DESIGN AND CONSTRUCTION OF A DIGITAL THERMOMETER

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DEDICATION

This work is dedicated to maker who has being with me right from the beginning even when I knew close to nothing about ,and he's still with me

DECLARATION

I **ILELAKINWA RONKE M.** declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

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ABSTRACT

The project involves a digital thermometer with large displays. It is designed to digitally display surrounding temperature within a range 0 -99° c. this device finds application in places like laboratories ,poultry farms ,meteorological centres incubators in hospitals ,kitchens and other places where temperature monitoring is of great importance. the design embodies modern electronic components for better acceptability and reliability for the temperature measurement involved. The components used are attributed to low cost, good availability and low power consumption

TABLE OF CONTENT

CHAPTER ONE

GENERAL INTRODUCTION

1.0 INTRODUCTION

Measurement of physical quantities is one of the most vital disciplines in harmonizing man, machines and environment to real world of elemental change. The scientific and technology progress of any nation depends on its ability to measure, calculate and finally estimate the unknown [1] .Temperature is one of the major physical quantities that is vital to humanity. Temperature is a property of an object which determines the direction of heat flow when the object is place in thermal contact with another object [2]. The temperature of a body is one of its most interesting scientific properties and the measurement of temperature is important in all branches of science [3]. Its measurement and control plays an integral role in a wide variety of industrial domestic and scientific activities. This is so since most of man's activity is affected by temperature, so knowledge of the temperature of ones environment cannot be overemphasized.

This project is a digital thermometer device that measures and digitally displays surrounding temperature within a range of 0-99°C. The design consists of a solid state temperature sensor, an analogue to digital converter circuitry and a large digital display.

1.1 OBJECTIVE AND MOTIVATION

The project is aimed at the design and construction of digital thermometer with large displays, suitable for use in measuring and displaying temperature in degree Celsius. The measurement of temperature is being achieved with the use of thermometer. Different types of thermometer had been used in the measurement of temperature, most of which gave their readings in Analogue from. Analogue form of reading temperature has resulted to error in interpreting the exact value of temperature indicated. Eliminating these problems encountered with analogue thermometer has been the motivating factor for this project.

1.2 IMPORTANCE OF PROJECT

Having a precise accurate measurement of the temperature of an environment is of great necessity because of its wide application in places like; hospitals in which the life's of premature babies depends on the temperature at which the incubator is kept, laboratories require the use of precise readout in carrying out analysis and test which requires specific temperatures.

Poultry farms are meant to be kept at certain reasonable temperature therefore having a readout temperature is necessary. Industries like pharmaceuticals petrochemicals and petroleum also requires precise easily readout temperature, the necessity of having a digital thermometer is so numerous that it cannot be exhausted in this material.

1.3 METHODOLOGY

The design is basically made up of a silicon integrated circuit temperature sensor which is the input of the design. The sensor is the LM35, It senses the temperature of the environment and gives output in the form of voltage corresponding to the temperature sensed. The output voltage of the sensor is now converted into binary code or digital format with the use of an analogue to digital converter the ADC 0804. The ADC 0804 is an analogue to digital converter that provides on 8 bit representation of the output voltage of sensor. The binary codes are converted from binary to decade form through a logic control unit. The converted codes are displayed on the seven segment display which consists of a set light emitting diodes arranged in a circuit to suit the design.

1.4 SCOPE AND LIMITATION

The temperature of the design ranges from 0°C – 99°C. It won't find applications in area of higher or lower temperature requirement. Its application is manly in areas/environment in which the temperature of the environment is required for various activities e.g. kitchens, boiler rooms, research centers, rectories, foundries. The mobility of this project is limited due to its AC power supply as it can be used only where AC power outlets are present.

CHAPTER TWO

LITERATURE REVIEW

2.1 BRIEF HISTORY OF THERMOMETER

The concept of temperature stems from the idea of measuring relative hotness and coldness of a body. Temperature is basically the measure of the average kinetic energy of molecules. The instrument used to measure temperature of bodies is called a thermometer. The first primitive thermometer was invented by Galileo (1564-16420. it used the expansion and contraction of air with temperature ,but the device was not equipped with scale [4] . His instrument then could rightly be called a thermometer because, rather than measure temperature, it only indicated temperature differences. The thermoscope was used widely by a group of scientist in vernice which included Galileo.[5,6]

An important step of attaching scale to make a thermometer was taken by Santorio ten years later [7]. Santorios instrument was an air thermometer invented in the year 1612. Change in atmospheric pressure affected the accuracy of the instrument. This effect was not known originally as there was no concept of atmospheric pressure at that time [8]. This was because the instrument was essentially barometers using water in the tube, and so they responded to changes in pressure as well as temperature.

These inaccuracies in the early thermometers led to the development of sealed thermometer known as liquid in glass thermometer. The sealed liquid in glass thermometer was first designed in 1654 by Ferdinard II, the grand duke of Tuscany. It used thermal dilation of a liquid instead of air to sense temperature change.One of the earliest attempts at caliberation and standardization between thermometers was made in October 1663 in London. The members of the royal society of London agreed to use one of the several thermometer made by Robert hooke as a standard so that the reading of others could be adjusted to it thus the reading in one laboratory could be compared to the reading in another through the standard correction. The method of making scale was in confusion at the time because craftmen in different countries used different calibration points thus scaling remained a problem. [6, 8]

A German physicist Gabriel Fahrenheit in 1724 began using mercury to fill his thermometer. The more predictable expansion of mercury combination with improved glass working techniques led to a much more accurate thermometer. Fahrenheit made the bulb of this thermometer a cylinder rather than a globe. He also calibrated his thermometer using a mixture of ice and water with sea salt at his zero, the temperature inside the mouth of a healthy human as his reference and a freezing point of 30^{0}. When the scale was adopted by Great Britain, the temperature of 212^{o} F was established as the boiling point and the freezing point was adjusted to 32^{0}F these were now used as the fixed calibration point [5, 8]

An astronomer called Rene Antoine Ferchauld de Reamur in 1731, proposed a thermometer scale in which the freezing point of water was 0^{o} and the boiling point 80^{0}. For some reasons, the Reamur scale was not easily adopted and so is not in use today. About two decades later, a Swedish astronomer named Andres Celsius devised a thermometer scale dividing the freezing and boiling point of water into 100. Celsius chose 0^{o}C for the freezing point a year later, a Frenchman, Jean Pierre inverted the Celsius scale to provide the centigrade scale used today . By international agreement in 1948, Cristins adopted scale became known as Celsius and is still in use till data [6].

The absolute temperature or Kelvin scale was proposed by Sir William Thompson, Baron Kelvin of kargs and Lord Kelvin of Scotland, in the year 1848. This scale had its zero degrees as being the theoretical lowest temperature possible (i.e. where molecular motion ceases). The value turned out to be – 273. The degree Kelvin is the current standard unit of temperature [6].

The early thermometers were non-electrical in nature because they had the disadvantage of processing a limited temperature range and were also subject to reading error. [9]]

Overtime, various temperature sensors have been developed thus slowly phasing out the basic liquid – in – glass thermometers. The advent of digitalization also improved upon the accuracy of thermometer devices.

2.2 THEORITICAL BACKGROUND

A digital thermometer is the combination of Simple electronics component to give the temperature of a body in digital from. The project is therefore made up of the temperature sensing unit, a display unit, and analogue to digital converting unit and a power supply unit.

2.2.1 TEMPERATURE SENSING TECHNIQUES

A temperature sensor is a device that senses temperature the variation in an environment and gives it value in electrical form. The thermal sensors is use include, thermocouples, Resistance temperature detectors (RTD), thermistors and integrated circuit sensors.

