DESIGN AND CONSTRUCTION OF AN ELECTRONIC STETHOSCOPE

BY

MAGANI MUSA GAYAUNAN
2000/9862EE

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

OCTOBER 2006

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DEDICATION

This project is specially dedicated to God Almighty and to my beloved parents, Mr. and Mrs. Magani, my siblings Jonathan ,Emmanuel ,Mary, Rejoice, and to my university colleagues, too numerous to mention.

DECLARATION

I, Magani Musa Gayunan, declare that this work was done by me and therefore presented for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

MAGANI MUSA GAYAUNAN

Name of Student

……………………………………

Signature and Date

A. S. MOHAMMED

MAL. S. AHMED

Name of Supervisor

…………………………… 10/10/08

Signature and Date

ENGR. MUSA ABDULAHI

Name of H.O.D

……………………………………

……………………………………

Name of External Examiner

……………………………………

ACKNOWLEDGEMENT

My first and sincere gratitude goes to Almighty God without whose love, guidance and protection this work would not have been accomplished.

My sincere thanks goes to my parents, Mr. Edward Magani and Mrs. Helen Magani, May God continue to bless you both with his abundant grace for all the days of your lives.

I am greatly indebted to my project supervisor Mall. A S Mohammed for providing a Conducive atmosphere during the project and also providing helpful advice that has left a strong impression in my life.

My gratitude also goes to my siblings, Jonathan, Emmanuel, Mary and Rejoice for all their general assistance in the course of this project.

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CHAPTER ONE

1.0 INTRODUCTION

Stethoscope, an instrument used for *auscultation*—that is, to detect and study sounds arising within organs such as the heart, lung, and stomach prior to treatment. The stethoscope consists of a bell and diaphragm, or receiving head, connected by a Y-joint and rubber tubing to two earpieces. Stethoscopes are not only useful for doctors, but home mechanics, exterminators, spying and any number of other uses. Standard stethoscopes provide no amplification which limits their use. This circuit uses op-amps to greatly amplify a standard stethoscope, and includes a low pass filter to remove background noise.[1]

A health-care professional uses an instrument known as a stethoscope to detect internal body sounds, including the sounds produced by the heart as it is beating. The characteristic heartbeat sounds are made by the valves in the heart—not by the contraction of the heart muscle itself. The sound comes from the leaflets of the valves slapping together. The closing of the atrioventricular valves, just before the ventricles contract, makes the first heart sound. The second heart sound is made when the semilunar valves snap closed. The first heart sound is generally longer and lower than the second, producing a heartbeat that sounds like *lub-dup, lub-dup, lub-dup*.[1]

Using the stethoscope, the trained clinician can obtain immediate information without the aid of other specialists. This feedback can provide clues to the true nature of a disorder, help determine if further tests are indicated, confirm a suspected diagnosis or provide evidence that may eliminate a diagnosis under consideration. Time and experience have shown that rather than discard the stethoscope for high tech tools, both can be used together—each for its unique advantage—leaving clinicians with the broadest possible range of options. Indeed, not only has the stethoscope *not* been discarded, it has continued to be refined and improved.

It is used to listen to sounds arising especially from the heart and lungs, a stethoscope has a two-part sound-detecting device at one end. The bell, bowl-shaped with a hole in the center, detects low-pitched sounds when the rim is pressed against the skin. The other side, called the diaphragm, has a thin, flat plastic cover. The diaphragm detects high-pitched sounds. A doctor hears these sounds through the earpieces of the stethoscope as they pass up the Y-shaped rubber

Long before, Hippocrates (ca. 460–380 B.C.) taught his disciples the importance of listening to breath sounds, references to its usefulness appeared in the Ebers papyrus (ca. 1500 B.C.) and the Hindu Vedas (ca. 1500–1200 B.C.). Nevertheless, it was not until the early 19th century that physicians began to explore in a systematic way the precise clinical meanings of both breath and heart sounds by correlating data gathered during patient examinations with what was ultimately discovered on the autopsy table. This was the period when Paris reigned as the international center for all things medical. Stethoscope is much more than a tool that allows us to eavesdrop on the workings of the body. Indeed, it embodies the essence of doctoring: using science and technology in concert with the human skill of listening to determine what ails a patient. [2]

1.1 AIM AND OBJECTIVES

The aims and objectives of this project are:

- To hear chest sounds
- Direct conversion of sound from the chest to electronic signals minimizes sound interference
- Ideal stethoscope for use in-diagnosis of patients.
- To make an electronic stethoscope that it's operation is simple and intuitive.

1.2 METHODOLOGY

This project is built mainly on operational amplifiers with the aid of the stethoscope cone .The MIC picks the low frequency heart beat sound and passes it through a low pass band filter of about 16 Hz .This is to cut off other sounds that has been picked by MIC .Then the signal is passed to a pre-amplifier for amplification then passed to band pass of 0 -100Hz.This also cuts-off unwanted amplifier signal

The output at this stage is being passed to the head phone driver and LED Driver. The LED are been driven by an operational amplifier which amplifiers the signal receive in order to show how the heart beats. The LEDs blinks in accordance to the heartbeats.

The headphone driver is also an operational amplifier that acts as a comparator .it compares the output of the previous stage with the value across the pin 2 then uses output to drive the headphones. The headphone vibrates proportionally to the output so as to produce an almost true replica of heart.

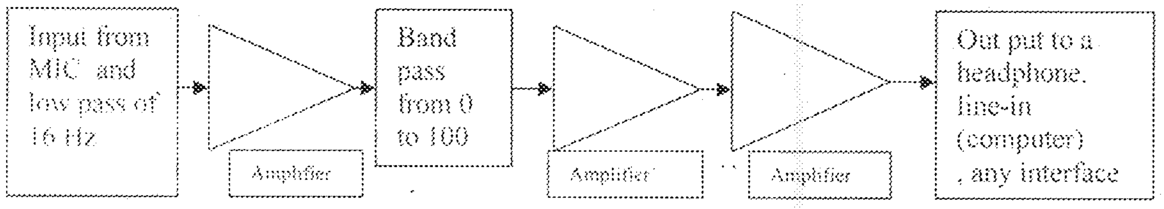


FIG 1.1 .Block diagram of an electronic stethoscope

1.3 SCOPE OF THE PROJECT

This project is all about making simple model to hear heartbeat sound electronically which can easily be store and connected to devices (e.g. computer) for further analysis.

This is only a simple model which requires more materials and technicality to achieve the full scale applications. This project is designed to cost effective with minimum number of electronic component.

CHAPTER TWO

2.0 LITERAURE REVIEW

The stethoscope was invented by the french inventor and physician (1781-1826) René-Théophile- Hyacinthe Laënnec , about 1819.In 1816 Laënnec accepted a position at Necker Hospital in Paris .While practicing there ,he invented and slowly perfected the stethoscope .In developing the stethoscope ,he discovered unknown symptoms of certain diseases, mastered the skill of listening to internal sounds ,and learnrd to record his clinical findings on pathological anatomy.One day in 1816 , Laënnec needed to examine an overweight woman with a cardiac disorder .the more of the day made it not possible to consider placing his ear directly upon her chest. He described his invention as follows (translated from French):

"In 1816 I was consulted by a young woman presenting with general symptoms of disease of the heart. Owing to her stoutness, little information could be gathered by application of the hand and percussion. The patient's age and gender did not permit me to resort to the kind of examination I have described (placing my ear to her chest). I recalled a well known acoustic phenomenon: if you place your ear against one end of a wood beam the scratch of a pin at the other end is distinctly audible. It occurred to me that this physical property might serve a useful purpose in the case I was dealing with. I then tightly rolled a sheet of paper, one end of which I placed over the precordium (chest) and my ear to the other. I was surprised and elated to be able to hear the beating of her heart with far greater clearness than I ever had with direct application of my ear. I immediately saw

that this might become an indispensable method for studying, not only the beating of the heart, but all movements able of producing sound in the chest cavity."

