.7 PROJECT SOURCE MATERIALS

Materials used for these project are ;

(i) Journals
(ii) Library
(iii) Oral interview with friends and acquaintances are source of information used in the project.
(iv) Internet was coupled with books gotten in the library for information.

1.8 ADVANTAGES OF HOME AUTOMATION WITH THE USE OF MOBILE PHONE.

- You can use this project to scare thieves away by switching on any of your home appliances so that the noise will make them think you are around.
- With this project, you can control any of your home appliances anywhere you are.
- With the use of this project, you can easily safe energy in your home.
- Money spent on the consumption of energy will be drastically reduced.

CHAPTER TWO

2.1 INTRODUCTION

This chapter talked about the literature review and will shed more light and also give sufficient insight on the theory and principles upon which the components used in this microcontroller projects are based. This involves the essential description of the ATmega16A microcontroller which comes from the ATMEL family and all other components used in this project.

2.2 LITERATURE REVIEW

For many years now, a lot of people have worked on home automation. Home automation can be described as introduction of technology within the home environment to provide convenience, comfort, security and energy saving to its occupants. Adding intelligence to home environment can provide increased quality of life for the elderly and disabled people who might otherwise require caregivers or institutional care. There has been a significant increase in home automation in recent years due to higher affordability and advancement in phones. Various works have been carried out with the use of microcontrollers to design Home Automation. Some of such works are highlighted below:

[1] Implementation of home automation system, by the use of SMS -text based control.

This work uses SMS – to control home appliances and this give the project a limitation because you will not know if the SMS gets to the phone in the project or not.

[2] A Remote Robot control System based on DTMF of Mobile Phone, IEEE International Conference INDIN 2008, July 2008.

The limitation of this project is that it only uses Android phone, means if you don't have an Android phone, you will not be able to control the home appliances, and the component used for this project is quite expensive.

[3] The use of controlling home appliance with Bluetooth, which means you can only control any Home appliance when you are close to it, or depending on the kilometre radius that the Bluetooth can cover.

[4] A multi-function control system using GSM modem Based SM5100B Module which uses internet to control home appliances. The limitation of this project is that you must be connected to the internet before you can control any Home appliance.

[5] Mobile-Based remote control of high efficiency to control home appliances.

The limitation of this project is that it uses remote control, which means if you don't have the remote, you can't control any home appliance.

2.3 TRANSFORMER

A transformer is an electrical device that transfers energy between two more circuits through electromagnetic induction. A varying current in the transformer's primary winding creates a varying magnetic flux in the core and a varying magnetic field having a negative effect on the secondary winding.

Step-down transformer is one whose secondary voltage is less than its primary voltage. It is designed to reduce the voltage from the primary winding to the secondary winding, this kind of transformer steps down the voltage applied to it.
As a step-down unit, the transformer converts high-voltage, low-current power into low-voltage, high-current power. The larger-gauge wire used in the secondary winding is necessary due to the increase in current. The primary winding, which doesn't have to conduct as much current, may be made of smaller-gauge wire. A step-down transformer with a primary voltage of 220V and a secondary voltage of 12V is the one that I used for this project.

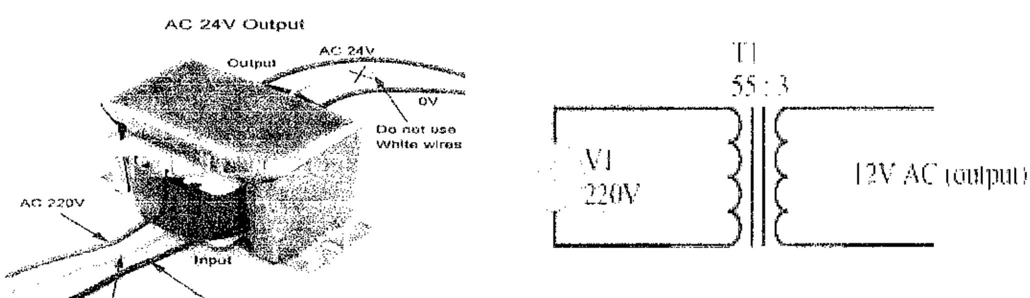


Fig 2.1: A Typical Diagram of Step down Transformer.

2.4 FULL WAVE BRIDGE RECTIFIER

A bridge rectifier is an arrangement of four or more diodes in a bridge circuit configuration which provides the same output polarity for either input polarity. It is used for converting an alternating current (AC) input into a direct current (DC) output. A bridge rectifier provides full-wave rectification from a two-wire AC input, therefore resulting in lower weight and cost when compared to a rectifier with a 3-wire input from a transformer with a center-tapped secondary winding.

The primary application of bridge rectifiers is to transform an AC supply into DC power. **Full Wave Bridge Rectifier** is a type of single phase rectifier that uses four individual rectifying diodes connected in a closed loop "bridge" configuration to produce the desired output. The main advantage of this bridge circuit is that it does not require a special center tapped transformer, thereby reducing its size and cost. The single secondary winding is connected to one side of the diode bridge network and the load to the other side as shown below.

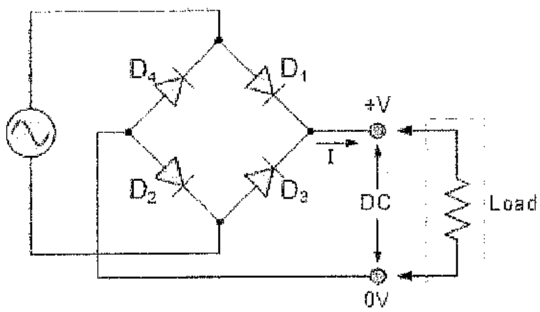


Fig 2.2: The Diode Bridge Rectifier

The four diodes labelled D_1 to D_4 are arranged in "series pairs" with only two diodes conducting current during each half cycle. During the positive half cycle of the supply, diodes D1 and D2 conduct in series while diodes D3 and D4 are reverse biased and the current flows through the load as shown below.

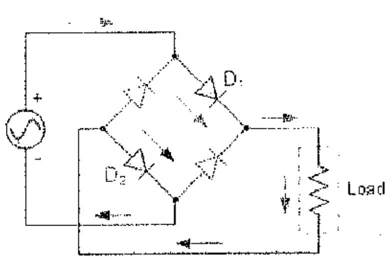


Fig 2.3: The Positive Half-cycle

During the negative half cycle of the supply, diodes D3 and D4 conduct in series, but diodes D1 and D2 switch "OFF" as they are now reverse biased. The current flowing through the load is the same direction as before.

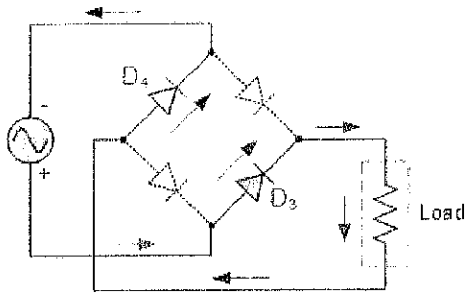


Fig 2.4: The Negative Half-cycle

As the current flowing through the load is unidirectional, so the voltage developed across the load is also unidirectional the same as for the previous two diode full-wave rectifier, therefore the average DC voltage across the load is $0.637V_{max}$.

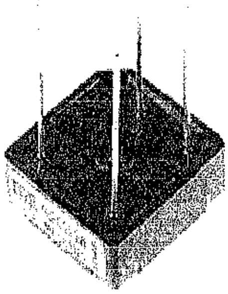


Fig 2.5: Typical Bridge Rectifier

During each half cycle the current flows through two diodes instead of just one so the amplitude of the output voltage is two voltage drops (2 x 0.7 = 1.4V) less than the input V_{MAX} amplitude. The ripple frequency is now twice the supply frequency (e.g. 100Hz for a 50Hz supply or 120Hz for a 60Hz supply.)

Four individual power diodes is used to make a full wave bridge rectifier in this project also,pre-made bridge rectifier components are available "off-the-shelf" in a range of different voltage and current sizes that can be soldered directly into a PCB circuit board or be connected by spade connectors.

2.5 *CRYSTAL OSCILLATOR*

A Crystal oscillator is an electronic oscillator circuit, when electric field is applied across certain materials it produces mechanical deformation. Thus it uses mechanical resonance of a vibrating crystal of piezoelectric materiel to create an electric signal with very precise frequency. There are different types of piezoelectric resonators, but typically, quartz crystal is used in these types of oscillators. Hence, these oscillator electronic circuits are named as crystal oscillators. They have high stability, quality factor, small size and low cost and this makes them superior over other resonators like LC circuit, ceramic resonator, turning forks etc.

In the figure below, we can represent the crystal action by an equivalent electrical resonant circuit as show below. The inductance and capacitance L1 and C1 represents electrical equivalents of crystal mass and compliance, while the resistance R1 represents the friction of crystal's internal structure and C0 represents the capacitance formed due to mechanical moulding of the crystal.