Thermocouples, measure temperature difference using voltage development by the junction of two dissimilar-metals. One junction called the sensing junction is placed at the point of interest, while the other called the reference junction is maintained at a reference temperature. The voltage developed across the junction is proportional to the difference between the two temperatures. Thermocouples are subject to error which may arise due to variations in resistance of the thermocouples wires and leads. Variations in ambient temperature can be lead to error. It is used in high temperature applications. [9]

Another temperature sensor in use is the thermistor. It could either be negative temperature coefficient (NTC) or positive temperature coefficient (PTC) thermistor. The resistance of the NTC decreases with increase in temperature while that of PTC increases as the temperature increase. Thermistors are fabricated in discs/rods,, beads, and washers covering resistance $10^6\Omega$ and a wide variety of temperature coefficient. It offers greater accuracy and stability than thermocouples but its non-uniform resistance temperature characteristics can be disadvantageous in some applications where it is required to obtain a more linear variation. It's also sensitive to self-heating and errors introduced by added resistance of lead wires connected to them [10].

Integrated circuit (IC) temperatures sensors differ significantly from the other types of temperature sensors. They generate an output voltage proportional to the temperature sensed. Integrated circuit temperature sensor posses excellent linearity and do not require compensation circuit. The LM 35 sensor is the IC used in the project. It provides a voltage output of 10mv/°C. The choice of the IC in this project is because of its linearity, accuracy, availability and low self-heating. [11]

2.2.2 ANALOGUE TO DIGITAL CONVERSION

An analogue to digital converter is an electronic circuit that converts analogue Voltage to digital form; it coverts analogue (continuous) signals to discrete (digital) form. The error attributed to the ADC is its non-linearity caused by its physical imperfections giving an output that deviates from a linear function. Quantization error also occurs due to its finite resolution. This error can be reduced by proper calibration.

The ADC used in realization of this project is the ADC 0804, which employs the use of successive approximation in its conversion method. It is used because of its availab lity and cheapness. [12]

The seven segment display unit requires BCD codes and therefore needs a binary to decimal conversion unit. The binary to decimal conversion unit consists of a down 8-bit binary counter And-Not gate logical unit and two up BCD Counters.

2.2.3 THE DIGITAL DISPLAY

The digital display unit is a unit, which gives the visual presentation of the output information numerically, and alpha numerically. This unit is made up of two seven-segment display chips and two seven segments decade driver. This decoder is used to convert the Binary coded decimal into viable readout corresponding to the decoded value of binary input. The seven-segment display consists of a well arranged group of Light Emitting Diodes (LED). LEDs are electroluminescent system that emits light when a voltage is impressed on it LED require low voltages for its powering so each LED is connected to power via a resistor other electroluminescent system are Liquid Crystal Display (LCD) and the Light Emitting Film (LEF). The LEDs are connected in the common Cathode mode.

2.2.4 THE POWER SUPPLY UNIT

The power supply unit consists of a step down transformer, a bridge transformer and an appropriate voltage regulator. It provides the circuit with necessary voltage rating for component and a 6V rechargeable battery.

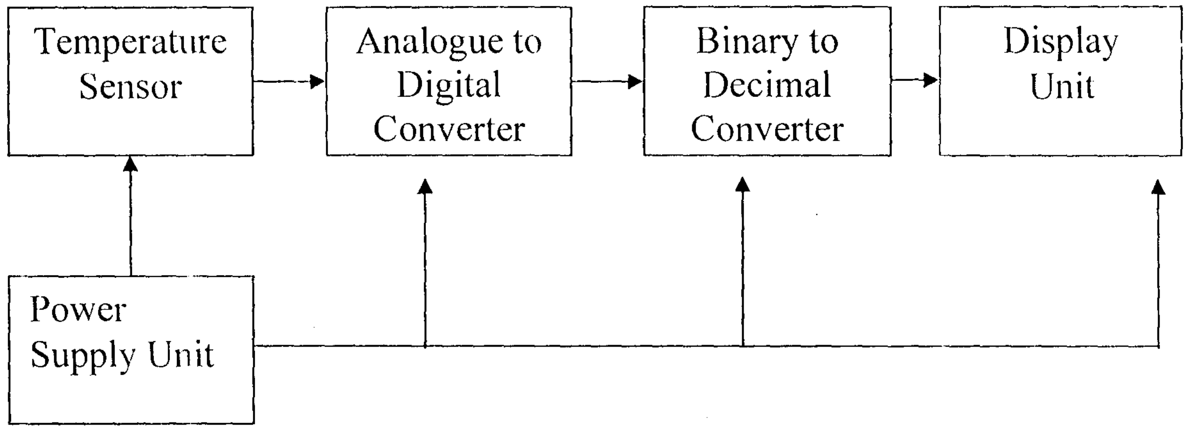


Fig2.0 block diagram of the design

CHAPTER THREE

SYSTEM DESIGN AND ANALYSIS

3.1 CIRCUIT DESIGN AND ANALYSIS

The design is a digital thermometer, which senses the ambient temperature and gives a digital display. The proper assemblage of components in different units actualizes this. These units are

- The Power Supply Unit
- The temperature sensing unit
- The Analogue to Digital Conversion Unit
- Binary to decade decoder unit
- Display Unit

3.2 POWER SUPPLY UNIT

This unit powers the circuit, supplying the required potential difference across the circuit. It makes use of different components, which is properly combined in a circuit. The required potential difference is 5volt dc. The mains supply is 240v A.C, so to obtain the required potential difference of 5v dc from the main supply some stages is required. These stages as listed below make up the power supply unit.

- Transformation Stage
- Rectification Stage
- Smoothing Stage
- Regulation Stage

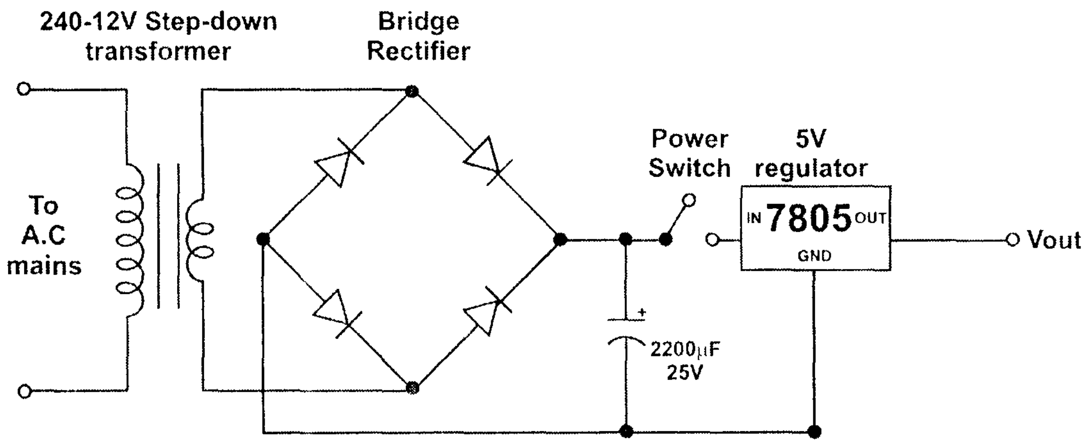


Fig. 3.1 The circuit diagram of the power supply unit

3.2.1 TRANSFORMATION STAGE

The component used in this stage is a transformer. A transformer is a stationary piece of apparatus by means of which electric power in one circuit is transformed into electric power of the same frequency in another circuit [1]. It consist of one coil of wire placed in close proximity to one or more other coils and is used to couple two or more AC circuit together by employing the induction between the coils. The coil connected to the power source is called the primary coil and the other is known as secondary. A transformer could be step up or step down. In the step up transformer the secondary voltage is more than the voltage in the primary side. While in the step down the voltage in the primary side is more than that in the secondary side. Electronic circuits require smaller type of power transformers. For this project work, a 240/12V step down transformer is used. The voltage transformation ratio is given as follows;

$$\frac{E_2}{E_1} = \frac{N_2}{N_1} = \frac{240}{12} = 20:1$$

Where, E_2, E_1, N_2 & N_1 are the secondary voltage, primary voltage, number of turns in secondary and number of turns in primary winding of the transformer respectively. The symbol of the transformer is as shown in fig. 3.2.