{"Auscultation Mediate", translated by John Forbes ,in Familiar medical quotations, Strauss}[1, 4]

Realising the enormous potential of a listening instrument to dectect not only heartbeat but respiration and a host of other sounds , Laënnec created just a device :a wooden cylinder (12.5 x1.25in.,31 x 33 cm) with a hole length wise down to the center .this could be place inside to complete the cylinder (enabling him to better hear the heart and signs related to voice), or removed ,leaving a funnel –shaped opening which served as a bell chest piece and also enhanced sounds of respiration .thus .the first stethoscope (from the Greek stethos stands for "chest " and skopein stands for "to examine ") was created .

Not long after its introduction, the stethoscope was being independently manufactured in a variety of locations. Thus, many different devices were available, each one a bit different from the next. All these devices had common features. They were all more or less cylindrical, hardwood stethoscopes, with certain problems inherent in the form. Some patients felt uncomfortable having these hard objects pressed against their bodies, and even more troublesome was the scope's rigidity that forced both doctor and patient to bend and turn in a variety of positions to conduct an examination. Subsequently modification were done with time to enhance the flexibility, portability, accuracy and durability of the stethoscope .These are the modification done with time as follows:

1829 –Binaural stethoscope (two ear piece models) male their debut .but not with much success by a doctor in Dublin .Nicolas Comins, a physician in Edinburgh ,Scotland .responded to this models by devising the first "flexible " stethoscope in 1829.It consists of two rigid tubes joined together to permit movement at any angle .Over the next 20 years ,other simply incorporate a pliant tubing between the chest and ear pieces, making it the stethoscope truly flexible and non rigid .

1860s- The Camman Stethoscope, a binaural model with a bell shaped chest piece is now considered the standard for superior "auscultation (the act of listening to the sounds made by a patient's internal organs, especially the heart, lungs, and abdominal organs, usually with a stethoscope, in order to make a diagnosis)" by American Physician .It was soon followed by the Ford Model.

1898- The Bowles Stethoscope with its diaphragm chest piece in a flat-iron shape appears. By the 1890s, the binaural stethoscope had virtually replaced the monaural devices. Sound quality improved when users learned that certain sounds could be enhanced by stretching a rigid diaphragm over the open chest piece. These would be joined by the "combination stethoscope "in 1902- having both bell and diaphragm chest pieces for better diagnosis.

The firet workable binaural stethoscope was design by George P. Cammann around 1951 in New York .Over a foot long ,it consisted of two pliant tubes that led from an ebony chest piece to german silver band connected the tubes and helped to maintain a snug fit with the ears .It was non rigid,flexible and easy to carry .

Another flexible binaural ,the differential stethoscope invented by S. Scott Alisonin the 1960's enabled physician to hear sounds from two different poarts of the chest .It had two pliant tubes made of wire ,each withs its own chest piece , for consecutive or simultaneous listening .

1900-The "Cardiophone" an early electronic instrument to help augment heart sounds arrives on the medical scene .Today's electronic stethoscope ,power by two hearing aid batteries, can amplify superbly up to 100 times .

From 1991 to 1994, the Clinical Research Institute of Montreal was commissioned to Theratechnologies Inc. to conduct a feasibility study to determine the marketability of the electronic stethoscope. The results of this major clinical study were the ideal design requirements for a superior stethoscope. Upon completion of these studies, Andomed Inc. was created to develop a new electronic stethoscope called "Stethos." After several design iterations the Stethos was introduced in Canada. [3]

My design is simply electronic stethoscope using operational amplifers to amplifier the sounds and using filter to get rid of unwanted signals .this gives an alomost replication of the heart beat sound which also can futher be used for medical dignosis .

2.1 THEORETICAL BACKGROUND

The term 'op-amp' was originally used to describe a chain of high performance dc amplifiers that was used as a basis for the analog type computers of long ago. The very high gain op-amp IC's our days uses external feedback networks to control responses. The op-amp without any external devices is called 'open-loop' mode, refering actually to the so-called 'ideal' operational amplifier with infinite open-loop gain, input resistance, bandwidth and a zero output resistance.

However, in practice no op-amp can meet these ideal characteristics. And as you will see, a little later on, there is no such thing as an ideal op-amp. It had higher gain, a larger bandwidth, lower input current, and a more user-friendly supply voltage requirement of approximately +15 Volt DC. Its power can be supplied by a +5 to +15vdc single supply system

Open-Loop Gain & Frequency:

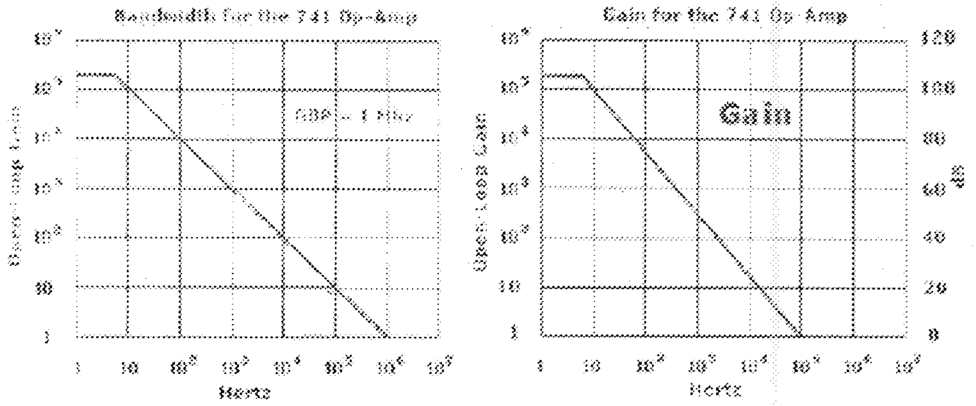


Fig 2.2

Unlike the ideal op-amp (Fig. 2.3), the op-amp that is used in more realistic circuits today, does not have infinite gain and bandwidth. Look at Open-loop gain in Fig. 2.2 above, it is graphed for a type 741 op-amp as a function of frequency. At very low frequencies, the open-loop gain of an op-amp is constant, but starts to taper off at about 6Hz or so at a rate of -6dB/octave or -20dB/decade *(an octave is a doubling in frequency.*

and a decade is a ten-fold increase in frequency). This decrease continues until the gain is unity, or 0 dB. The frequency at which the gain is unity is called the unity

gain frequency or fT.

Maybe the first factor in the consideration of a specific op-amp is its *"gain-bandwidth product"* or GBP. For the response curve of Fig. 2.2 *the product of the open-loop gain and frequency is a constant at any point on the curve.*

Graphically, the bandwidth is the point at which the closed-loop gain curve intersects the open-loop curve, as shown in Fig 2.2 for a family of closed-loop gains. For a more practical design situation, the actual design of an op-amp circuit should be approximately 1/10 to 1/20 of the open-loop gain at a given frequency. This ensures that the op-amp will function properly without distortion. As an example, using the response in Fig. 2.2, the closed-loop gain at 10Khz should be about 5 to 10, since the open-loop gain is 100 (40dB).

One additional parameter is worth mentioning, the *Transient Response, or rise time* is the time that it takes for the output signal to go from 10% to 90% of its final value when a step-function pulse is used as an input signal, and is specified under close-loop condistions. From electronic circuit theory, the rise time is related to the bandwidth of the op-amp by the relation: BW = 0.35 / rise time

Open-Loop Gain:

Lets have a look how the 'ideal' amplifier would look like in Fig2.3. The search for an ideal amplifier is, of course, a futile exercise. The characteristics of the operational amplifier are good enough, however, to allow us to *treat* it as ideal. Below are some amplifier properties that make this so. (Please realize that these ratings are next to impossible to achieve).

1. Gain--infinite

2. Input impedance--infinite

3. Output impedance--zero

4. Bandwidth--infinite

5. Voltage out--zero (when voltages into each other are equal)

6. Current entering the amp at either terminal--extremely small

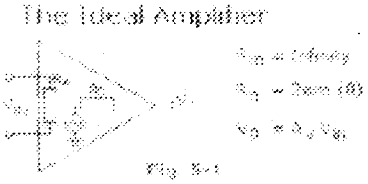


Fig 2.3 Ideal Amplifier

2.1.1 Power Supply:

In general op-amps are designed to be powered from a dual or bipolar voltage supply which is typically in the range of +5V to +15Vdc *with respect to ground,* and another supply voltage of -5V to - 15Vdc with respect to ground, as shown .

