DESIGN AND CONSTRUCTION OF ELECTRONIC STESTHOSCOPE WITH LED DISPLAY

JIMOH SAHEED ADESHINA.

(2004/18830EE)

DEPARTEMENT OF ELECTRICAL AND COMPUTER ENGINEERING FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

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BY

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A THESIS SUBMITTED TO THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE, NIGERIA

DECEMBER, 2009

DEDICATION

This project is dedicated to God almighty, who in his infinite mercy has made it possible for me to start my programme in his name and end in his glory, also to my loving family for their love, moral and financial support to the success of this project.

DECLARATION

I Jimoh Saheed Adeshina declare that this work was done by me and has never been presented elsewhere for the award of degree. I also hereby relinquish the copy right to Federal University of Technology, Minna.

Jimoh Saheed Adeshina.

(Name of Student)

8/2/2010

(Signature and Date)

Mr. Michael David

(Name of Supervisor)

8/2/2010

(Signature and Date)

for, Engr. Dr. Y.A. Adediran

(Name of H.O.D)

(May 6, 2010)

(Signature and Date)

DR. (Engr.) B. A. Adegboye

(Name of External Examiner)

03/03/10

(Signature and Date)

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Thanks to God Almighty for seeing me through my studying period and through the course of this project. My sincere gratitude to my supervisor Mr David Michael, who took the pain of going through the project and giving out some advice. His encouragements and attention giving to me cannot be quantified. My sincere Appreciation goes to all academic and non academic staff of the department for their support. I will forever give gratitude to my uncle Alhaji Sanusi and all the member of my family. Their love, prayer and provision are felt always, especially at the time of my project work. May I also acknowledge my friends and all the member of my class for their concern and encouragement during the time of my challenges. I just want to say, no tyranny of circumstances can stop a determined will. We have won.

ABSTRACT

This project deals with the design and construction of an electronic stethoscope. The instrument used by doctors, nurses and other health care professionals to check the rate of heartbeat. It is design to greatly amplify standard stethoscope, and display output waveform of the amplified sound on the LED DISPLAY. This includes low pass filter to remove background noise, electrets microphone (transducer), operational amplifier, and LED indicator. The circuit is also designed to indicate on LED and headphone the input fed into the transducer (microphone). It operates on small voltage supply by two 9V dry cell battery connected in series.

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CHAPTER ONE

1.1 INTRODUCTIONS.

This project is another step in the quest for the improvement of man's living conditions. A great deal of equipment used by the hospital today is used as a diagnostic tool for doctors, nurses, and other health care professional.

Man was subjecting his body to unknown environment and forces which necessitate the need monitor physiological parameter and leads to the development of this type of equipment. As machines were developed that could carry man beyond the speed of sound and constraints of gravity. Scientists were interested in measuring the effect on the human body.

Methods and equipment were developed to measure heart rate, blood pressure, respiration, body temperature, electrical brain activity etc. often this information was transmitted over radio signal to allow the subject total freedom of movement. This entire instrument found a ready market in health care and biomedical sectors.

The primary sign of life that must be ascertained is the functioning of the heart. In first aid situation, pulse can be taken by feeling the pressure change in a major blood vessel. The existence of a pulse indicates presence of life, but dies not provide much needed information about the condition of the patient's heart function.

The early stethoscope makes uses of mechanical principle. Which makes it relatively costly and does not provide amplification

Based on old and new research in electronics, the project and report presented here involves the design and construction of electronic stethoscope with a LED display.

This instrument is quiet different from the standard one because it uses operational amplifier which greatly amplify a standard stethoscope, and includes low cost filters to remove background noise, it also contains LED display to display the output waveform of the heart beat on the screen for further analysis by the professional and cost less.

1.2 AIMS AND OBJECTIVE

The target of this project is to design and construct an electronic stethoscope with a LED display (which display the heartbeat wave form on the screen)

The objective of the project is as follows:

- To serve as a guide on how to use or modify electronic circuit to construct useful gadgets, which are of immense significance to the society.
- To make use of operational amplifier to greatly amplify a standard stethoscope.
- To remove background noise by using a low pass filter.
- To display the heartbeat output waveform on the screen by making use of LED display, for easy analysis of the patient's condition.
- To design a simple but cost effective device.

- To make student exhibit their hands on practical situation on what they are taught theoretically.
- To emphasize and appreciate causes such as digital electronics and analog electronics etc.

1.3 PROJECT METHODOLOGY

This project is achieved by amplifying sound of the heart beat picked by electric microphone. This amplified sound is then passed to power amplifier, which is amplified for it be to audible through the earphone and the background noise removed. The final amplified signal is fed into the LED Display, which consists of Johnson counter (4017) that makes one out its ten outputs high while the others are low base on the pulse generated to it by 4011 IC, the LM3914 dot bar display driver which give bar display; While 4011 is used to generate pulse of regular frequency that is used to create an oscillation. This pulse are in the solid state oscilloscope to control time base, so that each output of 4017 is generated per second, while the LM3914 give the amplitude in response to the input signal such that output of LM3914 and 4011 are combined by the 100LEDS which display output wave form of the heartbeat i.e. serve as (display screen) .

