DESIGN AND CONSTRUCTION OF AUTOMATIC HEAT AND SMOKE DETECTOR SYSTEM

BY
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DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

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FEDERAL UNIVERSITY OF TECHNOLOGY
MINNA
NIGER STATE

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IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF A BACHELOR OF ENGINEERING DEGREE (B.ENG) IN ELECTRICAL/ COMPUTER ENGINEERING

NOVEMBER, 2005

DECLARATION

We hereby declare that this thesis "The design and construction of automatic heat and smoke detector" is the original work of **Joseph, John. A (2000/10659EE)** carried out under my supervision. We had found the work to be adequate both in scope and quality for the partial fulfillment of the requirement for the award of Engineering (B.Eng) in Electrical/Computer Engineering.

....	5/12/2005 ....
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EXTERNAL EXAMINER	**Date**

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DEDICATION

This project is dedicated to JEHOVAH GOD, the creator of heaven and earth, and to my dear mother Mrs. Omuni Modupe who always stand by me throughout my academic carriers up to this level. May Jehovah add more grace to your elbow

ABSTRACT

This design and construction of heat and smoke alarm system is described in this project. The project is intended to produce an Audio alarm to in **4Ω, 12W** Audio speaker, as well as visual flashing light alarm using lighting emitting diodes (RED) and (Green) for heat and (Blue) for smoke respectively.

This project report is intended to produce two outputs, which depends solely upon the temperature of the sensor device (thermistor) and the high resistance of the photocell sensor due to the deflection/reflection of the infra-red transmitter through the smoke to the infra-red sensor.

The thermistor here is subjected under the heat with its two leg pin connected to wire and connected to the probes digital multi-meter, the resistance of the thermistor increases, thereby causing it to approach the set trip value.

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CHAPTER ONE

INTRODUCTION

1.1 Brief History about the Project

Fire detectors are devices that sense the early stages of fire and sound a warning so that the occupants of a building may safely escape. They detect smoke and heat in a variety of ways. The two basic types of fire detectors are smoke detectors and heat detectors. A smoke detector transmits a signal to the control unit when the concentration of airborne combustion products reaches a predetermined level. A heat detector transmits a similar signal when the temperature reaches a predetermined level or when there is an abnormal rate of temperature rise.

There are two principal types of smoke detectors: photoelectric and ionization. Photoelectric detectors are sensitive to the presence of ions, which are electrically charged particles produced by the chemical reactions that take place during combustion. Both ionization and photoelectric detectors are effective. Which one is better in a given situation depends on the nature of the fire. Hot gases with few smoke particles are more readily detected by ionization smoke detectors, while photoelectric detectors are more sensitive to cooler smoke with large smoke particles.

The smoke detectors should not be confused with self-contained devices commonly used in apartment suites and houses that are technically referred to as smoke alarms. Smoke alarms have a build-in audible alarm device in addition to a smoke sensor. Smoke alarms are intended to warn only the occupants in the room or suite in which they are located. Smoke detectors, on the other hand, are connected to the building's fire alarm system and are designed to initiate an alarm signal to warn the occupants of the entire building. Heat detectors, like smoke detectors, when actuated send a signal to the control unit to initiate an alarm throughout the building. This type of detector is not prone to false alarms although it is rather insensitive to smoldering fires of low temperature.

Automatic sprinklers can perform the same function as a heat detector. A water system is installed so that when the sprinklers operate the fire alarm system is actuated. This form of fire detection has the advantage of automatically suppressing the fire [14].

1.2 Scope of the Project

The scope of the project is to design a fire alarm with some complex features such as heat detector, smoke detector and loud-speaker. However, they are usually much more complex when components such as fire detectors, annuciator panels, telephones, control panels and pull boxes are included [14].

The system designed and constructed enables the loudspeaker to produce the audible alarm signals. It also enables the speaker to provide voice communications so that additional equipment is not required and lesser energy and time is expended.

1.3 The Necessity of the Project

The project is a necessity for building codes. In the case of a new building, this is usually accomplished through the adoption of building regulations. In existing buildings, fire alarm systems may be required by municipal or provincial fire code provisions or by special provincial acts or municipal by-laws directed at specific classes of building.

1.4 Methodology Adopted in the Project

The first approach here is to provide a description of each component used in the circuit in order to give a very clear understanding and intuitive findings for the design behavior. After physical insight has being obtained into the operation of the circuit then mathematics is applied in deriving the circuit parameters. The concluding steps include the construction, testing, trouble-shooting and packaging of smoke and the heat alarm system. This is followed by conclusion and recommendation. Each chapter is well defined with illustrations using block diagram and circuit diagrams provided where necessary.

The project report is divided into five chapters. Chapter one introduces the project. Chapter two contains literature review. Chapter three gives design and system operation project report such as captioned diagrams. Chapter four gives construction, testing and the result obtained. Chapter five gives the conclusions and recommendations. Finally the materials consulted are contained in the references.

1.5 Constraint to the project

The constraints of the project is that it is limited to the design and construction of smoke detector, heat detector and alarm system which can detect heat, smoke and give alarm signal but it cannot automatically engage equipment to pressurized stairways to shut down recirculation of air system.

1.6 Objectives of the Project

The objective of the project is to design an efficient fire alarm that will be able to alert the occupants of a building to the presence of fire. It may also perform other functions. For instance, the system can be designed to simultaneously alert the fire department by means of a direct or relayed signal where a response by the fire department is essential. This is particularly important in certain industrial establishments containing large quantities of highly explosive materials where a fire can develop rapidly and in high buildings, hospitals and nursing homes where evacuation assistance may be required. In other cases, because of the nature of the building occupancy, the alarm system may be designed to alert initially only the building staff before the general alarm is activated.

1.7 Economic Importance

The economic importance of this project design is to save cost. It costs ₦3, 930 to design and construct a smoke and heat detecting system (refer to bill of quantities on page 38). This can be compared with research carried out at a security company, 61 MOBOLAJI BANK–ANTHONY WAY IKEJA LAGOS. It was found that imported smoke detector costs ₦3, 500 while imported heat detector cost ₦3, 000. A single zone fire alarm panel costs ₦7, 000, whereas the design and construction of smoke, heat detector and alarm system cost below a price for a single detecting system **[13].**

CHAPTER TWO

2.1 LITERATURE REVIEW

The design of heat and smoke detector dated back to the beginning 19th century when George Andrew Darby, an electrical engineer of 211 Bloomsbury street, Birmingham, England, in 1902 patented the electrical heat-indicator and fire alarm. The devices indicated any change of temperature in the apartment where it was fixed. The devices operated by closing an electrical circuit to sound an alarm if the temperature rose above the safe limit. The contact was made by bridging a gap with a conductor or allowing one plate to fall on anther. This closing movement was caused simply by a block of butter which melted as the temperature rose. This early device subsequently gave way to more modern fire alarm and eventually smoke alarm **[11]**.

Another significant development occurred in the 1920's as a result of several resort fires which claimed many lives around the world. The leading members of Japan's insurance industry founded the Hochiki Corporation in 1918. The Hochiki Corporation undertook the design, manufacturing, installation and maintenance of fire alarm systems and produced in excess of 3.5 million units each year. The first mechanical manual (MM) style fire alarm system was installed in Japan by Hochiki Corporation.

