DESIGN OF CLAP SWITCH DEVICE

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DESIGN OFCLAP SWITCH DEVICE

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by

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Declaration

We, Kambale Kamate and Mohamed Hassan Jama, hereby affirm that this work was done by us and has never been presented anywhere else for the award of a degree.

....   **...**

Kambale Kamate   **Mohamed Hassan Jama**

Approval

It is certified that the work contained in the project titled "design of clap switch device" by Kambale Kamate BSTC/34945/122/DU and Mohamed Hassan Jama BSTC/36056/122/DF has been carried out under my supervision and that this work has not been submitted elsewhere for a degree final project.

Head of the Department	Project Supervisor
Mr. Nelson Njubo	**Mr. Pak Hyon Jun**

Dedication

We dedicate this project to the Glory of Almighty God and to the Kamate family(Dear father:Katsongo Maghulu,Dear mother:Masika Nzuva,Brothers:Benjamin Kamate,Vicky Malikuta and Muhindo Birihi,sisters:Deborah,Esperence,Esther,Leah,Grace and Noellah) and mohamed Hassan jama family. I would like to said thanks my parients(dear father:hassan jama ahmed, dear mother:amiina jama ahmed,special my dear uncle mohamoud haaji adam ahmed who support my financial)

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Our profound gratitude goes to God Almighty for his love, guidance, protection, provision, favours and blessings all through the period of my study.

I Kamate, present my sincere appreciation to my father and mum Katsongo Maghulu and Masika Nzuva respectively and my brothers Kasereka Kamate and Victoire Muhindo, Josue Birihi, sisters Leah Kamate, Esther Kamate, Noellah Kamate, Deborah Kamate and Kavira Maghulu for always being there to offer their uncompromising support in every wise.

I would also like to thanks my parents special thanks to my uncle mohamoud haaji adam ahmed support financial and friends who helped me alot in finalizing this project within the limited time frame.

Our appreciation is also greatly expressed to my supervisor Mr. Pak Hyon Jun and to the entire staff of the department.

Abstract

This project proposal is of a clap switch device. Clap switch is a switch which can switch on/off any electrical circuit by the sound of the clap. The basic idea of clap switch is that the electric microphone picks up the sound of your claps, coughs, and the sound of that book knocked off the table. It produces a small electrical signal which is amplified by the succeeding transistor stage. This circuit has been constructed using basic electronic components like resistors, transistors, relay, transformer, capacitors. This circuit will turn „ON" light for the first two claps. For the next two claps the light turns OFF. This circuit works with 12V voltage. Therefore a step-down transformer is employed. The primary application involves an elderly or mobility-impaired person. It is generally used for a light, television, radio, or similar electronic device that the person will want to turn on/off from bed. The major disadvantage is that, it is generally cumbersome to have to clap one's hands to turn something ON or OFF and it's generally seen as simpler for most use cases to use a traditional light switch.

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Nomenclature and Abbreviations

BJT	:	Bipolar junction transistor
CD	:	Counter/Divider
DIPs	:	8-pin mini dual-in-line package (DIP-8)
FET	:	Field-effect transistor
IC	:	Integrated Circuit
LED	:	Light Emitting Diode
RCUs	:	Remote Control Units
VR	:	Variable resistor
DC	:	Direct Current
CD	:	Decade counter

CHAPTER ONE:

INTRODUCTION

This chapter provides a clear understanding of the project vital aspects like its significance showing the importance of designing a clap switch device system and how problems faced by other aged and disabled people will be overcome.

1.0 Introduction

With the increasing interest in comfort and luxury and keeping in mind the disable persons a clap switch was invented. A device which can turn on or off an instrument with just clap of a hand. The basic idea of clap switch is that the electric microphone picks up the sound of your claps, coughs, and the sound of that book knocked off the table to turn on/off electrical appliances.

A circuited switch, which operates with sound of clapping hands or something similar; i.e. the switch comes to 'on' position when clapped once or twice, and to'off' position when again clapped once or twice (depends on circuit design).A clap-switch circuit is a sound sensitive circuit.

1.1 Background

The motivating force behind this design is based on the desire to alleviate the problem faced by the aged and physically challenged persons in trying to control some household and industrial appliances. It also takes into considerations the illiterates that may have problems operating some “complex” hand-held Remote Control Units (RCUs).

Therefore this project provides an introductory study on the basic principles involved in utilizing acoustic energy to control switching process. This is achieved by converting the energy generated by the “handclap” into electrical pulse, which is in turn used to drive an electronic circuitry that includes relays, which turn switches ON/OFF any appliance connected through it to the main.The device is activated by clapping within a set time period that is determined by IC timers component value in the circuit.

This circuit is constructed using basic electronic components like resistors, transistors, relay, microphone, ICs,capacitors and a step-down transformer.The condenser microphone picks up the sound of your claps, coughs, and the sound of that book knocked off the table. It produces a small electrical signal which is amplified by the transistor stage.

This circuit can switch on and off a light, a fan or a radio etc. by the sound of a clap.This working of the circuit is based on amplifying nature of the transistor, switching nature of transistor,the ICs as controllers and relay as an electronic switch.

1.2 Problem Statement

Due to challenges faced by aged and physically challenged persons who meet difficulties in trying to control some household and industrialappliances. In the same manner, manual switching is an uphill task for the disabled and the aged due to movement constraints. Sometimes, we are victims of electric shocks from our devices when we try to switch them ON/OFF due to leaking currents from the electric switches. Therefore, there is a pressing need to find a solution to this matter of great importance by designing a good clap switch device.

1.3 Significance of the Project

- To designa clap switch device that will serve well in different phono-controlled applications.
- To ensure an easier and safer method of switching domestic and industrial devices for instance, to avoid walking from point to point to switch switches will be a thing of the past.

- To alleviate the problem faced by the aged and physically challenged persons in trying to control some appliances in order to make our industries and homes become friendlier to disabled and aged people.

1.4 Aim and Objectives

1.4.1 General objective

The aim of this project is to design and implement a clap switch device in order to make the homes appliances and other electronic devices to be friendlier to the disabled.

1.4.2 The specific objectives

- To design a timer circuit.
- To design a switch circuit
- To design a amplifier circuit

1.5 Research questions

- How can the difficult task for the disabled and the aged due to movement constraints be overcome by designing and implementation of a good clap switch device?
- Why do we need to find an easier way of switching off/on electronic appliances ?

1.6 Scope of the Project

Development of clap switch for devices is a difficult task which requires a good knowledge in electronics. As this is a complex project, special scope of work is yet to be determined so that the main objective and goal can be achieved.

These scopes help us to be focused and know about the project. The major steps that will be involved in this current project are: literature review on clap switch for devices, the design of a switch device that will be implemented in home/industries with an integrated circuit to control the switching, theassembling of the different equipment to obtain the relevant system,testing of the system.

The switching device in this project is of the general purpose type as it is not restricted to only one type of load.The hand clap accepted by the system, will not be limited to just one person.

These scopes require: punctuality, self-discipline, time management and problem solving so that to obtain sufficient and good result.

CHAPTER TWO

LITTERATURE REVIEW

This chapter will discuss more about all of the information related to the project. It discusses about the previous history and the present work about our project. The literature review in this paper is based on internet, journal, books, and articles.

2.0 Historical Background

In 2008, Olokede carried out a research titled "Design of a Clap Activated Switch". He used IC 7490 to implement the clap activated switch. The clap activated switching device could basically be described as a low frequency sound pulse activated switch that is free from false triggering. The input component was a transducer that receives clap sound as input and converts it to electrical pulse. This pulse was amplified and was used to drive IC components which changes output state to energize and also de-energize a relay causing the device to be able to switch larger devices and circuits. The output state of the switching device circuit could only change, when the circuit receives two claps within a time period that will be determined by the RC component value in the circuit.[8]

In 2009, Ogunfayo performed a project titled "Design and construction of clap activated switch". He add an Operational Amplifier (741) in his block diagram. This project presented the design and construction of a clap activated switch device that would serve well in different phono-controlled applications, providing low expensive key and at the same time free from false triggering. The project involved the design of various stages consisting of the pickup transducer, signal amplification, pulse shaper and missing pulse detector (these were used for timing and clocking), bistable and switching circuit. The clap switch was used to switch ON and OFF two devices depending on the number of claps.[7]

In 2010, Sahiti and Lakshmi performed a project titled "Clap Switch". Their circuit is simple because there is no any integrated circuit (IC) in its block diagram. This was a project on clap switch which could switch on/off any electrical circuit by the sound of a clap. The operation of the circuit was simple. If we clap the lamp turns on and to switch it off clap again. The condenser microphone picked up the sound of your claps, coughs, and the sound of that book knocked off the table. This circuit can switch on and off a light, a fan or a radio etc by the sound of a clap.[9]

In 2013, Walchli and Arnould performed a project titled "Clap detection with microcontroller" they used both hardware and software. They emphasis on the software and algorithm aspects using matlab. They realized that clap detectors have been around for quite some time to switch lights on and off and probably for other gimmicks. On the internet there are different suggestions on how to detect claps and even complete circuit diagrams for analog, digital and hybrid clap detectors. They wanted to see if we could implement their own clap detector using the AMIV Bastli AVR-board, which would require them to deal with both hardware and software aspects of the problem. They did, however, lay a special emphasis on the software and algorithmic aspects.[5]

2.0.1 Development of Switches

The first light switch employing "quick-break technology" was invented by John Henry Holmes in 1884 in the Shieldfield district of Newcastle upon Tyne.

