DESIGN, CONSTRUCTION AND IMPLEMENTATION OF QUEUE MANAGEMENT SYSTEM FOR BANKING INSTITUTION

BY

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DEDICATION

The project is dedicated to Almighty Allah for His favour, guidiance, luck and protection.

DECLARATION

I, Adebimpe Ayodeji Azeez, declare that this work was done by me under the close supervision and guidance of Mr. Odunayo Imoru and never been presented elsewhere for the award of Bachelor of Engineering degree. I hereby relinquish the copy to the Federal University of Technology, Minna.

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ABSTRACT

This Queue Management System is implemented for Banking Institution due to consolidation by Central Bank of Nigeria in 2005 which led to few banks and more queues. This project aim to prevent rendering services to customers under unpleasant conditions, reducing the complexity of embedded type and also enhance the performance of the cashiers/officers. It incorporates microcontroller which is programmed to monitor the inputs and outputs. The output units consists of two subunits; visual display unit built around dual seven segment display that is suppose to place before cashier, and audio unit with central speaker which announce cashier identification number through pre-recorded speech whenever he/she pushes his/her button.

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CHAPTER ONE

GENERAL INTRODUCTION

1.1 INTRODUCTION

Queue Management System (QMS) is an electronic system by means of which queue can be regulated sequentially and maintained in an orderly manner. The project is to serve as a cost effective solution to implement a fair, regulated queuing system whenever people are being served, counseled or treated in a customer friendly manner. It can also be used where there is a congestion of people in a place like banking industries, health sector, institutions, administration department etc.

The useful of queue management especially in the fast growing banking industries cannot be overemphasized. The activities of establishments like banks, insurance companies are becoming prevalent nowadays that they continue to render services to customers under unpleasant conditions if there is a queue. This project research is highly essential to put an end to customers wasting their valuable personal time everyday on unregulated queue and to increase service efficiency and for high reliability.

This project research also incorporates an audio-visual system. It employs dual seven segment display that displays an officer (cashier) identification number which is simultaneously accompanied with pre-recorded speech ("cashier one is free'') each time a particular cashier pushes his or her button. The digits display and speech announcement depend on a particular pushed-button and both last for preset time handed by the microcontroller.

1.2 MOTIVATION

The first motivation of this research project was as a result of recent reform of Central Bank of Nigeria of consolidating banking industries in December, 2005. This has led to large number of customers' per bank. Although, Automated Teller Machines (ATM) installed by some banks cannot still yet control the queue because it is mainly use for withdrawing cash. For the purpose of consolidation, which leads to twenty-five (25) banks in Nigeria i.e. the number of banks per customers has been drastically reduced and customers are increasing daily.

Consequently, there arise a very long and more queues than what can be easily and ordinary regulated.

1.3 AIMS OF THIS PROJECT

The aim of this project is to display cashier identification number and at the same time make announcement that the cashier with the displayed identification is service-ready to the next person on the queue. The display and the announcement go off five seconds after the cashier pressed his/her button.

It is also for energy conservation by enabling only one display and speech at a time and puts the other on hold if two or more cashiers press their buttons at a time. This does not only conserve energy but also avoid choruses and interferences.

The operation described above is possible because of the micro-second (approximately one micro second per instruction cycle) operation of the microcontroller. It makes it possible to prioritize the cashiers on the basis of microsecond difference when pressing the button.

The following are the goals of this project;

a. To prevent customers on the queue from being aggressive by making a bit of entertaining.

b. To manage, maintain and regulate queue in an orderly manner.

c. To check and improve performance of individual cashiers

d. To avoid congestion on the queue which might result into a nuisance

e. To improve service efficiency

1.4 JUSTIFICATION AND RELEVANCE

i. **Easy mode of operation:** A dual seven-segment display and the central speaker is to be enable when a cashier is service-ready and pushes his/her button and then disabled five (5) seconds after the button was pushed in order to enable another one if its button has been pressed.

ii. **Fatigue**: Pressing button to alert or call the customer for attention causes less fatigue than if it were to be done verbally by the staff themselves.

iii. **Rowdy Environment:** The commotion and nuisance or noise that is concomitant with the unregulated queue and other pollution can be curtailed.

iv. **Aggression:** Long waiting or standing on unregulated queue can make customers become aggressive which might lead to customers fighting one another against a particular position.

v. **Complexity:** The embedded system which is complex has been simplified, the whole system which reduced the number of hardware.

vi. **Wastage of Electrical Energy:** Only one output at a time putting all other on hold save tremendous amount of energy and makes the system stress free.

vii. Rigidity: Using microcontroller with EPROM (Erasable Programmable Read Only Memory) enables the system operations to be as flexible as possible.

Operation can be easily changed by only changing the software and not the hardware. Similarly, application can be diverted by changing the of choice of speech announcement whenever there is necessity

viii. Cost Effectiveness: The numbers of hardware is reduced which leads to reduction of cost.

1.5 THESIS LAYOUT

This thesis consists of five chapters, each of which consists of sections and sub-sections as outlined on the table of contents for easy reference. The write-up is well structured to meet up the technical report standard. Figures, tables and symbols are numbered and cited appropriately.

Chapter one deals with the introductory aspect of the project research.

Chapter two reviews the literature and describes in details the major components of the system.

Chapter three is based on the hardware design analysis and software design techniques.

Chapter four deals with the implementation, construction and testing

Chapter five contains recommendation and conclusion

Lastly, the sources of information and knowledge are referenced orderly. Some indispensable facts like circuit diagrams, program source code are in appendices.

CHAPTER TWO

LITERATURE REVIEW

2.1 QUEUE MANAGEMENT SYSTEM IN THE OLDEN DAYS

Before the advent of technology, pieces of paper, cardboard or plywood were cut into square shape and numbered orderly. It would then be given to the customers based on the arrival to form the queue, with the aim of regulating the queue. This is traceable to an old Swede, about seventy years ago who had the ingenious idea of taking a serially numbered block, like the old-tear off calendars nailing it to the wall and in the small corner sharps. This simply gives the customers a running number to regulate the sequence. [1, 2]

This primitive means of regulating queue can still be found in some part of the developing countries or even some tertiary institutions e.g students' garage/bus stop. This is highly cruel and not friendly, this causes boredom and also requires manpower and as a result, the goals cannot be completely achieved.

2.2 ELECTRONIC CALLER MACHINE AND DEVELOPING STAGE

During the era, QMS was called electronic caller machines. This is because the system was mainly achieved using pure electronic components like 555 timer chip, 74LS48 driver, decade canter, logic gate etc.

The goals like good power management, operation flexibility and cost effectiveness cannot be achieved due to complexity of too many hardware [3, 4].

2.3 EMBEDDED QMS AND MORDERN DAY TECHNOLOGY

With the advent of embedded technology which is presently on its youthful stage, the objectives are not totally achieved. In this stage, Queue management is microcontroller based and this enables optimum functionality, high reliability and flexibility as well as cost effectiveness but complex circuit and high waste power. [5, 6, 7]

The electronic caller machine is basically hardware, while embedded type consists of both hardware and software. The advent of this type makes the problems associated with the previous versions to reduce if not completely eliminated.

2.3.1 TICKET CONTROLLED QMS

This is one example of embedded QMS. It allows customer to take a sequentially number ticket that automatically organizes the queue flow. The customer knows their place in the queue, so they can either take a seat, or browse surrounding amenities and shopping areas, when the ticket panel and a variety of audible sounders inform the customer that it is his or her turn to be served [6,7].

2.4 OPERATIONAL PRINCIPLE OF QUEUE MANAGEMENT SYSTEM

The operation will be best described using the block diagram of figure 2.1. When the power is on, the microcontroller looks at the condition or state of input push buttons in turn and executes a section of program depending on the state of those inputs either high (on) or low (off). This phenomenon is referred to as scanning or polling [8] that is detecting and converting state to digital form for storing or processing.

When the microcontroller senses a high logic level of a particular button, present output states is checked. If there is no output on, high (ON) state, it enables the corresponding seven-segment display and through the voice server, a corresponding speech is referenced from its location play through the central loudspeaker. This action takes place automatically for just five (5) seconds, but if during operation, microcontroller finds that there is a display and speech ON, it places the just pressed button on hold (i.e. at high logic) despite the release using internal latch until after five seconds when it is then enable. The operation continues as stated above.

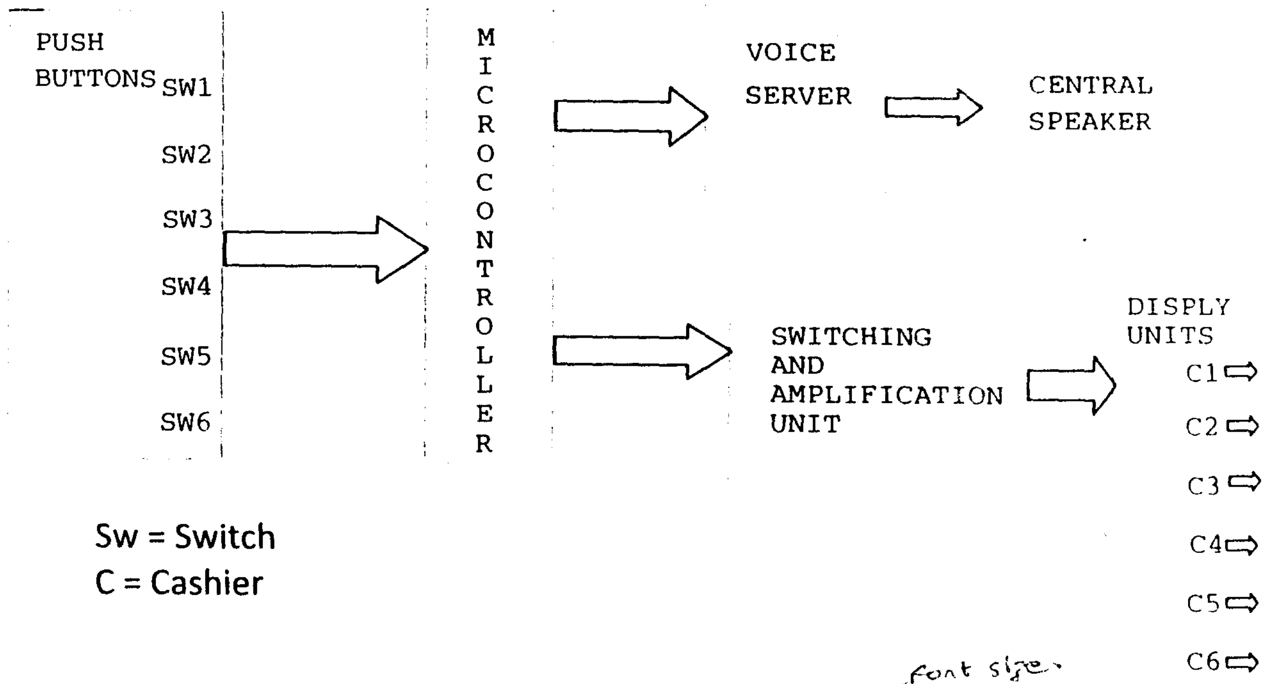


Figure 2.1 Block diagram of QMS [10] font size

This makes it possible to ensure that there is only one output at a time in order to avoid confusion or interference.

Table 2.1 shows the truth table of the queue management system for six cashiers.

Table 2.1 TRUTH TABLE FOR THE QUEUE MANAGEMENT SYSTEM [to not bold] .