Schematic Diagram

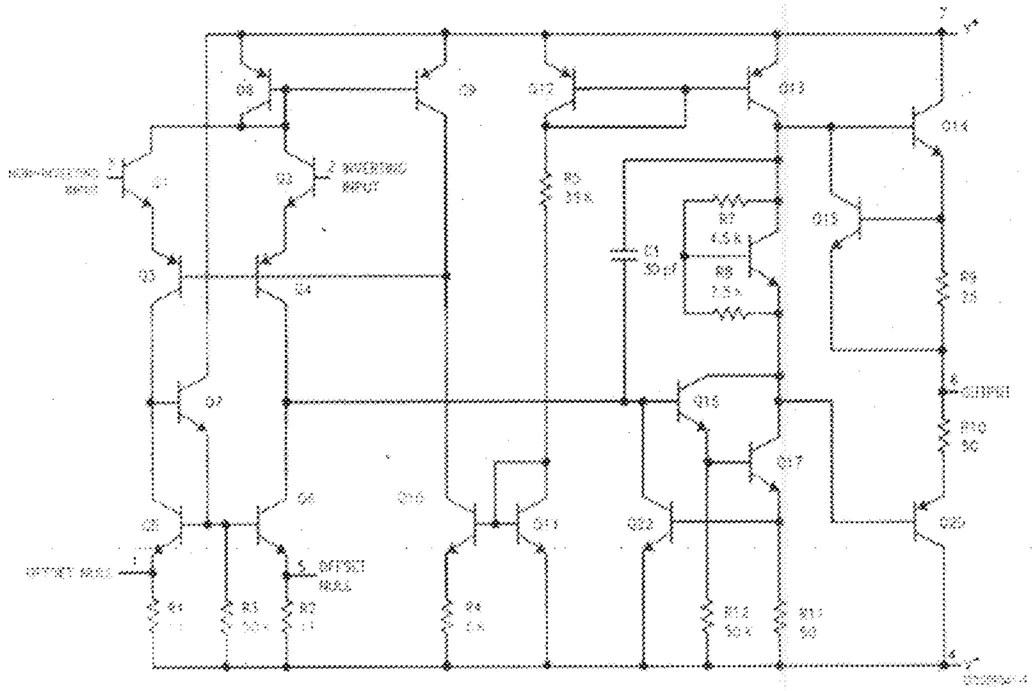


Fig 2.4 Schematic Diagram [6]

2.1.2 Definition of 741-pin functions: (Refer to the internal 741 schematic of Fig. 3)

Pin 1 (Offset Null): Offset nulling,. Since the op-amp is the differential type, input offset voltage must be controlled so as to minimize offset. Offset voltage is nulled by application of a voltage of opposite polarity to the ofset. An offset null-adjustment potentiometer may be used to compensate for offset voltage. The null-offset potentiometer also compensates for irregularities in the operational amplifier manufacturing process which may cause an offset. Consequently, the null potentiometer is recommended for critical applications. See 'Offset Null Adjustment' for method.

Pin 2 (Inverted Input): All input signals at this pin will be inverted at output pin 6. Pins 2 and 3 are very important (obviously) to get the correct input signals or the op amp can not do its work.

Pin 3 (Non-Inverted Input): All input signals at this pin will be processed normally without invertion. The rest is the same as pin 2.

Pin 4 (-V): The V- pin (also referred to as Vss) is the negative supply voltage terminal. Supply-voltage operating range for the 741 is -4.5 volts (minimum) to -18 volts (max), and it is specified for operation between -5 and -15 Vdc. The device will operate essentially the same over this range of voltages without change in timing period. Sensitivity of time interval to supply voltage change is low, typically 0.1% per volt. (Note: Do not confuse the -V with ground).

Pin 5 (Offset Null): See pin 1

Pin 6 (Output): Output signal's polarity will be the oposite of the input's when this signal is applied to the op-amp's inverting input. For example, a sine-wave at the inverting input will output a square-wave in the case of an inverting comparator circuit.

Pin 7 (posV): The V+ pin (also referred to as Vcc) is the positive supply voltage terminal of the 741 Op-Amp IC. Supply-voltage operating range for the 741 is +4.5 volts (minimum) to +18 volts (maximum), and it is specified for operation between +5 and +15 Vdc. The device will operate essentially the same over this range of voltages without change in timing period. Actually, the most significant operational difference is the output drive capability, which increases for both current and voltage range as the supply voltage is increased. Sensitivity of time interval to supply voltage change is low, typically 0.1% per volt

Pin 8 (N/C): The 'N/C' stands for 'Not Connected'. There is no other explanation. There is nothing connected to this pin, it is just there to make it a standard 8-pin package. [10]

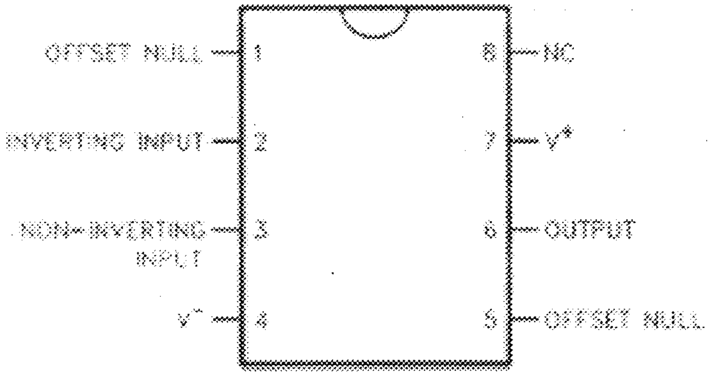


Fig 2.5 Operational Amplifier

2.1.3 Butterworth Filters [7,8,9]

Filters are classified according to the functions that they are to perform, in terms of ranges of frequencies. We will be dealing with the low-pass filter, which has the property, that low-frequency excitation signal components down to and including direct current, are transmitted, while high-frequency components, up to and including infinite ones are blocked. The range of low frequencies, which are passed, is called the pass band or the bandwidth of the filter.

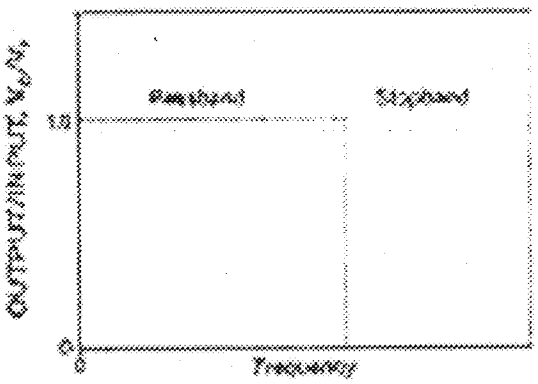


Figure 2.6 – Ideal low-pass filter

The ideal low-pass filter is shown in Figure 1. However, a physical circuit cannot realize this response. The actual response will be in general as shown below.

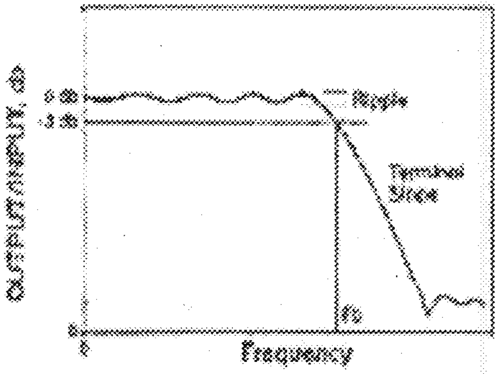


Figure 2.7 – Actual low-pass filter characteristics

It can be seen that a small error is allowable in the pass band, while the transition from the pass band to the stop band is not abrupt. The sharpness of the transition from stop band to pass band can be controlled to some degree during the design of a low-pass filter.

The ideal low-pass filter response can be approximated by a rational function approximation scheme such as the Butterworth response.

Several Butterworth polynomials are tabulated below (from Millman and Halkias [8]) for various values of the parameter n. The design of a Butterworth filter involves choosing the mid-band gain Av0, and n, the order of the filter necessary to yield the desired response. These design parameters are chosen based on the frequency characteristics of the signal being studied.