The word “switch” is a very common name found in almost all aspects electrical/electronic engineering. Switches can be found in information technology computers, telecommunications, power electronics, power systems, instrumentation etc.

They have been defined by various people or organizations in different ways. Some of the definitions of switches are listed below;

- As a device that is used to break or stop the flow of charges in a circuit.
- As a device used to connect two or more computers together.
- A device used to interrupt the flow of electrons in a circuit.[11]

All the above definitions are correct, but for this project a switch provide means for connecting two or more terminals in order to permit the flow of current across them, so as to allow for interaction between electrical components, and to easily isolate circuits so as to terminate this communication flow when needed.

2.1 Circuit Components

2.1.1 Transistor

A transistor is a semiconductor device used to amplify and switch electronic signals and electrical power. It is composed of semiconductor material with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current flowing through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal. Today, some transistors are packaged individually, but many more are found embedded in integrated circuits.

Transistors fall into twomajor classes: the bipolar junction transistor (BJT) and the field-effect transistor (FET).We will use bipolar junction transistor (BJT).

Bipolar Junction Transistors

The most common type of transistor is a bipolar junction transistor. This is made up of three layers of a semi-conductor material in a sandwich. In one configuration the outer two layers have extra electrons, and the middle layer has electrons missing (holes). In the other configuration the two outer layers have the holes and the middle layer has the extra electrons.

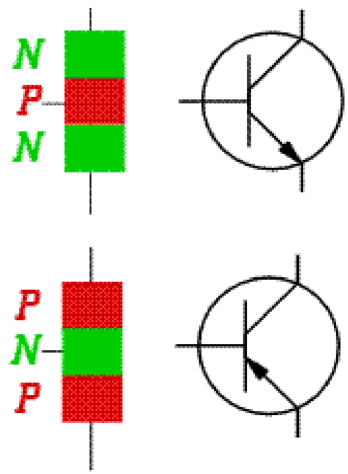

Fig 2.1 Symbol of NPN & PNP transistor

Layers with extra electrons are called N-Type, those with electrons missing called P-Type. Therefore the bipolar junction transistors are more commonly known as PNP transistor and NPN transistors respectively.Bipolar junction transistors are typically made of silicon and so they are very cheap to produce and purchase.[2]

Basic Transistor Amplifiers

An electrical signal can be amplified by using a device which allows a small current or voltage to control the flow of a much larger current from a dc power source. Transistors are the basic device providing control of this kind. There are two general types of transistors, bipolar and field-effect. Very roughly, the difference between these two types is that for bipolar devices an input current controls the large current flow through the device, while for field-effect transistors an input voltage provides the control.

To set a transistor to a certain DC level is done by setting up the V_{CE} and I_C.[3]

Fig 2.2 Symbol of transistor amplification

The three terminals of a bipolar transistor are called the emitter, base, and collector (Figure 2.3). A small current into the base controls a large current flow from the collector to the emitter. The current at the base is typically one hundredth of the collector-emitter current. Moreover, the large current flow is almost independent of the voltage across the transistor from collector to emitter.[3]

This makes it possible to obtain a large amplification of voltage by taking the output voltage from a resistor in series with the collector. We will begin by constructing a common emitter amplifier, which operates on this principle.[3]

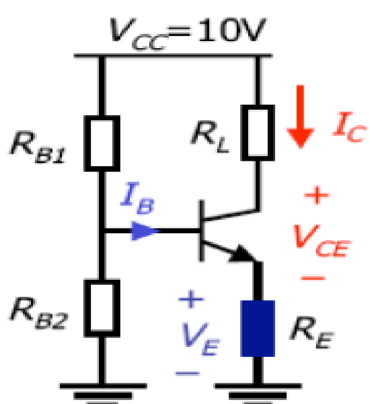

Fig 2.3 Schematic of transistor amplification mechanism.

2.1.2 Resistors

Resistors are the most common passive electronic component (one that does not require power to operate). They are used to control voltages and currents. While a resistor is a very basic component, there are many ways to manufacture them. In the past, most resistors were manufactured from carbon composition, a baked mixture of graphite and clay. These have been almost completely superseded by carbon or metal film resistor. Wire-wound resistors are used for comparatively low values of resistance where precise value is important, or for high dissipation. Each style has its own characteristics that make it desirable in certain types of applications. Choosing the right type of resistor is important to making high-performance or precision circuits work well. There are several different resistor construction methods and body styles (or packages) that are designed for a certain range of applied voltage, power dissipation, or other considerations. The construction of the resistor can affect its performance at high frequencies where it may act like a small inductor or capacitor has been added, called parasitic inductance or capacitance.[4]

Fig 2.4Resistor

2.1.3 Capacitor

A capacitor is a tool consisting of two conductive plates, each of which hosts an opposite charge. These plates are separated by a dielectric or other form of insulator, which helps them maintain an electric charge. There are several types of insulators used in capacitors. Examples include ceramic, polyester, tantalum air, and polystyrene.

Other common capacitor insulators include air, paper, and plastic. Each effectively prevents the plates from touching each other.[4]

Capacitor has ability to store charge and release them at a later time. Capacitance is the measure of the amount of charge that a capacitor can store for a given applied voltage. The unit of capacitance is the farad (F) or microfarad. The capacitors that will be used in the circuit are electrolytic-capacitor.[4]

Fig 2.5Electrolytic Capacitor

2.1.4 Battery

In electricity, a battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy. Since the invention of the first battery (or "voltaic pile") in 1800 by Alessandro Volta and especially since the technically improved Daniel cell in 1836, batteries have become a common power source for many household and industrial applications.[10]

According to a 2005 estimate, the worldwide battery industry generates US$48 billion in sales each year, with 6% annual growth.[10]

There are two types of batteries: primary batteries (disposable batteries), which are designed to be used once and discarded, and secondary batteries (rechargeable batteries), which are designed to be recharged and used multiple times. Batteries come in many sizes, from miniature cells used to power hearing aids and wristwatches to battery banks the size of rooms that provide standby power for telephone exchanges and computer data centres.

Fig 2.6 Battery Cell

2.1.5 Solid-state relay.

A solid-state relay (SSR) is an electronic switching device that switches on or off when a small external voltage is applied across its control terminals. SSRs consist of a sensor which responds to an appropriate input (control signal), a solid-state electronic switching device which switches power to the load circuitry, and a coupling mechanism to enable the control signal to activate this switch without mechanical parts. The relay may be designed to switch either AC or DC to the load. It serves the same function as an electromechanical relay, but has no moving parts.[10]

Packaged solid-state relays use power semiconductor devices such as transistors, to switch currents up to around a hundred amperes. Solid-state relays have fast switching speeds compared with electromechanical relays, and have no physical contacts to wear out.

Most of the relative advantages of solid state and electromechanical relays are common to all solid-state as against electromechanical devices.

- Slimmer profile, allowing tighter packing.

- Totally silent operation
- SSRs switch faster than electromechanical relays; the switching time of a typical optically coupled SSR is dependent on the time needed to power the LED on and off - of the order of microseconds to milliseconds
- Increased lifetime, even if it is activated many times, as there are no moving parts to wear and no contacts to pit or build up carbon
- Clean, bounceless operation
- No sparking, allows it to be used in explosive environments, where it is critical that no spark is generated during switching
- Much less sensitive to storage and operating environment factors such as mechanical shock, vibration, humidity, and external magnetic fields.[10]

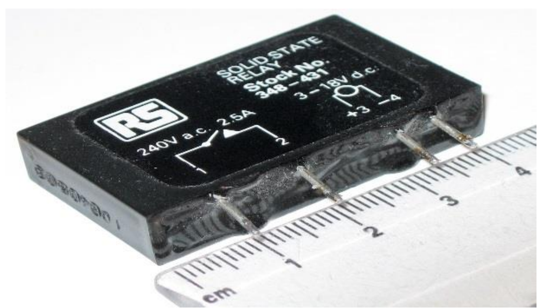

Fig 2.7Relay

2.1.6 LED (Light Emitting Diode)

A light-emitting diode (LED) is a semiconductor device that emits visible light when an electric current passes through it. The light is not particularly bright, but in most LEDs it is monochromatic, occurring at a single wavelength. The output from an LED can range from red (at a wavelength of approximately 700 manometers) to blue-violet (about 400 nanometres). Some LEDs emit infrared (IR) energy (830 nanometres or longer); such a device is known as an infrared-emitting diode (IRED).[2]

An LED or IRED consists of two elements of processed material called P-type semiconductors and N-type semiconductors. These two elements are placed in direct contact, forming a region called the P-N junction. In this respect, the LED or IRED resembles most other diode types, but there are important differences. The LED or IRED has a transparent package, allowing visible or IR energy to pass through. Also, the LED or IRED has a large PN-junction area whose shape is tailored to the application.[2]

SYMBOL OF LED

Circuit Symbol

Fig.2.8 LED

2.1.7 Condenser Microphone

A microphone is an acoustic-to-electric transducer or sensor that converts sound into an electrical signal. The condenser microphone, invented at Bell Labs in 1916 by E. C. Wente is also called a capacitor microphone or electrostatic microphone.[2]

Condenser microphones require power from a battery or external source. The resulting audio signal is stronger signal than that from a dynamic. Condensers also tend to be more sensitive and responsive than dynamics, making them well-suited to capturing a sound.