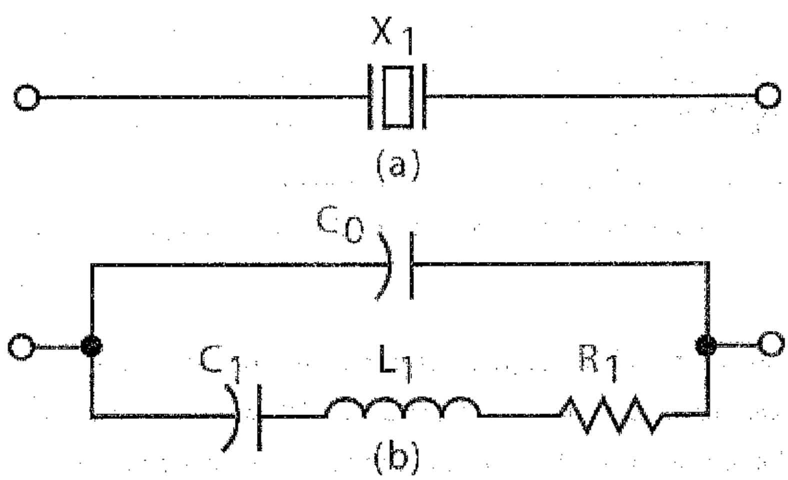


Fig 2.6: A crystal resonator can be represented by the above equivalent circuit

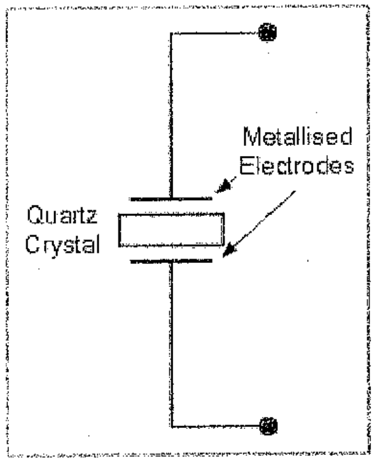


Fig 2.7: Electronic symbol for piezoelectric crystal Resonator

The above diagram represents the electronic symbol for a piezoelectric crystal resonator which consists of two metalized electrodes and quartz crystal.

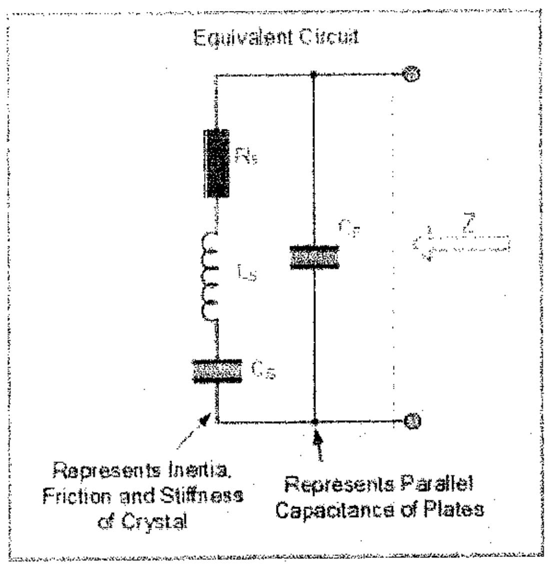


Fig 2.8: Equivalent circuit diagram of quartz crystal

The above figure shows the equivalent circuit diagram of quartz crystal in an electronic oscillator that consists of resistor, inductor, and capacitors which are connected as shown in the figure.

2.5.1 How Crystal Oscillator Works

Crystal oscillator circuit works on the principle of the inverse piezoelectric effect, i.e., a mechanical deformation is produced by applying an electric field across certain materials. Thus, it utilizes the vibrating crystal's mechanical resonance which is made of a piezoelectric material for generating an electrical signal of a specific frequency.

These quartz crystal oscillators are highly stable, consists of good quality factor, they are small in size, and are very economical. Hence, quartz crystal oscillator circuits are superior compared to other resonators such as LC circuits, turning forks, and so on. The equivalent electrical circuit also represents the crystal action of the crystal. The basic components used in the circuit, inductance L1 represent crystal mass, capacitance C1 represents compliance, resistance R1 represents the crystal's internal structure friction, and C0 is used to represent the capacitance that is formed because of crystal's mechanical molding. The quartz crystal oscillator circuit diagram consists of series resonance and parallel resonance, i.e., two resonant frequencies. If the reactance produced by capacitance C1 is equal and opposite to the reactance produced by inductance L1, then the series resonance occurs. The series and parallel resonant frequencies are represented by fs and fp respectively, and the values of fs and fp can be determined by using the following equations shown in the figure below.

$$f_S = \frac{1}{2\pi\sqrt{L_S C_S}}$$

$$f_P = \frac{1}{2\pi\sqrt{L_S\left(\frac{C_P C_S}{C_P + C_S}\right)}}$$

Fig 2.9: Series Resonant Frequency and Parallel Resonant Frequency

Thus, the impedance is approximately equal to the resistance R1 during this condition. If the series resonant leg reactance is equal to the reactance caused due to capacitance C0, then parallel resonance occurs. Thus, the external circuit if offered a very high impedance by the crystal during this condition.

Crystal oscillators are used in the microprocessors and microcontrollers for providing the clock signals

Fig 2.10: A Typical Diagram of a Crystal Oscillator.

2.6 DUAL TONE MULTI FREQUENCY

The MT8870D/MT8870D-1 is a complete DTMF receiver integrating both the band split filter and digital decoder functions. The filter section uses switched capacitor techniques for high and low group filters; the decoder uses digital counting techniques to detect and decode all 16 DTMF tone-pairs into a 4-bit code.

External component count is minimized by on chip provision of a differential input amplifier, clock oscillator and latched three-state bus interface.

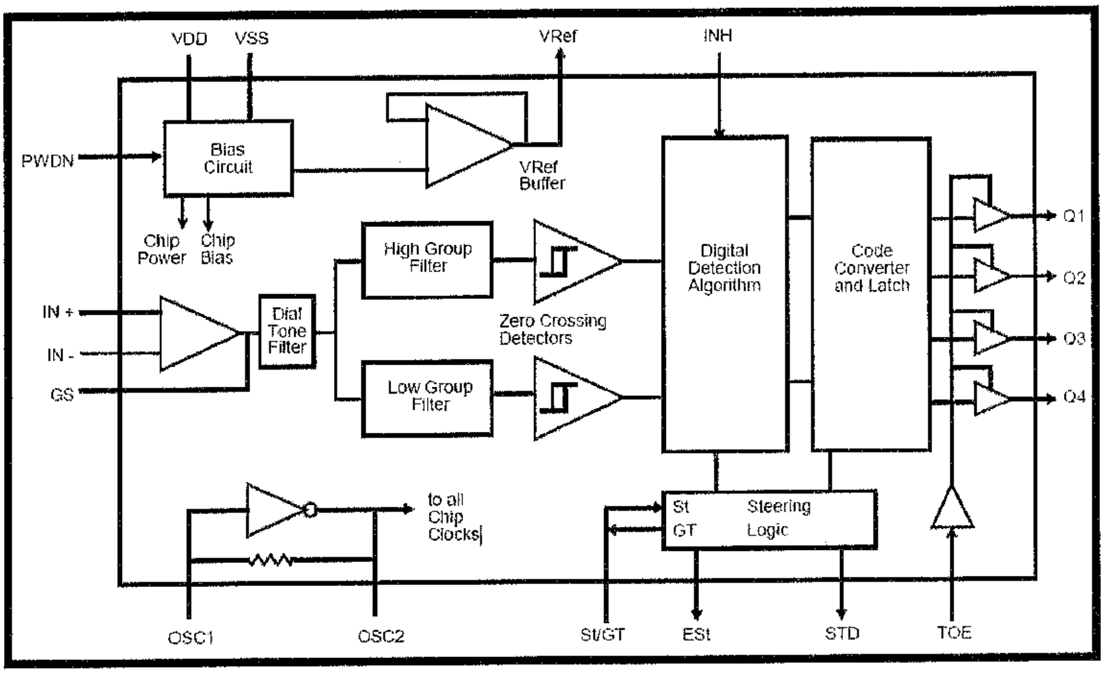


Fig 2.11 Functional Block Diagram of MT8870D-1

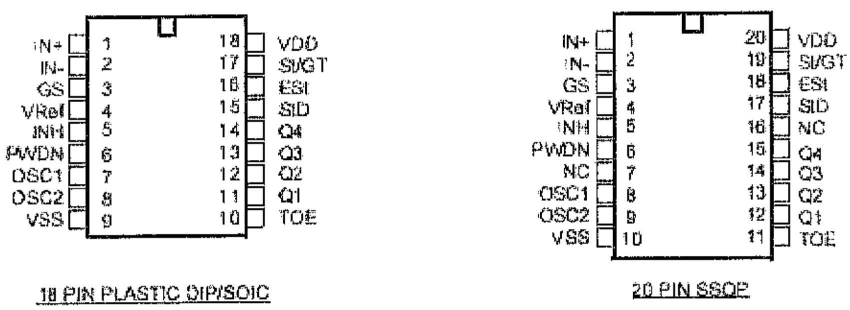


Fig 2.12: 18 and 20 pins arrangement

DTMF Pin Description

Pin #		Name	Description
18	20		
1	1	IN	**Non-Inverting Op-Amp (Input).**
2	2	IN-	**Inverting Op-Amp (Input).**
3	3	GS	**Gain Select.** Gives access to output of front end differential amplifier for connection of feedback resistor.
4	4	V_{Ref}	**Reference Voltage (Output).** Nominally VDD/2 is used to bias inputs at mid-rail
5	5	INH	**Inhibit (Input).** Logic high inhibits the detection of tones representing characters A, B, C and D. This pin input is internally pulled down.
6	6	PWDN	**Power Down (Input).** Active high. Powers down the device and