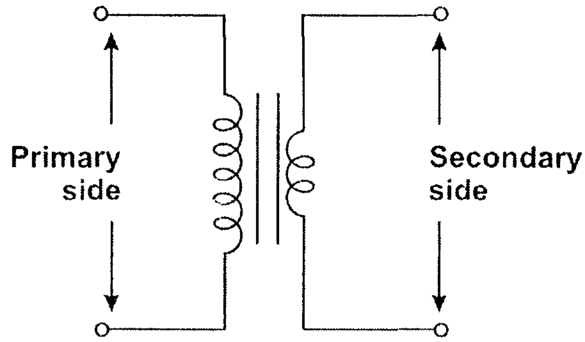


Fig. 3.2 A simple step-down transformer

The transformer therefore turns the 240v supply form mains to 12v A.C

3.2.2 RECTIFICATION STAGE

This stage is made up of a rectifier circuit; t converts A.C voltage to D.C form [13]. Rectification is achieved with the use of diodes. Diodes are electronic component with two terminals, which allows current flow in only one direction. A simple diode and its symbol is as shown fig 3.3.

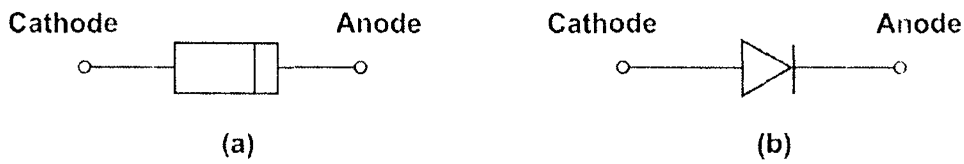


Fig. 3.3 (a) Diode (b) Symbol

A full wave bridge rectifier is employed in this design because its more efficient compared to other forms of rectification. The circuit is made up of 4 solid state diodes of value 1N400l.

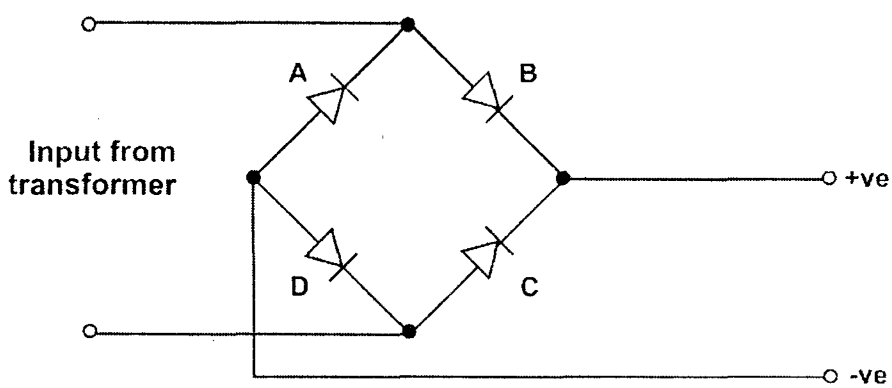


Fig. 3.4 Full wave bridge rectifier

Diodes B and D works on the positive half cycle of the input voltage, while Diodes A and C work on the negative half cycle of the input voltage. When the A.C voltage output of the transformer is fed into the rectifier circuit, diodes B and D becomes forward biased during the positive half cycle, while Diodes A and C is reverse biased thus, producing a D.C voltage output. When the negative cycle of the input voltage enters the circuit, Diodes A and C becomes forward biased while B and D are reversed biased also resulting in a DC voltage output. The waveform generated is as shown in Fig 3.5.

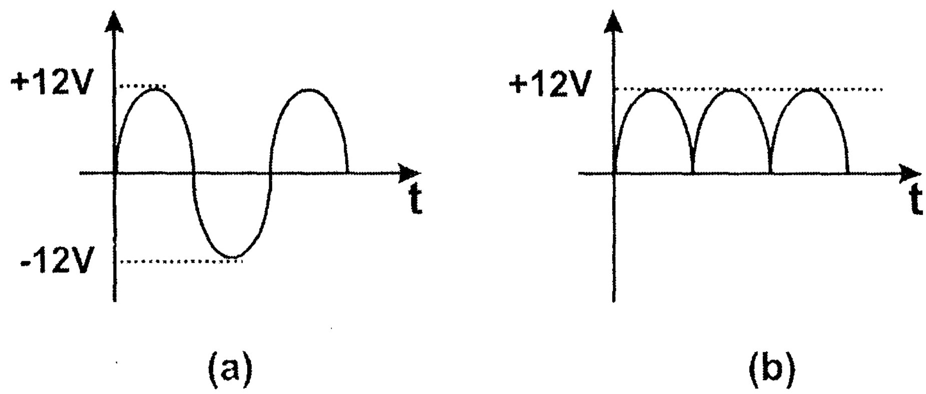


Fig. 3.5 Input and output waveform of the rectifier (a) AC input waveform (b) DC output waveform

3.2.3 SMOOTHING STAGE

The output voltage of the rectifier is usually not constant. It is characterized by some ripple components; therefore some form of smoothing which is the removing of the ripples is inevitable. Smoothing is achieved with the use of filtering capacitor whose voltage rating should be at least twice the voltage in the circuit. Since the voltage in the circuit is 12V a capacitor of 25V, 2200μF is used in this design. The waveform regenerated before (Fig 3.6a) and after (Fig 3.6b) are as shown in Fig 3.6.

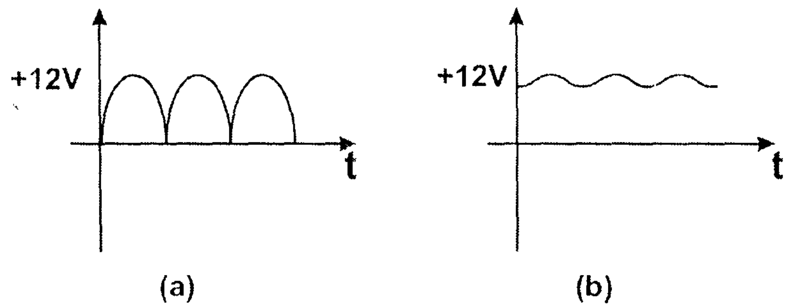


Fig. 3.5 Input and output waveform of the smoothing stage

(a) Input waveform (b) Output waveform

3.2.4 REGULATION STAGE

The component in this stage is a D.C voltage regulator. The regulator is an electronic device that receives an input voltage and gives an output voltage according to its rating. The regulator used for this design is a 7805, it is a 5V positive regulator. The output from this stage is a 5 volt D.C voltage as required in the project design.

3.2.5 ALTERNATIVE POWER SUPPLY

This unit provides an alternative power supply, such that when supply from mains is off the device keeps working. This unit consists mainly of a 6V battery and a diode. Basically batteries are energy storage devices. Very many types of batteries exist; these types are based on the chemistry and application of the battery, [1, 7]. For this project a 6V lead acid battery is used. The battery's terminals are connected to the terminals of the capacitor through the diode such that the battery charges when there is supply from mains and supplies the circuit when there is no supply.

The main objective of this unit is to avoid disruption of the operation of the circuit.

3.3 THE TEMPERATURE SENSING UNIT

This is the input unit of the design. This unit senses the temperature. The temperature sensor is realized with an integrated circuit (LM 35). LM 35 is a precision IC temperature sensor whose output voltage is linearly proportional to it input temperature in Celsius. It senses the surrounding (ambient) temperature and gives a corresponding output voltage. It can be easily calibrated and has a linear output as well as a sensitivity of 1°C to 10m. It can sense temperature within the range of 0°C to 99°C. It has an accuracy of 0.5° C, which can be guaranteed at 25° C. [11]

The schematic diagram of LM 35 is shown in Fig 3.8.

