DESIGN AND CONSTRUCTION OF A MICROCONTROLLER BASED DIGITAL ALARM CLOCK

BY

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FEDERAL UNIVERSITY, OYE EKITI.

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A PROJECT PRESENTED TO THE DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING, FEDERAL UNIVERSITY, OYE EKITI, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR DEGREE IN ELECTRICAL AND ELECTRONICS ENGINEERING (B.ENG)

SEPTEMBER, 2016.

DECLARATION

I declare that this project was carried out by me under the supervision of Dr. O. Akinsanmi 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.

.... 17-10-2016

Signature Date

CERTIFICATION

This is to certify that this project work has been read and found worthy of approval, having met the requirement of the Department Of Electrical and Electronics, Federal University, Oye Ekiti, for the award of Bachelor of Electrical Engineering (B. Eng) degree.

.... 26/05/2016

Dr. O. Akinsanmi — Date

(Project Supervisor)

.... 26/05/2016

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External Supervisor — Date

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

I am deeply grateful to Dr. A.O Akinsanmi, my supervisor for his assistance and fatherly advice towards the success of this project.

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To all my well-wishers and course mates, especially Mr. & Mrs. Oyebola, Miss. Ogunyemi Mercy, Miss Taiwo Akisanmi and Adigo blessing, 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.

ABSTRACT

This report presents a design and implementation of a micro controller based digital alarm clock. In this project a Seven-segment Display has been used for each of four digit which shows hours and minutes. Two switches have been used one for entering the hour and other is for minute's increment. The alarm clock was tested with a digital multimeter to measure the input and output voltage and oscilloscope is used to determine the waveform generated from the oscillator. The digital alarm clock finds its application in cars, building and offices.

TABLE OF CONTENTS

CONTENTS

Pages

CHAPTER TWO: THEORETICAL BACKGROUND

CHAPTER THREE: SOFTWARE AND HARDWARE DESIGN

CHAPTER FOUR: CONSTRUCTION AND TESTING

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ABBREVIATIONS

LED ....Light Emitting Diode

PIC ....Peripheral Interface Controller

EEPROM ....Erasable Electrical Programming Read Only Memory

RAM...Read Access Memory

RISC ....Reduced Instruction Set Computer

GPR..General Purpose Register

SFR...Special Function Registers

AC..Alternating current

DC ....Direct Current

IC..Integrated Circuit

NPN..Negative Positive Negative

PNP..Positive Negative Positive

CMOS ....Complementary Metal Oxide Semiconductor

TTL..Transistor-Transistor Logic

FSR ....Feedback Shift Register

CHAPTER ONE
GENERAL INTRODUCTION

1.1 PREAMBLE

A digital clock is a type of clock that displays the time digitally, i.e. in numerals or other symbols, as opposed to an analog clock, where the time is indicated by the positions of rotating hands. In this project, a digital clock with 12 hour count time. The clock runs from 00:00 to 11:59 and then back to 00:00. The display has four digits, two digits for minutes and two for hour. The uniqueness of this clock is that it has very low power consumption and reduced layout. A PIC16F84A microcontroller and 7806 IC were used. The outputs would be connected to LEDs and would make the LED glow for a high output and vice-versa for a low output. We make a seven segment display by using LEDs.

1.2 PROJECT MOTIVATION

This project was borne out of the need to design an efficient, portable and reliable clock system. You truly cannot be an organized human being unless you use a good timing system and if you're still someone who likes to keep all of their appointments, activities - I highly encourage you to consider tossing out the paper and find an electronic clock system. This clock will be useful in our homes, schools and offices.

1.3 AIM & OBJECTIVES

The aim of this project to design and construct a microcontroller based digital alarm clock. The objectives are to:

1. Design the circuit of the digital clock
2. Develop a code for the microcontroller
3. Construct and test the digital clock and alarm system

1.4 BLOCK DIAGRAM OF THE PROJECT

The building blocks of the digital clock are shown in figure 1.1; and the functional relationship between them is schematically represented.

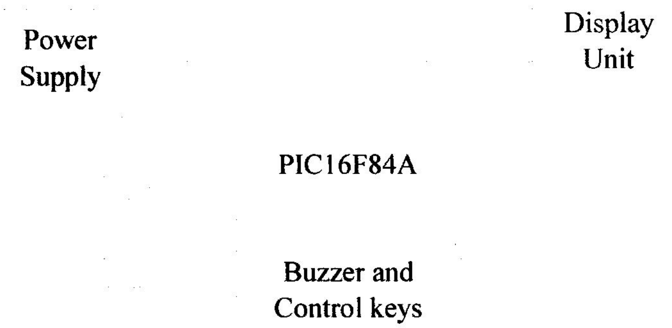

Fig 1.1: General block diagram of the digital clock

1.5 PROBLEM DEFINITION

Digital clocks that runs on means of electricity and have no battery must be reset every time the power is cut off. Even if power is cut off for a second, most clocks will have to be reset. This is a particular problem with alarm clocks that have "battery "backup" because even a very brief power outage during the night usually results in clock failing to trigger the alarm in the morning.

1.6 SCOPE OF WORK

This work comprises of both the hardware and software design phase. The hardware entails making necessary calculations and determining the specifications for the components to be used for the work. The final part of this phase involves preparing the digital alarm clock by connecting all the necessary components on the board and making the data circuits for onward transmission to the point of display. The software phase involves writing the program: assembling it, debugging to check errors and correcting those errors before then burning it into the PIC16F84A chip.

1.7 ADVANTAGES OF DIGITAL CLOCK

- Even if there is power failure, this clock displays the right time using a battery.
- Simplicity of the system.
- Accuracy of the system.

1.8 APPLICATIONS

Because digital clock is small and inexpensive devices that enhance the popularity of product designs, they are often incorporated into all kinds of devices such as Cars. Radios, Televisions, microwave ovens, standard ovens, computers and cell phones.

1.9 REPORT OUTLINE

Chapter Two, covers the theoretical background of the design and discusses the principles upon which the various components used in this project are based on.

Chapter Three is centered on the hardware components used and their physical realization on the overall circuitry and software design which consist of the various stages of development.

Chapter Four talks about the simulation, loading, and interfacing of the microcontroller output to the circuit and final testing of the whole work.

Chapter Five states the limitations and recommendation for further work.

CHAPTER TWO

THEORECTICAL BACKGROUND

2.1 INTRODUCTION

The primary objective of this chapter is to 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 PIC 16F84A microcontroller which comes from the PIC family.

2.2 LITERATURE REVIEW

In [1] designed a digital clock using microcontroller with seven-segment display. Moreover, his system became relatively expensive due to the use of external decoder.

Few researches have been done for displaying Bangla numerals. [2] Designed a 24 segment display for Bangla characters and Numerals. But this design is redundant when it comes to display only numerals.

Similarly, [3] Designed a 10-segment display for Bangla digits but their segment were not uniform and in addition to it their design has some controversy regarding portraying digits „1", „2", „3" and „7" accurately.

[4] Designed a 12 hour mode digital alarm clock with thermometers. The digital clock was configured by programming the ARDUINO (Atmel ATmega328) microcontroller. An LM 35 IC sensor was used but alarm goes off when the temperature is less than 40^0C.