1.4 SCOPE OF PROJECT

The electronic stethoscope is expected to be used for all kinds of medical practices that involve the use of the stethoscope. It is expected to detect all kinds of sounds from the human body for proper diagnosis by the doctor. It can also detect all kinds of mechanical sounds with frequencies up to103Hz efficiently. The stethoscope is expected to count pulse rates up to 99 beats per minute, and to display output waveform on the LED Display.

1.5. CONSTRAINTS OF ACHIEVABLE PERFORMANCE

Among the challenges faced while carrying out the project, was the modification from my initial construction titled around the stethoscope. It principal handicap was the dot-bar driver (LM3914) which is not readily available in Minna market. To remedy this, I have to travel to Lagos to purchase the component, wiring of veroboard and packaging of the work to achieve workability.

1.6 PROJECT LAYOUT

The write up is divided into chapters:

Chapter one focuses on the introduction: gives a brief overview of the topic and states project objectives, scope, problems as well as methodology adopted.

Chapter two deals with the literature review, bringing to light historical development, advancement if any and the theoretical background of the project as well as limitation of previous works. Chapter three is concerned with circuit design and analysis. Chapter four treats the system construction and testing. Chapter five summarizes the work. It specifies the projects area of application; problems encountered and limitations of the works and suggestions' for further improvement.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION.

The stethoscope got its name from the Greek word stethos meaning "Chest" and skopeein meaning "to examine", is an acoustic device use to listen to internal sounds in the human body [1]. It is often used to listen to the heart sounds and breathing or blood flows in arteries and veins. Less commonly, "mechanic's stethoscope" which are used to listen to internal sounds made by machines, such as diagnosing a malfunctioning automobile engine by listening to the sounds of its internal parts. Stethoscope is also often used as a symbol of the doctors, is seen with a stethoscope hanging around their neck.

The stethoscope is not a new invention. Over the years there are companies engaged in the production of standard stethoscope, their production were based on mechanical technique or principle, which does not offer amplification, filtering and volume control. These limit its area of application. The mechanical method makes use of electrodes; the electrodes are small metal disc made of silver and silver chloride. They are mounted on an adhesive donut; a sponge saturated with an electrolyte gel, couples the electrodes to the skin. A small potential is always generated across and electrode that is in contact with the skin. The combination of electrode material and the ions of the body act similar to a battery. As the ions ebb and flow, due to cardiac activity, the voltage on the electrodes charges accordingly. This produces an electrical signal indicating the activity of the heart.

2.2 HISTORICAL BACKGROUND OF THE STETHOSCOPE

The stethoscope was invented in 1816 by a French physician called Rene Theophile Hyacinth Laennec so that he would not have to place his ear against the breast of French women.The stethoscope devised by Rene consisted of a slender wooden tube about 30cm long, one end which has a broad flange, or a bell shaped opening. When this opening was placed against chest of the patient, the physician could hear the sounds of breathing and heart actions.

In 1851 Arthur Leareds invented a binaural stethoscope. After few years, the modern stethoscope was invented by G.P Cammann, a New York physician. Cammann produced the first recognizable binaural stethoscope. It consists of two earpieces with flexible rubber tubing connecting them to the two branched metal chest cone. Thus, the sound could be heard with both ears, and the instruments flexibility permits the physician to listen to various areas without changing his position. After many years of development from some other physician, Rappaport and Sprague designed a new stethoscope in the 1940s which became the standard by which other stethoscope are measured. Several other minor development were made to stethoscope by some medical school professors like Dr. David Lithmann (Harvard Medical School in 1960s), Professor W.Proctor Harvey (Georgetown University) etc.

There are two main types of stethoscope in use today; they are the convectional acoustic stethoscope and the digital electronic stethoscope.

2.2.1 ACOUSTIC STETHOSCOPE.

In a conventional acoustic stethoscope, the diaphragm vibration causes air pressure behind the diaphragm to change, which passes up the tubes as a sound wave to impinge pressure changes on the listener's eardrums. Losses occur through the tubing and there is no amplification. Also, the doctor has to count the heartbeats over a period of time, mostly a minute, to determine the heartbeat rate, and the listening also provide a" measure" of the clarity of the nasal passage to determine congestion. In using this type of stethoscope, once the user is distracted, he or she has to start carefully over again [2]

Stethoscope of today has a combined "bell and diaphragm" chest pieces made of stainless steel. The bell (hollow cup) section is open and has a diameter of 2.85cm and depth of about 0.6cm. It is used to hear relatively low pitched sound in the range of 30-500Hz. The diaphragm (plastic disc) section is sealed with rigid linear-Bakelite or plastic material and has a diameter of about 4.4cm. It is designed to filter out the lowest possible sound but pass high pitched sounds.

The earpiece (made of stainless with plastics cup designed to be large enough to block any external sounds from the ear). The stethoscope chest piece collects sound from chest, lungs and stomach area and transmits the sound using acoustic principle to the earpieces.

