DESIGN AND CONSTRUCTION OF A MICROCONTROLLER BASED DIGITAL CLOCK WITH CALENDAR AND MESSAGE DISPLAY

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DEDICATION

This project is dedicated to God almighty, whose grace, unfailing love and mercy has seen me through the challenges and hurdles of my academic pursuit. It is also dedicated to my parents Mr and Mrs Tony Ezeh Nomeh and my brothers and sisters, Agatha Ezeh, Arinze Ezeh, Obinna Ezeh, Gloria Ezeh, and little Amarachi Ezeh and lastly to my love Medayedu Tayo.

DECLARATION

I, Ezeh Ugochukwu declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

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ABSTRACT

This project is about the design and construction of a digital clock with calendar and a digital message display using a microcontroller (AT89S52) a liquid crystal display (LCD), a 9v battery and other circuitry like the crystal, resistor, push buttons, and capacitors. These three major components (The microcontroller, the liquid crystal display and the battery), help keep track of time: hours, minutes, seconds, months, years. The LCD is the display unit while there are push buttons to be used to control the resetting of time where necessary. The instruction to be carried out is programmed on the microcontroller which accesses its own memory, and displays the information on the Liquid Crystal Display.

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CHAPTER ONE

GENERAL INTRODUCTION

Time is an essential part of the measuring system, used to sequence events, to compare the duration of events and the intervals between them, and to quantify the motions of objects. Time has been a major subject of religion, philosophy and science.

Time is one of the seven fundamental physical quantities in the international systems of units. Time is used to define other quantities such as velocity, acceleration, impulse etc. the importance of time in our lives cannot in any way be over emphasized, you can't imagine the life that we are leading without the invention of the concept of time. Even more important is a time system that can easily be accessible or readable.

A clock is a device that enables us keep track of time, hours minutes and seconds. With a complete cycle of 24 hours making a day. Once it's a new day, then we have a complete event of a new calendar day.

A calendar system is a system of measuring time for the needs of civil life, by dividing time into days, weeks, months and years. Calendar divisions are based on the movement of the earth and the regular appearance of the sun and the moon. A day is the average time required for one rotation of the earth on its axis. The measurement of a year is based on one revolution of the earth around the sun and is called a seasonal, tropical or solar year. A solar year, contain 365 days, 5 hours, 48 minutes and 45.5 seconds.

This project involves the design of a system that enables us keep track of time, dates, and at the same time has an additional feature of a message display. This digital clock and calendar will make use of a microcontroller, an LCD display and other circuitries such as crystal oscillator, resistors etc. for its operation. The fast growth in electrical and electronic technology has made it now easy to design a digital clock/calendar making use of microcontroller. A combination of the functionality of the microcontroller and the efficiency of the LCD display provides a flexible and a more effective device.

1.2 PROJECT OBJECTIVE

In an attempt to design an effective and accurate means of time measurement using digital systems most previous local researchers, project-works of many graduates in the department of the electrical and computer engineering F.U.T Minna utilized NE555 IC for generating oscillation which most often was affected by variation in temperature though robust in construction. This project is aimed at implementing the same digital design with a low power IC device and a construction that is simpler, with a view to providing more accurate timing.

Another major drive to this project is the design and construction of a digital clock system that in addition to the display of time and date, will have a message display that will display either the name of an organization or the name of the occupant of an office and hence eliminate the need for metallic name tags placed in offices.

1.3 METHODOLOGY

In this project, one will use a microcontroller, its circuitries and a LCD display basically. A microcontroller is a programmable Interface controller (PIC) that will be programmed with a low level program to help achieve a high level of timing as required for the implementation of the digital clock and calendar with message display. Here, the microcontroller (AT89S52) is programmed and interfaced with the liquid crystal display. The result of this is to access the data provided in its memory and displays the output on the liquid crystal display.

1.4 PROJECT OUTLINE

This report comprises five chapters, chapter one which introduces the project topic, the project objective, the methodology and project outline. Chapter two is comprised of the background information and the literature review. Chapter three consists of the brief description of components used, the design, construction and implementation. Chapter four contains the testing of the project and result. And finally chapter five consists of the conclusion and recommendation.

CHAPTER TWO

LITERATURE REVIEW

2.1 HISTORICAL BACKGROUND

Time is defined as the interval between two physical events. Any event which repeats itself in regular intervals is called a periodic event. We can use periodic events to measure time.

The first device used to record time of the day was stick or pillar driven into the ground, the length of the shadow cast gives an indication of the first time of the day, while the time at night or when the sun is down was observed by water clocks. This is simply by measuring the amount of water escaping from a vessel through a small hole into the other. This method was rendered inaccurate due to the difficulty in regulating the pressure of water outflow.

The sand glass was also another clock used in the ancient period. It uses the same principle like that of the water clock but here, by means of sand running from one vessel through a narrow passage to another vessel which indicates half an hour and one full hour.

Another clock in use was candle and lamp clocks. This consists of a small glass with numbers inscribed by the side containing oil burning in the glass. As the oil burns out, the oil level reduces, and the time in hour will be indicated with the aid of the inscribed numbers by the side of the bottle.

The construction of the mechanical clock dates back to the 14^{th}century, although there were some primitive versions as early as the 200BC. The first mechanical clocks were sound clocks. They had no faces or hands to look at but bell that rang a number of times each day. More advanced versions of the bell clock were driven by a weight attached to a cord that was wrapped around a cylinder. The weight pulled down the cord to ring the bell. Such were not regular or efficient. And this led to the development of the pendulum clock in 1656 by a Dutch scientist called Christian Huggen and subsequently, due to the short coming of the ancient clocks, the early clock timing systems went into different development processes and this led to the evolution of the modern clocks.

Clockmakers developed their art in various ways. Building smaller clocks was a technical challenge. Clocks could be impressive showpieces to demonstrate skilled craftsmanship, or less expensive, mass-produced items for domestic use. The escapement in particular was an important factor affecting the clock's accuracy; so many different mechanisms were tried.

The first record of a minute hand on a clock was in the Almanus Manuscript of Brother Paul in 1475.[1]

During the 15th and 16th centuries, clock making flourished, particularly in the metal working towns of Nuremberg and Augsburg, and, in France, Blois. Some of the more basic table clocks have only one time-keeping hand, with the dial between the hour makers being divided into four equal parts making the clocks readable to the nearest 15 minutes. Other clocks were exhibitions of craftsmanship and skill, incorporating astronomical indictors and musical movements. The cross-beat escapement was developed in 1585 by JobstBurgi, who also developed the remontoire. Burgi's accurate clocks helped Tycho Brahe and Johannes Kepler to observe astronomical events with much greater precision than before. The first record of a second hand on clock is about 1560, on a clock in the Fremersdorf collection. However, this clock could have been accurate, and the second hand was probably for indicating that the clock was working. The next development in accuracy occurred after 1657 with the invention of the pendulum clock. Galileo had the idea to use a swinging bob to propel the motion of a time telling device earlier in the 17th century. Christian Huygens, however, is usually credited as the inventor. He determined the mathematical formula that related pendulum length to time

