DESIGN AND CONSTRUNCTION OF AUTOMATIC WATER HEATER TEMPERATURE CONTROL SYSTEM

BY

OLAOYE ADEWALE OLUFEMI

99/9298EE

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

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NOVEMBER, 2005.

CERTIFICATION

This is to certify that this thesis "The design and construction of automatic water heating temperature control system" is the original work of **OLAOYE ADEWALE OLUFEMI (99/9298EE)** carried out under my supervision. I found the work adequate both in scope and quality for the partial fulfillment of the requirement for the award of Engineering (B.Eng) in Electrical/Computer Engineering.

.... 12/12/05..................

DR. E ONWUKA DATE

Project Supervisor

....

ENGR. M.D Abdullahi DATE

Head of Department

....

DATE

External Examiner

DECLARATION

I, Olaoye Adewale Olufemi, hereby declare that this project was carried out by me in the department of electrical and computer engineering under the supervision of my supervisor, Dr. Engr. E. N Onwuka.

All Information obtained from published and unpublished works are been duly acknowledged accordingly.

....   12/12/05 ....

OLAOYE ADEWALE OLUFEMI   DATE

Reg. No. 99/9298EE

....

DR. ENGR. E. N. ONWUKA   DATE

SUPERVISOR

DEDICATION

This project is dedicated to GOD ALMIGHTY, the creator of heaven and earth, and to my dear parents Mr. and Mrs. Israel Sunday OLAOYE who always stand by me throughout my academic carriers up to this level. May the good lord add more grace to your elbows.

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ABSTRACT

The design and construction of automatic water heating temperature control system described here in this project is intended to maintain the temperature of boiling water and also to alert through the production of an audio alarm through a loud speaker, as well as visual flashing light alarm using light emitting diodes (LED)

.This project report is intended to produce two outputs. (1 & 0) which depends solely upon the input voltage equivalent of the temperature of the sensor device (transducer), LM 35 and that of the potentiometer (variable resistor). The design is based on the principle of using the temperature transducer (sensor) that converts temperature variation into an electrical signal which is then used to activate the alarm circuit. The alarm circuit in the design is of two types -: light flashing alarm and audio alarm.

LIST OF FIGURES/TABLES

FIGURE **PAGE**

TABLE

TABLE OF CONTENT

Chapter three

Chapter four

Chapter five

CHAPTER ONE

1.0 INTRODUCTION

1.1 Brief History about Energy

Energy in so many years, especially at post second world war has become one of the most significant and important tool in the process of development both in the developed and developing nations of the world. Prior to this era, energy was not considered so important since production was to a large extent dependent on human and animal energy resources.

Heating of water is part of energy utilization and is a process that is as old as man. With passage of time and transformation, the mode of heating water has change from the use of sun to the modern day electricity. The rapid advancement in technology has however reveals that variety of energy sources ranging from the sun to the present day electricity can be use in one way or the other to accomplish this objective of water heating with greater efficiency.

Electricity can be converted into heat and used for raising body temperature using variety of equipments both domestically and industrially. In most of the developing countries, heating of water for bathing during the cold season and also for other purposes represent a significant portion of electricity consumption in the domestic sector. In Nigeria, especially in the urban areas, electricity has proven to be the most widely used source of energy in water heating. It is the most versatile form of energy and most easily distributed.

1.2 NEED FOR AUTOMATIC CONTROLS

The subject of automatic controls is enormous, covering the control of variables such as temperature, pressure, flow, level, and speed. There are three major reasons why automatic control is needed:-

Safety - The system or device must be safe to operate the more complex or dangerous the system or device, the greater is the need for automatic controls and safeguard protocol.

Stability - The system or device should work steadily, predictably and repeatable, without fluctuations or unplanned shutdowns.

Accuracy - This is a primary requirement in factories and buildings to prevent spoilage, increase quality and production rates, and maintain comfort. These are the fundamentals of economic efficiency.

Other desirable benefits such as economy, speed and reliability are also important, but it is against the three major parameters of safety, stability and accuracy that the control application will be measured. A controlled condition might be temperature, pressure, humidity, level, or flow. This means that the measuring element could be a temperature sensor, a pressure transducer or transmitter, a level detector, a humidity sensor or a flow sensor. The manipulated variable could be steam, water, air, electricity, oil or gas, whilst the controlled device could be a valve, damper, pump, fan, or heater. For the purposes of demonstrating the basic principles of this project, concentration will be on heater as the controlled device, water as the manipulated variable, temperature as the controlled condition and temperature sensor as the measuring element.

Temperature data is very helpful when available Manufacturers of certain goods and most especially geographers need it for their data bank. Temperature studies are also very useful for hydrological data and in the study of how plants can survive. Before the construction of power stations, temperature studies used to be carried out so as to know the estimated water level for hydro dams, know the estimated temperature before the design and construction of solar stations etc. [2] [3].

The automatic electric water heater temperature control system is a simple electric device that can be used in various household, offices, industrial plants, cafeterias, manufacturing processes, shower-room, laundry, etc

1.3 SCOPE OF THE PROJECT

The system was achieved by connecting various components together such as a temperature sensor, comparator, a step down transformer, heating element, a regulator, an oscillator, a relay, inverters, power switch, buzzer, rectifying diodes, variable resistors, transistors, resistors, LED`s, SR latch among others. They perform varying functions ranging from stepping down of the input AC to DC by the diodes, filtering and smothering of the DC components by the capacitors and stability by the resistors. The system consists of an automatic temperature switch that can control a powerful heater in a hot water storage vessel. It generally has two fixed temperature settings, one to switch the water heater ON and another to switch it OFF.

