DESIGN AND CONSTRUCTION OF A MULTI-OPTION SIREN SYSTEM

BY

ABOLARINWA JOSHUA ADEGBOYEGA

95/4379EE

DEPARTMENT OF ELECTRICAL/COMPUTER ENGINEERING

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA.

A PROJECT SUBMITTED TO THE DEPARTMENT OF ELECTRICAL/COMPUTER, ENGINEERING IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF ENGINEERING [B. ENG.] DEGREE OF THE FEDERAL UNIVERSITY OF TECHNOLOGY MINNA.

DECEMBER, 2000.

CERTIFICATION

I certify that I supervised and approved this project work which I have found to be adequate in scope and quality for the partial fulfillment of the award of Bachelor Degree in Electrical/Computer Engineering [B.Eng.].

Dr. Y.A. Adediran

Project supervisor.

Date

Dr. Y.A. Adediran

Head, Electrical/Computer Engineering Department.

Date

External Examiner.

17/1/01

Date

DECLARATION

I Abolarinwa. Joshua Adegboyega hereby declare that this entire project work is an original concept designed and constructed by me. And that it is based on information from people of relevant experience in the field, from records, texts and observations all of which are acknowledged under close guidance and supervision of Dr. Y.A Adediran the Head of Department, Electrical/Computer Engineering, Federal University of Technology, Minna.

....

STUDENT DATE

DEDICATION

This project is dedicated to the glory of God and to the entire members of my present family and that which is to emerge in the near future if Christ tarries.

ACKNOWLEDGEMENT

Firstly, I wish to appreciate the assistance rendered me by my supervisor Dr. Y.A. Adediran. I greatly appreciate his constructive criticism, correction and assistance rendered me in the course of this project write-up.

I also want to thank everyone that made my project work a reality. I cannot but remember Kachi for the material he gave me that assisted me in my circuit design. Also I owe so much to Elisha Tiyagnett, he had been a kind, understanding electronic tutor and helper. Mention has to be made of Olumide Asenuga for the assistance rendered in seeing that my circuit functioned well.

Too numerous to be mentioned are the company of those who had contributed to the successful completion of this project. The entire member of final year brethren fellowship [Deeper Life Campus Fellowship], the whole fellowship at large and other friends alike have been of great encouragement. God be with you all.

I want to appreciate my darling parents Ven. and Mrs Abolarinwa. You have been so wonderful to me throughout my academic carrier until this point. You will live to enjoy the labour of your hand. I also want to appreciate all my brothers and sisters. You are the best family members I can ever have. Also to my in-laws I say thank you.

Above all, unto God who is able to do exceedingly, abundantly, above all I can ever think or imagine are blessing, glory, honour, praise, majesty, and dominion forever and ever.

ABSTRACT

Siren system has been in existence for several centuries, and it has witnessed fundamental changes over the years. Modern siren systems are made from passive and active electronic components, and are electrically driven.

But, with the multi-option siren system, which is the main focus of this project, it is not only an electronic system, which produces sound, it equally incorporates some digital logic features based on some chips. It is this distinguishing feature that brought out the name **'multi-option siren'.** The aim is to produce a single system that produces different types of sound. This objective was achieved from various stages involved in the theory of design.

With the use of astable multivibrator, flip-flop and operational amplifier, the system was able to produce as many different sounds as possible. This then suggests that, by way of one's ingenuity, it is possible to design and realize any imagined electronic system like the multi-option siren.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

GENERAL INTRODUCTION

An Electronic Siren System is a device used to generate audible sound. Because the output of the system is audible sound, it can be developed to become alarm system.

Although, there are in existence different types of siren system over the years, the Multi-Option Siren System is different and unique in its functions and mode of operation. Most common siren systems are dedicated to produce a single or, at most, two different types of sound. With this multi-option siren, it can produce as many different sounds as possible. From its name and function it is not an over statement to say that it is a tone generator system of infinite type of sounds.

Brief details of how these multi sounds is achieved is given later in the course of this write-up. This project is meant to give some improvement on the existing siren systems. It incorporates certain features that distinguish it from other sirens. Such features as gating facilities are introduced as part of the system design.

With some of the new features incorporated into the system design, it has made the system to find application in various fields. It can be used in Police patrol vehicles, entertainment escort for executives, ambulance and as security alarm system.

1.1 AIMS AND OBJECTIVES

As earlier mentioned in the general introduction, this project work is aimed at building a siren system that can produce or generate multiple sound. This actually was the idea conceived. Because there has not been any work done to bring out a single electronic system that can perform this function, I decided to embark on this work. With rigorous work carried out on the design and construction carried out based on the design specifications, the goal of multi-option siren system was achieved, solving the problem at hand.

The scope of this project work is limited to the use of tone generator to produce audible sound. The tone generator has its operating frequency varied over the full audio range {0.3-3.4} kHz by a single tone control. This system is not meant to be an alarm security system of any kind, but room for further development is provided in the system design.

1.2 LITERATURE REVIEW

Siren systems have been in existence since the beginning of 19th century. The system has undergone fundamental change, which produced the basis of the device in general, use today. Modern siren systems are electrically driven. These sirens have an advantage that they can be made to function anywhere there is AC or DC electricity supply.

With the use of **very low frequency ramp** signal generator circuit, a wailing sound siren has been produced. This is the kind of sound typically used by the American police cars. Also, another type of siren that has been developed is the type that produces ' dee-dah' warbling sound typically used by the British police cars. This type of siren was developed using a very low frequency {VLF} **pulse modulation circuit**. The circuit produces sound without **vibrato** {pulsating effect}.

Also there are other types of siren that have been produced over the years. All of them are meant to generate one type of sound. But, with the multi option siren system, it incorporates both the wailing and the warbling types of sound together in it. As it can produce wailing sound, so also it can produce warbling sound. At some other time, it can produce sound of repeatedly scaled {up and down} piano sound when the signal generators generate pulsating signal {vibrato} in the system.

1.3 PROJECT OUTLINE

This project thesis has been divided into four (4) major chapters, each of the chapters dealing with important stages of the project work.

Present in chapter 1 is the introduction to the work done. This also includes the aims and objectives of the project work. Review of the past work done as related to the one this project is meant for is also included in this chapter.

Moving down to chapter 2 is the project design. This includes the various stages of the design. Some important design procedures, calculations are discussed in this chapter.

Chapter 3 deals with the actual construction, testing and results that came out from the testing. This chapter gives the details of the construction and result analysis. Measurements taken, observations made in the course of testing were also included in this chapter.