Copy of table of Butterworth polynomials (from [8])

n	*Factors of polynomial* $B_n(s)$
1	$(s + 1)$
2	$(s^2 + 1.414s + 1)$
3	$(s + 1)(s^2 + s + 1)$
4	$(s^2 + 0.765s + 1)(s^2 + 1.848s + 1)$
5	$(s + 1)(s^2 + 0.618s + 1)(s^2 + 1.618s + 1)$
6	$(s^2 + 0.518s + 1)(s^2 + 1.414s + 1)(s^2 + 1.932s + 1)$
7	$(s + 1)(s^2 + 0.445s + 1)(s^2 + 1.247s + 1)(s^2 + 1.802s + 1)$
8	$(s^2 + 0.390s + 1)(s^2 + 1.111s + 1)(s^2 + 1.663s + 1)(s^2 + 1.962s + 1)$

Table 2.1

Butterworth filters have the properties that

1) The response is "maximally flat," which means that there is no ripple in the pass band.

2) As the order of the filter n gets larger, the filter characteristics approach those of the ideal low-pass filter.

To calculate the parameters for a high-pass filter, simply interchange the resistors and capacitors. To design a band-reject filter, add appropriately designed high-pass and low-pass filters. To design a band-pass filter, cascade an appropriately designed low-pass with an appropriately designed high-pass.

The filters can be realized with the following circuits [8]:

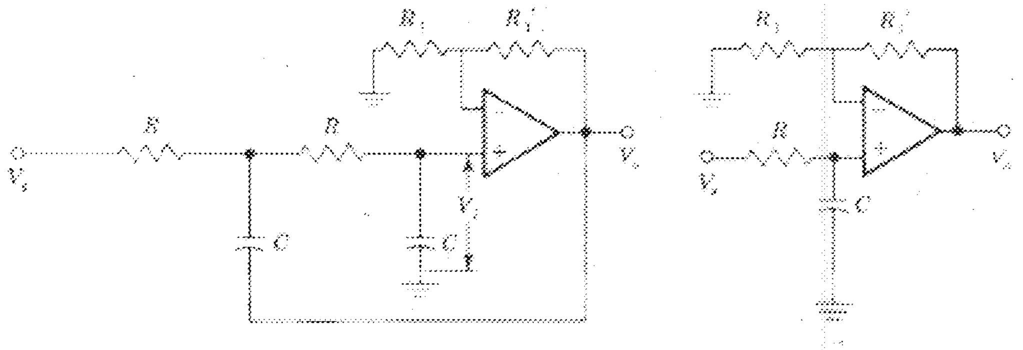


Figure 2.8 - First- and second-order filter realizations with op amps, and passive resistor and capacitor networks.

$$H(S) = \frac{A}{B(S)}$$ Equation 2.1

Millman and Halkias [8] show that the circuits in Figure 2.8 have the transfer functions given in Equation (2.1) if the cutoff frequency Ω and gain are given by

$$A = 1 + \frac{R'}{R} \qquad \Omega = \frac{1}{RC}$$ Equation 2.2

For a second-order filter, and if the cutoff frequency for a first-order filter is

$$\Omega = \frac{1}{RC}$$ Equation 2.3

The value of Av0 for the first-order system is not important to the design, and can be any value. The damping ratio for the second-order frequency is found by solving Equation (2.3)

$$A = 3 - 2\xi$$ Equation 2.3

2.14 Design Synopsis:

The procedure for designing analog Butterworth filters is:

1. Define the desired filter characteristics (fiducial points K1, K2, Ω1, and Ω2).

2. Calculate the required order of the filter n from Equation (2.6).

3. Calculate the required 3-dB point (cutoff frequency Ω0)

4. If the design includes a second-order filter, calculate the required mid-band gain Av0 from Equation (2.3). The damping ratio ξ is found from Table 1. The feedback resistors are then calculated from. If the design includes a first-order filter, the value of the mid-band gain is not important.

5. Calculate required values of R and C from.

6. If a hi-pass filter is desired, then switch the R and C components. If a band-pass filter is desired, then cascade a low-pass with a hi-pass filter. If a band-reject is desired, then add high-pass and low-pass filters.

CHAPTER THREE

The circuit design of the electronic stethoscope is as shown below in fig 3.1

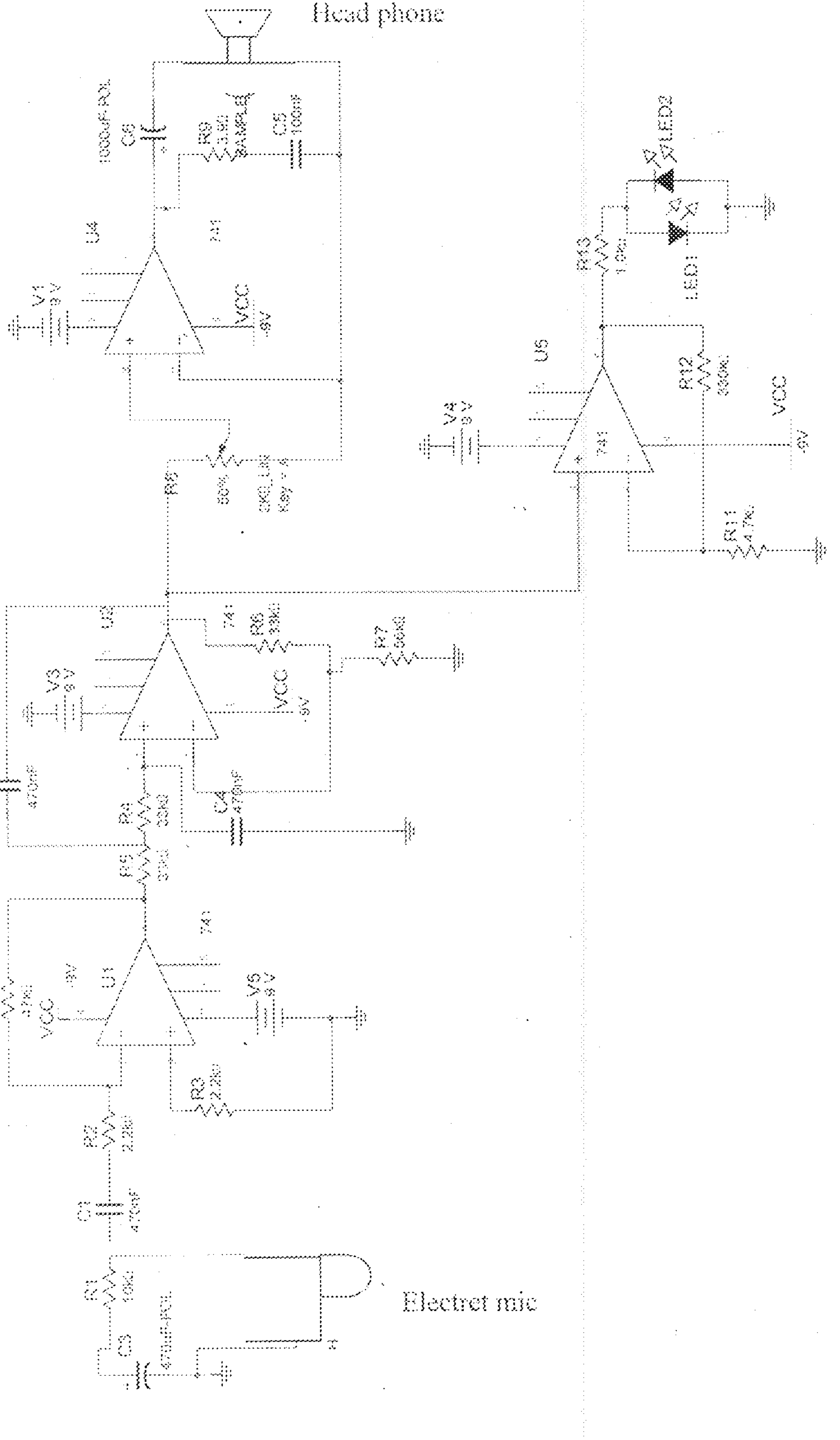


Fig 3.1 electronic stethoscope

3.0 PRINCIPLE OF OPERATION

The electronic-stethoscope is design with four operational amplifiers in different modes. This can further be simplified by dividing it into four different sections in accordance to the operation of the operational amplifiers. These are:

1. Microphone Preamplifier

2. Buffer and Isolating Amplifier using Butterworth response

3. Power Amplifier (Drives the earphone)

4. Light Emitting Diode (LED) Driver

3.1 Microphone Pre-amplifier

In the pre-amplification stage a non inverting operational amplifier is use to give a voltage gain of about 3.9 with a cut off frequency of about 16 Hz.