This project is primarily concerned with the measurement and response to changes in temperature of heated water at a certain temperature range. The heating source, electric immersion element, heats the water until the water temperature in the vessel rise. When the temperature is high (i.e. above 95), the output voltage of the digital comparator reads 1.This turns OFF the heat source automatically. As the hot water is being drawn from the vessel for use and replaced with another or as the water drops below the setting (i.e. low temperature below 80), the heating source is activated i.e. turns ON to continue the heating. The device is also design in such a way that it creates awareness when the heated water has reached its maximum preset temperature. It produces an audible sound, with the aid of SR latch and oscillator, and a light with the LED which indicates or informs the user that the water has reached its optimum boiling

1.4 AIMS AND OBJECTIVES

The aims and objectives of this project cannot be overemphasized. Listed below are some of the aims and objectives.

1. To develop an affordable and cost effective way of monitoring heated water temperature.
2. To reduce the frequent visit to heated water to desired temperature.
3. To improve on the efficiency of water heater for domestically purposes.
4. To demonstrate the principle of controlling water heater temperature use especially in homes and industries.
5. To achieve a very portable and accurate means of maintaining water heater used for domestic and industrial purposes.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 The History of Domestic Water heating

In the beginning, there was cold water and people didn`t bathe much. They masked body odor with perfumes and oils or just went around smelly. Even as recently as the turn of the century, running hot water was a luxury. It was available only to those who were well off. In Nigeria today, a personal supply of hot water is thought of as a necessity, right up there with food and shelter.

Over time, people have heated water in many ways. A brief look at some of these methods offers an interesting perspective and demonstrates how some of these older and now unused techniques could have applications today.[1]

2.1.1 From stove to storage tank

When wood and coal were the prevalent fuels, water was usually heated in a pot over the fire or in a kettle over the cooking stove. Heating enough water for a bath was a time-consuming ordeal. Much of Saturday was spent getting cleaned up for church on Sunday. Later, when running water came indoors, a chamber or pipe loop called a water-back (or a water-front) was installs in the fire box of the stove. Heated water would move by convection through this chamber to a storage tank. These tanks were called range boilers. The oldest water-back/range boiler still hooked up and in use dates back to the early 1920s.[2].

A variation of the stove/storage tank idea was the "scuttle-a-day" heater, which used coal. It used one scuttle (bucket) of coal per day to keep the water hot-at least relatively hot. This heater had damper controls to adjust the rate of burning, but fully automatic water heating was yet to come.

Another interesting type of heater was the side-arm. Originally, side-arm heaters simply had a gas valve that was operated by hand. The gas was lit with a match when you wanted a bath. Later, automatic controls and safeties were developed that made the side-arm heaters easier to live with.

It's interesting to note that one of the most efficient water heaters available today, the Marathon, is an updated side-arm heater. One of the main reasons it is so efficient is that the burner is separated from the storage tank. Because there is no flue running up through the stored hot water, standby heat loss from the tank is greatly reduced.[3] [4].

2.1.2 Hot water in an instant

Until the 1890s, all forms of water heating both heated and stored the water. With the advent of ELECTRICITY, instantaneous heating became possible. This electricity is much easier to regulate automatically than wood or coal. The bath heater was one of the first instantaneous types. This heater was extremely efficient, though it did result in slightly tainted bath water. Today, the most efficient water heater is the automatic water heater temperature control system.

2.1.3 As the century turned

For many reasons, precise temperature control has always been difficult with heaters. When the "rain bath" or shower became more common, water temperature fluctuated and was not much appreciated. Tank-type heaters seemed to gain in popularity around this time. Later, some innovative ways of getting hot water from a tank within a few minutes after heating had begun came up[4] [5].

2.1.4 Safety and energy upgrades

water heaters are generally the least thought-about piece of equipment in most homes. But it's useful to take the time to understand them, learn a little about their past and guess at their future. That way we're in a good position to do what's needed to get the best performance and longest life from our water heating systems. It's the best way to stay in hot water. [5].

CHAPTER THREE

3.1 THE DESCRIPTION OF COMPONENTS

The circuit is designed with high simplicity. The major components are cheap and easy to get. The audio alarm is generated by a complementary metallic oxide semi-conductor (CMOS) integrated circuit. It provided the circuit with a low power consumption, high compatibility, high fan-out, power supply voltage range, high compatibility and availability. Modern circuit design incorporates the leading logic by reason of the early. The design holds 4000 series complementary metallic oxide mode for implementing logic designs

3.2 THE OSCILLATOR (4060UB)

It is a 14-stage binary ripple counter with an on-chip buffer. The oscillator configuration allows design of either RC or crystal oscillator circuits. Also included on this is a reset function which places all outputs into the new state and disables the oscillator. A negative transition on clock will advance the counter to the next state. Schmitt trigger action on the input line permits very slow input rise and fall times.

Applications of the oscillator include time delay circuits, counters controls and frequency dividing circuits. The integrated circuit is fully static operation, diode protection or all inputs, supply voltage range from 3.0V to 18V, capable of driving two low-power TTL loads or one low-power TTL load over the rated temperature range, buffered outputs available from stage 4 through 10 and 11 through 14, common reset line. It is designed to have a main oscillation and ten frequency outputs from its pin. The integrated circuit holds sixteen (16) pins in which ten of such are for the corresponding frequency outputs. The pin

12 is used for enabling and disenabling the integrated circuit. It is a control terminal. A specific resistor and capacitor are connected to the leading pins.[8]