[5] Designed and Constructed a four - hourly digital alarm clock. It was constructed with decade counters, decoders, Seven Segment display which makes the alarm clock to be used for regulating activities of persons in government parastatals, companies, higher

institutions and industries. In addition to this the alarm clock goes on every four hours which rendered the clock useless in our homes and offices.

In the design, the problems were corrected. [6] and et al also designed an 11-segment display for Bangla, Arabic and English numerals. Their design almost uniform and has no segment intersections. In this project, a microcontroller based Digital alarm clock has been designed and constructed. A 7-segment LED displays and PIC16F84A microcontroller was used.

2.3 THE PIC16F84A MICROCONTROLLER

The PIC16F84A belongs to the mid-range family of the PIC microcontroller devices. There are two types of memory in PIC16F84A which are the program memory and data memory. The program memory contains 1K words, which translates to 1024 instructions. The data memory (RAM) contains 68 bytes and data EEPROM is 64 bytes. PIC16F84A is an 8 bit microcontroller which means that it is capable of processing only 8-bits at a time. It also comes in various packages. Following are the specifications of the PIC16F84A. It has only 35 Instructions which makes it a popular RISC (Reduced Instruction Set Computer), operating frequency up to 20 MHz, 15 Special function registers (SFRs), Operating voltage 2 to 5 volts and has 13 I/O pins which can be configured either as input or output individually. Figure 2.1 shows the pin configuration of the PIC16F84A, for further explanation on each pin description; see Appendix A. [7]

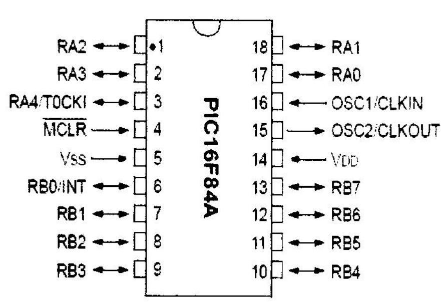

Fig 2.1: Pin configuration of PIC16F84A. and

Figure 2.2 shows the block diagram of PIC16F84A microcontroller.

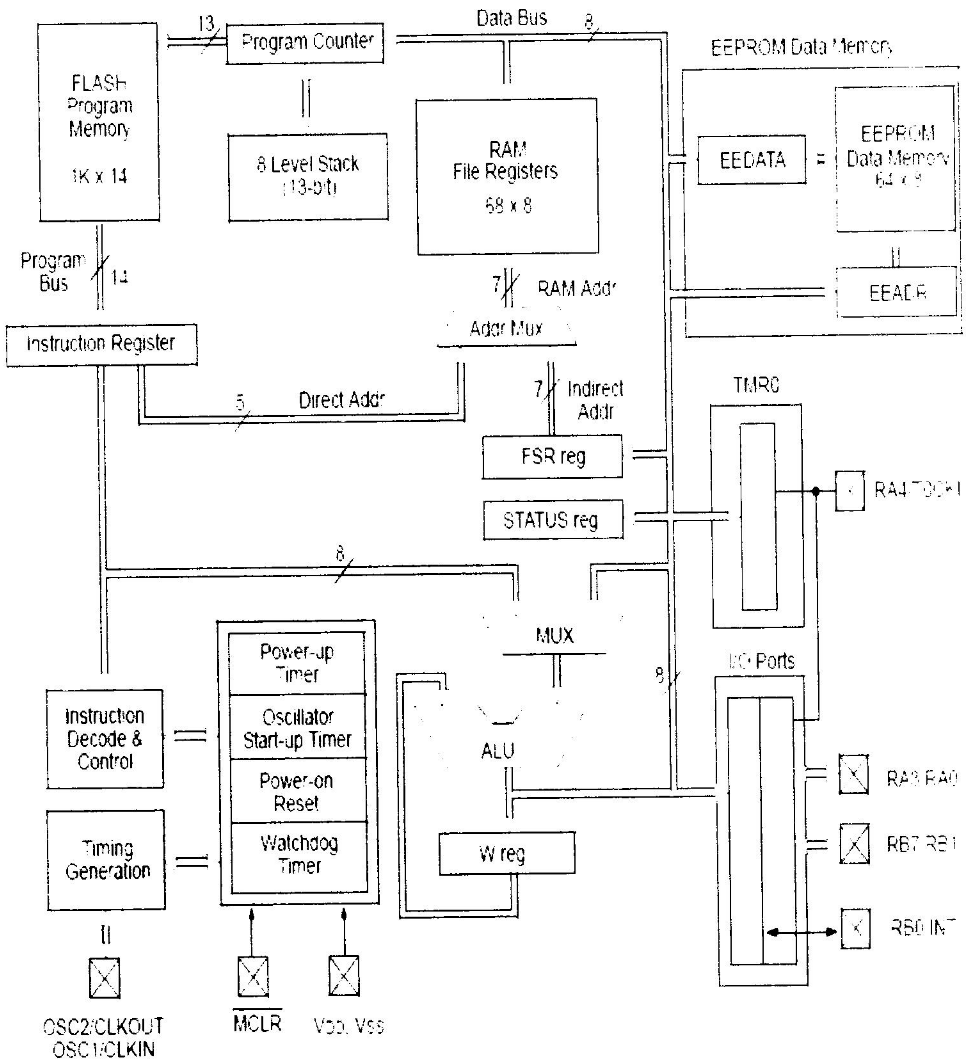

Fig 2.2; Block diagram of PIC16F84A [7]

2.3.1 REGISTERS

Each General Purpose Register (GPR) is 8-bits wide and is accessed either directly or indirectly through the Feedback Shift Register (FSR). The GPR addresses in bank 1 are mapped to addresses in Bank 0. As an example, addressing location 0Ch or 8Ch will access the same GPR.

2.3.2 MEMORY ORGANIZATION

There are two memory blocks in the PIC16F84A. These are the program memory and the data memory. Each block has its own bus, so that access to each block can occur during the same oscillator cycle. The data memory can further be broken down into the general purpose RAM and the Special Function Registers (SFRs). The operations of the SFRs that control the "core" are described here. The SFRs used to control the peripheral modules are described in the section discussing each individual peripheral module. The data memory area also contains the data EEPROM memory. This memory is not directly mapped into the data memory, but is indirectly mapped. That is, an indirect address pointer specifies the address of the data EEPROM memory to read/write. The 64 bytes of data EEPROM memory have the address range 0h-3Fh.

The PIC16FXX has a 13-bit program counter capable of addressing an 8K x 14 program memory space. For the PIC16F84A, the first 1K x 14 (0000h-03FFh) are physically implemented (Figure 2-1). Accessing a location above the physically implemented address will cause a wraparound. For example, for locations 20h, 420h, 820h, C20h, 1020h, 1420h, 1820h, and 1C20h, the instruction will be the same instruction. The reset vector is at 000h and the interrupt vector is at 0004h. Fig 2.3 shows the program memory map and stack of PIC16F84A [7].