Microphones are types of transducers, they convert acoustic energy i.e. sound signal. Basically, a microphone is made up of a diaphragm, which is a thin piece of material that vibrates when it is struck by sound wave. This causes other components in the microphone to vibrate leading to variations in some electrical quantities thereby causing electrical current to be generated.[3]

The current generated in the microphone is the electrical pulse. The current generated by a microphone is very small and this current is referred to as mic level and typically measured in milli-volts. Before it is usable, the signal must be amplified, usually to line level, with typical value within (0.5 – 2) volts, which is stronger .So the signal produced by microphone is amplified by a transistor.[3]

The basic action of this transistor is to receive an input signal from the input transducer (microphone), control the amount of power that the amplifier takes from power source (Vs) and converts it into power needed to energize the load.[3]

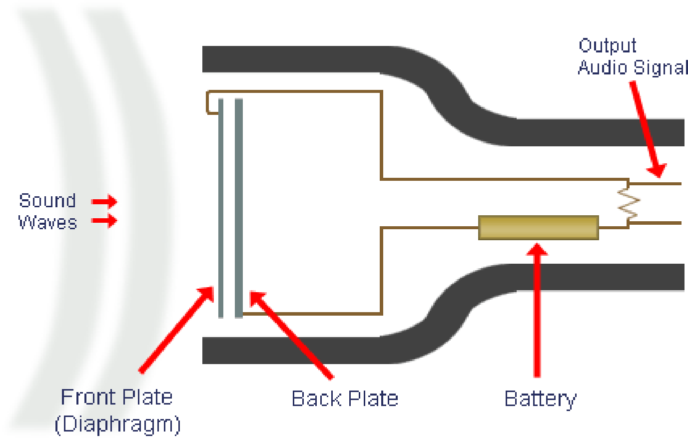

Fig 2.9. Cross-Section of a Typical Condenser Microphone

2.1.8 The 555 Timer

The 8-pin 555 timer must be one of the most useful ICs ever made and it is used in many projects. With just a few external components it can be used to build many circuits, not all of them involve timing. The NE 555, to be used in this design is a popular version that is suitable in most cases where a 555 timer is needed. It is a dual-In -line (DIL) package.[4]

The 555 timer IC is an integrated circuit (chip) used in a variety of timer, pulse generation, and oscillator applications. The 555 can be used to provide time delays, as an oscillator, and as a flip-flop element. Derivatives provide up to four timing circuits in one package. Depending on the manufacturer, the standard 555 package includes over 20 transistors, 2 diodes and 15 resistors on a silicon chip installed in an 8-pin mini dual-in-line package (DIP-8).[4]

The 555 timer configuration can be done in three modes but for the purpose of this design, two of them are required namely; Astable and Monostable mode. An astable circuit produces a square wave with sharp transitions between low and high. It is called astable because it is not stable in any state since the output is continually changing between "low" and "high".[4]

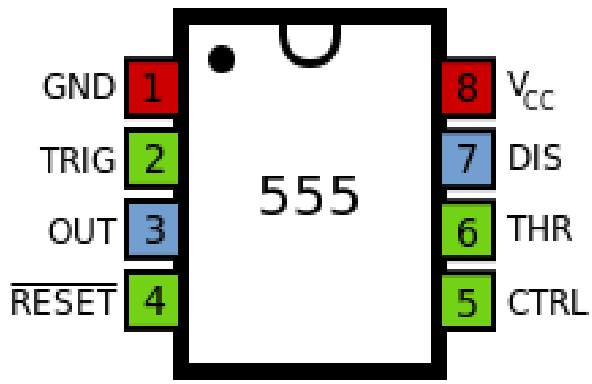

Fig 2.10. Pinout Diagram

Trigger input

When <1/ 3 Vs ('active low') this makes the output high (+Vs). It monitors the discharging of the timing capacitor in a stable circuit. It has a high input impedance > 2M.

Threshold input

When >2 / 3 Vs ('active high') this makes the output low (0V). It monitors the charging of the timing capacitor in a stable and monostable circuits. It has a high input impedance > 10Mproviding the trigger input is >1 / 3Vs, otherwise the trigger input will override the threshold input and hold the output high (+Vs).

Reset input

When less than about 0.7V ('active low') this makes the output low (0V), overriding other inputs. When not required it should be connected to +Vs. It has an input impedance of about 10k.

Control input

This can be used to adjust the threshold voltage which is set internally to be 2 / 3 Vs. Usually this function is not required and the control input is connected to 0V with a0.01µF capacitor to eliminate electrical noise. It can be left unconnected if noise is not a problem.

The connection of the pins for a DIP package is as follows:

Table 1:Pin table

Pin	Name	Purpose
1	GND	Ground reference voltage, low level (0 V)
2	TRIG	The OUT pin goes high and a timing interval starts when this input below ½ of CTRL voltage (hence TRIG id typically 1/3 V_{CC}.CTRL being 2/3 V_{CC} by default, if CTRL is left open).
3	OUT	This output is driven to approximately 1.7 below $+V_{CC}$ or GND.
4	RESET	A timing interval may be reset by driving this input to GND, but the timing does not begin again until RESET rises above approximately 0.7 volts. Overrides TRIG which overrides THR.
5	CTRL	Provides "control" access to the internal voltage divider (by default, 2/3 V_{CC}).
6	THR	The timing (OUT high) interval ends when the voltage at THR is greater than that at CTRL (2/3 V_{CC} if CTRL is open).
7	DIS	Open collector output which may discharge a capacitor between intervals. In phase with output.
8	V_{CC}	Positive supply voltage, which is usually between 3 and 15 V depending on the variation

2.1.8.1 The Monostable mode

A monostable circuit produces a single output pulse when triggered. It is stable in just one state; the "output low" state. This is known as the triggered pulse producer. Once triggered by an input voltage, it gives a fixed length output pulse. It will do this for even short input pulse. The "output high" state is temporary. The duration of the pulse is called the time period (T), which is determined by resistor R5 and capacitor C3. The time period T, is the time taken for the capacitor to charge to 2/3 of the supply voltage is given as T=1.1*R5*C3 where T is in seconds, R is in ohms (resistance) and C in farads (capacitance).[4]

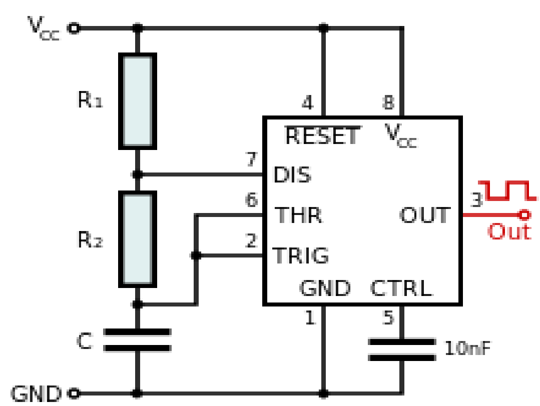

Fig 2.11 Schematic of a 555 in monostable mode

2.1.9 Decade Counter CD4017

Counters are electronic circuits that count in binary and give outputs that change every time an input signal changes from high to low (i.e. at every falling edge of the signal). A counter requires a square wave input signal to make it count. This wave is a digital waveform with sharp transition between low (0 V) and high (+Vs), such as the output from a 555 timer circuit.[4]

CD4017 is a CMOS counter/divider IC. It receives a clock signal through the clock input and in the sequential manner it turns ON all the 10 outputs, every time it gets the clock input pulse.[4]