Chapter 4, which is the concluding chapter of this thesis centers on the conclusion drawn, and some recommendations made. This design has a total of seven variable controls plus six switch-selectable operating modes which makes it possible to generate such a vast range of different sounds. This then, is what distinguishes it from other existing siren systems

CHAPTER 2

SYSTEM DESIGN

INTRODUCTION

For easy design and realization of the set objectives, **top-down** design method was used. This involves breaking the whole-conceived idea into manageable pieces. Hence, the project design was broken into three sub units. These units include-

(I) .the power supply unit

(II) the main siren circuit

(III) The gating facility circuit.

With these sub groupings, the design process was easier to carryout. The inter connection of the various sub units is shown in the fig. 2.1 below.

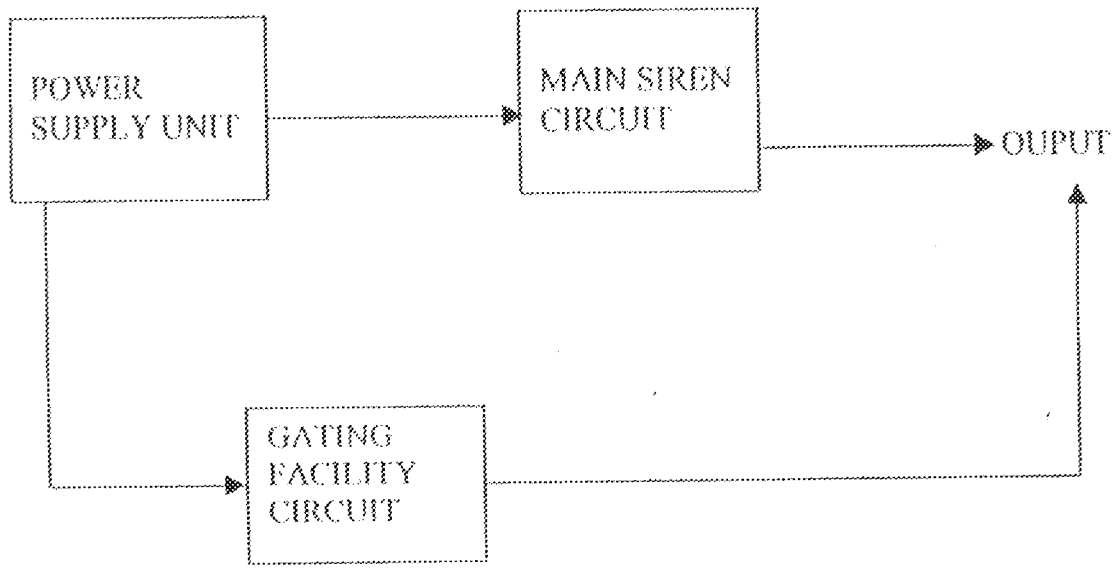

Fig. 2.1. Block Diagram of the multi-option siren.

The power supply unit is the basic unit that supplies power to drive the siren system. The system was designed to operate with 12V supply that can be derived from either batteries or AC mains with suitable supply circuit. The main siren circuit unit consists of a tone generator, with audio range operating frequency, several frequency modulator generators, operational amplifier network, and transistor switching network. The gating circuit unit consists of the flip-flop network connected to the audio amplifier components.

The gating unit is equally connected to the main circuit as well directly to the output speaker. All these sub divisions of the designed are duly interconnected after the final design was done.

2.1 THEORY OF OPERATION

The heart of the project is the tone generator designed around IC3 in the fig. 2.2 below. This fig. is also used to explain the theory of operation.

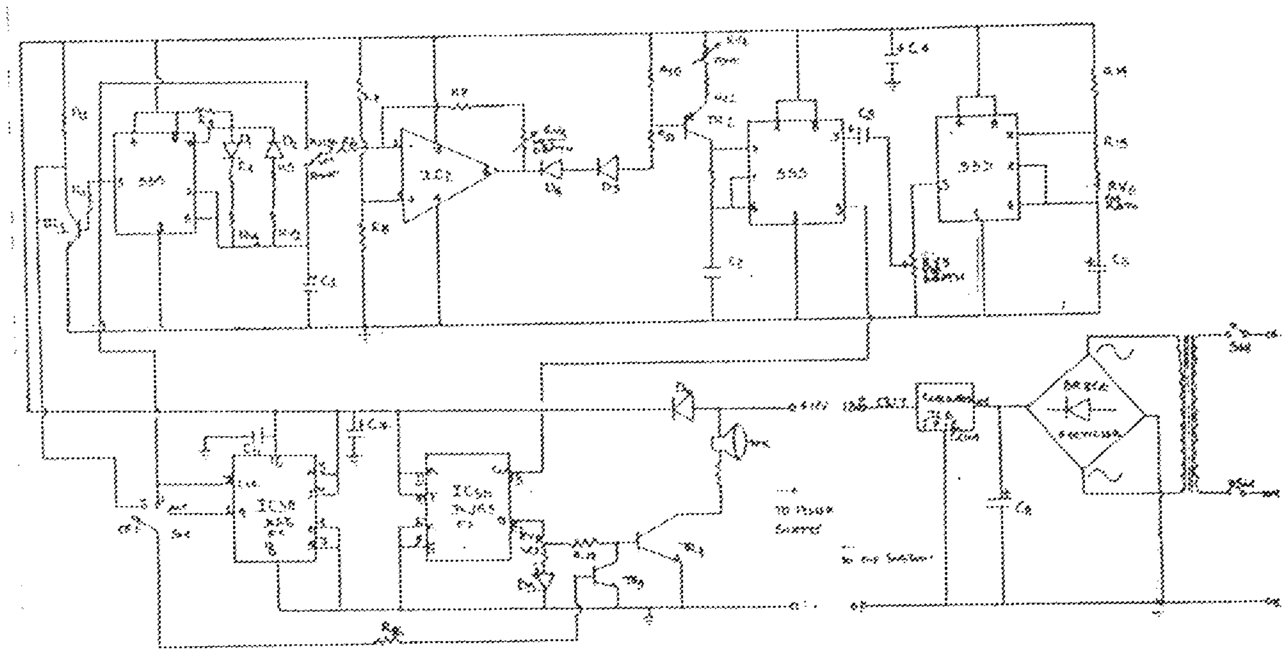

Fig. 2.2.The main circuit layout.