In the 1960's the mechanical manual (MM) style fire alarms system was exported by Bangkok, Thailand. The manufacturing and testing facility was constructed in Machida which is a suburb of Tokyo **[15]**. Also in 1969, British company Electronics designed the first battery-operated smoke alarm to received UL (Underwriters Laboratories Inc) listing. During the 1970's as part of the Pittway Corporation, the smoke alarm division flourished. As a division of Pittway, British company Electronics flourished. During the early 70's, intense product development produced a series of high quality and affordable battery and AC powered and system smoke alarm. British Electronics used these successes to enter the new construction and mobile home markets and increase its share of the commercial system smoke alarm market **[16, 17]**.

In 1974, Sears, Roebuck and Company put its name on British company Electronics battery-operated smoke alarms. The response was outstanding. The popularity of the Sears Alarm was so strong it prompted other manufacturers to enter the residential smoke detector market. In 1976, British company Electronics introduced First Alert brand battery-operated residential smoke alarms. Consumers responded enthusiastically and sales of First Alert brand alarms became a major part of British company Electronics' total sales. By 1980, First Alert brand products had became the most recognized name in smoke detection. First Alert, together with BRK brand alarm sold primarily to electrical contractors, combined to make British company Electronics the leading manufacturer of residential alarms. The major contribution of British company Electronics in the field of fire and smoke detectors are as follows:

- Residential smoke, in 1967
- Residential carbon monoxide (CO) alarm, in 1993
- Combination smoke and CO alarm, in 1996
- Remote control CO alarm, in 2000
- Remote control smoke alarm, in 2001 **[16]**.

In modern time, optical smoke and heat detectors such as the one produced by C-TEC Company, a British Fire Protection System Association, incorporates a pulsing LED which is located in a labyrinth within its housing. The labyrinth is designed to exclude light from any external source. At an angle to the LED is a photo-diode which normally does not register the beam of light emitted by the LED. In the event of smoke entering the labyrinth the light pulse from the LED is scattered and registered by the photo-diode. If the photo-diode 'sees' smoke on the two following pulses, the detector changes to the alarm state and its LED illuminates. This detector is usually used for detecting fires from materials which produced large smoke particles such as PVC insulation, fabrics, furnishings etc.

All series C60 heat detectors, produced by C-TEC, operate by using a matched pair of Thermistor to sense heat. One Thermistor is exposed to the ambient temperature, the other is sealed. In normal conditions the two Thermistor register similar temperatures but, on the development of a fire, the temperature at the exposed Thermistor will increase rapidly. This imbalance causes the detector to go into alarm.

The European Standard categorized heat detectors according to their response time and fixed upper limits. Detectors are classified as being grades 1, 2 or 3 (for most normal applications) or ranges 1 and 2 (for high temperature environment). The fixed upper temperatures for grade 1, 2 and 3 are 60°C, 65°C and 75°C respectively and for ranges 1 and 2 they are 80°C and100°C. All grades have a rate or rise element, but this differs according to the response time, grade 1 being the fastest in responding [22].

Heat detectors are normally used in areas where too much smoke is produced for the reliability of optical or ionization detectors (public house, waiting rooms, etc) or in high temperature environments such as boiler houses. An efficient heat and smoke detector should be able to detect fire from materials which produce small smoke particles such as PVC insulation, fabrics, paper and wood. The latest innovation has been able to meet this requirement of efficiency in smoke and heat detectors **[20]**.

CHAPTER THREE

3.1 DESIGN OVERVIEW

The circuit is designed to be both simple and economical. This requirement is made possible by the use of complementary metallic oxide semiconductor (CMOS) integrated circuit. Such logic technique is attributed to low power consumption, high compatibility, high fun-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 DESIGN OPERATION

The circuit is designed with two input sections or circuits, the smoke and heat detector circuit. The leading two involves specific sensors or transducers that helps in the basic technique is the convection of the varying physical and external conditions or energies into corresponding electrical quality is now processed to yield a predetermined result or detection

3.2.1 THE OSCILLATOR

The 4060B is the oscillator of the circuit. It is a 14-stage binary ripple counter with an on-chip oscillator 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 full 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 schottky TTL load over the rated temperature range, buffered outputs available from stage 4 through 10 and 11 through 14, common reset line[1].

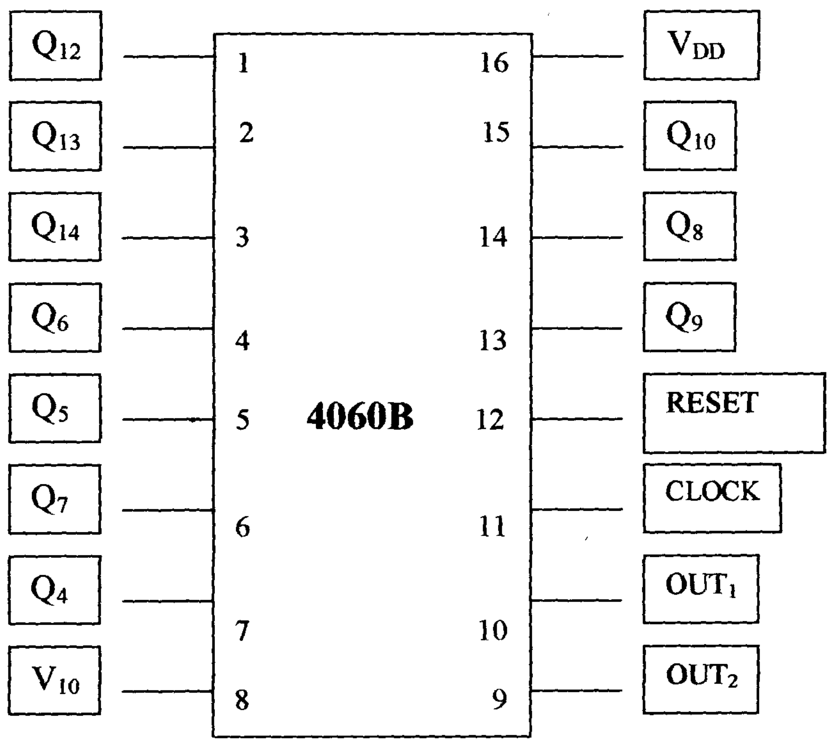


*Fig 3.2.1(a) Pin assignment of **4060B***

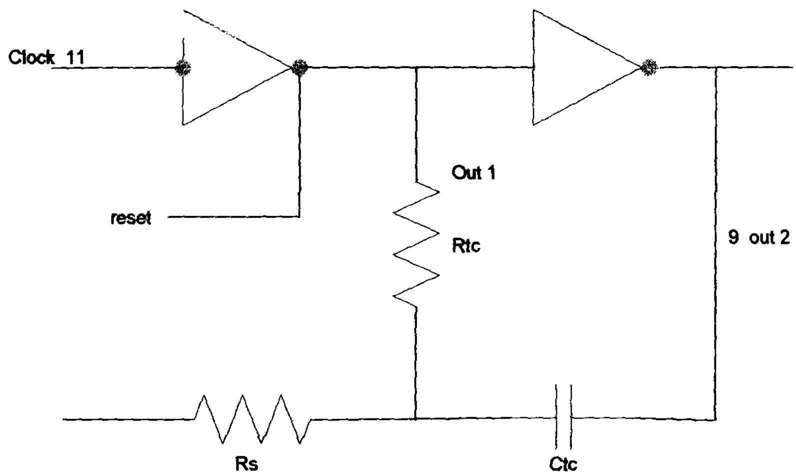


Fig 3.2.1(b) Oscillator circuit using RC configuration

The frequency of operation of the integrated circuit is given by

$$f \approx 1/(2.3RtcCtc)$$

If 1 kHz ≤ f ≤ 100 kHz

And 2Rtc < Rs < 10Rtc

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

The formula may vary for other frequencies.

