DESIGN AND CONSTRUCTION OF DIGITAL STETHOSCOPE

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ATTESTATION

I, *IBRAHIM ALHASSAN KEHINDE*, declare that this work was done by me and has never been presented else where for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

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DEDICATION

This project work is dedicated to Allah for his divine provisions and tolerance.

My parents, Alh. and Mallama Ibrahim Salawu whose parental love remain evergreen and their spiritual guidance abides always. Late Mrs. Baje, whose inspiration is the foundation of my career.

ACKNOWLEDGEMENT

My profound gratitude goes to Allah for his unflinching love, mercy, provision and for seeing me through all odds and obstacles I encountered during the period of my academic endeavour.

Special acknowledgement is gratefully given to my parents who have taken it upon themselves to shoulder all my educational responsibilities. May Almighty Allah in his supreme mercy reward them abundantly.

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I am much indebted to all my departmental lecturers for their enhancement in my academic excellence. I register my deep gratitude to my brothers: Ilyas, Ayuba and my sisters, Zuleihat, Sidikat and Shefinat for their patience, understanding and prayers. Also deserving gratitude is late Mrs. Baje for her love, care and encouragement during this period before her departure.

ABSTRACT

THE Digital Stethoscope circuit consists of condenser microphone which detect the heart beat in one minute. The pulse signal is amplify, filter to attenuate unwanted frequencies and then trigger to convert the pulsating a.c signal into square waves for the counter via the AND gate. The counter count the heart beat and display them on the seven-segment display through the decoder or LED driver. After one minute, the information is held on stored in the segment displays via the decoders and counters, hence, the counter are reset to zero by a push button switch in starting a new count sequence.

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CHAPTER ONE: INTRODUCTION

1.1 DIGITAL STETHOSCOPE

Stethoscope in general, is an acoustic medical device for listening to the internal sounds of an animal body. It is often used to listen to heart sounds or blood flow in arteries and veins. It could also be used to check scientific vacuum chambers for leaks and for various other small-scale acoustic monitoring tasks.

The stethoscope was first invented in France in 1816 by Rene-Theophile-Hyacinthe Laennec at the Neckerentants maladies Hospital in Paris. [1] This devices operate in the transmission of sound from the chest piece, a diaghragm, via air-filled hollow tubes, to the listener's ears.

For the fact that the device is used by a trained professionals (Doctors, Nurses, Paramedics, Emergency medical technicians and other associated personnel) which all depend on the accuracy or inaccuracy of human measurement and needs to be done with maximum concentration.

This work (Digital Stethoscope) becomes important in this regard as it detects and displays the heart beat and beats per minute digitally. This stethoscope requires conversion of acoustic sound waves to electrical signals which can then be amplified and processed for optical listening. Unlike the former ones, which are all based in the same physics (purely mechanical forms) transducers are used in latter ones which made them to vary well.

1.2 AIMS AND OBJECTIVES

The project aims at measuring/detecting the heart beat and beats per minutes (i.e. Heart Rate Detection) in our hospitals, clinics or emergency cases and automatically obtain a digital display of the information.

It also aims at Detecting Heart Defects such as: Murmur, Regurgitation, Septal Defects, Mitral Value Pmlapse, Stenosis and others from the result obtained in the digital display.

1.3 RELEVANCE OF THE PROJECT

In our hospitals where the conventional stethoscope detect heart beats in mechanical firm or in analogue firm. This device when designed will detect the hearts beat and beats per minute and automatically display the information.

Since the firmer depends on the accuracy in inaccuracy of human measurement, the need for an automated system to be put in place to detect this unwanted situation should not be over emphasized.

1.4 METHODOLOGY

The digital stethoscope system in its scope detect and displays the heart beat and beat per minute. The first part of the system is the acquisition unit, which basically consists of an actual stethoscope mounted with a microphone and an amplifier circuit. The microphone captures the audible signal from the body. This signal is passed to the pre-amplifier section for amplification, since the detected pulsating signal is usually small. The amplified signal is then passed to the low-pass filter to attenuate unwanted frequencies, after which, the low frequency signal is then passed to the schmitt's trigger to convert the pulsating a.c. signal into square waves signal for the counter through the AND – gate.

Meanwhile, before counting commences, the 555 timer in monostable mode is triggered by resistors, capacitors and a transistor network and its timing components (a resistor and a capacitor network) by pressing a push button switch. Hence, for a minute, the counter count the heart beats and display the results on the seven-segment displays via the decoder or LED driver.

After a minute, the information is held or stored in the segment displayed via the decoders and counters. The counters are then reset to zeros by a push button switch when staring a new count sequence.

1.5 SAFETY ENFORCEMENT AND INTERFERENCE

Safety is one of the paramount assignment of a staff in an engineering out-fit. In this project design, the safety enforcement and interference is put into consideration. The design is inherently safe for several reasons:

- The only contact of the device with the user is the end piece of the stethoscope (i.e. microphone) placed against the neck or chest.
- For the construction of this project, high voltage or current is not required in the circuit. Hence for any accidental exposure of conducting wire, it will have little or no effect to the user.

CHAPTER TWO: THEORETICAL BACK GROUND

2.1 LITERATURE REVIEW

An electronic stethoscope (or stethophone) overcomes the low sound levels encounter in the early type of stethoscope by electrically amplifying body sounds. This kind of stethoscope falls into different categories, those concerned with signal enhancement, those with both visual and audio out put and those with a recording device. The letter comprising a vibration transducer, an amplifier, a headphone arrangement, a pre-emphasis filter means for emphasizing high frequencies, a schmitt's trigger circuit which converts sinuosoidal signal to a square which is used as a clock input to the counter section, a decoder and a seven segment display of which this project falls into the former groups, like those concerned with signal enhancement required earpieces in which different sound signal are sent to each of left and right ears of a user and those with both visual and audio output displays its information in a television or an oscilloscope. All these are inefficient because the accuracy still depend on the human measurement.

To over come these problems, this project intend to provide a solution using a digital electronic circuit that would display the count of the heart beats and beats per minute and stored it.

Digital electronic circuits can be thought of as a circuit that handle only high and low signals. These circuits are required when data must be stored, used for calculation or displayed as numbers and/or letters as in the case of this project. They are mostly appearing as a discrete or integrated circuits (ICS)

2.2 ELECTRONIC COMPONENTS AND CIRCUIT RELEVANCE

Electronic circuits are made up of electronic components. Electronic components are categorized as discrete or integrated circuits (ICS). Integrated circuits are subdivided into small scale integrations (SSI). Medium scale integration (SLSI) which is popularly known as microprocessors.

For effective circuitry design, adequate knowledge of electronic components is necessary. Consequently, this section of the project text is concerned with reviewing the electronic components use in this project design.

2.2.1 Resistor

A resistor is an electronic component that limits the flow of current in an electric circuit. Various types as well as sizes are available commercially. The different types of resistors are: the fixed value resistors and the variable resistors. The four common types of fixed resistor are shown in the table below.