The power supply delivers a 12V 1A regulated DC to the system. The IC3, which is the heart of the design, is a fairly conventional **555- type astable**, except that capacitor C2 charges via R13 and the constant current generator formed by transistor TR2 and its associated resistor and diode network. Normally, the output of IC2 {feeding D4} is half supply volts so TR2 base is at a couple of volts below the positive supply value. The operating frequency of IC3 tone generator is variable via tone control RV4. The output of IC3 tone generator is divided-by-two, to provide a symmetrical waveform {via IC5b} and the resulting audio signal is fed to the speaker via TR4, R17 and volume control RV7.

IC4 is wired as a perfectly conventional 555-type astable and is used as a vibrato {back and forth} generator, with its square wave output being used to frequency modulate the IC3 {tone generator} via pin 5. The **vibrato rate** is variable via RV6 and the **vibrato depth** via RV5. To completely remove vibrato effect, RV5 is varied to minimum, which coupled with C3, reduces the modulated frequency.

IC1 is also wired as a 555-type astable, but in this case, RV1 and RV2 independently vary the charge and discharge times of C1 respectively and the circuit operates at a very low frequency {VLF}. The outputs of the VLF oscillator can be used to frequency modulate tone generator IC3 via IC2 and constant current generator TR2. The pin 3 being used to provide pulse modulation and the C1 output to provide ramp modulation. The depth of the modulation can be varied by mod-depth control RV3 which enables the gain of IC2 to be varied from close to zero {RV3=0} to approximately {RV3=4.7M}.

The square wave pin3 output of the VLF oscillator can be used to synchronously gate the audio of the output signal of the siren ON and OFF via TR3. When this transistor is driven to saturation {by a high bias to R16} it kills the input signal to amplifier TR4. If R16 is driven directly from pin 3 of IC1, the audio signal is killed {gated off} when the VLF output is high. If collector of the inverter TR1 drives R16, the audio signal is killed when the VLF output is low. If R16 is driven from the output of divide-by-two flip-flop IC5a, the audio signal is killed on alternate VLF cycles.

2.2 OPERATION OF THE INTERNAL CIRCUITRY OF 555 TIMER ASTABLE MODE.

It becomes very important at this juncture to investigate the internal principle of operation of 555 timers since they are being made use of extensively in this system. A 555 timer is a low frequency clock signal generator. It is an 8-pin integrated circuit (IC), which can operate as monostable and astable multivibrator. Attention is given to its astable mode of operation in this system. Astable means that, its output continuously alternates or switches back and forth, between the two **quasi-stable** (high and low) states, for a period of time determined by network parameters.

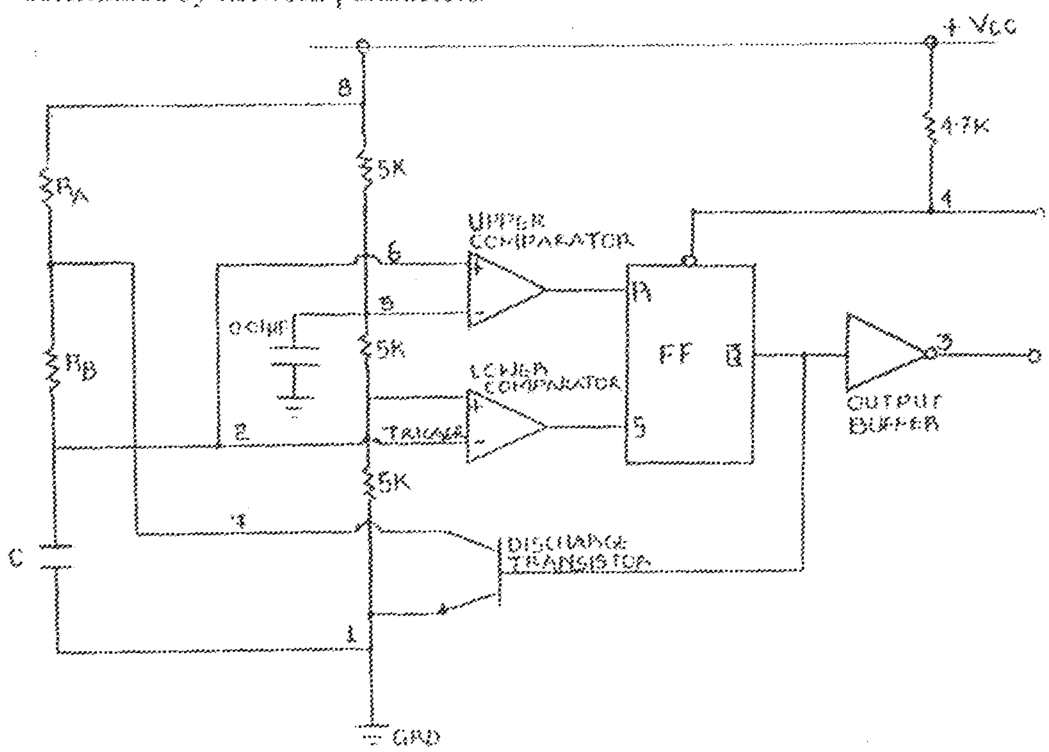

Fig. 2.3 555 Timer configured for astable mode of operation.

From fig. 2.3 above, the values of the external components C, R_A and R_B determine the frequency and duty ratio of the signal output of the 555 timer. The voltage divider of the three 5kΩ resistors sets a threshold of 1/3 V_{CC} on the positive non inverting side of the input of the lower comparator, and threshold of 2/3 V_{CC} on the negative inverting side of the input of the upper comparator.

If the voltage applied to the pin 2 of the lower comparator is less than 1/3 V_{CC}, the output of the lower comparator will be HIGH. This will SET flip-flop. With the flip-flop SET, the Q output will be LOW and the discharge transistor will be off. Then the buffer output connected to Q will produce a HIGH on the final output. If the voltage on the signal input pin 6 of the upper comparator is greater than 2/3V_{CC}, the output of the upper comparator will be HIGH and the flip-flop will be RESET. This causes discharge transistor to be ON and the final output at pin3 will be LOW.

Note that the input of both comparators is connected to the timing capacitor C. when the power is first turned ON, C charges up with 0V. Because this is less than 1/3 V_{CC}, the flip-flop will be SET; the discharge transistor will be off, and the final output is HIGH. As time passes, the voltage on C charges through R_A and R_B. When the voltage on C passes 2/3V_{CC}, the output of the upper comparator will go HIGH and RESET the flip-flop. This turns ON the discharge transistor and makes the final output LOW. When the discharge transistor is LOW, it acts as a low resistance so the charge on C is drained off to ground through R_B. When the voltage on the C drops below 1/3V_{CC} again, the output on the lower comparator goes HIGH and SETS the flip-flop. This causes the transistor to turn off and final output to go HIGH again. The control voltage pin5 can be used to vary the output frequency. The cycle continues alternately as C charges to $2/3V_{CC}$ and discharges to $1/3V_{CC}$.