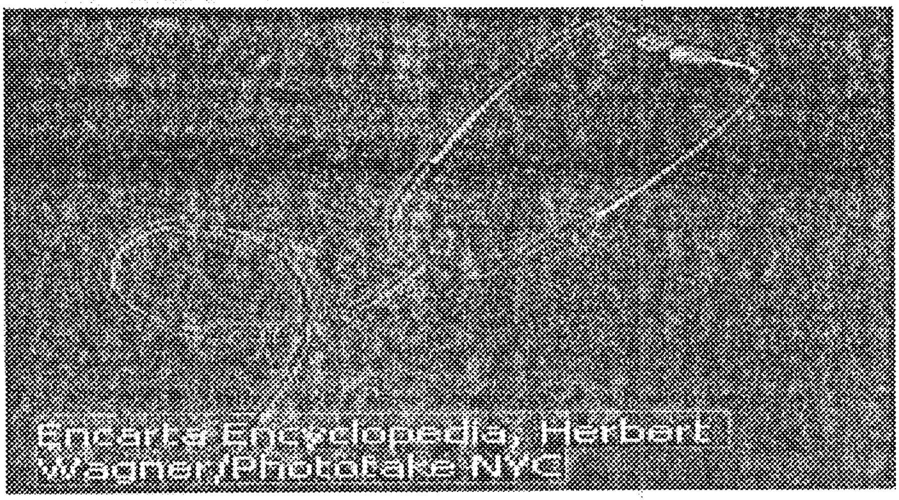


Fig 2.2 below figure is a conventional acoustic stethoscope.

2.2.2 THE ELECTRONIC STETHOSCOPE.

Electronic stethoscopes require conversion of acoustic sound waves to electrical signals which can then be amplified for optimal listening. It overcomes the low sounds output/waves by amplifying the body sounds electronically. Unlike acoustic stethoscope which has no amplification. The electronic stethoscope is an improvement of the conventional stethoscope with the incorporation of electronic component. This electronic stethoscope greatly amplifies the sound from the heartbeats and includes a low pass filter to remove the background noise.

2.3. THEORETICAL BACKGROUND

The electronic stethoscope is the combination of a condenser microphone which acts as a transducer by converting sound vibrations received in a hollow tube through the diaphragm of a stethoscope head into an electrical signal. This signal is pre-amplified and fed through the low pass filter to remove background noise. The filter has a cut-off frequency of 103Hz.

Though the frequency of the heartbeats is about 20-30Hz, the cut-off frequency is made of 103Hz so that the stethoscope can be used to listen to other body sounds and also mechanical sounds.

The filtered signal is fed to the voltage buffer, which isolate the input signal from load. The output of the buffer is fed through a variable resistor to the power amplifier. This amplifier then amplifies the sound for audible hearing through an earphone.

Part of the filtered sound from the filter is fed to the solid state oscilloscope circuit which shows the output waveform of the heartbeat.

2.3.1 TRANSDUCERS

A Transducer is a device that converts one type of energy or physical attribute to another for various purposes including measurement or information transfer. For example pressure sensors [3]. The device may be electrical, photonic, electro-mechanical, electro-magnetic, electronic.

There are two types of transducers:

a) Input transducer which converts one form of energy into other such as sound, light and other physical quantities into an electrical signal e.g. a microphone (which converts sound energy into electrical energy) photoelectric materials (which convert light energy into electrical energy) piezoelectric energy crystal (which convert heat energy into electric energy) [4].

b) Output transducer on the other hand, converts electrical signals into energies of physical quantities e.g. a loudspeaker which converts electrical energy to sound energy [5].

A microphone is an input transducer that converts sound into an electrical signal. They are sometimes called mic. They're used in many applications such as telephones, tape recorders, hearing aids, live and recorded audio engineering in radio and television broadcasting and in computers for recording voice, VoIP and for non-acoustic purposes such as ultrasonic checking [6].

A microphone is made to capture waves in air, water or hard material and translate them into an electrical signal. The most common method is through a thin membrane producing some proportional electrical signal. Most microphones in use today for audio use electromagnetic generation (dynamic microphones), condenser microphones or piezoelectric generation to produce the signal from mechanical vibrations.

In a condenser microphone, also known as capacitor microphone, the diaphragm acts one plate of a capacitor, and the vibrations produce changes in the distance between the plates.

.3.2. AMPLIFIERS

Amplifiers are devices for increasing the amplitude or power level of an electrical current drawn from the antenna of a radio receiving set, the weak output of a photoelectric cell, the diminished current in a long distance telephone circuit, the electrical signal representing sound in microphone circuit and for many other purposes.

Typically, small variations in input voltage produce corresponding but much larger variation in the output voltage. The ratio of these voltage changes is called the gain of the amplifiers can be cascaded if greater amplification is required. Such an amplifier is called a multistage amplifier.

Amplifiers are usually classified by the type of electrical elements in the circuit. Inductor-coupled amplifiers are connected by coils and transformers, capacitor-coupled amplifiers are connected by condenser and direct-coupled are connected without such electrical components, and are used for alternating currents of very low frequency. Audio frequency amplifiers are operated at about 0 to 100 kHz. Audio amplifier was used because of its advantages over other types of amplifier for the design of this project.