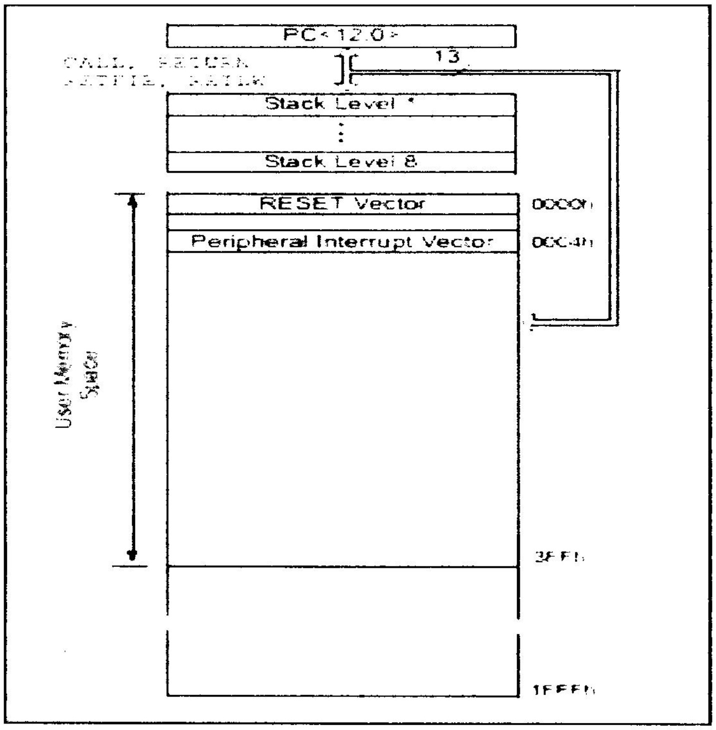

Fig 2.3: Program memory map and stack [7].

2.4 LED DESCRIPTION AND CONFIGURATION DIAGRAM

A light-emitting diode (LED) is a semiconductor device that emits visible light when an electric current passes through it - essentially it converts electricity into light. When one or more LED's are combined with an electrical driver and placed in a housing unit, you have a complete system.

A LED is often small in area (less than 1 mm^2) and integrated optical components may be used to shape its radiation pattern. Early LEDs were often used as indicator lamps for electronic devices, replacing small incandescent bulbs. They were soon packaged into numeric readouts in the form of seven-segment displays, and were commonly seen in digital clocks.

LED display system are used over others display system because they are Long-lasting, durable, lower energy consumption, improved physical robustness, smaller size, and faster switching, can withstand jarring, bumping, shock and vibration, cool, Mercury free. Additionally, they have excellent cold weather performance and Efficient. Using of LED save, money, energy, and the environment [8]. In this project, LED is used for the display unit. Figure 2.4 shown below is the circuit symbol of led.

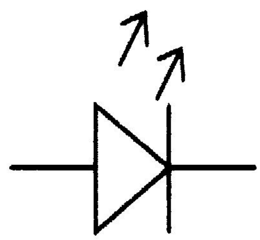

Fig 2.4: Light Emitting Diode

2.4.1 CONFIGURATION OF LED

Common Anode: In this all the Positive terminals (anode) of all the 8 LEDs are connected together as shown in Fig 2.5(a) diagram, named as COM. And all the positive terminals are left alone.

Common Cathode: In this all the negative terminals (cathodes) of all the 8 LEDs are connected together, as shown in Fig 2.5(b) diagram, named as COM. And all the negative thermals are left alone.

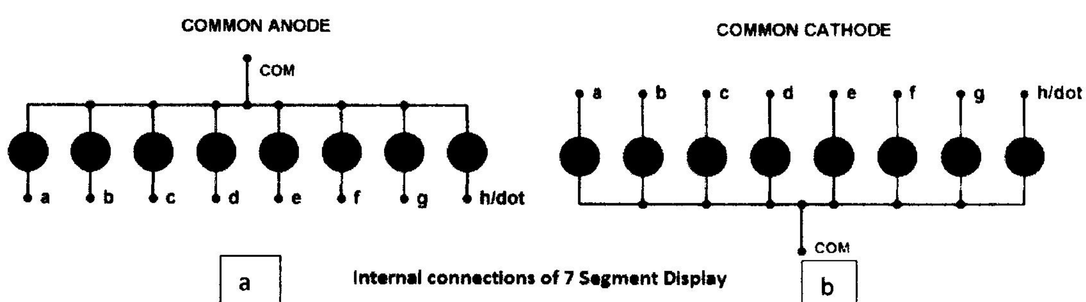

Fig 2.5 Connection of LED using (a) Common cathode, (b) Common anode

A 7-segment display consists of 8 LEDs, each LED used to illuminate one segment of unit. We can refer each segment as a LINE, as we can see there are 7 lines in the unit. which are used to display a number/character. We can refer each segment "a, b, c, d, e, f. g" and for dot character we will use "h". There are 10 pins, in which 8 pins are used to refer a, b,c,d,e,f,g and h/decimal point (dp), the two middle pins are common anode/cathode of all he LEDs. This common anode/cathode is internally shorted so we need to connect only one COM pin. If we want to display the number "0", then we need to glow all the LEDs except LED which belongs to line "g" (see Fig 2.6 below,)

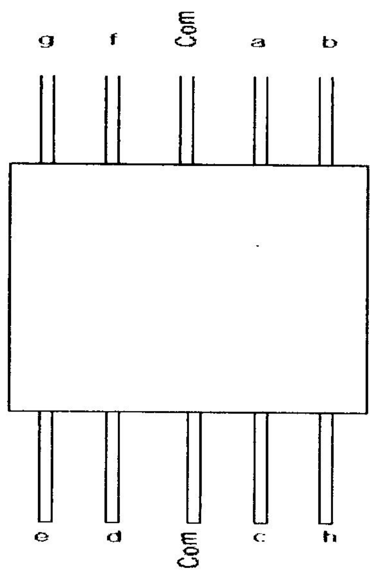

Fig 2.6: Seven Segment Display

so we need a bit pattern 11000000. Similarly to display "1"we need to glow LEDs associated with b and c, so the bit pattern for this would be 11111001. A table has been given below for all the numbers while using Common Anode Configuration. Table 2.1 shows the table for LED configuration.

Table 2.1: LED Configuration

Digit to Display	h g f e d c b a
0	11000000
1	11111001
2	10100100
3	10110000
4	10011001
5	10010010
6	10000010
7	11111000
8	10000000
9	10010000

2.5 CRYSTALOSCILLATOR

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a precise frequency. This frequency is commonly used to keep track of time, as in quartz wristwatches, to provide a stable clock signal for digital integrated circuits. Quartz crystals are manufactured for frequencies from a few tens of kilohertz to hundreds of megahertz. Most are used for consumer devices such as wristwatches, clocks, radios, computers, and cellphones. In this project, crystal oscillator is used to provide a reliable clock for the controller processes. At the most basic level, the clock provides a timing interval to account for the circuit rise times and to allow data to stabilize before that data is processed. This is a "synchronous" process. The applications may include keeping "real time", or timing sensitive processes such as serial data communication. The accuracy of these timing applications is dependent upon the accuracy of the clock oscillator. Fig 2.7 shown is the circuit symbol of a crystal oscillator.

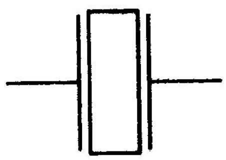

Fig 2.7: Crystal Oscillator

2.6 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 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. Bridge Rectifier can be made using four diodes (i.e. D1, D2, D3 and D4) as shown below.