Also, the external RESET input {pin 4} can be used to gate the circuit ON and OFF. If the external RESET input of a 555 timer is made low, the output immediately goes low and stays low. When the RESET is made HIGH, the circuit starts pulsating again. The CONTROL VOLTAGE {pin5} can be used to vary the output frequency of the circuit. A voltage applied to this input will change the threshold voltage of the comparator and then change the frequency oscillation. The cycle of charging and discharging capacitor C repeats giving a rectangular output waveform whose part periods {t_1 and t_2} are now calculated thus. To calculate t1, that is the charging time at V_C approaching 2/3 V_{CC} Consider the waveform in fig. 2.4

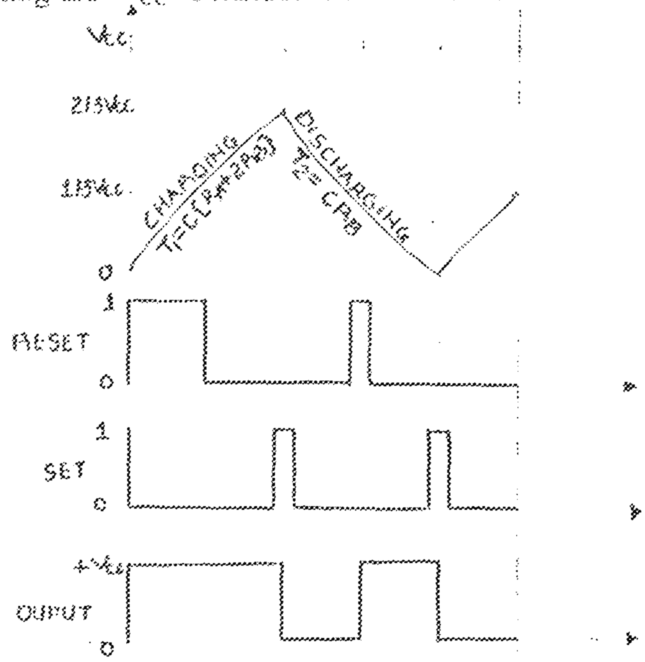

Fig.2.4 Waveform of 555 timer

To determine the charging time t_1

$V_C = V_{CC}\,[1-\exp^{-t/T_1}]$ where

$T_1 = C\,\{R_A + R_B\}$

$1/3V_{CC} = 2/3V_{CC}\,[1-\exp^{-t/T_1}]\,T_1.$

Hence, $t_1 = \ln 2\,[C\,\{R_A+R_B\}]$

$= .693\,C\,\{R_A+R_B\}$

To determine the discharge time t_2

$V_C = V_{CC}\,[1-\exp^{-t/T_2}]$ where

$T_2 = CR_B$

$1/3V_{CC} = 2/3V_{CC}\,[1-\exp^{-t/T_2}]\,T_2$

Hence, $t_2 = \ln 2\,CR_B$

$= .693CR_B$

Where $t_1+t_2=T$

Therefore, the frequency (f) of oscillation is given by

$F = 1/t_1+t_2 = 1/.693\,C\,\{R_A+R_B\}$

$= 1.44/C\,\{R_A+R_B\}$

$=1/T$

2.3 DESIGN STAGE 1 (TONE GENERATOR)

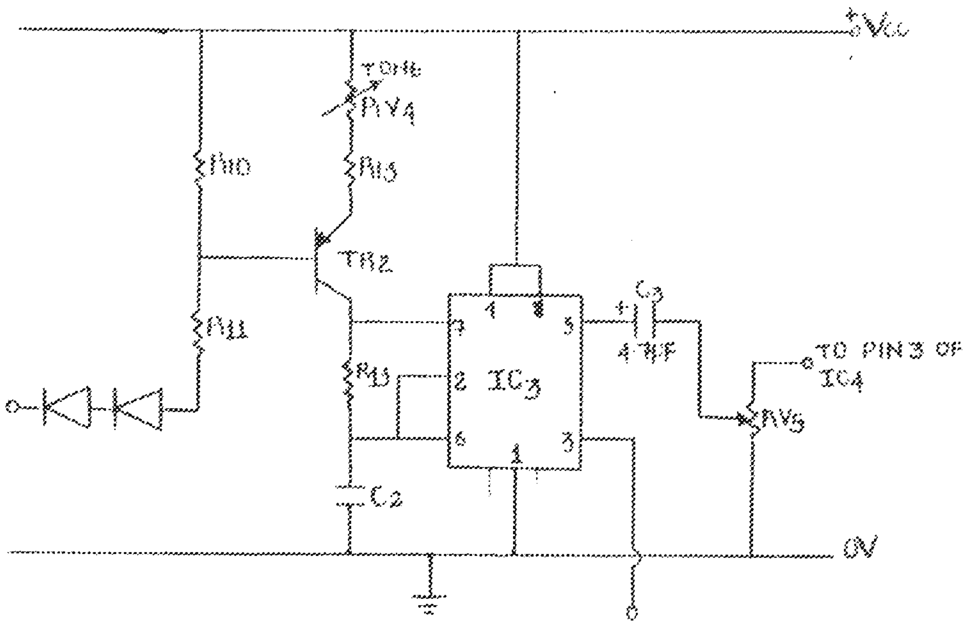

Fig. 2.5 Tone generator designed around IC_3

The tone generator operates with frequency over the full audio range [300Hz-3400Hz]. RV_4 is a variable resistor, which is used to vary the operating frequency of IC_3. RV_4, R_{12}, R_{13}, and C_2 are responsible for the determination of the operating frequency (f) of IC_3.

Maximum frequency is determined at $RV_4=0$

Let f_{max}=3400Hz

To choose the value of R_{12} and R_{13}, the conditions -

$6.6M\Omega \geq R_{12}$ or $R_{13} \geq 1K\Omega$ and $R_{12} < R_{13}$ has to be satisfied.

Let R12 and R13 be of ratio 1:3.1, having in mind a relatively shorter discharge time compared to charge time. Hence, choosing

R_{12} =2.2KΩ

R_{13}= (3.1*2.2) KΩ

=6.8KΩ

Therefore, R_{12}=2.2KΩ; R_{13}=6.8KΩ .