S/N	INPUTS						OUTPUTS					
	Sw1	Sw2	Sw3	Sw4	Sw5	Se6	C1	C2	C3	C4	C5	C6
0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	1	0	0	0	0	0
2	0	1	0	0	0	0	0	1	0	0	0	0
3	0	0	1	0	0	0	0	0	1	0	0	0
4	0	0	0	1	0	0	0	0	0	1	0	0
5	0	0	0	0	1	0	0	0	0	0	1	0
6	0	0	0	0	0	1	0	0	0	0	0	1

Note 0 – off/low

1 – on/high

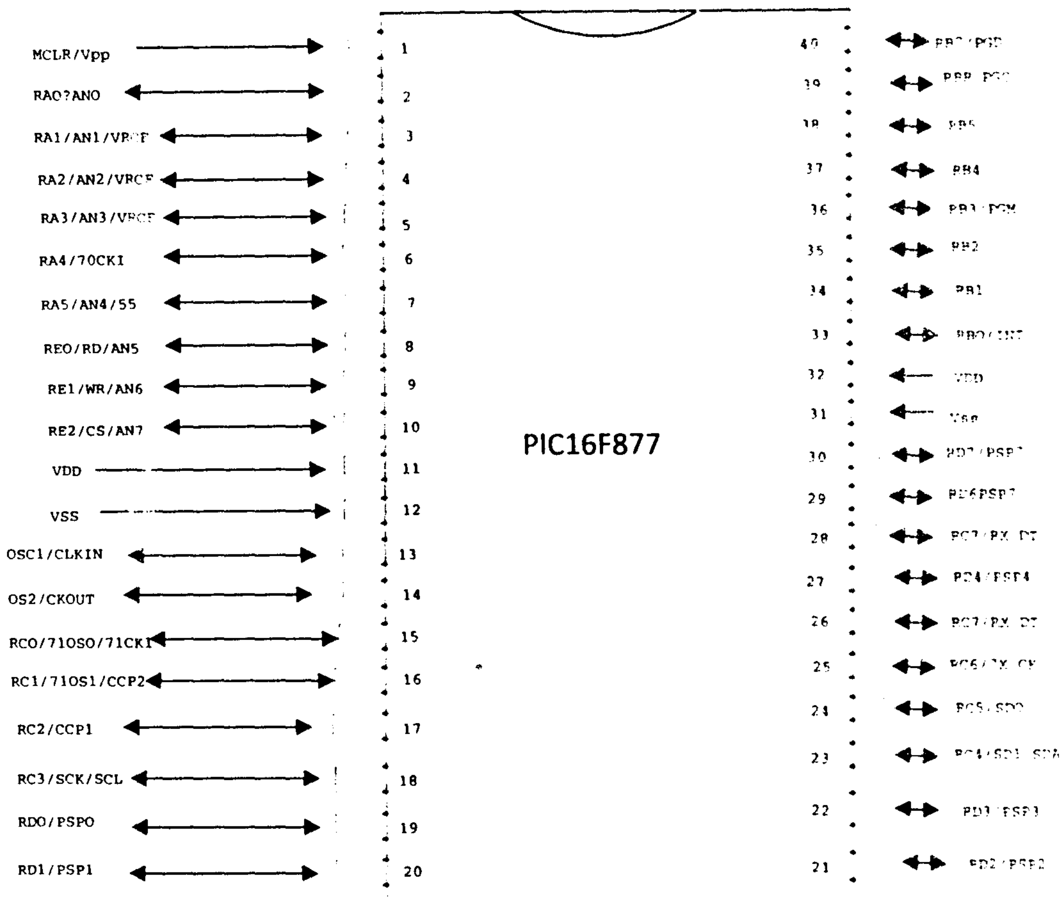


Fig 2.2 16F877PIC PIN OUT

The PIC16F877 is a very versatile chip and can be programmed in a number of different configurations. The 16F877PIC is a flash device that can be electrically erased and reprogrammed without using an ultraviolet eraser. The PIC16F877 has the following features.

- It can be used up to an oscillation frequency of about 16MHZ and comes as a standard 40 pin package

- It has flash program memory of 8 kilobytes and date memory of 368 bytes.
- It includes an EEPROM data memory of 256
- It has five input/output ports labeled as ports A, B, C, D and E
- It is capable of addressing an 8 kilobytes and 14-bit program device.

[12].

The PIC16F877 is a 33 inputs/outputs device, which means it has 33 inputs and outputs. The input/output 20 inputs, 18 inputs, 15 outputs etc. these inputs/outputs are connected to outside word through registers called ports. As stated earlier, it has fire ports, PORT A, PORT B. PORT C, PORT D and PORT E. PORT A is a six-bite wide and bidirectional port as shown in figure 2.2, it consists of RAO, RA1, RA2, RA3, RA4 and RA5 on pin numbers 2,3,4,5,6 and 7 respectively. Some ports are multiplexed with function. For instance RA4 is multiplexed with timer 0 module clock in out to become RA4/TOCK1 pin. Other PORT A pins are multiplexed with along inputs and the analogue V_{REF} (voltage reference) input for both the analog to digital converters and the comparators.

PORT B is a right-bit wide and bidirectional port. It consists of RB0. RB1, RB2, RB3, RB4, RB5, RB6 and RB7 on pin number 33, 34, 35, 36, 37, 38 39 and 40 respectively. Three pins of PORT B are multiplexed with in-circuit debugger and low-voltage programming function: RB3/PGM. RB6/PGC and RB7/PGD. These functions are part of special function registers (SFF).

PORT C is also an eight-bit wide and bidirectional ports. It consists of RC0, RC1, RC2, RC3, RC4, RC5, RC6 and RC7 on pin numbers 15, 16. 17, 18, 23, 24, 25 and 26 respectively. In the same way, PORT C is also multiplexed with several peripheral functions such as Schmitt Trigger input buffer.

PORT D is also an eight-bit wide with port with Schmitt trigger input buffers and also bidirectional that is each pin is individually configurable as an input or output. It consists of RD0, RD1, RD2, RD3, RD4, RD5, RD6 and RD7 on pin numbers 19, 20, 21, 22, 27, 28, 29 and 30 respectively.

PORT E has only three pins RE0, RE1and RE2 on pin number 8, 9 and 10 respectively. These pins have Schmitt trigger input buffers. It is also bidirectional. [13]

2.6 SOFTWARE TECHNIQUES

Programming is defined as the steps implemented to present a problem to the input of a computer. The problem must first be analyzed carefully to determine the input and output variable as well as how they are interrelated. The number of solving the problem by breaking it down into a number of logical steps is employed. This referred to algorithm. Algorithm may be pictorially represented in form of flowcharts. They are designs with number of objectives. These include speed of execution, program size, ease of understanding, and less memory requirements. The designed program may then be written out in a specific programming language e.g C^{++}, C or assembly language. This is referred to as coding. The code use in writing the program is referred to as Source Code. The source code is checked for errors through assembly, and compilation. If there is any error, the file is debugged and modified. The modified code is then saved as object file. This file is linked through hex converter to generate HEX file or executable file which is used to program the codes into the chip [8].

2.7 PROGRAMMING THE MICROCONTROLLER

Microcontroller can only understand a specific language known as programming language in order to perform controlling action very well.

The programming language for the PIC microcontroller uses 35 instruction sets in its vocabulary. A few more instructions are used in the bigger microcontrollers [8].

To program a microcontroller, the following steps must be follows

- Write the instruction in a program

- Change the text to object code through assembler to detect if there is any error
- If no error, the object code generated is passed through hex converter to convert it to HEX file or machine code that the microcontroller will understand.
- The code is then now program into the chip using appropriate programmer.

2.8 DUAL SEVEN-SEGMENT DISPLAY

Seven-segment display consists of seven LEDS that are arranged such that they form a digit 8. It is housed in a typical dual-line integrated circuit package as shown in one package manually used for two digits display.

By energizing the proper pins with a typical 2v DC level, a number of LEDs can be energized and the desired numeral or alphabets displayed. The pins can be identified directly using data sheet or by the use of multi-meter. Most seven-segment displays are either common-anode or common-cathode display with the anode referring to defined positive side of each diode and the cathode referring to the negative side [10, 11].

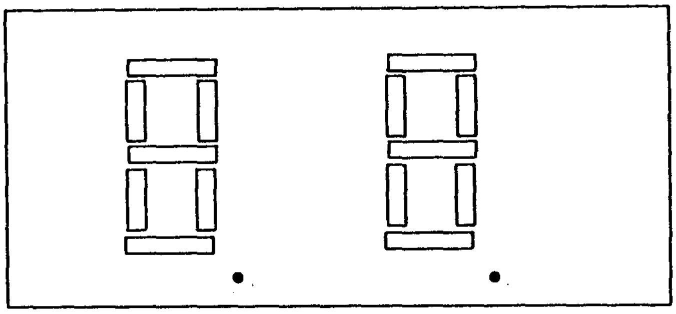
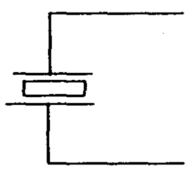


Figure 2.3 Dual seven segment display

2.9 CRYSTAL OSCILLATOR

Crystal oscillator is an electrical device which when energized, emits pulses at a fixed frequency. One can find crystals of virtually any frequency depending on the application requirement. Where an oscillation at a fixed frequency is requires, a piezo-electric crystal mode from quartz is used.

A crystal comes as an encapsulation with two leads the symbol and equivalent circuits are as shown in figure 2.4 [14, 15].



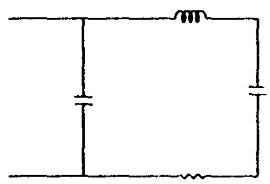


Fig 2.4 (a) electrical symbol of a crystal

fig 2.4 (b) Cs equivalent LCR circuit of a crystal

Microcontrollers and any other electrical and digital systems use crystal to synchronize operations. It also use as an indicator of microprocessor performance. It synchronizes the microprocessor aid timing its activities [9, 12].

2.10 BC548 TRANSISTOR

BC548 Transistor is an NPN amplifier transistor with current rating of 100mA and emitter-base voltage of 0.6v. It mainly used in amplifying and linear amplification circuits [17].

2.11 VOICE SYSTEM

The voice system consists of D-type latch (74LS374) erasable programmable read only memory (EPROM), A727C512R, 8-bit digital-to-analog converter, (DAC-08), low noise operational amplifier (TL072), low voltage audio power amplifier (LM386) and 8Ω speaker.

2.11.1 D-TYPE FLIP-FLOP (74LS374)

This is high speed CMOS octal D-Types flip-flop with three states output. It is controlled by a clock input (CK) and output enables (OE).

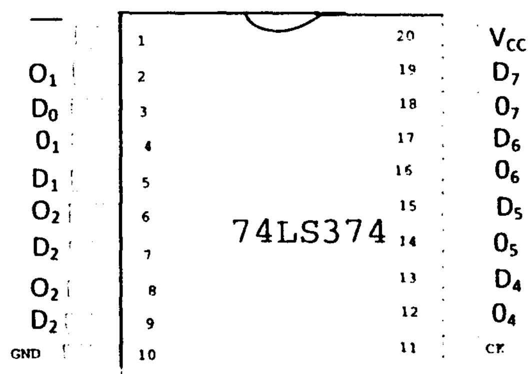


Figure 2.5 Pin out configuration of 74LS374

2.11.2 ERASABLE PROGRAMMABLE READ ONLY MEMORY (AT27C512R)

AT27C512R is 524, 288 bits (512KB) EPROM organized as 64k words by 8 bits. This ensures compatibility with high performance microprocessors allowing full speed operation.

The block diagram and pin configuration of AT27C512R is as shown below.