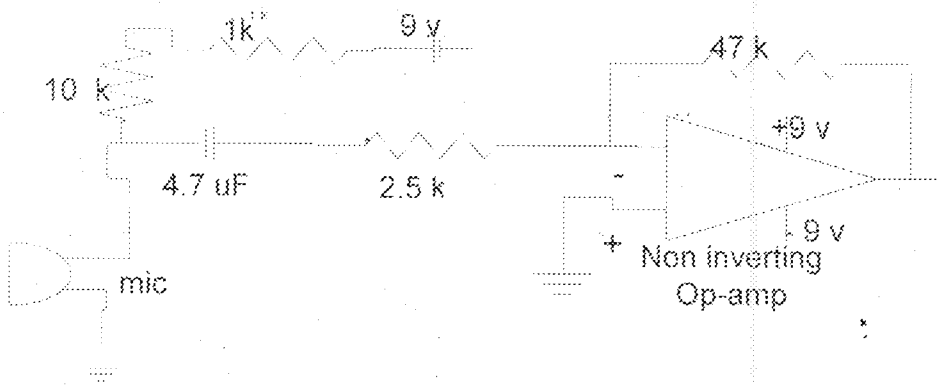


Fig. 3.2 Diagram for the Pre-amplification stage

To calculate for the gain for the inverting operational amplifier we have

$$A = -\frac{Rf}{Ri}$$

Where Rf= Feedback Resistance

Ri=Input Resistance

$$A = \frac{-4.7k}{12.2\,k} = -3.9$$

Also C2 and R2 with values 4.7uF and 2.2k resectively gives a low pass of about

16 Hz.

$$F = \frac{1}{2x3.142xRC}$$

Where F=Frequency for the low pass

C=Capacitance =4.7uF

R=Resistance = 2.2 k

$$F = \frac{1}{2x\,3.142x4.7ux2.2k} = 15.6$$

F=15.6=16 Hz

The low is set to 16 Hz to enable the heart sound which is relatively of low frequency to be passed.this also aid in producing an almost true replica of a heart beat sound .also C2 is I

3.2 BUFFER AND ISOLATING AMPLIFIER

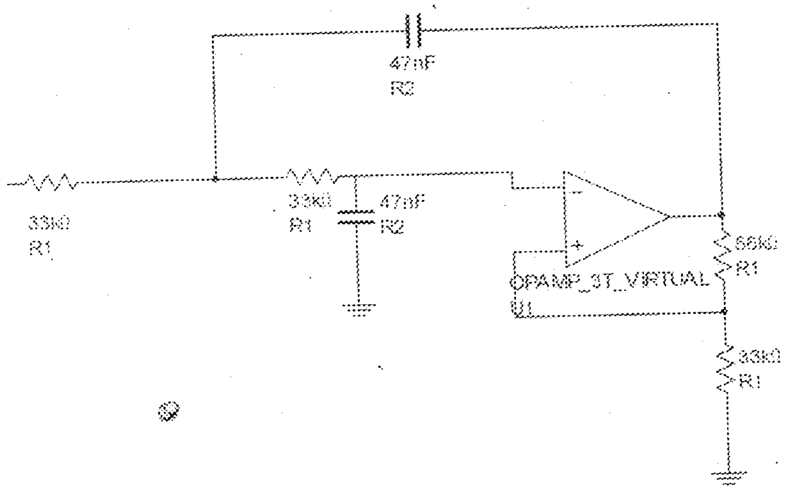


FIG 3.3 BUFFER AND ISOLATING AMPLIFIER

The output from the pre-amplifier is being passed through R5. R6. and C2and C5 with a cut off frequency of about 103Hz .this can be calculated using the formula below

$$F = \frac{1}{2 \times 3.142 \times (RC)}$$

Where F=Frequency

R5=R6= Resistance=33 k

C2=C5= Capacitor= 47nF

$$F\ (\text{both}) = \frac{1}{2(3.142)(33k)(47n)}$$

F=102.61 Hz ≈ 103 Hz

Using a 2nd butter worth response to determine the values of the resistors (R5, R6) and capacitors (C2, C5) that is to get a desired frequency of 103 Hz.

Considering the Butterworth response table show below, to determine the order of response and the required equation to used to get the required values, we will consider the nature of our operational amplifier configuration .

TABLE 3.1 GENERAL 2ND ORDER BUTTER RESPONSE [8]

n	*Factors of polynomial* $B_n(s)$
1	$(s+1)$
2	$(s^2+1.414s+1)$
3	$(s+1)(s^2+s+1)$
4	$(s^2+0.765s+1)(s^2+1.848s+1)$
5	$(s+1)(s^2+0.618s+1)(s^2+1.618s+1)$
6	$(s^2+0.518s+1)(s^2+1.414s+1)(s^2+1.932s+1)$
7	$(s+1)(s^2+0.445s+1)(s^2+1.247s+1)(s^2+1.802s+1)$
8	$(s^2+0.390s+1)(s^2+1.111s+1)(s^2+1.663s+1)(s^2+1.932s+1)$

From the table above and base on the configuration of the operational amplifier 2nd equation will be used to generate the required values for the resistors and capacitors.

The equation is

$S^2+1.414S+1$

The second order transfer function has as the numerator the polynomial $S2+\varepsilon S+1$

(assuming that the natural frequency is unity).using this relation this equation

$A= 3 - 2\varepsilon$ 3.

Where ε is the damping ratio

A=Gain

Also $A=1+\frac{Rf}{Rin}$ (For non-inverting amplification)

From equation 3.

$A= 3-1.414 = 1.586$

Also $1.586 = 1 + \frac{Rf}{Rin}$

Taking our Rf to be 56 K

$$1.586 = 1 + \frac{Rf}{56K}$$

$$1.586 - 1 = \frac{Rf}{56K}$$

$Rf = 0.586 \times 56k$

$Rf =32.81k \approx 33\ k$

To determine the value of our capacitor in order get a low pass filter for 100 Hz .using equation 3. and making C subject of formula we have

$$C = \frac{1}{2x3.142x\,(FR)}$$

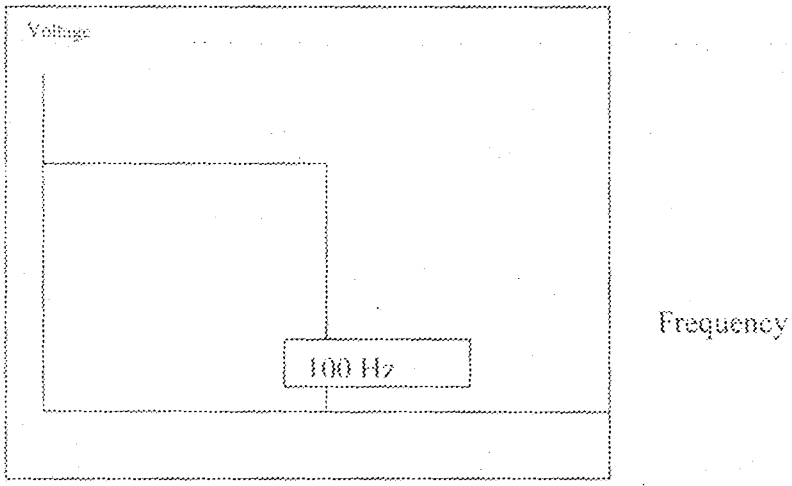


FIG 3.4 Ideal low pass filter

The closet practical capacitor value is 47 nF and this will have a new low pass frequency of about 103 Hz as shown in the calculation below

$$F = \frac{1}{2x3.142x\,(47nx33k)}$$

$F \approx 103$ Hz

This gives low pass of 103Hz i.e. allowing frequency between 0 to 103Hz while blocking all frequencies outside this range.