Standard RV_4 of 470KΩ is used in order to have operating frequency < 300Hz.

To obtain the value of C_2, the operating frequency is taken to be 3400Hz. For an astable mode 555 timer, the frequency is given by-

F_{max}= 1/ .693$C_2\{R_{12}+2R_{13}\}$ where f is in Hz, C in Farad and R in Ω.

Hence,

3400= 1.44/C_2 {2.2+2(6.8)}KΩ

Therefore, C_2=1.44/3400{2.2+2(6.8)KΩ

=26.8nf

≈26nf

With R_{12}, R_{13}, RV_4 and C_2 values determined, the minimum operating frequency of IC_3 can be determined thus-

F_{min} at RV_4=470KΩ

F_{min}=1.44/26nf(470+2.2+2(6.8)KΩ

≈113.5Hz.

The charging time t1 is determined thus- t1 = ln2 [C_2 {R_{12}+R_{13}}] at f_{max}

=.693 [26nf{2.2+6.8}KΩ]

=.162ms.

The discharging time t_2 can also be determined thus- t_2=ln2 [C_2R_{13}]

=.693 [26nf6.8KΩ]

=.123ms

It can be observed from the values of t_1 and t_2 above that t1<t_2. This means that the discharge time is shorter than the charging time of C_2. It implies that resistor R_{12} is redundant at the discharging time, and C_2 discharges through R_{13} only.

TR_2 and its associated resistor and network form a constant current source. TR_2 is a PNP AF preamplifier with the ratings $V_{CBO(max)}$=80V, $V_{CEO(max)}$=80V, $V_{EBO(max)}$=5V, I_C=1A, P_D=0.6W, F=200MHz and hfe=180.

R_{10} and R_{11} both form a voltage divider network between the source and the base of TR_2. Because the output of IC_2 is half V_{CC}, therefore, V_B is lower than V_{CC}. With V_B maintained at 8.2v, then using the voltage divider network,

$V_B = V_{CC} R_{11}/R_{10}+R_{11}$ where $V_{CC}=12V$

i.e. 8.2/12=0.683

For proper biasing $R_{10} < R_{11}$

Choosing R_{10}= 4.7KΩ

Therefore, $0.683 = R_{11}/4.7K\Omega + R_{11}$

Giving

R_{11}=10KΩ.

C_3 is a high-value capacitor used to block dc voltage from the variable resistor RV_5. It only allows ac to pass. Its value was chosen to be C_3=4.7μf.

2.4 DESIGN STAGE 2. {THE VIBRATO GENERATOR}

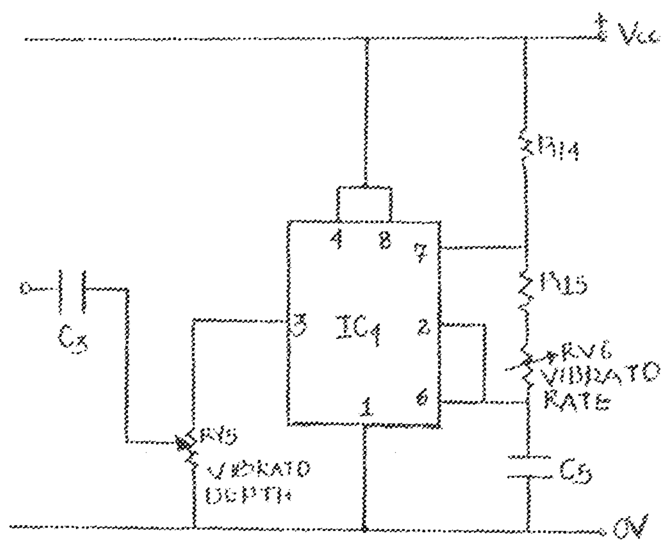

Fig 2.6a Vibrato generator circuit.

The circuit designed around IC_4 {a perfect conventional 555 astable mode} is used to generate **vibrato** {square pulsating signal}. This square wave output is used to frequency-modulate IC_3{tone generator} via pin 5.

RV_5 and RV_6 are responsible for the 'vibrato depth' and 'vibrato rate' respectively. For proper vibrato depth, standard variable resistor of 10kΩ was chosen for RV_5. Also, for wide range of vibrato rate, standard variable resistor of 100kΩ was chosen for RV_6.

Using a similar method employed to determine the timing capacitor and resistors in astable mode of IC_3 values of R_{14}, R_{15}, and C_5 were also chosen. R_{14} and R_{15} were chosen in ratio 1:1 bearing in mind RV_5 at 100kΩ and that discharging time of C_5 should be less than its charging time. Hence, if R_{14}=2.2KΩ, therefore R_{15}=2.2KΩ, to maintain the free running frequency of IC_4 at that within the audio range say 218Hz, assuming RV_6=0,

$F = 1.44/C_5\,(R_{14}+2R_{15})$

$C = 1.44/218(2.2k+2.2k)$

$= 1.0008\mu f$

$\approx 1.0\mu f$ standard value

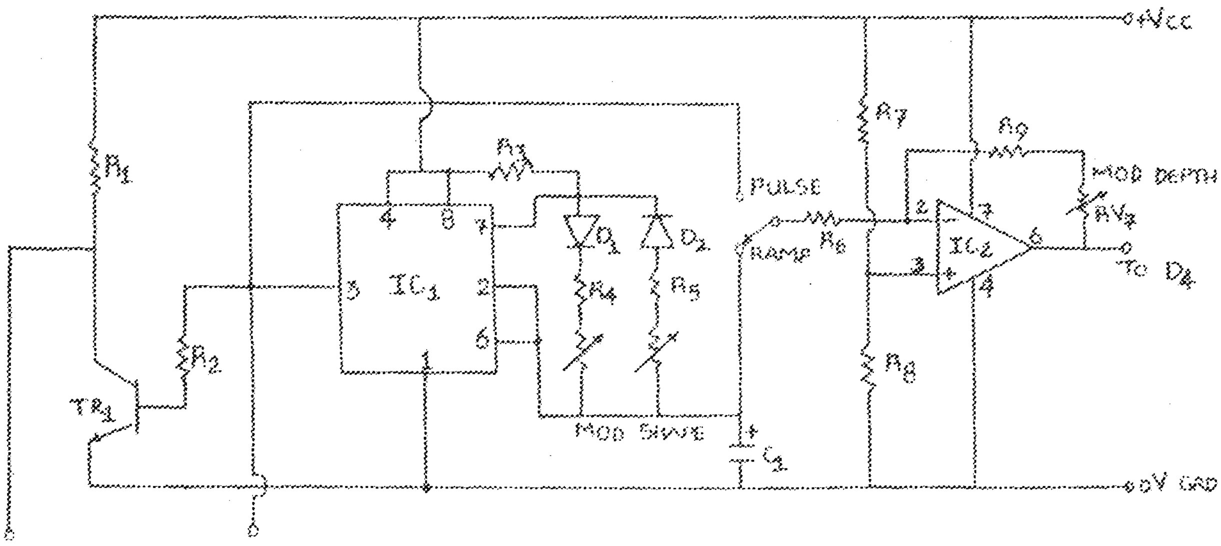

Fig 2.6b Very low frequency [VLF] oscillator.