In order to get familiar with the working of the IC, it is essential for the one to get familiar with the every pin of the IC. These ICs consist of 3 input pins along with 10 output pins also have one pin for ground and one more for the power supply and one more pin for the Carry out. Pin diagram of the IC is designed below -

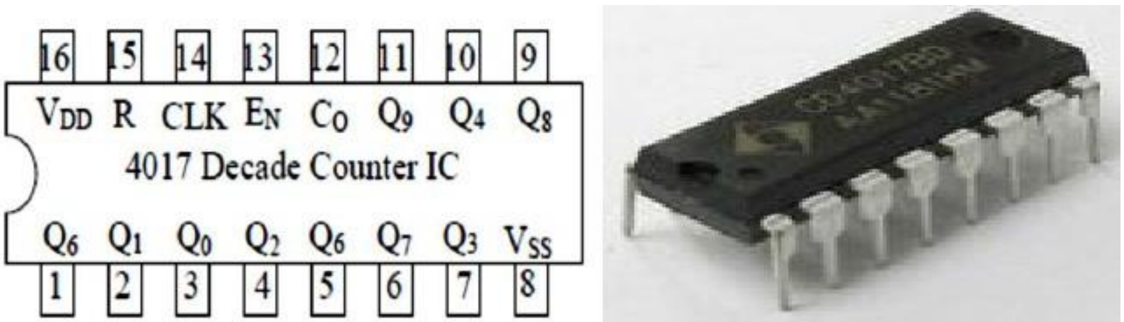

Fig 2.12Pinout Diagram of CD4017 IC

1. **Input Pin:**
   - **Reset Pin (Pin 15)** – The counter is reset to the zero position by this pin. Suppose you wish that the counter will only count till third position then you need linked the fourth pin with 15 pin. So after reaching to the third output it will automatically begin its counting from zero.
   - **Clock Pin (Pin14)** – In each of the timing pin 14 moves at high the output will be given to you. From the initial clock pulse output will be received at the pin 3 likewise for the next clock pulse output will be received at the pin 2 and so on.
   - **Clock Inhibit Pin (Pin 13)** – The counter is switched to "on" and "off" by this pin. If you need that the counter to be switched off then for that pin 13 must be at high state. If the pin is at high then it will disregard the clock pulse without paying attention that how much time you press the switch i.e. the count will not go forward. Pin 13 in our circuit is grounded.
2. **Output Pin (Pin Q0- Q9)** -It is used to get the input in chronological order. Like pin 3 will give you the output for the first pulse and so on.

3. **Ground Pin (Pin 8) and Supply pin (pin 16)** – For the proper working of these IC these pins are used to give ground as well as power supply.
4. **Carry out Pin (Pin 12)** – These pins are used to link one or more CD4017 IC with each other. Suppose you have a desire to connect one more CD4017 IC then attach pin 12 to the clock input to its next one. The carry pin of first CD4017 is connected to clock input of the second and the carry pin of the second is connected to the clock input of the third and so on. In our circuit we will leave this pin as we have desire of only one IC in our circuit.[4]

2.1.10 Electrical Power Transformer

A transformer is a static machine used for transforming power from one circuit to another without changing frequency. This is a very basic definition of transformer.[1]

A transformer is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. Commonly, transformers are used to increase or decrease the voltages of alternating current in electric power applications.[1]

A varying current in the transformer's primary winding creates a varying magnetic flux in the transformer core and a varying magnetic field impinging on the transformer's secondary winding. This varying magnetic field at the secondary winding induces a varying electromotive force (EMF) or voltage in the secondary winding. Making use of Faraday's Law in conjunction with high magnetic permeability core properties, transformers can thus be designed to efficiently change AC voltages from one voltage level to another within power networks.[1]

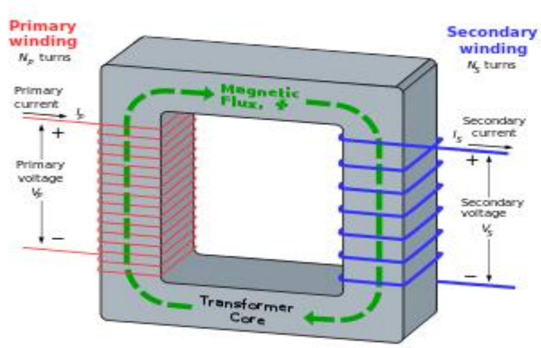

Fig.2.13 Power transformer diagram

2.1.11 Diode

Electronic current converter: an electronic device that has two electrodes and is used to convert alternating current to direct current.[2]

Diode can be made of either two of semiconductor materials, silicon and germanium. Power diodes are usually constructed using silicon and germanium. Silicon diode can operate at higher current and at higher junction temperature, and they have greater reverse resistance. The structure of a semiconductor diode and it symbol are shown in Figure. The diode has two terminals, an anode, a terminal (Pjunction) and a cathode K terminal (Njunction). When the anode voltage is more positive than the cathode, the diode is said to be forward biased and it conducts current readily with a relatively low voltage drop. When the cathode voltage is more positive than the anode, the diode is said to be reverse biased, and it blocks current flow. The arrow on the diode symbol shows the direction of convection current flow when the diode conducts.[3]

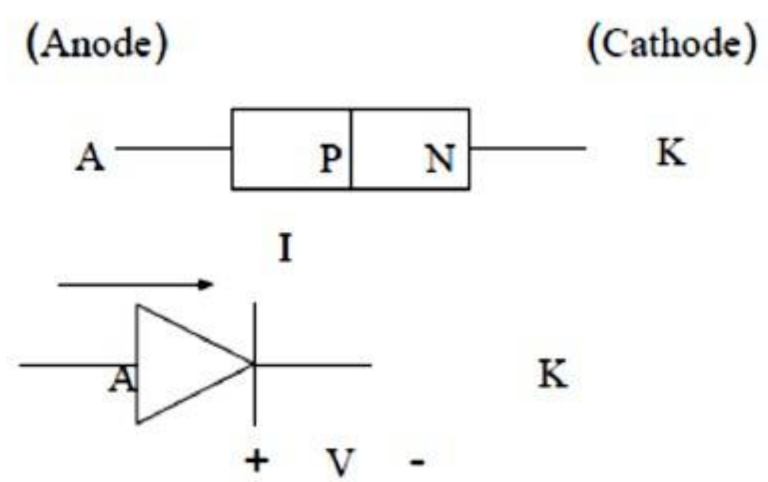

Fig 2.14 Symbol of a Diode

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter explains in detail the methodology and components of this project proposal. Each part and component that has been selected has as its own purpose mostly focused on functionality and low cost. In this chapter as well, the technical plan, analysis and the specifications are being explained.

3.1 System Block

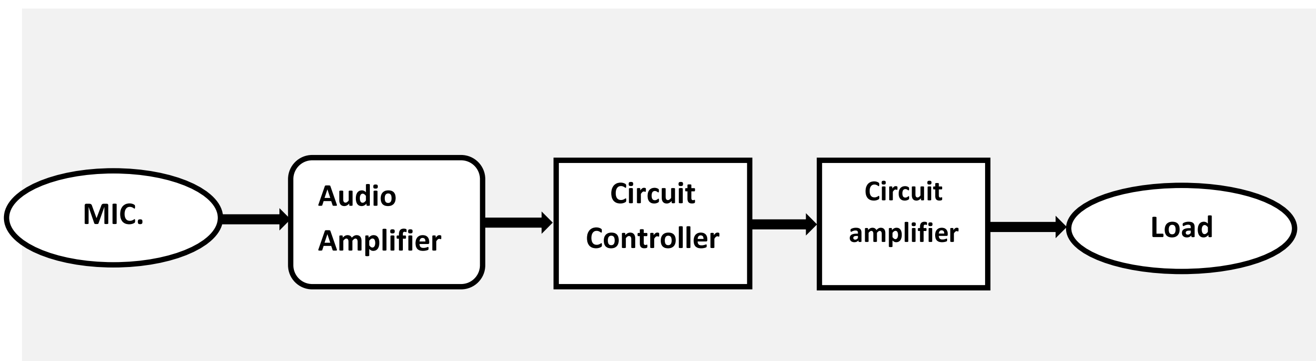

Fig 3.1 System Block

This block diagram shows us how the circuit will be split up into different sections.
At the time when someone claps in front of the microphone, the sound signal is converted into the electrical signal by the condenser microphone. This weak signal is then amplified by a transistor. The amplified signal provides a negative pulse to the timer turns on the counter for the predetermined time. Finally, the signal after this process the outcome electric signal becomes very weak. So, it is amplified using another transistor and given to relay, it acts as a switch.

3.2 Planning and Approach

A part from the relay,transformer and the microphone,all other components will contained on a single circuit printed board (PCB). We will begin our construction by soldering in the resistors and wire links. We will also ensure that all electrolyte capacitors,transistors,diodes and bridge rectifiers are well connected.