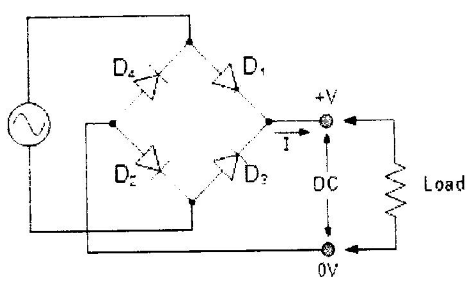

Fig2.8: Bridge Rectifier

It is also known as full wave rectifier because it uses all AC waveform. (I.e. both positive and negative). The voltage used up in bridge rectifier is 1.4v because each diode is 0.7v when conducting (i.e. forward biased mode) and there are always two diode conducting. Considering the positive half AC input voltage. The secondary part becomes positive. Diode D2 and D4 will be forward biased while D1 and D3 will be reversed biased. The two diodes

D2 and D4 will conduct while D1 and D3 will not conduct and will act as open circuit. Also in the next half cycle, the polarity of AC voltage reverses and hence D1 and D3 are forward biased. D1 and D3 will conduct while D2 and D4 will not conduct and act as open circuit. Bridge rectifiers are rated by the maximum current they can pass and the maximum reverse voltage they can withstand. In this project, bridge rectifiers are to transform an AC supply into DC power. All electronic devices require direct current, so bridge rectifiers are used inside the power supplies of almost all electronic equipment.

2.7 LM 7806 VOLTAGE REGULATOR

7806 is a voltage regulator integrated circuit. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator IC maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage it is designed to provide. 7806 provide +6V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels. Fig 2.9 shows the pictorial illustration of the 7806 voltage regulator.

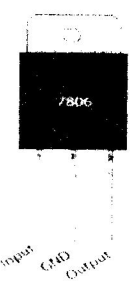

Fig 2.9: 7806 Voltage Regulator.

Table 2.2: Pin Description of 7806 Voltage Regulator

Pin No.	Function	Name
1	Input voltage (5V-18V)	Input
2	Ground (0V)	Ground
3	Regulated output; 6V (5.75V-6.25V)	Output

2.8 TRANSISTOR

A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power.

It is composed of semiconductor material usually with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal. Today, some transistors are packaged individually, but many more are found embedded in integrated circuits. transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. There are two types of standard transistors, NPN and PNP, with different circuit symbols. The letters refer to the layers of semiconductor material used to make the transistor. Fig 2.10 shows the circuit symbol of a NPN and PNP transistor. The leads are labeled base (B), collector (C) and emitter (E).

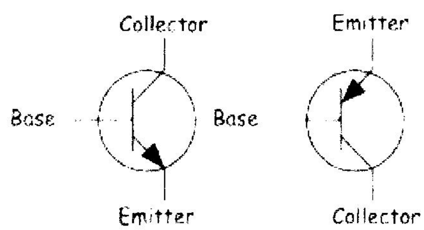

Fig 2.10: NPN and PNP transistor.

In this project, the TIP41C transistor was used. It is a NPN power transistor which has the following features new enhanced series, High switching speed, hFE grouping and hFE improved. It finds application in general purpose circuits, audio amplifier and power switching and uln2003an transistor which consist of array of seven NPN Darlington transistors capable of 500mA, 50V output. ULN2003A is used in driver circuits for relays, lamp and LED displays, stepper motors, logic buffers and line drivers. It has the following features 500 mA rated collector current (single output) 50 V output (there is a version that supports 100 V output), Includes output fly back diodes and Inputs compatible with TTL and 5-V CMOS logic. The ULN2003 is known for its high-current, high-voltage capacity. A Darlington transistor (also known as Darlington pair) achieves very high current amplification by connecting two bipolar transistors in direct DC coupling so the current amplified by the first transistor is amplified further by the second one.

2.9 CAPACITOR

Capacitor is a passive element that stores electric charge statistically and temporarily as a static electric field. It is composed of two parallel conducting plates separated by non-conducting region that is called dielectric, such as vacuum, ceramic, air, aluminum, etc.
The standard unit of capacitance is Farad, most commonly it can be found in micro-farads, Pico-farads and Nano-farads. There are various types of capacitor which include electrolyte capacitor, paper capacitor and ceramic capacitor.
In this project, an electrolytic capacitor and ceramic capacitors are used. Electrolytic capacitor is used because they are high voltage capacitors which produce high value of capacitance in a small component at the expenses of wide tolerance in the marked value and the necessity of connecting the capacitor so that one terminal is always positive. When very large capacitance values are required, electrolytic capacitors are generally used. Due to their large capacitance and small size, they are also used in DC power supply circuits to help reduce the ripple voltage.
Ceramic Capacitors are non-polarized devices and they exhibit large non-linear changes in capacitance against temperature, they are manufactured by coating two sides of a small porcelain or ceramic disc with silver and are then stacked together to create a capacitor. They are generally small, cheap and useful for high frequency applications, although their capacitance varies strongly with voltage. Although small in physical size, they have high

dielectric constant. Figure 2.12 below shows the diagram of an electrolytic capacitor and Figure 2.11 shows the diagram of a ceramic capacitor.

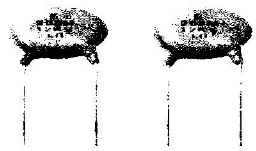

Figure 2.11: Ceramic capacitor

Figure 2.12: Electrolytic capacitor

2.10 RESISTOR

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. In electronic circuits, resistors are used to limit current flow, to adjust signal levels, bias active elements, and terminate transmission lines among other uses. High-power resistors that can dissipate many watts of electrical power as heat may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.

Resistors are common elements of electrical networks and electronic circuits and are useful in electronic equipment. Practical resistors as discrete components can be composed of various compounds and forms. Resistors are also implemented within integrated circuits. The electrical function of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than nine orders of magnitude. The nominal value of the resistance will fall within a manufacturing tolerance. Figure 2.13 shows the diagram of a resistor.

Fig 2.13: Resistor

2.11 BUZZER

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. This is a small 12mm round buzzer that operates around the audible 2 KHz range. Fig 2.14 shows the diagram of a buzzer.

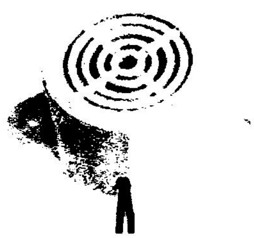

Fig 2.14 Buzzer

CHAPTER THREE

SOFTWARE AND HARDWARE DESIGN

3.1 INTRODUCTION

In this Chapter, the steps taken to design the component used is discussed. In addition, the software that will control the hardware aspects of the embedded application written in assembly language using the PIC instructions is also presented. 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.