			inhibits the oscillator. This pin input is internally pulled down.
7	8	OSC1	**Clock (Input).**
8	9	OSC2	**Clock (Output).** A 3.579545 MHz crystal connected between pins OSC1 and OSC2 completes the internal oscillator circuit.
9	10	V_{SS}	**Ground (Input).** 0V typical.
10	11	TOE	**Three State Output Enable (Input).** Logic high enables the outputs Q1-Q4. This pin is pulled up internally.
11-14	12-15	Q1-Q4	**Three State Data (Output).** When enabled by TOE, provide the code corresponding to the last valid tone-pair received. When TOE is logic low, the data outputs are high impedance.
15	17	StD	**Delayed Steering (Output).**Presents a logic high when a received tone-pair has been registered and the output latch updated; returns to logic low when the voltage on St/GT falls below VTSt.
16	18	ES_t	**Early Steering (Output).** Presents logic high once the digital algorithm has detected a valid tone pair (signal condition). Any momentary loss of signal condition will cause ESt to return to a logic low.
17	19	S_t/GT	**Steering Input/Guard time (Output) Bidirectional.** A voltage greater than VTSt detected at St causes the device to register the detected tone pair and update the output latch. A voltage less than VTSt free the device to accept a new tone pair. The GT output acts to reset the external steering time-constant; its state is a function of ESt and the voltage on St.
18	20	V_{DD}	**Positive power supply (Input).** +5V typical.
	7,16	NC	No Connection.

Table 2.1: Functional Description of DTMF

The MT8870D/MT8870D-1 monolithic DTMF receiver offers small size, low power consumption and high performance. Its architecture consists of a bandsplit filter section, which separates the high and low group tones, followed by a digital counting section which verifies the frequency and duration of the received tones before passing the corresponding code to the output bus. Filter Section Separation of the low-group and high group tones is achieved by applying the DTMF signal to the inputs of two sixth-order switched capacitor bandpass filters, the bandwidths of which correspond to the low and high group frequencies. The filter section also incorporates notches at 350 and 440 Hz for exceptional dial tone rejection. Each filter output is followed by a single order switched capacitor filter section which smooths the signals prior to limiting. Limiting is performed by high-gain comparators which are provided with hysteresis to prevent detection of unwanted low-level signals. The outputs of the comparators provide full rail logic swings at the frequencies of the incoming DTMF signals.

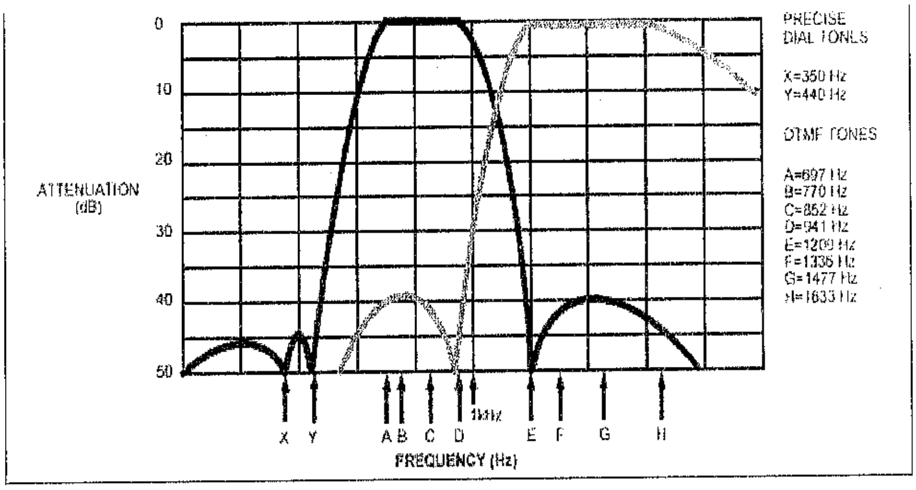


Fig 2.13: Filter Response

Decoder Section Following the filter section is a decoder employing digital counting techniques to determine the frequencies of the incoming tones and to verify that they correspond to standard DTMF frequencies. A complex averaging algorithm protects against tone simulation by extraneous signals such as voice while providing tolerance to small frequency deviations and variations. This averaging algorithm has been developed to ensure an optimum combination of immunity to talk-off and tolerance to the presence of interfering frequencies (third tones) and noise. When the detector recognizes the presence of two valid tones (this is referred to as the "signal condition" in some industry specifications) the "Early Steering" (ESt) output will go to an active state. Any subsequent loss of signal condition will cause ESt to assume an inactive state

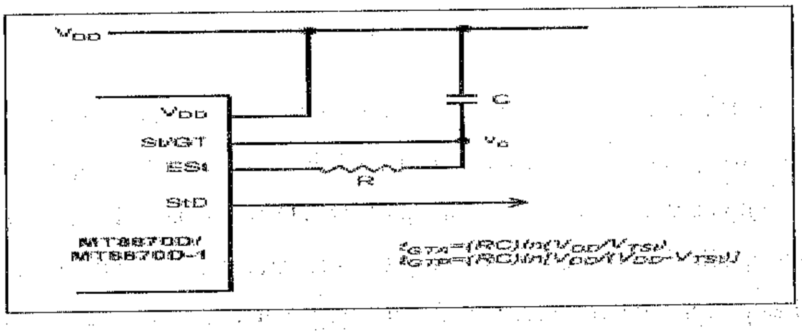


Fig 2.14: Basic Steering Circuit

Steering Circuit Before registration of a decoded tone pair, the receiver checks for a valid signal duration (referred to as character recognition condition). This check is performed by an external RC time constant driven by ESt. A logic high on ESt causes Vc (see Figure 2.13) to rise as the capacitor discharges. Provided signal condition is maintained (ESt remains high) for the validation period (tGTP), Vc reaches the threshold (VTSt) of the steering logic to register the tone pair, latching its corresponding 4-bit code into the output latch. At this point the GT output is activated and drives Vc to VDD. GT continues to drive high as long as ESt remains high. Finally, after a short delay to allow the output latch to settle, the delayed steering output flag (StD) goes high, signaling that a received tone pair has been registered. The contents of the output latch are made available on the 4-bit output bus by raising the three state control input (TOE) to a logic high. The steering circuit works in reverse to validate the inter digit pause between signals. Thus, as well as rejecting signals too short to be considered valid, the receiver will tolerate signal interruptions (dropout) too short to be considered a valid pause. This facility, together with the capability of selecting the steering time constants externally, allows the designer to tailor performance to meet a wide variety of system requirements.

<table>
<tr><th>Digit</th><th>TOE</th><th>INH</th><th>ESt</th><th>Q_4</th><th>Q_3</th><th>Q_2</th><th>Q_1</th></tr>
<tr><td>ANY</td><td>L</td><td>X</td><td>H</td><td>Z</td><td>Z</td><td>Z</td><td>Z</td></tr>
<tr><td>1</td><td>H</td><td>X</td><td>H</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>2</td><td>H</td><td>X</td><td>H</td><td>0</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>3</td><td>H</td><td>X</td><td>H</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>4</td><td>H</td><td>X</td><td>H</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>5</td><td>H</td><td>X</td><td>H</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>6</td><td>H</td><td>X</td><td>H</td><td>0</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>7</td><td>H</td><td>X</td><td>H</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>8</td><td>H</td><td>X</td><td>H</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>9</td><td>H</td><td>X</td><td>H</td><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>H</td><td>X</td><td>H</td><td>1</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>*</td><td>H</td><td>X</td><td>H</td><td>1</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>#</td><td>H</td><td>X</td><td>H</td><td>1</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>A</td><td>H</td><td>L</td><td>H</td><td>1</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>B</td><td>H</td><td>L</td><td>H</td><td>1</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>C</td><td>H</td><td>L</td><td>H</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>D</td><td>H</td><td>L</td><td>H</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>A</td><td>H</td><td>H</td><td>L</td><td rowspan="4" colspan="4">undetected, the output code will remain the same as the previous detected code</td></tr>
<tr><td>B</td><td>H</td><td>H</td><td>L</td></tr>
<tr><td>C</td><td>H</td><td>H</td><td>L</td></tr>
<tr><td>D</td><td>H</td><td>H</td><td>L</td></tr>
</table>

Table 2.2: Functional Decode Table.