Recommended maximum value for the resistor is 1mΩ.

The values of Rtc and Rs for the leading circuit are 33kΩ and 100kΩ respectively.

So that the frequency of application is

$$=1/(2.3 * 33 * 10^3 * 0.001 * 10^{-6})$$

$$= 13.175 \text{ kHz.}$$

So that the frequency of pin 13 and 7 are as follow;

For pin 13

$f_{pin13}=f/2^9 \quad = 13.175*10^3/2^9 = 25.73Hz.$

For pin 7

$f_{pin7}=f/2^4 \quad = 13.175*10^3/2^4 = 823.45Hz.$

The oscillator produces the mixed audio frequencies for the audio alarm.

3.2.2 THE SR LATCH

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 output latch (4013B at SR flip-flop configuration) is designed to store the input sensors results so that even when the smoke and heat source is off, the latch is still held the information. The Q output of the latch is connected to the reset pin12 of the 4060B. A high voltage or logical level the oscillator is enabled. The two frequencies output are together to form the audio alarm effect.

The N-channel MSFET amplifies the mixed audio signal or frequency. So that strong audio output is transferred into the speaker. The speaker is a 3watt 4Ω type. The value is not really critical, similar ones should do [2].

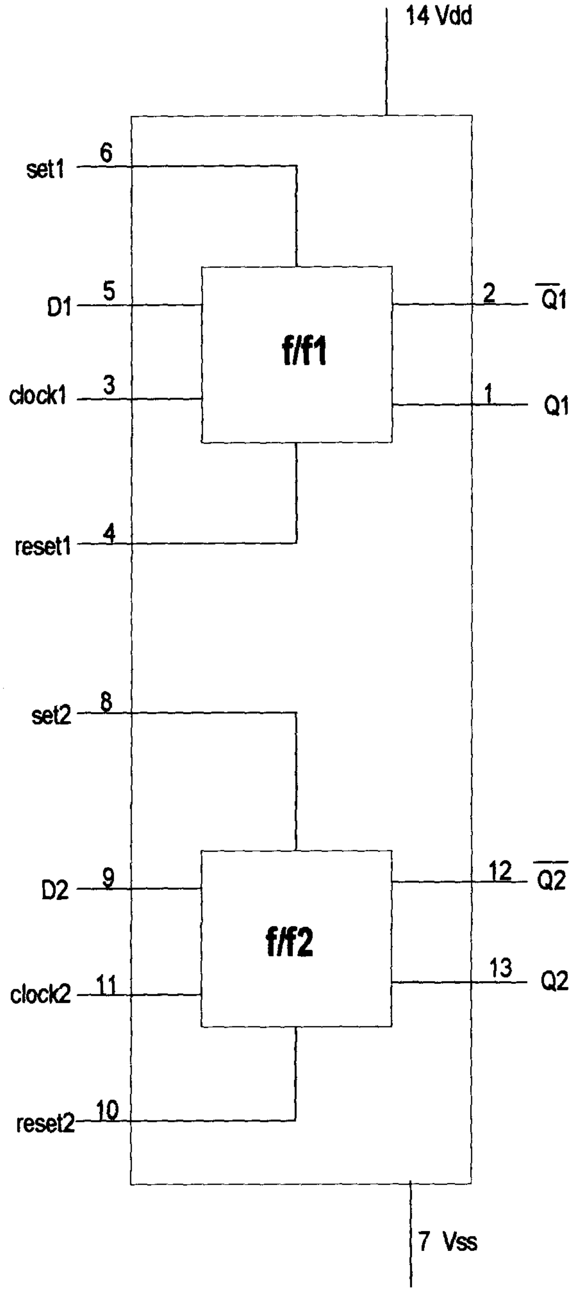


Fig 3.2.2(a) *__Functional diagram of 4013B__*

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.

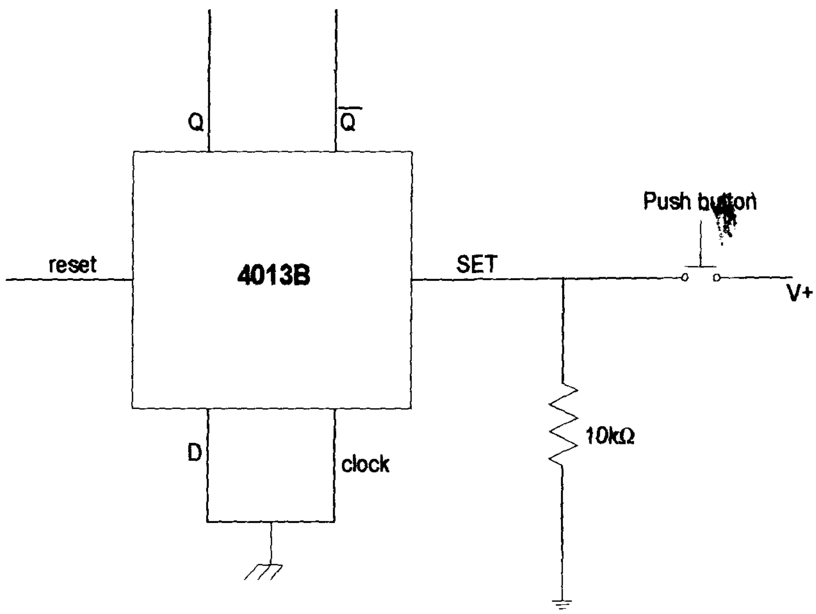


Fig 3.2.2 (b) *<u>The mode of usage of 4013B in the circuit.</u>*

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

TRUE TABLE OF SR FLIP-FLOP

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. Ii really disallows indeterminacy at the input.

3.2.3 THE N-CHANNEL MOSFET (AUDIO ALARM AMPLIFIER)

The IRF244 is a high and power switching transistor. It involves advanced processing techniques to achieve extremely low on-resistance per silicon area.

This benefit, combined with the fast switching speed and rugged zed device design that HEXFET power metallic oxide semiconductor field effect transistors are well known for, provides the designer with an extremely efficient and reliable for use in a wide variety of applications. The device works at an average of continuous drain current of 40A, giving out an output power of about 3.8W, at Gate-to-Source Voltage of ±70V. Moreover, the Drain-source resistance is 0.0175Ω at switching on. This merit makes the device quite good for audio frequency amplification such as audio alarm output [3].