3.2.1 Working of the basic circuit components

First we take a condenser microphone that senses the sound of the clapping. Next is the amplifying stage that will amplify the sound received from the microphone. Two ICs have been used. The first one senses the first clap and the output of which gives power to the second IC. The second IC is activated by the second clapping sound and its output is fed to the relay which switches on the load when output from the second IC is received.

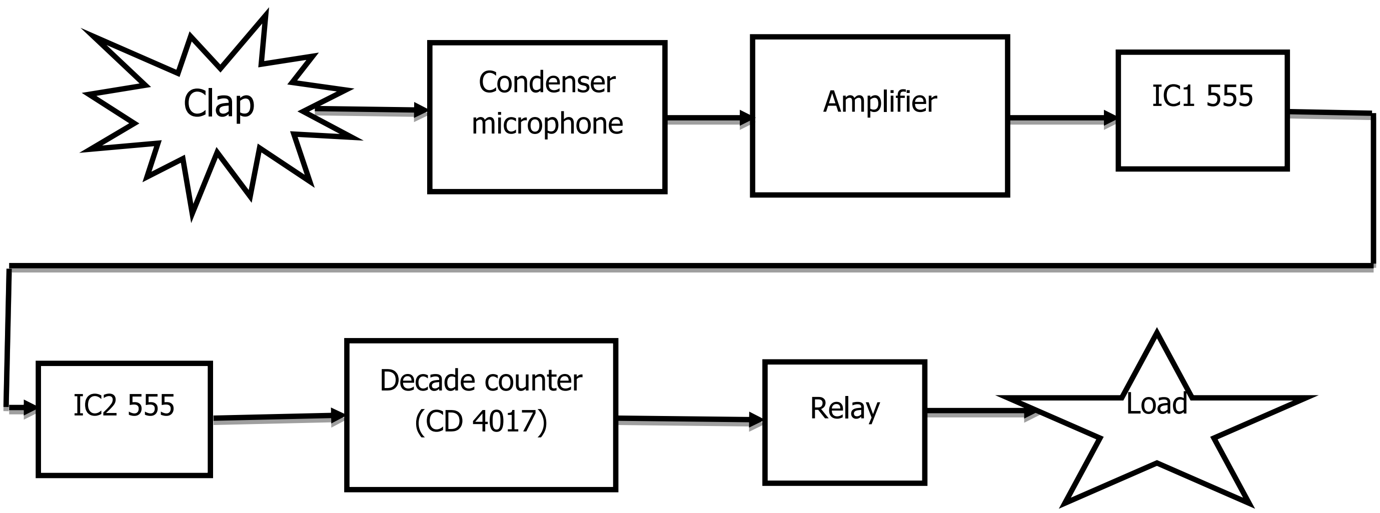

Fig 3.2 clap switch device diagram

3.2.1.1 Power supply (Transformer)

The power will be derived from a.c mains and transformer to provide an isolated voltage of 9V a.c. A 9V a.c supply will be bridge-rectified by a rectifier (diode) and smoothed by a capacitor producing a d.c supply of about 12V.

A fuse should be included in the mains a.c live before the connection to the relay and transformer. This will be rated to suit the maximum load that the relay is required to switch, plus about 1A margin for the current through the primary wending of the transformer.

3.2.1.2 Condenser microphone

Sound energy received by microphone will be converted to electrical signals. Microphones are types of transducers, they convert acoustic energy i.e. sound signal. Basically, a microphone is made up of a diaphragm, which is a thin piece of material that vibrates when it is struck by sound wave. This causes other components in the microphone to vibrate leading to variations in some electrical quantities thereby causing electrical current to be generated. The current generated in the microphone is the electrical pulse. The current generated by a microphone is very small and this current is referred to as mic level and typically measured in milli-volts. Before it is usable, the signal must be amplified, usually to line level, with typical value within (0.5 – 2) volts, which is stronger .So the signal produced by microphone is amplified by transistor.

The basic action of this transistoris to receive an input signal from the input transducer (microphone), control the amount of power that the amplifier takes from power source and converts it into power needed to energize the load.Hand claps are typically within the 2200 to 2800 hertz range.

Transistor as a switch (T2 BC 548)

The bipolar NPN transistors used in this design are basically used as switch, to trigger the relay and as amplifier to boost the mic level to line level. When a transistor is used as switch, it must be either OFF or fully ON. In the fully ON state, the voltage VCE across the transistor is almost zero and the transistor is said to be saturated because it cannot pass any more collector current IC. The transistor is off when VIN is less than 0.7 V, because the base current will be zero. The power developed in a switching transistor is very small

In the OFF state

Power = VD *IC but IC = 0 (3.1)

P = 0

In the ON state

Power = VC * IC but VCE ≈ O (almost) (3.2)

$P \approx 0$

So, the power is very small

Transistor as Amplifier (T1 BC 549)

The basic action of the BC 549 transistor used for amplifier circuit in this design is to receive an input signal from the input transducer (microphone), control the amount of power that the amplifier takes from power source (Vs) and converts it into power needed to energize its load i.e. the 555 timer. Generally, the collector current is controlled by the emitter or base current. By connecting a load effectively between the collector and the common terminal, the transistor can produce gain, and the input signal is generally an alternating quantity. However, the transistor requires operating in a unidirectional mode, otherwise, the negative parts of the alternating quantity would cause the emitter-base junction to be reverse biased and this would prevent normal transistor action. Consequently, it is necessary to introduce a bias. A transistor in the common-emitter circuit has the base-emitter junction forward biased and the collector-base junction reverse biased.

The leakage current is not necessarily negligible. The leakage is temperature dependent; hence an increase in temperature causes the leakage to rise. In turn, this result in collector current and a change in bias condition. The change in bias condition is therefore stabilized by using a potential divider R3 and R4 as shown in figure 3.4 . The potential divider holds the base voltage almost constant.

3.2.1.3 First and second IC 555

The secondstage amplifier will enlarge the signal which will help the first555 timer to recognize the first clap. The IC1 555 will sense the first clap.

Now, if a secondclap will be recognized by the second555 timer within an interval of 3 seconds. Then the switch will trigger the device and move to ON state.

The 555 timer is a very versatile 8-pin, which can be configured with a few external components and to build many circuits involving timing. The NE 555, used in this design is a popular version that is suitable in most cases where a 555 timer is needed. It is a dual-In -line (DIL) package.

The 555 timer configuration can be done in three modes but for the purpose of this design, two of them are required namely: astable and Monostable mode. An astable circuit produces a square wave with sharp transitions between low and high. It is called astable because it is not stable in any state since the output is continually changing between "low" and "high".

A monostable circuit produces a single output pulse when triggered. It is stable in just one state; the "output low" state. This is also known as the triggered pulse producer. Once triggered by an input voltage, it gives a fixed length output pulse. It will do this for even short input pulse. The "output high" state is temporary. The duration of the pulse is called the time period (T), which is determined by resistor R and capacitor C. The time period T, which is the time taken for the capacitor to change to 2/3 of the supply voltage is given as

$T = 1.1 * R * C$

3.2.1.4 Decade counter

The decade counter is there to check if the two claps are generated within 3 seconds. After the second clap, turns on the light.

Counters are electronic circuits that count in binary and give outputs that changes every time an input signal changes from high to low (i.e. at every falling edge of the signal). A counter requires a square wave input signal to make it count. This wave is a digital waveform with sharp transition between low (0 V) and high (+Vs), such as the output from a 555 timer circuit.

In this design, the output of a decade counter is used for a transistor switch that enables the switching of the relay. The decade counter, CD4017BC, used in this design is a 5 stage divide-by-10 counter with 10 decoded outputs and a carry out bit. The decade counter is a 16 pin Dual-in-Line (DIL) package. The decade counter IC CD4017B, used in this design is wired as a bistable, by connecting its decoded output "2" (Pin 4) to its reset (Pin 15).

3.2.1.5 Relay

A solid-state relay (SSR) is an electronic switching device that will be switching on or off when a small external voltage is applied across its control terminals. SSRs consist of a sensor which responds to an appropriate input (control signal), this solid-state electronic switching device which will be switching power to the load circuitry, and a coupling mechanism to enable the control signal to activate this switch without mechanical parts. This relay will be designed to switch DC power to the load.

3.3 CIRCUIT DESIGN AND CIRCUIT OPERATION:

The device is expected to control switching process by sensing hand claps, but must avoid being triggered by false signals, such as voice and mechanical noise impulse. The design of a clap circuit is expected to respond to two claps only when it is received within three seconds to energize a relay which will make connection with an external circuit.