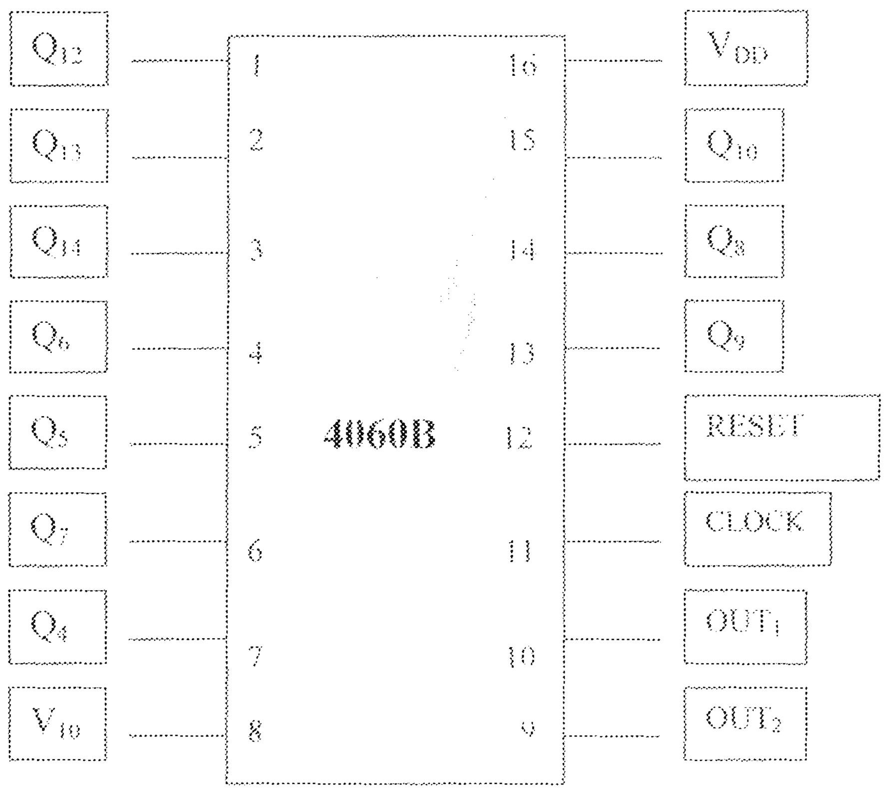

fig 3.1 Pin assignment of **4060B**

The RC configuration determines the oscillation frequency. The frequency of operation of the integrated circuit is given by

$$f \approx 1/23ReCo$$

The relationship of R1 to the circuit is

$$2R2 \leq R1 \leq 10\ R2$$

(f in Hz, R in ohms, C in farads).

The formula have a limited application for it only give the idea or range of frequency operation of the device. The oscillator produces the audio frequencies for the audio alarm

3.3 THE SR LATCH (4013B)

The 4013B is responsible for the input latching of the circuit. The integrated circuit consists of two identical independent data-type flip-flops. Each flip-flop has independent data-type, set, reset and clock inputs and Q and (not Q) outputs. These devices can be used for shift register application input, for counter and toggle applications.

The logic level present at the D input is transferred to the Q output during the positive going transition of the clock pulse. Setting and resetting is independent of the clock and is accomplished by a high level on the set or reset line respectively. The flip-flop can be configured to work only as a SR flip-flop by grounding only data and clock inputs.

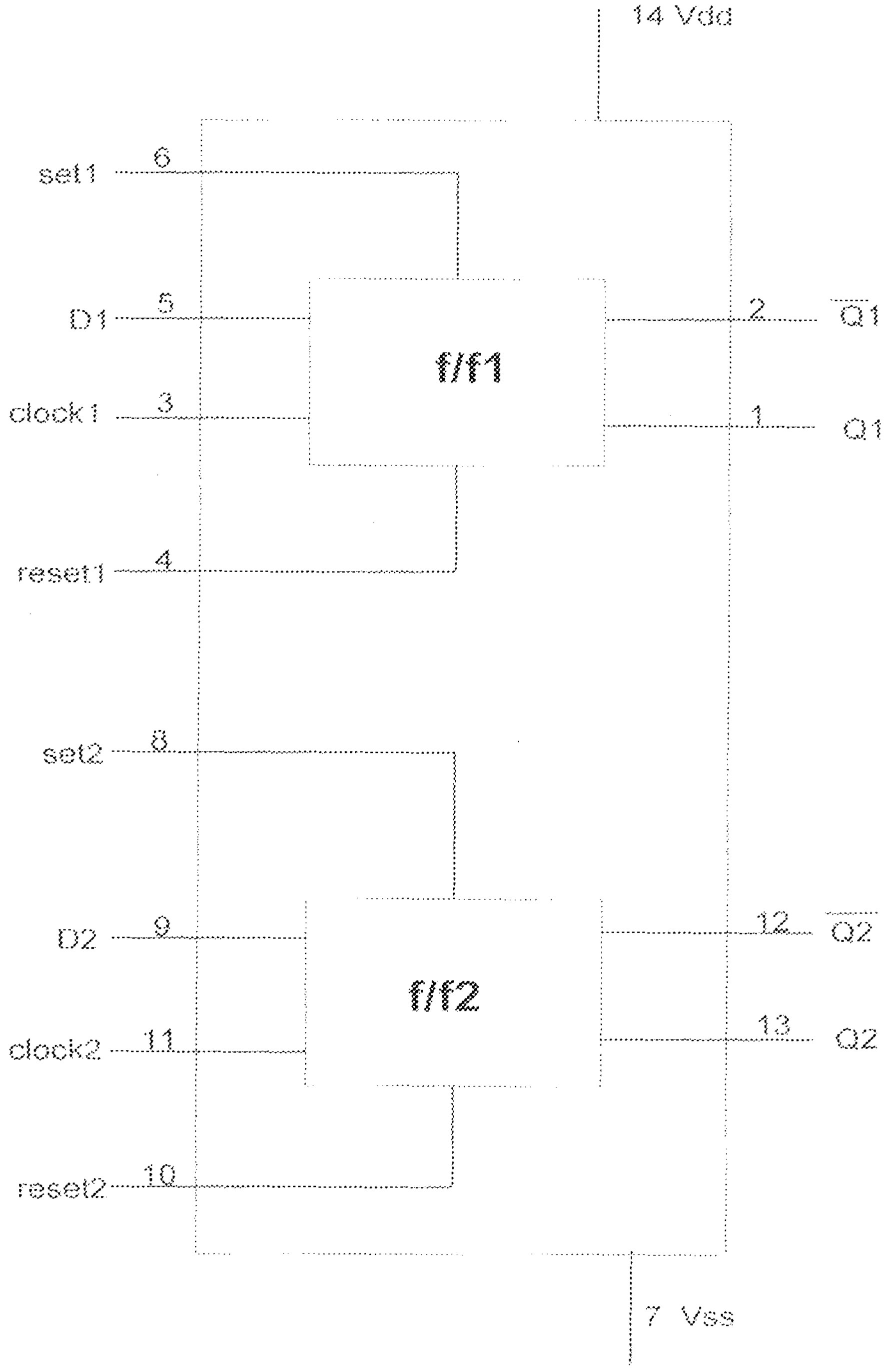

fig. 3.3 Functional diagram of 4013B

The mode of usage in the circuit is merely as a SR flip-flop or latch. The D and clock inputs are ground. So that only the set and reset are actively in use.