IC_1 operates as VLF oscillator in an astable mode. Its output at pin 3 frequency modulates IC_3 via IC_2. The charging and discharging of C_1 is controlled by RV_1 and RV_2 independently. The values of RV_1 and RV_2 were chosen in ratio1:1to be of standard value 470kΩ each in order to achieve uniform mod shaping of the ramp signal with each variation. Also R_3, R_4, and R_5 were of ratio 1:1 for the same reason as above, the required value of which are 2.2kΩ each. These values were chosen with the intention of making the operating frequency of IC_1 as low as possible. Assuming a free running frequency of 46Hz, at RV_1=0 and RV_2=0 (that is maximum frequency), the value of the capacitor required is calculated as

$$C_1 = 1.44/f(R_3+2R_4)$$

$$= 1.44/46Hz(2.2k+2*2.2k)$$

$$= 4.74\mu f$$

$$\approx 4.7\mu f$$

The C_1 output produce ramp modulation, while the pin 3 output produce the pulse modulation within the audio frequency range. The modulation depth is controlled by RV_3 and it also varies the gain of IC_2. IC_2 linear non-inverting operational amplifier with its gain greater than 1. For high mod depth,RV_3 was chosen to be 4.7MΩ, to increase the gain of IC_2, a 2.2kΩ has to be connected in series with RV_3

To have a gain > 1, R_6 was calculated as

Assuming gain Av=3.14

$$Av = 1 + (R_9 + RV_3)/R_6$$

$$= (R_6 + R_9 + RV_3)/R_6$$

Hence, $R_6 = (R_9 + RV_3)/(Av - 1)$

$$= (2.2k + 4.7M)/(3.14 - 1)$$

$$= 2.19M$$

$$\approx 2.2M\Omega$$

2.5 DESIGN STAGE 3 (THE GATING FACILITY)

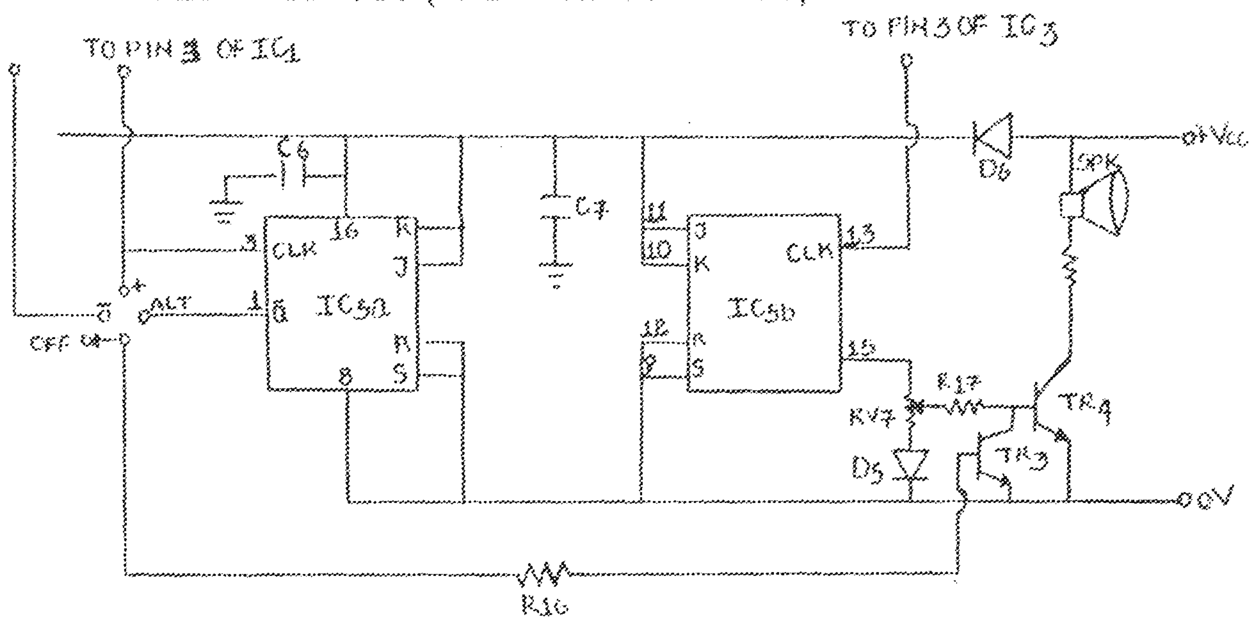

Fig 2.7 The gating circuit.

The major components present in the gating circuit are the two JK-flip-flops. Each one of them is a dual JK master/slave flip-flop that operates with dc supply voltage between 3V to 15V. The output of IC_3 is meant to be divide-by- two to provide symmetrical waveform via IC_{5B}. IC_{5a} also acts in the same way on the output of IC_1.

TR_3 and TR_4 form a darlington pair which are used as an audio preamplifier network together with R_{22}, R_{17}, and RV_7. TR_3 and TR_4 are both BC 109 NPN transistors with ratings

$V_{CBO}=60V$

$V_{CEO}=30V$

$V_{ECO}=5V$

$I_{C(MAX)}=0.8_A$

$P_{D(MAX)}=0.8_W$

$F_t=250MHz$

$Hfe=150.$

R_{16} is a base current limiter for TR_3, the value of which was chosen to be $R_{16}=2.2k\Omega$. So also, R_{17} is a base current limiter toTR_4 with a value of $4.7k\Omega$. RV_7 is the volume control and it is maintained at $10k\Omega$ maximum.

2.6 THE POWER SUPPLY UNIT.

The block diagram of the power supply unit is shown bel ow. The output of the power supply required for this system is regulated 12V, 1000mA dc power supply. A commercial 220V to 12V (rms.) step down transformer was used. The transformer provides electrical isolation between the ac line and the rest of the system.