3.2 CIRCUIT DIAGRAM

Fig 3.2 shows the circuit diagram of the digital alarm clock

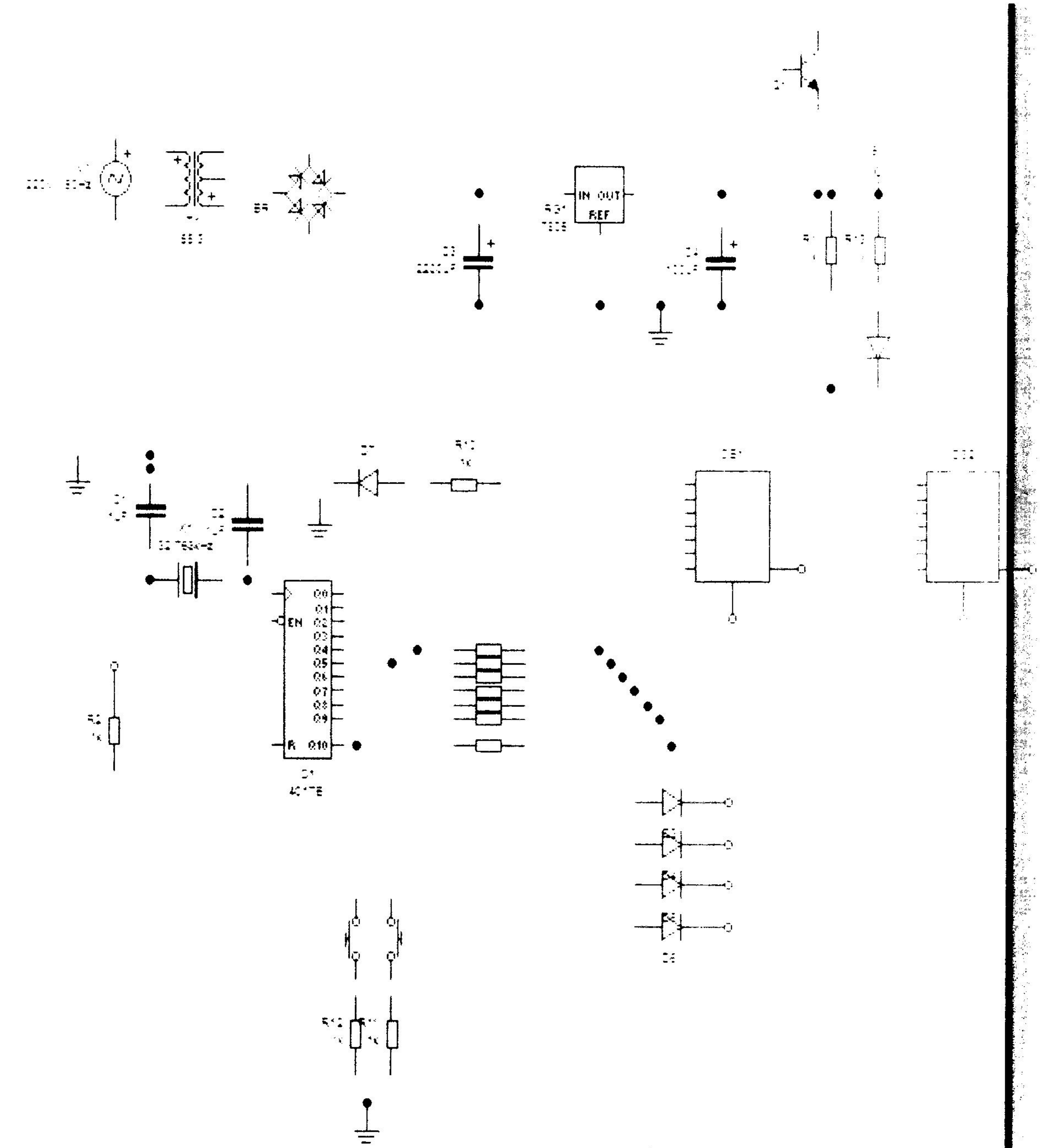

Fig 3.1: Circuit Diagram

Figure 3.1 shows the circuit diagram of the clock. It comprises a 5v supply, switches, resistors, capacitors, transistors, bridge rectifier, transformer and seven segment displays. The output of the power supply is connected to the capacitor C1 which is connected to the input EN of the microcontroller. Pin Q4 to Q9 are connected to the seven segment display in which a limiting resistor is placed there to limit the maximum current from the microcontroller. All the circuit components were first connected on a breadboard, and were transferred to a permanent circuit board when found to function as designed.

When a regulated voltage of 5v provided by 7805 is supplied to the circuit, a signal is generated by crystal oscillator and fed into the input EN of the microcontroller. In the power circuit, a bridge rectifier is used to convert the AC to DC and capacitors used at the power stage are used as filter.

Looking at the output devices controlled by the PIC, the alarm buzzer is driven via Q2, while Pin Q4-Q9 controls LED1 and LED2, the Hour/Minute separator in the readout. Four common-anode 7-segment displays, LD1-LD2 constitute the clock readout. These displays are driven by Pin Q4 to Q9. The microcontroller program will clock 32-bit strings into the shift registers whenever a display update is necessary. Pin Q5 controls the RESET pin of the shift registers. This port line will be held Low when the display is to be turned off. The 9VDC power may be supplied by a standard AC or DC adapter. Diodes will guarantee exclusive operation of the 9 V battery power source.

3.3 DESIGN CONSIDERATIONS

3.3.1 POWER SUPPLY STAGE

The power supply stage involves a step down transformer, filter capacitor, bridge rectifier and voltage regulator, to give the various voltage levels. The selection of optimal digital circuit components for the implementation of the alarm clock was one of the most important considerations made in this work. The power supply circuit diagram is shown in fig. 3.2

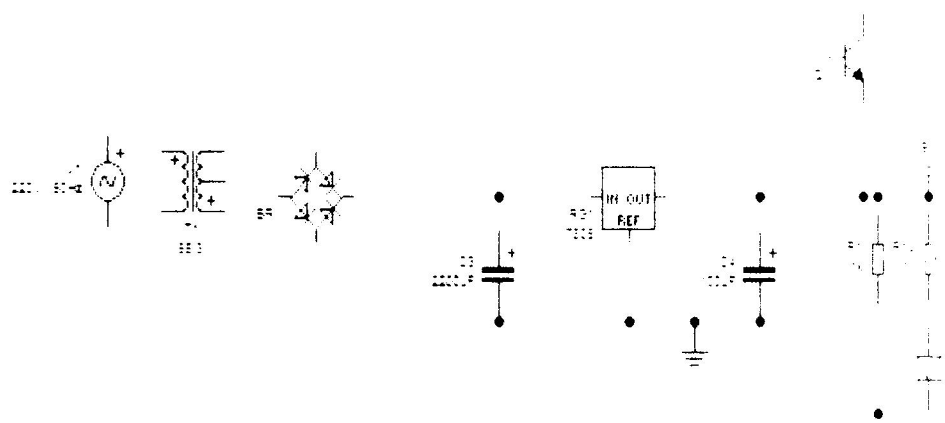

Fig. 3.2: Power supply circuit

The rectifier is designed with four diodes to form a full wave bridge network. C_1 is the filter capacitor and C_1 is inversely proportional to the ripple gradient of the power supply. Bridge rectifier converts A.C into D.C to power the system.

For an r.m.s voltage of 15volts (from transformer).

Vpeak = rms x √2 = 15 x √2 = 21.2V.

Hence letting a ripple voltage of 15% makes dv = 3.18

But $\frac{1}{c} = \frac{dv}{dt}$

$C = \frac{dt}{dv}$

$= \frac{10ms}{3.18v}$ (where dt = 10ms for 50Hz)

= 3144.7μF

A preferred value of 3200μF was employed for the power supply stage.

A 7806 Regulator was used. The transistor TIP41C that is used to buffer the output drops 0.7V (V_{BE}) to reduce the +6 to 5.6V, which is approx. +6V, and a 7806 regulator was used for the 12V supply generation.

3.3.2 TRANSISTOR TO DRIVE THE CIRCUIT

An NPN transistor ULN2003AN required supplying the required current to drive the circuit. To calculate the required base Resistor to be connected to the Transistor:

$$R_B = \frac{Vcc - V_{BE}}{I_B} \qquad \text{...} 3.1$$

$V_{cc} = 50V$

$V_{BE} = 0.6$

$I_B = 500mA$

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

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 needed base current.

