THE DESIGN AND CONSTRUCTION OF A CONTINUITY TESTER

BY

EMMANUEL GWANA

OCTOBER 2004

ELECTRCAL ELECTRONICS ENGINEERING DEPARTMENT.

SCHOOL OF ENGINEERING TECHNOLOGY
NUHU BAMALLI POLYTECHNIC ZARIA

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NUBP/EET/ND/2004/17182

A PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF NATIONAL DIPLOMA IN ELECTRICAL ELECTRONICS ENGINEERING TECHNOLOGY.

OCTOBER, 2004

DECLARATION

This is to certify that this project work, The Design and Construction of Continuity Tester was carried out in the Laboratory of the Department of **ELECTRICAL/ELECTRONICS ENGINEERING TECHNOLOGY, NUHU BAMALLI POLYTECHNIC ZARIA** under the Supervision of **MALLAM ATIKU BELLO.** This project is an original work carried out by ME, **EMMANUEL GWANA NUBP/EET/2004/17182**

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DATE: 3rd | 12 | 2004

APPROVAL PAGE

This project write has been approved for acceptance by the under signed on behalf of the Department of **ELECTRICAL/ELECTRONICS ENGINEERING TECHNOLOGY** as meeting the requirement for the award of the National Diploma in **ELECTRICAL/ELECTRONICS ENGINEERING TECHNOLOGY OF NUHU BAMALLI POLYTECHNIC ZARIA.**

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DEDICATION

This project work is first dedicated to the Almighty God for his infinite mercy, blessing and protection throughout the duration of my study and to my father, **MR. HARUNA GWANA** who ~~have~~ contributed both financially, morally and spiritually to the success of this project.

ACKNOWLEDGEMENT

In producing this project write-up, I wish to express my profound gratitude especially to my father who has been supporting me throughout the years of my studies and finally making this project work a reality, and to my able Supervisor **MALLAM ATIKU BELLO** for taking his time and pains in reading over the manuscript of this book, and making valuable / constructive suggestions and corrections arising therein.

I am also expressing my sincere gratitude to the entire Staff of the Department of **ELECTRICAL/ELECTRONICS ENGINEERING TECHNOLOGY**, who have contributed immensely to the success of my study. And also to my brethren, Victor, Henry, Davina, Faith and Dorcas who stood by me all the year. Also to my Coursemates, Kelvin, Faith, Zakariah, Dogara, Magaji Achi. Elkana, Solomon, Jonah, Vincent, Augustine, MoseMagaji, Kefas, Manasseh, Victor, Emmanuel Nok, Jonathan Stephen Dikko and finally to God Almighty who spare my life up to this time.

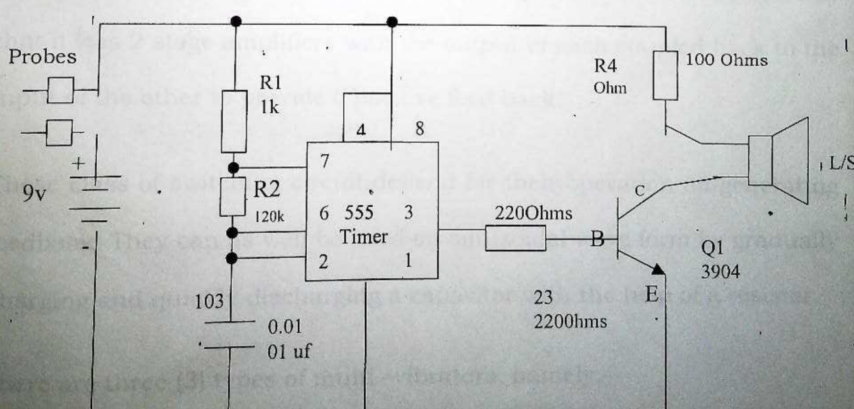
TABLE OF CONTENTS

CHAPTER ONE

1.0. INTRODUCTION

A continuity tester is an electrical/electronics instrument used for detecting or tracing out whether a given electrical connection is continuos or broken.(i.e. open or short circuited.)