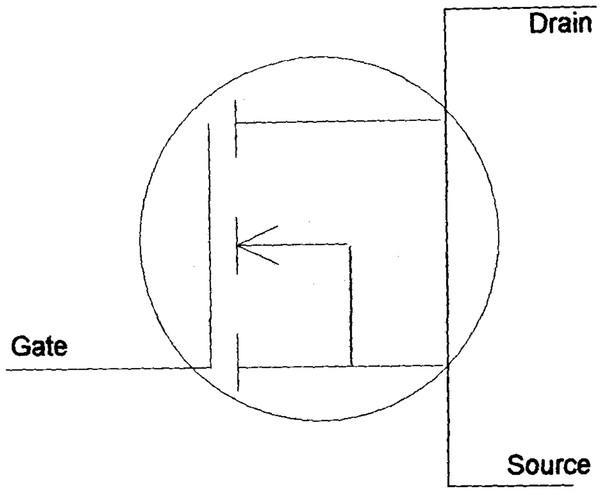


Fig 3.2.3 Device symbol

3.2.4 THE LOGIC INVERTER

The 4069VB is a hex inverter. It consists of six CMOS inverter circuits. These devices are intended for all general purpose inverter applications where the medium operation speed is required **[4]**.

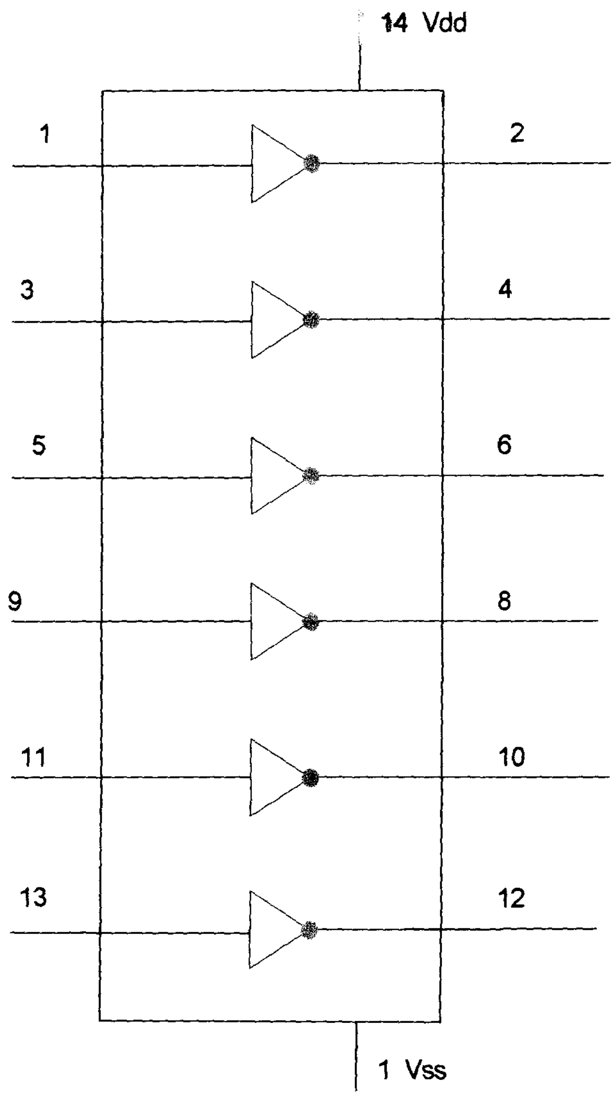


Fig 3.2.4. *Functional diagram of 4069VB*

3.3 VOLTAGE REGULATOR

The voltage is regulated by the 7805 (5V regulator). It is part of the 78XX series of three terminal positive regulators available in the 10-770/D0PAK package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut down and safe operation area protection, making it essentially indestructible. If adequate heat sinking is provided they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components obtain adjustable voltage and currents.

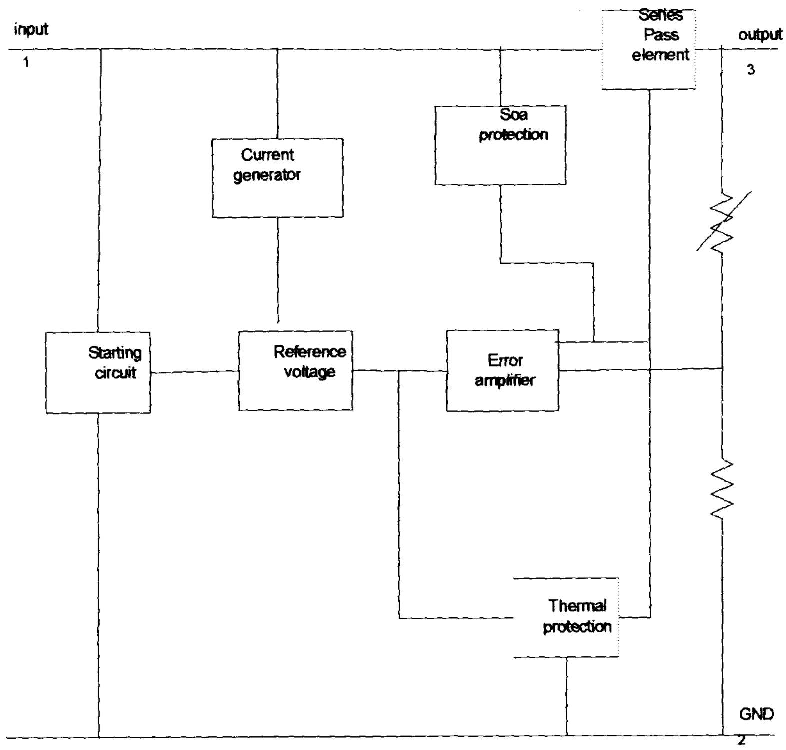


Fig 3.3(a) Internal *functional of 78XX*

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 **[5]**.

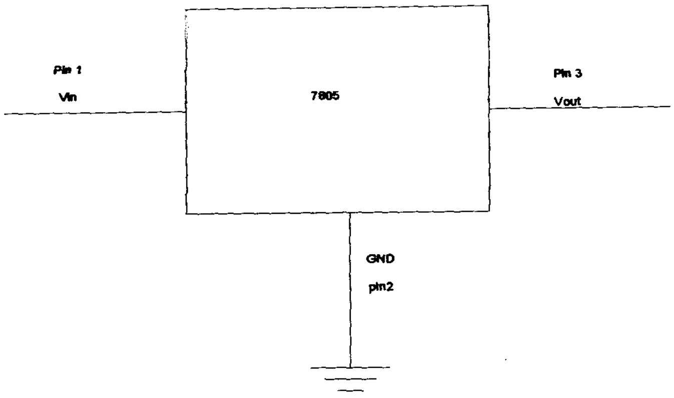


Fig 3.3(b) *Block diagram of 7805 regulator*

3.4 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.

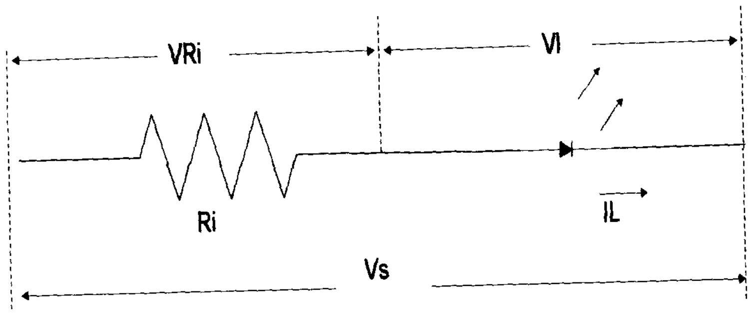


Fig 3.4 Light *emitting diode circuit.*

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.