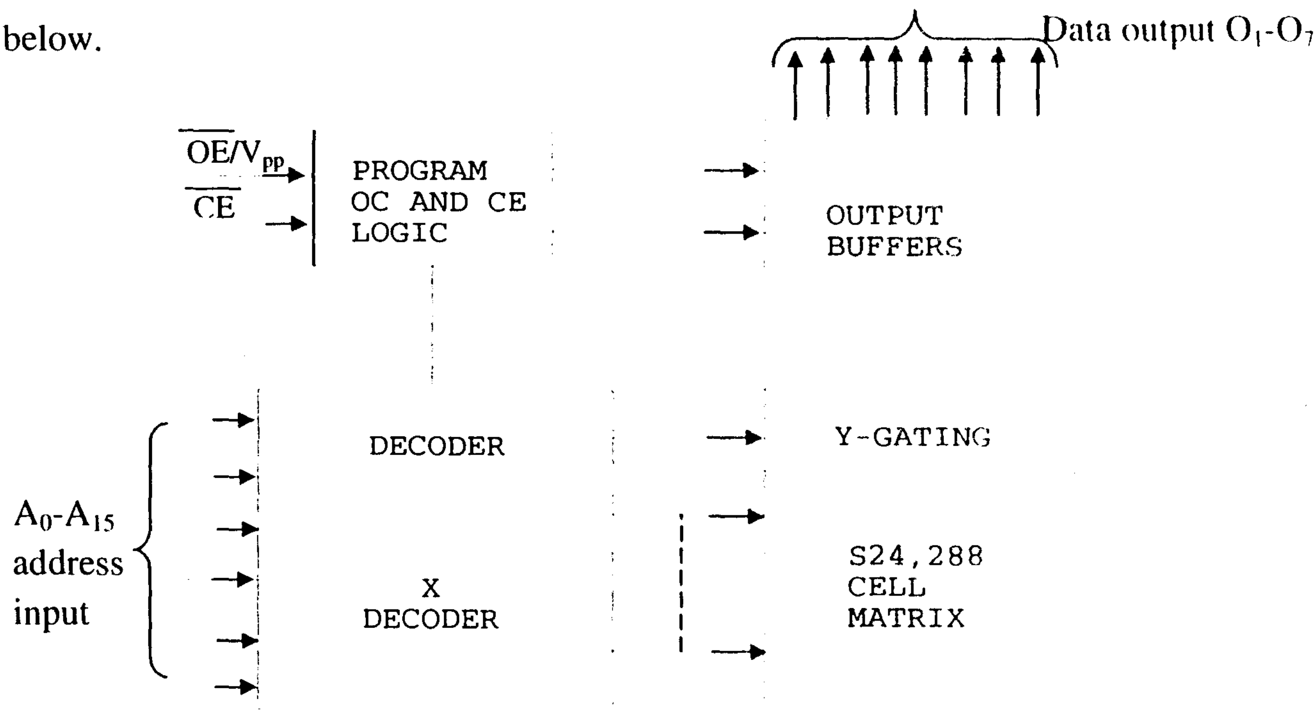


Figure 2.6 Block diagram of AT27C512R

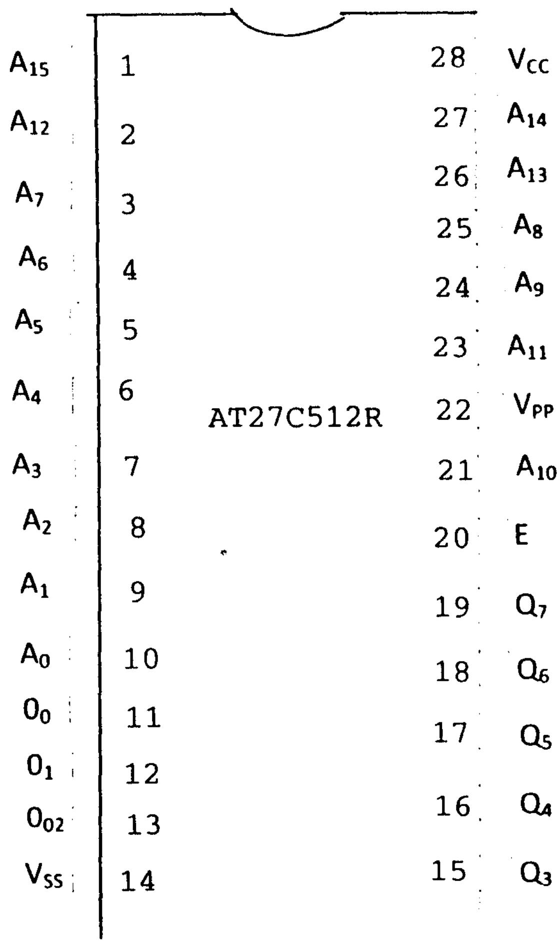


Figure 2.7 Pin configuration of AT27C512R

AT27C512R is operate by single 5v supply voltage, extended temperature range, fast programming algorithm and fast accessing of about 200ns [18]

2.11.3 DIGITAL-TO-ANALOG CONVERTER (DAC-08)

The DAC-08 series is monolithic 8-bit high speed multiplying digital-to-analog converter. It has 16 pins out and wide power supply range $\pm$4.5v to

±18v. Also, it has low power consumption and fast settling time less than 85ns. [19].

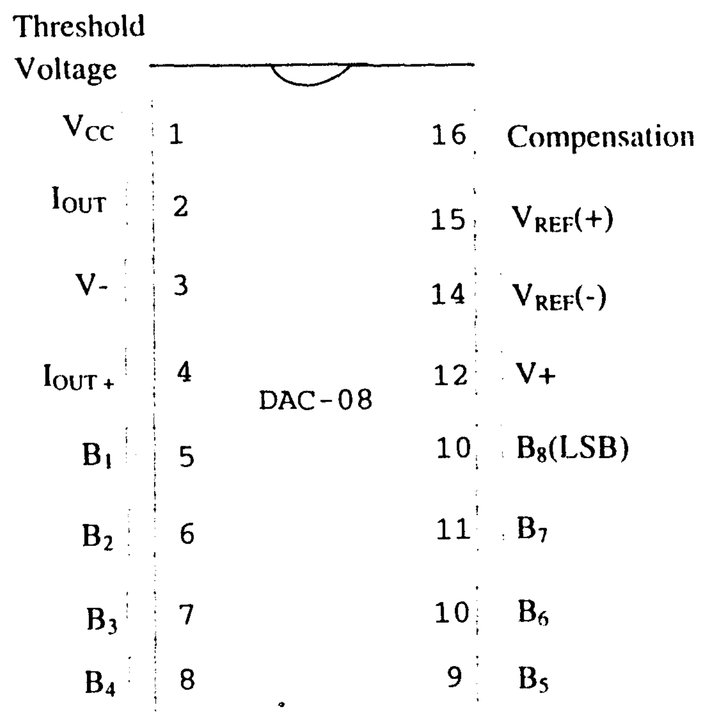


Figure 2.8 Pin configurations of DAC-08

2.11.4 OPERATIONAL AMPLIFIER (TL072)

TL027 is a low noise operational amplifier, low power consumption, the input biased as offset currents, high input impedance internal frequency operation and characterized for operation from 0^0C to 70^0C. It is operated with 15V supply voltage. The pin configuration of TL072 is as shown below [20a].

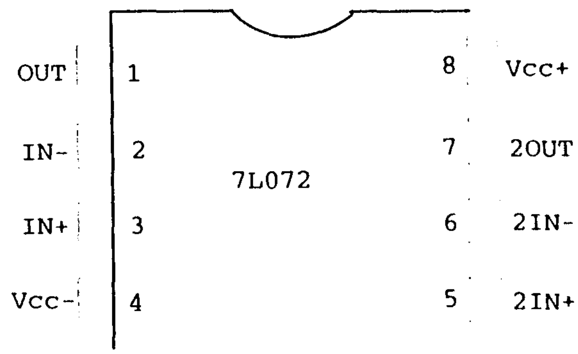


Figure 2.9 Pin out diagram of TL072

2.11.5 LOW VOLTAGE AUDIO AMPLIFIER

LM386 is a power amplifier design for use in low voltage consumer applications. The gain is internally set to 20 to keep external part count low, but the addition of an external resistor and capacitor between pin 1 and 8 will mere age the gain to any value up to 200. It has node supply voltage rage of 4v-12v or 5v – 18v, low distortion, minimum external parts [20] and output resistance of 8Ω.

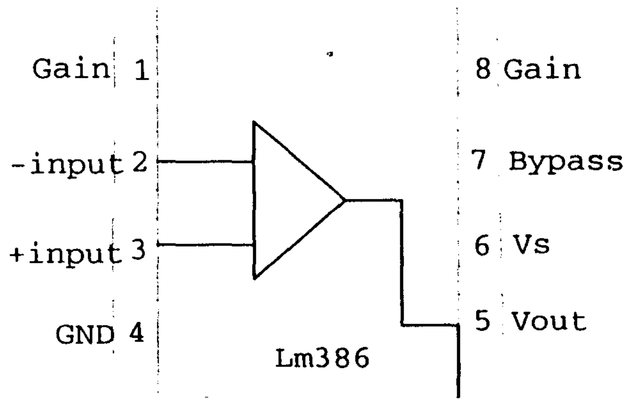


Figure 2.10 Pin configurations of LM386.

2.12 POWER TRANSISTOR

TIP41 is an NPN epitaxial transistor-base silicon power transistor designed for power amplifier and high speed switching applications. It has V_{CEO} of 40v, V_{CEO} of 10v, base current I_B of 3A and power dissipation, P_D of about 65 watts; it is decided for power supply unit because of its characteristics [21].

2.13 RC4558 DUAL HIGH GAIN OPERATIONAL AMPLIFIER

RC4558 integrated circuit is a dual high gain operational amplifier internally compensated and constructed on a single silicon IC. It combines the features of LM741 into the closer parameter matching and tracking of a dual service on a monolithic chip results in unique performance characteristics.

The block diagram is shown below [22].

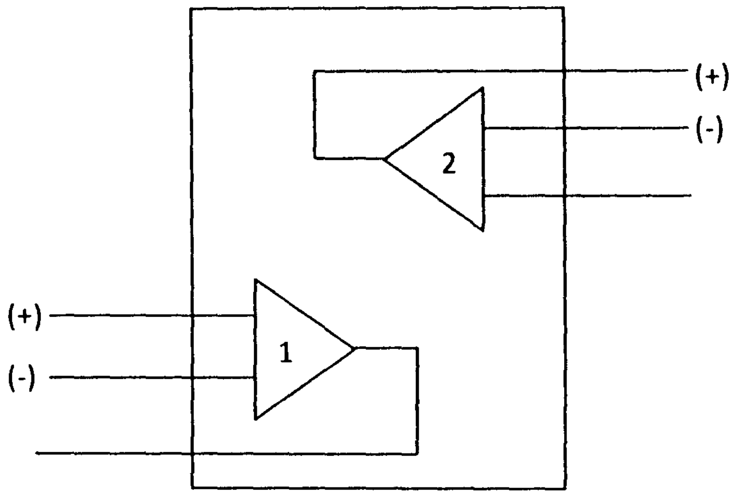


Figure 2.11 Block diagram of RC4558

CHAPTER THREE

PROJECT DESIGN, ANALYSIS AND SOFTWARE DEVELOPMENT

3.1 INTRODUCTION

This chapter basically deals with the design and analysis of components used for the implementation of this project as well as evidencing the basis criteria for the selection, of the components.

The block diagram of the design is as shown below for the purpose of analysis.

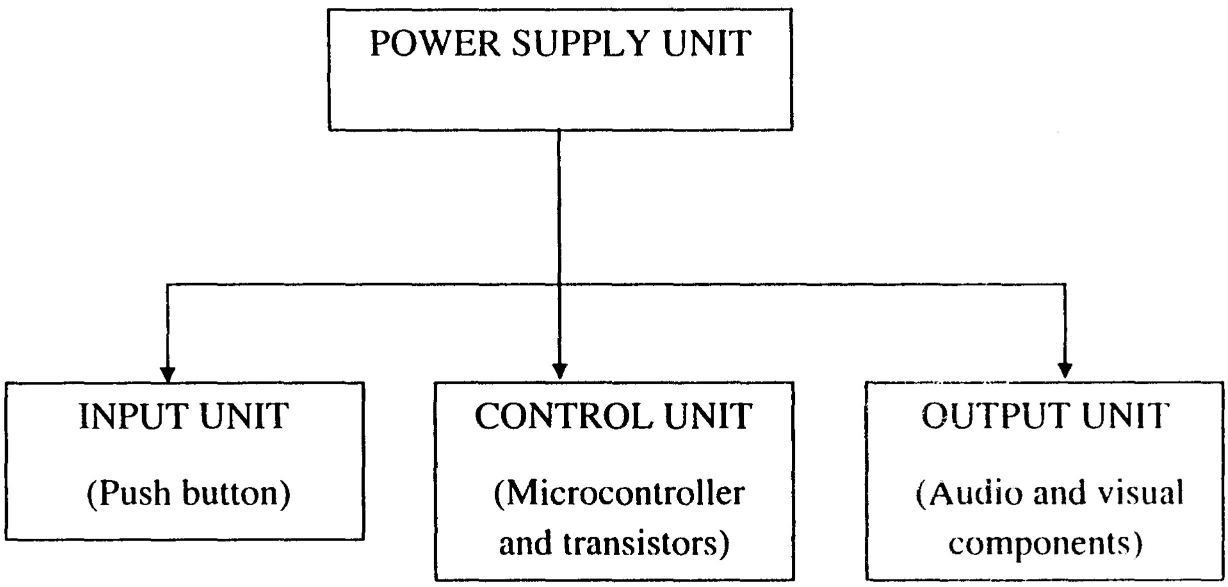


Figure 3.1 QMS analysis block diagram

3.2 POWER SUPPLY UNIT

Power supply unit is consists of the following units;

i. Transformation unit

ii. Rectification unit

iii. Filtering unit

iv. Regulation unit

3.2.1 TRANSFORMATION UNIT

The transformation unit consists of two-output 220v-12v step down transformer as shown below. The transformer steps down 220v to 12v.