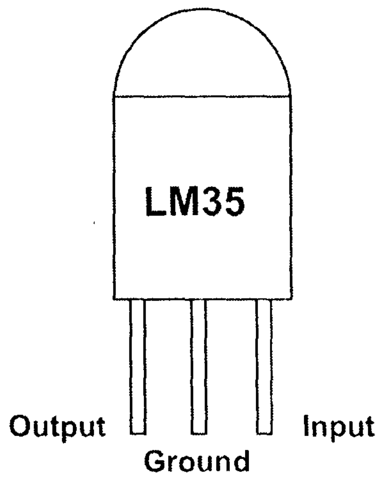


Fig. 3.8 LM35 IC

The sensor is a three terminal device (Fig 3.8) namely, input, output and ground terminals. The input and ground terminals are used to power the IC. The Input terminal is connected to a 5V d.c supply and the ground terminal is connected to a ground terminal in the circuit. [15]

The third terminal (i.e the output terminal) gives an out put voltage corresponding to the temperature surrounding the IC. For instance, if the surrounding temperature is 35°C the output terminal will read 350mV. The IC (LM35) could be referred to as a transducer, since it converts it ambient temperature into an electrical signal. This unit is the main unit of this design.

3.4 ANALOGUE TO DIGITAL CONVERSION UNIT

The Analogue to Digital Converter (ADC) unit converts it input analogue signals to their digital equivalent. The design is a digital device therefore requires an appropriate digital input signal. This unit receives it input from the output terminal of the temperature sensor and converts it to the equivalent digital value. This conversion is accomplished with the use of an integrated circuit ADC 0804. The ADC 0804 is a 20 pin CMOS IC that Performs Analogue to Digital conversion using successive approximation method [12]. The schematic diagram of ADC 0804 IC is shown in Fig 3.9

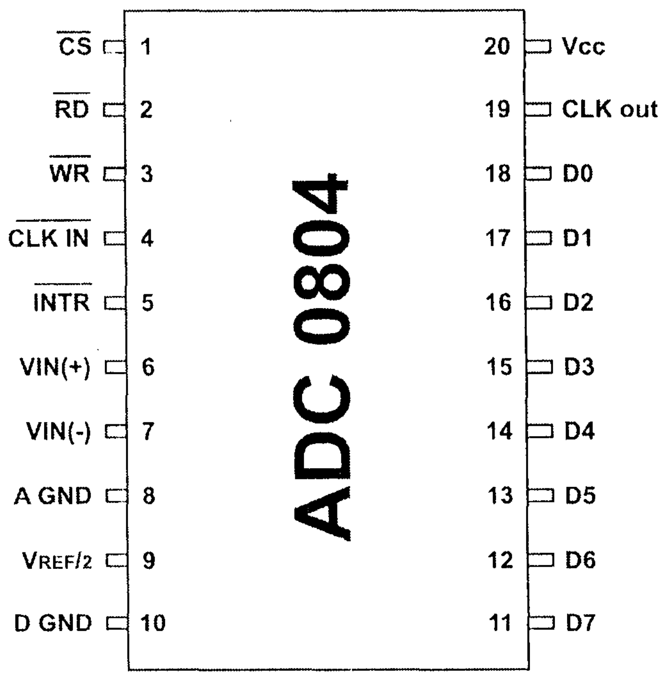


Fig 3.9 The schematic diagram of ADC 0804 IC

Where pins 6 and 7 indicated as Vin^+ and Vin^- are the input pins of the IC, D0-D7 are the output pins of the IC. The IC has an internal clock generator circuit that produces a frequency of F=1/1.1RC where R & C are values of components connected to the

CLK in & CLK out PIN respectively. The clock frequency used is 606KHz which gives a conversion time of approximately 100 ns.

The Pins 8 and 1 are the analogue and digital ground terminal of the IC. The two pins are both connected to the ground of the design. Pin 20 is the terminal that receives 5V supply from the power unit for powering the IC. The IC was designed to be interfaced with a computer system, so Pin 1, 2, 3 & 5 are for interfacing with the system. For this design this Pins are not required, so the ADC circuit was connected as shown in fig. 3.10.

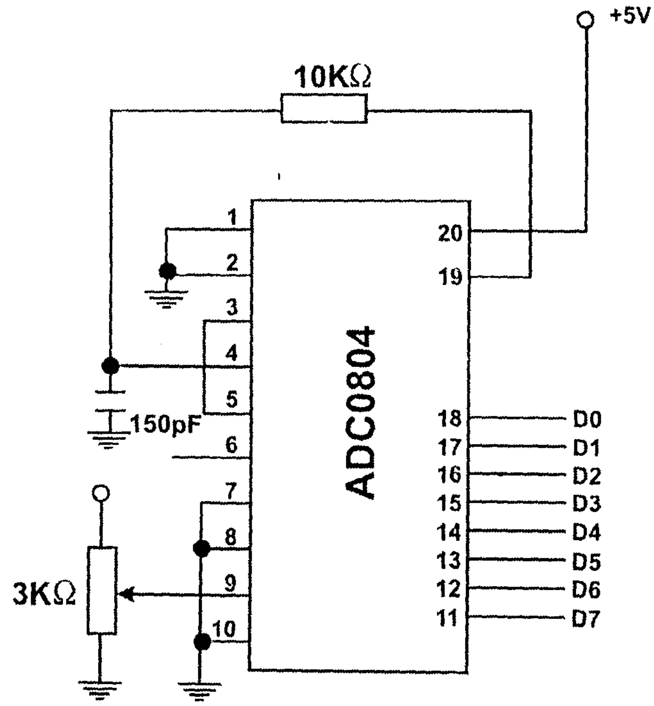


Fig. 3.10 Function diagram of ADC 0804

The Pin 9 i.e. the Vref/2 terminal is used to achieve the desired calibration since it adjusts the sensitivity of the device. The reference voltage is usually half the expected full analogue input. In this design, the sensitivity of the sensor is 10mv/°C. Therefore for an accurate calibration, the reference voltage must correspond with the input sensor's sensitivity. When the reference voltage is at 2.5V, the analogue input coverage is 5V.Sensitivity of the analogue to digital converter is as shown

$$\frac{Vcc}{256-1} = \frac{5}{255} = 19.60mV$$

(From the device data sheet)

So for 10MV sensitivity the reference voltage is put at

$$\frac{V_{ref}}{2} = \frac{(256-1)\times(10\times10^{-3})}{2} = 1.275V \qquad \frac{V_{ref}}{2} = 1.275V$$

This is achieved with the use of a 3KΩ variable resistor which is adjusted to

$$\frac{V_{ref}}{2} = 1.275V$$

So the unit receives the output of the LM 35 and gives it corresponding value in 8 bit binary form.