3.3.1 CIRCUIT DESIGN CALCULATIONS

3.3.1.1 Transistor as a switch

Using general purpose transistor BC 548

Supply voltage, Vs = 9V

The load driven by the transistor is the relay R_L

Load resistance R_L= 150 ohm

Load current $I_L = \frac{\text{Supply Voltage,Vs}}{\text{Load Resistence,}R_L} = \frac{9}{150} = 60\text{mA}$

Since I_C (max) must be greater than Il and from the date sheet I_C(max) = 100mA

$I_C > I_L$

To calculate for Base Resistor, R_{13}

$R_{13} = \frac{V_C \times hFE}{5 \times I_C}$(3.3.1)

Where

V_C = Chip supply voltage

But since V_C = Vs

Then,

$R_{13} = \frac{Vc \times hFE}{5 \times Ic} = \frac{9 \times 400}{5 \times 100} = 7.2\text{k}\Omega$ (3.3.2)

Where the typical hfe value = 400 from the data sheet, and I_C = 100 mA.

Therefore,R_{13} is selected to be 10 KΩ.

Note: The hFE of a transistor is the current gain or amplification factor of a transistor.it is also referred to as ß is the factor by which the base current is amplified which is fed into the transistor. The formula is below:

$\mathbf{I_C = hFEI_B = \beta I_B}$

Where,

I_C = the amplified current

hFE =the transistor current amplification factor which is the same as ß

I_B=is the base current

3.3.1.2 Light Emitting Diode (LED)

To determine the value of the voltage dropper resistor, the voltage supply value must be known. From this value, the characteristic voltage drop of an LED can then be subtracted, and the value of drop across an LED depending on the desired brightness and colour will range from 1.2 V to 3.0 V.

If (max) = 20mA

V_{CC} = 9V

V_F= 2V

Required current I (req) = 5mA.

$$R_{LED1} = \frac{Vcc-VF}{If(max)} = \frac{9-2}{5\times10^{-3}} \quad (3.4.1)$$

$$R_{LED1} = 1.4\ K\Omega \quad (3.4.2)$$

But choosing IR (LED) = 10mA

$$R_{LED2} = \frac{9-2}{10\times10^{-3}} = 0.7\ k\Omega \quad (3.5)$$

Where,

V_F = the maximum forward voltage drop

V_{CC}= the supply voltage

R_{LED}= the LED current limiting

Considering equations (3.4.1) and (3.5)

$R_8$and R_{12} are chosen to be 1KΩ

3.3.1.3 Design calculation for condenser microphone

From the data sheet, the electrets condenser microphone has the following specifications:

Rated Voltage = 2V

Operating Voltage = 1–10 V

Sensitivity = -44+/-3dB

S/N = 55dB

The microphone – biasing resistor, R1 is given by

$$R_1 = \frac{Vs - V(rated)}{2mA} = \frac{9-2}{2\times10^{-3}} = 3.5K\Omega \quad (3.6)$$

R_1= 3.5 KΩ

Therefore, $R_1$was chosen to be 3.3KΩ.

3.3.1.4 Design and calculation for IC1 (Monostable Multi vibrator)

The ON time (T) is the duration of the pulse and it is determined by the values of resistor and capacitor R_7 and C3 respectively. The ON time (T) duration of the pulse is determined by the selected values of R_7 and C3. Choosing C3 =10uF, since there are few available values: calculating for a time period of 3 seconds

T = $1.1\times R_7$ ×C3

R_7= T/1.1×C3 (3.7)

= $3/10\times10^{-3}\times1.1$

= 273 KΩ

The nearest available resistor chosen as R_7 = 270 KΩ

3.3.1.5 Design Calculation forIC2 (Monostable) with power on reset

To de-bounce the switch, IC1 (555 timer) is connected to make it trigger a 555 monostable circuit of IC2 with a very short time period (milli-seconds) and the output is used to drive the clock input of the counter.

Resistor R_9 and capacitor C5 determines duration of the pulse and to prevent contact bounce

Choosing C5 = 0.01 μF

Calculating for a very short time of 1msec

T = $1.1\times R_9\times$C5

R_9 = T/ 1.1×C5 (3.8)

$= 1\times10^{-3}/1.1\times0.01\times10^{-6}$

$= 90.91\ K\Omega$

Therefore selecting $R_9 = 100K\Omega$

3.3.1.6 To prevent false triggering

It is ensured that the monostable circuit of IC2 is reset automatically when power is supplied to it. This is achieved by a "Power ON" reset circuit. The capacitor C7 must take a short time to change, so as to briefly hold the input close to zero volts when the supply comes on resistor R_{10} of about 10 KΩ is usually used. R_{10} and C7 determine the duration for the brief delay before IC2 receives the triggering signal.

Chosen $R_{10} = 10K\Omega$ (Recommended)

Calculating for a time period of 24 milliseconds

T = 24msecs

$R_{10} = 10\times10^3$

$T = 1.1\times R_{10}\times C7$ (3.9)

$C7 = T/1.1\times R_{10}$

$$= \frac{24 \times 10 -{}^{3}}{1.1 \times 10 \times 10^{3}}$$

C7 = 2.18 μF

Therefore, C7 is selected to be 2.2 μF

3.3.1.7 Design calculation for Transistor Amplifier

For linear amplification and maximum output purpose, the operating point should lie around the dc load-line. The quiescent point normally takes a value of about half the supply voltage.

The quiescent, V_{CE}= 9/2 (3.)

= 4.5 V

To set a transistor to a certain DC level is done setting up the V_{CE} and I_C.

Suppose that we want the following biased conditionsV_{CE} = 4.5V and Ic = 2mA.

Therefore, to find our collector resisstor R_C which R_5 in this current project.

We know that,$\mathbf{V_{CE}}$ **= 10-**$\mathbf{R_C} \times \mathbf{I_C}$

But V_{CE}=4.5V and I_C =2mA

Therefore, 4.5=10-R_C × (2×10-^{3})

$$R_C = \frac{-5.5}{-2 \times 10 - {}^3} = 2.75K\Omega$$

Therefore selecting R_5 = 3.3KΩ

Also,the V_{BE}(base-emitter voltage) ≈0.7V

Then,I_C=(10-V_{BE})/R_{B1}

I_C=(10-0.7)/R_{B1}

But, I_C=ß× I_B and I_C=2mA and also ß=475

Therefore, 2mA=475(10-0.7)/R_{B1}

Making Rb the subject,

$$2 \times 10^{-3} = \frac{475 \times 9.3}{R_{B1}}$$

$$(2\times 10^{-3})R_{B1} = 4{,}417.5$$

$$R_{B1} = \frac{4{,}417.5}{2 \times 10^{-3}} = 2{,}208.75 \times 10^3\Omega$$

Therefore selecting R_3 = 2.2MΩ

We should know that,the second base resistor R_{B2} is almost always the 10thof R_{B1}.

This implies that $R_{B2} = \frac{2.2\times10^{6}}{10} = 220 \times 10^{3}\Omega$

R_{B2} =220KΩ

Therefore,selecting R_4= 270KΩ

3.4 CIRCUIT OPERATION

The clap sound sensed by condenser microphone is amplified by transistor T1. The amplified signal provides negative pulse to pin 2 of IC1 and IC2, triggering both the ICs. IC1, commonly used as a timer, is wired here as a monostable multivibrator. Triggering of IC1 causes pin 3 to go high and it remains high for a certain time period depending on the selected values of R_7 and C3. This 'on' time (T) of IC1 can be calculated using the following relationship: T=1.1× R_7 ×C3 Seconds where R_7 is in ohms and C3 in microfarads. On first clap, output pin 3 of IC1 goes high and remains in this standby position for the preset time. Also, LED1 glows for this period. The output of IC1 provides supply voltage to IC2 at its pins 8 and 4.Now IC2 is ready to receive the triggering signal. Resistor R_{10} and capacitor C7 connected to pin 4 of IC2 prevent false triggering when IC1 provides the supply voltage to IC2 at first clap.

On second clap, a negative pulse triggers IC2 and its output pin 3 goes high for a time period depending on R9 and C5.This provides a positive pulse at clock pin 14 of decade counter IC 4017 (IC3). Decade counter IC3 is wired here as a bistable. Each pulse applied at clock pin 14 changes the output state at pin 2 (Q1) of IC3 because Q2 is connected to reset pin 15. The high output at pin 2 drives transistor T2 and also energises relay RL1. LED2 indicates activation of relay RL1 and on/off status of the appliance. A free-wheeling diode (D1) prevents damage of T2 when relay de-energises.