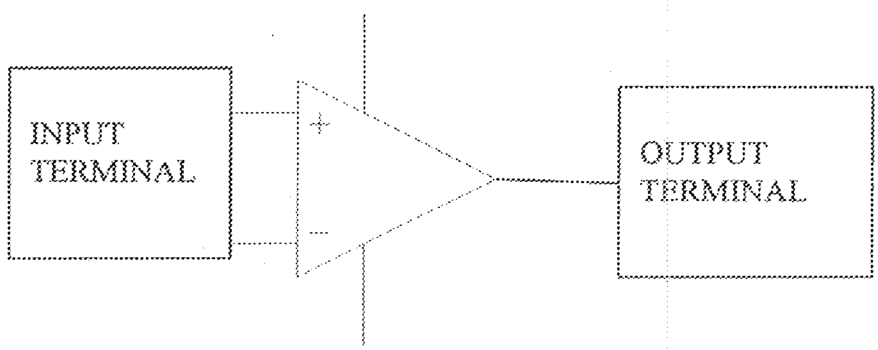


Fig 2.3: Circuit diagram symbol for an Op-amp.

The use of operational amplifier as circuit blocks is much easier and clearer than specifying their individual circuit elements (transistors, resistor) whether the amplifier is use an integrated circuit or discrete. In the first approximation op-amps can be used as if they were ideal differential gain blocks; at a later stage limits can be placed on the acceptable range of parameters for each op-amp [7]

2.3.2.1. INVERTING AMPLIFIER.

The most widely used constant-gain amplifier circuit is the inverting amplifier because it has better frequency stability [8].The output is obtained by multiplying the output by a fixed on constant gain, set by the input resistor (Rin). In this type of amplifier, the input voltage is applied to negative terminal of the amplifier.

The inverting amplifier inverts and amplifies a voltage (multiply by negative constant)

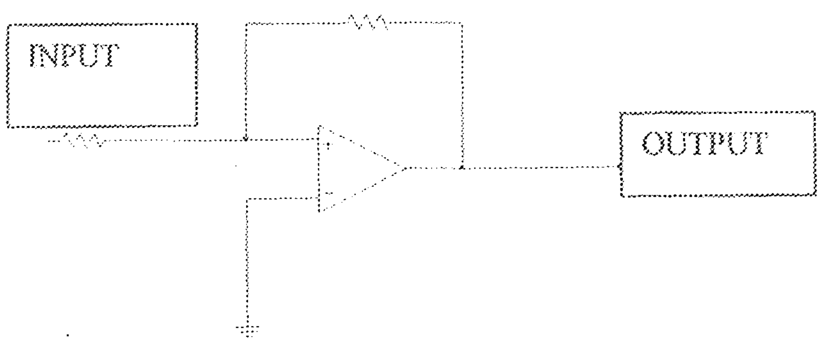
$V_{out}= -V_{in} (R_f/R_{in})$.

The gain of the amplifier;

$G=- (R_f/R_{in})$.

2.3.2.2. NON- INVERTING AMPLIFIER

The non-inverting amplifier only amplifies the input voltage without inverting the output. And in this case the input voltage is fed into the positive (non-inverting) terminal of the amplifier.



$V_{out} = V_{in}(1+R_2/R_1)$

The voltage gain of the amplifier with feedback

$G = 1 + (R_2/R_1)$

.3.3. FILTER

Filters are electronic circuits designed to alternate or eliminate signals of unwanted frequencies (electrical noise or other forms of interference). It passes signals with high frequencies or low frequencies depending on the design purpose [9]. A filter can be active or passive based on the components that make up the circuit.

Basically, filters are classified into five. They are;

a) Low-pass filter

b) High-pass filter

c) Band-pass filter

d) Band reject (notch) filter

e) Band Equalizers

An active filter can be constructed around an operational amplifier using passive elements. The OPAMP provides voltage amplification and signal isolation or buffering [10]

.1. LOW-PASS FILTER

Low pass filter is a filter that passes low-frequency signals, but alternate signals with frequencies higher than the cut-off frequency? The actual amount of alternation for each frequency varies from filter to filter. Sometimes called a high-cut filter or treble cut filter. When used in audio application [11].

The concept of a low-pass filter exist in many different forms, in electronic circuits (like a hiss filter used in audio) digital algorithms for smoothing set of data, blurring of images and so on. Low-pass filters play the same role in signal processing [12]. The circuit shown below is a low pass filter (which is called the first differential low pass filter circuit).

The cut-off frequency for the circuit is

$$F=1/(2\pi RC)$$

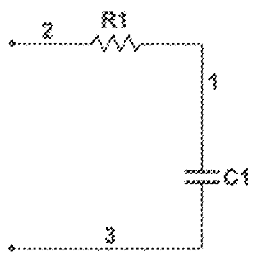


Fig.2.5 Low Pass filter circuit

Beyond the cut-off frequency, the gain does not reduce immediately to zero, but reduces with a slope of 20dB/decade (this means the output reduces by a factor of 100 when the frequency increases by a factor of 10).

2.3.4 LED DISPLAY.

The LED Display use in this project were not designed to high performance but rather to offer various solution where and when and LED display had to be integrated into an electronic system. The main improvement was the full-transistorized designed providing reliable, low maintenance operation with less frequency calibration.

The LED Display (Pocket oscilloscope) incorporates in this project; match the need of health care professional and biomedical institution.

This display consist of mainly, the dot-bar display driver (LM3914), Johnson counter (4017) and the display unit for displaying the output waveform.