The instrument is fast becoming necessary especially when carrying out electrical/electronic troubleshooting, maintenance and repairs. In some instance tracing out a fault in a loom of wires connecting one section to another ~~of any difficult or impossible~~, as in television receivers, will be difficult or impossible with the use of the volt metre especially when there are duplicate wire color within the loom. But with the use of continuity tester, such a job can be carried out successfully and easily without difficulty.



SCHEMATIC DIAGRAM

The circuit in this project uses as an table multi – vibrator, operating at frequency close to one kilo Hertz (1kHz.) in this case the out put terminal is connected to a loud speaker within the circuit is a variable resistor(Rs) which is used to either increase or decrease the volume of the 555 as a table multi-vibrator. The value of the Rs will depend upon the ~~independence~~ ohmic value the loud speaker and the desired volume level.

The testing probes are to apply V+ (low voltage supply to the 555 timer. If the circuit under test is continuos as the table audible multi-vibrator will receive low voltage and therefore switch "ON" position.

1.1. MULTIVIBRATORS

Multivibrators are class of electrical switching circuit made in such a way that it has 2 stage amplifiers with the output of each coupled back to the input of the other to provide a positive feed back.

These class of switching circuits depend for their operation on generating feedback. They can as well be used on sinusoidal wave form by gradually charging and quickly discharging a capacitor with the help of a resistor.

There are three (3) types of multi –vibrators, namely:-

1. Monostable (one stable)

2. Bistable (two stable)

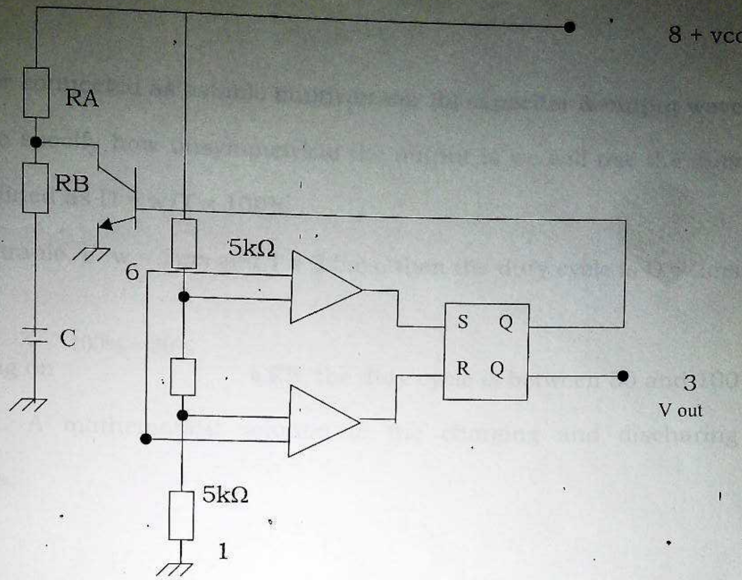
3. Astable (no stable point)

(1) **MONOSTABLE:**- This type of multi – vibrator has one stable operating point as well as one quasistable state (semi-stable) it is also called single shot. It can be triggered to change the state, but only for certain interval, after which it

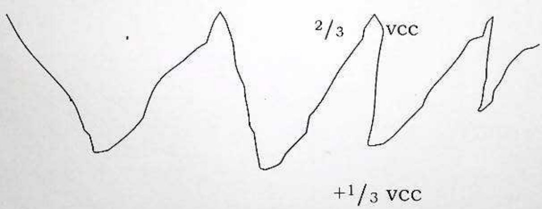
return to it's original state automatically. It is mainly used in generating width pulse for gate.

(2) **BISTABLE** :- "Bi" means two, just as "MONO" means one. A Bistable multi-vibrator has two permanent stable state in which it can be made work in both state by triggered ring it. It is also called a flipflop multi-vibrator. It is mainly used for counting as we have in the electronic counter circuit.