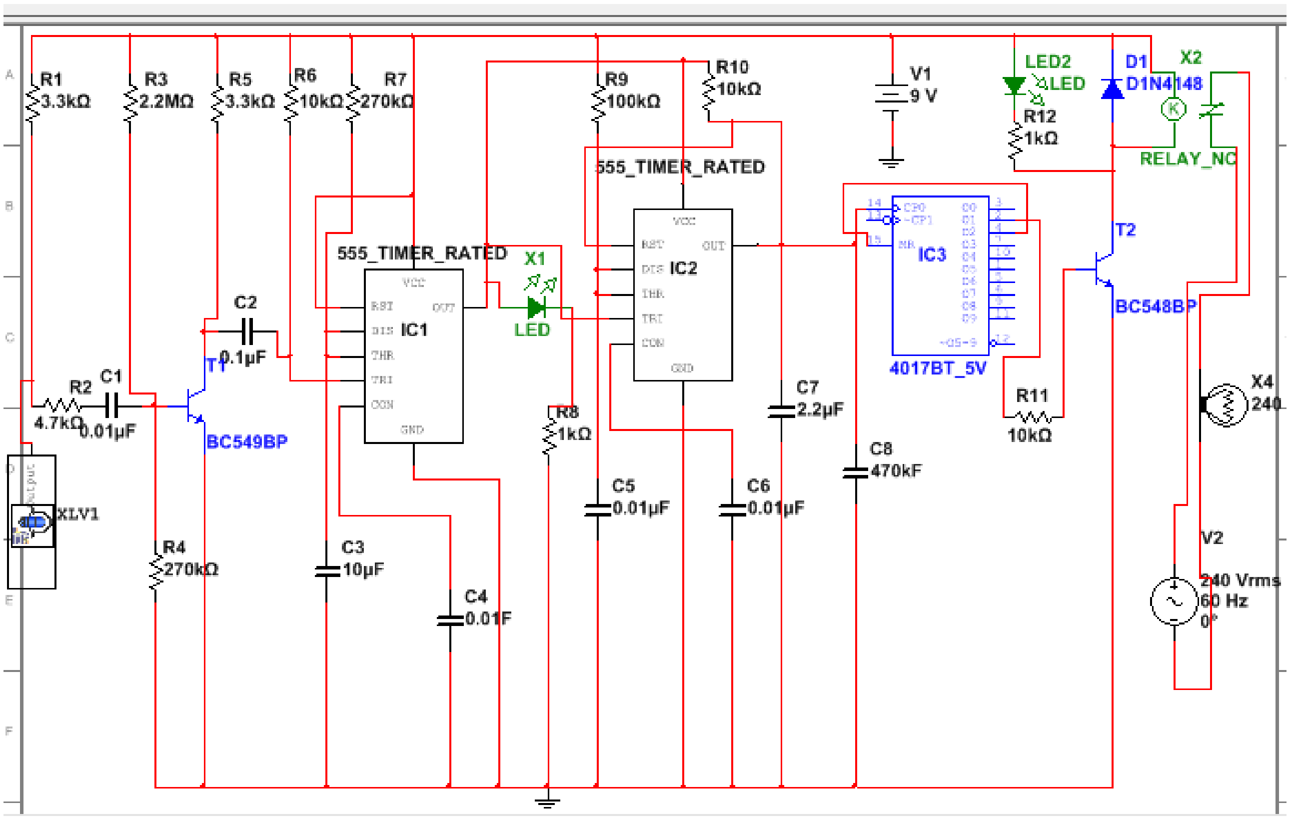

Figure 3.3 Circuit Diagram of Clap Switch

CHAPTER FIVE:

RESULTS AND DISCUSSION

Fig. 4.1: When the circuit is not powered

Fig. 4.2: When the circuit is powered

During the practical implementation of the project, some of the values or components had to be changed in order to get more accurate result. The circuit was first performed on bread board and only after successful implementation and satisfied output, it was built on a vero board.

- In the output, a bulb is used instead of an LED.
- A red LED is used to indicate the first clap. When the first NE 555 timer generates the output, the LED glows.
- A 12 volts power supply has been used instead of the 9 volts power supply to get satisfied results.
- The relay can drive any common home electrical appliance like fan, light, television etc.

The time period of the pulse applied as the power supply of the IC 2(second NE 555 timer) is calculated by the formula:

T = 1.1 x R_7 x C3

According to the theoretical values, the time period should be:

T = 1.1 x 270k x 10u

=2.97

But the practical value of T in this circuit is 3.20 seconds which is slightly greater than the calculated theoretical output. This is due to the tolerance of the components used in the circuit.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSIONS

We assembled the circuit on a general-purpose PCB. This circuit is very useful in field of electronic circuits. By using some modification it area of application can be extended in various fields. It can be used to raise alarm in security system with a noise, and also used at the place where silence needed.

This project gives us a great deal of knowledge about the 555 timer chips, working of clocks and the relay. This type of device provides us with the working of NE555 timer chips and the relay. The relay is a type of switch which provides a conducting path only when current flows it. In this project as soon as the 2nd timer triggers the relay a conducting path is established between terminals of the load and hence the device is turned on. The time interval between the claps is judged with the time constant established with the RC configuration which is T=1.1R7*C3.

This switch is very low cost and is very useful to the elderly and physically challenged people. But the major disadvantage of this switch is false triggering. The switch can be triggered by any two sounds similar to that of hands clapping. So care has to be taken to avoid this kind of false triggering and the switch should not be used in very sensible applications. It is only for home uses.

But nevertheless it is an excellent example of electronics evolution and how engineering and electronics have made our life easier.

Advantages and Applications:

Advantages:

1. The primary application involves an elderly or mobility-impaired person.

2. Energy efficient

3. Low cost and reliable circuit

4. Reduction of manpower

Applications:

The major advantage of a clap switch is that you can turn something (e.g. a lamp) on and off from any location in the room (e.g. while lying in bed) simply by clapping your hands.

The primary application involves an elderly or mobility-impaired person. A clap switch is generally used for a light, television, radio or similar electronic device that the person will want to turn on/off from bed.

The major disadvantage is that it is generally cumbersome to have to clap one's hands to turn something on or off and it is generally seen as simpler for most use cases to use a traditional light switch.

5.2 RECOMMENDATIONS

There is a further scope of work on this project. This circuit can be made more accurate and more sensible to suit the practical use in our daily lives.

No filter has been used here so the switch will respond to more or less every two sounds similar to clapping that come with a gap of in between 3 seconds. But if a simple band pass filter is used then this problem could be avoided. The frequency range of hand clapping is in between 2200 and 2800 Hertz.

Here the signal from the condenser microphone is beta times amplified by the amplifier stage. To add more sensitivity to the switch, the amplification factor may be increased.

We can increase the range of this equipment by using better microphone. It can also be used as Remote Controller.

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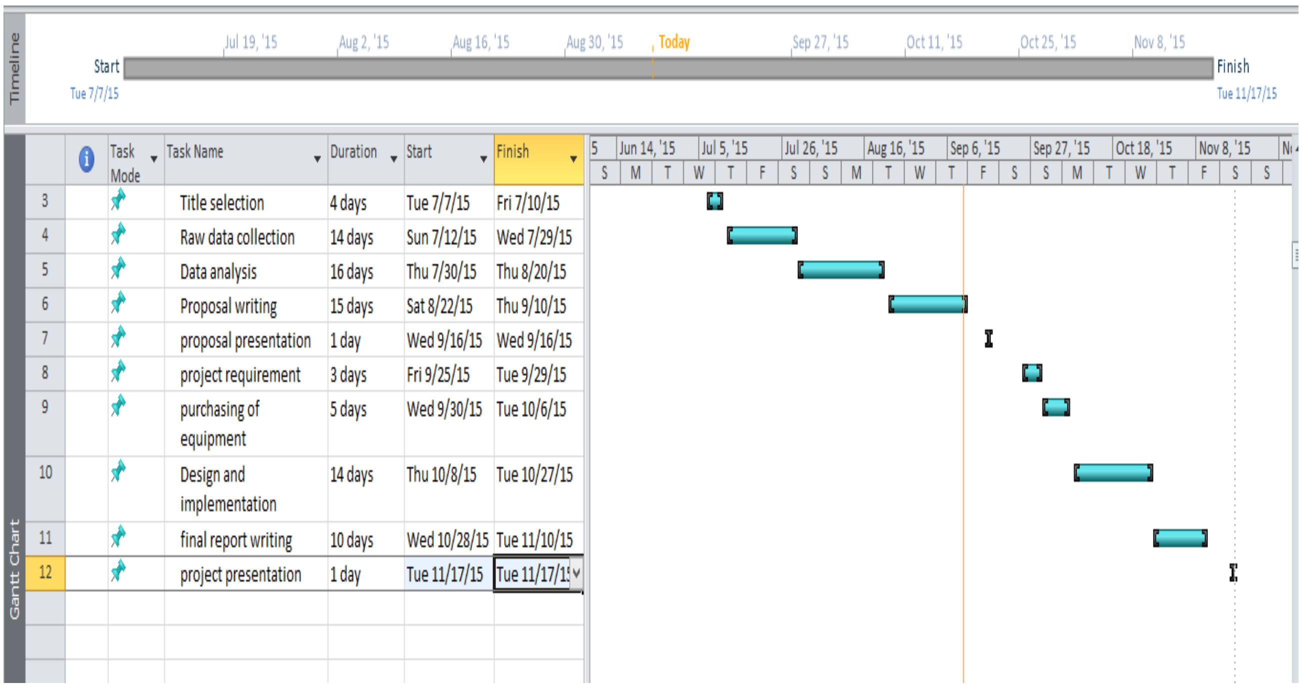
Appendix I:Budget