3.5 BINARY TO DECADE DECODER UNIT

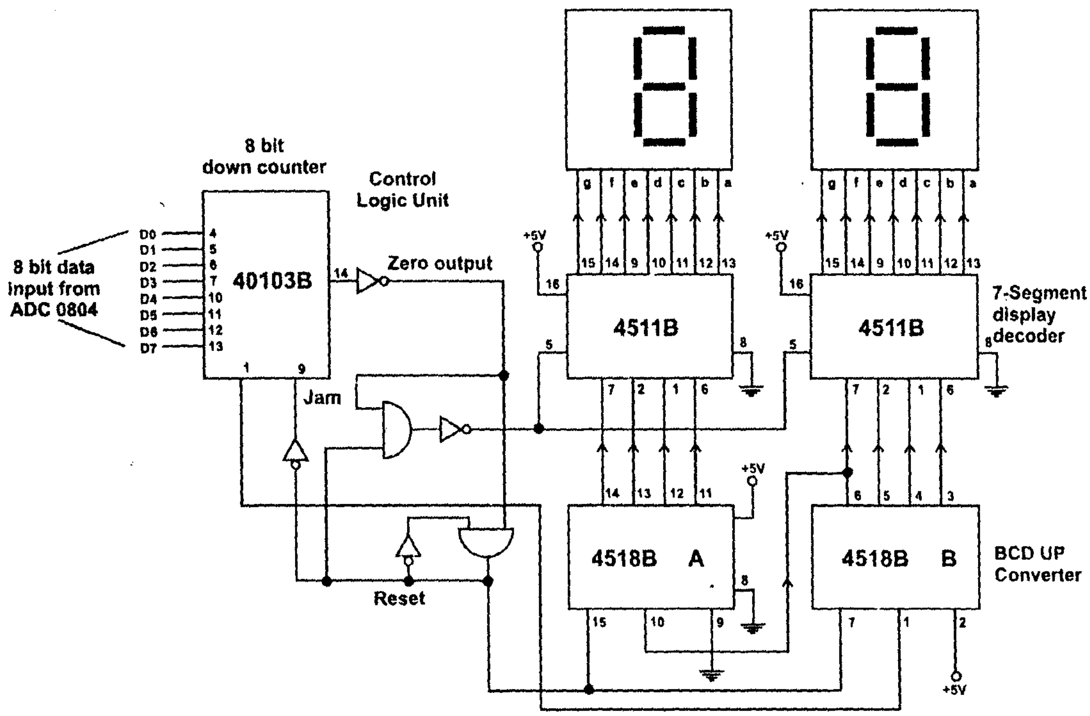


fig 3.11 diagram of binary to decade decoder unit

This unit converts the binary output of the ADC 0804 to decade from. This is achieved with the use of ICs like 40103B, 4511B, 4518B and a control logic unit (comprising of AND and NOT gates)

3.5.1 THE 40103B INTEGRATED CIRCUIT

The 40103B IC receives the binary output of the ADC 0804 and gives output in the form of counts corresponding to the binary in put. The IC is a CMOS 8 stage presetable Synchronous down counter. The IC is as shown in fig 3.12

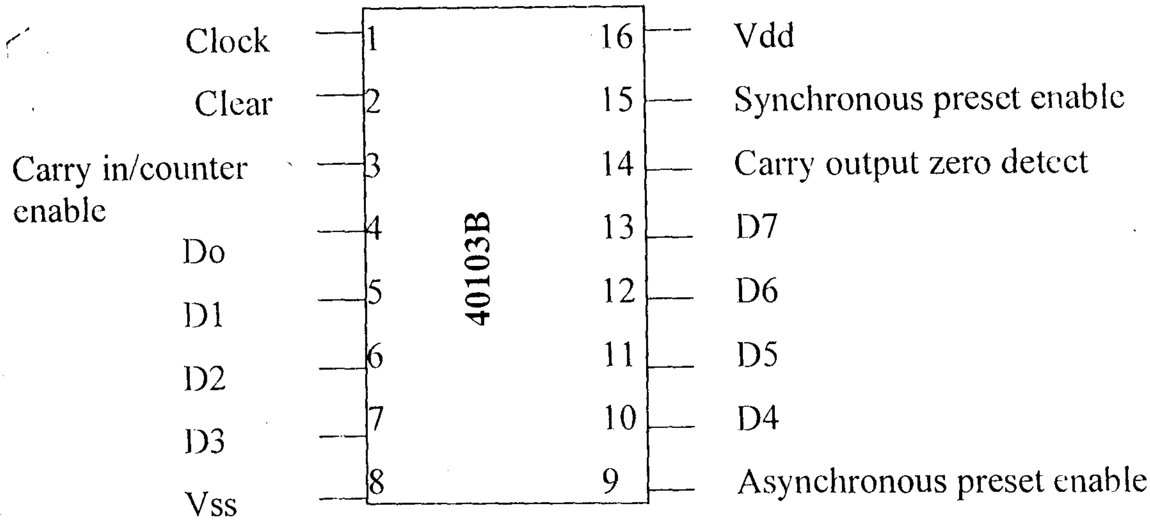


Fig 3.12 40103B IC

The IC has control inputs for Enabling or disabling the clock for clearing the counter to it maximum count, and for presetting the counter. All control inputs and the carryout/zero detect (CO/ZD) output are active low logic. During operation, the counter is decremented by one count on each positive transition of the clock. Counting is inhibited when the carrying/counter enable CI/CE input is high. The carryout/zero detect (C0/CD) output goes low when the count reaches zero if the CI/CE input is low, and remain low for one full clock period.

When the synchronous present enable SPE input is low, date at the Jam input is clocked into the counter on the next positive clock transition regardless of the state of the CI/CE input when the Asynchronous preset enable APE input is low, data of the jam inputs is asynchronously forced into the counter regardless of the State of the SPE, CI/CE, or clock inputs. Jam input Jo –J7 represent the 8 bit binary input of the

CD 40103B. when the clear CLR input is low, the counter is asynchronously cleared to it maximum count 255_{10}, regardless of the state of any other input.

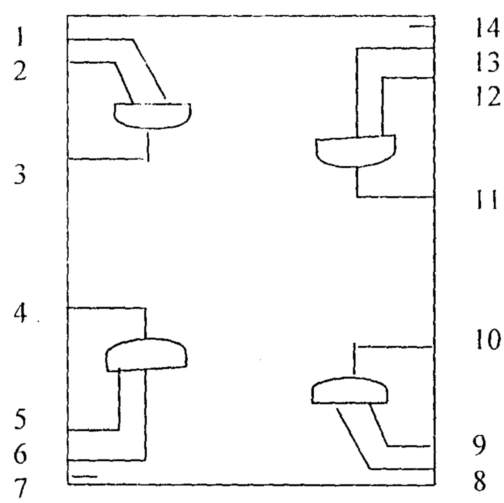
If all control input except CI/CE are high at the time of zero count, the counters will jump to the maximum counts, giving a counting sequence of 100 or 256 clock pulse long.

This causes the CO/ZD output to go low to enable the clock on each succeeding clock pulse.

3.5.2 CONTROL LOGIC UNIT

In this unit for proper conversion a control unit is required this control unit consist of two integrated circuits, the 4081B and the 4069B.

The 4081B contains 4 independent 2 input and gates shown below.



The logic table and symbol of a simple 2 inputs AND gate is as shown below.