(99.38cm or 39.13 inches for the one second movement) and had the first pendulum-driven clock made. In 1670, the English clockmaker William Clement created the anchor escapement, an improvement over Huygen's crown escapement. Within just one generation, minute hands and then second hands were added. A major stimulus to improving the accuracy and reliability of clocks was the importance of precise time-keeping for navigation. The position of a ship at sea could be determined with reasonable accuracy if a navigator could refer to a clock that lost or gained less than about 10 seconds per day. Many European governments offered a large prize for anyone that could determine longitude accurately. The reward was eventually claimed in 1761 by John Harrison, who dedicated his life to improving the accuracy of his clock. His clock is reported to have lost less than 5 seconds over 10 days. The excitement over the pendulum clock had attracted the attention of designers resulting in a proliferation of clock forms. Notably, the long case clock (also known as the grandfather clock) was created to house the pendulum and works. The English clockmaker William Clement is also credited with developing this form in 1671. It was also at this time that clock-cases began to be made of wood and clock faces to utilize enamel as well as hand-painted ceramics. On November 17, 1797, Eli Terry received his first patent for a clock. Terry is known as the founder of the American clock-making industry. The development of electronics of the twentieth century led to clocks with no clockwork parts at all. Time in these cases is measured in several ways, such as by the behavior of quartz crystals, the decay of radioactive element or resonance of polycarbonates. Even mechanical clocks have since come to be largely powered by batteries, removing the need for winding.[2]

The early clocks were affected by gravity, location, movement, wear, temperature and they needed constant attention. A pendulum clock would be of little use in a tossing ship at sea. The movement of such things as shadow, sand, fir, sun and moon are not sufficient to measure the change in atomic particles or the movement of bodies in outer space. For these purposes, scientist needed a steady and detailed standard. They eventually found the answers in atoms themselves. Science found out that the predictable vibration (also called waves, oscillations, and resonance) of certain elements could function as a time standard, and this eventually led to the development of the atomic clock which uses the oscillation of the element "Cesium" to measure time. In 1967 the number of oscillations was adopted in the International systems of Unit (SI) as the definition of one second. Years are now officially measured in seconds, which at one time was based on astronomical observation. [3,4]

The advances in technology within the period 1937- 1971 that led to the development of "integrated circuits" culminated in the implementation of several logic functions on a single chip and the introduction of the LSI (Large Scale Integrated) chip in 1970, which witnessed the fourth generation of computing technology and ushered in the modern "Digital Clocks".[4,5]

A digital clock is a type of clock that displays the time digitally, i.e. in cyphers, as opposed to an analog clock, where the time is displayed by hands. Usually, digital clocks are associated with electronic drives, but the "digital" description refers only to the display, not to the drive mechanism. (Analog clocks are driven mechanically or electronically.) The biggest digital clock is the Lichtzeitpegel ("Light Time Level") on the television tower Rheinturm Düsseldorf, Germany. [6]

The digital clock was first invented in 1956 using a collaboration of methods and techniques that had been developed through other technological advances. The main difference a digital clock has over previous pendulum clocks, which were traditionally used before this time, is that its uses electronics method of time keeping. This means that all the functions which aid the clock in telling the time are powered electronically rather than mechanically. The digital clock was traditionally powered by an electronic power supply or quartz movement, the time base or "heartbeat" of the clock is electronic. The gearing mechanism which extract the different component of the time, e.g. hours, minutes and second are electronic, and finally, there is also an electronic display. This uses LCDs or LEDs to show the time in four digits either using the 12 or 24 hour method. With the 12 hour display clocks, the time mechanism had to be set so that when the display fell on 12: 59:59 the reset time shown was not 13: 00: 00 but 01: 00: 00[6].

When digital clocks were first invented, they were simply for telling the time. However, over the years, their functions had really widened and are now incorporated into different uses; the most common of this is the digital alarm clock.

The digital clock provides an accurate, precise and easy to read time display in numerical form unlike the analogue clock that shows time by means of hands on dial hence posing a little difficult for the lay man to read and interpret.

On the other part, the theme of calendar making is the desire to organize units of time to satisfy the needs and preoccupation of society. Calendars have served as a source of sacred order and cultural identity. Calendars have provided the basis for planning agricultural, hunting and migration cycles and to keep track of important events.

According to a recent estimate (Fraser, 1987), there are over forty calendars used in the world today. Some few examples include

The Julian calendar introduced by Julius Caesar in -45 which was a solar calendar with months of fixed lengths.

The Chinese calendar which was a lunisolar calendar based on the calculation of the position of the sun and the moon.

The Gregorian calendar which today serves as an international standard for civil use. It regulates the ceremonial cycle of the Roman Catholics and protestant churches

2.2 THEORETICAL BACKGROUND

There are two basic digital clock constructions, which are the electronic digital clock and the microcontroller based digital clock. The electronic digital clock uses electronic components like capacitors, resistors and the 555 timer as its gearing mechanism. While the microcontroller based digital clock, which is the main focus of this project, is a relatively simpler construction compared to the electronic digital clock, because it only requires the programming of the microcontroller to perform the gearing mechanism and the liquid crystal display to display the timing.

A little improvement to this project is the inclusion of the message display, which displays either the name of an organization, the occupant of an office, and so on. This little modification is aimed at educating any visitor to either the organization or an office, about whom he or she is conversing with or about to meet as the case may be, this digital message display unit is also performed with the aid of a microcontroller.

Materials used in the project are analyzed below.

2.2.1. Resistors: Electrical materials could be divided into conductors, semiconductors and insulators. The parameter used to determine this classification is the resistivity (ρ) of such materials. Good conductors are usually metals and have resistivity in the order of 10^{-7} to $10^{-8}\Omega$m, semiconductors have resistivity in the order of 10^{-3} to $3 \times 10^{3}\Omega$m, and the resistivity of insulators are in the order of 10^{4} to $10^{14}\Omega$m [7]. The resistance of an electrical conductor depends on four factors, these being: (a) the length of the conductor,

(b) The cross-sectional area of the conductor, (c) the type of material and (d) the temperature of the material. Resistance, R, is directly proportional to length, l, of a conductor and inversely proportional to cross-sectional area, A, of a conductor, i.e.

$R = \rho l/A$...2.1

R is measured in Ω, l in m while A in m^2. Resistance is the opposition to the flow of electrons or simply the opposition to electric current [8]. It is required in electronic circuits to limit the current flow, limit the voltage drop and divide the voltage. In combination with capacitor, it is used as filter or it can be used to achieve time constant and so on. The pictures below reveal the different types of resistors used and the circuit representations.

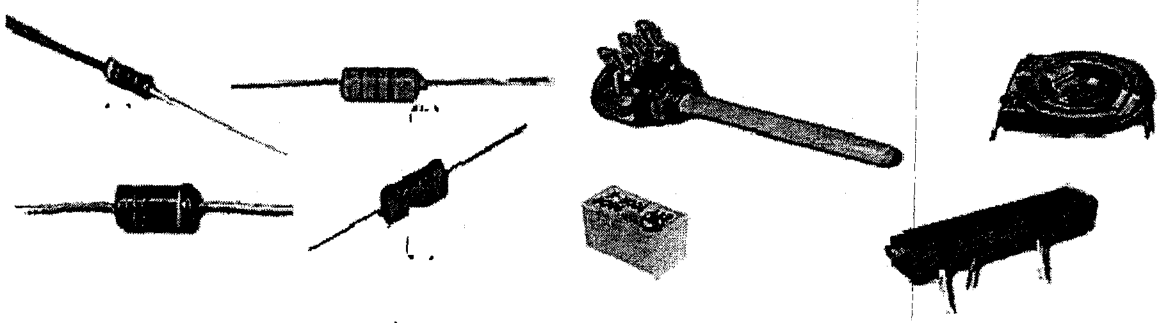


Plate 2.0. Various types of resistors

2.2.2. Capacitors: Two conductors that are not connected and are separated by an insulator constitute a capacitor. When a source of EMF such as a cell is connected to such an arrangement, current flows momentarily, transferring charge (in the form of electrons) from one conducting plate to the other. When a quantity of charge Q (measured in units of coulombs) has been transferred, the voltage across the plates equals the voltage V across the voltage source. For a fixed arrangement of conductors and insulator, the ratio Q/V is a constant called the capacitance, C.