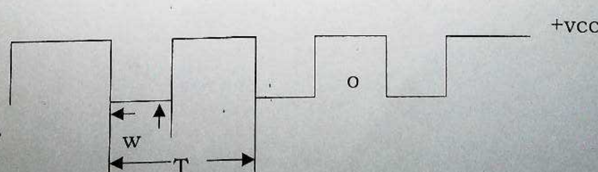
(3) **ASTABLE** :- ~~These~~ This multi-vibrator does not have permanent stable state but it is operated in between the two quasistable state (Semi stable) in which it continuous to alternate remaining in each for an interval controlled by the circuit parameters and switching rapidly from one quasistable state to the other. It is some times called free running multi-vibrators. It is used for the generation of clock pulse chain for sweep generator.



STABLE STATE ASTABLE MULTI-VIBRATOR



SINOISIDAL WAVE FORM



RECTANGULAR WAVE FORM

555 timer connected as astable multivibrator (b) capacitor & output wave forms. To specify how unsymmetrical the output is we will use the duty cycle, defined as D = w/T x 100%

as an example, if w = 2ms and T = 2.5ms, then the duty cycle is D = 2ms

$$\frac{2.5\text{ms}}{} \times 100\% = 80\%$$

depending on & RB, the duty cycle is between 50 and 100 per cent. A mathematical solution to the charging and discharing equations.

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CHAPTER TWO

2.0 THEORITICAL REVIEW OF ACTIVE COMPONENT USED

I basically look at some of the components used in this project for example the 555 timer astable multivibrator as a gate (switch).

2.1 555 TIMER

The external configuration of the 555 timer is as shown in figure 2.1 moulded into as integrated circuit (i.c).

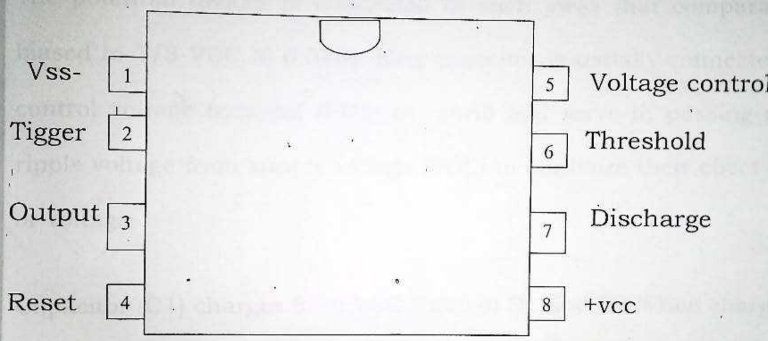


Fig 2.2 Pin connection of 555 timer internally the i.c represented as shown in fig 2.2 below.

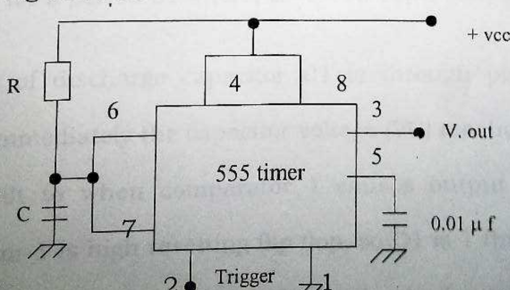


Fig. 2.2 PIN CONNECTION OF 555 TIMER

formular for the pulse width is w = 1.IRC if for instance R = 22KΩ and C = 0.06μ f then w = 1.1 (22 kΩ) (0.06 μ f) = 1.65m^3.

From the circuit it can be observed that the tuner contains four resistor potential divider R1, R2, R3 and R4 two voltage comparators namely (comp 1 and comp 2), a flip flop, a transistor (a1) and output buffer (A1) not indicated in the sketch.