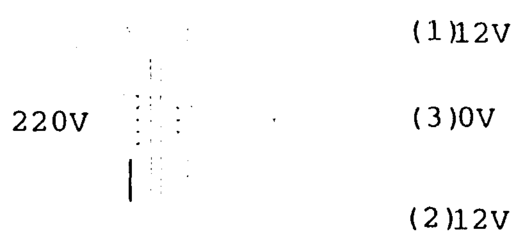


Figure 3.2 Transformation unit

3.2.2 RECTIFICATION AND FILTERING UNITS

The rectification unit consists of 2 bridge rectifiers (four diodes) on each bridge circuit to convert AC voltage to DC voltage. This involves four general-purpose rectifier diodes (IN4001) as shown below.

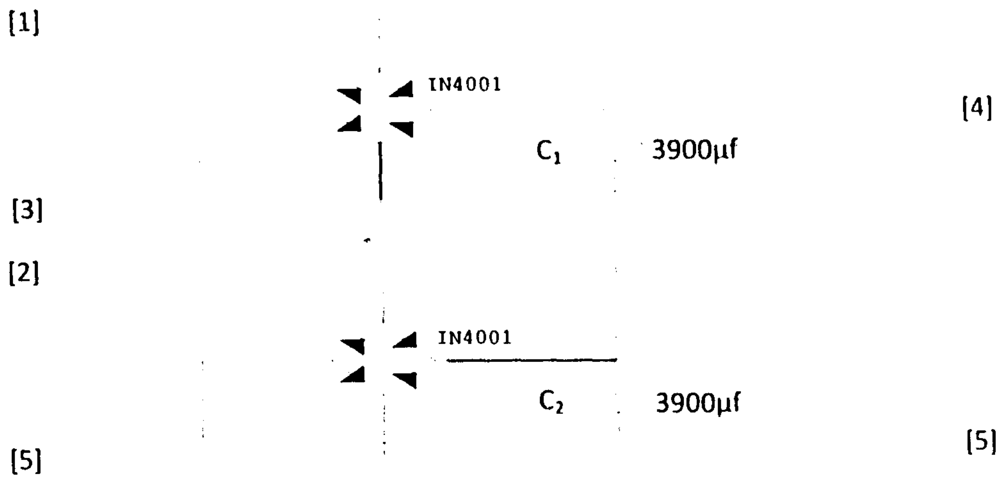


Figure 3.3 Rectification units

As shown above in figure 3.3, the outputs of transformer are fed into two bridge rectifier circuits and capacitors C_1 and C_2 are connected for the purpose of filtering.

Transformer secondary voltage, $V_{rms} = 12v$

V_{peak} = Transformer peak voltage = V_0

I_{rms} for the transformer = 1000mA (rating of transformer by measurement)

$$V_0 = \sqrt{2} \times V_{rms} \qquad 3.1$$

$$\therefore V_0 = \sqrt{2} \times 12v$$

$$V_0 = 16.97V$$

V_D = Diode forward voltage drop

Typically $V_D = 0.7v$ for most diodes

∴ For full wave bridge rectification

$V_{DR} = 2 \times V_D = 2 \times 0.7$

$V_{DR} = 1.4v$

$V_{dc} = output\ voltrage\ from\ the\ rectifier$

$V_{dc} = \frac{2Vo}{\bar{\lambda}}$ 3.2

$V_{dc} = \frac{2 \times 16.97}{\bar{\lambda}}$

$V_{dc} = 10.80v$

For full wave bridge rectifier, the peak inverse voltage = V_o

$\therefore PIV = 16.97V$

For filtering unit

Rectifier output Regulator input

C_1, 3900µf

Figure 3.4 the filtering circuit

Applying KVL to the first loop of the low voltage side of the transformer,

$V_0 = V_{dc} + V_{DR} + d_v$ 3.3

$d_v = V_o - V_{dc} - V_{DR}$

$$d_v = 16.97 - 10.83 - 1.4$$

$$d_v = 4.74v$$

$$i = C\frac{dv}{dt} \qquad 3.4$$

$$d_v = \frac{i}{c}\,dt \qquad 3.5$$

And

$$dt = \frac{1}{2f} \qquad 3.6$$

Substitute (3.5) into

$$dv = \frac{i}{2fc} \qquad 3.7$$

From 3.6

$$C = \frac{i}{2fdv}$$

For i = 1.0A f = 50Hz ad dv = 4.74v

$$C = \frac{1.0}{2\times50\times4.74} = 2.109 \times 10^{-3}F$$

$$C = 2109\mu F$$

Due to market unavailability, 2109 μF was not found, so 3900 μF was chosen for both C_1 and C_2 as shown.

3.2.3 REGULATION UNIT

The regulation unit consists of IC regulators LM7805 and LM7905, RC4558 and two power transistors TIP41. The circuit is shown below

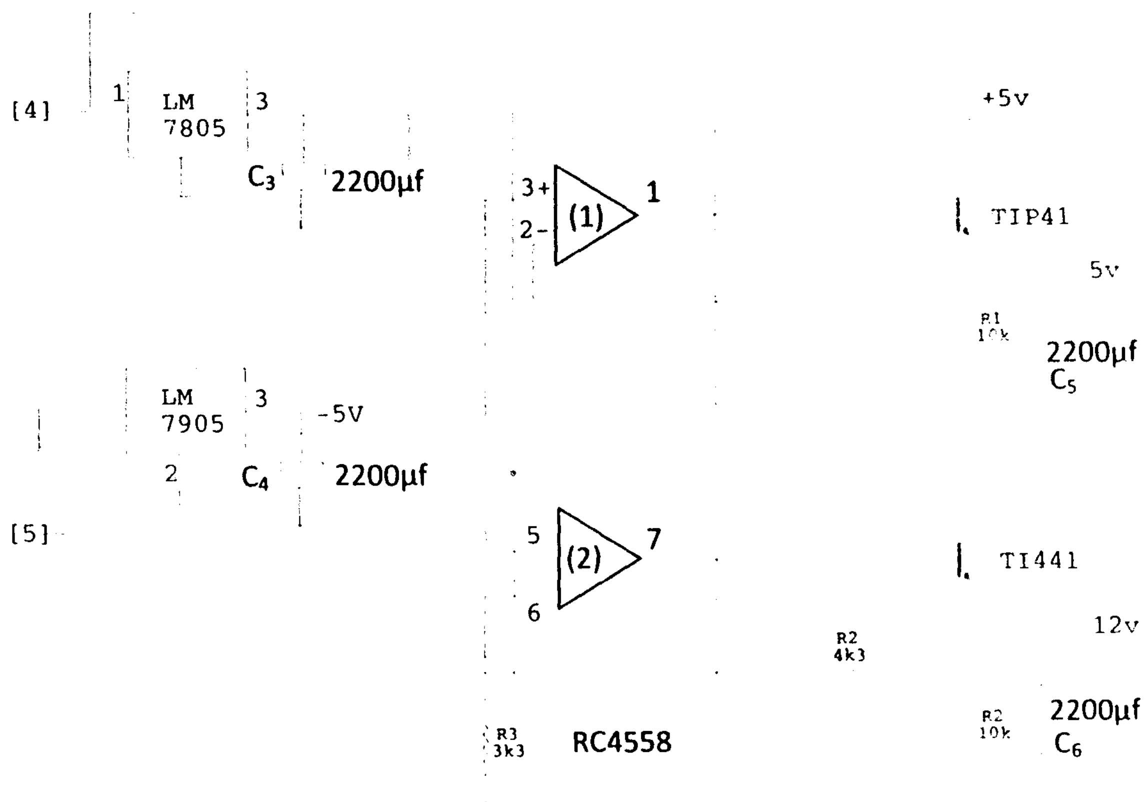


Figure 3.5 Regulation unit

LM7805 and LM7905 generate fixed output of 5v and -5v respectively. The supply voltage, to both 7805 and 7905 from rectification unit is Vdc =

10.80v. The supply voltage to both IC can be from 7v – 30v. The ratings of both IC are stated below

- Voltage input = 7v – 30v
- Supply current = 1A maximum
- Output voltage = 5v fixed for 7805 and -5v fixed for 7905 [23, 24].

For supply current of 1A and V_{out} = 5v voltage across the regulator

Vreg = V_{dc} -V_{out} = 10.80v – 5v = 5.8v

Power dissipated = I*Vreg = 1 x 5.8 = 5.8 watts in each regulator

Since power dissipated is not much, heat sink might not be necessary but ventilation space is provided in the design.

The capacitor C_3 and C_4 connected to prevent any high frequency component and acts basically as a line filler to improve transient response. [5]. The RC4558 consists of two operational amplifier to generate fixed and stabilized 5v and 12v through power transistor TIP 41 as shown in figure 3.5.

The first operational amplifier generates 5v through TIP41 as shown. The TIP41 has V_{CEO} of 40v minimum, V_{CBO} of 40v minimum, V_{EBO} of 5v, I_c of 6A, I_B of 2A and power dissipation at 25^0C of 65w [21]. The connection of the first amplifier to TIP41 which generate 5v fixed is known as transistor shut voltage regulator. In this case TIP41 uses only as a control element which make the output fixed to 5v.

The input to non-inverting terminal (pin 3) is 5v directly from LM7805 and ampere it motion invert terminal (2) which control the output voltage fixed to 5v always.

For the second operational amplifier, the non-inverting input is connected to 5v from LM7805 as shown. This amplifier is connected as non inverting amplifier. The gain of the amplifier is given as

$$A = 1 + \frac{R_2}{R_3} \quad 3.8$$

Where $R_2 = 4.3k\Omega$

$R_3 = 3.3k\Omega$

Neglecting base emitter voltage of TIP41

$$\text{Voltage output} = \left(1 + \frac{R_2}{R_3}\right) V_5 \quad 3.9$$

Where $V_5 = 5v$

$$V_0 = \left(1 + \frac{4.3K\Omega}{3.3K\Omega}\right) 5v$$

$$V_O = 11.52v$$

$$V_O \approx 12v$$

The output of second TIP41 is 11.52v. With the use of RC4558 and TIP41 power transistors, the output voltage of power supply units is controlled whenever there is an increase or decrease in voltage which is sense by resistor R_2.

The capacitor C_5 and C_6 act as a decoupling capacitor to provide a low reactance path to AC at the relevant frequencies without affecting DC conditions. The complete power supply unit is shown on appendix A.

3.3 MICROCONTROLLER HARDWARE

The hardware that the microcontroller needs to be function is shown in figure 3.6 below.