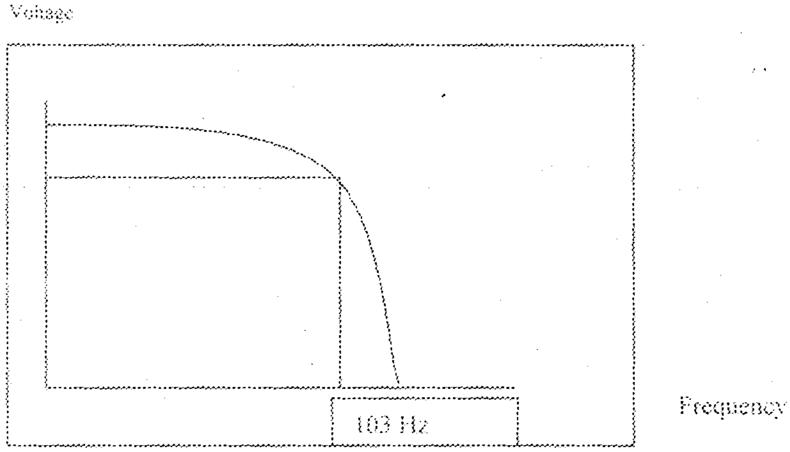


FIG 3.5 Actual low pass filter

3.3 OPERATIONAL AMPLIFIER AS A LED DRIVER

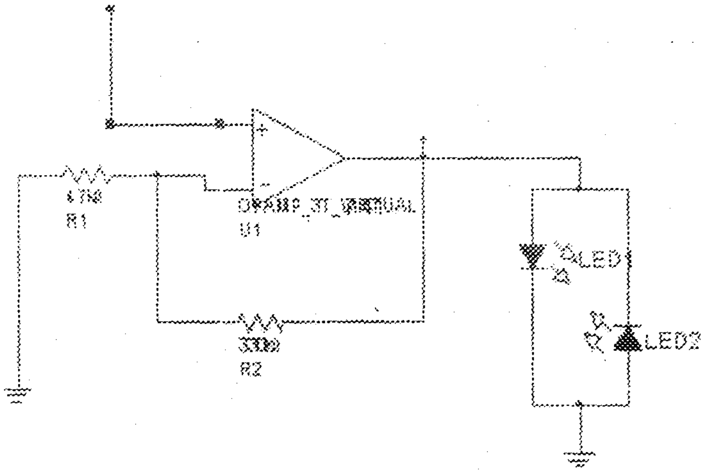


FIG 3.6 OPERATIONAL AMPLIFIER AS A LED DRIVER

Here the operational amplifier operates as an inverting amplifier with a target high gain of 71. This could be achieved by using the amplification formula of non inverting operational amplifier.

Taking an input resistor of 4.7 kΩ

$A = 1 + \frac{Rf}{Rin}$. (For non-inverting amplification)

$71 = 1 + \frac{Rf}{47k}$.

$71 - 1 = \frac{Rf}{47k}$.

$Rf = 329\ k\Omega$

Since practical it`s not possible of getting an exact 329k Ω resistor a 330KΩ is use which is available.

This high gain enables the amplified signal (heart beat signal) be able to drive the LEDs in its respective cycles. The heart beat signal is an AC signal with both positive and negative cycles. The AC signal is as the result of the operation of the electret's microphone .this makes the positive cycles to drive the the green LED and the negative cycle to drive the red LED .these LEDs are connected in opposite polarites .each heart beat causes the colurs to indicate different beats.the first LED indicates the thumping of the heart and the second LED indicate the thomping of the heart

3.4 HEAD PHONE DRIVER.

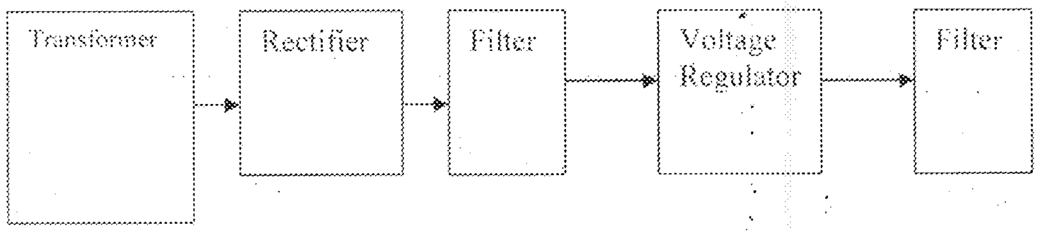
This a 0.25 watt power amplifier IC with a built in biasing and inputs that are referred to the ground .it has a gain of about 20 .this can driver any type of headphones including low impedence ones e.g 8 ohms headphone which commonly used for stereos.

3.5 POWER SUPPLY

Most electronics devices and circuits require a DC source to their operation .since the most convenient and economical source is the domestic AC supply .It is advantageous t convert this alternating supply to DC voltage is called rectification and it is accomplished with the stages and components ;

1. Stepping down of Voltage using Transformer
2. Rectifier –using Diodes
3. Filtering – using capacitors
4. Voltage regulation – using Regulators

This can be represented in block Diagram as shown below.



FIGS 3.7 Block Diagram of power supply

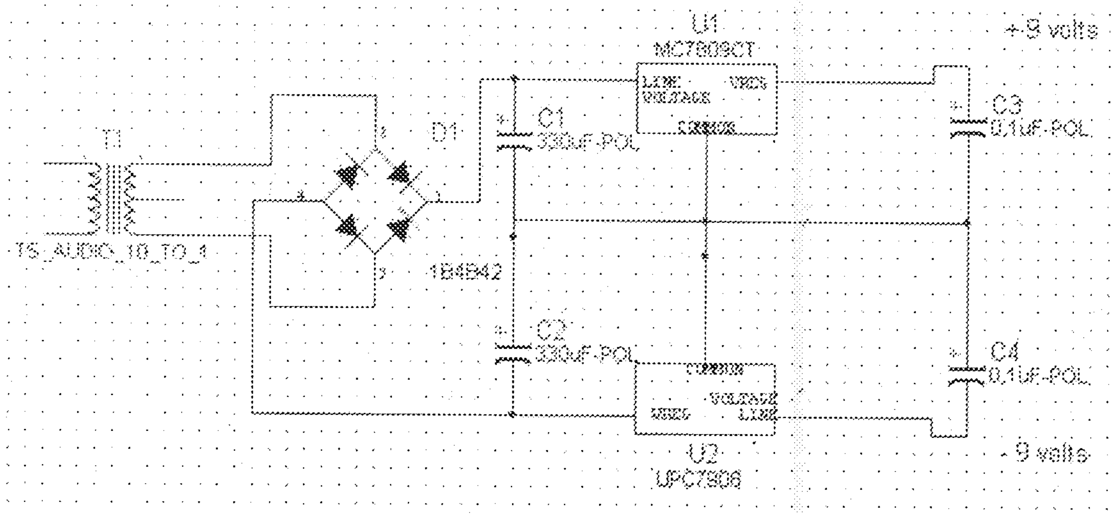


FIG 3.8 Circuit Diagram of the power supply

The power supply is built as shown in the schematic above .This is preferred to the two (2)Connected in series with like polarities .the centre tap transformer steps down 240 v to 12 volt making it to have a ratio 20:1 .