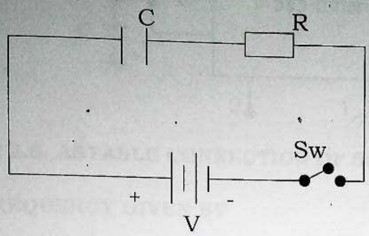
The potential divider is connected in such away that comparator 1 is biased to 1/3 VCC.A) 0.01NF filler capacitor is usually connected to the control voltage terminal (PMS) to round and serve in passing noise or ripple voltage from supply voltage (VCC) to minimize their effect on solid or voltage.

Capacitor (C1) charges from VCC through R1 and R2.While charging, the output voltage (VO) is high thereby making the comparator 2 to go high Q1 is off) for a period tH where, th=0.693 c1(R1+R2) seconds.

The part of discharge capacitor C1 is through pin 7 and R2 which happen immediately the capacitor voltage (VC) reaches 2/3 VCC.

This result to when comparator 1 causes output voltage to go low, comparator 1 is high resetting flip flop, so Q1 is 1 thus A1 is low and Q1 torns "On" this setting the period for the discharge capacitor, which is

Once switch is closed a potential difference is noticed across capacitor (C) consequently, the current is at maximum and the whole voltage is applied across RO



In the figure the voltage across the capacitor increases as the time increases to a period of it's maximum thereby making the current to be Zero.

The instantaneous voltage of a capacitor is usually given by – VC=VCC (1e – t/RC)----2.1 Assuming the capacitor to be initially charged to VCC then,

VC=VCC (1-e - +/RC

½= 1 – e - +/RC

e – t /RC = 1-1/2=1/2

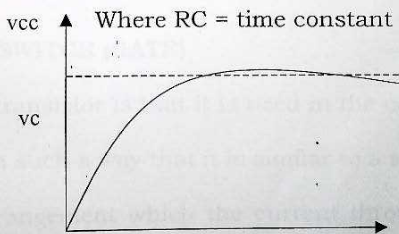
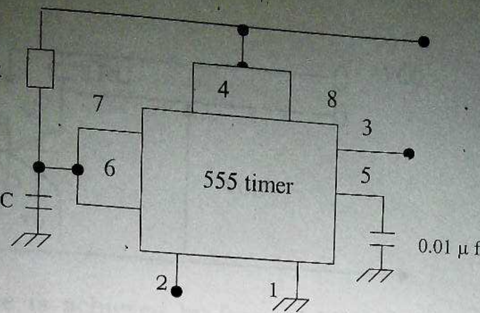


Fig. 2.5 RC = time constant



2.2. **Fig 2.6. ASTABLE CONNECTION OF 555 TIMER CLOCK FREQUENCY GIVEN BY**

$$F = \frac{1}{06.93\ C1\ (R1 + R2)} = \frac{1.443 - 2.2}{C1\ (R1 + R2)}$$

The duty cycle of an Astable multi vibrator is defined as the ratio of time positive portion of the period to the total period.

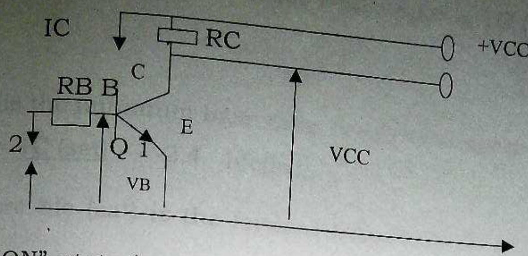
Or duty cycle =t1

t1 t2

2.3. TRANSISTOR AS A SWITCH (GATE)

The important aspect of transistor is that it is used in the control of flow of current through load in such a way that it is similar to a switch.

Figure 2.7. shows an arrangement which the current through the load RC is controlled by a transistor. With a reverse potential applied to the base of a transistor, only the little collector to base leakage current flows. In this situation the transistor does not conduct, hence it serves as a switch in "OFF" position.



The "ON" state is achieved by forward biasing the emitter junction on such that base current is large enough to drive the transistor into it's situated condition.