Resistor Type	Values	Tolerance	Power Rating	Stability
Solid Carbon	1 – 10MΩ	± 10%	0.125-1w	Fair
Carbon Film	1 – 10MΩ	±5%	0.125-13	Good
Metal (oxide) film	1 – 10MΩ	±1%, 2%	0.125-3w	Very Good
Wire wound	0.1-25kl	±1%	1 – 50w	Good

Table 2.1. Common Types of fixed Resistor.

The resistance of a resistor is measured in ohms (Ω) and the symbols for the different forms of resistors are shown in figure 2.1.

Fig. 2.1. Resistor symbols (a) Fixed, (b) Variable

Resistor values could either be inscribe in its colour codes (bands) could be used. This system uses four colour bands. Three of the bands are closely spaced which shows the resistance value while one fourth band is often gold or silver (though other exist like red, brown and blacks) is the tolerance. The table 2.2 below shows the colour code of a resistor and its correspond bands values.

Colour	1st Digit	2nd Digit	Multiplier	Tolerance
Black	0	0	10^0	-
Brown	1	1	10^1	±1%
Red	2	2	10^2	±2%
Orange	3	3	10^3	-
Yellow	4	4	10^4	-
Green	5	5	10^5	-
Blue	6	6	10^6	-
Violet (mauve)	7	7	10^7	-
Grey	8	8	-	-
White	9	9	-	-
Gold	-	-	10^{-1}	±5%
Silver	-	-	10^{-2}	±10%
No Colour	-	-	-	±20%

Table 2.2 Colour Code for Resistors

Resistors play vital role in electronic circuits, they are used with active devices like in amplifiers or rectifier devices, with capacitor to establish time instant and also in voltage dividers. Wire-wound resistors of very close tolerance are used in measuring equipment while variable resistors or potentiometers are used as volume controls in radio and television sets.

Resistors can be arranged either in series or in parallel depending in the circuit in which it is being used.

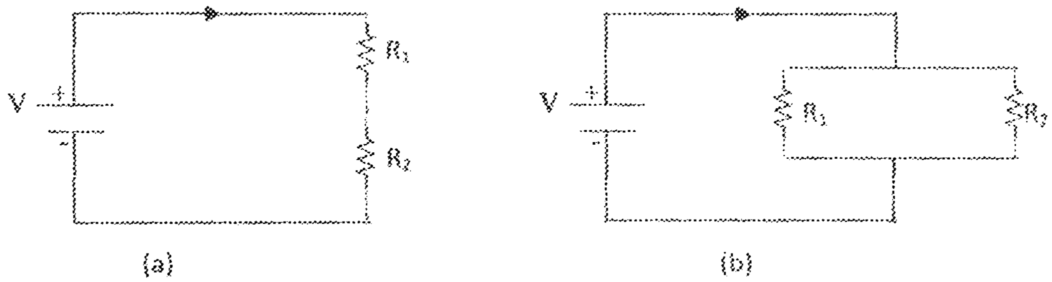


Fig. 2.2 Arrangement of Resistors (a) in series (b) in parallel.

For resistors in series, current flow through is the same and the value of its combined resistor is calculated as:

$$R_{Total} = R_1 + R_2$$

For resistors in parallel, the voltage is the same and its combined value is calculated as:

$$R_{Total} = \frac{R_1 + R_2}{R_1 + R_2}$$

2.2.2 Capacitors

These are electronic components that have the ability of storing energy in form of electric field. Their ability to store or absorb electricity is called capacitance and it is measured in farads (f) with other units as microfarad (µf), nano farads (nf), etc.

The discharging and charging characteristics was used in building oscillators while its smoothening ability is explored in filtering ripples from the rectified A.C. in the power supply unit. An ideal capacitor presents infinite reactance to d.c. current and negligible reactance at high frequencies, while a coupling capacitor is connected in series with a resistor to block the direct current (DC), a decoupling capacitor is connected in parallel with a resistor to provide a low reactance path to a.c. at the relevant frequencies without affecting the d.c conditions.

Various types of capacitors are available commercially and the six common types of fixed capacitor is shown in table 2.3 below:

Capacitor Type	Values	Tolerance	Working voltage	Leakage current
Ceramic	10pf - 1µf	±10%	300v	High
Mica	1pf - 10µf	±2%	500v	Low
Polysterence	1pf – 22nf	±5%	300v	Low
Aluminum Electrolytic	Up to 100,000µf	±50%	3v-100v	High
Tantalum Electrolytic	Up to 100µf	±20%	Gv-600v	Fairly high
Polyester	10nf - 10µf	±20%	300v	Low

Table 2.3 Common types of fixed capacitor

Except for the electrolytic and large type of capacitor which usually have its values being printed in them. Most of the smaller capacitors values are in colour code as in the case of resistor. The first four bands are the same as for resistors while the last fifth band indicates the voltage rating or working voltage i.e. the maximum d.c voltage that can be applied between the plates of the capacitor without breaking the dielectric insulating material.

The formula to calculate the amount of capacitance of capacitor is given as:

$$Q = cv$$

Where Q – charge in coulombs (c)

C – capacitance in farad (f)

V – voltage in volts (v)

When a charge is stored, the amount of energy is thus

$$W = ½ cv^2$$

Where W - Energy stored in Joule s (j) capacitors can be arranged in series or in parallel as shown in fig 2.3.

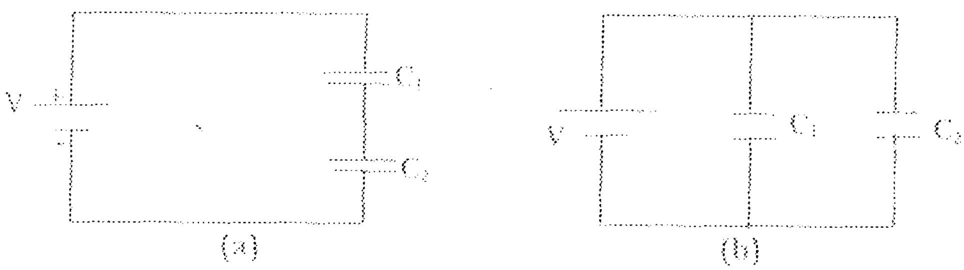


Fig 2.3 Arrangement of capacitors (a) in series (b) in parallel for capacitors in series, the equipment capacitance C is given as:

$$C = C_1 + C_2$$

2.2.3 Diodes

The diodes is a semi conductor devices that allows the flow of current in only one direction. They are made from both n-type and p-types depending on the semiconductor materials used. The diode can be classified as silicon nr germanium diodes. Diodes types include power diodes used mainly for rectification, zener diode used for voltage stabilization, fast switching or signal diode for signal channeling.

Other types of diode have the ability of emitting light when current flows through them. These are the light emitting diodes (LEDs). These are used in assembling all the seven segment displays. Pictorial sketch of power, zener and LEDs as well as their symbols are shown in fig 2.4.