The voltage transformation ratio K

$$\frac{E2}{E1} = \frac{N2}{N1} = K$$

E1= Voltage on the primary side

E2= Voltage on the secondary side

N1= Number of turns on the primary side

N2 = Number of turns on the secondary side

$$K = \frac{12}{240}$$

$$K = \frac{1}{20}$$

This gives a 1:20 Ratio. This can be seen using an oscilloscope as shown below

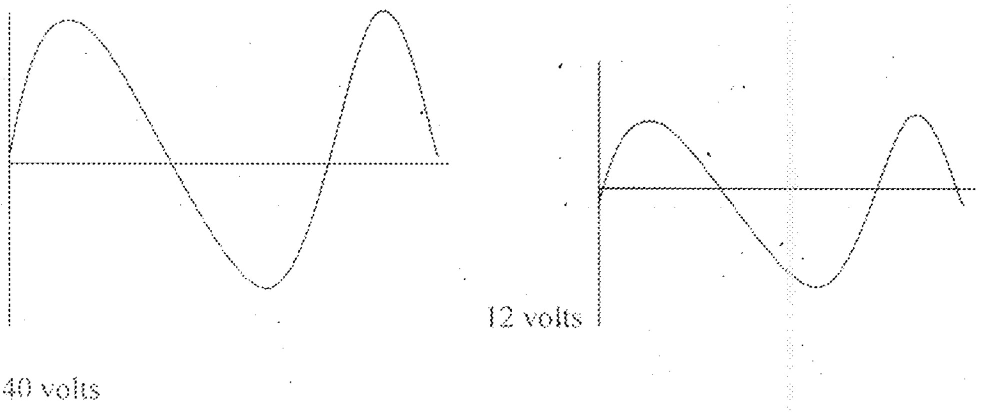


Fig 3.9 Diagram showing the stepping down of voltage from 240 v to 12 v

3.5.1 RECTIFICATION

This employs the use of four (4) diodes to convert the Ac voltage into pulsating DC voltage. The full rectification uses the four diode as shown in the diagram.

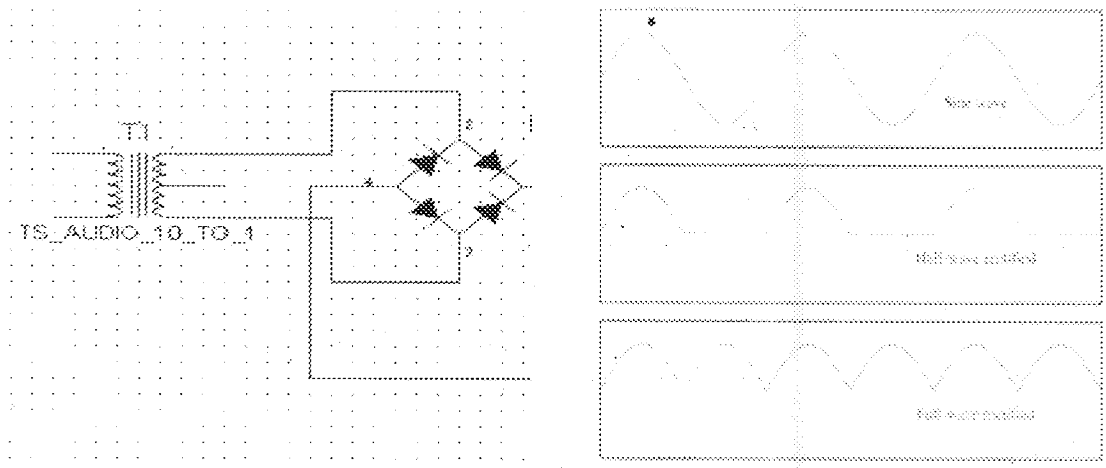


Fig 3.10 Rectification using Diodes

When input AC signal is switch on both of the secondary cables becomes positive and negative alternatively. During the positive half cycle of the AC input ,terminal M+ is positive ,G is at zero potential and N is at the negative potential .Hence being forward biased diode D1 (but not D2 which reversed biased) current flows along MD1CABG, as a positive half of the cycle of the voltage at the output .

During the negative half of the cycle .when N becomes positive the D2 conducts (but not D1 which is now reversed biased) and current flows along ND2CABG.so we find that current keeps flowing through DC in the same direction in both half cycles of a DC component and many Ac component of diminishing amplitudes.

3.5.2 FILTERING

In this circuit suitable capacitors are use across the rectifier and in parallel with the load .This type of filter is known as capacitor input filter. The filter circuit depends for its operation the property of a capacitor to charge up. During conducting half cycle.

When positive half cycle of the Ac input is applied, the diode is forward –biased and hence is turn on and this allows capacitor holds the charge till input AC supply to rectifier goes negative .During the negative half cycle, the capacitor attempts discharge .however this cannot through diode which is being now reversed biased, is off. Hence it discharges through RL .the capacitor doesn`t have sufficient time to discharge appreciably before the next positive cycles.

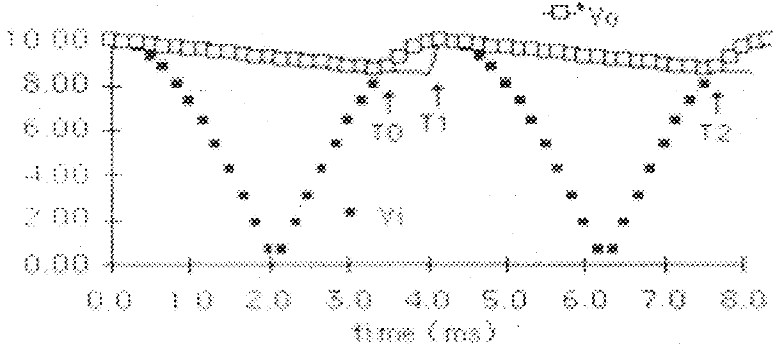


Fig.3.11 Graph showing the filtering effect of a capacitor

3.5.3 VOLTAGE REGULATOR

Most DC power supply circuit today make use of integrated circuit (IC) regulators ,such as the one shown in figure 3. .The IC regulator contains about 50 individual or discrete component all integrated in one silicon semi-conductors chip and then encapsulated in a three –pin package. shows how all of the IC regulators internal components from the circuit which are shown as blocks .For example,a short circuit protection and thermal shutdown exceeds the regulator's rated currents or if the heating is too small and the IC regulator is generating heat faster than it can dissipate it.

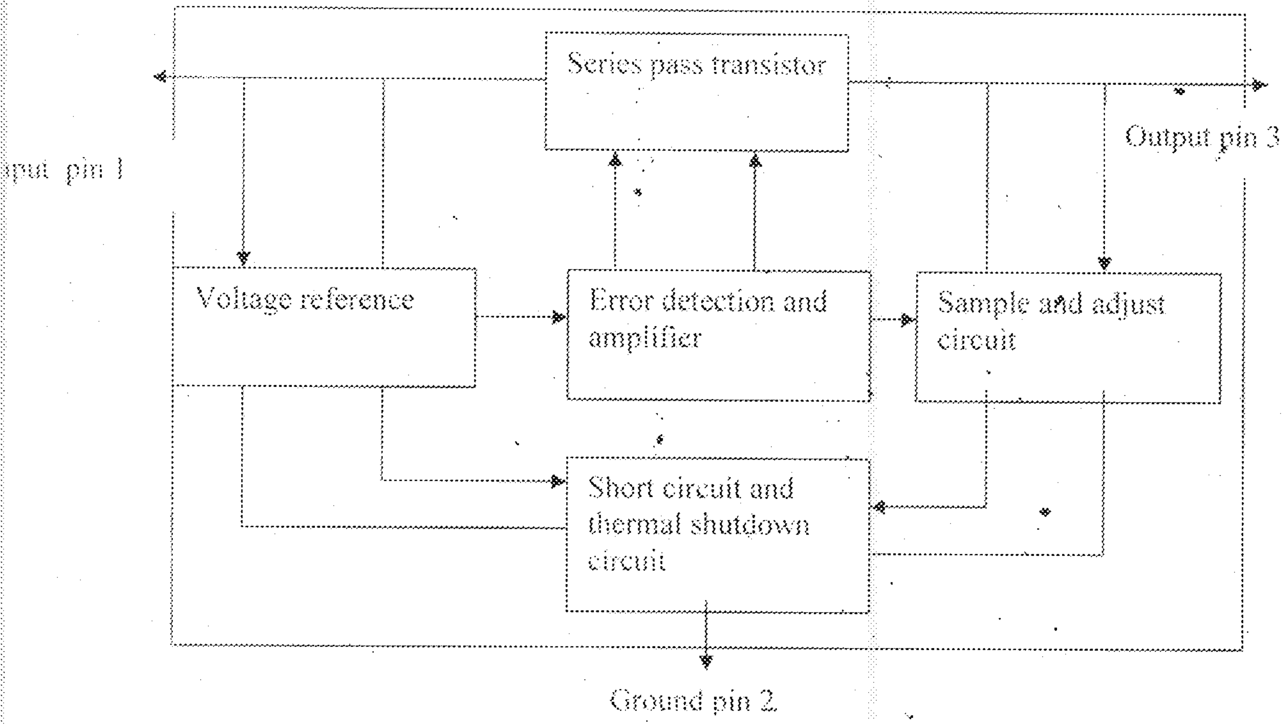


Fig 3.12 Voltage Regulator

CHAPTER FOUR

4.1 TEST AND MEASUREMENT

The realization of the project is very vital. After carrying out all the paper design and analysis, the project was implemented and tested to ensure its working ability, and was finally constructed to meet desired specifications. The process of testing and implementation involve the use of some equipments stated below:

(I) **BENCH POWER SUPPLY:** this was used to supply voltage to the various stages of the circuit during the breadboard test before the power supply in the circuit was built. Also during the soldering of the project the power supply was still used to test various stages before the d.c power supply used in the project was finally constructed.