This is to say that the collector current (1C) is very small. The valve of VCC in the saturated condition is generally known as VCC (sat). The "ON" and "OFF"

Condition are clearly indicated in figure 2.8 which is a plot of collector current (1C) as a function of base current (1B)

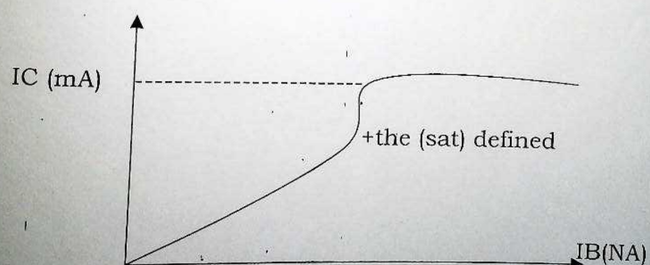


Figure 2.8. A sketch of 1C against 1B for a transistor serving as a switch.

In the "ON" state, the collector current is 1C (sat) = $\frac{VCC-VC= (sat)}{RC}$ – 2.3

While the minimum base drive required to saturate the transistor is

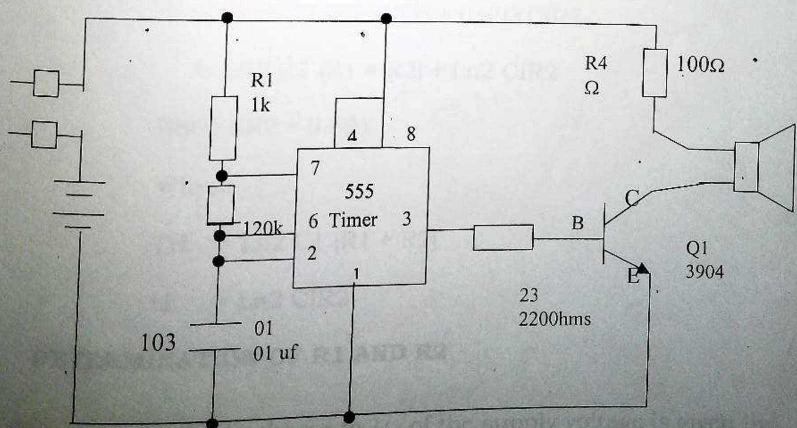
1B = $\frac{1C (sat)}{hfc(sat)}$ - - -2.4

Where hfc (sat) is the forward transfer ratio at the onset of saturation. That because the "ON" state is insensitive to increase of the base current (1B), above the threshold set by equation 2.3 it is necessary to ensure that base current (1B) exceeds minimum valve for the transistor to be properly switched "ON".

3.0 CIRCUIT DESIGN

In this chapter we will focus our alternation on the procedure of the construction and method used in determining the values of the component used in this project. As stated earlier in chapter one, the operation of the timer is based mainly on the simple operation of a 555 Astable multi vibrator, which operate at a frequency of about 1KHZ.

The first thing to be put into consideration is how and what circuit elements are combined to give the required frequency of 1KHZ or closer to it. As fully explained and shown in chapter two (figures 2.3) the integrated circuit (IC) requires that the capacitor C charged to a voltage of about $^2/_3$ of the supply voltage (VCC) and discharge to a voltage of about $^1/_3$ of the supply voltage.



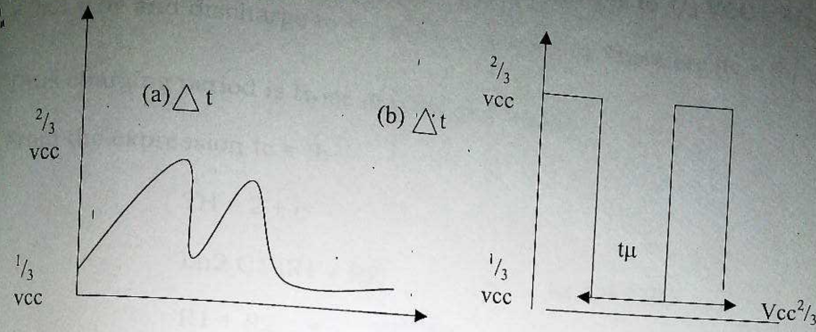


Fig. 3.1

The total period of oscillation is given by T = charging period+ discharging period