$Q = CV$...2.2

Also the quantity of charge stored is related to the period (t) of charge storage and current (I) that flow through it as indicated below

$Q = It$……………………………………………………………………………………………2.3

The picture below shows us the various common capacitors one can find around and the circuit symbol.

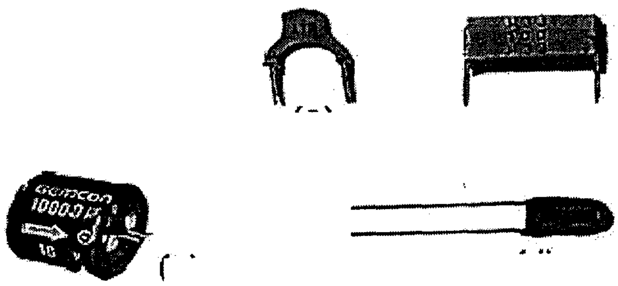
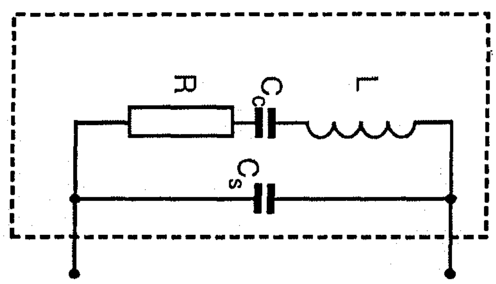


Plate 2.1. Various kind of capacitors.

2.2.3. Crystals: Quartz crystals, cut into thin plates and with electrodes plated onto opposite flat faces, can be used as resonant circuits with Q values ranging from 20 000 to 1 000 000 or more. They are all piezoelectric and can therefore be used as transducers (sender or receiver) for ultrasonic waves [9]. The equivalent circuit of a crystal is shown below.



The L and C values in this equivalent circuit are referred to as *motional inductance* and *motional capacitance*, and values will be specified by the manufacturer. These values, with a very high ratio of L to C, could not be provided by any assembly of separate components, and it is that which provides the very high Q-factor for a crystal. The crystal by itself acts as a series resonant circuit with a very large inductance, small capacitance and fairly low resistance (a few thousand ohms). The stray capacitance across the crystal will also permit parallel resonance to occur at a frequency that is slightly higher than that of the series resonance. This is a highly important component in the project since it determines the performance of the system.

2.2.4. Microcontrollers: The microcontroller may be considered as a specialized computer-on-a-chip or a single-chip computer. The word 'micro' suggests that the device is small, and the word 'controller' suggests that the device may be used to control one or more functions or objects, processes or events. It is also called an embedded controller as microcontrollers are often embedded in the device or system that they control. A microcontroller is a programmable Interface controller (PIC) that can be programmed with op codes to help the operation of the real time clock. Here, in this project, the microcontroller is interfaced with the real time clock and the liquid crystal display. The result of this is to access the data provided by RTC and displayed it on the liquid crystal display.

CRITERIA FOR CHOOSING A MICROCONTROLLER

The basic criteria for choosing a microcontroller suitable for the application are:

1) The first and foremost criterion is that it must meet the task at hand efficiently and cost effectively. In analyzing the needs of a microcontroller-based project, it is seen whether an 8- bit, 16-bit or 32-bit microcontroller can best handle the computing needs of the task most effectively. Among the other considerations in this category are:

(a) **Speed:** The highest speed that the microcontroller supports.

b) **Packaging:** It may be a 40-pin DIP (dual inline package) or a QFP (quad flat package), or some other packaging format. This is important in terms of space, assembling, and prototyping the end product.

(c) **Power consumption:** This is especially critical for battery-powered products. (d) The number of I/O pins and the timer on the chip.

(f) How easy it is to upgrade to higher –performance or lower consumption versions.

(g) **Cost per unit:** This is important in terms of the final cost of the product in which a microcontroller is used.

(2) The second criterion in choosing a microcontroller is how easy it is to develop products around it. Key considerations include the availability of an assembler, debugger, compiler, technical support.

(3) The third criterion in choosing a microcontroller is its ready availability in needed quantities both now and in the future. Currently of the leading 8-bit microcontrollers, the

8051 family has the largest number of diversified suppliers. By supplier is meant a producer besides the originator of the microcontroller. In the case of the 8051, this has originated by Intel several companies also currently producing the 8051.

Thus the microcontroller AT89S52, satisfying the criterion necessary for the proposed application is chosen for the task.

The AT89S52 is a low-power, high-performance CMOS 8-bit microcomputer with 8Kbytes of Flash programmable and erasable read only memory (PEROM) [10]. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80S51 and 80S52 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications. Below is the diagram of a typical AT89S52.

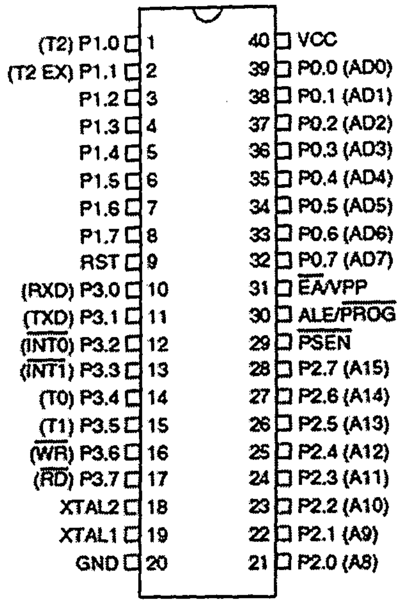


Fig.2.3. a typical AT89S52 Microcontroller

PIN DESCRIPTION

- **VCC:** Supply voltage.
- **GND:** Ground.
- **Port0:**Port0 is an 8-bit open drain bidirectional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port0 pins, the pins can be used as high-impedance inputs. Port0 can also be configured to be the multiplexed low-order address/data bus during accesses to external program and data memory. In this mode, P0 has internal pull-ups.
- **Port1:** Port1 is an 8-bit bidirectional I/O port with internal pull-ups. The Port1 output buffers can sink/source four TTL inputs. When 1s are written to Port1 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port1 pins that are externally being pulled

low will source current (IIL) because of the internal pull-ups. In addition, P1.0 and P1.1 can be configured to be the timer/counter2 external count input (P1.0/T2) and the timer/counter2 trigger input (P1.1/T2EX), respectively.

- **Port2:** Port2 is an 8-bitbidirectional I/O port with internal pull-ups. The Port2 output buffers can sink/source four TTL inputs. When 1s are written to Port2 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port2 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups. Port2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that uses 16-bit addresses (MOVX@ DPTR). In this application, Port2 uses strong internal pull- ups when emitting 1s. During accesses to external data memory that uses 8-bit addresses (MOVX @ RI); Port 2 emits the contents of the P2 Special Function register.

- **Port3:** Port3 is an 8-bitbidirectional I/O port with internal pull-ups. The Port3 output buffers can sink/source four TTL inputs. When 1s are written to Port3 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port3 pins that are externally being pulled low will source current (IIL) because of the pull-ups. Port3 receives some control signals for Flash programming and verification.