3.3.3 TRANSFORMER

The selection of optimal digital circuit components for the implementation of the alarm clock was one of the most important considerations made in this work. To ensure fidelity of operation, the following circuit components, based on different integrated circuit technologies, were considered.

The choice of the transformer was based on the voltage (V) and current (I) specifications: V = 12V, I =1.5A

It is a step-down transformer having the turn ratio:

$$\frac{Vp}{Vs} = \frac{Np}{Ns} \qquad \text{.......................................} \; 3.2$$

where Vp, the primary voltage is 240V while Vs , the secondary voltage is 12V and the turn ratio is 20.

$V_{peak} = \sqrt{2}V_{rms}$, ...3.3

where V_{rms} = 12V. Hence, V_{peak} = 16.97V = V_m.

R is the load resistance in the power supply.

The ripple factor, $\Upsilon = V_{\Upsilon}/V_d$ 3.4

where V_{Υ} = 4.97, Υ = 0.65

The filtering capacitance, $C = I_{dc}/4\sqrt{3}fV_{\Upsilon}$ - 3.5

where f, the frequency of the power source is 50Hz. Thus, C = 871 μ F.

To ensure a more thorough filtering, a greater capacitance of 3300 μ F was chosen.

For voltage regulation, a choice was made of a 7806 IC voltage regulator to take an input of 12V and produce a regulated output of 6V.

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 the PIC16F84A 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 MPLAB AND PICKIT

MPLAB is a proprietary freeware integrated development environment for the development of embedded applications on PIC microcontrollers, and is developed by Microchip Technology. The entire clock program was written in the PIC Assembly Language using the MPLAB Integrated Development Environment (v.5.70.40). MPLAB performs the following functions:

i. Do the high level design – from the features and performance desired, decide which PIC micro or PIC device you need, and then design the associated hardware circuitry.

ii. Compile or assemble the software using a language tool to convert your code into machine code for the PIC micro device.

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.

The PIC kit microcontroller Programmer is a low cost development programmer. It is capable of programming most of Microchip's Flash microcontrollers [9]. Figure 3.3 shows the interface of a PIC kit.

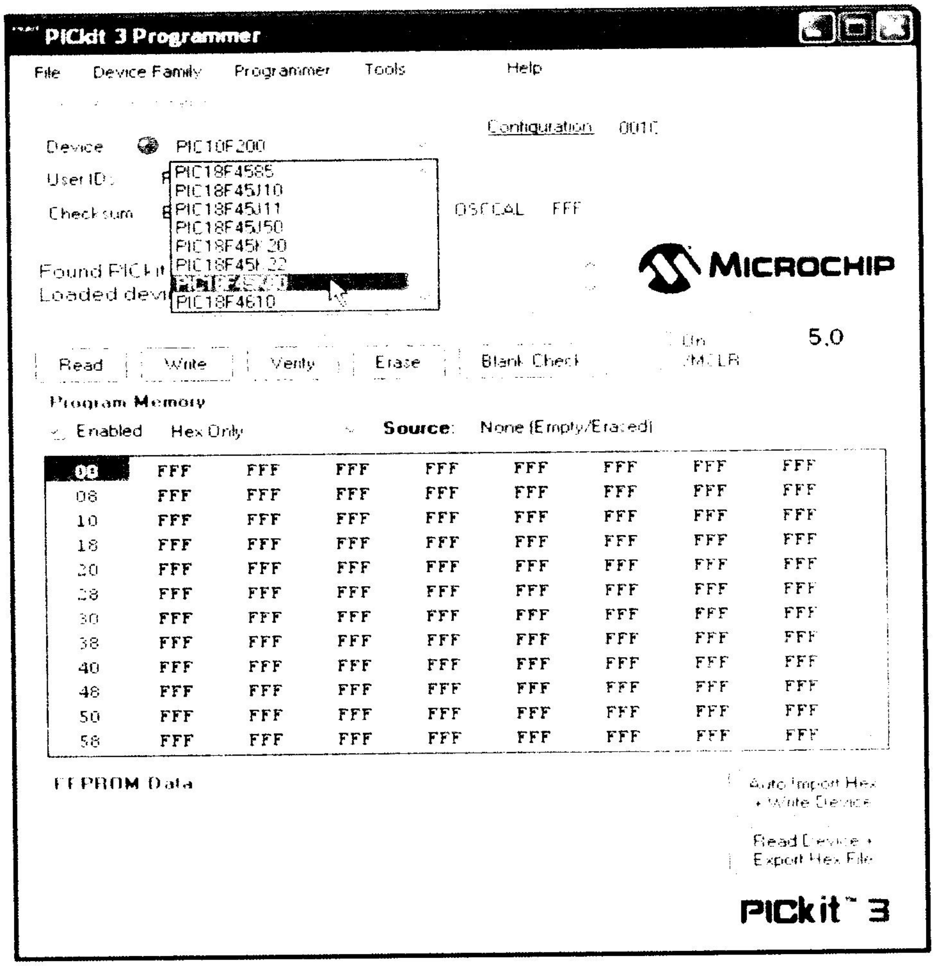

Fig 3.3 PICkit Programming Software

CHAPTER FOUR

CONSTRUCTION AND TESTING

4.1 INTRODUCTION

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

4.2 CONSTRUCTION

The entire 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 circuit was then transferred to a Vero board and firmly fixed on the Vero board by soldering. The project work is cut in two by separating the main board from the display board. Start by soldering the wire links onto the main board and is secured to the main board. The display board which consists of LED is soldered using common anode configuration and the battery as our power source was attached to the power circuit. The battery used was a 9V battery with a 7806 regulator to give a regulated 6V input. The switch is located beside the display to make them accessible from the outside.

4.3 CASING

The Circuit was housed in a box, which served as protection as well as for mechanical support. The case has a dimension of 62.3cm by 30.5cm with a switches connected to the side of the case. The LED was also placed outside the case and the switch beside the case.

4.4 TESTING

The physical realization of the system is very vital. This is where the fantasy of the entire idea meets reality. After putting into effect all the design and analysis, the project was implemented and tested to ensure its working ability, and was finally constructed to meet the anticipated specifications. The process of testing and implementation involved the use of some equipment such as digital multi-meter, and Oscilloscope. The digital multi-meter basically measure voltages, currents, frequency, resistance and transistor hFE. The activity of implementation of the design on the board required the measurement of parameters like, voltages, resistance values of the components and also in some cases frequency measurement. The digital multi-meter was used to check the various voltage drops at all stages in the system. Also the digital multi-meter was used for troubleshooting the soldering and coupling. The oscilloscope was used to observe the behaviors of the oscillators and also in checking the accuracy of the input and output voltages at each stage.

The oscilloscope is also used to check for the results generated by the oscillators and the rectifiers. Fig 4.1 shows the result and shape of the waveform when the oscilloscope is used to observe the oscillator and rectifier.