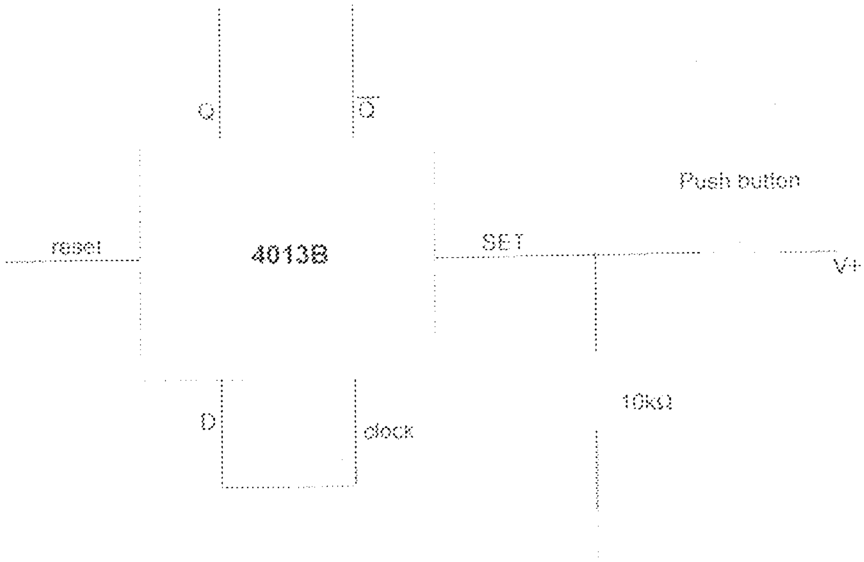

fig. 3.4 The mode of usage of 4013B in the circuit.

TABLE 3.1 TRUTH TABLE OF SR FLIP-FLOP

S	R	Q	Q
0	1	0	1
1	0	1	0

The signal entranced to a push button which when pressed feeding high logical level. The 10kΩ resistor is designed to stabilize the concerned pin whenever the push button is inactive. It really disallows indeterminacy at the input.[10].

3.4 THE TRANSDUCER

Transducer is any device which converts energy from one form to another form such as heat energy into electrical signals. There are two (2) type of transducers grouped as: - INPUT TRANSDUCERS (Examples are: - Thermistor, Photocells, Thermocouple etc). OUTPUT TRANSDUCER (Examples are: - loudspeakers, Motors, Solenoid, Electronic valves etc).

Transducers may be a small part of a system and they are very important device in electronics that especially in control system owing to the success of any control system in terms of its operation and performance which often depends on the quality, sensitivity and stability on the input sensor. This sensor has to pick up the small changes in the input qualities and translate these tiny changes into useful electrical signals.

3.5 THE COMPARATOR

A voltage regulator is a circuit that compared input signal V_{in} with a referenced voltage V_r when the input signal exceeds the referenced signal. A comparator detects two input voltages the output of the circuit is proportional to the signal between the inputs.

3.5.1 LM 339 (QUAD-OPERATIONAL AMPLIFIER) AS A COMPARATOR

The integrated circuit is a quad-comparator package. It is designed with the following features:-

1. Single or split supply operation
2. Low input Bias current 25nA (typical).
3. Low input offset current +- 5.0nA (typical)
4. Low input offset voltage.
5. Input common mode voltage range to GND.
6. Low output saturation voltage 130mV (typical) at 4.0mA.
7. TTL and CMOS compatible.
8. ESD clamps on the input increase reliability without affecting device operation.

It is used in this project as a Digital voltage comparator circuit on whether one of the inputs is greater or less than the other. So the output voltage level therefore represents the output voltage of decision. For this comparator, when the non inverting input is greater than the inverting input, the output is high but when the inverting input is less than or equal to the non inverting input, the output is low. This is mostly determined by the saturation position of the OP-AMP. The circuit thus functions as a precision voltage comparator or balanced detector [7] [9],[10]

3.6 THE DC POWER SUPPLY

The alternating current from the mains is converted to suitable form, use by the system components. The alternating current passes through the following processes.

1. transformation
2. Rectification
3. Regulation

3.6.1 TRANSFORMATION

The transformation of an A/C voltage of a known magnitude (240V) to a lower magnitude (12V) was achieved by using transformer rated 240/12V.

3.6.2 RECTIFICATION

This process is achieved by use of a bridge rectifier. The final voltage needed for the operation of this device has a DC voltage; therefore the 12V alternating voltage from the output of the step down transformer will have to be converted to DC voltage through the bridge diode device as shown in the circuit diagram of power section.

3.6.3 REGULATION

The 7805 voltage regulator is a three- terminal positive regulator and available in the TO-220/D-pak package. This is made to easily protect against short circuits, overheating etc, with excellent properties as a voltage source (e.g. internal resistance measured). The use of 7805 regulator reduces the triple voltage to a desired level. When adequate heat sinking is provided, it can deliver over 1A output current. Although designed primarily as fixed regulator, this device can be used with external components to obtain adjustable voltages and currents. The regulation to the comparator and CMOS ICs is kept at 5V as shown in the circuit diagram to ensure that the switching of the output devices does not affect the circuit operation and also to prevent damage to the ICs if any fault condition arises.