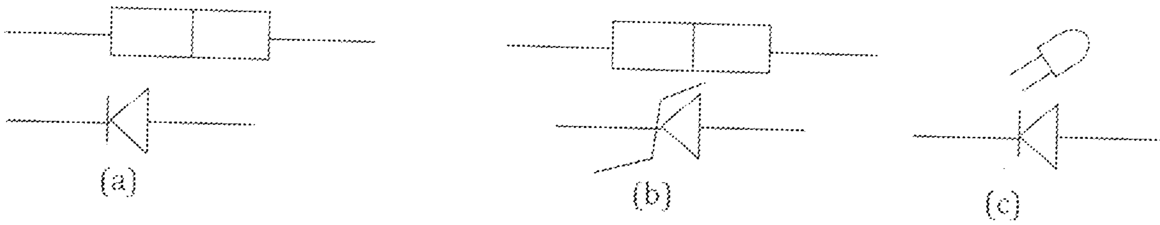


Fig. 2.4. Diode types and symbols (a) power diode (b) zener diode (c) light emitting diode.

2.2.4 Transistors

A transistors is a controllable semi conductor devices. They are active devices since that they can deliver power to a load. There are two types of construction, PNP and NPN.

Transistors are generally used in circuits for amplification of signal and to switch on/off various circuits. There are two basic types of transistors. Bipolar junction transistor (BJT) and field-effect transistor (FET).

The bipolar junction transistor (BJT) is a three (3) terminal device. The terminals are called emitter (E) base (B) and collector (C). A BJT has two P.N junction in the same crystal. The collector base junction (CBJ) and the base-emitter junction (BEJ). There are three possible configuration; common base (CB), common emitter (CE) and common-collector (CC) i.e. emitter flower. The BJT has three mode (or region) of operation, the cut off active (normal) and saturation region.

2.2.4.1 Transistor as an Amplifier

In the active region, the transistor acts as an amplifier and a linear relationship exist between collector and base currents. The CBJ is reverse biased while the BEJ is usually way of connecting a transistor amplifier is CE configuration while provide both current and voltage gain and therefore a best power gain. But if high input resistance (or low output resistance) is required, the CC configuration is employed and for best frequency performance CB configuration is employed.

Figure 2.5 below shows the configuration of NPN transistor as an amplifier.

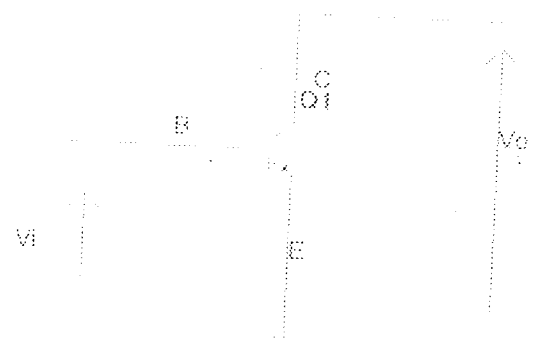


Fig. 2.5 A transistor as an amplifier

2.2.4.2 Transistor as a switch

Transistor can be used as an electronic switch in a circuit when it is constrained to operate between cut-off and saturation region. In the cut-off region, both junction are revised biased. The transistor will be off because the base current is not large enough to turn it on. In the saturation region, both junction are forward biased. The base current is relatively high and the collector-emitter voltage drop (Vce) is low.

2.3 555 Timer

The 555 timer is one of the most popular and versatile integrated circuits ever produced. It includes 23 transistors, 2 diodes and 16 resistors in a silicon chip installed in 8-pin mini dual-in-line package. The 8 pin 555 timer is used in many projects with just a few external components. It can be used to build many circuit not all of them involve timing. The pin configuration of 555 timer is shown in fig 2.6 below

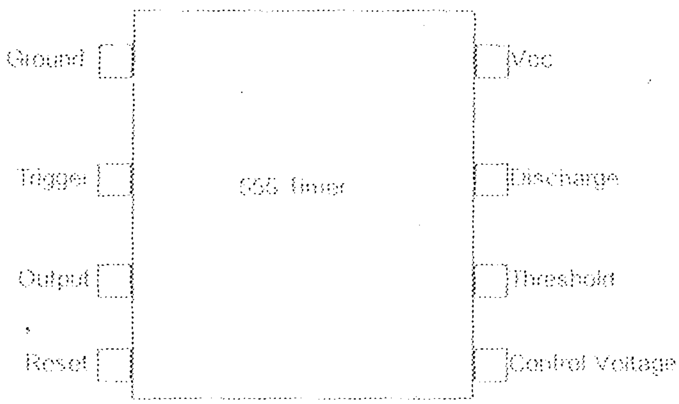


Fig 2.6 pin configuration of 555 timer

2.3.1 Operational mode of the 555 Timer

The 555 timer has two basic operational modes namely: Monostable multivibration and a stable multivibrator. A monostable multivibrator is said to have a single stable state that is the off-state. Whenever it is triggered by an input pulse, the monostable switches to temporary state. It remains in that state for a period of time determined by the rc network. It then return to its stable state.
The other basic operational mode of the 555 timer, a state multivibrator is simply an oscillator. It generates a continuous stream of rectangular off-inpulses that switch between two voltage levels. The frequency of the pulses and their duty cycle are dependent upon the RC network values. Other mode of operational of the 555 timer are bi-stable (flip-flop) which have two stable states and as inverting buffer (Schmitt trigger) in which the output logic state is the inverse of the input state.

2.3.2 Definition of Pin Functions

Pin 1 (Ground). The ground (or common) pin is one most negative supply potential of the device which is normally connected to the circuit common when operated from positive supply voltage.

Pin 2 (trigger): is the input of the lower comparator and is used to set the latch which is turn causes the output to go high. This is the beginning of the timing sequence in monostable operation.

Pin 3 (output): This is the output of the 555 timer. The output of a standard 555 can sink and source up to 200MA. The output does not quite reach 0V or Vcc in the low and high state respectively.

Pin 4 (Reset): this pin is also used to reset the latch and return the output to a low state. The reset voltage threshold level is 0.7v and a sink current of 0.1MA from this required to reset the device.

Pin 5 (control voltage): This pin allows direct access to the 2/3 +VCC voltage-divider point the reference level for the upper comparator. It also gives direct access to the lower comparator. The control input can used to adjust the threshold voltage which is internally set 2/3 +vcc. Usually this function is not required and the control input is connected to 0V with a 0.01NF.

Pin 6 (Threshold): It is one of the input to the upper comparator and used to reset the latch which causes the output to go low. It monitors the charging of the timing comparator of the a stable and mino stable circuits. It has a high input impedance > 10M

Pin 7 (Discharge): this pin is not an input, it is connected to the open collector of a npn transistor. the emitter of which goes to ground, so that when the transistor is turned "on", pin 7 effectively shorted to ground.

Pin 8(+Vcc): The Vcc is the positive supply voltage terminal of the 555 timer IC. The supply-voltage operating range for the 555 is + 4.5V to 16V.

2.4 COUNTERS

A counter can be described as a tallying device that tallies, or counts some number of events. An electronic counters needs that data be converted into electric pulse, each of which represents one bit of information. These pulse are

In case of a synchronous counter all the flip-flops are clocked simultaneously.