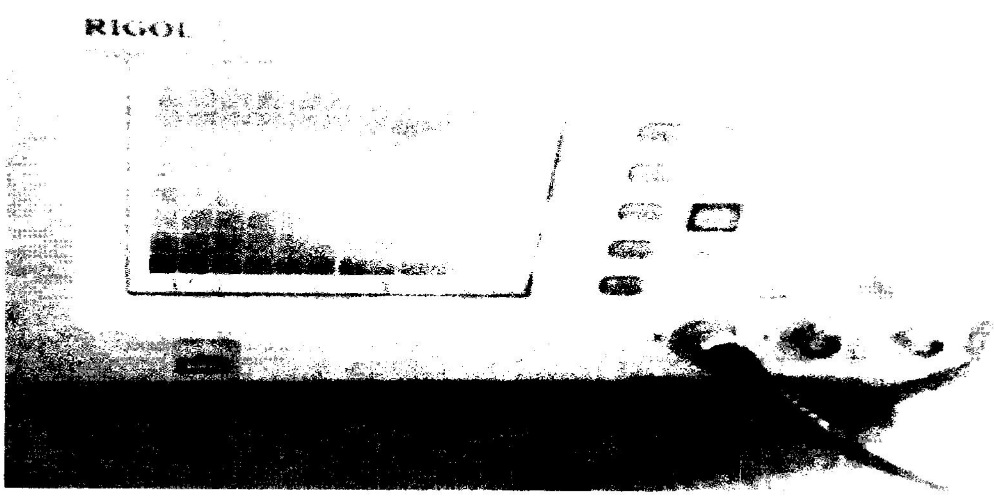

Fig. 4.1: Waveform generated

The Figure 4.2 shown below shows the picture of the project in working mode. The time is 11:21 when snapped.

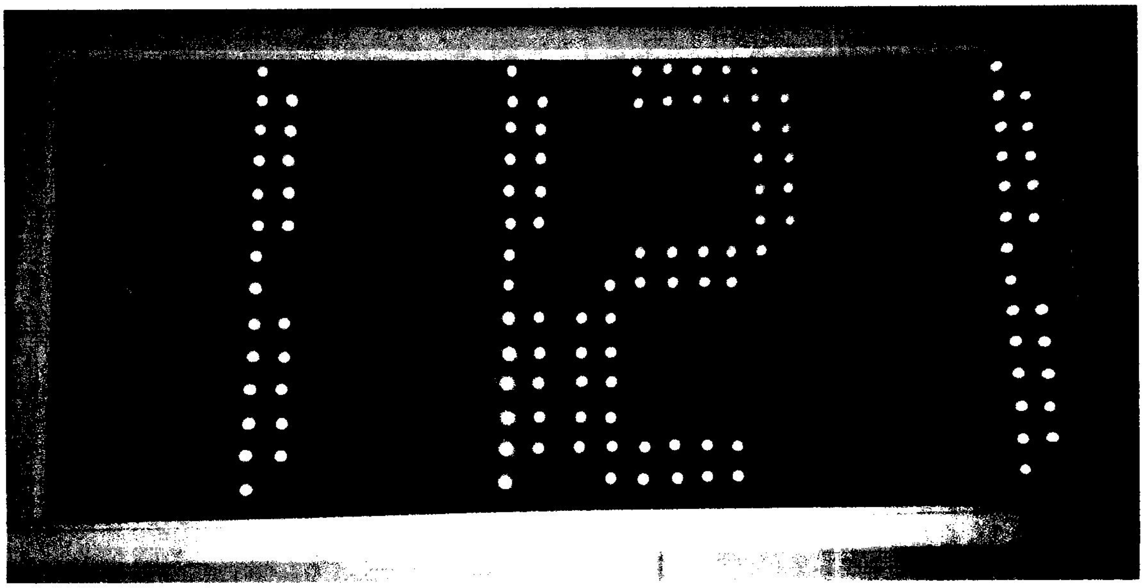

Fig 4.2: Finished Project and Testing

5.3. RECOMMENDATION

The following recommendations were noted for further work:

Provision of a more efficient power source such as rectified AC source.

The use of other programming language with greater flexibility than assembly Language such as programming in C.

Integrating a Speaker to the Buzzer to increase the amplitude of pitch of the sound generated.

A red LED colour should be used to increase the brightness of the display.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

A unique PIC and seven segments based intelligent Digital alarm clock was designed successfully. Its required power is very low. To make it user friendly, different button has been assigned for minute and hour to operate the device.

The accuracy of the clock is dependent upon the accuracy of the crystal and the accuracy of the match between the capacity load of the oscillator circuit and the capacitive load for which the crystal was trimmed.

This project can find its applications in buildings such as hospitals, offices, libraries, and personal houses.

5.2. LIMITATION

During the work, certain limitations were encountered despite the fact that the circuit can save a lot of time and eliminate fatigue and inefficiencies in human operation, it has the following limitations:

The reliability depends largely on the power source. Failure of the battery in case of low battery strength, this will make the system stop operation.

- The digital clock can't be used in our cars because of its size.
- Low finance during Implementation.
- Difficulty when writing programs, debugging and interfacing
- Component Failures.

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APPENDIX I

Table A: Pin Description of PIC 16F84A

Pin Name	DIP No.	SOIC No.	I/O/P Type	Buffer Type	Description
OSC1/CLKIN	16	16	I	ST/CMOS [3]	Oscillator crystal input/external clock source input.
OSC2/CLKOUT	15	15	O	—	Oscillator crystal output. Connects to crystal or resonator in crystal oscillator mode. In RC mode, OSC2 pin outputs CLKOUT which has 1/4 the frequency of OSC1, and denotes the instruction cycle rate.
MCLR	4	4	I/P	ST	Master clear (reset) input/programming voltage input. This pin is an active low reset to the device.
					PORTA is a bi-directional I/O port.
RA0	17	17	I/O	TTL	
RA1	18	18	I/O	TTL	
RA2	1	1	I/O	TTL	
RA3	2	2	I/O	TTL	
RA4/T0CKI	3	3	I/O	ST	Can also be selected to be the clock input to the TMR0 timer/counter. Output is open drain type.
					PORTB is a bi-directional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs.
RB0/INT	6	6	I/O	TTL/ST [1]	RB0/INT can also be selected as an external interrupt pin.
RB1	7	7	I/O	TTL	
RB2	8	8	I/O	TTL	
RB3	9	9	I/O	TTL	
RB4	10	10	I/O	TTL	Interrupt on change pin.
RB5	11	11	I/O	TTL	Interrupt on change pin.
RB6	12	12	I/O	TTL/ST [2]	Interrupt on change pin. Serial programming clock.
RB7	13	13	I/O	TTL/ST [2]	Interrupt on change pin. Serial programming data.
VSS	5	5	P	—	Ground reference for logic and I/O pins.
VDD	14	14	P	—	Positive supply for logic and I/O pins.

Legend: I = input O = output I/O = Input/Output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

Note 1. This buffer is a Schmitt Trigger input when configured as the external interrupt.
2. This buffer is a Schmitt Trigger input when used in serial programming mode.
3. This buffer is a Schmitt Trigger input when configured in RC oscillator mode and a CMOS input otherwise.