3.7 LED INDICATOR

The LED indicator used in this project looks electrically like a diode (i.e. light emitting diode) with a forward voltage drop of about 2volts. They are built with gallium Arsenide phosphate which has a larger band gap and hence a larger forward drop voltage than Silicon. It is used as a power indicator.

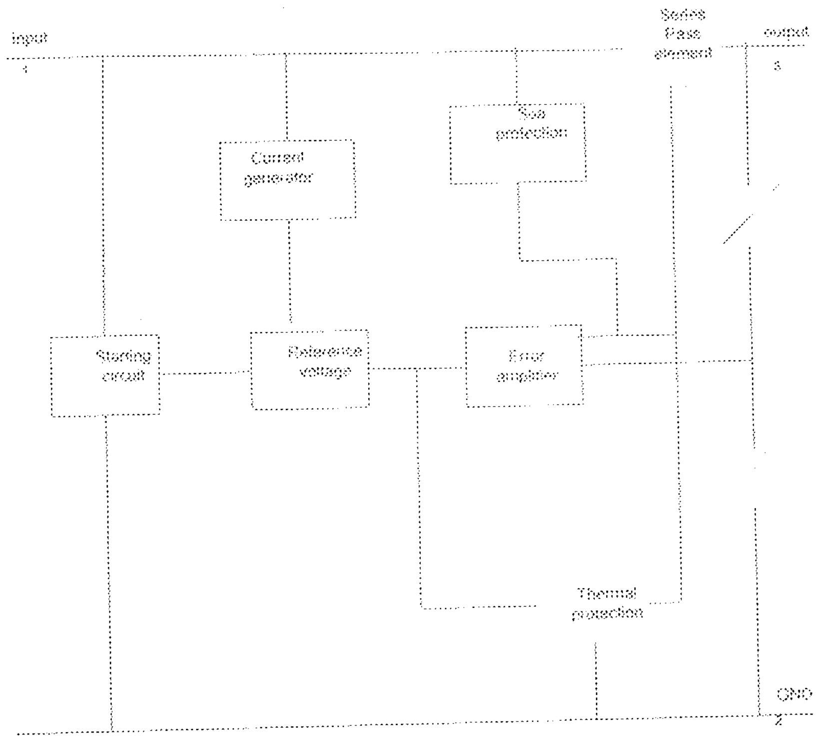

FIG. 3.3 Internal functional of 78XX

The 7805 is designed for a supply voltage of about 35V. And it regulates a voltage of 5 at the pin3 (input). The minimum and maximum output voltages are 4.8 and 5.2 voltage respectively.[13].

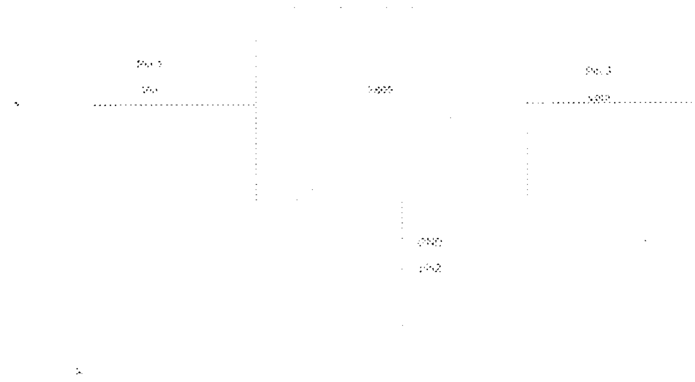

fig. 3.6 Block diagram of 7805 regulator

3.8 THE POWER CIRCUIT

The main power supply comes from a 220/12V step-down transformer. The output alternating current or voltage is applied to a bridge-type rectifier. The rectifier consists of the normal four-diode configuration. The leading diode is IN4001. It is quite a common rectifying diode. Moreover, the ripple filtering is done by a 2200μF 25V electrolytic capacitor.

The power circuit has a power switching which serves as power link to the other part of the circuit. A power indicator is connected along the supply line to indicate the status of current flow in the circuit.

The indicator is a light emitting diode (LED) type. It is connected in series with a 1kΩ resistor. The leading resistor serves as a current limiting device. It disallows damage to be done to the light emitting device.

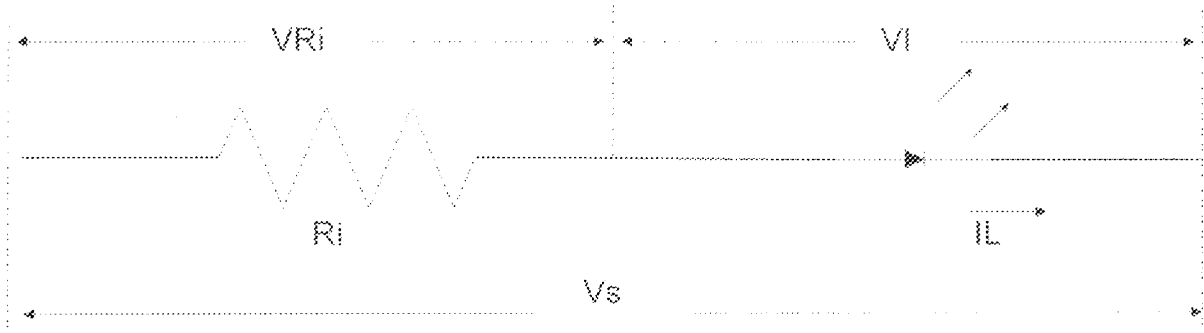

fig. 3.7 Light emitting diode circuit

The specified voltage for a light emitting diode is 2.3V, taken the supply voltage to be 12V. Therefore, voltage across the resistor for normal no-destructive flow is 12-2.3=9.7V. Let's assume a current of 10mA for such a circuit. Therefore, the value of Ri is

$V_{Ri}/Ii=9.7/(10*10^{-3})=970\Omega$.

A 1KV is quite suitable for a 970Ω design result. To add more weight, the 7805 (5V regulator) needs the other part if the circuit with a regulated supply of 5V from the rectified 12V supply provided the transformer.