3.5 SMOKE DETECTOR CIRCUIT

It requires both an infra-red transmitter and receiver. The two devices are linked in line but with some set of obstacles in between. The obstacles cause a cut-off or barrier state for link, so that only the reflection medium could cause the in-line situation for the two devices. A medium or gas such as carbon monoxide is a good reflecting medium for infra-red radiation. The leading beam would be scratched through such a gaseous, which resulted to deflection and reflection.

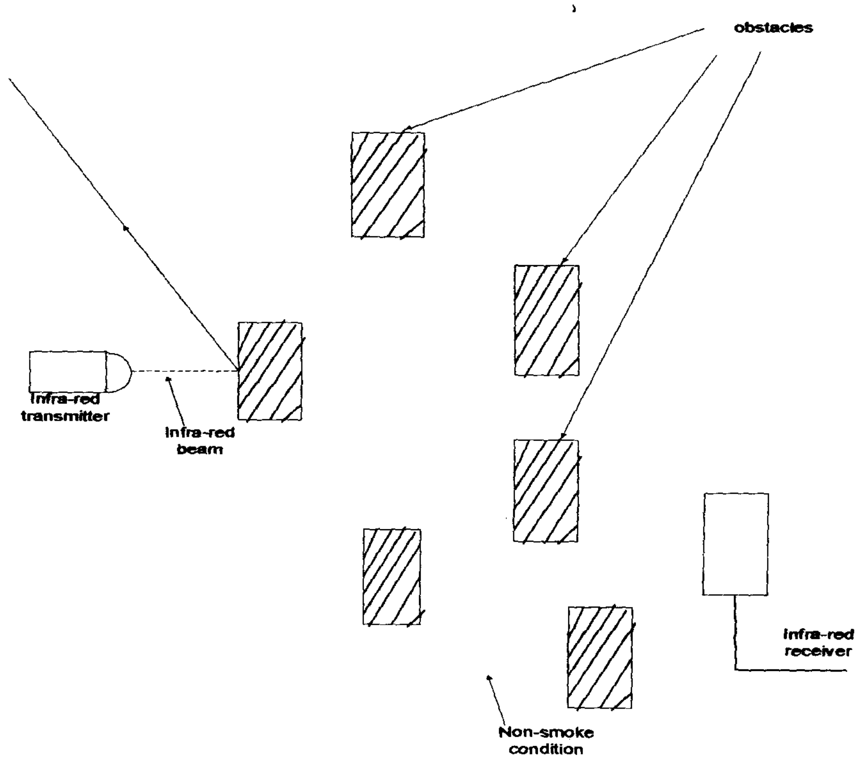
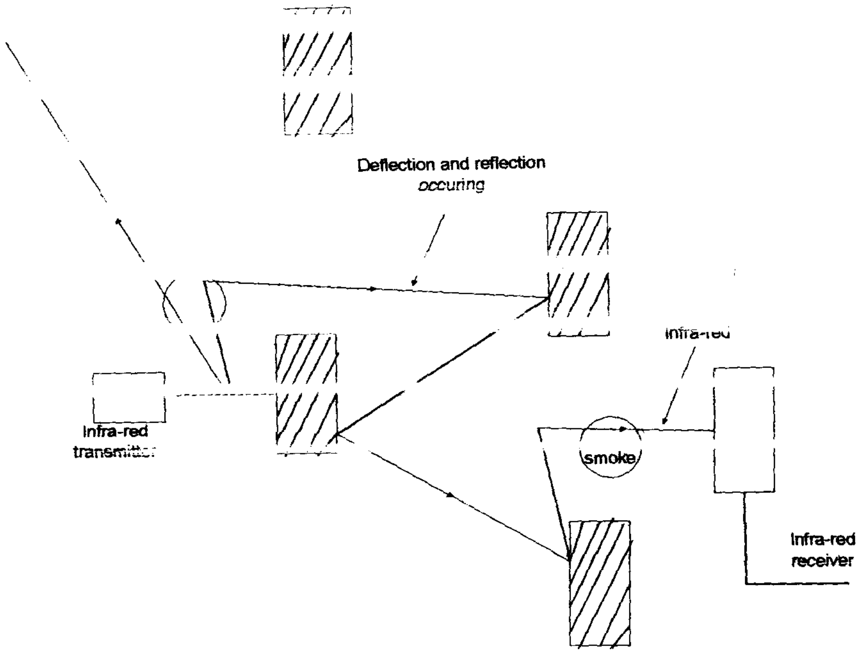


Fig 3.5 (a) *A non-link condition between an infra-red transmitter and receiver*



An in-line condition due to the presence of smoke

The infra-red transmitter holds the same light emitting diode (LED) circuit configuration with the series 1kΩ resistor in place.

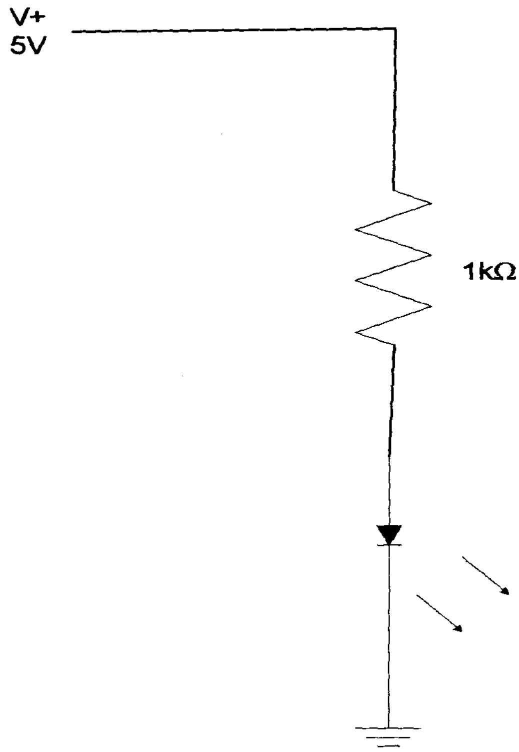


Fig 3.5 (b) Infra-red transmitter circuit.

The other side, the infra-red receiver, consists of an infra-red detecting diode/transistor circuit. The sensor also requires a 1kΩ current limiting resistor in series.

The transistor in use is 25C945. It is an NPN type with a current gain of 120. It is widely use as a switching device. And it holds the same importance in the circuit for while the infra-red link is active. The base current of the transistor is relatively high. And it is quite sufficient to trigger or switch the device on. And switching the transistor ON is merely making the emitter-collector voltage very low, if possible zero voltage. But a breakage to infra-red link results to a switched off transistor set-up, and when the transistor is switched off, the emitter-collector voltage is high as possible, if possible the supply voltage. The above really threw light to the basic principle of operation of the smoke detector and how detection is defined. So that for a non-smoke conditions the output (collector) if the transistor is relatively high. And, in-smoke condition the output (collector) is relatively low. But the reverse is required. And the application of an inverter is logical level. So that for a non-smoke condition the output is relatively low. And a relatively high voltage or logical level recognizes the detection of smoke of the sensor section. A light emitting diode (LED) indicator circuit is connected to the output to light up whenever smoke is detected. Also, an OR gate is incorporated to the output line to sum up results from both smoke and heat detector circuit. The common output line is fed to the input SR latch, and triggers on the audio alarm circuit [6].