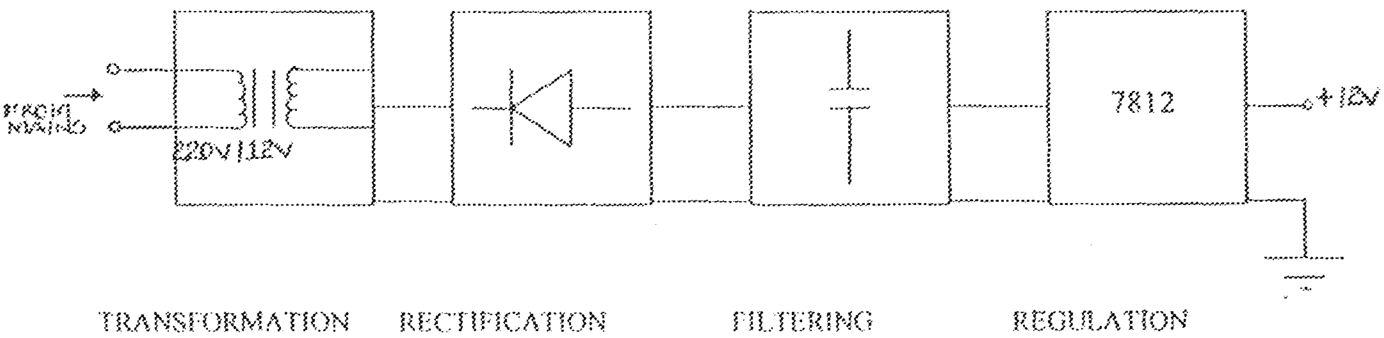

Fig. 2.8 Various stages of power supply unit

Bridge rectifier was used in order to achieve full wave rectification. This involves four (4) general-purpose rectifier diodes (IN4001). The filtering was accomplished using high value electrolytic capacitor. This capacitor is required to remove ripples from the rectified dc voltage. The value of the capacitor is chosen to be 1000μf. To regulate the output voltage at a specific value of 12V dc, a 7812 voltage regulator IC was used. This produced a fixed output voltage of 12V for the system.

CHAPTER 3

CONSTRUCTION, TESTING AND RESULTS.

CONSTRUCTION

The first step in the realization of this project work was the initial design. After the design was carried out and various component parts were gotten, the next thing was the prototype construction. The prototype construction (which was the first stage of the construction) was carried out 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 flow of current.

The IC chips were first mounted and properly spaced to allow for fixing of other components. Next to the chips were the other active components (transistors and diodes) contained in the circuit. The passive elements (resistors, capacitors and variable resistors) were mounted last. Jumpers (connecting cables) were used where necessary to connect two points together. After mounting the components on the BB, power supply to the board was initially obtained through a multi level adapter. This was used to test the circuit. Later, the system power supply unit was constructed. Both means of power supply was able to power the system for testing.

Initial testing on the BB was carried out. Some observations were made and some necessary modifications were carried out. These modifications were effected on the final construction. The final construction was done on the printed circuit board (PCB) commonly called 'vero-board'. There are different sizes of PCB. The one used for the construction is 14.5cm by 6.5cm size with 1320 number of holes present on it. Mounting of components on the PCB began with the low profile components. The resistors, diodes, capacitors and transistors follow this. The orientations of polarized components were properly observed. The chips were fitted last with proper handling. Soldering was done on the IC sockets and on the legs of other components ensuring no bridge of lead between two points.

3.1 CHOICE OF WOODEN CASING

With the prior knowledge of the intended output (sound), I decided to opt for a wooden casing. Because the desired output is sound, I felt wooden casing will be a better choice. This is because vibration of sound (especially that produced by this system) will be lesser with wooden casing than in metallic one. The resonance effect that the wood will produce with the sound coming from the speaker is very low compared to that produced by the other materials. Also plywood material produces good acoustic for sound.

The casing was constructed based on the required dimension (20 by 12 by 12) cm The speaker was fixed at the side with holes drilled into the wood to provide vent for it. Also the power supply was located at a corner where holes were also drilled at that end to provide cooling for the transformer. The variable controls and switches were well arranged and fitted to the casing properly. The casing was finally covered using small nails for tight fixing.

Other finishing touches were put on the casing (like spraying) to make it look attractive and presentable.

3.2 TESTING

The system was tested both at the prototype stage and the final construction stage. The testing was done with the system connected to the mains and the power switch flicked on. With the power switch on, various sound effects were tested. This is by changing the various sound selectable switches and also the various controls at different times. Multiple of sounds were heard using various controls. Also, voltages at some selected points in the circuit were measured. Also the output waveforms were also observed using oscilloscope.

3.3 PROBLEM ENCOUNTERED AND SOLUTIONS

Before the final construction was put in proper reliable state in conformity with the desired function of the system, some problems were encountered during testing. One of such problems was that there was short circuit between the source and the ground.

As a result of this fault, current was not flowing through the circuit, hence causing over heating of the power supply unit. This fault was corrected by point to point continuity test of the circuit.

Another problem encountered was that, at the initial testing, there was no output voltage delivered to the 4Ω speaker. By confining the whole output stage of the circuit, it was discovered that the current limiter resistor between the collector of TR_4 and the speaker is open-circuited. This was removed, and replaced with another functioning resistor with proper connection. After this, the speaker started working.

Also, there was a little problem with the gating section of the circuit. This has to do with gating switch and the JK-flip-flops. Since the gating circuit is driven by the VLF oscillator output, the problem also affected the VLF oscillator 555 timer (IC_1). This problem was solved by reconnecting the switch SW_2 pins properly with the JK-flip-flops and the IC_2.

After all these tests were carried out, the system was put on final test to determine its reliability. This was done by powering it ON for some time. Using fault-tree analysis, considering various mode of failure as pertained to the circuit, the reliability was determined to be greater than 95%.