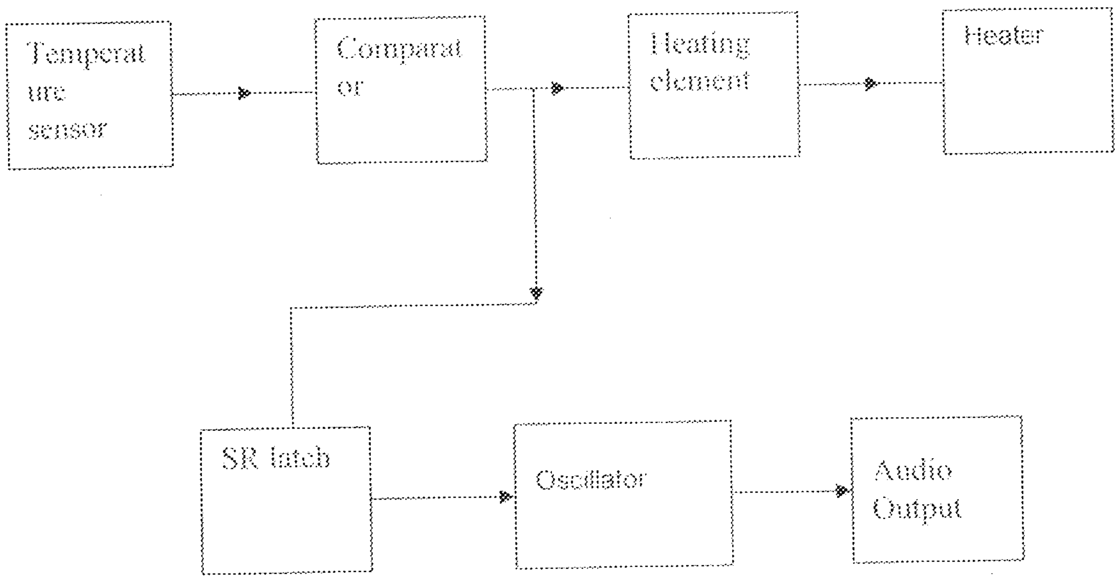

Fig. 3.8 Block diagram of water heater temperature control system

3 9 THE MODE OF OPERATION

The output of the entire circu0it is the LM 35 temperature sensor. Its output is connected to the non-inverting input (+) of the comparator (LM339). In addition, as early stated, the sensor provides an output voltage of 10mV for every degree rise in temperature so that a temperature of 30°C is recognized as 300mV at the sensor`s output. Moreover, the inverting input (-) of the comparator is the reference. A 50KΩ variable resistor is connected to the leading terminal. A suitable voltage of about 950mV (0.95V) is adjusted at the reference.

The comparator merely weighs the two inputs and provides a logical output for the result. When the reference voltage is greater than the voltage output from the sensor (that is at the non-inverting input), the output of the comparator is low logical level. However, in a case the inverting input voltage is greater than the reference due to increases in temperature around the sensor, the output of the comparator is high logical level. This response defines the main operation of the circuit altogether.

A 2MΩ variable resistor is connected from the output to the non-inverting input (+) of the comparator for smooth and fast voltage level switching. And the leading output is connected directly to the base of a switching transistor through a 1KΩ resistor. A light emitting diode is connected in parallel to the line to indicate the presence of relative high voltage at the line.

The transistor is designed to switch ON and OFF the 12V relay. The relay is switched on whenever the base of the transistor is high. Moreover, it is switched off whenever the base is low logical level. A diode is reverse biased at the terminals of the relay to minimize spark and back e.m.f due to switching. The relay is connected to the heater and serves as the control for the output.

The same output is connected to the SET terminal of the SR latch (4013b), a high logical level at this terminal changes Q output to logical 1 and Q`, logical 0. The Q output is connected to a light emitting diode through a current limiting resistor so that whenever Q is high logical level the indicator comes on. The Q` is connected to pin 12 of the oscillator. This terminal controls or enables the oscillator (4060B) so that whenever Q` is low the integrated circuit is enabled. But it is disenabled with high logic level. The oscillator (4060B) is designed to generate two (2) frequencies. One at pin 2 and the other at pin 4. The frequency outputs at these terminals are given below:The main frequency of the integrated circuit is

1 / (2.3*3.3*0.001*10^6) =13.2KHz.

And frequency output at terminal 2 is

13.2*10^3 / 2^13 = 1611328125 Hz

Whereas that of pin 4 is given by

13.2*10^3 / 2^6 = 206.25 Hz

These two frequencies are mixed together to produce the audio alarm signal for the speaker. Whenever the RESET button is pressed, the Q condition is low logical level. Q' is high and the alarm stops.The temperature sensor helps in regulating the temperature of the water between 80°C and 95°C. This is based on the reference voltage adjustment.