The dot-bar display driver consist of ten comparator, ten LED and a buffer with mode select amplifier which controls the type of display, bar or single LED. A high input impedance buffer operates with signals from ground to 9V, and is protected against reverse and over voltages signals. The signal is then applied to a series of 10 comparators; each of which is biased to a different comparison level by the comparator with switch on another indicating LED. This resistor can be connected between any two voltages, providing that they are below positive voltage (internal) of LM3914 is designed to adjustable and develop a nominal 1.25V between the REF out (pin7) and REF ADJ (pin 8) terminals. The reference voltage is impressed across program resistor R_1 and, since the voltage is constant, a constant current I, the flow through the output set resistor R_2 giving output voltage or

$Vref\left(1+\frac{R_2}{R_1}\right)+I_{adj}R_2$. Pin 9, the mode select in controls chaining of multiple LM3914 and controls bar or dot mode operation.

When the voltage at pin 9 is sensed by comparator; nominally referenced to positive voltage, the chip is in bar mode when pin 9 is above this level; otherwise it's in dot mode. The comparator is designed so that pin 9 can be left open circuit for dot mode.

In this case, we need a counter that will provides individual digit output rather that a binary of BDC output and this is achieve by adding a decoder circuit to the binary counter. However, in most cases it is much simpler to use a different counter that will permit much simpler decoding of individual digit output.

For example, consider the counting sequence to the right (i.e. counting 000, 1000, 1100 which represent 0, 1, and 2 which continues to 9). It actually resembles the behavior of a shift register more than a counter, but that need not be a problem. Indeed, it is easy to use a shift register to implement such a counter, in addition, it notice that each legal count, may define by the location of the last flip-flop to change. States, and which way it changed state. This is accomplished with a simple two input AND or NOR gate monitoring the output state, In this way, we can use ten simple 2 input gates to provide ten decoded output for digit 0-9. This is referred to as JOHNSON COUNTING SEQUENCE and the counter that implement this approach are called JOHNSON COUNTER. Thus Johnson counter consist of ten AND gates which gives the output which are match to display screen and the flip-flops to change the states.

The counter is equivalent to the CMOS ICs 4017 and 4022 counter that implement this technique easily and cheaply. The Johnson counter is a five stage circuit which uses five flip-flops, and therefore has 32 possible binary states, yet only ten states is use. The four state counter uses only eight of 16 possible states, therefore a circuitry that will filter out the illegal states is included and force this circuit to go towards the correct counting sequence, even if it finds itself in an illegal mode when first power up.

However, all the five stage flip-flop adjacent to the other not directly driven from the output of the adjacent one. Rather, the compliment outputs are ANDeds together, and the combination is NORed with the output. As a result improper bit get blocked, and the flip-flop can only take on the correct state to reinstate the correct shifting sequence.

After careful consideration of the standard stethoscope, it can be seen that digital stethoscope is better. This was achieved by considering some important factors. These are simplicity, availability, reliability, versatility and wider range of operation.

The component use in the design is simple and easily available in Nigerian market, so as to enable an effortless maintenance of device.

CHAPTER THREE

DESIGN AND IMPLEMENTATION

3.1. INTRODUCTION.

The design and implementation of this device were greatly influenced by the need to produce the device at a low cost without compromising both functionality and efficiency.

This device is concerned with the design of its component units, which are made up of seven units with each unit consisting of different components performing various tasks. The units, the components and their mode of operation are what will be covered in this chapter.

The units are the power unit, input transducer, pre-amplifier stage, the filter stage, the light emitting light indicator stage, display unit and the final amplifier stage.

3.2. POWER SUPPLY UNIT.

It operate on a very little current which are supply by two 9v dry cell battery wired in series and tapped at the junction to obtained -9v to +9v.

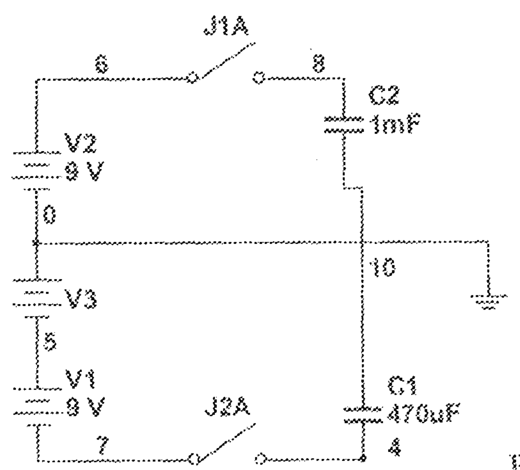


Fig 3.1 power supply unit

3.2 INPUT TRANSDUCER STAGE.

This stage consists of the transducer which converts sound energy to electrical energy. It consists of a condenser microphone, which is being powered by a 9V d.c supply. The microphone is made out of a stethoscope head and electret microphone. The head was cut off from the stethoscope and a small piece of rubber tube was use to join the nipple on the head to the microphone.

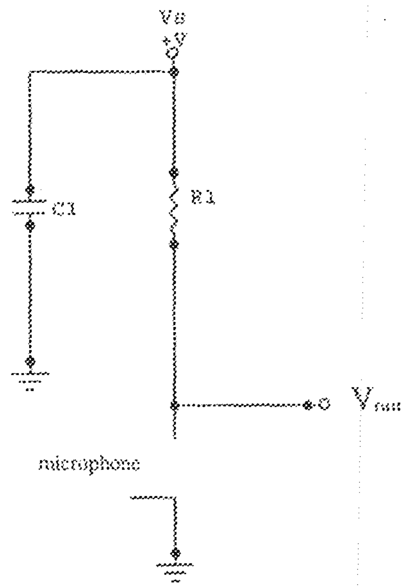


Fig. 3.2 input transducer circuit.