2.7 ULN2803 Darlington Transistor Arrays

The ULN2803A device is a DIP IC having high-voltage, **high-current Darlington transistor array**. The device consists of (Single Output) eight NPN Darlington pairs that feature high-voltage output with common cathode clamp diodes for switching inductive loads.

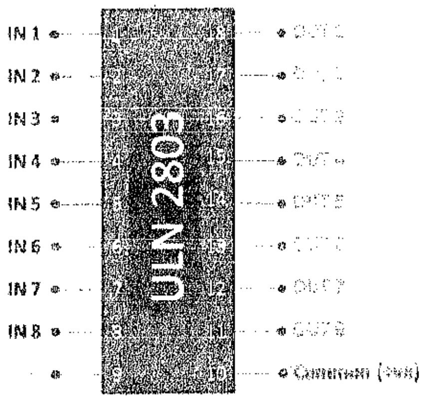


Fig 2.15: ULN2803 Darlington Transistor

2.7.1 Features of ULN2803 Darlington Transistor Array include:

- It is rated at 500-mA Collector Current.
- It also has High-Voltage Outputs of about 50 V.
- It has Output Clamp Diodes.
- The Inputs are Compatible With variable types of logic.
- It has a Relay-Driver Applications

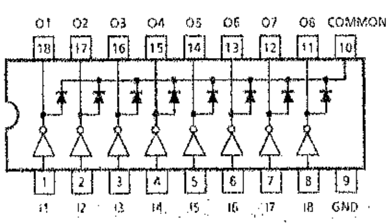


Fig 2.16 Top view of the pin connections.

Fig 2.17 Typical diagram of ULN2803 Transistor Arrays

2.8 RELAYS

Relays are electromechanical devices that use an electromagnet to operate a pair of movable contacts from an open position to a closed position. It is actuated by an electrical current. The current flowing in one circuit causes the opening or closing of another circuit.

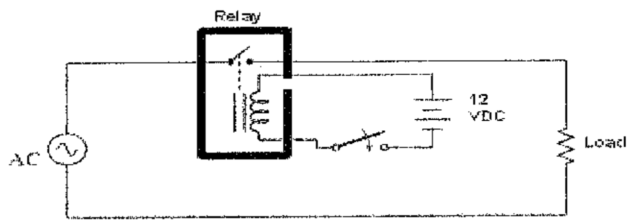


Fig 2.18 Current flowing in a relay

Relays are like remote control switches and are used in many applications because of their relative simplicity, long life, and proven high reliability. Relays are used in a wide variety of applications throughout industry, such as in telephone exchanges, digital computers and automation systems. Highly sophisticated relays are utilized to protect electric power systems against trouble and power blackouts as well as to regulate and control the generation and distribution of power. The advantage of relays is that it takes a relatively small amount of power to operate the relay coil, but the relay itself can be used to control motors, heaters, lamps or AC circuits which themselves can draw a lot more electrical power.

Relays contain a sensing unit, the electric coil, which is powered by AC or DC current. When the applied current or voltage exceeds a threshold value, the coil activates the armature, which operates either to close the open contacts or to open the closed contacts. When a power is supplied to the coil, it generates a magnetic force that actuates the switch mechanism. The magnetic force is, in effect, relaying the action from one circuit to another. The first circuit is called the control circuit; the second is called the load circuit.

2.8.1 There are two basic classifications of relays:

- Electromechanical and
- Solid State.

The relay I used for this project is the solid state

2.8.2 SOLID STATE RELAY

These active semiconductor devices use light instead of magnetism to actuate a switch. The light comes from a LED, or light emitting diode. When control power is applied to the device's output, the light General Purpose Relay is turned on and shines across an open space. On the load side of this space, a part of the device senses the presence of the light, and triggers a solid state switch that either opens or closes the circuit under control. Often, solid state relays are used where the circuit under control must be protected from the introduction of electrical noises. Advantages of Solid State Relays include low EMI/RFI, long life, no moving parts, no contact bounce, and fast response.

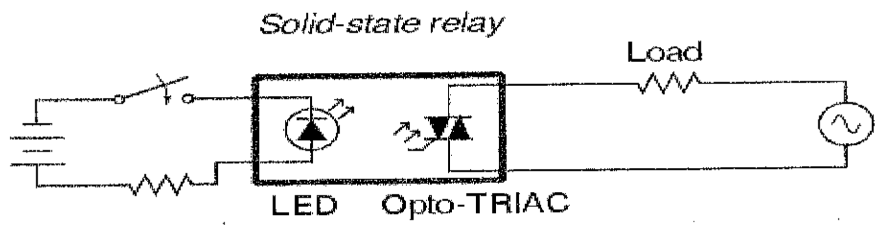


Fig 2.19: solid state relay

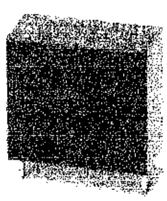


Fig 2.20: **A Typical Diagram of A Solid State Relay.**

2.9 THE ATMEGA16 MICROCONTROLLER

A microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input /output peripherals. Program memory in the form of Ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems

The Microcontroller I used for this project is called ATmega16.

ATmega16 is an 8-bit high performance microcontroller of Atmel's Mega AVR family with low power consumption. Atmega16 is based on enhanced RISC (Reduced Instruction Set Computing) architecture with 131 powerful instructions. Most of the instructions execute in one machine cycle. Atmega16 can work on a maximum frequency of 16MHz.ATmega16 has 16 KB programmable flash memory, static RAM of 1 KB and EEPROM of 512 Bytes. The endurance cycle of flash memory and EEPROM is 10,000 and 100,000, respectively.ATmega16 is a 40 pin microcontroller. There are 32 I/O (input/output) lines which are divided into four 8-bit ports designated as PORTA, PORTB, PORTC and PORTD. ATmega16 has various in-built peripherals like USART, ADC, Analog Comparator, SPI, JTAG etc. Each I/O pin has an alternative task related to in-built peripherals. The following table shows the pin description of ATmega16.

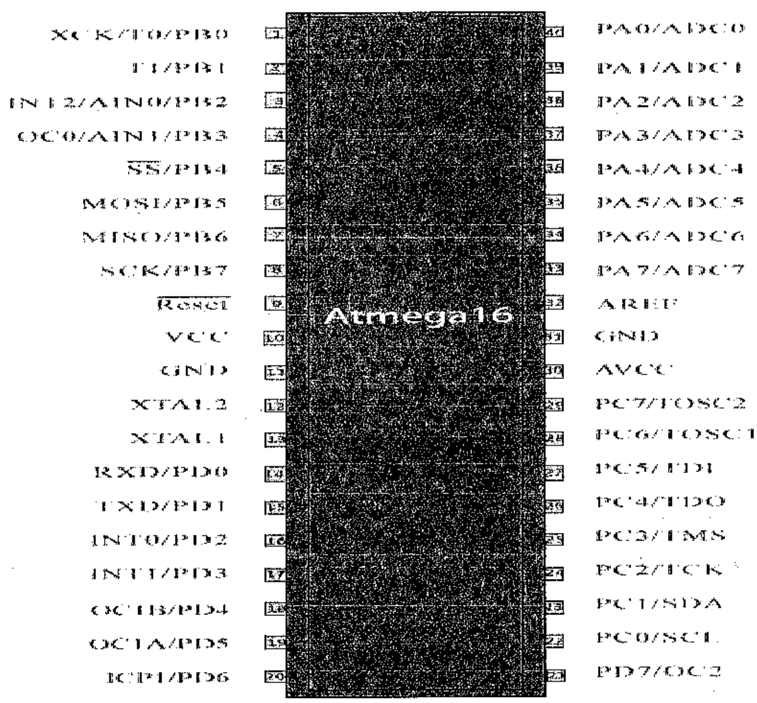


Fig 2.21: Atmega 16a Pin Diagram

Pin No.	Pin name	Description	Alternate Function
1	(XCK/T0) PB0	I/O PORTB, Pin 0	T0: Timer0 External Counter Input. XCK : USART External Clock I/O