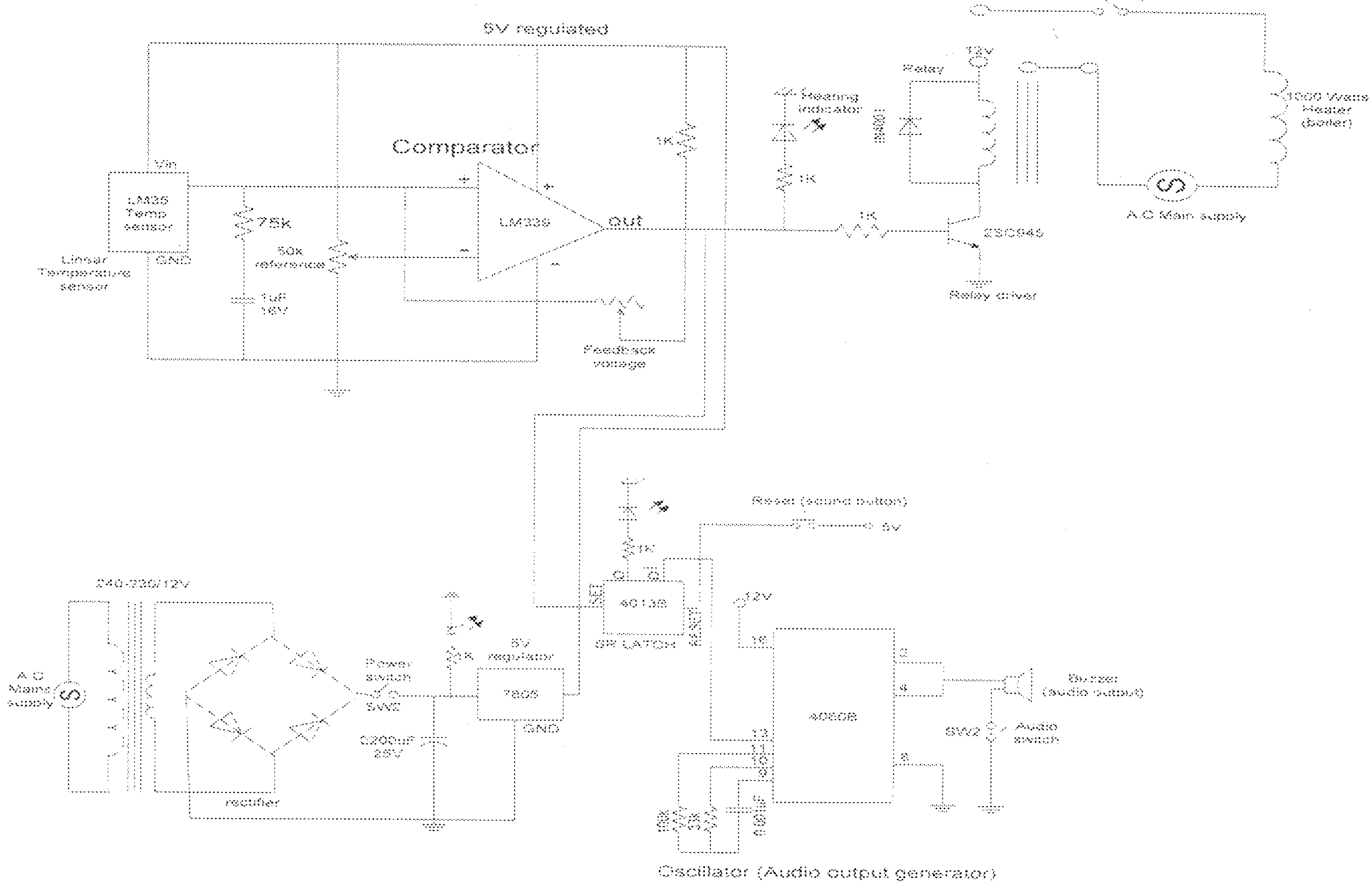

Fig 3.9 circuit diagram of water heater temperature control system

TABLE 3.2 BILL OF MATERIAL (QUANTITY FOR THIS PROJECT DESIGN)

S/N	Description of Components	Quantity	Unit	Rate (#)	Total Amount (#)
1	Step down transformer (240V/12v)	1	LOT	130.00	130.00
2	Diode (In4001)	5	LOT	10.00	50.00
3	Fixed Resistor	14	LOT	10.00	140.00
4	Variable Resistor	2	LOT	20.00	40.00
5	Regulator (5v, 7805)	1	LOT	50.00	50.00
6	Capacitor (47μF,16V)	1	LOT	20.00	20.00
7	Capacitor (2200μF,25V)	1	LOT	60.00	60.00
8	Capacitor (0.001μF)	1	LOT	30.00	30.00
9	NPN Transistor	1	LOT	100.00	100.00
10	Relay	1	LOT	100.00	100.00
11	SR Latch (4013B)	1	LOT	100.00	100.00
12	Oscillator (4060B)	1	LOT	120.00	120.00
13	Loud Speaker (8W, 16Ω)	1	LOT	60.00	60.00
14	Transistor (2SC945)	1	LOT	30.00	30.00
15	Sensor	1	LOT	200.00	200.00
16	Vero board	1	LOT	100.00	100.00
17	LED	3	LOT	10.00	30.00
18	Power Switch (50V/3A)	1	LOT	50.00	50.00
19	Plug (10A, 220V)	1	LOT	50.00	50.00
20	Connection Wires (26Ma/1.8v)	-	LOT	120.00	120.00
21	Miscellaneous	-	LOT	1370.00	
				TOTAL	# 2,580.00

CHAPTER FOUR

4.0 CONSTRUCTION, TESTING AND RESULTS

The circuit connections of the Automatic Water Heating Temperature Control system were carefully constructed with durability in mind.

4.1 ARRANGEMENT

The assembling of components of this project is straight forward and the design layout was carefully followed to avoid wrong connection of some of the components. The assembling of these components is divided into two (2) stages

The first stage was an experiment, which involves mounting of the components on the breadboard. After undergoing the first stage, necessary adjustment was made to the circuit so as to meet the specification and standard required. After the first stage, the circuit construction was then mounted on the Vero board. This permanent connection of the components is carefully done with a moderately heated soldering iron. This is simply done to avoid heat destruction of the loading components. Also, the components are handed with care in order to avoid `static electricity effect or damage.

The power section is firstly implemented on the Vero board. That was after the metallic surface of the board is strictly scrapped with razor blade. The operation encourages smooth and neat soldering of the leading components on the Vero board. Usually the surface of the board is covered with dirt that limits the "metal-to-metal" soldering contact. The sub-circuits were interconnected, so that a whole new circuit was achieved. The circuit was set to meet the aim of the project by careful adjustment of the values of critical value components like the resistors and capacitors toward the output section of the device.

4.2 SOLDERING

Some soldering precautions taken are outline below.

1. Little but enough solder was applied to any joint to ensure proper contact of the components.

2. Care was taken to ensure proper soldering of each joint. so that the lead of individual joint would not heat away.

3. Heat sink was used to conduct heat away.

4. Made sure that the soldering-iron temperature was not too high to prevent damage that could result from other-heating.