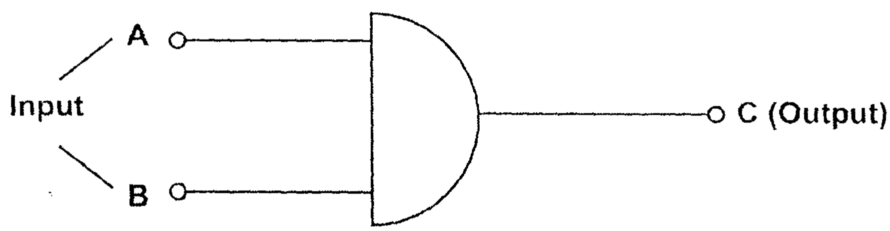


Fig 3.14 The symbol of an AND gate

Table 3.1 Truth table for 2 inputs AND gate

A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

The 4069 contains six impendent NOT gate converters which is shown in fig. 3.15

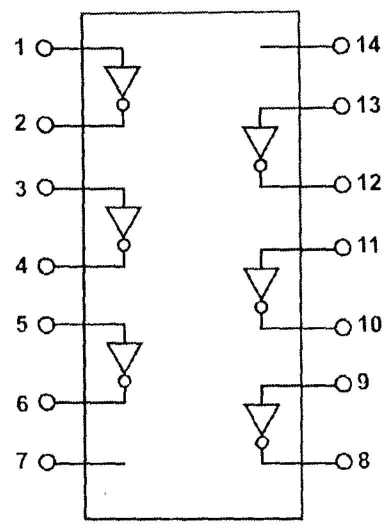


Fig. 3.15 Functional diagram of 4069B

The symbol and truth table for an inverter circuit is as shown in fig 3.16

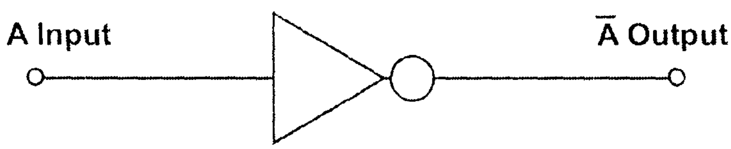


Fig. 3.16 Symbol of a NOT gate

Table 3.2 Truth table for 2 inputs NOT gate

A	$\overline{A}$
1	0
0	1

3.5.3 THE 4518 INTEGRATED CIRCUIT

Also required in conversion process is the 4518B IC. The 4518B IC is a CMOS dual BCD up counter. It consist of two identical synchronous 4 Stage counter. The counter is cascaded by connecting pin 6 to the enabling input (Pin 10) of the other counter, while the other clock enable is held low. This is to achieve a maximum count of 99. Hence the BCD output of the 4518B is transferred to the 7 segment display 4511B [14, 16]. The function diagram of the 4518B the 4069 contains six independent NOT gates converters which is as shown in fig 3.17

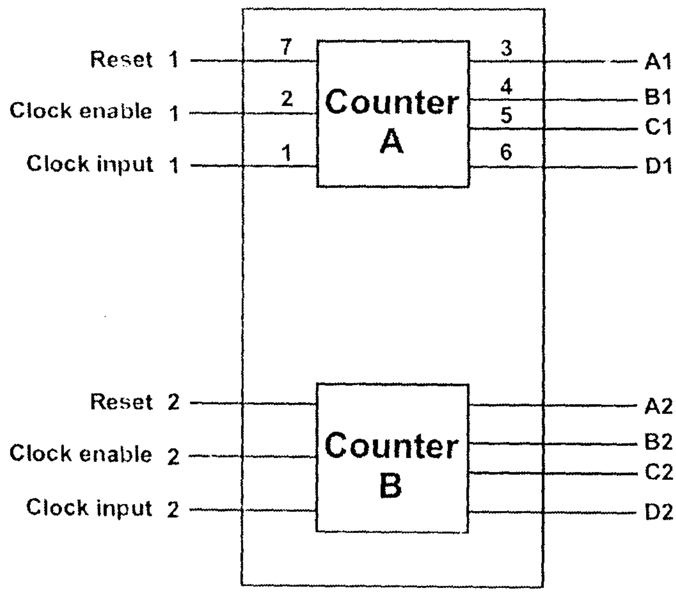


Fig. 3.17 Diagram of the 4518B IC

The 4511B is a seven segment display decoder IC. The IC is CMOS and has 16pin. It receives its input from the 4511B IC and decodes it, to drive a seven segment display the IC is as shown in fig3.18

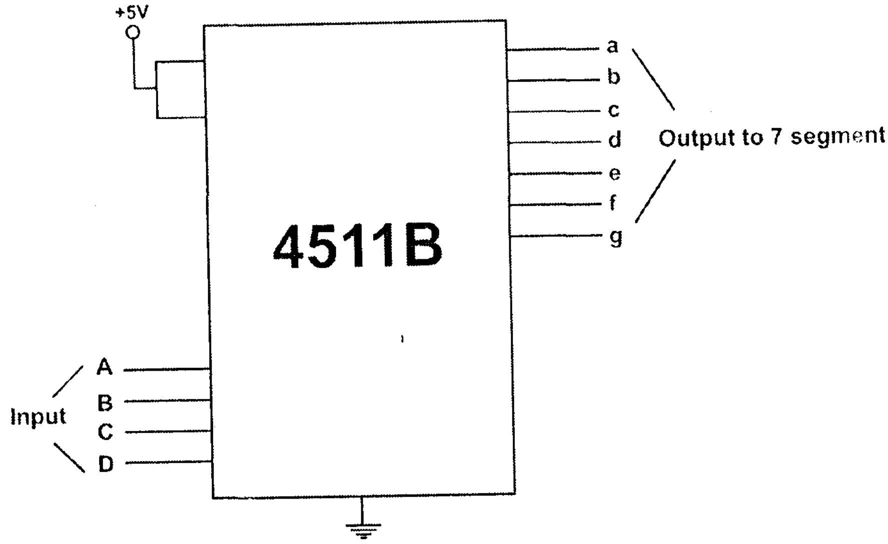


Fig. 3.18 Diagram of 4511B IC

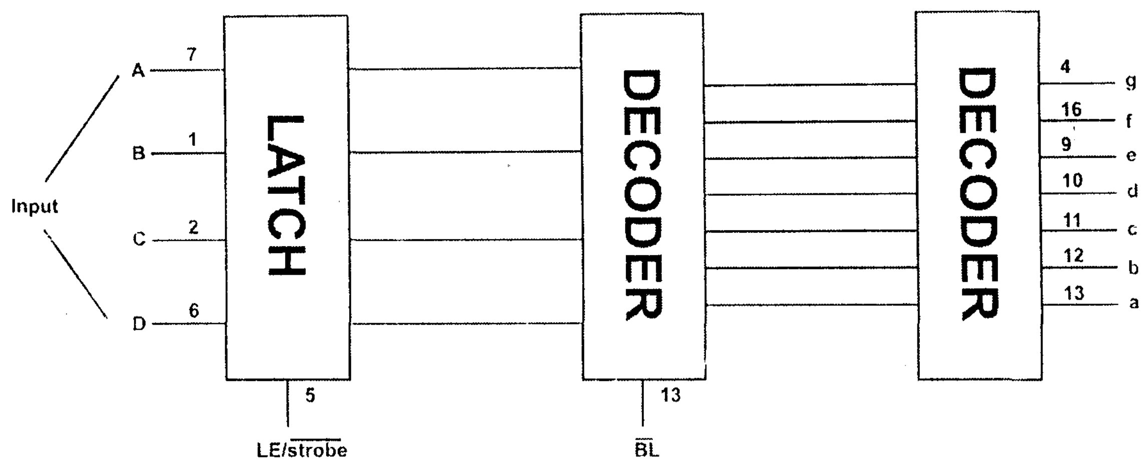


Fig. 3.19Funional diagram of 4511B IC

Table 3.3 Input code-output display truth table of the 4511B

BCD Input Code	Binary input of Seven Segment Display							Decimal Output
A B C D	a	B	C	d	e	f	g	
0 0 0 0	1	1	1	1	1	1	0	0
0 0 0 1	0	1	1	0	0	0	0	1
0 0 1 0	1	1	0	1	0	0	1	2
0 0 1 1	1	1	1	1	0	0	1	3
0 1 0 0	0	1	1	0	0	1	1	4
0 1 0 1	1	0	1	1	0	1	1	5
0 1 1 0	0	0	1	1	1	1	1	6
0 1 1 1	1	1	1	0	0	0	0	7
1 0 0 0	1	1	1	1	1	1	1	8
1 0 0 1	1	1	1	0	0	1	1	9
Other bit Codes	*	*	*	*	*	*	*	Blank

Pin 1,2,6 &7 are the input pins, then pin 9, 10, 11, 12, 13,14 and 15 are output for the e,d,c,b,a,g,& f input 3 is the lamp test which chip doesn't output to the display. Pin 4 is the blank input used by the IC for conserving battery life, when low the chip does not give an output. For this design pin 3 and 4 are connected to positive voltage (Vcc). Pin 5 is the latch enable; it stores the applied 4 bit BCD code whenever its low.

The IC performs the function of the latch, decoder and driver. The function diagram of the 4511B IC is as shown in fig 3.19

3.6 DISPLAY UNIT

The display unit gives the visual presentation of the output of the design. This is actualized by arranging light emitting diodes (LED) in the convectional seven segment display format as shown in fig. 3.21.