2	(T1) PB1	I/O PORTB, Pin 1	T1:Timer1 External Counter Input
3	(INT2/AIN0) PB2	I/O PORTB, Pin 2	AIN0: Analog Comparator Positive I/P INT2: External Interrupt 2 Input
4	(OC0/AIN1) PB3	I/O PORTB, Pin 3	AIN1: Analog Comparator Negative I/P OC0 : Timer0 Output Compare Match Output
5	(SS) PB4	I/O PORTB, Pin 4	In System Programmer (ISP) Serial Peripheral Interface (SPI)
6	(MOSI) PB5	I/O PORTB, Pin 5	
7	(MISO) PB6	I/O PORTB, Pin 6	
8	(SCK) PB7	I/O PORTB, Pin 7	
9	RESET	Reset Pin, Active Low Reset	
10	Vcc	Vcc = +5V	
11	GND	GROUND	
12	XTAL2	Output to Inverting Oscillator Amplifier	
13	XTAL1	Input to Inverting Oscillator Amplifier	
14	(RXD) PD0	I/O PORTD, Pin 0	USART Serial Communication Interface
15	(TXD) PD1	I/O PORTD, Pin 1	
16	(INT0) PD2	I/O PORTD, Pin 2	External Interrupt INT0
17	(INT1) PD3	I/O PORTD, Pin 3	External Interrupt INT1
18	(OC1B) PD4	I/O PORTD, Pin 4	PWM Channel Outputs
19	(OC1A) PD5	I/O PORTD, Pin 5	

20	(ICP) PD6	I/O PORTD, Pin 6	Timer/Counter1 Input Capture Pin
21	PD7 (OC2)	I/O PORTD, Pin 7	Timer/Counter2 Output Compare Match Output
22	PC0 (SCL)	I/O PORTC, Pin 0	TWI Interface
23	PC1 (SDA)	I/O PORTC, Pin 1	
24	PC2 (TCK)	I/O PORTC, Pin 2	JTAG Interface
25	PC3 (TMS)	I/O PORTC, Pin 3	
26	PC4 (TDO)	I/O PORTC, Pin 4	
27	PC5 (TDI)	I/O PORTC, Pin 5	
28	PC6 (TOSC1)	I/O PORTC, Pin 6	Timer Oscillator Pin 1
29	PC7 (TOSC2)	I/O PORTC, Pin 7	Timer Oscillator Pin 2
30	AVcc	Voltage Supply = Vcc for ADC	
31	GND	GROUND	
32	AREF	Analog Reference Pin for ADC	
33	PA7 (ADC7)	I/O PORTA, Pin 7	ADC Channel 7
34	PA6 (ADC6)	I/O PORTA, Pin 6	ADC Channel 6
35	PA5 (ADC5)	I/O PORTA, Pin 5	ADC Channel 5
36	PA4 (ADC4)	I/O PORTA, Pin 4	ADC Channel 4
37	PA3 (ADC3)	I/O PORTA, Pin 3	ADC Channel 3
38	PA2 (ADC2)	I/O PORTA, Pin 2	ADC Channel 2
39	PA1 (ADC1)	I/O PORTA, Pin 1	ADC Channel 1

40	PA0 (ADC0)	I/O PORTA, Pin 0	ADC Channel 0

Table 2.3: Pin Description

2.10 REGULATOR IC (78XX)

It is a three pin IC used as a voltage regulator. It converts unregulated DC current into regulated DC current.

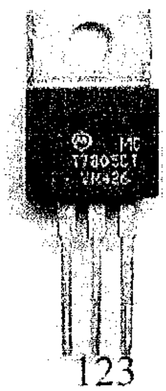


Fig 2.22: Voltage Regulator IC

Normally we get fixed output by connecting the voltage regulator at the output of the filtered DC (see in above diagram). It can also be used in circuits to get a low DC voltage from a high DC voltage (for example we use 7805 to get 5V from 12V). There are two types of voltage regulators:

1. Fixed voltage regulators (78xx, 79xx)

2. Variable voltage regulators (LM317).

In fixed voltage regulators there is another classification i.e.:

1. +ve voltage regulators 2. -ve voltage regulators

POSITIVE VOLTAGE REGULATORS: This include 78xx voltage regulators. The most commonly used ones are 7805 and 7812. 7805 gives fixed 5V DC voltage if input voltage is in (7.5V, 20V).

2.11 THE CAPACITOR FILTER

The simple capacitor filter is the most basic type of power supply filter. The application of the simple capacitor filter is very limited. It is sometimes used on extremely high voltage, low-current power supplies for cathode ray and similar electron tubes, which require very little load current from the supply. The capacitor filter is also used where the power-supply ripple frequency is not critical; this frequency can be relatively high.

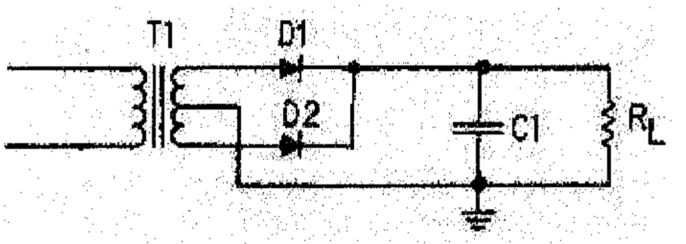


Fig 2.23: Full-wave rectifier with a capacitor filter.

When this filter is used, the RC charge time of the filter capacitor (C1) must be short and the RC discharge time must be long to eliminate ripple action. In other words, the capacitor must charge up fast, preferably with no discharge at all. Better filtering also results when the input frequency is high; therefore, the full-wave rectifier output is easier to filter than that of the half-wave rectifier because of its higher frequency.

2.12 LIGHT EMITTING DIODE

Light emitting diodes must be chosen according to how they will be used, because there are various kinds. The diodes are available in several colours. The most common colours are red and green, but there are even blue ones. The device on the far right in the photograph combines a red LED and green LED in one package. The component lead in the middle is common to both LEDs. As for the remaining two leads, one side is for the green, the other for the red LED. When both are turned on simultaneously, it becomes Orange.

Fig.2.24: Light Emitting Diode (LED)

When an LED is new out of the package, the polarity of the device can be determined by looking at the leads. The longer lead is the Anode side, and the short one is the Cathode side. The polarity of a LED can also be determined using a resistance meter, or even a 1.5 V battery. When using a test meter to determine polarity, set the meter to a low resistance measurement range. Connect the probes of the meter to the LED. If the polarity is correct, the LED will glow. If the LED does not glow, switch the meter probes to the opposite leads on the LED. In either case, the side of the diode which is connected to the black meter probe when the LED glows, is the Anode side. Positive voltage flows out of the black probe when the meter is set to measure resistance.

It is possible to use an LED to obtain a fixed voltage. The voltage drop (forward voltage or VF) of an LED is comparatively stable at just about 2V.

2.13 RESISTORS

A **resistor** is a passive two-terminal electrical component that implements electrical resistance as a circuit element. **Resistors** act to reduce current flow, and at the same time, act to lower voltage levels within circuits.

2.13.1 TYPES OF RESISTOR

- **Fixed Resistors**

A fixed resistor is one in which the value of its resistance cannot change.

- **Carbon film resistors**

This is the most general purpose, cheap resistor. Usually the tolerance of the resistance value is ±5%. Power ratings of 1/8W, 1/4W and 1/2W are frequently used.

Carbon film resistors have a disadvantage; they tend to be electrically noisy. Metal film resistors are recommended for use in analog circuits. However, I have never experienced any problems with this noise. The physical size of the different resistors is as follows.

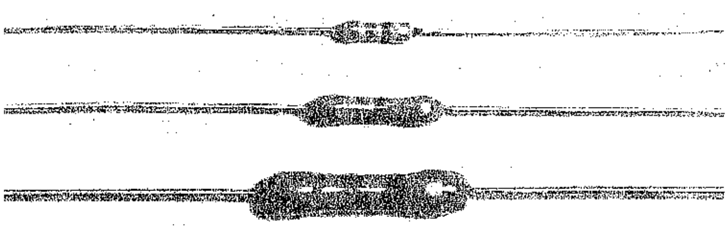
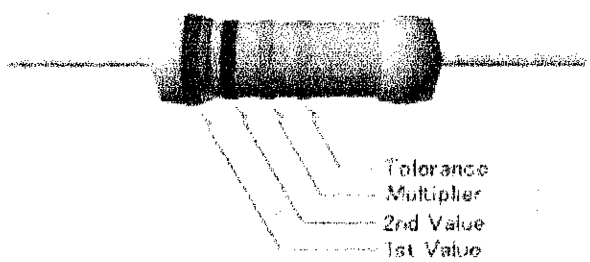