4.3 DIFFICULTY ENCOUNTERED

Difficulty encountered during the construction of the project involved:

1. Unclosed connection. which was bridged with a wire.

2. Short circuit that rises through de-soldering of concerned.

3. Readjustment or redesigning of the circuit to fit the real target.

4. Unavailability of some components. which resulted in looking for substitutes

4.4 TESTING

The system was powered from the 12volt DC supply after the components have been mounted on the Vero board and proper safety precaution carried out. Heat was source from soldering iron which was preparedly heated and placed on the temperature sensor (LM 35) directly, so that it could sense the heat and activate whole system. There was audible sound from the loudspeaker as a result of the heat activated and also a light indicator from the LEDs. The alarm and LEDs stop immediately the heat was removed.

4.5 DISCUSSION OF RESULT

It can be seen that the sensor output once increases with increase in temperature. When heat is applied to the sensor, its temperature changes which increases the voltage value of the sensor. At 95°C of the sensor, this causes the output voltage of 5V to trigger audio alarm circuits, for some minutes until the set button is pressed and this clear the latch and the audio alarm is OFF.

4.6 SYSTEM PACKAGING

The complete unit was housed in a wooden case, this is because it's readily available cheaper and convenient to construct. The case is rectangular in shape. It's constructed in such a way that, there is enough at the top, sides and front parts of the case, so that there is enough room for heat and smoke to enter into the chamber of the heat/smoke alarm system case.

Length = 8cm

Breath = 15cm

Height = 10cm

The total volume of the casing is:

Volume = Length * Breath * Height

= 8 * 15 * 10 =1200cm3

The power pack, the speaker and the LED were mounted on the front of the case, while provision were made at the back of the casing for AC and DC supply, for the input transducers. The Vero board was mounted firmly on the base of the wooden case with nuts.

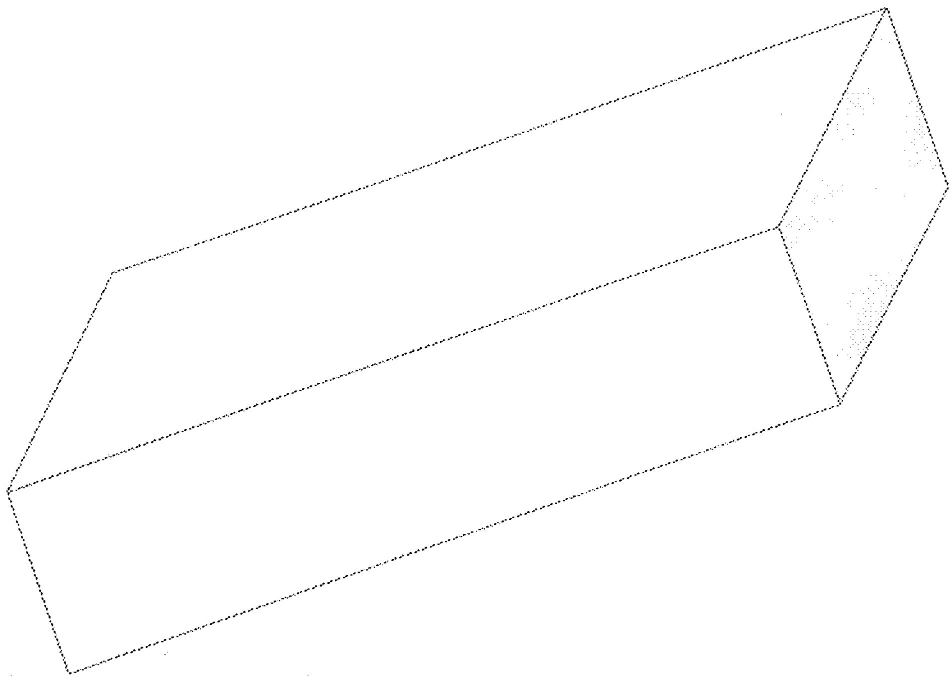

fig.4.1 The system casing

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The design and construction of automatic water heater temperature control system had successfully been carried out as described. The demonstration of the temperature control of water depends solely upon the temperature of the sensor device (LM35).
The aim of this project which is to produce a prototype of water temperature control system which could accept an input signal from the sensory device and give an output to indicate that the condition at the output has been achieved.

5.2 RECOMMENDATION

The design can be improved upon, since there is always room for improvement on ideas. Moreover, the design will serve as a stepping stone for whoever is interested in building or constructing modern water heating temperature control system with a higher sensitivity and lower rate of false alarm. Thus, it is hoped also that it will provide a solution to the difficulty of life in several places of work, houses and industries.

REFERENCES

[1]. www.Ideafinder.com.

[2] www.Absoluteastronomy.com.

[3]. www.howstuffwork.com

[4] www.asianelenex.com

[5] www.fire.nist.com.

[6] www.c-tec.co.uk

[7]. National Operational Amplifiers Data book, 1995 edition, pp 1 – 32

http//www.wsc.com

[8].Oscillator Design Electronic. A Self-Teaching Guide. John Wiley & Sons. 1979. pp 34 – 42, 180, 204.

[9].D.C. Ramsay, Engineering Instrumentation and Control, Stanley thornes (publishers) limited 1981 pp 34 – 42.

[10].Paul Horowitz & Winfield Hill, The Art of Electronics 2nd edition. Cambridge University Press. 1989. pp 992 – 996, 590, 580.

[11].Jerry C. Wintakes, The electronics Handbook published in co-operation with IEE press, published by CRC Press Beverton, Oregon. page 150. 1996.

[12]. W.H. Dennis: Electronics components and systems: , Butterworth & co (publishers) Ltd, 1992 pp 28 – 50.

[13] .S. D. Sentura and B. D. Wedlock, Electronics circuit and Applications: , John Wiles & Sons,1975(New York).