- **ALE/PROG:** Address Latch Enable (ALE) is an output pulse for latching the low byte of the address during accesses to external memory. This pin is a l so the program pulse input (PROG) during Flash programming. In normal operation, ALE is emitted at a constant rate of 1/6 the oscillator frequency and may be used for external timing or clocking purposes. Note, however, that one ALE pulse is skipped during each access to external data memory. If desired, ALE operation can be disabled by setting bit 0 of SFR location 8EH. With the bit set, ALE is active only during a MOVX or MOVC instruction. Otherwise, the pin is weakly pulled high. Setting the ALE-disable bit has no effect if the microcontroller is in external execution mode.

•**PSEN:** Program Store Enable (PSEN) is the read strobe to external program memory. When the AT89S52 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

• **EA:** External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH. Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset. EA should be strapped to VCC for internal program executions. This pin also receives the 12-volt programming enable voltage (VPP) during Flash programming.

•**XTAL1:** Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

• **XTAL2:** Output from the inverting oscillator amplifier.

2.2.5 REGULATORS

The MC78XX/LM78XX/MC78XXA series of three terminal positive regulators are available in the TO-220/D-PAK package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents. [11]

The diagram below shows the diagram and features of a typical regulator in a TO-220 package [11]

TO-220

Fig.2.4. a typical regulator

FEATURES:

- Output Current up to 1A
- Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24V
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

2.2.6 THE LIQUID CRYSTAL DISPLAY

The Liquid crystal display (LCD) is a flat panel display noted for its thin profile, light weight, and low power consumption it has numerous advantages over the Light emitting diode display (LED) some of which include; much lower power consumption and better visibility in direct sunlight.[12]

The Liquid crystal display (LCD) display is a device designed for interfacing with embedded systems. They come with common configurations of 8x1 characters, 16x2, and 20x4 among others. The largest such configuration is 40x4 characters, but these are rare and are actually two separate 20x4 screens seamlessly joined together. Character LCDs can come with or without backlights. Backlights can be LED, fluorescent, or electroluminescent. LCDs can also come with one controller or two controllers. Most LCDs with 1 controller has 14 Pins and LCDs with 2 controller has 16 Pins (two pins are extra in both for back-light LED connections). The diagram and Pin description of a 16 pin LCD is shown below [13].

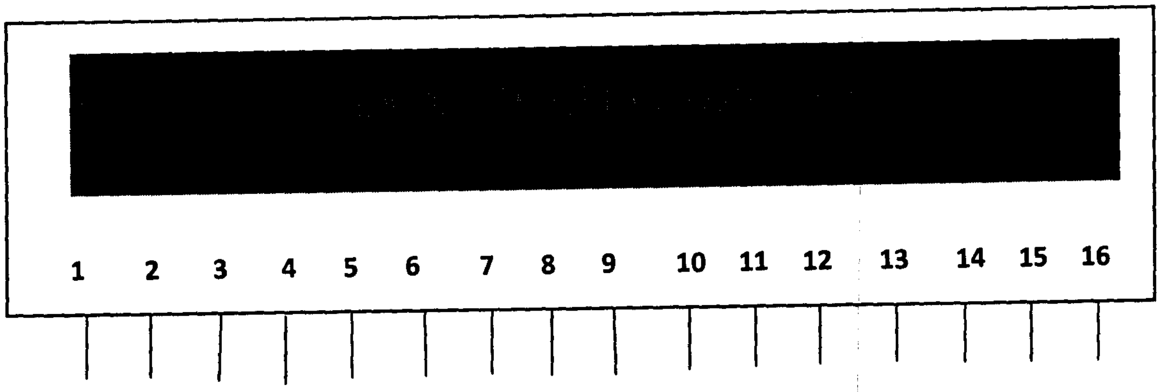


Fig.2.5.A 16 pin LCD display

PIN NUMBER	NAME	DESCRIPTION
1	VSS	Power supply (GND)
2	VCC	Power supply (+5V)
3	VEE	Contrast adjust or Operating Voltage of LCD
4	RS	0 =Instruction input 1 = Data input
5	R/W	0 = Write to LCD module 1 = Read from LCD module
6	EN	Enable signal
7	D0	Data bus line 0
8	D1	Data bus line 1

9	D2	Data bus line 2
10	D3	Data bus line 3
11	D4	Data bus line 4
12	D5	Data bus line 5
13	D6	Data bus line 6
14	D7	Data bus line 7
15	A	LED+
16	K	LED-

Table 1: Character LCD pins with 2 Controller

CHAPTER THREE

DESIGN AND IMPLEMENTATION

3.1 PRINCIPLE OF OPEERATION

The digital clock with calendar and message display is designed around a 16X2 LCD display and a microcontroller. The microcontroller, initializes via the power on resetting of the microcontroller, computes the variables associated with the systems functionality, and communicates with the 16X2 LCD display.

A 16X2 liquid crystal display provides feed back to the user. And also, since solely digital parts are used, this device communicates via defined protocols and hence the need for a microcontroller that will emulate this protocol.

The microcontroller coordinates the system's activities and generates the necessary signals besides undertaking logical operations on the various variables stored on its on-chip memory. The microcontroller is an AT89S52 has a 2KB of internal flash (read only memory), 128 bytes of RAM (Random access Memory) and a hand-full of on-chip peripherals.

The block diagram below shows the building blocks of the digital clock.

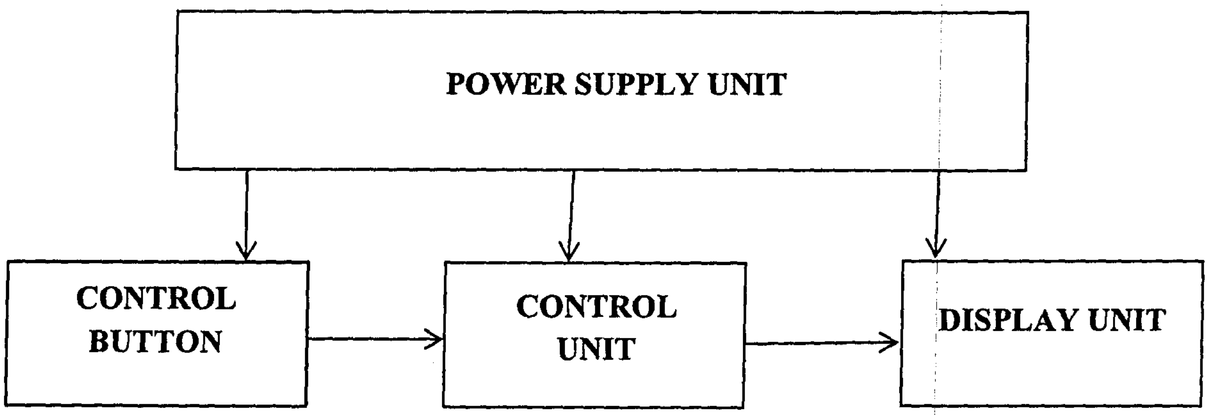


FIG. 3.0 Block diagram of a digital clock with calendar

3.2 THE POWER SUPPLY UNIT

The power supply unit used here is a combination of a 9 V battery and a 5V regulator, the regulator is chosen because the VCC value needed for the purpose of this project is 5V, hence the regulator here, allows only about 5V through its output, which is tapped to supply the power required in the circuit. The circuit below shows the basic design of the power supply unit