$$= \mu t + C$$

T is also given by time constant of an astable multi – vibrator as:

$$T = 0.693\,C1\,(R1 + R2) + 0.693\,CIR2$$

$$= LN2\,C1\,(R1 + R2) + Ln2\,CIR2$$

Note: LN2 = 0.691

Where

$$TH = Ln2\,C1\,(R1 + R2)$$

$$t1 = Ln2\,CIR2$$

3.1 DETERMINATION OF R1 AND R2

The time taken by C1 to charge to $^{2}/_{3}$ of the supply voltage is given by:

T1 = Ln2 CI R2 (as it discharges through R2 only)

Since the supply to the circuit is 9v then C1 charges to $^2/_3$ VCC = $^2/_3$ x 9 = 2x3 = 6v and discharge to $^1/_3$ VCC = $^2/_3$ x 9 = 3v Therefore (tc = th)

Thus charging period is twice discharging period.

From the expression tc = th

TH = 2 + c

Ln2 C1 (R1 + R2) = 2x LM CIR2

R1 + R2 = 2R2 R1 = 2R2 - R2

Assuming R1 = R2 R2 = 2R2 - R1

Thus Oscillation period T = tH + tc

= Ln2C1sR2 + Ln2R1R2

but R1 = 2

= 3R2C1Ln2 -------- (3.1)

The aim is to attain a frequency of 1KHZ or almost close to it, we choose a tentative frequency between the range 850Hz to 990Hz (0.85 kHz to 0.99 Hz). (0.85KHZ to 0.99HZ)

The frequency is the reciprocal of the period of oscillation

T Mathematically. = 1 = 1 - - - (3.2)

T 3R2C1Ln2

3.2 DETERMINATION OF C1 AND R2

In determination of the values of the constant C 1 an R2, it is more preferable for one to select one and calculate for the other using the expression for the frequency.

R2 = 1 = 10

3C1f Ln 23 x 0.15850 x 0.693

= 3772 ohms

Preferable value will be 3.7 k thus

R1 = R2 = 3.7 kn

And C1 = 0.15 NF

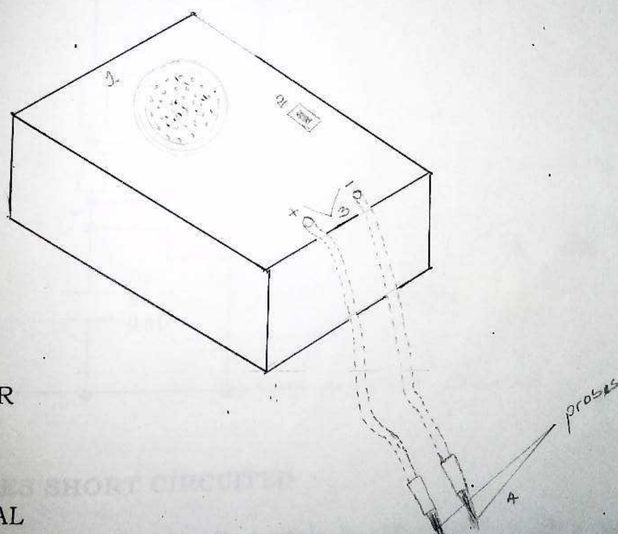
3.3 SELECTION OF C2 AND C3

The selection of C2 and C3 is based purely on their respective function in the circuit. As it can be seen C2 is connected in such away that it will filler out noise and distortion from the power supply.

In this case an available value of D.INF is chosen. Capacitor C3 is connected such that it's positive terminal is coupled to the output of the multi-vibrator which is as well coupled to the load and present any D.C. component from reaching the loud speaker.