3.6 THE HEAT DETECTOR CIRCUIT

The circuit incorporates an NPN transistor common-emitter configuration. And the sensor for this case is a thermistor. Such transducer converts heat energy into corresponding electric current or voltage. The device senses the application of heat with the variation of self resistance.

There are two type of thermistor, the positive coefficient and the negative coefficient type. The early response of increase in temperature also corresponds to increase in resistance. While the negative coefficient type decreases in self resistance with an increase in temperature.

The circuit is attributed to a positive coefficient type. It has an initial resistance of 53Ω at room temperature. And increasing temperature raises the resistance extremely high.

The transistor circuit has a 100kΩ base resistor which provides a 0.7V at the base of the transistor. So that the applied voltage sources the resistor with a voltage of 1.3V (5-0.7)

The current at the base= 4.3/ (100*10^3).

=0.0000043A≈4.3μF

The emitter-base resistor is assumed zero for easily calculation. So that at normal set-up while the thermistor resistance is minimum, the output or collector of the transistor is relatively low. Or zero voltage. Moreover, increasing the temperature of the thermistor increases the resistance of the thermistor tom about 2oo0Ω which switches off the transistor.

A high emitter-resistance of about 2000Ω relatively increases the voltage level of the collector. The output is connected to a light emitting diode (LED) indicator circuit which indicates the detection is connected to the other input of the 2-input OR gate **[8]**.

3.7 THE THERMISTOR

Thermistor is a transducer which converts Heat-energy to Electrical signal. A thermistor is a semi-conductor whose resistance varies as the temperature changes. The thermistor used in this project is FC27M 270 as already mention, the thermistor is used as a control device which actuated when there is changes in temperature. A laboratory measurement of resistance variation versus temperature was effected to enable proper design of the quiescent operation point of the bridgecircuit. The data collected is given in table 3.7 and the ensuring graph in fig 3.7.

The general temperature versus resistance relation is of the form [7].

$$R = R_o \exp (1/T - 1/T_o)$$

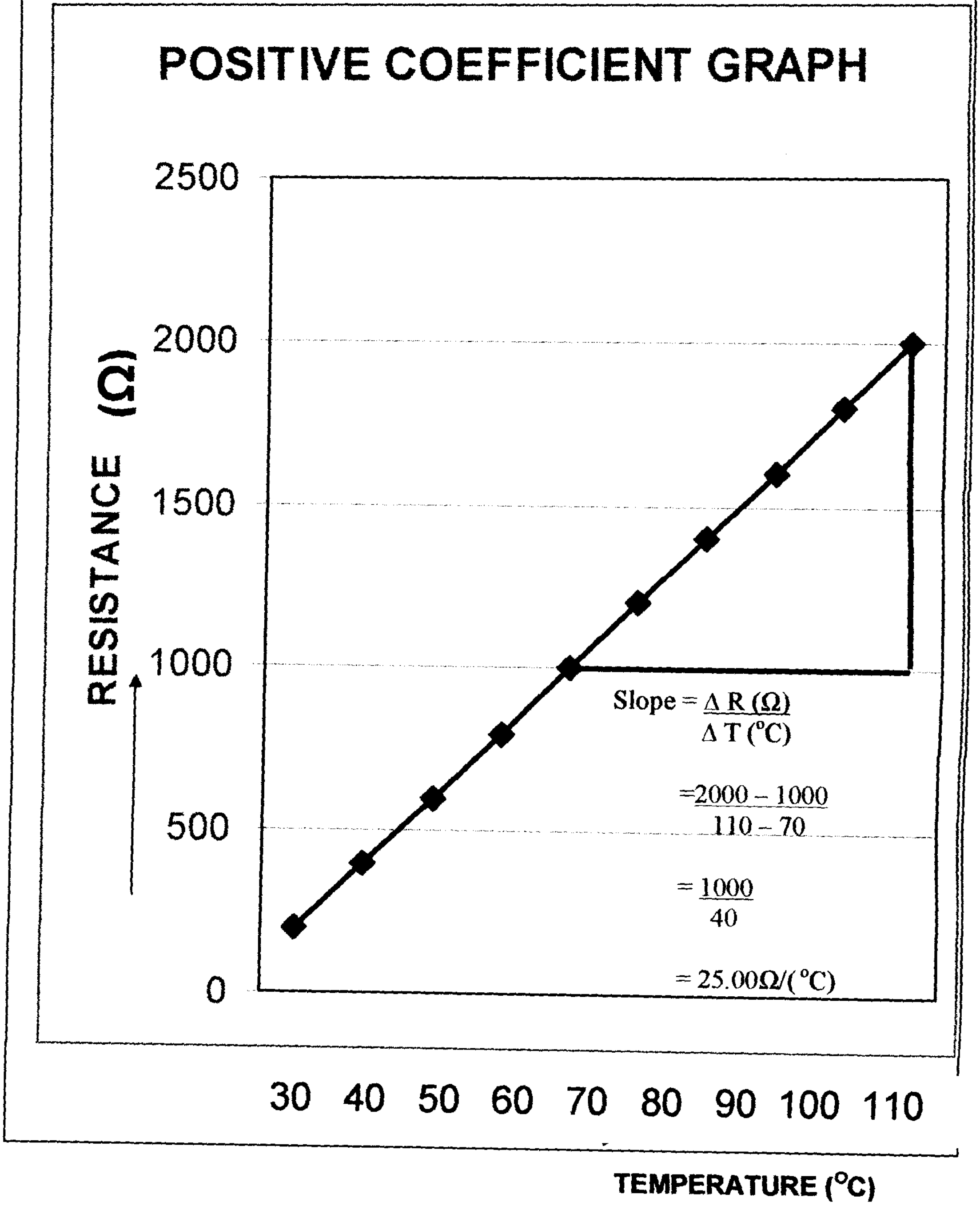
Where,

R and R_o are resistance of T and T_o respectively.

Table 3.7

Temperature (°C)	Resistance (kΩ)
30	53
32	700
38	800
45	900
50	1000
54	1100
60	1200
68	1300
73	1400
80	1500
86	1600
90	1700
98	1800
104	1900
110	2000

The table of increment in Resistance (Ω) Versus Increases in temperature (^{0}C)


POSITIVE COEFFICIENT GRAPH
2500
2000
1500
1000
500
0
RESISTANCE (Ω)
Slope = Δ R (Ω) / Δ T (°C)
=2000 – 1000 / 110 – 70
= 1000 / 40
= 25.00Ω/(°C)
30 40 50 60 70 80 90 100 110
TEMPERATURE (°C)

3.8 TESTING AND OBSERVATION

The device is simply tested by formulating the triggering conditions such as smoke and heat for the device. The smoke is generated by putting off lighted matches. And both audio and light indicators are switched on. The same happens to the heat detector. By putting a soldering iron in the thermistor, the alarms are switched on. It shows the unit is working and by pressing the set button clears the latch and the audio alarm is off.