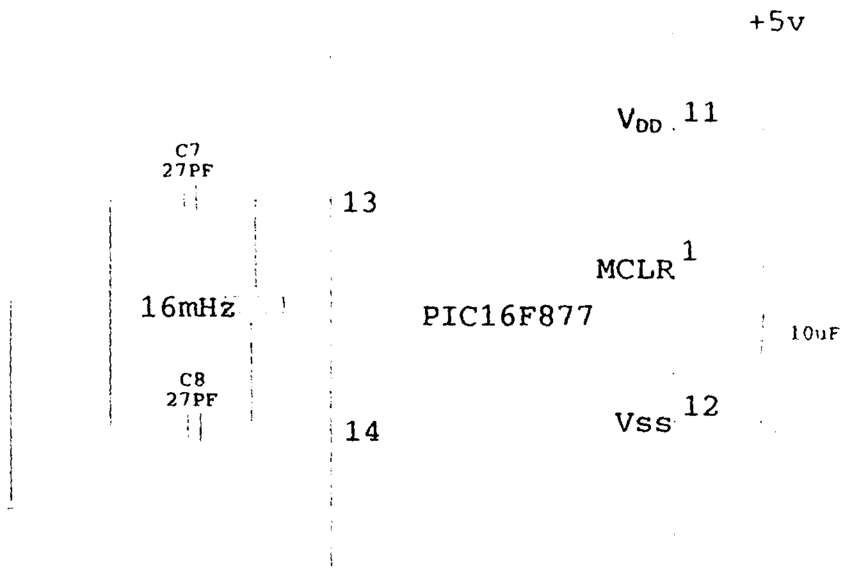


Figure 3.6 Microcontroller hardware

The crystal and capacitors connected to pins 13 and 14 of the PIC16F877 produces the clock pulses that are required which provided the timing impulses. The $10\mu F$ capacitor placed as close to the chip as possible between 5v and 0v. Its role is to divert (filter) any electrical noises on the 5v power supply line to 0v, thus bypassing the microcontroller. This capacitor must always be connected to stop any noise affecting the normal ruining of the microcontroller.

From $X_c = \frac{1}{2\bar{\lambda} fc}$ $for\ f = 50H_2\ of\ noise\ signal$

The reactance if the capacitor is thus;

$$X_c = \frac{1}{2\bar{\lambda}\times 50\times 10\times 10^{-6}} = 318.3k\Omega$$

This capacitor value is selected to give a significant reactance to avoid unnecessary short circuit or excessive current flow [12, 13]. To reduce reactance value 10kΩ resistor is connected in parallel to the capacitor. The total value is 9.7kΩ.

3.3.1 MICROCONTROLLER POWER SUPPLY

The power supply for the microcontroller needs to be between the 2v (minimum) and 5v (maximum) from the specification sheet. If a battery is provided especially 6v battery as shown in fig. 3.7 below, the diode is connected in series with it.

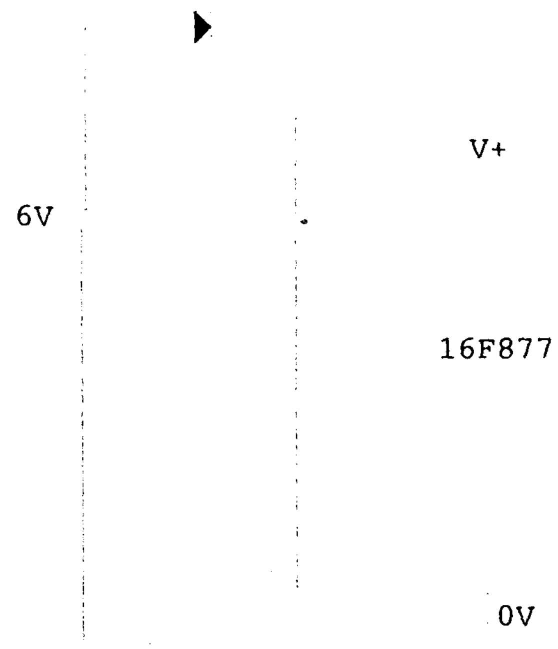


Figure 3.7 Microcontroller power supply

The diode in the circuit provides protection for the microcontroller if the battery is suddenly connected in the reversed biased and no current would flow.

3.3.2 MICROCONTROLLER CLOCK

The instructions of microcontroller need a clock frequency to ease the movement of the data. This is achieved by providing two capacitors and a crystal or by an internal oscillator circuit as shown in figure 3.6

For this project, the crystal used is 16MHZ base on standard crystal configurations.

i.e F_{oscmax} = 16MHz

$C_7 = C_8 = 27pF$ [12]

The higher the capacitance value, the higher the stability.

Instruction cycle time, Tcy = 4 x input oscillator base period [12]

For crystal oscillator mode, the minimum oscillator base period = 40000ns

$\therefore Tcy = 4 \times 40000ns$

$Tcy = 160000ns$

$$\text{Instruction cycle period} = \frac{4}{F_{oscmax}} \quad 3.10$$

Instruction cycle period = 4/16MHZ

Instruction cycle period = $0.25\mu s$

3.3.3 MICROCONTROLLER TIMING

The PIC16F877 has three timer registers TIMERO, TIMER1 and TIMER2. These timers run at a speed of ¼ of the clock speed i.e machine cycle. With 16MHZ crystal, the internal timer will run at ¼ of 16MHz = 4,000,000Hz. This implies that to turn ON an output device, says LED; for 1 second, 4,000,000 for this timing pulse would be counted.

This was reduced by dividing it by 256 to ensure maximum slow down so that instructions are not skipped if too fast.

$$\therefore F_{osc} = {}^{4{,}000{,}000Hz}/_{256} = 15{,}625Hz$$

This implies that, there will 15,625 pulses in a second.

Also for 5 seconds delay,

1 second requires 15,625 pulses

5 seconds will required 5 x 15625 = 78,125Hz

3.3.4 CONNECTION OF PUSH BUTTONS TO THE MICROCONTROLLER

The push button was connected to a microcontroller via a pull-up resistor of 10kΩ each as shown below

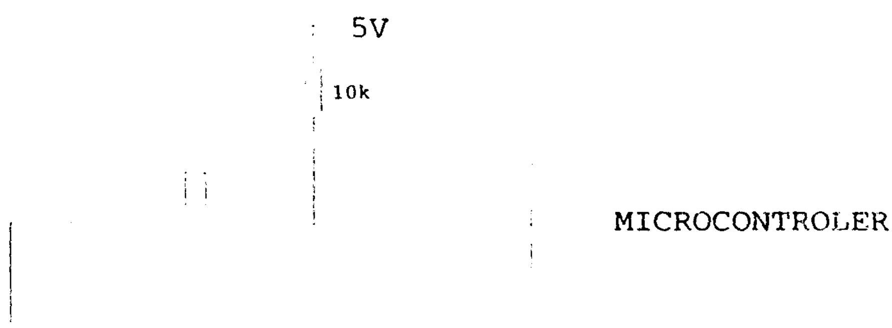


Figure 3.8 Connecting switch to the microcontroller

When the switch is open, 5v, logic 1 is connected to the microcontroller.

When the switch is closed 0v, logic 0 is connected to the microcontroller.

This technique is employed to reset the operation of the microcontroller at the button is pressed i.e. interrupt.

3.3.5 CONNECTION OF OUTPUTS TO THE MICROCONTROLLER

The PIC16F77 is capable of sourcing or sinking current of approximately 20mA-25mA to or from an output pin. It can drive loads such as LEDs and small relays directly [12, 25].

The dual seven-segment display used cannot be connected directly. It was interfaced via a transistor for 5vdc.

The microcontroller unit of the QMS is shown figure below

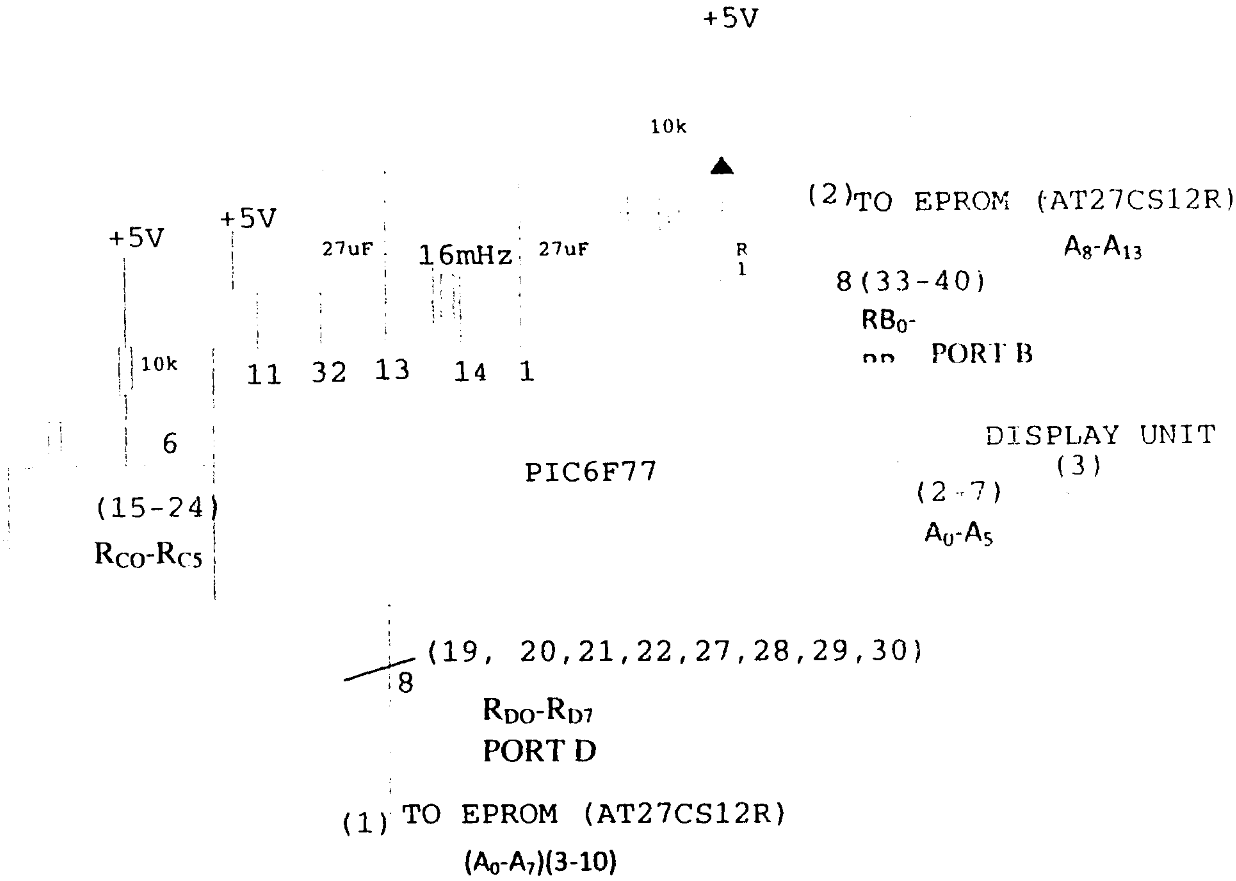


Figure 3.9 Microcontroller unit of the QMS.

3.4 DISPLAY UNIT

The display unit consists of dual seven segment display and BC548 transistor each.

The current sourced from the controller is not more than 25mA which is significantly insufficient to drive a dual seven-segment display. A transistor used as interfaced which was configured as Emitter follower as shown in the figure below.

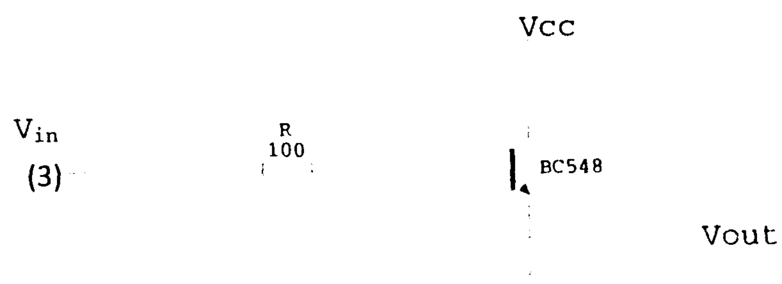


Figure 3.10 Emitter follower

V_{in} is the signal from microcontroller with maximum current of 25mA.