2.5 Decoder

Decoder is a code translator that translate 8421 BCD code to a seven-segment display code that lights the proper segments on the display. Decoding is necessary in application such as data demultiplexing, seven-segment display, memory address decoding. A decoder circuit takes information presented in one form and convert into another form.

There are different kind of decoder; these are decoder that convert binary numbers into BCD or BCD number into binary; some other ones convert BCD numbers into grey code. A common decoder circuit takes a BCD digit and converts into suitable driving signals for the seven segment LED display.

2.6 Seven Segment Display

Seven-segment display is a form of electronic display device for displaying decimal numerals. A seven-segment display as its name indicates, is composed of seven elements and each segment in the display is a LED. By forward biasing selected combinations of segment, any decimal digit and a decimal point can be formed. The display may have 7, 8 or 9 leads on the chip. Usually, leads 8 and 9 are decimal points. The LED segment arrangement is shown in fig. 2.7 below.

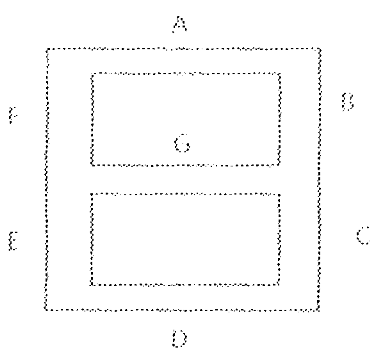


Fig. 2.7 LED Arrangement of seven-segment display

2.7 Block diagram of the System

This project, aimed to detect and display the heart beat and beat per minute in our hospitals, clinics is implemented on a circuit board in eleven (11) main modules which includes:

* Power supply stage
* Condenser microphone biasing unit
* Pre-amplifier unit
* Low pass filter unit
* Voltage follower unit
* Schmitt's trigger unit
* Gating unit
* Termer unit
* Counter unit
* Seven-segment display unit.

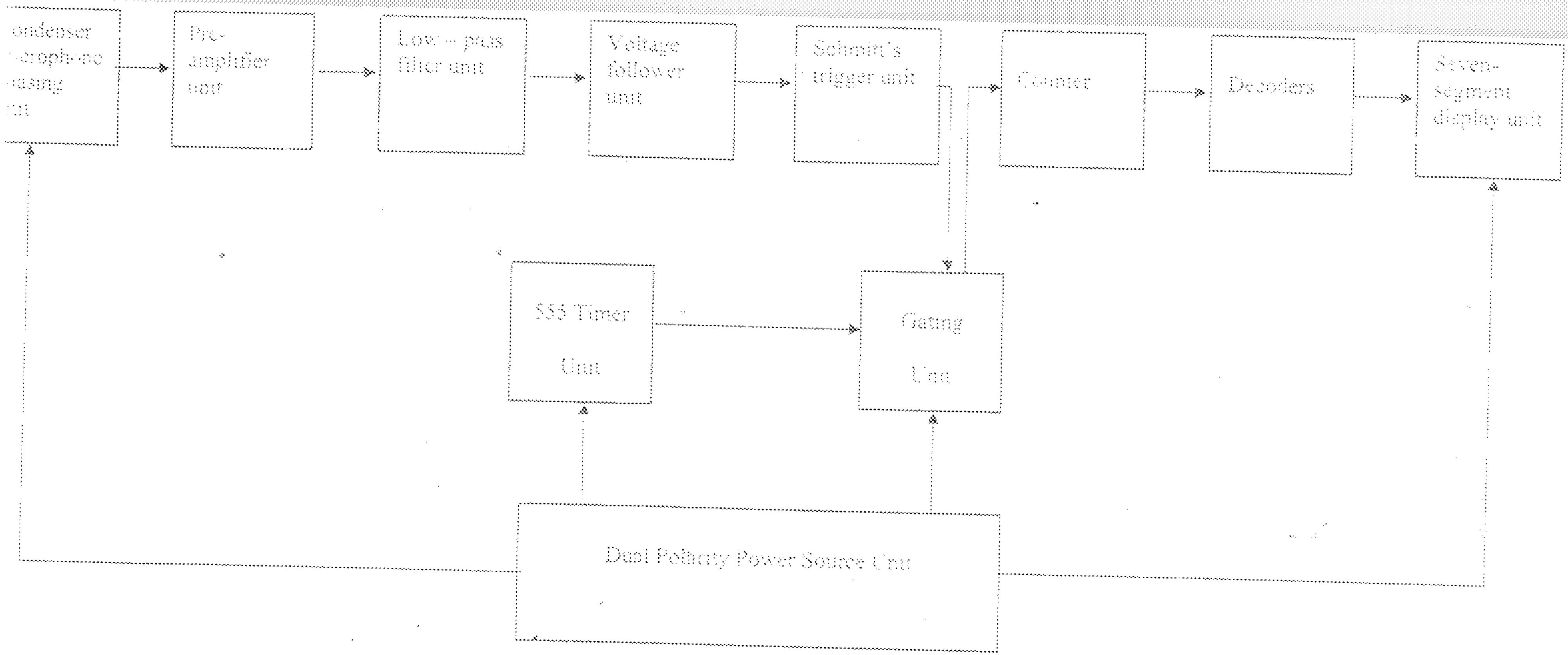


Fig. 2.8 Schematic Block Diagram of Digital Stethoscope

CHAPTER THREE: DESIGN AND IMPLEMENTATION

3.1 INTRODUCTION

This chapter is based on designing the digital stethoscope including the winking principles and detailed analysis of block diagram as shown in figure 2.8 in previous chapter.

3.2 POWER SUPPLY UNIT

This project was designed to be powered by two 9v alkaline dry cell batteries. This is because the LM 741CN requires positive and negative supply voltage in the range of ± 4.5v to ± 18v (from its data sheet). Hence, the needs to settle for a (±9v) mid range value if we are to design with a safety factor of 2.

To obtain ±9v value, we connect two 9v batteries in series and tap the centre to be referred as the ground. The circuit schematic diagram is shown in figure 3.1 below.

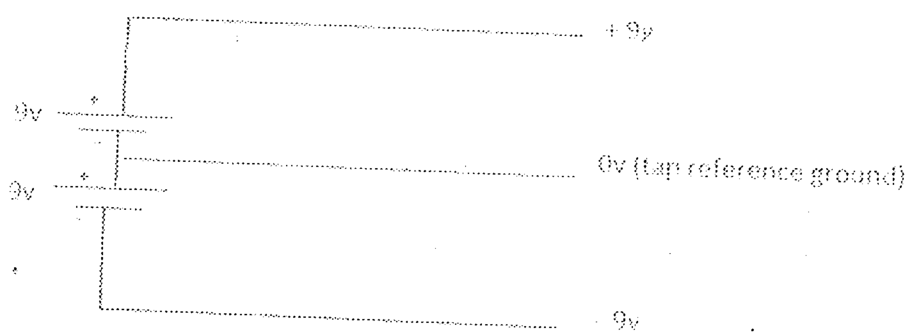


Fig. 3.1 Dual Polarity power source.