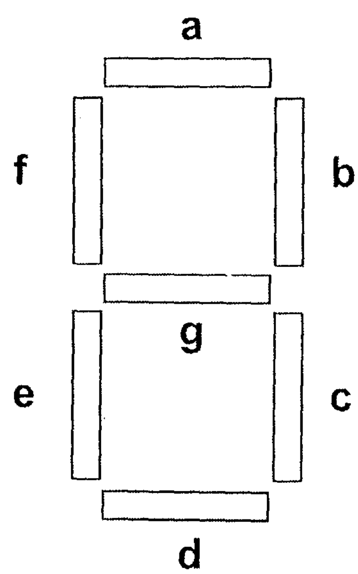


Fig 3.21 A seven segment display.

The mode of the display is common cathode i.e the cathode of the LEDs are connected to ground and the anode represents the a,b,c,d,e,f,g terminal of the display. Each segment of the display consists of three LEDs connected in series.

Segment A is as shown in fig. 3.22

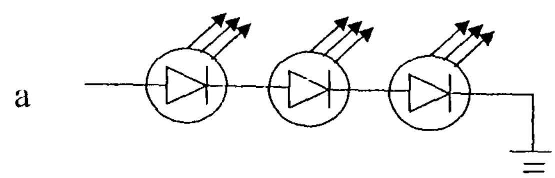


Fig. 3.22 Segment a of the seven segment

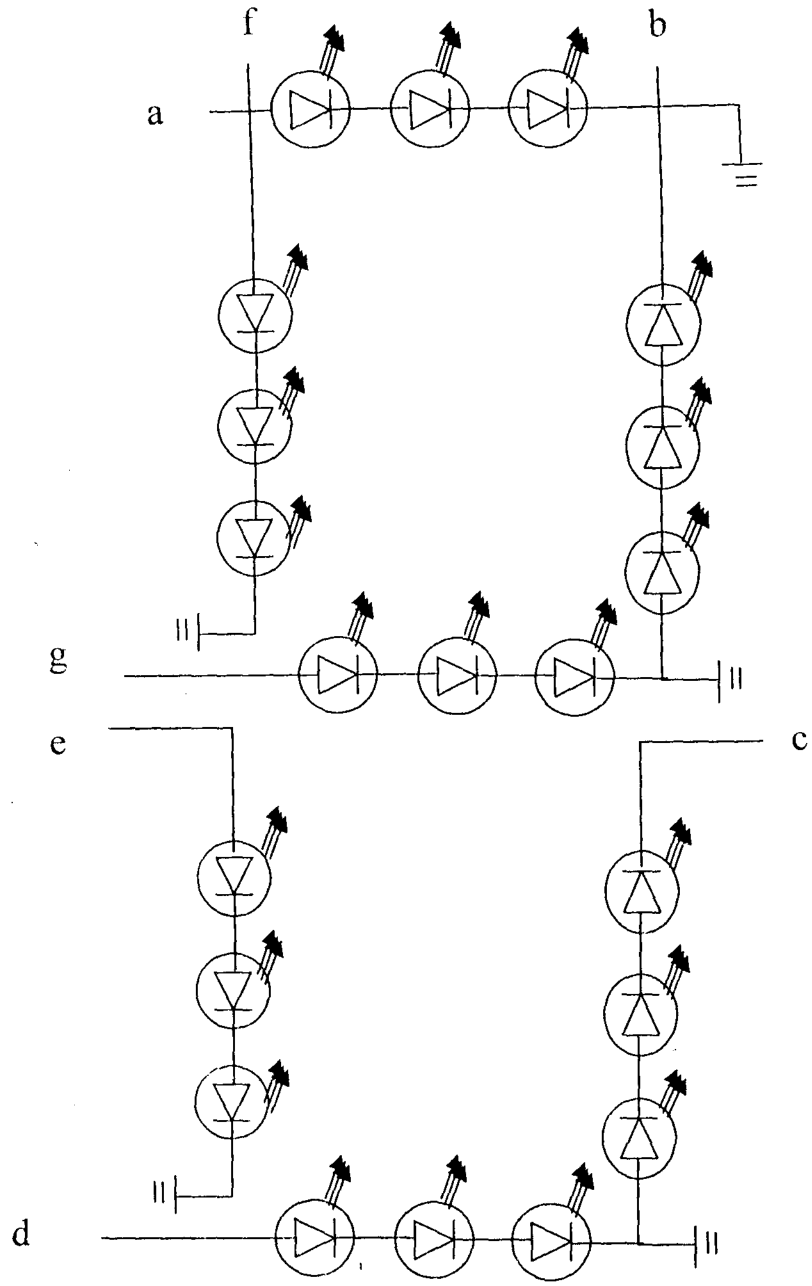


Fig 3.33 circuit diagram of display showing the a,b,c,d,e,f ang g terminal

The display for each number will be as shown in fig 3.34.

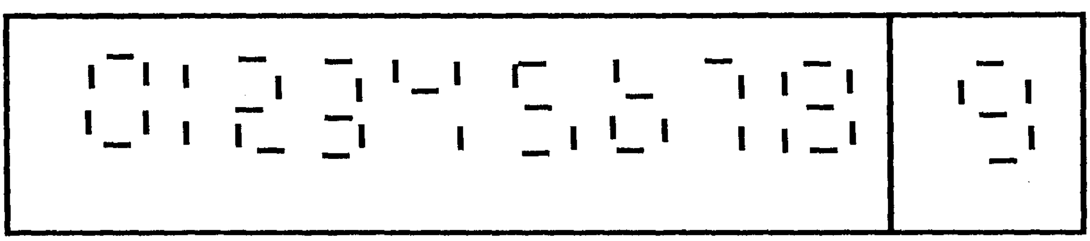


Fig 3.34 Seven segment display

3.70 BASIC OPERATION OF THE CIRCUIT

The digital thermometer is achieved by the careful assemblage of all the components described in this chapter. When connected to power source, the power supply unit receives from the main supply and then to the transformer which steps the supply voltage down. The stepped down voltage is passed to the rectifier circuit which converts the stepped down A.C voltage to DC. The Dc voltage is passed to the capacitor for smoothing operation. Then the Dc voltage obtain is sent to the 5V regulator. From the regulator power required for the design is obtained.

The input unit is the temperature sensor LM35, the LM35 gives on output voltage corresponding to it surrounding temperature. So the LM35 senses the temperature and gives an output voltage. The output voltage is sent to the analogue to digital conversion unit. The analogue to digital conversion unit comprising of the ADC 0804 receives the output voltage from the LM35 and then gives on output which is an 8 bit binary form. This 8 bit binary output is the equivalent value of the voltage input. For further conversion the binary signal is sent to the other unit.

The binary to decade decoder conversion unit comprises of an 8 bit binary down counter 40103B, a BCD up counter 4518B, a BCD to seven segment decade driver , and a control logic unit (Containing an And and a
Not gate). As the eight bit binary output from ADC 0804 is passed to 40103B, the down counter assumes the corresponding value of the binary input and begins to count down to zero, as the 40103B counts down the BCD up counter which was zero, counts up to attain the equivalent BCD value of the 8 bit binary input from the ADC0804, this conversion process is possible through the control logic unit.

The BCD output is then inputed to the 4511B IC a seven segment decade drive, which performs the function of the latch, decoder and driver to give an output for the seven segment display. The seven segment display made up of well arranged LEDS that comes on indicating the temperature of the surrounding.