The light indicators are directly connected to the detection circuits, so they response to the instant state of the sensors.

CHAPTER FOUR

CONSTRUCTION, TESTING AND RESULTS

The circuit connections of the Heat and Smoke Alarm system were carefully constructed with durability in mind.

4.1 ARRANGEMENT

Due to the encouraging assurance of the workability of the circuit design, the circuit construction was directly performed 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.

Moreover, the two sensor circuits were put into the Vero board. That was after the power circuit is tested working. The addition two circuits were independently tested. The errors of unclosed contacts were detected and carefully bridge-over. Also the alarm circuit was the next, the circuit was tested alone. And the frequency of operation of the oscillator was carefully adjusted to suit the audio alarm requirement.

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:

- Unclosed connection which was bridged with a wire.
- Short circuit that rises through de-soldering of concerned.
- Readjustment or redesigning of the circuit to fit the real target.
- Unavailability of some components which resulted in looking for best alternative.

4.4 TESTING

The smoke sensor is quite sensitive but the limitation is a false alarm when the sensor is highly illuminated with light. This effect is attributed to the light or infra-red concept of the design, as far as infra-red beam or ray is concerned. The error is minimized by proper shielding of the sensor.

The limitation of the heat sensor is merely the exposure to water or other conducting liquid. The liquid bridges the contact terminals of the device and result in a false audio alarm triggering. The thermistor involved in the circuit is well placed and isolated.

4.5 SMOKE TEST

The test began with a lighted paper and the light was later put OFF in order for carbon mono-oxide or carbon dioxide (i.e. thick gas) to come out. The carbon dioxide was carefully directed to the smoke detector circuit which breaks the barrier between the infra-red transmitter and the infra-red sensitive diode. With the aid of the carbon dioxide entering into the sealed smoke detector circuit there was a reflection from the infra-red transmitter to the infra-red sensitive diode which triggered ON the alarm.

The reason for the triggering of the alarm was that, the air between the infra-red transmitter and infra-red sensor contained a gas with particles. But not just a gas with particles, rather a thick gas (i.e. carbon mono-oxide or carbon-dioxide). And this is the only gas attributed to such characteristic due to their carbon content [9].

4.6 HEAT TEST

A plug soldering iron was carefully placed on the thermistor when it was 53Ω for some moment. The thermistor was subjected to the heat coming-out from the iron until the temperature reaches 110°C degree centigrade when the thermistor was 2000ohms. At this temperature the alarm was triggered indicating the abnormality of the temperature.

4.7 DISCUSSION OF RESULT

From table 2.5.1.1, it can be seen that the thermistor resistance once increases with increase in temperature. When heat is applied to the sensor, its resistance changes from 50Ω -100Ω which increases the resistance value of the thermistor (says 2000Ω while the temperature is 110°C. At this 110°C of the thermistor, 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.

Likewise for the smoke test, when the smoke covered the surface of both the sensor and the transmitter, the infra-red from the transmitter reflected, traveling through the smoke that covered the surface. During this process, the infra-red sensitive diode sensed the present of the infra-red from the transmitter through the smoke and this triggered ON the alarm until the set button is pressed and this clear the latch and the audio alarm is OFF [10].

4.8 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 = 19.5cm

Breath = 7cm

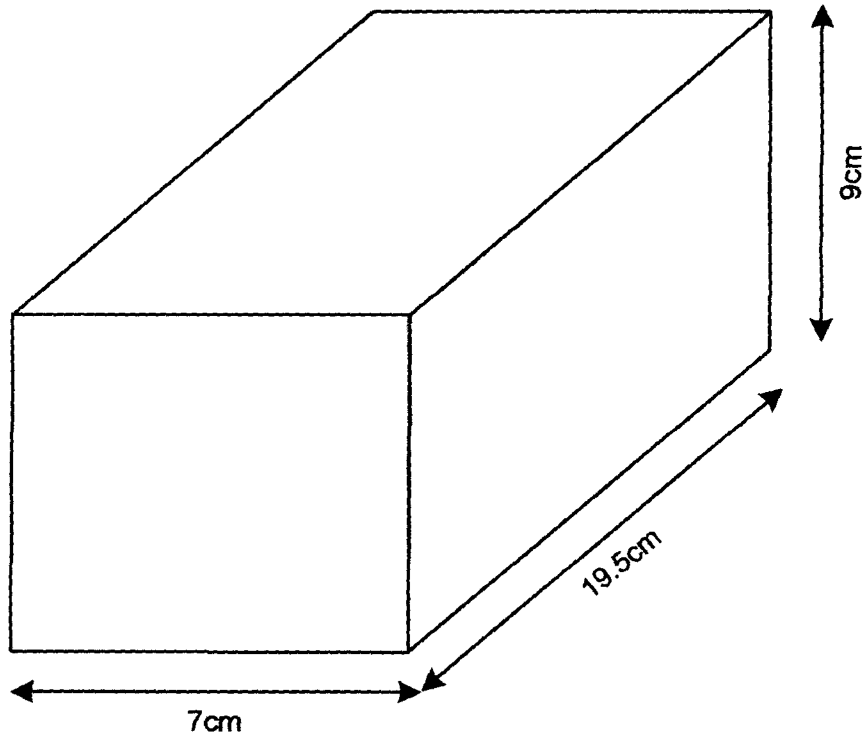
Height = 9cm

The total volume of the casing is:

Volume = Length * Breath * Height

= 19.5 * 9 * 7 =1228.5cm

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 casi



ng 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 4.8 Schematic diagram of the casing