3.3 CONDENSER MICROPHONE BIASING UNIT

The condenser microphone used in this project is a very sensitive electric condenser microphone of model No. XF180. This microphone requires a constant current source of 2 - 20MA. But, the current needed to bias the microphone is about 1.2MA. adopting a safety factor of 2 in the design, a current of 0.9 – 1.0 mA was taken from a 9v constant voltage supply obtained from 1000μf capacitors.

$$R_1 = \frac{9v}{0.9mA} = 10k\Omega$$

Hence, the current requirement of the microphone is obtained through a 10KΩ resistor. This is used to bias the FET inside the electric Microphone which has a high output impedance. C. is chosen to be 470μf to block the d.c. in the circuit as shown in figure 3.2 below.

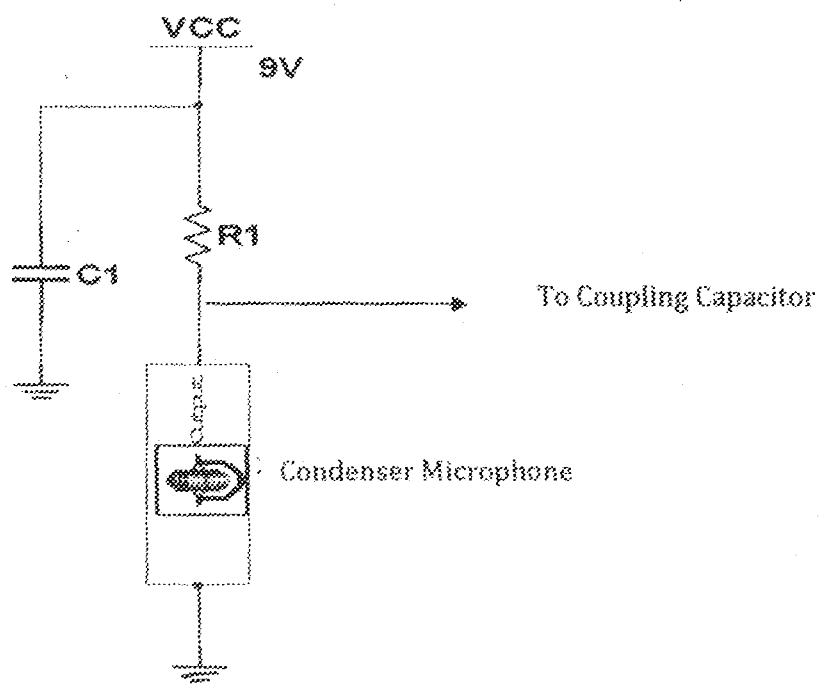


Fig. 3.2 Condenser Microphone

The condenser microphone and the 10kΩ resistor firms a voltage divider/network that is balanced in the absence of sound pressure impinge on the condenser microphone diagram. As sound pressure iminges on its diagram, its capacitance varies slightly; hence node A experience a fluctuation. It then generates a varying voltage between 1 to 3MV which is coupled through a DC blocking capacitor to the pre-amplifier stage.

3.4 PRE-AMPLIFIER UNIT

The signal from the electric microphone is coupled into an operational amplifier which processes the generated input signal. The choice of the amplifier is important in considering the desired performance of the entire system. To implement this stage of the project a LM741 CN low noice dual operational amplifier is chosen as the integrated circuit. The device requires a low supply current and yet maintains a large band width product and a fast slow rate. The varying voltage of 1 to 3MV is fed through a coupling capacitor (to block DC compliment of 4.5v) to the pre-amplifier as shown in figure 3.3 below.

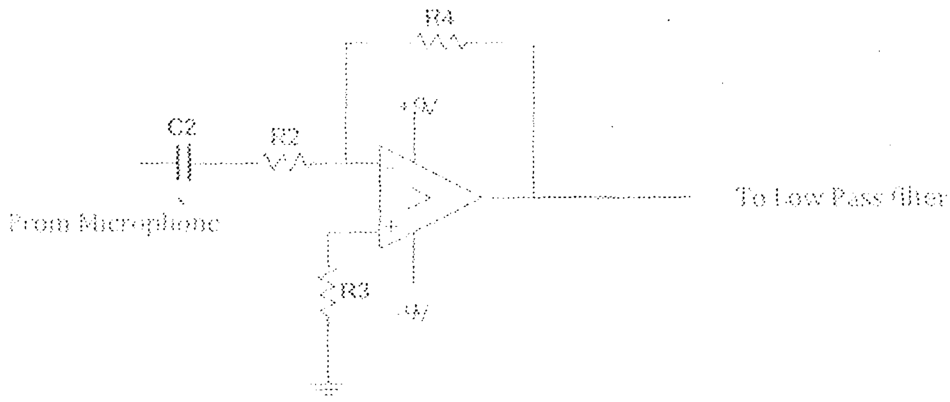


Fig. 3.3 Pre-amplified unit

Care was taken not to have a very large gain at this stage to prevent noise from being amplified too much. Assuming a gain of 50 (33.98dB): using op-amp as an inverting amplifier and taking $R_2 = 2.2k\Omega$ arbitrarily, then.

$R_4 = 2.2k \times 50 = 110k\Omega$

taken $100k\Omega$ for R_4 (closest possible value) gain of pre-amplifier (A) is:

$$A = \frac{R_4}{R_7} = \frac{100}{2.2} = 45.45$$

also, taken R_3 to be 2.2kΩ to minimize the effect of input off set current. But the unity gain frequency of the LM 741C is 1MHZ, so the closed loop gain band width of the pre-amplifier stage is:

$$= \frac{1 \times 10^6}{45.45} \approx 22k\,Hz$$

With this gain, we can amplify a signal whose frequency is up to 22KHz since audible range is from 20Hz – 720KHZ.

Also, C_2 (0.047μf) and R_7 (2.2kΩ) from a low pass network with a cut – off frequency of:

$$Fc = \frac{1}{2\pi RC}$$

$$= \frac{1}{2\pi 2200 \times 0.047 \times 10^{-6}}$$

$$= 1539.2HZ$$

$$\approx 1.54KHZ$$

With this frequency, our pre-amplifier stage will get signal whose frequency will not exceed 1540HZ, Hence, it can support a closed loop gain of

$$\frac{1 \times 10^6}{1540} \approx 650$$

3.5 LOW PASS FILTER UNIT

The frequency of the heart beat is between 1 – 100Hz and the most audible is from within 20 – 60Hz. Hence trying to amplify a frequency above 100Hz could be of no use. Hence, the cut – off frequency of the pre – amplifier stage that was

1540 Hz was sufficient to have allowed our usual signal to pass through before alternating the frequencies that are far higher than 1540Hz. Hence, for the filter unit, a Butter worth filter was chosen because it has a smooth pass band and moderate roll – off.