The output current from the microphone is given by;

$$i_{out} = \frac{V_{CC}}{R_1 + R_{mic}}$$

Assume R_1 = 10kΩ, Microphone impedance = 200Ω

$$i_{out} = \frac{9}{10000+200}$$

$$i_{out} = 882.35\mu A$$

Output voltage from the microphone is given by;

$$V_{out} = i_{out} R_1$$

$$V_{out} = 882.35\mu A \times 10k\Omega$$

$$V_{out} = 8.8V$$

3.4 PRE AMPLIFIER STAGE

This stage is designed to amplify input signal from electrets microphone by a gain of 25 such that output obtained is fed into power amplifier. It is also designed to achieved d.c temperature stabilization (i.e. it maintain d.c operating point) through the used of negative feedback resistor R_B .

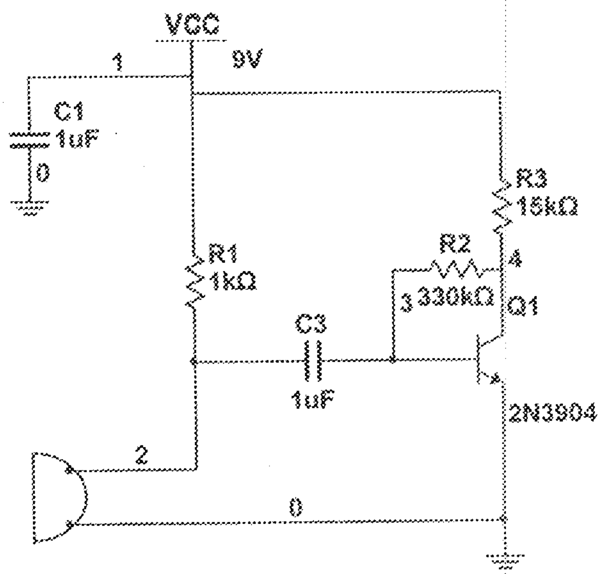


Fig 3.4 pre-amplifier circuit

For gain of 25

$$h_{fe} = {}^{I_C}/_{I_B} \quad \text{thus ;} \quad I_B = {}^{I_C}/_{h_{fe}}$$

$$I_C = \frac{V_{CC}-V_{CE}}{R_L} \quad \text{and} \quad V_{CE} = \frac{V_{CC}}{2}$$

$$V_{CE} = \frac{9}{2}V = 4.5V \quad \text{and} \quad I_C = \frac{9-4.5}{15\times10^3} = 0.3mA$$

$$I_B = {}^{0.3mA}/_{25} = 0.012mA$$

$$R_B = \frac{V_{CE}-V_{BE}}{I_B} = \frac{4.5-0.6}{0.3mA} = 325K\Omega$$

Thus, 330K-Ohms is choose

3.5. LED INDICATOR UNIT.

With the reference to complete circuit diagram, the output of stage two is fed into the light indicating stage, which is a non-inverting amplifier, it is designed to achieve a gain of 71. This was achieved by trying different values of resistances until designed gain was obtained. The limiting resistor R_{13} was chosen within range of voltage, which the circuit operates on. The indicator stage is shown in fig 3.4 below

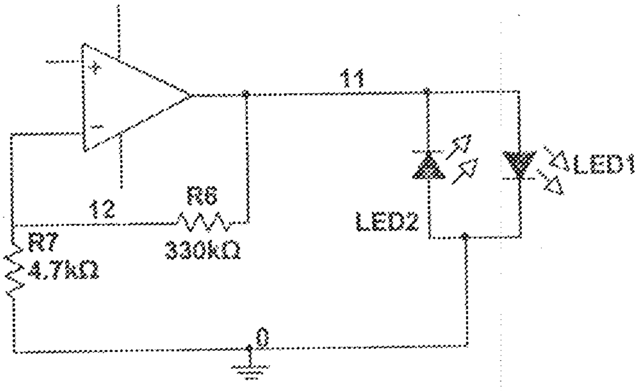


Fig 3.5 led indicator circuit

$$Gain = 1 + {R_{12}}/{R_{10}}$$

$$= 1 + {330k}/{4.7k} = 1 + 70.21$$

$$= 71.21$$

3.6 DISPLAY UNIT.

This unit is compose of Johnson counter (Logic Circuit) which makes one out of the output high while others are low in response to clock pulse generated by oscillator.

Dot-bar display driver (LM3914) is often used as dot or bar graph display due to its ability; that is as a bar graph display it can light up LED connected to it in response to the input signal (i.e. the fluctuating voltage). This is achieved by connecting pin 9 of LM3914 to the VCC for bar display and pin 9 to pin 11 for dot display.