Table A1: Budget Table

Item	Description	Quantity	Unit Price	Amount
1	Resistors	15	500 Ugx	7,500 Ugx
2	Capacitors	5	1,000 Ugx	7,000 Ugx
3	Variable Resistor	2	1,500 Ugx	3,000 Ugx
4	Transistor BC 547	5	1,000 Ugx	5,000 Ugx
5	LED green	2	1,000 Ugx	2,000 Ugx
6	LED red	2	1,000 Ugx	2,000 Ugx
7	IC1 NE 555	2	2,500 Ugx	5,000 Ugx
8	Battery 9V	1	5,000 Ugx	5,000 Ugx
9	IC2 CD 4017	2	4,000 Ugx	8,000 Ugx
10	Jumper wires	1	5,000 Ugx	5,000 Ugx
11	Breadboard	2	15,000 Ugx	30,000 Ugx
12	Condenser Microphone	2	5,000 Ugx	10,000 Ugx
13	Relay	2	30,000 Ugx	60,000 Ugx
14	Power transformer	1	55,000 Ugx	55,000 Ugx
15	Power switch	1	2,000 Ugx	2,0000 Ugx
16	Diode IN4001	1	2,000 Ugx	2,000 Ugx
16	Miscellaneous			55,000 Ugx
	TOTAL			261,500 Ugx

Appendix II:Project schedule

Table B1: Project Plan



	Task Mode	Task Name	Duration	Start	Finish
3		Title selection	4 days	Tue 7/7/15	Fri 7/10/15
4		Raw data collection	14 days	Sun 7/12/15	Wed 7/29/15
5		Data analysis	16 days	Thu 7/30/15	Thu 8/20/15
6		Proposal writing	15 days	Sat 8/22/15	Thu 9/10/15
7		proposal presentation	1 day	Wed 9/16/15	Wed 9/16/15
8		project requirement	3 days	Fri 9/25/15	Tue 9/29/15
9		purchasing of equipment	5 days	Wed 9/30/15	Tue 10/6/15
10		Design and implementation	14 days	Thu 10/8/15	Tue 10/27/15
11		final report writing	10 days	Wed 10/28/15	Tue 11/10/15
12		project presentation	1 day	Tue 11/17/15	Tue 11/17/15

Appendix III:List of items

Table C1:UsedItems and Components Details:

Items name	Value/details	Quantity
Capacitor C1	0.01uF ceramic	1
Capacitor C2	0.1uF electrolytic	1
Capacitor C3	10uF electrolytic,25V	1
Capacitor C4	0.01uF electrolytic	1
Capacitor C5	0.01uF electrolytic	1
Capacitor C6	0.01uF electrolytic	1
Capacitor C7	2.2uF electrolytic,15V	1
Diode	IN4001	1
LED_1	Green	1
LED_2	Red	1
Resistor R_1	3.3K	1
Resistor R_2	4.7K	1
Resistor R_3	2.2M	1
Resistor R_4	270K	1
Resistor R_5	3.3K	1
Resistor R_6	10K	1
Resistor R_7	270K	1
Resistor R_8	1K	1
Resistor R_9	100K	1
Resistor R_{10}	10K	1
Resistor R_{11}	470K	1
Resistor R_{12}	1K	1
Resistor R_{13}	10K	1
IC_1,IC_2	555	2
IC_3	4017	1
T1 BC548	NPN	1
T1 BC549	NPN	1
Condenser Microphone	----------------	1
Power step-down transformer		1
Relay(RL1)	9V,150 ohm, 1C/O	1
Jumper wires	---------------	1

Appendix IV :Input and Output characteristics of BC548/549 transistors

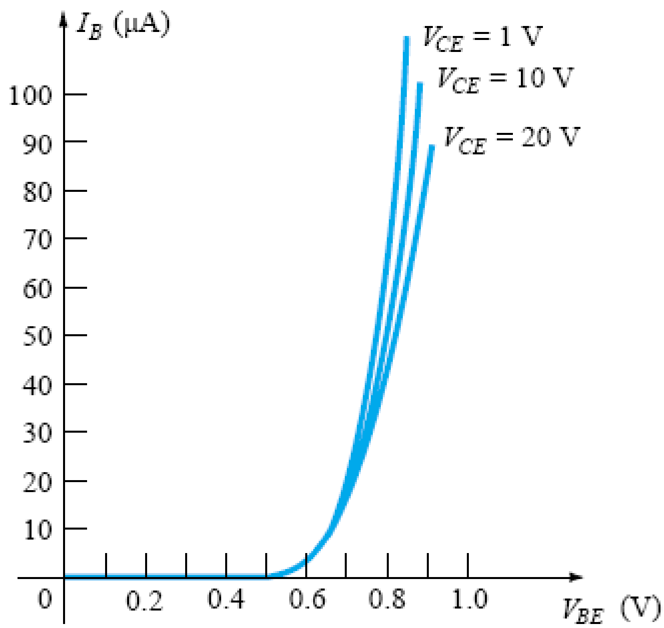


Fig. D2: BC548/549 and its input characteristics

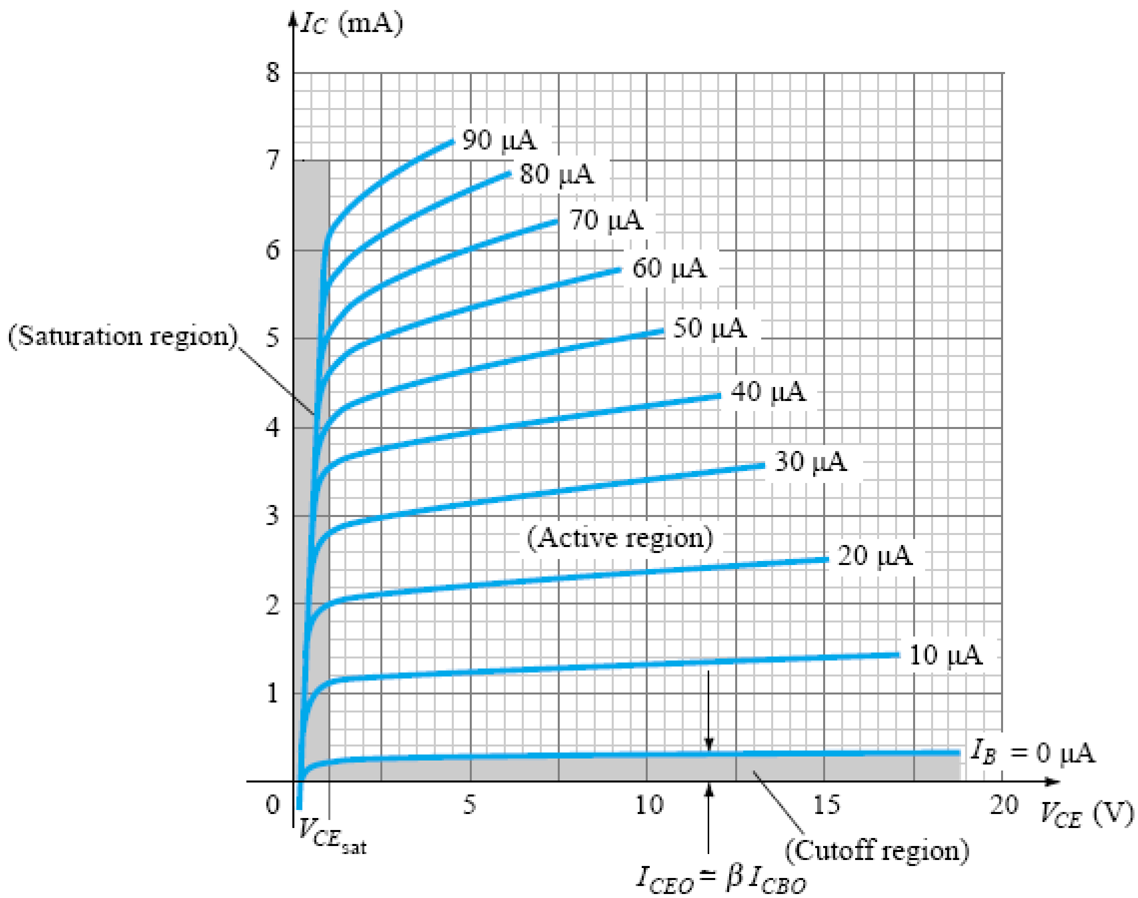


Fig. D2: BC548/549 and its output characteristics