Fig 2.25: Rough size of Resistors

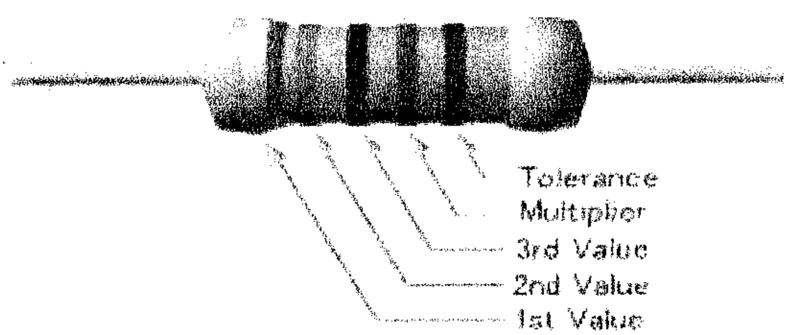
Color	Value	Multiplier	Tolerance (%)
Black	0	0	-
Brown	1	1	±1
Red	2	2	±2
Orange	3	3	±0.05
Yellow	4	4	-
Green	5	5	±0.5
Blue	6	6	±0.25
Violent	7	7	±0.1
Gray	8	8	-
White	9	9	-
Gold	-	-1	±5
Silver	-	-2	±10
None	-	-	±20

Table 2.4: Resistor colour code



Example 1

(Brown=1), (Black=0), (Orange=3) =10 x 10^3 = 10k ohm, Tolerance (Gold) = ±5%



Example 2

(Yellow=4), (Violet=7), (Black=0), (Red=2) =470 x 10^2 = 47k ohm, Tolerance (Brown) = ±1%

Fig 2.26: Resistor colour code

CHAPTER THREE

SOFTWARE AND HARDWARE DESIGN

3.1 INTRODUCTION

The steps taken to write and design of the component used is discussed, the software that will control the hardware aspects of the embedded application in assembly language using the ATMEL instruction. The hardware design involves the integration of selected and designed sub-units together with analysis and calculations made at various stages of the design all these are presented in this chapter.

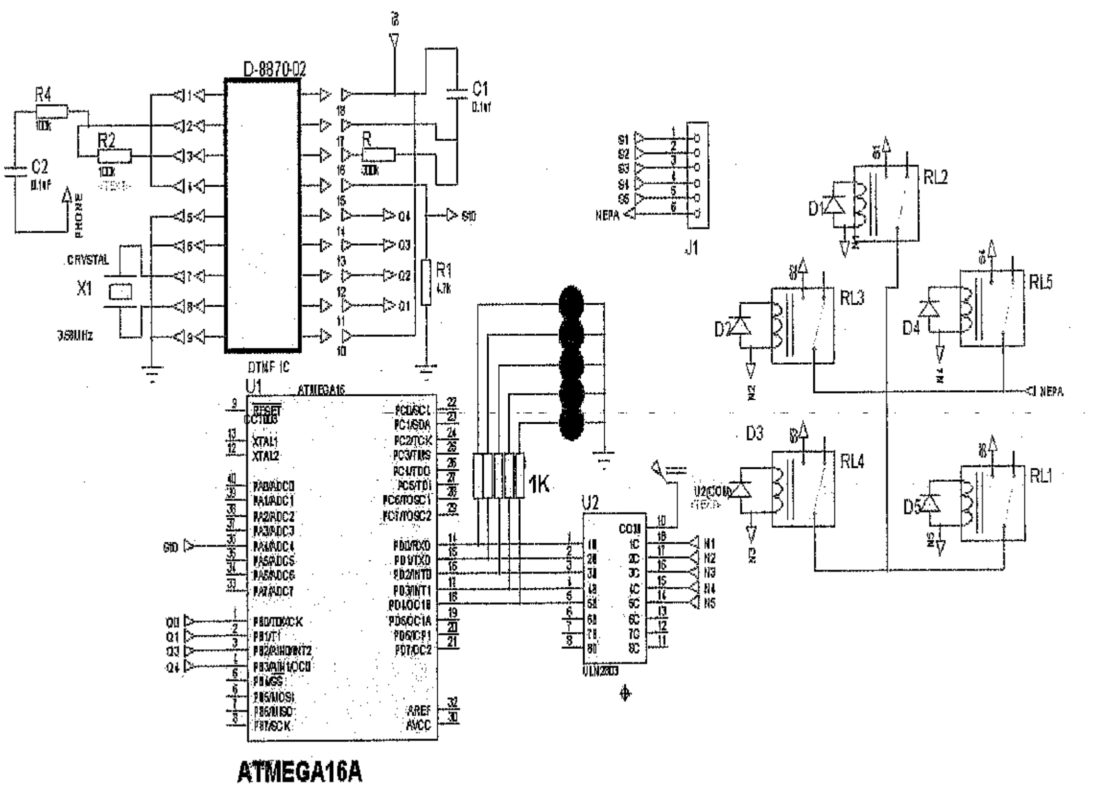


Fig 3.1: Complete Simulation of Circuit Diagram with the use of Proteus

3.2 THEORY OF OPERATION

The figure 3.1 above shows the complete diagram of the home automation. All intelligence is vested on the ATMEGA16A and other IC used, the connection is done by the use of connectors instead of using wire that will make the circuit very complex and difficult to interpret. A fair amount of executable code run from the on-chip memory is able to take total control of the circuit, requiring just a 12-V supply voltage. The DTMF used is MT8870D-1 which as 1 input pin connected to the phone inside the circuit. Four output pins were used in the DTMF which is connected to the Microcontroller. It uses the principle of Dual Tone Multi-Frequency, When you press any key from your phone,(the DTMF inside the home automation will decode the button , because each button has its own specific frequency. Four (4) output pins was used from the DTMF and they are Q_1, Q_2, Q_3, Q_4 ,one of the pins in the DTMF is refer to as the STD pin),the initial state of the STD pin changes ,and when such happens, the initial state of the four output pins used also changes. The Microcontroller used is ATMEGA 16A. The pins have been grouped, we have group A, B, C and D, 12V power supply coming from the transformer will move from the DTMF to the MICROCONTROLLER, then to the ULN 2803(bank of transistor) and it will move to the Relay to energize it(the relay is a 12V relay) it makes the relay act like a switch. The capacitors in this project are for filtering, meant for the removal of noise.

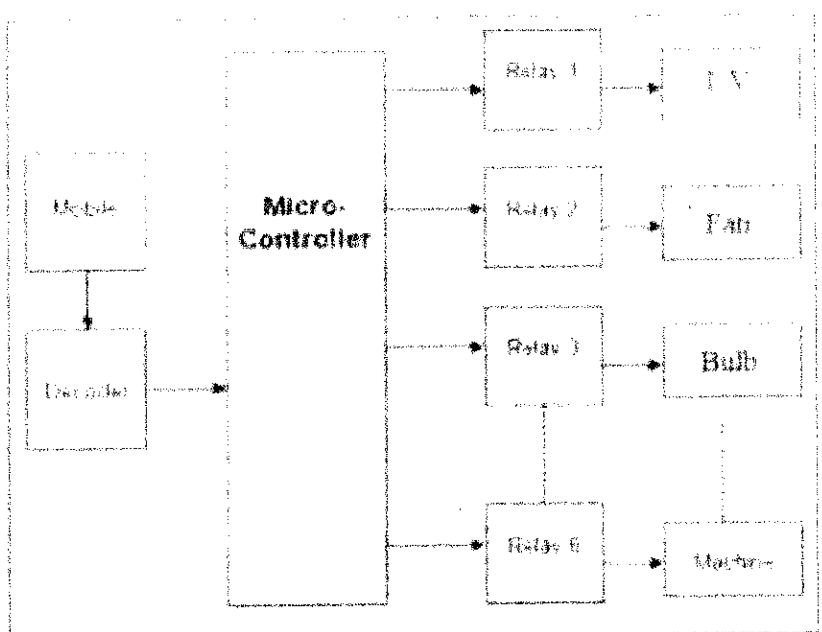


Fig 3.2: Showing a Block Diagram

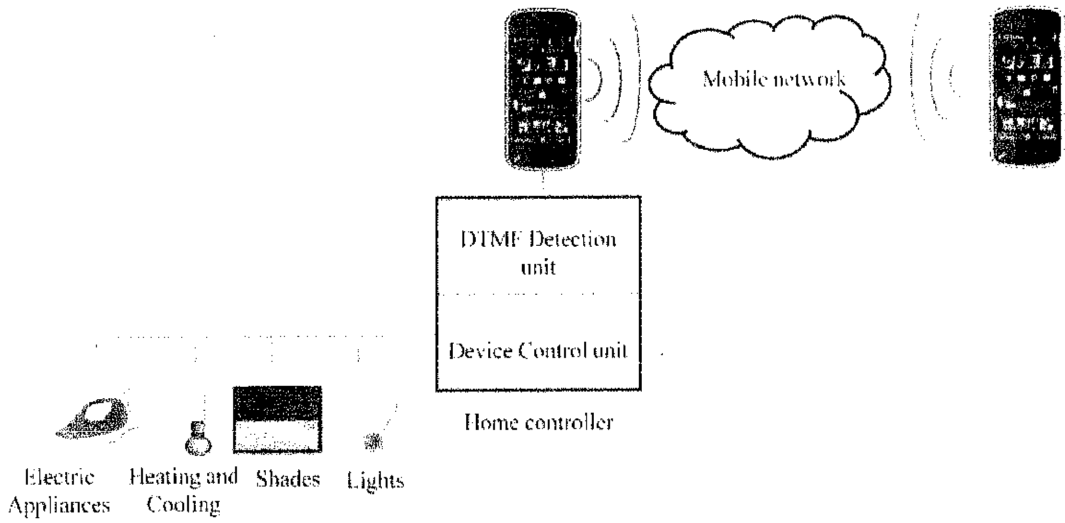


Fig 3.3: Structure of How the Project Works.