Resistor R4 and R5 serves as current limiting resistors, which are connected in series to limit and maintain the required base current (IB) when the circuit under test is continuous or when the probes are joined.

THE PICTORIAL VIEW OF THE TESTER

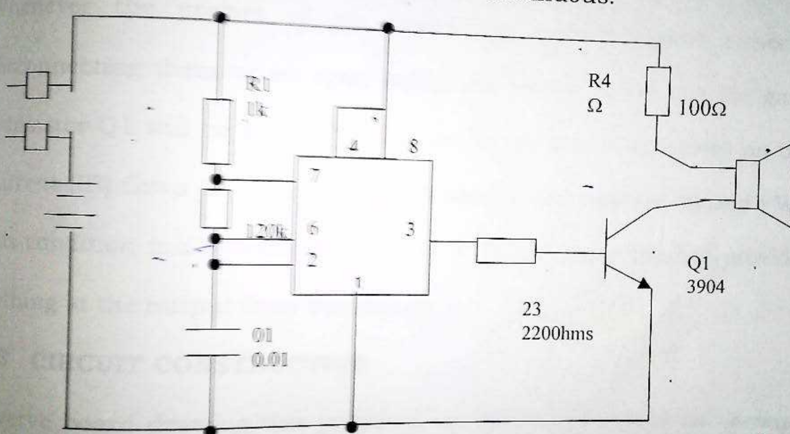


1. SPEAKER
2. SWITCH
3. TERMINAL
4. TEST LEAD

CHAPTER FOUR

4.0 CIRCUIT OPERATION

The operation of the circuit depend fully on the simple operation of Astable multi-vibrator. The main aim of this circuit as earlier stated in the previous chapter is to generate an output frequency of about 1KHZ For the loud speaker to function thereby producing an audio signal indicating that the circuit under test is continuous.



4.1 PROBES SHORT CIRCUITED

When probes are short-circuited either by direct or through a continuous Electrical path, a current will be applied through the resistance R4 and R5, respectively to the base of the transistor.

As the astable multi-vibrator is connected with it's negative terminal to the collector of gating transistor, the moment the transistor is turned "ON" (Forward biased). The negative terminal of the Astable is rounded, turning "ON" the Astable multi-vibrator which, will in return produce the required output frequency of about 1KHZ to enable the loudspeaker produce an audio signal. This indicates the continuity of electrical path under test.

4.2 PROBES OPEN CIRCUITED

Whenever the probes of the tested are open circuited either by disconnecting them or an open within the circuit under test the gating transistor Q1 will be in "OFF" state due to the fact that little or no base current (IB) flows to drive it to saturation (hence reversed biased.) With this condition multi-vibrator will be in a "Reset" mode thereby providing nothing at the output from the circuit.

4.3 CIRCUIT CONSTRUCTION

A verve board drawing was prepared for the circuit layout as shown in figure 4.2 it will be seen how the Vero board and how the setup is further used as a guide for maintenance purposes. The interconnection are made with flexible standard wires to fit nearly into the matrix holes of the Vero board connected done on the underside with flexible wires are shown with broken lines.

All wires tips and components' bad are well cleared and tinned before soldering. The Vero board itself is a board with one of its side almost completely insulated with the exception of two copper tracks, which are usually used as the components. With this arrangement of the board it is easy to avoid making short circuit.

All through the stages of construction a short and open circuit test were carried out and errors were corrected as well. While soldering the integrated circuit (IC) adequate care was taken to ensure that it is not damaged due to excessive amount of heat when soldering the integrated circuit base socket in position before inserting the integrated circuit itself.

4.4 CASING

Figure 4.2 shows the packaging arrangement of all the components used in the construction of the tester. The case used in housing the tester is a wooden box-measuring (4.4 x 4.4 x 10) cm it has a removable cover at the top so that maintenance can be carried out.