V_{out} is load voltage to drive the display (dual seven-segment display) transistor. The above configuration is called emitter follower or common collector, because the output terminal is the emitter, which follows the input (the base) [14].

Input voltage V_{in} must stay at 0.7 volts or more to obtain the output. This circuit requires less current as well as power from the signal source (microcontroller) to drive the given load (dual seven-segment display).

From figure 3.10

$Vin \geq V_B$

$V_{out} = V_E$

And $V_E = V_B - V_{BE}$ 3.11

Where $V_B = V_{in} = 5v\ (signal\ from\ microcontroller)$

$V_{BE} = 0.7v\ for\ silicon$

Voltage gain $= \frac{V_E}{V_B} = \frac{V_{out}}{V_{in}} = \frac{4.3v}{5v} = 0.86$

In an ideal case, $V_{BE} \approx 0\ and\ V_B \approx V_E$

Av ≈ 1.

3.4.1 SEVEN SEGMENT DISPLAY DESIGN

The single-seven segment display consists of seven LEDs with specification of 2v/10mA relay each, forming each segment.

Below shows a typical seven-segment display and truth tables

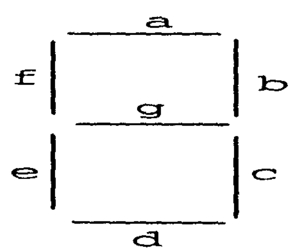


Figure 3.11 (a) Typical seven-segment display

announced through the speaker. The algorithm of the program is stated below:

Step 1: Check if switch SW1 is close

Step 2: If closed display C1 on its display unit and play "cashier one free"

Step 3: Delay for five seconds

Step 4: Turn off display unit for C1

Step 5: Repeat step 1 to step 4 for switch 2-6

Step 6: repeat step 1 to step 5

Step 7: end

The above algorithms is showing pictorially on the flowchart for easy understanding as shown below

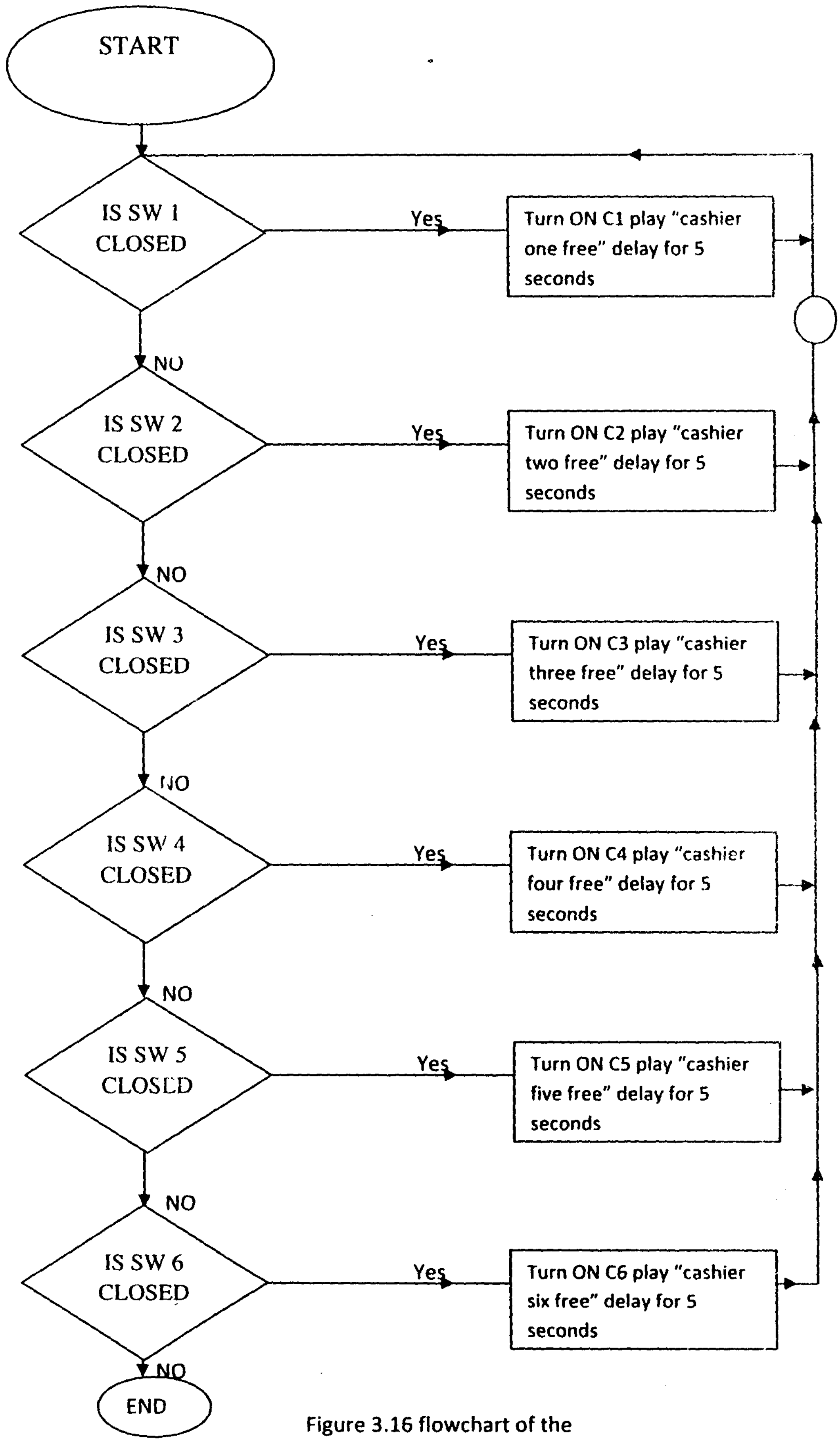


Figure 3.16 flowchart of the

The program was written base on instruction set of PIC16F877 Microcontroller and its detail is on appendix D.

The following step was taking in programming the code to the IC:

- Assembly: The program was written on low-level language and assembled to check if there is any error. The assembling of the program generated LIST FILE and OBJECT FILE.
- Conversion: The object file generated was converted to hexadecimal codes or simply HEX FILE
- Programming: The hex file was used to program the IC by its appropriate programmer [20].

3.7 VOICE RECORD AND PLAYBACK IMPLEMENTATION

The circuit diagram for voice record is shown below

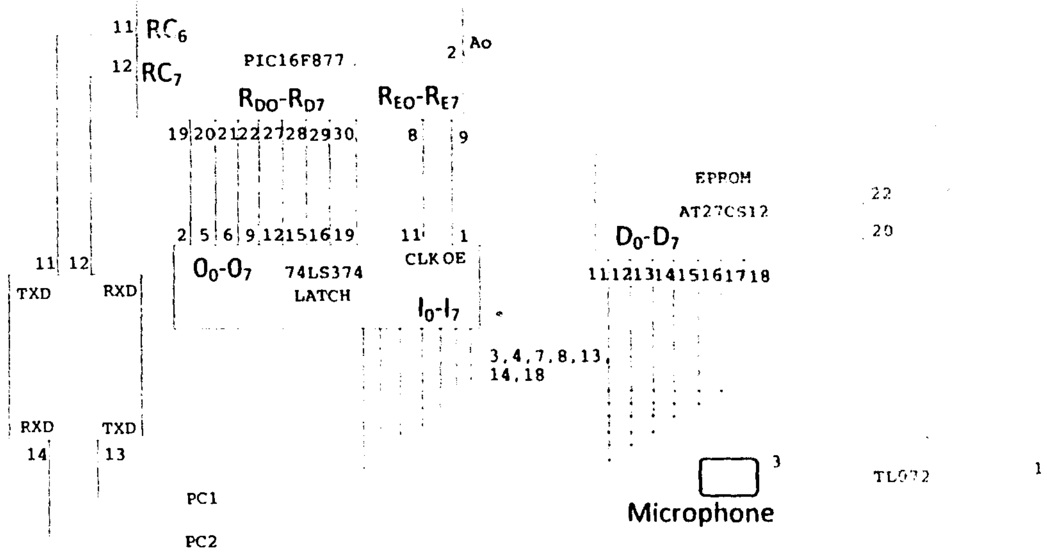


Figure 3.17 Voice record circuit diagram

As show in the diagram of figure 3.17 the voice is recorded through TL072 amplifier via an electrets microphone and the output is send to the microcontroller at pin number 2 which is one of it analog input of PIC16F877.

The PIC 16F877 convert the analog to digital form and send to MAX232 driver through RC_6 and RC_7 to connect to personal computers (PC_1 and PC_2) as shown [24].

The purpose of MAX232 driver is to transmit and receive voice edit on personal computers. The signal will transmit through RC_6 to TXD (transmitter) (11) [24] of MAX232 and return back to RC_7 through RXD (receiver) (12) of MAX232 as shown after edition. For this project, the sound was sampling at the rate 10 kHz.

The RE_0 and RE_1 of the microcontroller clock and OE (output enable) of latch, 74LS374 were connected as shown to have the same working configuration.

The digital sound is presented in 8bit from PIC16F877 to latch 74LS374. The main aim of this latch is used as temporary memory device as widely used in most application [27]. It latches the data present at the inputs to the output but delay for one clock pulse from getting to the output.

The data latch to its output is now program on the AT27C512, EPROM in a named file location. Each sound recorded pass through the above steps before program on EPROM.

The details voice recorded circuit diagram is shown on appendix C.

CHAPTER FOUR

CONSTRUCTION, TESTING AND PERFORMANCE ANALYSIS

4.1 CONSTRUCTION

The prototype construction of each of the units (power supply unit, microcontroller unit, display unit and voice unit) was carried based on the circuit developed from the design. This construction was done on project test board commonly called "bread-board" (BB). Following the circuit diagram, the components were carefully dipped into the holes on the BB with proper consideration for polarity and direction of current.

The integrated circuit (IC) chips were first mounted and properly spaced to allow for fixing of other components also, transistors, diode crystal oscillator, dual-seven segment display, resistors, capacitors, were pointed properly. Jumpers (connecting cables) were used where necessary to connect two points together.

The Multi-meter was used to test the continuity. Power supply to the board initially obtained through batteries of 5v and 12v. This was used to test the circuit.

Some observations were made and some necessary modifications were carried out. These modifications were effected on the final construction. Many ICs were burnt, before finally made connection as the circuits. Very challenging!

The final construction was done on printed circuit board (PCB) commonly known as "Vero-board". The one used for the construction has dimension of 20cm by 10cm with about 1320 number of holes. The resistors, diodes, capacitors were first mounted on the Vero-board followed by the ICS. The orientations of polarized components were properly observed and also the ICs chips were fitted with proper handing and also pin configuration. Soldering was done on the IC sockets and on the legs of other components ensuring no bridge of load between two points.

4.2 TESTING AND INTERFACING

After all the ICS and other components have fixed on Vero-board and workability of each unit was ensured through testing, the followings were carried out after permanent circuitry.

4.2.1 CONTINUITY TESTING

With the aid of digital multi-meter, all the units and each component were tested individually. All terminals connected to the same point e.g V_{cc} or ground was confirmed.

4.2.2 PERFORMANCE TESTING

The operational performance of each individual unit was examined. The power supply unit was tested and then the expected output voltage was measured using multi-meter. Each display unit was power on to ensure that the expected digits are displayed with the sense of sight as feedback. Similarly, the voice unit was tested and very good response was obtained.

4.2.3 SIMULATION

This part of performance is used to check the performance of the microcontroller before other units were interfaced it. The program was simulated to predict its real life performance before programming into the microcontroller. After several simulations and debugging, correct code was actualized. Various manipulations and modifications were done until the exact output was achieved.

The modifications involve changing resistors values, command syntax that were found no more compatible during compilation to rectify syntactic error(s). Some lines of code were interchanged during debugging to rectify the semantic errors. This continues until optimum performance was attained.

4.3 PACKAGING AND CASING

A lot of factors were considered in the selection of casing materials and size. These include portability, protection, aesthetic, heat dissipation and others. The plastic, tinted for the display was selected.