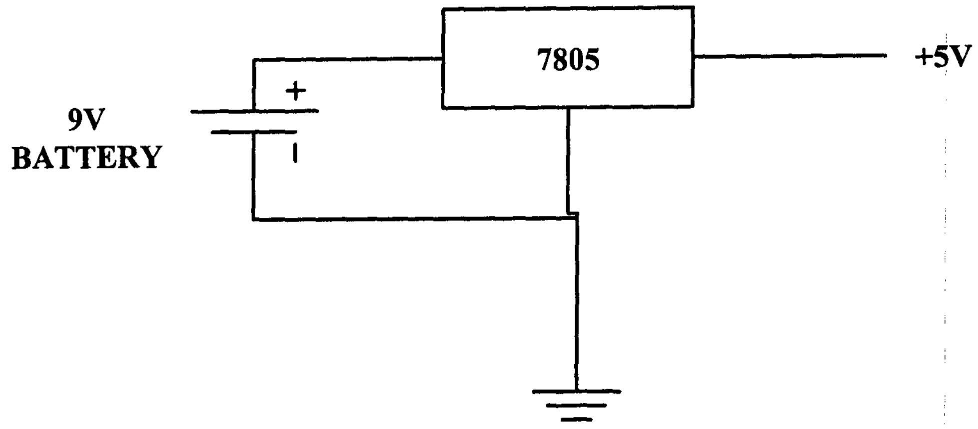


FIG 3.1 the power supply unit

3.3 THE DISPLAY UNIT

The Display Unit is made up of the Liquid Crystal Display and its circuitry; like the connecting wire and variable resistors. The variable resistors are used here to adjust the screen brightness of the LCD, one is connected between pin 3 and 15 and the other links pin 2 to the VCC. For the LCD to be used, first it has to be initialized, that is, some instructions have to be sent from the microcontroller to the LCD to set the LCD ready to receive data. Part of the initializations, include; setting of function, entry mode, display ON as seen in a data sheet of the LCD. After initialization, one can then send any desired data.

Sending data are in two ways;

- 8-bit mode.
- One nibble mode

The 8-bit mode uses 8-bit of a port in the microcontroller to send data or instruction, while the one-nibble uses 4-bit to send data or instruction. In this project, the 4-bit mode is used to send data. In the 4-bit mode, only four from the eight data bit line were used, while others i.e. Pin 7, 8, 9 and 10 were grounded. Pin 11, pin 12, pin 13, pin 14 were connected to pin 2.0, pin 2.1, pin 2.2, and pin 2.3 of the microcontroller respectively.

In order to set the operating voltage of the LCD, pin 3 was connected to the variable resistor, to power the LCD, pin 1 was connected to ground and pin 2 was connected to VCC. And also, since it is required in this project that the microcontroller writes to the liquid crystal display, the read-write pin (pin 5) is grounded because a logic 0 or ground at pin 5 initiates a write to LCD module operation. The background light of the display is a blue LED that is lighted through the pin 15 and 16 of the LCD, pin 16 is grounded while pin 15 is connected to VCC through a protective resistor of 470Ω to protect the LED from excess voltage.

The diagram below shows the circuit arrangement for the display unit.

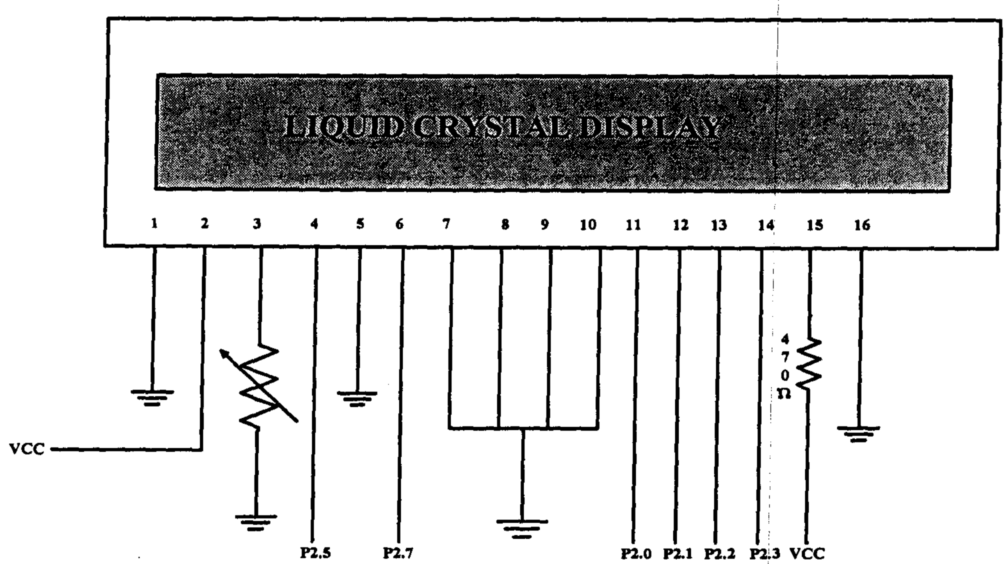


FIG.3.2. the display unit

3.4 THE CONTROL UNIT

The control unit is an AT89S52 microcontroller, which is a 40 pin device having four (4) port (port 0, port 1, port 2, port 3), these ports are 8-bit or 1 byte in nature. The microcontroller cannot work properly except with the help of some basic components as shown below;

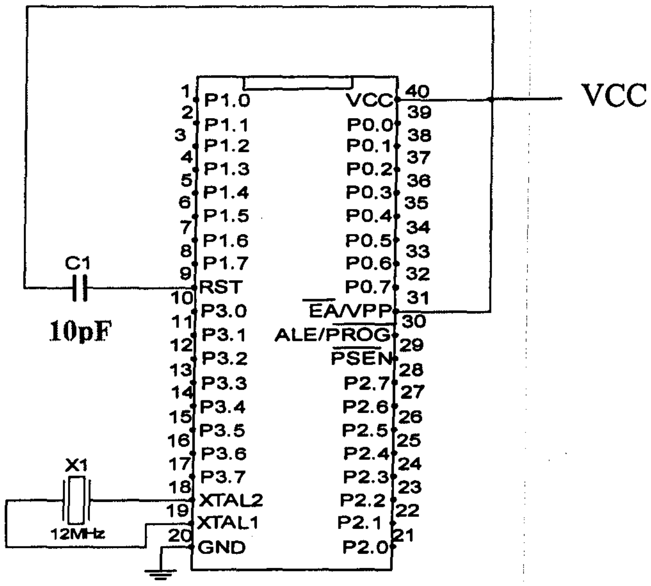


Fig 3.3.The control unit.

The capacitor between pin 9 and VCC is called reset. The capacitance of the capacitor is enough to initiate a delay so that the program counter of the microcontroller can be reset back to the beginning of the program. The resetting is done automatically when the system is powered ON, hence it is termed a power on reset method, in contrast to the push button or switch activated reset method where the system can be set back to the beginning manually via a push button or switch.

Pin 18 and 19 consist of the crystal oscillator. This oscillator is like the heartbeat of the microcontroller because it determines the speeds of operation of the microcontroller.

Pin 31 of the microcontroller is connected to the VCC so as to enable the microcontroller fetch codes from within its memory.

3.5 THE CONTROL BUTTON

This is a combination of push button interfaced with the microcontroller, such that one could call for a setting interrupt, via the pin 12 of the microcontroller, when the interrupt request is granted by the microcontroller, the push button on pin 11 and 10 are used to either increment or decrement the time or date, respectively as the case may be. This unit gain there functionality by working with the program in the microcontroller, a special interrupt had been programmed into the microcontroller for the specific purpose of setting the digital clock using the control button. The diagram bellow shows the circuit layout for the control button unit.