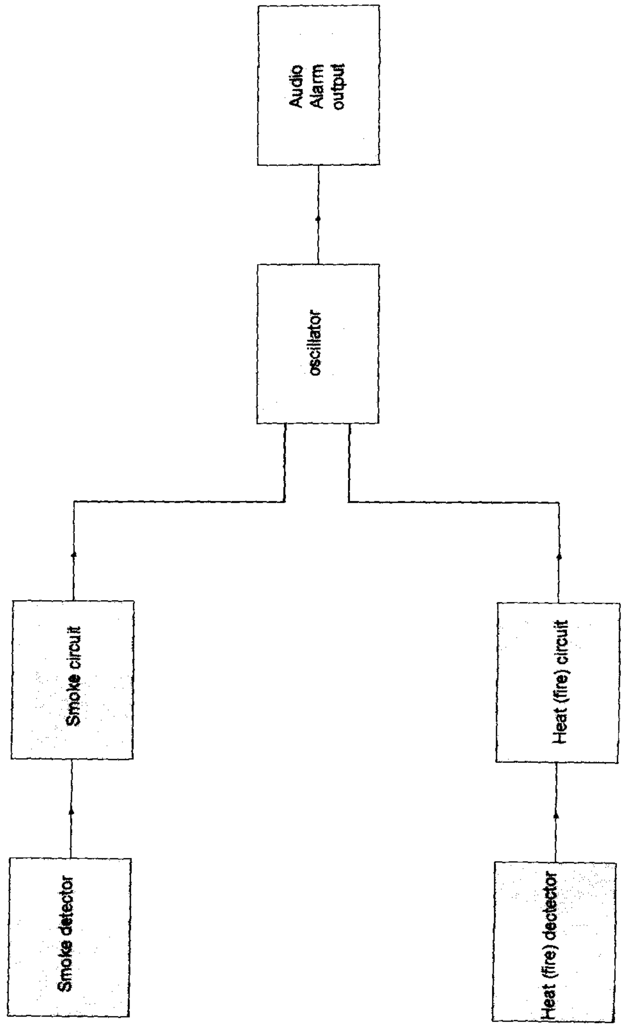
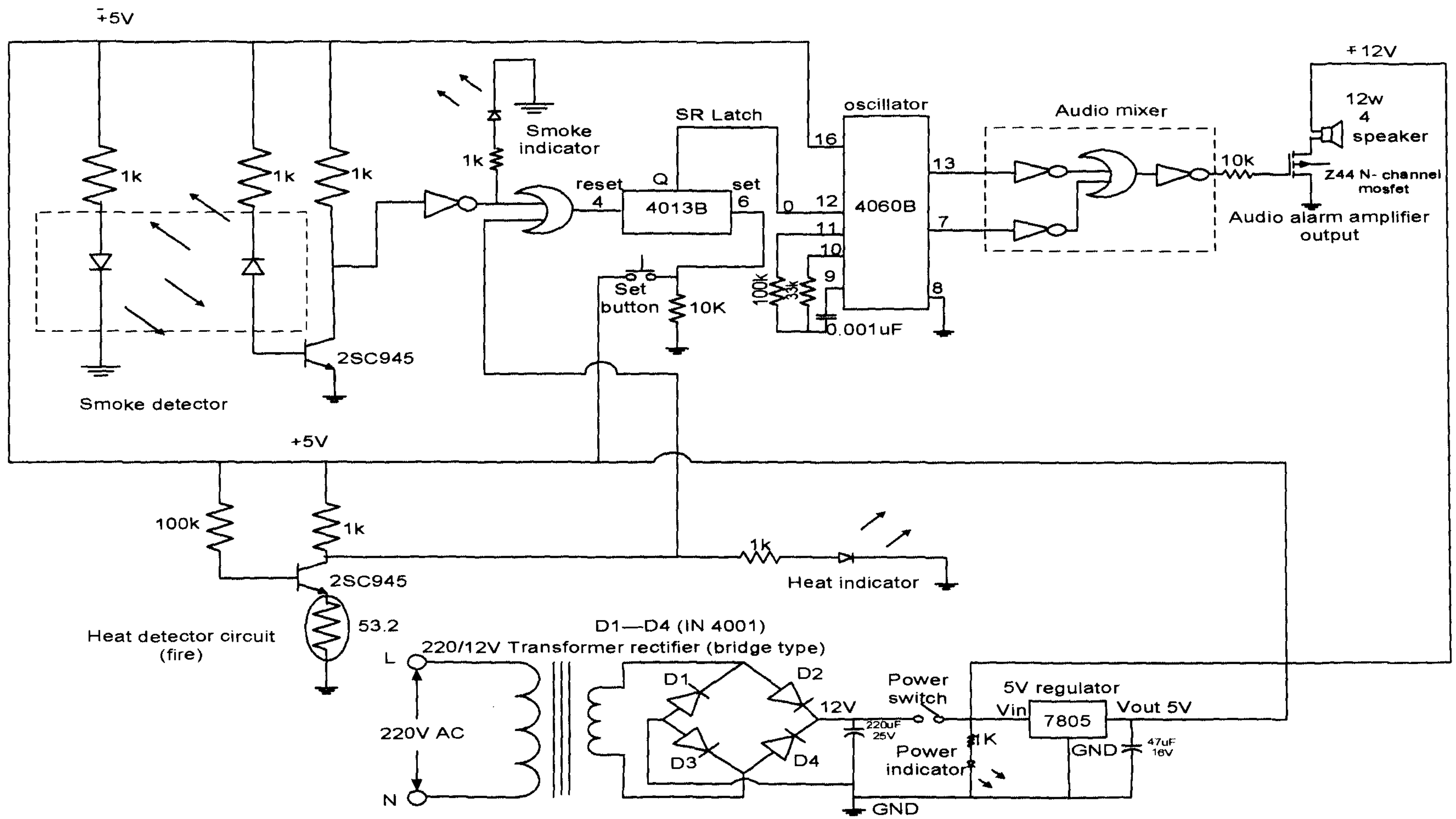


Fig 4.9 Block diagram of heat and smoke detector circuit



CIRCUIT DIAGRAM OF HEAT AND SMOKE DETECTOR

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

The design and construction of heat and smoke detecting circuit through an alarm system had been carried out successfully. The demonstration of the detecting circuit followed the other of which, fire produces heat which are detected through "Thermistor", while the smoke is been detected by the infra-red transmitter and infra-red sensitive diode.

The primary objective of this project was to produce a very sensitive detecting circuit that can detect the presence of smoke via the combination of the infra-red transmitter and infra-red sensitive diode, with an increase in the temperature of the environment beyond the required temperature through the thermistor and subsequently give an alarm to indicate the condition of the heat and the smoke, which has been fulfilled.

5.2 RECOMMENDATION

Despite the high reliability of the design, some area of the circuit can still be improved upon so as to enhance it performance. Such improvement could include an increase in sensitive of the smoke and heat detector, and the use of high watt speaker.

The fire alarm system should be incorporated with a back-up sealed acid battery and a charging circuit for this battery should also be provided so as to provide an emergency supply to the alarm system incase of power failure from PHCN.

BILL OF MATERIAL
(QUANTITY FOR THIS PROJECT DESIGN)

S/N	Description of Components	Quantity	Unit	Rate (#)	Total Amount (#)
1	Step down transformer (240V/12v)	2	LOT	130.00	260.00
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	OR gate (4071B)	2	LOT	120.00	140.00
10	Hex. Inverter gate (4071B	5	LOT	120.00	120.00
11	SR Latch (4013B)	1	LOT	100.00	100.00
12	Oscillator (4060B)	1	LOT	120.00	120.00
13	N-Channel MOSFET (Z4	1	LOT	100.00	100.0
14	Loud Speaker (8W, 16Ω)	1	LOT	60.00	60.00
15	Transistor (2SC945)	2	LOT	30.00	60.00
16	Infra-red Sensitive Diode	1	LOT	120.00	120.00
17	Thermistor	1	LOT	200.00	200.00
18	Vero board	1	LOT	100.00	100.00
19	LED	3	LOT	10.00	30.00
20	Power Switch (50V/3A)	1	LOT	50.00	50.00
21	Plug (10A, 220V)	1	LOT	50.00	50.00
22	Connection W 26Ma/1.8v)	-	LOT	120.00	120.00
23	Miscellaneous	-	LOT	1000.00	1000.00
24	Sealed Acid Battery	1	LOT	600.00	600.00
25	Infra-red Transmitter	1	LOT	120.00	120.00
26	Power Resistor (3W, 2Ω)	1	LOT	50.00	50.00
				TOTAL	**# 3,790.00**

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