The casing was constructed based on the required dimension (24.5cm by 12cm by 5.cm). The speaker was fixed at top with holes drilled to provide vent for it. Also the buttons and display unit were also arranged for easy access and identification. The power supply unit was located at the end to provide cooling for the transformer. The casing was tight with bolts and nuts for easy accessed. The detail photographs are shown on appendix E.

The following sequential steps were taken for casing construction.

- Measurement with metre rule
- Making out with scriber
- Cutting out or drilling with the aid of cutter/hack saw or drill respectively.
- Filling and trimming using file and sand paper
- Filting of Vero-board containing components and power supply unit
- Assembly of individual units to form a whole
- Covering the casing tight with the aid of bolts and nuts as appropriate.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The project has been highly challenging its implementation was very interesting. All the hardware, the software, display unit, voice unit and others were completely achieved. It unit mentioning that sequel to the completion of this project great engineering knowledge had acquired both practically and theoretically.

The use of that versatile and electronic made simple chip, the microcontroller to accomplish easily some seemingly difficulty and tedious projects was understood.

The voice recording was also interesting and intriguing. It helps in understanding more of conversion of analog sound to digital sound and how digital sound is played.

With these, the aim of undergraduate research was greatly achieved.

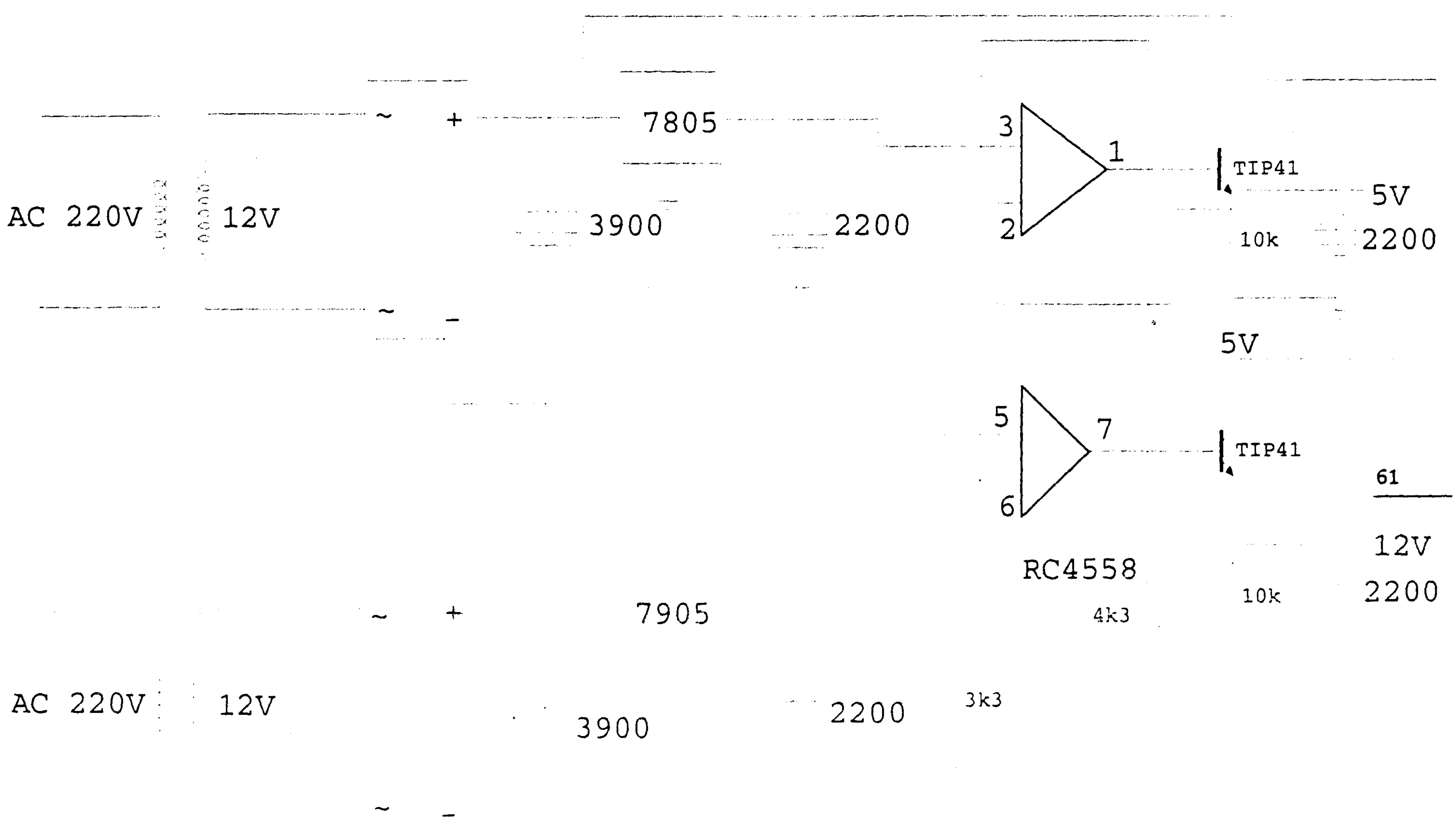
5.2 Recommendation

There are a lot of features that can be added or changed to this project to improve its efficiency and the target goals.

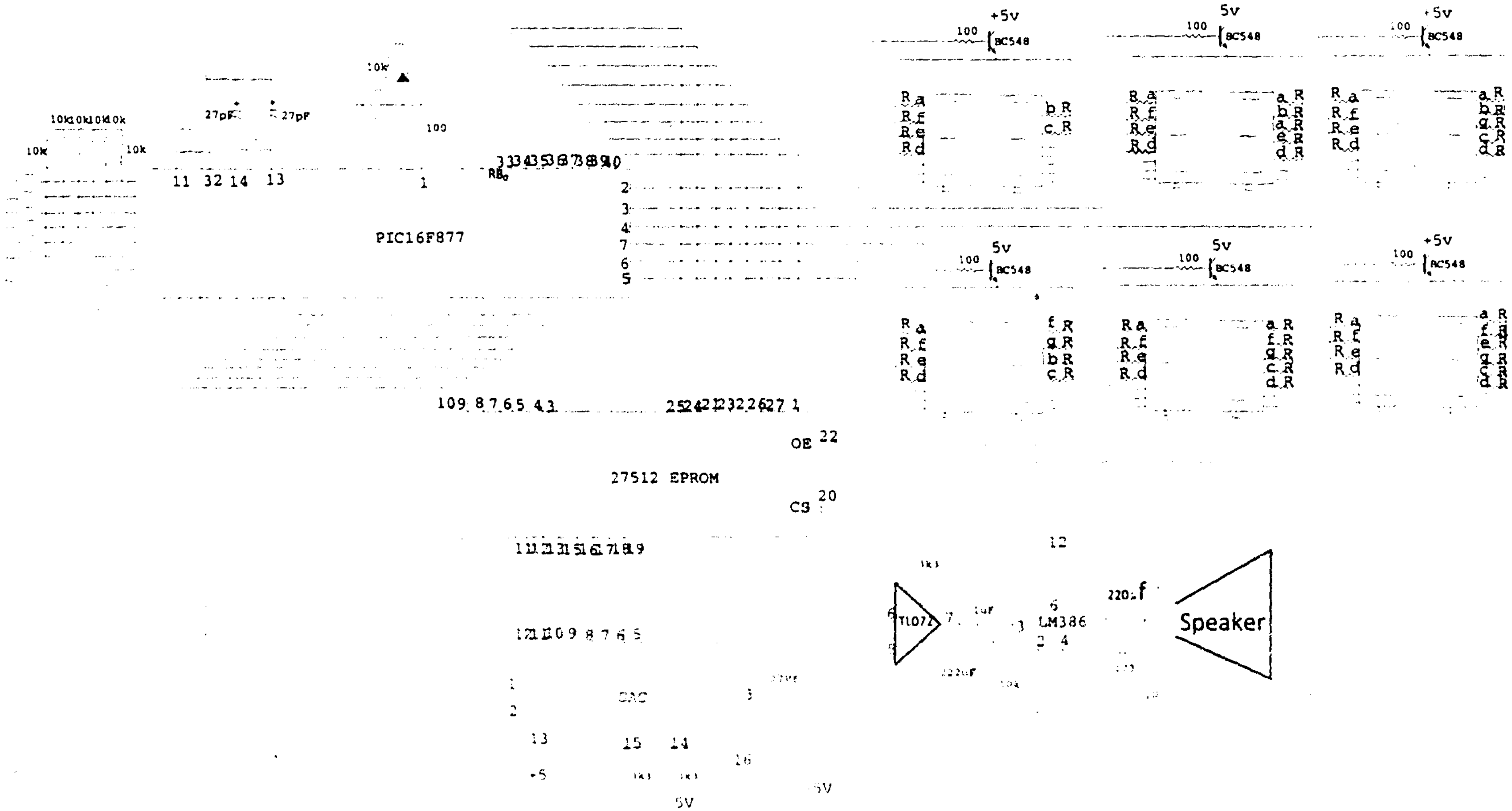
The voice unit should be check and changed with a single voice module to reduce the complexity of the circuit. I recommended that feedback should be included to notify other cashier. Also research can be further on speaker such that its output supervised that of the customers' noise. The counter should also included that would be noting the number of transactions via annulment/display of a particular cashier to know the number of customers attended to per cashier per day.

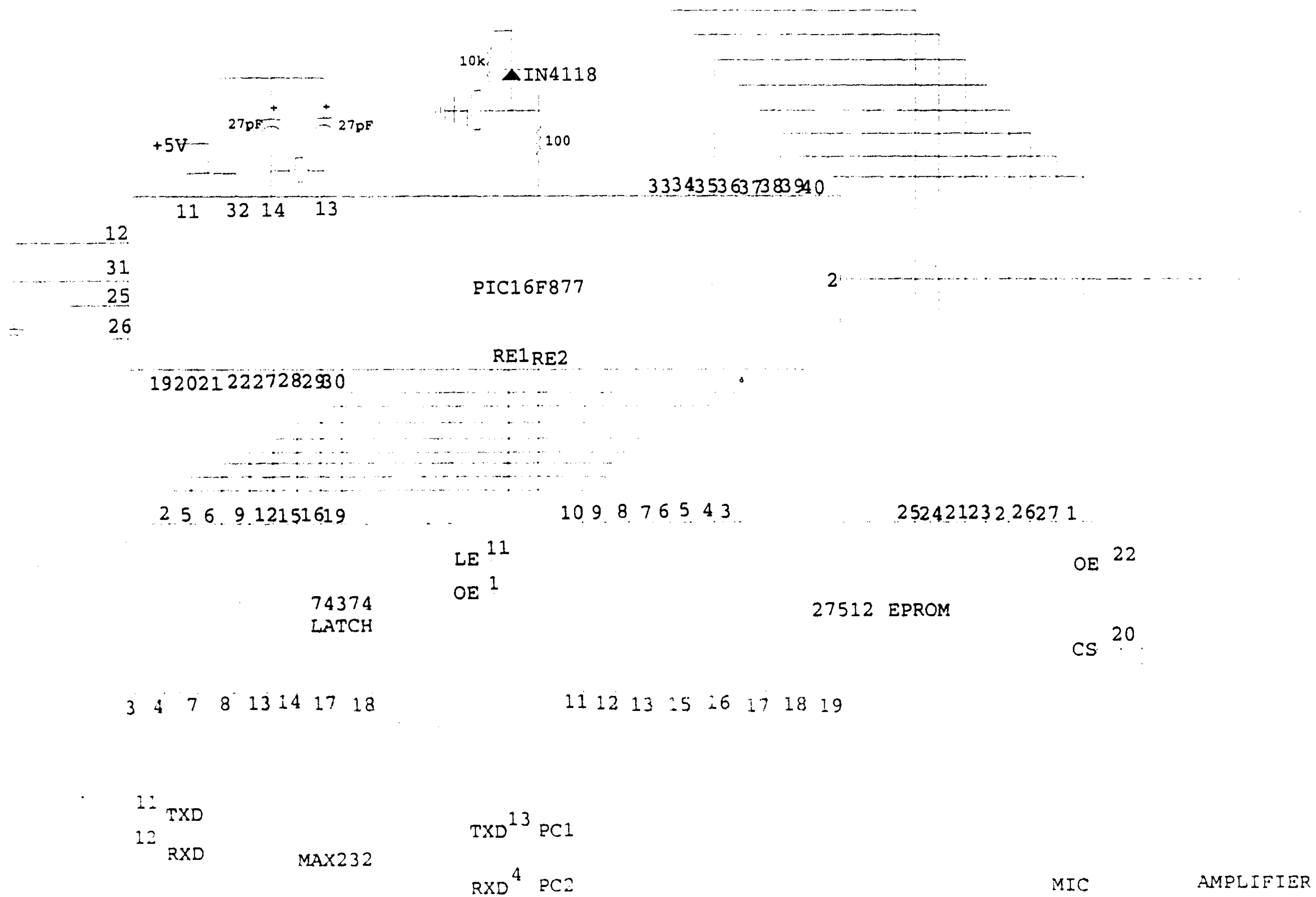
I strongly recommended that research should be given to the students and computer engineering courses should be start at early stage of 300 level for more understanding and quick completion of these kind of projects.