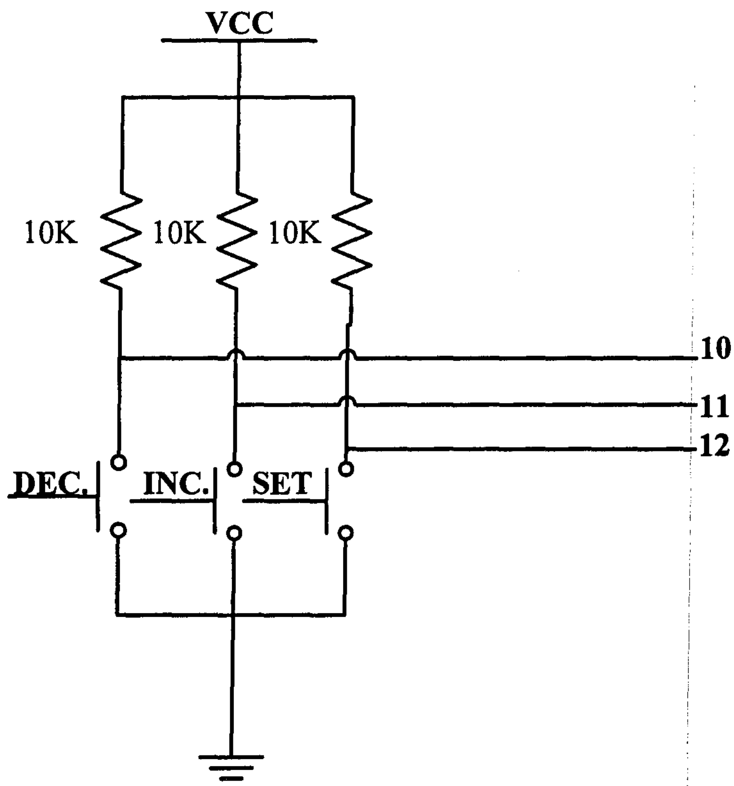


FIG.3.4. the control button.

3.6 THE COMPLETE CIRCUIT DIAGRAM

The figure below shows the interconnection of all the units discussed above and hence the complete circuit diagram of the system.

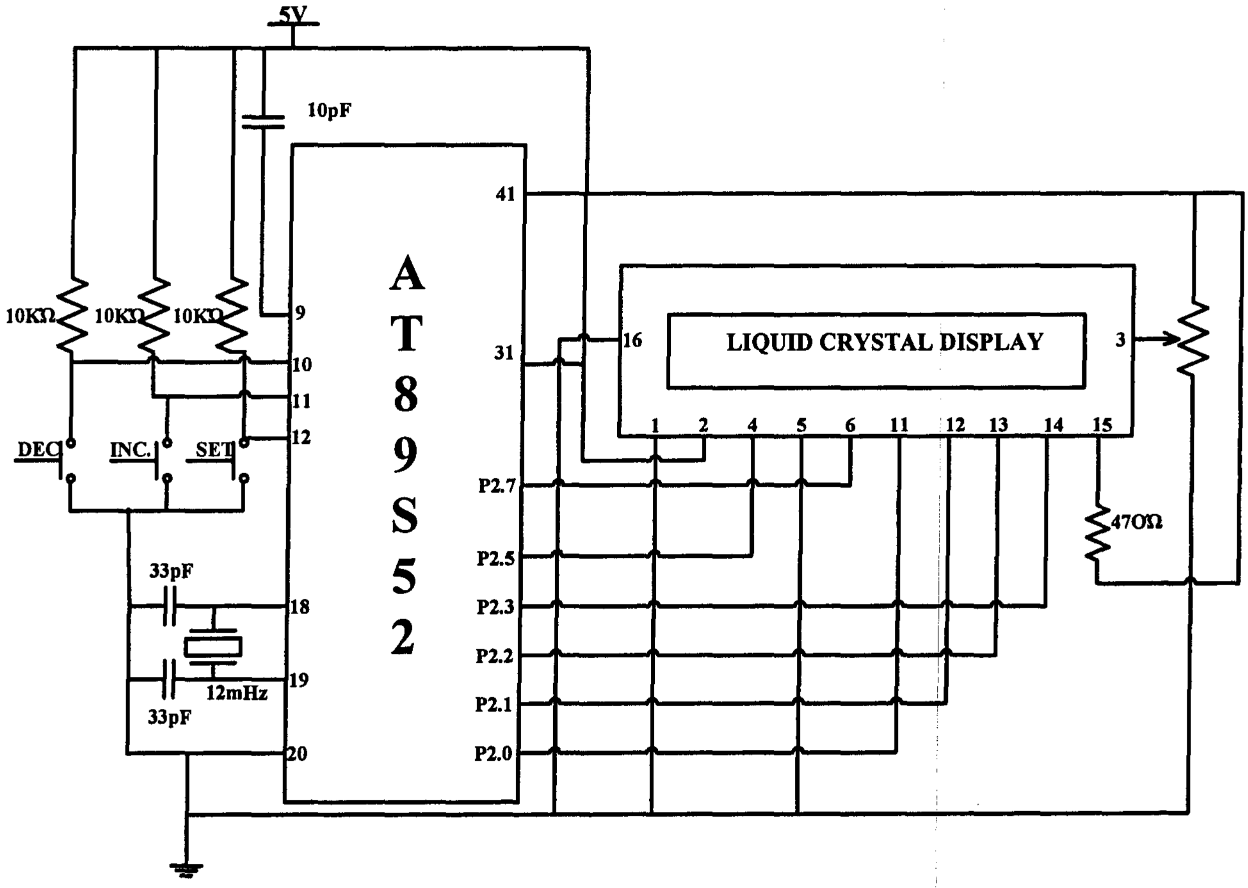


FIG. 3.5 complete circuit diagram

CHAPTER FOUR

CONSTRUCTION AND TEST

4.1 CONSTRUCTION AND CASING.

Each stage of the circuit was first built on a breadboard to check the practical workability of each stage. As soon as all was seen to be working, the whole work was then transferred on a 30cm x 80cmVero board and tests were carried out on it. When it was discovered that the whole project was working in a good condition, everything was then cased.

4.2. PRECAUTIONS.

Proper and neat soldering was carried out to avoid unnecessary short circuiting on the board. Components soldered on the Vero board were spaced from each other to avoid complications. The project was tested to determine its reliability and durability.

4.3 TESTING

The source code was carefully written to avoid logic error. The hex file from the source code was generated and burnt into the microcontroller with the aid of a programmer.

Adequate tests were carried out on each stage of the project so as to see to the proper working condition of the project. The timing of the clock was compared with the timing of a typical digital clock and the following results were obtained.

PROPERTY	TYPICAL CLOCK	DESIGNED CLOCK	EFFICIENCY OF DESIGN	ERROR IN DESIGN
1 MINUTE	60 seconds	58 seconds	97%	3%
1 HOUR	3600 seconds	3480 seconds	97%	3%

TABLE 2: Result From Test

4.4. DISCUSSION OF RESULT.

From the result obtained above, an error of 3% was obtained for our design; this is mainly due to approximations in our 1 second delay estimation at the software design stage. But this error can be accommodated. And on the positive side, an efficiency or quality of 97% is very fair and hence we have an efficient time measuring tool.

CHAPTER FIVE

CONCLUSION

5.1 PROBLEM FACED

Most components to be used were hard to obtain. And during the bread board testing, the output obtained was not the desired output, this really caused much delay in the construction until it was found out that liquid crystal display do not function effectively on bread board.