(II) **DIGITAL MULTI-METER:** It basically measures voltage, resistance, continuity, current, frequency, and transistor h_{FE}. The process of implementation of the design on bread-board required the measurement of parameters like voltage, continuity, resistance values of the components. The digital multi-meter was used to check the various voltage levels of the stages in the circuit, especially the power supply stage.

4.2 CONSTRUCTION

The design of the various circuits comprising the Electronic Stethoscope was tested using the specified components, and testing them on a breadboard, to ensure workability of the design. When the system was certified to be working, the components were then permanently fixed by soldering on a Vero board.

Breadboards are prototype boards, which are modules containing well-arranged pin-socket for fixing-in components. The breadboard is ideal for testing full working of systems and components, as it serves as a temporary construction board. For this project, all the components used in the work were laid-out on the breadboard, according to the specifications of the project design. All the adjustments were made using the breadboard, and the effect of interchanging components was observed and noted [3].

The breadboard proved to be very convenient, and played an integral role in circuit design of this project, as theoretical designs were realized with ease and components were easily experimented with.

The Vero-board is an insulator strip, comprising several parallel tracks of strips with small holes drilled along its length, giving a matrix format. The components were fixed to the Vero board by placing each of the pins of the components in a separate hole with the pin soldered into the hole in accordance with the circuit design. This ensures rigidity of the components. Uniformity of the arrangement of components with the tested design was ensured which eliminates the removal of components for the purpose of correction.

4.3 CONTRUCTION OF CASING

Allowance was made for operating the sets to the system accessible for easy maintenance. The subscribers units are two in number, which made it a channel system. Spaces were also provided for the switches, cables and sound outlet.

Lastly, floor flex tiles were chosen for the casing because of its lightweight, availability and easy to work with it. The Vero board was then inserted into the constructed casing so as to avoid short-circuiting. The switches were firmly fixed at various appropriate points on the casing.

4.4 PRECAUTIONS

Several precautions were taken in putting together this project. This was done to ensure the system working well with components not damaged in the process of construction so as to maintain a low cost of construction.

4.4.1 SOME OF THIS PRECAUTUION ARE

1. The circuit diagram was followed during the breadboard and Vero board stages of the construction.

2. The values of the circuit components were ensured to be very closed to their calculated values.

3. The correct polarity of the components "Ics" used were correctly ascertained before soldering so as to prevent internal damages that may be caused to them

4. Conduction substances that could bridge the legs of the IC's were kept away from the immediate working table during soldering.

5. Proper soldering techniques were applied – stray solders were carefully removed to avoid short-circuits. High grade soldering lead was used with IC sockets so as to reduce ICs damage when heat of the soldering was high.

6.Shielded cables were used to shield the Microphone .this is very important as non shielded wire would pickup a lot of main hum that can overload U1 due to its high gain.

4.5 TESTING

Most of the testing had been performing before construction i.e. bread boarding, measurement of the components value such as capacitor, resistors etc. During construction, the output of each stage was monitored and the final stage of testing was done when the project had finally been completed.

4.6 RESULTS

Measurement taken at different stages

1. The D.C Voltage at the Microphone with a 9 V supply is 4.80 V
2. The DC voltage at pin 6 of U 2 is 03.9mV
3. The DC voltage at pin 6 of U5 with the volume control down is 4.19 V and with the volume control turned fully on it continuously changes between 4.07 V and 4.22V.

4.6 Problems Encountered

Several problems were encountered during the project. The problems range from design problems to implementation problems and also construction problems. The major problems are as follows:

1. Operational Amplifier are noisy ICs (Integrated Circuit).This limits the amplification stages and also can generated noise within it self.
2. Getting a cone (stethoscope head) that will exactly fix the MIC making the contact between the MIC and cone not air tight.

PICTURE OF THE CIRCIUT ON THE VERO BOARD

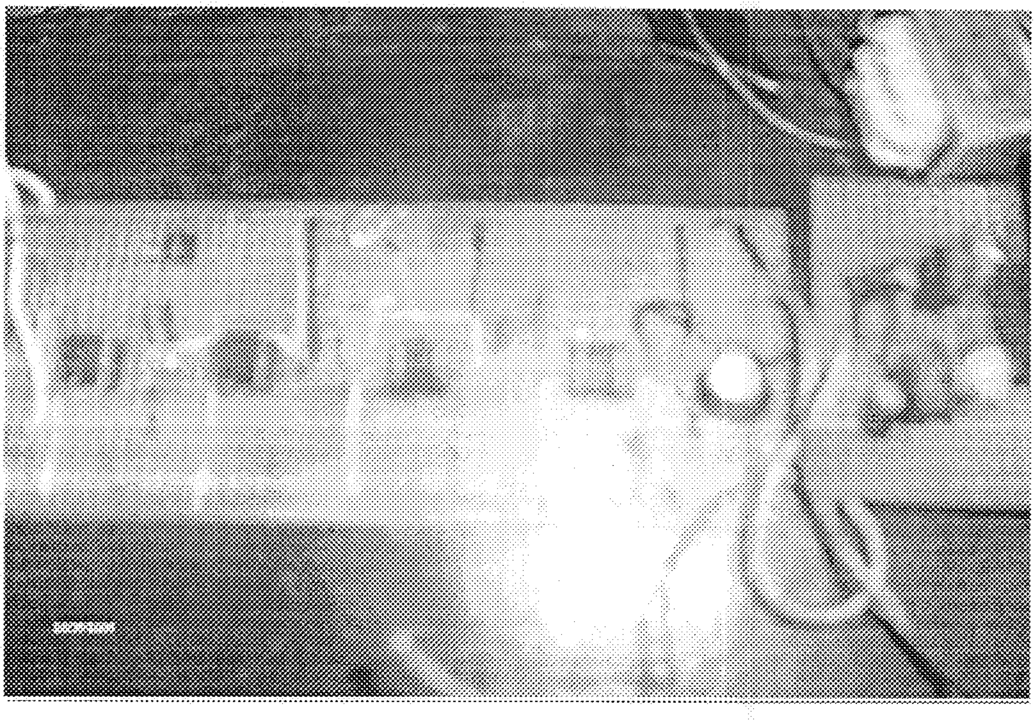


Fig 4.1

CHAPTER FIVE

5.1 CONCLUSION

The electronic stethoscope was designed considering some factors such as economy, availability of components and research materials, efficiency, compatibility and portability and also durability. The performance of the project after test met design specifications.

The general operation of the project and performance is dependent on the user who is prone to human error such as mishandling.

Also the operation is dependent on how well the soldering is done, and the positioning if the components on the Vero-board. Logic elements were soldered away from components that radiate heat especially in the power supply circuit, which might cause overheating and affect the performance of the system.

The construction was done in such a way that it makes maintenance and repairs an easy task and affordable for the user should there be any system breakdown.

The project has really exposed me to digital electronics and practical electronics generally which is one of the major challenges I shall meet in my field now and in future. The design of the digital sequential lighting system involved research in both digital electronics.

The project was quite challenging and tedious but eventually was a success. Also, proper positioning of the components on the Vero board was needed to avoid heat radiation on the IC's which affects the performance of the entire system. Then, the final construction was made for easy maintenance and repairs in the event of fault.

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