Now, for the low - pass filter unit, sallen and key filter was chosen because of the importance of gain accuracy and least number of pole pair. Also, we intend that the filter should act as some kind of buffer as shown in figure 3.4 below.

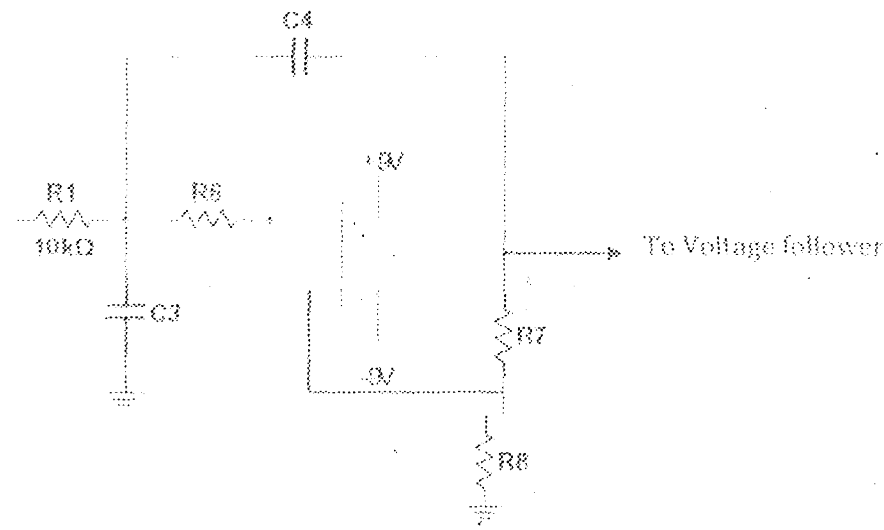


Fig. 3.4 Low-pass filter unit

Taking a gain of 1.6, to reduce sensitivity, components tolerances as well as circuit complexity which still maintaining accuracy and reliability with cut-off frequency fc ≃ 100Hz and $C_3 = C_4 \quad = \quad 0.47\mu f$

$$Fc \quad = \quad \frac{1}{2\pi RC}$$

Where $R = R_2 = R_6 = R_7$

Thus, $\quad R = \quad \frac{1}{2\pi fcC}$

$$= \frac{1}{2\pi \times 100 \times 0.047 \times 10^{-6}}$$

$$\simeq 33k\Omega$$

Hence, 33kΩ was chosen.

Recall,

For a non - inverting amplifier

$$\text{Gain (A)} = 1 + \frac{R_7}{R_8}$$

$$1.6 = 1 + \frac{33{,}000}{R_8}$$

$$R_8 = \frac{33{,}000}{1.6 - 1}$$

$$= 55k\Omega$$

R_8 = 56kΩ was chose based on 5% tolerance. Two capacitors, $C_3 = C_4 = 0.047\mu f$, was used because it is a low pass second under Butter worth sallen and key.

3.6 VOLTAGE FOLLOWER UNIT

The signal output from the low pass filter unit is fed to the voltage follower. The voltage follower is used so that the signal from the low pass filter can be maximally coupled to the schmitt's trigger circuit. This is achieved because the voltage follower has theoretically infinite input impedance and zero out put impedance. However, this may not be achieved practically. The circuit diagram is shown in figure 3.5 below.

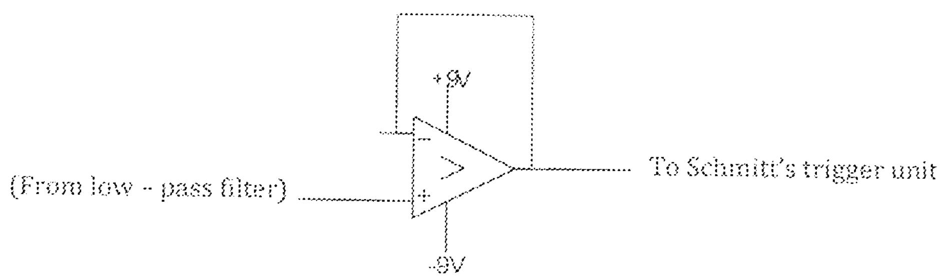


Fig. 3.5 Voltage follower circuit

3.7 SCHMITT TRIGGER UNIT

Digital circuits prefer wave forms with fast rise and fall times. Sinusoidal wave from signal might lead to unreliable operation if fed directly into counters, gates or other digital circuitry. In this project, a Schmitt trigger inverter is being used to "square up". The input signal and make it more useful. Thus a schmitt's trigger circuit converts sinusoidal signal to a square wave which is used as a clock input to the 2 - bit counter. Its circuitry is shown in fig. 3.6 below

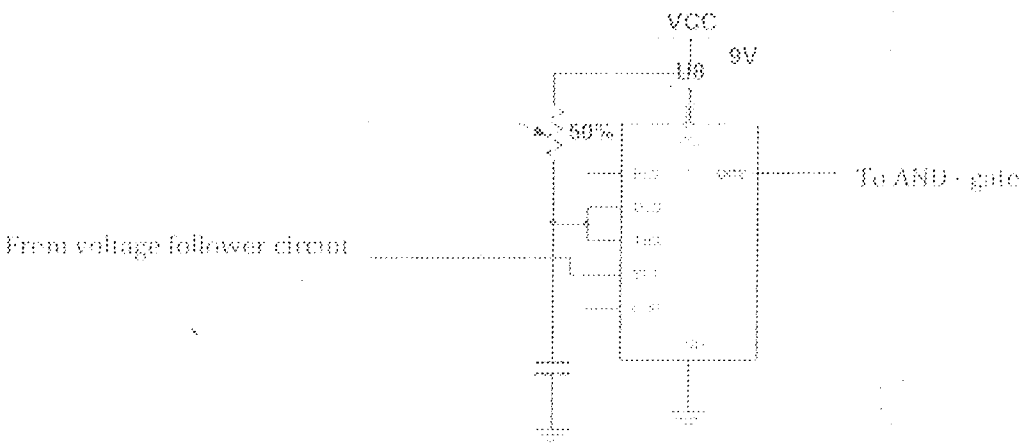


Fig. 3.6. Schmitt's trigger circuit

3.8 GATING SECTION

This unit is easily realized by a two input AND gate as shown in figure 3.7 below.

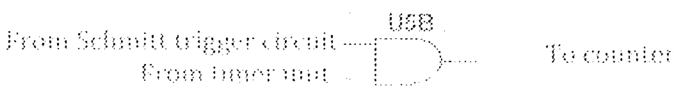


Fig. 3.7 AND gate circuit

3.9 TIMER UNIT

The timer circuit is easily designed by connecting a 555 timer in a monostable mode or one shot mode of operation as shown in fig. 3.8 below.