5.2 RECOMMENDATION

I recommend that prior preparation should be made as regards to the availability of design components, before embarking on the design, and also during the testing of work on bread board, it should be noted that liquid crystal displays do not perform effectively on bread board, this will help avoid wastage of time troubleshooting at the preliminary stage of design.

5.3 POSSIBLE IMPROVEMENT

To improve the functionality and performance of this device, the following improvements could be made.

- A real time clock should be used, as this will help take care of leap years automatically, and also, the real time clock has internal battery that will help during power outage by keeping the clock running internally, such that when power is restored, no need for setting of time, because the time that will be displayed will be the accurate time.
- A larger liquid crystal display (like the 20 by 4) should be used, so that complete information about time, the date and the message will be displayed to avoid too much abbreviation due to lack of space on the display modules.

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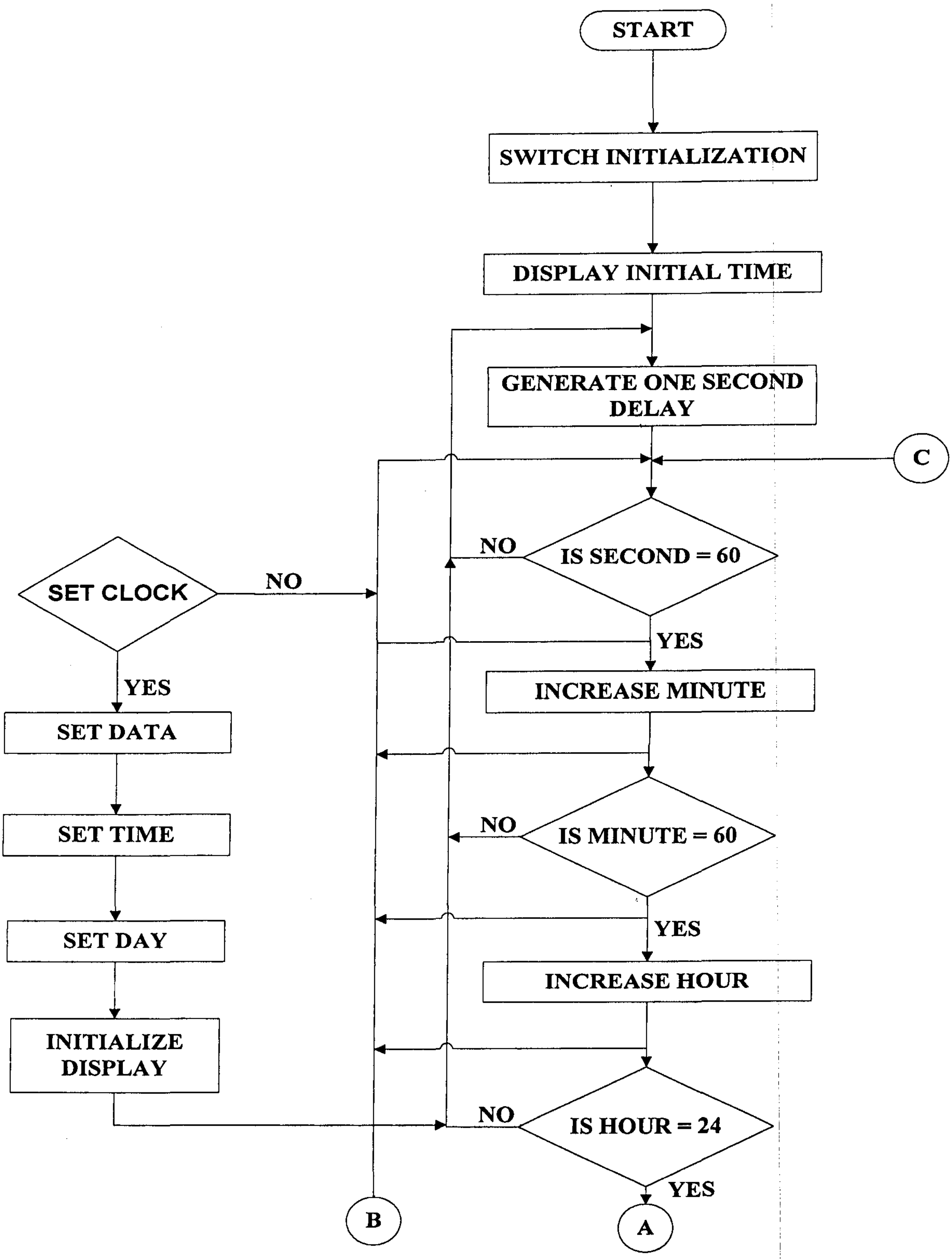
APPENDICES

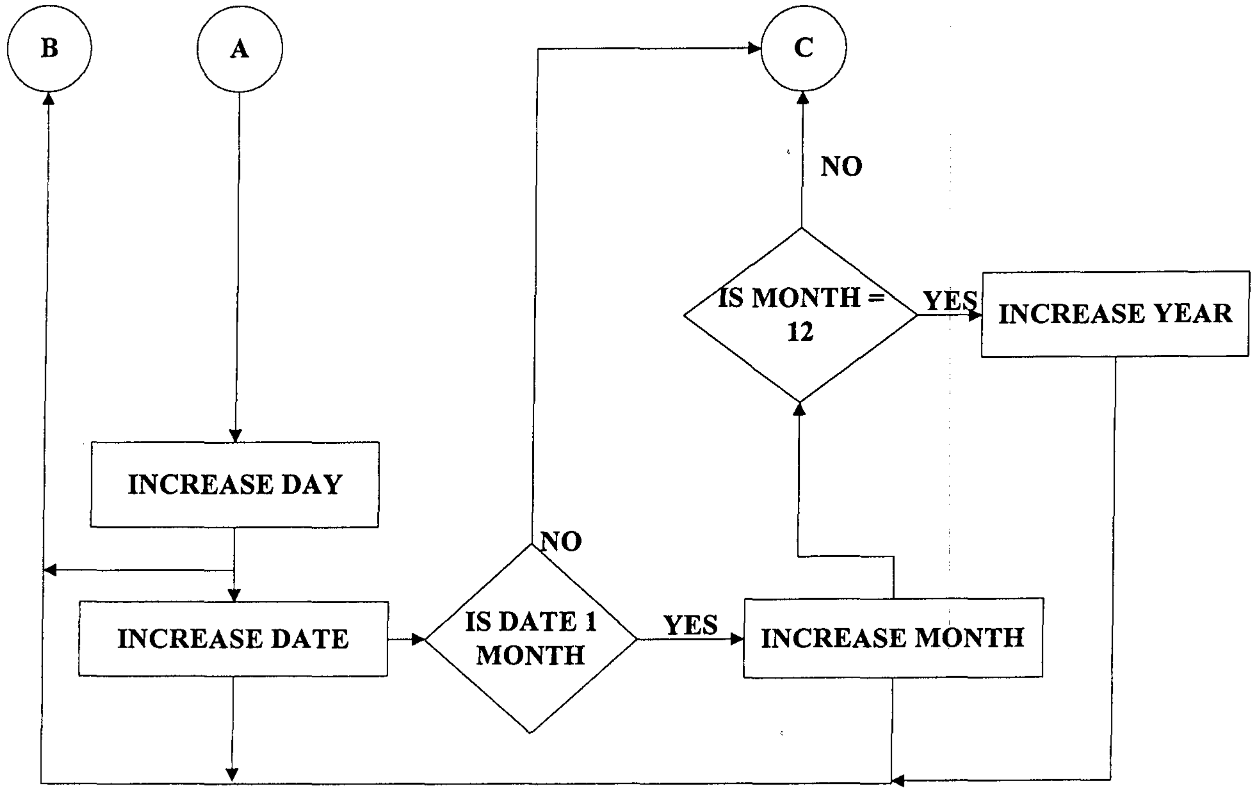
APPENDIX 1: PICTURE OF COMPLETED DESIGN.