APPENDIX A: POWER SUPPLY UNIT



APPENDIX B: CIRCUIT DIAGRAM




10k
IN4118
27pF
27pF
+5V
100
11 32 14 13
33 34 35 36 37 38 39 40
12
31
25
26
PIC16F877
2
RE1 RE2
19 20 21 22 27 28 29 30
2 5 6 9 12 15 16 19
10 9 8 7 6 5 4 3
25 24 21 23 2 26 27 1
LE 11
OE 1
74374
LATCH
OE 22
27512 EPROM
CS 20
3 4 7 8 13 14 17 18
11 12 13 15 16 17 18 19
11 TXD
12 RXD
MAX232
TXD 13 PC1
RXD 4 PC2
MIC
AMPLIFIER

APPENDIX D: SOURCE CODE

QMS SOURCE CODE

```
QMS.ASM
TRISA EQU    85H
TRISB EQU    86H
TRISC EQU    87H
TRISD EQU    88H
TRISE EQU    89H
PORTA EQU    05H
PORTB EQU    06H
PORTC EQU    07H
PORTD EQU    08H
PORTE EQU    09H
ADCON1       EQU    9FH
ADCON0       EQU    1FH
VALUE1       EQU    20H
VALUE2       EQU    21H
VALUE3       EQU    22H
ADRH   EQU    23H
ADRL   EQU    24H
TEMP   EQU    25H
HOLD1  EQU    26H
HOLD2  EQU    27H
HOLD3  EQU    28H
HOLD4  EQU    29H
CON    EQU    2AH
GODONE       EQU    2
ZEROBIT      EQU    2
ADRESL       EQU    9EH
ADRESH       EQU    1EH
SPBRG EQU    99H
TXSTA EQU    98H
RCSTA EQU    18H
PIR1  EQU    0CH
STATUS       EQU    3
TXIF  EQU    4
RCIF  EQU    5
TXREG EQU    19H
RCREG EQU    1AH
FSR   EQU    04H
INDF  EQU    00H
LIST  P=16F877
ORG          0
GOTO  START
ADC1
             BANKSEL      TRISA
             MOVLW 0X00
             MOVWF TRISA
             CLRF  TRISB
             MOVLW 0XBF
             MOVWF TRISC
```

```
            CLRF   TRISE
            CLRF   TRISD
            MOVLW  0X06
            MOVWF  ADCON1
            BANKSEL      PORTA
            CLRF   PORTA
            CLRF   PORTB
            CLRF   PORTC
            CLRF   PORTD
            MOVLW  0X06
            MOVWF  PORTE
            RETURN
DELAY
            CLRF VALUE2
DELAY3B
            INCF   VALUE2,F
            MOVF   VALUE2,W
            SUBLW  0X40
            BTFSS  STATUS,ZEROBIT
            GOTO   DELAY3B
            RETURN
DELAYX
            CLRF   VALUE1
DELAY3X
            CLRF   VALUE2
DELAY3
            INCF   VALUE2,F
            MOVF   VALUE2,W
            SUBLW  0X00
            BTFSS  STATUS,ZEROBIT
            GOTO   DELAY3
            INCF   VALUE1,F
            MOVF   VALUE1,W
            SUBLW  0X00
            BTFSS  STATUS,ZEROBIT
            GOTO   DELAY3X
            RETURN
PLAY
            MOVLW  0X6F
            MOVWF  ADRH
            MOVLW  0X05
            MOVWF  ADRL
PLAY2
            CALL   DELAY
            MOVF   ADRL,W
            MOVWF  PORTD
            MOVF   ADRH,W
            MOVWF  PORTB
            MOVF   ADRH,W
            SUBLW  0X94
            BTFSS  STATUS,ZEROBIT
            GOTO   PLAYX1
            MOVF   ADRL,W
            SUBLW  0X05
            BTFSS  STATUS,ZEROBIT
            GOTO   PLAYX1
            GOTO   PLAYX2
```

```
PLAYX1
            INCF   ADRL,F
            MOVF   ADRL,W
            SUBLW  0X00
            BTFSS  STATUS,ZEROBIT
            GOTO   PLAY2
            INCF   ADRH,F
            GOTO   PLAY2


            CLRF   CON

CONS2
            CALL   DELAYX
            INCF   CON,F
            BTFSS  CON,5
            GOTO   CONS2


PLAYX2
            MOVF   HOLD2,W
            MOVWF  ADRH
            MOVF   HOLD1,W
            MOVWF  ADRL
PLAY2B
            CALL   DELAY
            MOVF   ADRL,W
            MOVWF  PORTD
            MOVF   ADRH,W
            MOVWF  PORTB
            MOVF   ADRH,W
            SUBWF  HOLD4,W
            BTFSS  STATUS,ZEROBIT
            GOTO   PLAYX3
            MOVF   ADRL,W
            SUBWF  HOLD3,W
            BTFSS  STATUS,ZEROBIT
            GOTO   PLAYX3
            GOTO   PLAYX4
PLAYX3
            INCF   ADRL,F
            MOVF   ADRL,W
            SUBLW  0X00
            BTFSS  STATUS,ZEROBIT
            GOTO   PLAY2B
            INCF   ADRH,F
            GOTO   PLAY2B


            CLRF   CON

CONS
            CALL   DELAYX
            INCF   CON,F
            BTFSS  CON,5
            GOTO   CONS
```

```
PLAYX4
        MOVLW 0X5D
        MOVWF ADRH
        MOVLW 0X03
        MOVWF ADRL
PLAY2C
        CALL  DELAY
        MOVF  ADRL,W
        MOVWF PORTD
        MOVF  ADRH,W
        MOVWF PORTB
        MOVF  ADRH,W
        SUBLW 0X6F
        BTFSS STATUS,ZEROBIT
        GOTO  PLAYX5
        MOVF  ADRL,W
        SUBLW 0X04
        BTFSS STATUS,ZEROBIT
        GOTO  PLAYX5
        GOTO  PLAYX6
PLAYX5
        INCF  ADRL,F
        MOVF  ADRL,W
        SUBLW 0X00
        BTFSS STATUS,ZEROBIT
        GOTO  PLAY2C
        INCF  ADRH,F
        GOTO  PLAY2C

PLAYX6

        CLRF  CON

CONS3
        CALL  DELAYX
        INCF  CON,F
        BTFSS CON,5
        GOTO  CONS3
        RETURN

PLAYM1
        BSF   PORTA,0
        CALL  PLAY
        BCF   PORTA,0
        RETURN
PLAYM2
        BSF   PORTA,1
        CALL  PLAY
        BCF   PORTA,1
        RETURN
PLAYM3
        BSF   PORTA,2
        CALL  PLAY
        BCF   PORTA,2
        RETURN
PLAYM4
        BSF   PORTA,3
```

```
        CALL   PLAY
        BCF    PORTA,3
        RETURN
PLAYM5
        BSF    PORTA,4
        CALL   PLAY
        BCF    PORTA,4
        RETURN
PLAYM6
        BSF    PORTA,5
        CALL   PLAY
        BCF    PORTA,5
        RETURN
START
        CALL   ADC1
REDO
        MOVLW  0X00
        MOVWF  HOLD1
        MOVWF  HOLD2
        MOVLW  0XFF
        MOVWF  HOLD3
        MOVLW  0X10
        MOVWF  HOLD4
        BTFSS  PORTC,0
        CALL   PLAYM1

        MOVLW  0X00
        MOVWF  HOLD1
        MOVLW  0X11
        MOVWF  HOLD2
        MOVLW  0XFF
        MOVWF  HOLD3
        MOVLW  0X20
        MOVWF  HOLD4
        BTFSS  PORTC,1
        CALL   PLAYM2

        MOVLW  0X00
        MOVWF  HOLD1
        MOVLW  0X21
        MOVWF  HOLD2
        MOVLW  0X00
        MOVWF  HOLD3
        MOVLW  0X2E
        MOVWF  HOLD4
        BTFSS  PORTC,2
        CALL   PLAYM3

        MOVLW  0X01
        MOVWF  HOLD1
        MOVLW  0X2E
        MOVWF  HOLD2
        MOVLW  0X01
        MOVWF  HOLD3
        MOVLW  0X39
        MOVWF  HOLD4
        BTFSS  PORTC,3
```

```
CALL   PLAYM4

MOVLW  0X02
MOVWF  HOLD1
MOVLW  0X39
MOVWF  HOLD2
MOVLW  0X02
MOVWF  HOLD3
MOVLW  0X45
MOVWF  HOLD4
BTFSS  PORTC,4
CALL   PLAYM5

MOVLW  0X03
MOVWF  HOLD1
MOVLW  0X45
MOVWF  HOLD2
MOVLW  0X02
MOVWF  HOLD3
MOVLW  0X5D
MOVWF  HOLD4
BTFSS  PORTC,5
CALL   PLAYM6

GOTO   REDO
END
```

APPENDIX E: CONSTRUCTION PHOTOGRAPHS

APPENDIX F: COST ANALYSIS

S/N	Components	Qty	Unit price(₦)	Amount(₦)
1	PIC16877 Microcontroller	1	2000:00	2000:00
2	AT27C512R EPROM	1	1000:00	1000:00
3	74LS374 LATCH	1	500:00	500:00
4	Dual seven segment display	6	250:00	1500:00
5	BC548Transistor	6	20:00	120:00
6	Electrets Microphone	1	50:00	50:00
7	16MHz Crystal oscillator	1	150:00	150:00
8	Resistors	15	5:00	75:00
9	8Ω speaker	1	100:00	100:00
10	Capacitors	22	50:00	1100:00
11	7805 Voltage Regulator	1	50:00	50:00
12	7905 Voltage Regulator	1	50:00	50:00
13	Bridge Rectifier	2	70:00	140:00
14	IN4118 diode	2	5:00	10:00
15	12V Transformer	1	250:00	250:00
16	Soldering Iron	2	150:00	300:00
17	LEDs	1	10:00	10:00
18	Push- Buttons	6	20:00	120:00
19	Bread Board	4	400:00	1600:00
20	Soldering Lead	½ coil	250:00	150:00
21	Digital Multi-meter	1	450:00	450:00
22	Flexible Wires	30 yards	10:00	300:00
23	Casing	-	-	2000:00
24	MAX232 drivers	1	150:00	150:00
25	TL072 Transistors	1	20:00	20:00
26	DAC-08 series	1	500:00	500:00
27	LM 386 Amplifier	1	150:00	150:00
28	RC4558 Dual Amplifier	1	200:00	200:00
29	TIP41 Transistor	2	50.00	100:00
30	Transportation	-	-	6000:00
31	Internet Browsing and Downloading	-	-	4000:00
32	Miscellaneous	-	-	100:00
33	Total			24145:00

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