While 4011 is used to generate pulse of regular frequency that is used to create an oscillation. This pulse are in the solid state oscilloscope to control time base, so that each output of 4017 is generated per second, while the LM3914 give the amplitude in response to the input signal such that output of LM3914 & 4011 are combined by the 100LEDS which display output waveform of the heartbeat i.e. serve as (display screen)

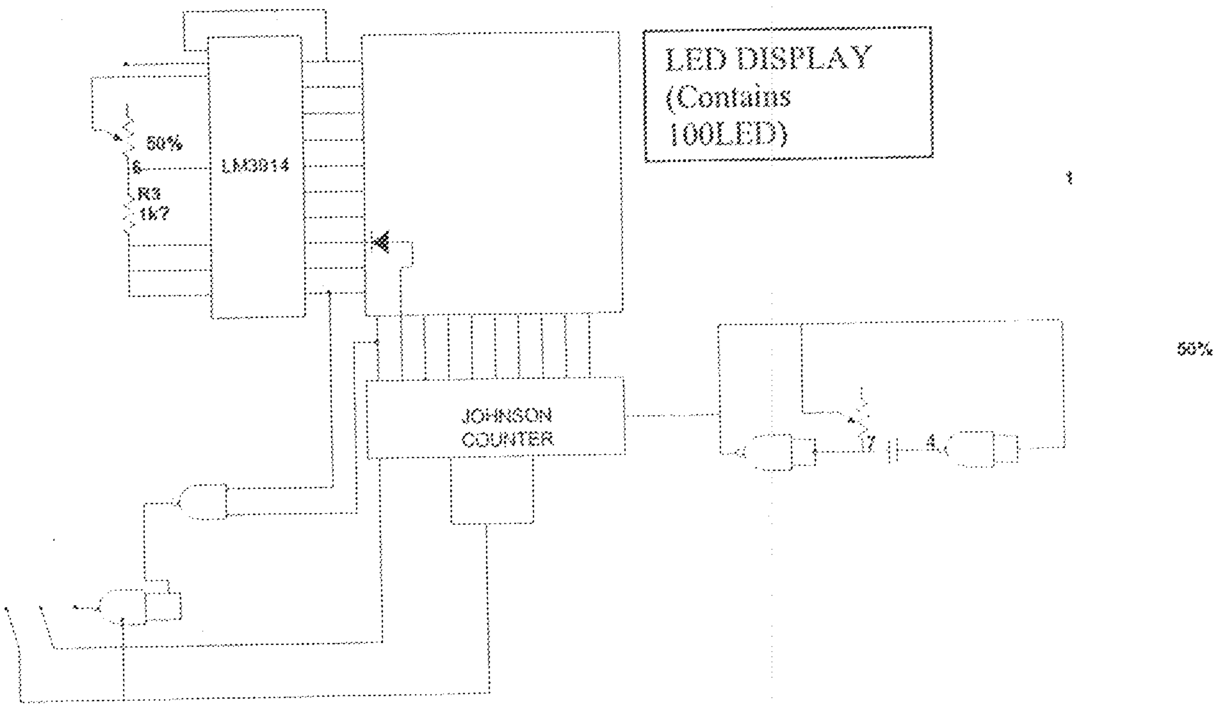


Fig 3 LED Display Unit.

The pulse of regular frequency generated by the oscillator is varied between 1Ω to 100kΩ.

The frequency of operation is evaluated using the formula below:

$$F = \frac{RC}{2.2}$$

For R=1Ω and C=1μF

$$F = \frac{1\times10^{-6}}{2.2} = 0.45\mu Hz$$

For R=100kΩ and C=1μF

$$F = \frac{100\times10^{3}}{2.2} \times \frac{10^{-6}}{1} = 0.045Hz$$

Thus, the time base (T) $= \frac{1}{F}$ $T_L = \frac{1}{0.045} = 22s$

$$T_H = \frac{1}{0.00000045} = 22 \times 10^3 s$$

3.7. POWER AMPLIFIER UNITS.

The power amplifier is built around a ¼ Watts power amplifier integrated circuit with built in biasing and inputs that are referred to ground. The amplifier has a gain of 20 and can drive any type of loudspeaker including low impedance ones.

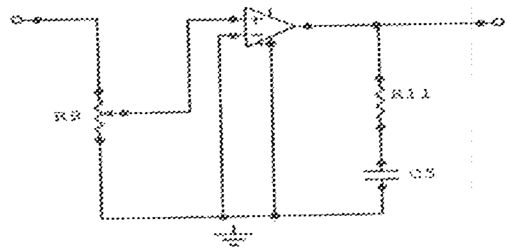


Fig 3.7 power amplifier circuit

CHAPTER FOUR

TEST, RESULTS AND DISCUSSION

4.1 TEST AND RESULTS.

The physical realization of the project is very vital. This is where the fantasy of the whole idea meets reality. The work at this stage is not just on paper but as a finished product. All components were tested immediately after purchase to determine their operability and confirmed stated values. Testing was carried out using a digital multimeter. Most of the components had less than their stated value though falling within the manufacturers operating range.

The construction of the project was done first by assembling the components on a breadboard, with the exception of the display whose construction was done directly on the veroboard. When the circuit performed as required, the components were then transferred to the veroboard with exception of the battery, electric microphone, volume control, switch, light emitting diodes and head phone jack, which were connected through standard insulated cables. IC base were used in order not to cause damage on the ICs in the process of soldering.

Before the soldering was done the components terminals and the new board strips were cleaned. At the time of soldering care was taken to prevent the damaging of the components by the excessive heat from the soldering iron. Care was also taken to avoid bridging the adjacent copper strips on the veroboard during soldering.