FRONT VIEW

ISOMETRIC VIEW

APPENDIX 2: THE FLOW CHART





The Flow Chart

APPENDIX 3: THE SOURCE CODE

```
#include <ugoport.h>
#include <intrins.h>
unsignedint x;

bit_8 code *days[]={"Sun","Mon","Tue","Wed","Thur","Fri","Sat"}; // days array

bit_8 code *mon[]={"Jan","Feb","Mar","Apr","May","Jun","Jul","Aug","Sep","Oct","Nov","Dec"};

bit_8 code *val[]={"0","1","2","3","4","5","6","7","8","9","10","11","12"};        // digit array

bit_8 month=1,date=1,hh,lmin,hmin,hsec,lsec,day=0,lyear=0,hyear=1,date_count;
bit flag;

voidmonth_select(bit_8 mon)
{
        bit_8 year;
        switch(mon)
        {
                case 1:
                case 3:
                case 5:
                case 7:
                case 8:
                case 10:
                case 12:
                        date_count=31;
```

```
                        break;
                case 2:
                        year=hyear*10+lyear;
                        if(year%4==0)
                                date_count=29;
                        else
                                date_count=28;
                        break;
                case 4:
                case 6:
                case 9:
                case 11:
                        date_count=30;
                        break;
        }
}
/*-----------------------
-- Displaying the date --
-----------------------*/

voiddate_in(bit_8 a)
{
        bit_8 j;
        j=a/10;
        data_in(val[j]);
        j=a%10;
        data_in(val[j]);
}
```

```
void sec1()
  {
        /*unsigned int i;
            for(i = 0; i < 33000; i++);*/
      bit_8i,j;
      TMOD=0x11;
      for(i=0;i<75;i++)
            _nop_();
      for(i=0;i<7;i++)
      {
            TH1=0;
            TH0=1;
            TL1=0;
            TL0=0;
            TR1=1;
            for(j=0;j<119;j++)
                  _nop_();
            while(TF1!=1)
            {
                  for(j=0;j<255;j++);
                        _nop_();
            }
            TF1=0;
            TR0=1;
            TR1=0;
            while(TF0!=1)
            {
```

```
                for(j=0;j<120;j++)
                        _nop_();
            }
            TF0=0;
            TR0=0;
    }
    }
void main()
  {
     bit_8 temp;
       ENABLE_INT
       LCD_INI();
            command(0x80);
            data_in("Digital Clock By");
            command(0xC1);
            data_in("Ezeh Ugochukwu");
            for(x = 0; x < 10; x++)
            sec1();
            command(0x06);
            command(0x01);
            command(0xC1);
            data_in("Engr A G Raji");
       //disp_intro();
     sel_param=1;
     chg_param_inc=1;
     chg_param_dec=1;
     month_select(month);
            while(1)
```

```
{
month_select(month);
        while(date<=date_count)
            {
                command(0x80);
                        date_in(date);
                        command(0x82);
                        data_in(" ");
                        data_in(mon[month-1]);
                        command(0x86);
                        data_in(",");
                        data_in(val[hyear]);
data_in(val[lyear]);
                        for(hh=1;hh<=24;hh++)
                            {
                                // command(0xC0);
                                    //data_in(days[day]);
                                   if(hh<=12)
        bdata_in(hh,0x8A);
    else
                {
        temp=hh-12;
        bdata_in(temp,0x8A);
                }
                                              if(hh<12||hh==24)
                {
        command(0x8F);
        data_in("a");
```

```
                        }
                else
                {
                        command(0x8F);
                        data_in("p");
                        }


}

voidset_clock(void)
  {
        bit_8 temp;
             DISABLE_INT
            command(0x01);
            command(0x80);
            data_in("set");
            command(0x8C);
            data_in("date");
            command(0x0F);
            command(0xC4);
            date_in(date);
            command(0xC6);
            data_in("/");
            if(month<=9)
            data_in(val[0]);
            data_in(val[month]);
        command(0xc9);
            data_in("/");
```

```
                data_in(val[hyear]);
        data_in(val[lyear]);
command(0x80);
                data_in("Select Date");
up2:  while(chg_param_inc!=0&&chg_param_dec!=0&&sel_param!=0);
if(chg_param_inc==0)
                  {
                        lyear++;
                        if(lyear==10)
                              {
                                 lyear=0;
                                 hyear++;
                              }
                                          command(0xc9);
                                          data_in(val[hyear]);
                                          data_in(val[lyear]);
                                          month_select(month);
                                          delay();
                                          goto up2;
                        }
                if(chg_param_dec==0)
                  {
                        lyear--;
                        if(lyear==-1)
                             {
                                 lyear=9;
                                 hyear--;
                                 if(hyear==-1)
```

```
                    hyear=9;
                }
                    command(0xC9);
                    data_in(val[hyear]);
                    data_in(val[lyear]);
                    month_select(month);
                    delay();
                    goto up2;
            }
        while(sel_param==0);
        command(0xC8);
        delay();
up1:while(chg_param_inc!=0&&chg_param_dec!=0&&sel_param!=0);
if(chg_param_inc==0)
            {
                month++;
                    if(month==13)
                    month = 1;
                    command(0xc7);
                    if(month <= 9)
                    data_in(val[0]);
                    data_in(val[month]);
                month_select(month);
                    delay();
                    goto up1;
                }
        if(chg_param_dec == 0)
            {
```

```
month--;
        if(month==0)
        month=12;
command(0xC7);
        if(month<=9)
        data_in(val[0]);
        data_in(val[month]);
    month_select(month);
        delay();
        goto up1;
    }
while(sel_param == 0);
command(0xC5);
delay();        delay();
while(sel_param == 0);
 LCD_INI();
command(0x01);
command(0xC1);
data_in("Engr A G Raji");
 //data_in(days[day]);
command(0x80);
date_in(date);
command(0x82);
data_in(" ");
data_in(mon[month-1]);
command(0x86);
data_in(",");
data_in(val[hyear]);
```

```
data_in(val[lyear]);
        if(hh<=12)
        bdata_in(hh,0x8A);
        else
                {
temp=hh-12;
                        bdata_in(temp,0x8A);
                }
        if(hh<12)
        {
                command(0x8F);
                data_in("a");
        }
        else
        {
                command(0x8F);
                data_in("p");
        }
        command(0x8C);
        data_in(":");
        command(0x8D);
        data_in(val[hmin]);
        command(0x8E);
        data_in(val[lmin]);
        delay();
        flag = 0;
        ENABLE_INT
}
```

```
/*--------------------
*** Delay function ***
--------------------*/

void delay(void)
{
        bit_8i,j;
        TMOD=0x11;
        for(i=0;i<2;i++)
        {
                TH1=0;
                TH0=1;
                TL1=0;
                TL0=0;
                TR1=1;
                while(TF1!=1)
                {
                        for(j=0;j<20;j++);
                }
                TF1=0;
                TR0=1;
                TR1=0;
                while(TF0!=1)
                {}
                TF0=0;
                TR0=0;
        }
    }
```