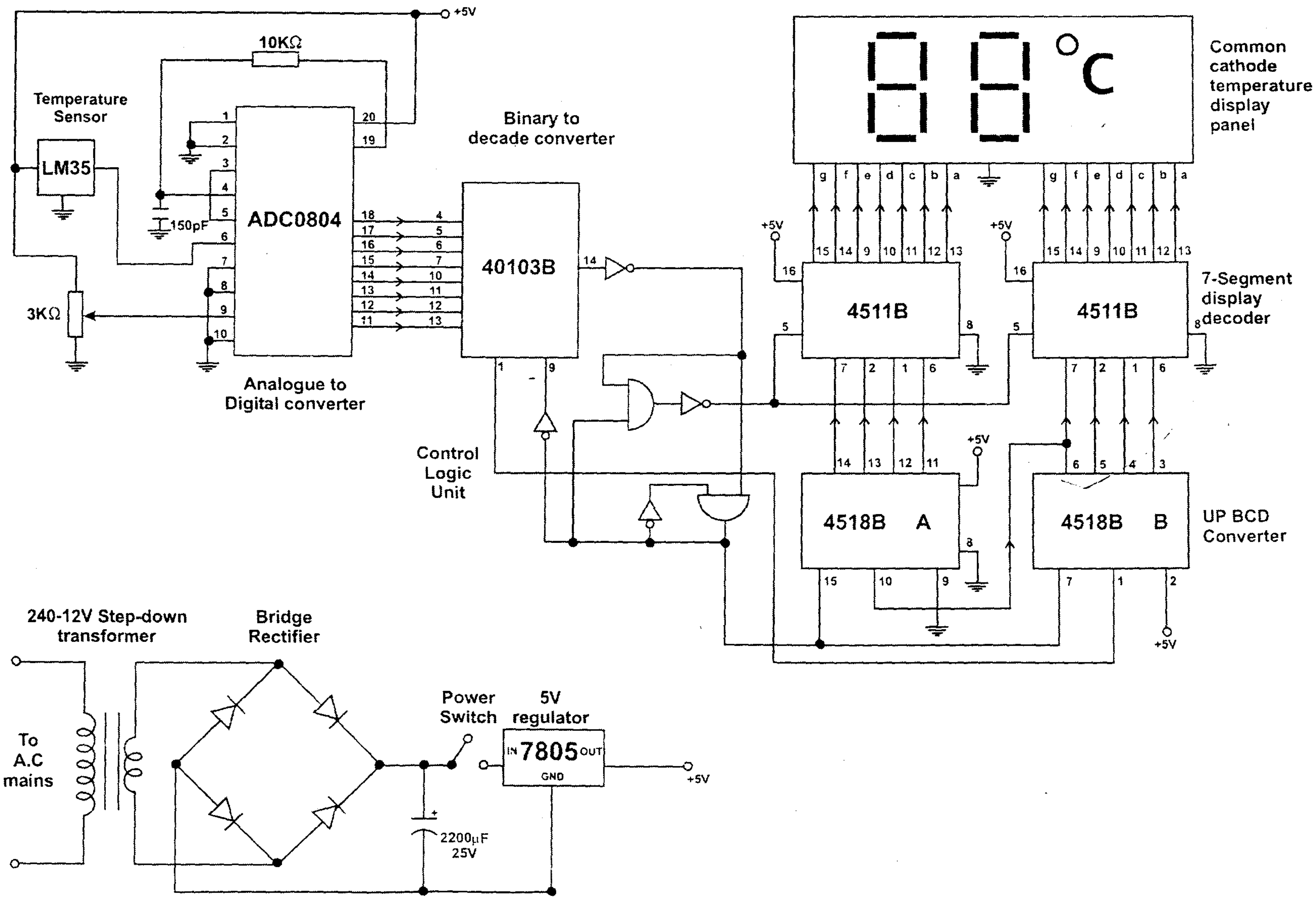


Fig 3.35 Circuit diagram of digital thermometer

CHAPTER FOUR

CONSTRUCTION TEST AND RESULT

4.1 TOOLS USED

1. Bread board
2. Vero board
3. Soldering iron
4. Lead
5. Digital meter
6. Plastic casing
7. Components
8. Bolts and nuts
9. Connecting wires
10. Solider sucker

Bread board – used for temporary connections

Vero board – user for permanent connections

Soldering iron – use for joining components to the Vero board

Lead: - used for soldering for joining.

Digital meter – use for measuring electrical values and testing connections

Plastic casing – used for caring the work done

Components – devices mounted on the Vero board for the constructions

Bolts and Nuts – they are used for joining the casing

Connecting wires – they are used in connecting points

Solider sucker – used for removing soldered joints

4.2 CIRCUIT CONSTRUCTION

The components were obtained and then tested to ensure they are in good working condition. So all components used were tested individually. Then using the circuit diagram as a guide the work was first carried out on a bread board so as to see the work ability of the design.

When the design worked on the breadboard, then it was mounted on the Vero board. Each component was soldered on the Vero board according to allow for easy testing.

Four boards were used; one carried the seven segment display. Second carried all the integrated circuit connected the third carried the sensor (LM35) and last board carrying the ICS is the main board. All the boards were connected to it through wives.

4.3 CASING CONTRUCTION

The casing is made up of rubber material was obtained from the casing of electric socket and was joined together with the use of bolts and nuts .in the casing space was given to allow for ventilations

4.4 TESTING

In the course of construction each component was tested individually to ensure they were in good working condition. Then on mounting on the Vero board each connection in each stage was tested with the use of the digital meter to ensure proper connections. The test was carried out severally as each unit was soldered to the board. Then at the end of the construction the sensitivity of the temperature sensor was tested, this was achieved by placing a hot object like the soldering iron close to the sensor, it was observe on the display the response to the change temperature.

4.5 RESULTS AND DISCUSSION

As the sensor (LM 35) senses its surrounding temperature, the display shows the value of the temperature. At varying the surrounding the display gave the values of the temperatures as they varied. Below is the table of results obtained as the output voltage of the sensor at certain temperatures.

Temperature reading corresponding voltage output of the surrounding

Table 4.1output voltage of sensor at varying surrounding temperature

S/No	Temperature (^{O}C)	Sensor Output (LM 35) (V)	Sensitivity
1.	34	0.34	10
2.	42	0.42	10
3.	50	0.50	10
4.	70	0.70	10
5.	86	0.86	10

From the result the sensitive of the sensor can be seen to be 10mV/1°C which is the same as the theoretical value

CHAPTER FIVE

5.0 CONCLUSION

The design of the digital thermometer was to achieve the aim of sensing and display of surrounding temperature. From the results of the test is can be seen that this aim was achieved.

The design can be used industrially and domestically. its measures the temperature within its range and displays the value in a digital form that can be read easily.

5.1 PROBLEMS ENCOUNTERED

The problem encountered during the design and constriction.

- ICs are delicate and get damaged when there's excessive heat. so during soldering some of the ICs got damaged.
- The ADC 0804 was made for computer interfacing, so it had to be adapted to suit design
- Short circuiting in the ADC0804 was one of the problems encountered.

5.2 RECOMMENDATION

Some recommendations for better performance of this design are as encountered.

- A sensor with wider temperature should be used range so as increase the application of the device.
- LCD type of display can be used instead of LED for less power consumption.
- Durable dry cells battery can be used as power supply to increase is portability.
- The design can be interfaced to a computer system

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APPENDIX

S/No	NAME	DESCRIPTION	QUANTITY	UNIT PRICE	COST
1	LM 35	Temperature sensor	1	250	250
2.	ADC 0804	Analogue to digital	1	900	900
3.	40103B	Down binary counter	1	300	300
4.	4069UB	Hex not gat logical unit	1	200	200
5.	4081B	Quad-and gate logical unit	1	200	200
6.	4518B	Up BCD counters	1	300	300
7.	4511B	Display decoder	2	250	500
8.	In 4000l	Diodes	4	10	40
9	1KΩ, 10KΩ, 3KΩ	Rated resistors	5	10	50
16.	150PF, 2200NF	Rated capacitors	3	50	150
17.	LED	Light emitting diodes	50	10	500
18	**Other expences**	**CASING ,Veroboard ,ICsockets**			**2000**
19	**Transformer**	**240/12V**	**1**	**400**	**400**
TOTAL COST					**6090**