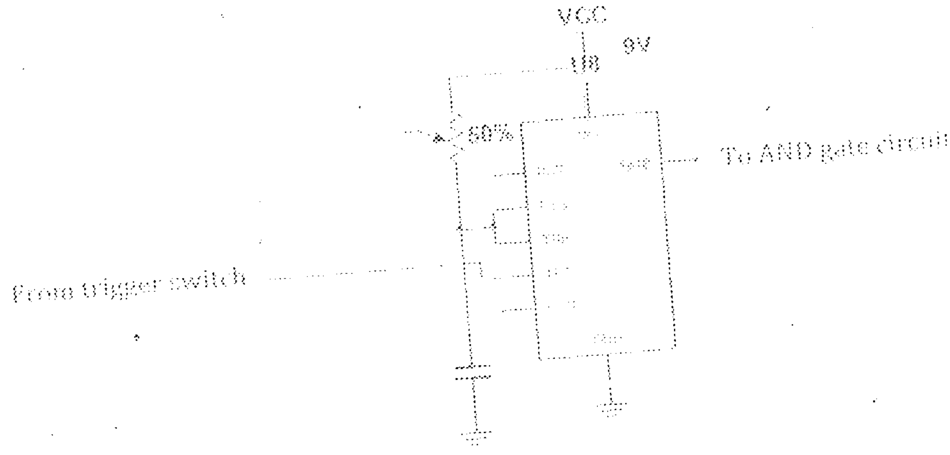


Fig. 3.8 Timer Circuit

Recall for a 555 timer in monostable mode of operation that:

T_{high} is the time taken for its input (pin 3) to go high.

With C_1 = 100μf and t_{high} = 1min = 60 sec.

$$R = \frac{t_{high}}{1.1 \times C} = \frac{60}{100 \times 10^{-6} \times 1.1}$$

$$= 545k\Omega$$

1MΩ variable resistor was used and set at 550kΩ approximately.

3.10 COUNTER UNIT

This unit achieved by using also two CMOS Synchronous IC counters (CD4029) as shown in fig 3.9 below.

3.11 DECODER SECTION

This unit is achieved by using also two CMOS decoder ICs for seven segment display (CD4511) as shown in fig 3.9 below.

3.12 SEVEN SEGMENT DISPLAY UNIT

The display unit consists of two common cathode seven segment that display the information being decoded by the two CMOS decoder as shown in fig. 3.9 below.

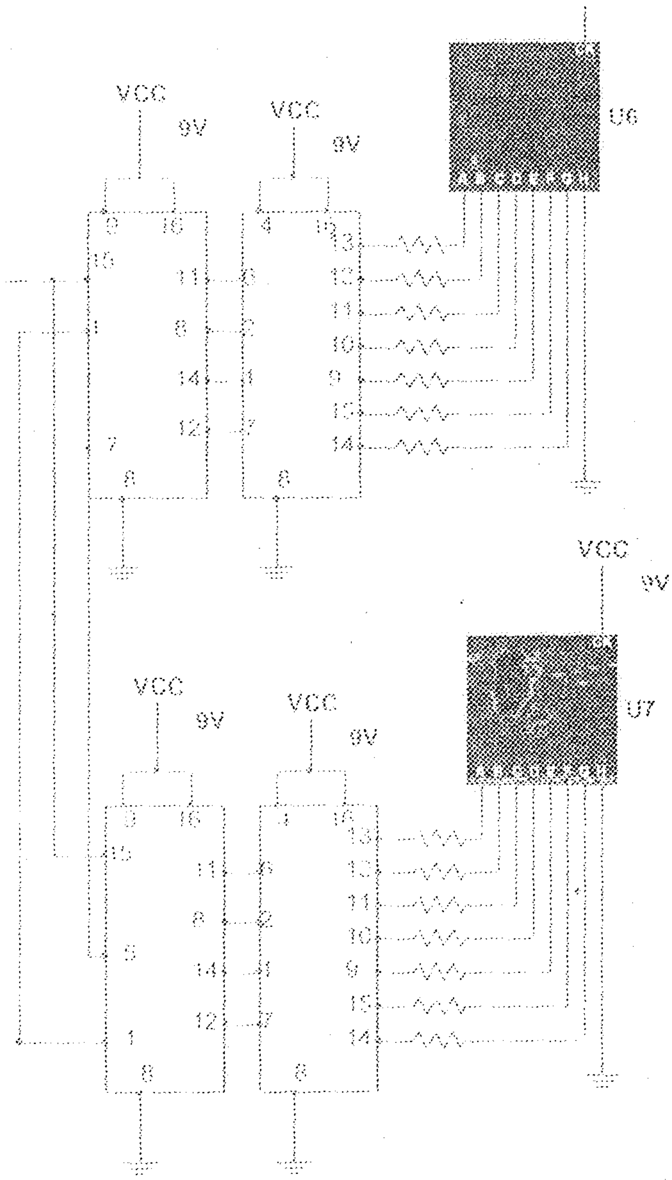


Fig. 3.9 Counter, Decoder and Display Circuit

For the seven segment,

$V_d = 1.2v$ (from data book)

Source voltage $(V_s) = 9v$

$I_d = 25mA$

Recall, $R = \frac{V_s - V_d}{I_d}$

Where R is the current limiting resistor i.e. $(R_5 - R_{21})$

$\therefore \quad R = \frac{9 - 1.2}{25 \times 10^{-3}} = 312\Omega$

330Ω was chosen for $(R_5 - R_{21})$ R, since it is the closet possible value.