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As far as this project is connected, the most essential test carried out is the test on the output terminal of the 555 timer, the display of which is shown below: .

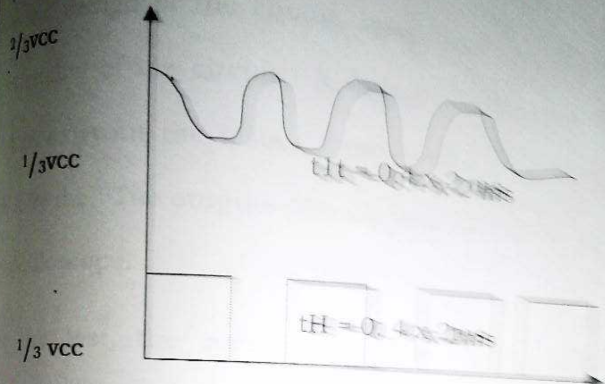

Fig 4.2

SINOISIDAL AND SQUARE WAVE FORM

Where tH = charging time = 4x0.2

Ms = 0.8 ms

TL = discharge time = 2x0.2 ms = 0.4ms

TL = tH + tL

= 0.8 + 0.4 = 1.2ms

F = 1

1.2x10 = 833.3HZ or 0.8333KHZ

This is the practical value of frequency for which the circuit operates. As earlier detailed in this chapter the circuit is expected to operate at

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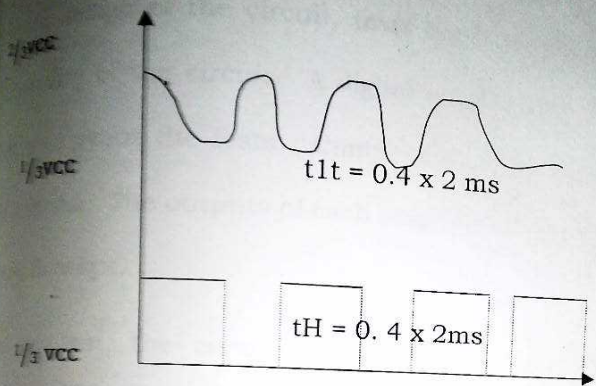

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4.5 TEST AND RESULT ANALYSIS

After the design of the circuit, tests were carried out to ascertain the functionality of the circuit. A digital oscilloscope and Vero board were used to carryout the tests. Components were mounted on the digital with a 9v d.c. The outputs of each stage of the circuit were monitored on the oscilloscope.

After the test, the components were transferred to Vero board for soldering. In the process of soldering, testing has been taking place to make sure that the signal flow is in order.

Then we tested the component which is the resistor when we tested another resistor, does not sound because it is not working, which means the resistor is not working accordingly.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

This kind of audio tester which is used in testing the continuity of a circuit has a series of advantages over other types of tester for the same purpose.

For instance an Ohm – meter can be used as an alternative, but difficulty might arise in which case, the Ohm – meter can not distinguish between low Ohmic valve when test is carrier out on a resistive circuit. The usual kind of tester as well will required us to took for an indication, thus diverting out attention from the place of work which is time consuming and tedious.

Another is that all the components used are simple and available at reasonable prices. The 555 timer itself has a reliability thus making the tester a reliable instrument.

Naturally since the tester does not drive any current in the "OFF" state (i.e when probes are open circuited) the power supply (battery) will last for a long time before it is drained, making the instrument economically better.

...has been greatly reduced ...ing it more portable and requiring less material in housing the unit.

...is contributes in making the tester a material in housing the circuit.

This contributes in making the tester as a whole to be cheaper just about, per unit also being small and portable, the tester can be easily handled and transported.

The choice of frequency of operation of this tester is optional hence it can be increased as required by choosing the right valves of C1 and R1.

By slightly modifying the circuit and introducing some additional components, it can be used for other purposes e.g. power failures alarm, bitonic audio frequency generator and traffic lighting system.

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Electrical Engineer.