3.4 RESULTS

As observed from oscilloscope, the output waveforms of the tone generator designed around IC_3 are shown below-

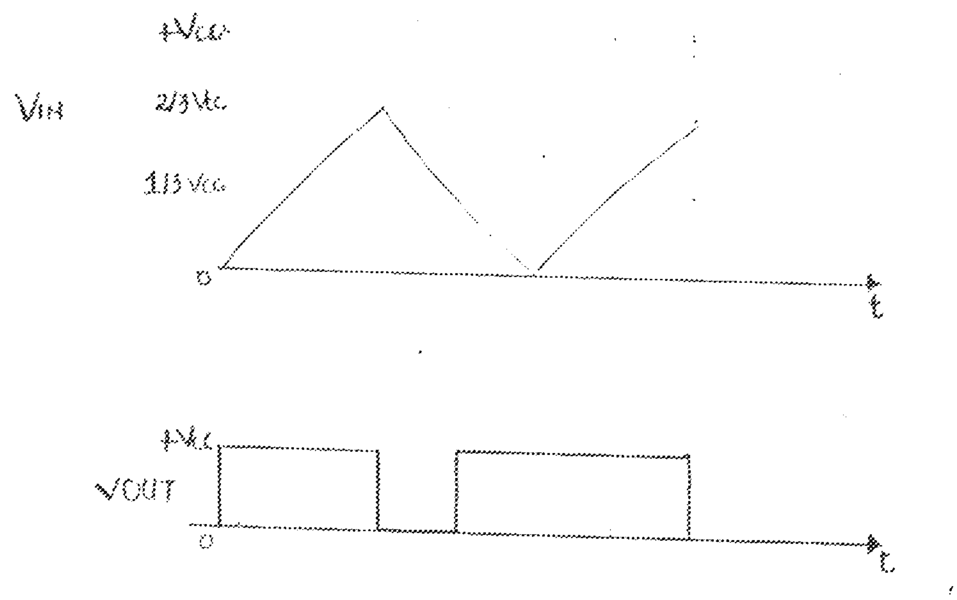

Fig 3.1 V_{IN} and V_{OUT} of IC_3

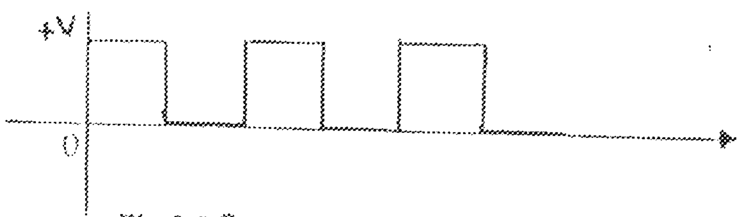

Fig 3.2 Output waveform of IC_4

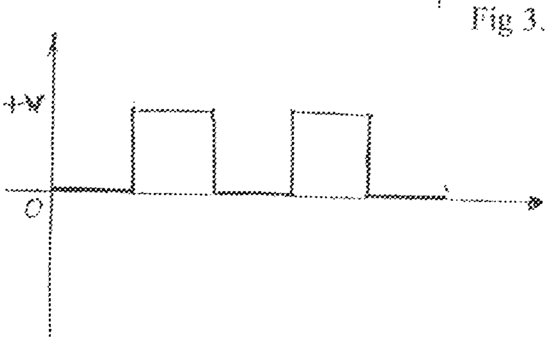

Fig 3.3a pulse output waveform of IC_1

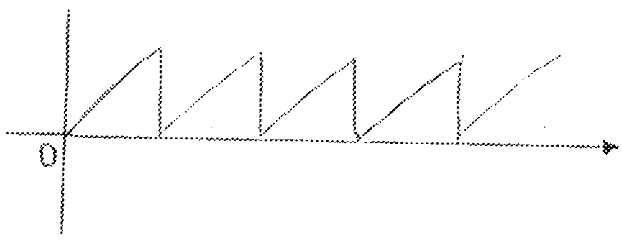

Fig 3.3bRamp output waveform of IC_1

3.5 DISCUSSION OF RESULTS

The tone generator designed around IC_3 is a fairly conventional 555-type astable except that C_2 charges via R_{13} and the constant current generator formed by TR_2 and the associated resistors and diodes. At normal operation, the output voltage of the operational amplifier (IC_2) that feeds D_4 is 1/2 Vcc, making TR_2 base at few volts below +ve Vcc. The operating frequency of IC_3 is varied through the tone control RV_4. The output of IC_3 is divided-by-two to provide a symmetrical waveform (via IC_{5b}), and the resulting audio signal is fed into the speaker through the TR_4, R_{17} and RV_7.

IC_4 is a vibrato generator with square wave output. The output is used to frequency modulate IC_3 via its PIN5. The vibrato rate is variable via RV_6 and vibrato variation through RV_5.

IC_1 produces two types of output waveforms, which are used to frequency modulate IC_3 via IC_2 and constant current generator TR_2. It produces pulse waveform at its PIN3, which provides pulse modulation. The modulation depth is controlled by RV_3 which also varies the gain of IC_2 from 0 to approximately $2*RV_3$. The second waveform produced is ramp waveform, which results when switch SW1 is turned such that the output of IC_1 is tapped via the 4.7µf capacitor C_1.

The square wave output tapped from PIN3 of IC_1 can be used to synchronously gate the audio output signal of the siren ON and OFF via TR_3. When the transistor is driven to saturation (by a high bias to R_{16}) it disables the input signal to amplifier TR_4. If R_{16} is driven directly from PIN3 of IC_1, the audio signal is gated OFF when the VLF output is HIGH. If R_{16} is driven by from the collector of inverter TR_1, the audio signal is gated OFF when the VLF output is LOW. If R_{16} is driven from the output of divide-by-two flip-flop IC_5a, the audio signal is killed on alternate VLF cycle.

CHAPTER 4

CONCLUSION AND RECOMMENDATION

4.1 CONCLUSIONS

Like any other electronic system, the design and construction of a multi-option siren system requires proper and careful planning and implementation.

In this project work, astable circuit from 555-timer integrated circuit (IC) was extensively used to generate tone signals of different types. This in turn has shown how versatile the chip is. This equally forms the basis for any alarm or security system.

As part of the versatility of this 555 timer, it has found so many applications in microcomputer systems of modern days. The multi-option siren systems as a whole affords one to make choice of sound one want for a particular event.

4.2 RECOMMENDATIONS

Because this project work or electronic system is still subject to future improvement, I hereby recommend that it should be developed to form different types of alarm system with different sound coded to convey different information. It is also recommended for future development in musical electronic industries.

4.2 REFERENCES

Adediran Y.A. (1998). Analog Electronics I and II

Lecture note.

Adediran Y.A. (2000). Reliability Engineering.

Lecture note.

Ajose S.O. (1997). Applied Electricity I and II.

Lecture note.

Howard J.G., and William E.D.,Jr., (1980). Electricity and Electronics.

The Goodheart-Willcox Company,Inc.

Paul Horowitz, and Winfield Hill, (1995). The art of electronics.

Cambridge University Press.