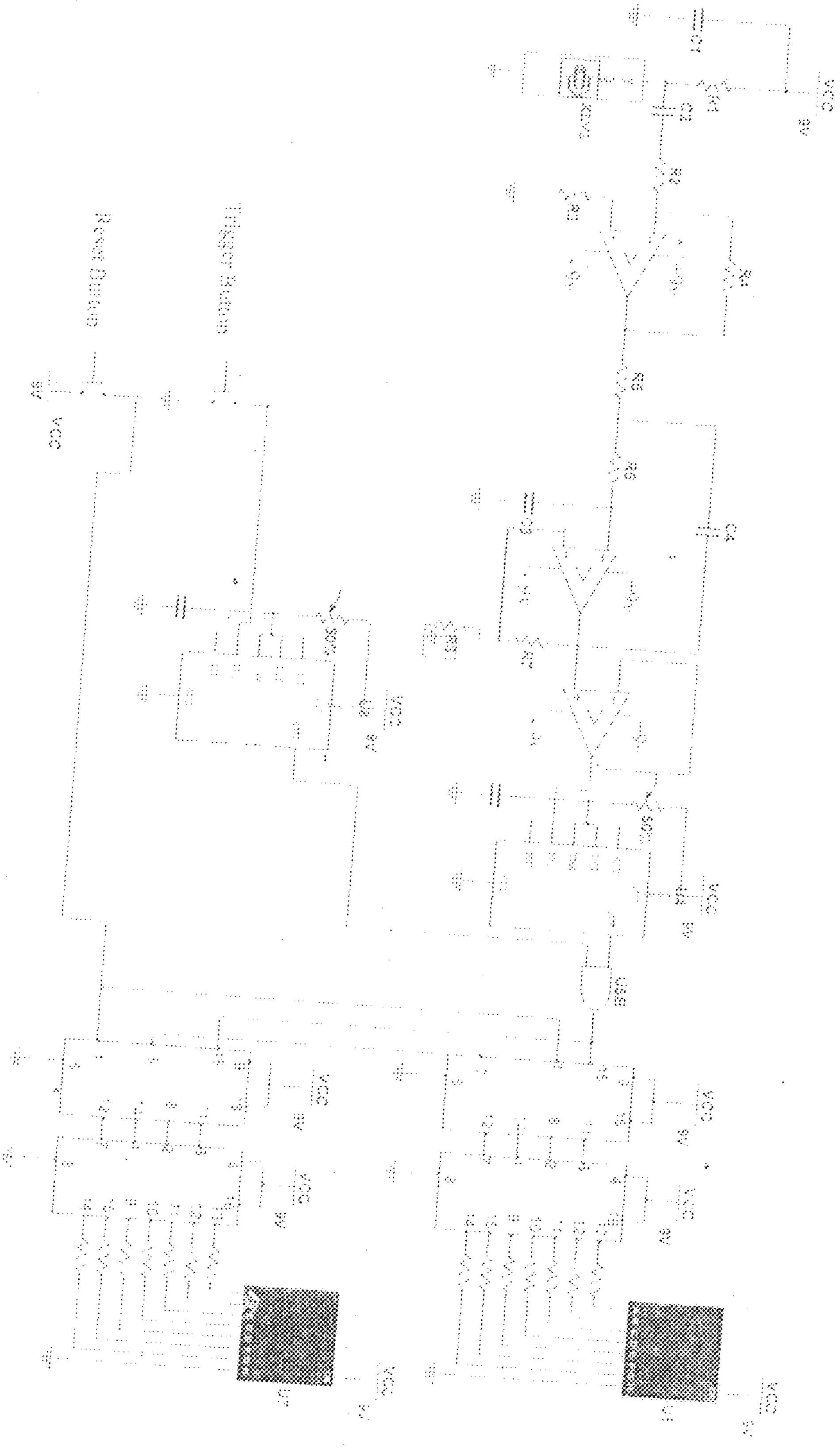
3.13 OPERATIONAL DESCRIPTION OF THE DIGITAL STETHOSCOPE

When power is supplied to the circuit from the dual polarity power source and the condenser microphone brought close to the heart (particularly the left chamber), the microphone starts detecting the heart beat or sound for one minutes and this signal is passed to the pre-amplifier unit for amplification (since the detected pulsating signal is usually small). The amplifier signal is then passed to the low-pass filter to attenuate unwanted frequencies. After which the low frequency signal (say, 100Hz) is then passed to the schmitt's trigger to convert the pulsating a.c. signals into square waves for the counter via the AND – gate.

Mean while, before counting starts, the 555 timer in monostable mode is triggered by pressing a push button switch (i.e. trigger switch). Hence, for one minutes, the counters count the heart beats and display them on the seven segment displays via the decoder or LED driver.

After one minutes, the information is held or stored on the segment display via the counters and decoders, hence the counters are reset to zero by a push button switch (i.e. reset Switch) in starting a new count sequence.

3.14 Complete circuit diagram of the digital stethoscope



CHAPTER FOUR

CONSTRUCTION, TESTING AND RESULTS

4.1 CONSTRUCTION

The designed circuit was first built in a bread board after which it was powered and the required outputs were tested. Adjustments were made and the modifications reflected in the design until the design specifications were met.

With the results in the bread board, every component was transferred to the Vero board, which involved soldering of the circuit component using 15w soldering iron and to ensure that the components are not being overheated in the course. Again, the circuit was powered and tested.

4.2 CASING

The casing of the circuit board (Vero board) in which components were soldered to was carried out using white transparent Pvc plastic material in which the seven-segment display, reset switch, power switch are mounted, leaving the sensor uncovered. This prototype design is meant to be a portable device, as such, it warrants the use of a high material to reduce the weight of the device. The dimension of the casing is approximately 27cm x 10cm x 5cm.

4.3 TESTING AND RESULTS

The design when tested confirmed that that microphone was picking up sounds (heart beats) and these sounds signal were amplified and decoded by the seven segments via the decoders and counters.

Further more the seven-segment indicator were realized using LED connection in parallel. Each segment was tested by applying a + 9v battery across the external terminal through an appropriate limiting resistor.

Test	Description of test	IC1	IC2	IC3	IC4	IC5	IC6
1	Voltage between +vcc and ground using a DMM	9.3v	9.30v	9.22v	9.20v	9.14v	9.13v
2	Voltage between – Vcc and ground using a DMM	-9.32v	-9.31v	-9.24v	-9.21v	0v	0v
3	Voltage between –V in and ground	-0.8mv	28.3mv	-5.9mv	-1.0mv	-	-
4	Voltage between V out and ground	2.50mv	0.60mv	0.43mv	1.30mv	8.30v	8.50v

Table 4.1 tests and Results in the digital stethoscope

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The digital stethoscope was designed and implemented in this project. Its gain is enough to amplify the electrical signal generated by the transducer (microphone). The amplified signal (heart beat) was decoded by the seven-segments via the decoders and counters.

The challenging task of this work was the design of the low pass Butter worth filter that minimizes noise or unwanted signal. This could not be achieved due to the use of discrete component. The pre-amplifier stage and main amplifier stage were also implemented using discrete components. Consequently, an excellent amplification was not achieved.

Furthermore, the stethoscope head affects the sensitivity of the stethoscope. Very sensitive stethoscope heads are quite expensive in the market. And point sensitivity of the stethoscope head limits the ability of capturing very small electrical signals.

However, the project to some extent met the set objective, as digital stethoscope was designed which measure the heart could beat and beats per minute.

5.2 RECOMMENDATION

A pressure sensitive transducer is highly recommended to reduce the input noise and thereby enabling the LED to produce a corresponding display out put. The use of precision operational amplifier to replace LM 741c, like AD 624IC is also recommended.

Microcontrollers could also be incorporated for better results and to reduce the number of components used hence the size of the project.

REFERENCES

1. Digital Electronics, http://en.wikipedia.org/wiki/digital-electronic
2. Maivino, "Electronic Principles" sixth edition. Glencoe/mc Graw-Hill, 1999.
3. Be 304 laboratory notes, michingan Technological University www.biomed.mtu.edu.au/osoykan/classes/be304/week3/week3.htm.
4. Bruce carter and Thomas R. Brown "Handbook of operational Amplifier Application". Applications reprint SBOA092A October, 2007.
5. RESQ product inc. RR6 – 1350 Martock ROO, 500ke, B.C Canada Vo5 N0. www.hypothermia.ca.com
6. B.L. Theraja and A.K. Theraja "A text book of electrical technology" revised Edition, 2005.
7. S.A Knight "Electrical and Electronic Principle Third edition 1998.
8. Lyide F. Coombs, J.R "Basic Electronic Instrument Measurement Hand Book" Hewlett Packard Singapore Ltd, 1994.
9. Texas Instrument Inc. USA www.datasheet.com
10. B.L Gupta and Kumar "Handbook of Electronics revised edition, 2000.