3.3 ATMEL STUDIO AND PROTEUS.

The entire home automation programme was written with the use of ATMEL STUDIO Assembly Language. ATMEL STUDIO helps to:

i. Compile or assemble the software using a Language Tool to convert your code into machine code for the PIC micro device. This machine code will eventually become firmware, the code programmed into the microcontroller.

ii. Knowing which peripherals and pins control your hardware, write the software. Use either assembly language, which is directly translatable into machine code, or using a compiler that allows a more natural language for creating programs. With These Language Tools you can write and edit code that is more or less understandable, with constructs that help you organize your code.

iii. Test your code. Usually a complex program does not work exactly the way you might have imagined, and "bugs" need to be removed from your design to get it to act properly.

iv. "Burn" your code into a microcontroller and verify that it executes correctly in your finished application.

3.4 MICROCONTROLLER SELECTION

This is the first aspect of the hardware design. This depends on the application and amount of memory required that determines the type of microcontroller used. In this case, ATMEGA 16A is preferred for this particular application because of its low power consumption, flexibility, reprogrammable flash memory and high speed technology makes it suitable as a control module for the intended application.

3.5 TRANSISTOR TO DRIVE THE CIRCUIT

An NPN transistor ULN2803AN is required to supply the required current to drive the circuit. The resistor used on the base of the transistor is typically around 1K ohm. To calculate the required base Resistor to be connected to the Transistor:

$R_B = \frac{V_{CC}-V_{BE}}{I_B}$ ....eqn

$V_{CC} = 50V$

$V_{BE} = 0.6$

$I_B = 500mA$

$R_B = \frac{50-0.6}{500mA} = 98.8\ ohms.$

Therefore, that is the minimum R_B to be connected to the base of the transistor, for this project 1KΩ is used to provide the need base current.

ULN2803 8-channel 500MA 50V

3.6 Capacitors:

C1, C2 = 0.1μF

C3, C4, C6-C10 = 100nF

C5 = 1000μF 16V radial

3.7 Semiconductors:

LED, 3mm, red, low current

D1 to D4 = are the diodes used for the rectifier

3.8 Resistors:

Resistor as we know are electrical components that oppose the flow of current, employed to protect the circuit. Resistors attached between the LEDs and other components in this project are meant to limit the current flowing into the LEDs to prevent any damage to the LEDs

To calculate the resistor using ohm's law:

V = I.R ....eqn 3.2

Ohm's Law now is

Vcc = (Current through RI) . R1..eqn 3.3

Rearranging the above equation to solve for the resistor:

$R1 = \frac{Vcc}{Current\ through\ R1} = \frac{12v}{0.01A} = 120ohms$ ....eqn 3.4

3.9 SELECTION OF TRANSFORMER USED

In order to achieve the required DC power by the IC's, a step down transformer of primary windings voltage of 220V/240V and secondary winding voltage of 12V was used. The transformer was assumed in an ideal situation which implies a unity power factor.

For an ideal transformer, we have;

$\frac{V1}{V2} = \frac{N1}{N2}$ ------------------------------ (4)

Therefore, $\frac{220}{12} = \frac{55}{3} = \frac{N1}{N2}$

CHAPTER FOUR

CONSTRUCTION AND TESTING

4.1 INTRODUCTION

This chapter gives the practical actualization of the project specification, where the construction, simulation and actual testing of the system are illustrated.

4.2 CONSTRUCTION

This is the physical realization of the project which is very vital in order to end up with an actual hardware.

After carrying out all the paper design and analysis, the circuit was first constructed temporarily on a breadboard and after loading the program source code on the microcontroller to confirm that its operation was according to the design specification and necessary adjustments were made whenever they are required. The project was implemented and tested to ensure it's working ability, and was finally constructed to meet desired specifications

The construction commenced with the soldering of the components to the board and testing. For the soldering the following steps were taken;

- All jumper wires were soldered first
- Followed by IC sockets
- The tip of the soldering Iron was tinned to avoid dry solder joints
- Each stage on the Vero-board was tested as soldering progressed

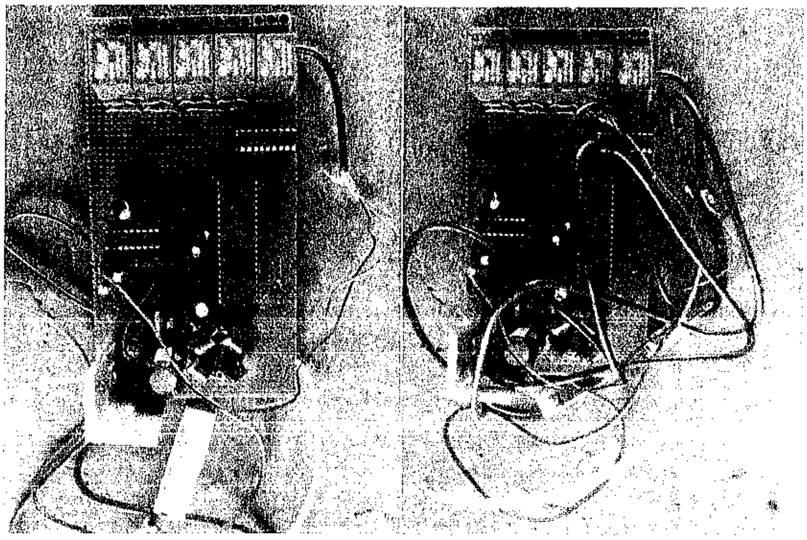


Fig 4.1: Project construction

4.3 CASING

The Circuit was housed in a rectangular box, which served as protection as well as for mechanical support. The case has a dimension of 22.5cm by 5.5cm with a switch connected to the side of the case. The indicator LEDS was also placed on top of the case with an array of connectors outside the case and the switch on the case.

4.4 TESTING

The complete circuit was built and tested for a period of time and it worked according to specifications. When the circuit was switched on, another phone was used to call the phone inside the project, the ON (2,4,6,8,0) and OFF(1,3,5,7,9) button were pressed respectively and they functioned according to specification, and the circuit was repeatedly tested and found efficient and reliable.

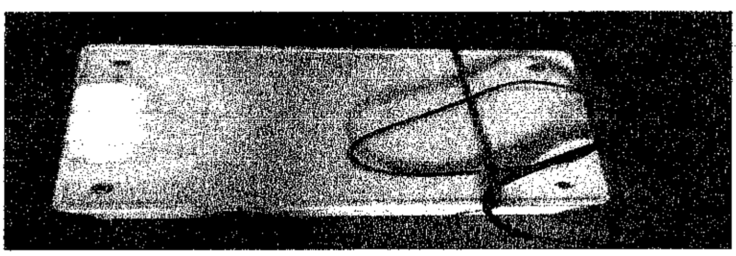


Fig 4.2: Finished Project and Testing

4.5 COST OF COMPONENTS

The following Component were used in the construction of this project work. The table 4.1 below shows the list of component with their respective prices:

S/N	COMPONENT	QUANTITY	UNIT PRICE (N)	TOTAL AMOUNT
1	D-8807 IC	1	2,000	2,000
2	ATMEGA 16A	1	1,500	1,500
3	LED	7	30	210
4	CAPACITOR	7	80	560
5	RECTIFIER	1	200	200
6	BREADBOARD	1	750	750
7	CASING	1	1000	1000
8	JUMPER WIRES	10	50	500
9	CONNECTORS	7	50	350
10	PLUG WIRE	1	200	200
11	VOLTAGE REGULATOR	1	250	250
12	VERO BOARD	1	250	250
13	SWITCH	1	200	200
14	ULN 2803AN TRANSISTOR	1	180	180
15	RESISTOR	9	50	450
16	MISCELLANEOUS			3000
	TOTAL			11,600

Table 4.1 Components Cost

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

In Nigerian Homes, appliances are known to be controlled via the switch button and only when close to the appliance you are controlling. This project and the design can avoid the problems caused when you are far away from home and you need to turn ON/OFF any of your home appliances, with this project you would only need to remember the number of the sim card inside the project and have little credit on your phone, thus making it much safer and easier.