The test was carried out by testing all the component use in this project in order to determine whether there is short circuit and open circuits in the circuit. The output of the stethoscope was connected to the input of solid state oscilloscope, which is triggered at a certain clock frequency and the result was obtained for various type of patient with respective heart beats.

4.2 TEST RESULT.

TEST NUMBER	POSITION OF VARIABLE RESISTOR (%) Ω	OUTPUT
1	0	Low output
2	20	Loud output with no distortion
3	40	Loud output with no distortion
4	60	Loud output with no distortion
5	80	Loud output with moderate distortion

TEST	FREQUENCY
NORMAL HEARTBEAT	Average, 71 beats/minutes
ABNORMAL HEARTBEAT	60 or 80 beats/minutes
DEAD HEART BEAT	0 beat/minutes

4.3 DISCUSSION OF RESULT.

From the result obtained, the average heart rate of a normal person is within 65-75 per minute. The output obtained is varied with a variable resistor and the result obtained shows that, as the position of the variable resistor varied, the output volume also changes. It can be seen that the stethoscope produces little or no distortion when operated between 30 and 80% of the volume control.Thus, the output waveform on the solid state oscilloscope shows the present condition of the patient (i.e. whether normal, abnormal, or dead). Therefore, it is advisable to operate the device between 40 – 70% for maximum efficiency of the devise.

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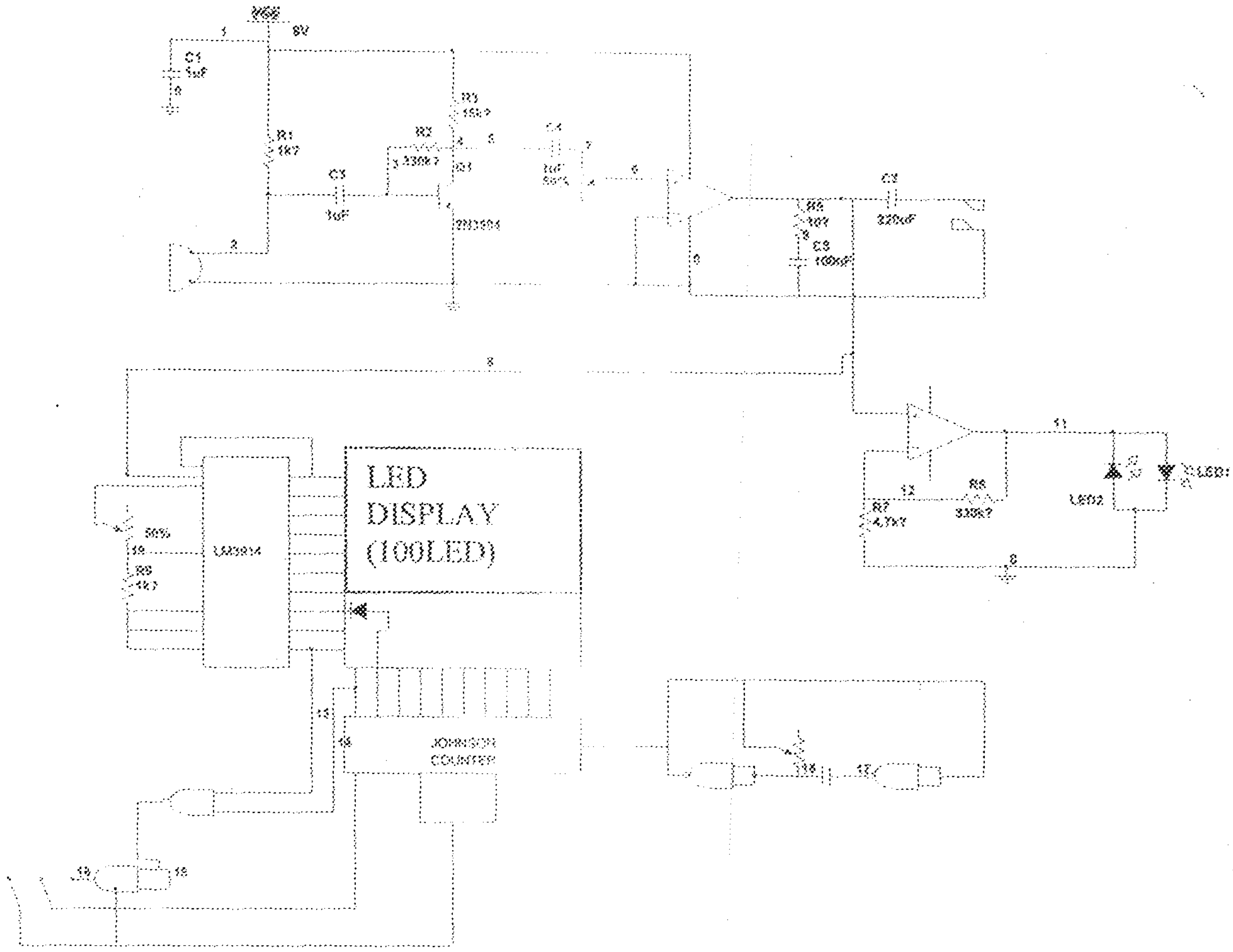
APPENDIX



Complete circuit diagram of electronics stethoscope