APPENDIX II

COST OF COMPONENTS

S/N	COMPONENT	QUANTITY	UNIT PRICE (N)	TOTAL AMOUNT
1	PIC 16F84A	1	2,000	2,000
2	LEDs	74	30	2,220
3	ELECTROLYTIC AND CERAMIC CAPACITORS	3	80	240
4	BRIDGE RECTIFIER	1	150	150
5	BREADBOARD	1	800	800
6	CASING		800	800
7	7806 VOLTAGE REGULATOR	1	250	250
8	VERO BOARD	1	250	250
9	KEYPAD SWITCHES	3	200	600
10	TIP 41C TRANSISTOR	1	150	150
11	BUZZER	1	300	300
12	ULN 2003AN TRANSISTOR	1	180	180
13	OSCILLATOR	1	250	250
14	RESISTORS	8	80	640
15	TRANSPORT			5000
	TOTAL			13,830

APPENDIX III

COMPLETE PROGRAM CODE

```
PROCESSOR PIC16F84A

INCLUDE          <P16F84A.INC>

RADIX            HEX

ORG        0000h

GOTO MAIN

ORG        0004h

GOTO ISR


;**********************************

***************************

;        12 HOUR DIGITAL CLOCK

PROGRAM

;        YOUR NAME:

;**********************************

*****************************



CBLOCK     0Ch

S1

S10

M1

M10

H1

H10

DEL

DEL0

DEL01

DEL02

WHAT

QSTAT


ENDC


BSF STATUS,5

CLRF TRISA

BCF STATUS,5
```

```
#DEFINE      DP PORTB,0   ; PIN NO
06  DECIMA POINT

BCF DP

DELAY01     DECFSZ      DEL,1
                    GOTO $-.1
                    CLRF  PORTB
                    RETURN
DELAY02     MOVLW       .2
                    MOVWF
       DEL01
                    DECFSZ
       DEL01,1
                    GOTO $-.1
                    RETURN

; SEVEN SEGMENT DISPLAY
CONNECTING  TABLE

TABLE       ADDWF       PCL,1;
                        hgfedcba  segments
            RETLW       B'01111110'
            ;0 ;
            RETLW       B'00001100'
            ;1
            RETLW       B'10110110'
            ;2
            RETLW       B'10011110'
            ;3
            RETLW       B'11001100'
            ;4
            RETLW       B'11011010'
            ;5
            RETLW       B'11111010'
            ;6
            RETLW       B'00001110'
            ;7
            RETLW       B'11111110'
            ;8
            RETLW       B'11011110'
            ;9
```

```
SCAN MOVLW      B'00000001'
        ;SEGMENT 01
                MOVWF   PORTA
                MOVFM1,0
                CALL TABLE
                MOVWF   PORTB
                CALL DELAY01
                MOVLW   B'00000010'
        ;SEGMENT 02
                MOVWF   PORTA
                MOVFM10,0
                CALL TABLE
                MOVWF   PORTB

                CALL DELAY01
                MOVLW   B'00000100'
        ;SEGMENT 03
                MOVWF   PORTA
                MOVFH1,0
                CALL TABLE
                MOVWF   PORTB

                CALL DELAY01
                MOVLW   B'00001000'
        ;SEGMENT 04
                MOVWF   PORTA
                MOVFH10,0
                CALL TABLE
                MOVWF   PORTB
                CALL DELAY01
                RETURN

INCR    INCF    S1,1
                MOVFS1,0
                BCF     STATUS,Z
                XORLW   .10
                BTFSSSTATUS,Z
                RETURN
                CLRF S1
                INCF S10,1
```

```
        MOVF S10,0
        BCF     STATUS,Z
        XORLW   .6
        BTFSS STATUS,Z
        RETURN
        CLRF  S10
INCR_SM     INCF  M1,1
            MOVF M1,0
            BCF
    STATUS,Z
            XORLW
    .10
            BTFSS
    STATUS,Z
            RETURN
            CLRF  M1
            INCF
    M10,1
            MOVF
    M10,0
                    BCF
        STATUS,Z
                    XORLW
        .6
                    BTFSS
        STATUS,Z
                    RETURN
                    CLRF  M10

INCR_SH         INCF    H1
            ;BSF DP
                SWAPF
        H10,0
                ADDWF   H1,0
                BCF
        STATUS,Z
                XORLW   13h
                BTFSS STATUS,Z
                GOTO $+6
                CLRF  H1
                CLRF  H10
```

```
                MOVLW .1
                MOVWF       H1
        ; BCF   DP
                RETURN
                MOVFH1,0
                BCF
        STATUS,Z
                XORLW       .10
                BTFSSSTATUS,Z
                RETURN
                CLRF  H1
                INCF  H10,1
                RETURN
ISR             BCF
        INTCON,GIE
            MOVWF       WHAT
            SWAPF       STATUS,0
            MOVWF       QSTAT
            BCF
        INTCON,T0IF
```

```
        MOVLW       .5
        MOVWF       TMR0
        INCF   DEL0,1
        MOVFDEL0,0
        ANDLW       B'01111111'
        BCF         STATUS,Z
        XORLW       .125
        BTFSSSTATUS,Z
        GOTO LABLE
        BTFSSDEL0,7
        GOTO $+.5
        CLRF  DEL0
        CALL  INCR
        GOTO LABLE
        GOTO LABLE
        BTFSSDEL0,7
        GOTO $+.5
        CLRF  DEL0
        BCF    DP              ;
DECIMAL  POINT
```

```
        CALL  INCR
        GOTO LABLE
        MOVLW       .200   ;
DECIMAL POINT DELAY SETTING
        MOVWF       DEL0
    ;DECIMAL POINT
        BSF     DP

LABLE           SWAPF
    QSTAT,0
                MOVWF
    STATUS
                SWAPF
    WHAT,1
                SWAPF
    WHAT,0
                BSF
    INTCON,GIE
                RETFIE

KEY             BSF
        OPTION_REG,7
                BCF
        INTCON,GIE
                BSF
        STATUS,RP0
                MOVLW
        B'11101111'
                MOVWF
        TRISB
                BCF
        STATUS,RP0
                MOVLW
        B'00000000'
                MOVWF
        PORTB
                CALL  DELAY02
;
**********************************
SM1   BTFSC         PORTB,1  ; SET
MINITUS
            GOTO SH1
```

```
        CALL  INCR_SM
        GOTO KEYX
;*********************************
*
;*********************************
*
SH1     CALL  DELAY02
        BTFSC      PORTB,2  ;
SET HOUR
        GOTO KEYDE
        CALL  INCR_SH
;*********************************
*
KEYX        BSF
        STATUS,RP0
            CLRF  TRISB
            BCF
        STATUS,RP0
```

```
                MOVLW       .100
                MOVWF
        DEL02
                CALL  SCAN
                DECFSZ
        DEL02,1
                GOTO $-.2
                BSF
        INTCON,GIE
                BCF
        OPTION_REG,7
                RETURN

KEYDE       BSF
        STATUS,RP0
                CLRF
        TRISB
                BCF
        STATUS,RP0
                BSF
        INTCON,GIE
```

```
BCF
OPTION_REG,7

RETURN

MAIN
BCF DP

CLRF  H1
CLRF  H10
CLRF  DEL
CLRF  DEL0
CLRF  DEL01
CLRF  DEL02
CLRF  WHAT
CLRF  QSTAT
BSF   STATUS,RP0
CLRF  TRISB
CLRF  TRISA
MOVLW      B'00000011'
MOVWF
OPTION_REG
BSF
INTCON,T0IE
BSF
INTCON,GIE
BCF
STATUS,RP0
CALL  SCAN
CALL  KEY

GOTO $-.2

ORG        2007h
DATA 3FF1h
END
```