This project can find its applications in various areas like, offices, and personal houses and virtually anywhere appliances are used.

The project is flexible because the code can be changed easily without much stress and the likelihood of failure or malfunction is controlled.

5.2 LIMITATIONS

This project can save a lot of time, energy, eliminate fatigue and inefficiencies in human operation, however it has the following limitations:

The project does not indicate the present state of any appliance controlled whether on or off, it also cannot detect fault in any appliance controlled and the master code can only be changed by modifying the entire programe.

5.3 RECOMMENDATION

The followings are recommendations for further work:

- Provision of a means of knowing the present state of your appliances anywhere you are, also provision of knowing whether any appliances connected to the project is at fault or not.
- Provision of a mode switch, in order to be able to switch to another mode when you are closer to your appliance so that you can control your appliance without the use of a phone. In this case, the appliance can easily be controlled by its switch button.

REFERENCES

[1] (Delgado,et,al.,2006) and (Ciubotaru,et al.,2006) who presented the designs and implementations of SMS -text based control .

[2] Yun Chan Cho and Jae Wook Jeon Proposed a Remote Robot control System based on DTMF of Mobile Phone, IEEE International Conference INDIN 2008, July 2008.

[3] Rifat Shahriyar1, Enamul Hoque2, S.M. Sohan3, Iftekhar Naim4, Md. Mostafa Akbar5 & Masud Karim Khan6 *Department of Computer Science &, Engineering Bangladesh University of Engineering & Technology, 6 Windows Mobile Division at Microsoft* International journal of smart HomeVol. 2, No. 3, July, 2008

[4] Afif Mghawish, Akram A. AbdelQader, Mahmoud A. Al-Jezawi, Mohammad AbuMahfouz. Multi Function Control System using GSM modem Based SM5100B Module. ICITST-2012 London, Technical CoSponsored by IEEE UK/RI Computer.

[5] (Afif Jadalla Al Mghawish, June 2013 edition volume 9, No 18) Mobile-Based remote control

[6] Fathia H. A. Salem, *A Design of a Home Appliances Control System using Cell phone & J2ME*, A Thesis Submitted in Partial Fulfillment of the Requirement for the Degree of Master of Science in Electrical and Electronic Engineering, University of Garyounis, Benghazi-Libya, 2008.

[7] Sanjit K. Mitra, *Digital Signal Processing*, Second Edition, McGraw-Hill, University of California, International Edition, 2002.

[8] Sen M Kuo, Bob H Lee, Wenshun Tian, *Real-Time Digital Signal Processing Implementations and Applications,* Second Edition, John Wiley & Sons, Ltd, 2006.

[9] www.datasheetcatalog.com

[10] Gunter Schmer, *DTMF Tone Generation and Detection: An Implementation Using the TMS320C54x*, Application Report, Texas Instrument, May 2000

[11] MicroTronics Technologies, Website: www.projectsof8051.com Mobile: 99707 90092 Email: info@mtronixtech.com

[12] GSM Association, Mobile Telephony Services Description, htttp://www.gsmworld.com

APPENDIX IA

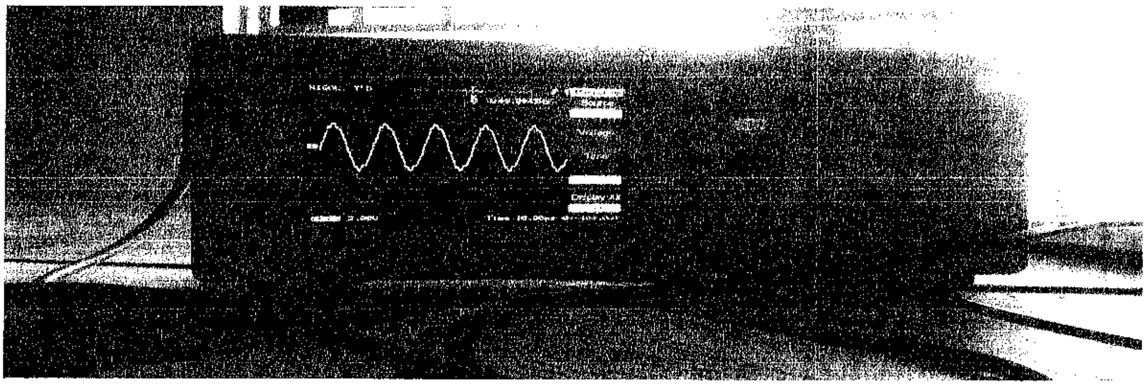
COMPLETE SOURCE CODE FOR THE MT8870D-1

```
/*

* Dtmf Remote Controller.cpp

*

* Created: 08/04/2016 19:48:59

* Author : EMOTECH

*/


#define F_CPU 8000000


#define usingPort     // allows us to have access to port in the hal lib

#define usingInt0     // allows us to use external interrupt in the hal lib


#include <avr/io.h>

#include <avr/eeprom.h>


#include "hal.h"      // hal lib

//#include "sal.h"
```

```
#define keyPort PINB

#define Relay1 PORTC_B0
#define Relay2 PORTC_B1
#define Relay3 PORTC_B2
#define Relay4 PORTC_B3
#define Relay5 PORTC_B4

char RelayStatus = 0;
uint16_t relayStatusAdd = 0x08;

void getRelayStatus(void);
void saveRelayStatus(void);

ISR(INT0_vect){          // external interrut0 vector address / sub routine / function
uint8_t key;
key = keyPort & 0b00001111;     //clear high nible, this ensure that the read data from the
port is 4bit

switch (key
```

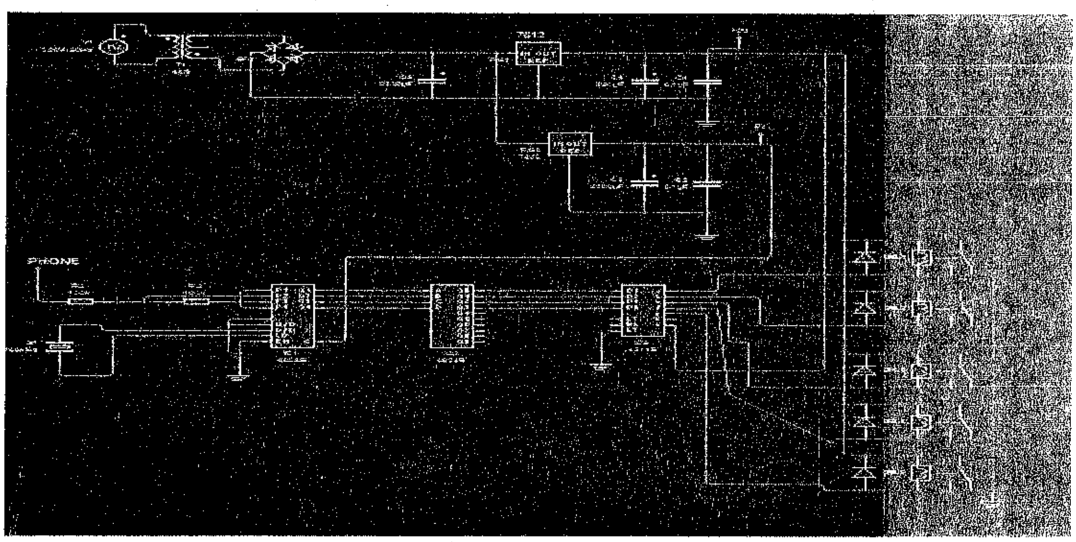
APPENDIX IB

Oscilloscope Measurement of the Output of The Project Which Produces Sinusoidal Wave Form.



APPENDIX IIA

Complete Simulation of Circuit Diagram With The Use Of circuit wizard.



APPENDIX IIA

COST EVALUATION OF THE WHOLE PROJECT

S/N	COMPONENT	QUANTITY	UNIT PRICE (N)	TOTAL AMOUNT
1	D-8807 1C	1	2,000	2,000
2	ATMEGA 16A	1	1,500	1,500
3	LED	7	30	210
4	CAPACITOR	7	80	560
5	RECTIFIER	1	200	200
6	BREADBOARD	1	750	750
7	CASING	1	1000	1000
8	JUMPER WIRES	10	50	500
9	CONNECTORS	7	50	350
10	PLUG WIRE	1	200	200
11	VOLTAGE REGULATOR	1	250	250
12	VERO BOARD	1	250	250
13	SWITCH	1	200	200
14	ULN 2803AN TRANSISTOR	1	180	180
15	RESISTOR	9	50	450
16	MISCELLANEOUS			3000
	TOTAL			11,600