DESIGN AND CONSTRUCTION OF A MICROCONTROLLER BASED DIGITAL THERMOMETER FOR MEASURING ATMOSPHERIC AND BODY TEMPERATURE

BY

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(B.Eng Electrical/Computer Engineering)

DEDICATION

I dedicate this project work to the almighty God and to my mum Mrs. Ifeoma Oyibo Okoli who have seen to the fulfillment of my dream in life.

CERTIFICATION

I hereby certify that this project design and construction of a microcontroller based digital thermometer for measuring atmospheric and body thermometer was carried out by OKOLI CHIDIEBERE.O, with Matric Number 2003/15430EE and meets the standard deemed acceptable by the Department of Electrical/Computer Engineering, School of Engineering and Engineering Technology. Federal University of Technology Minna.

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ACKNOWLEDGEMENT

First I am grateful to almighty God the creator of the universe that created me for sparing my life up to this moment and for his grace given to me to complete this program successfully.

My profound gratitude first goes to my mother Mrs Ifeoma Oyibo Okoli for the parental role played from the beginning of my life to date.

After my parent my gratitude goes to the H.O.D Electrical/Computer Eng. Dept. ENGR. A.G Raji and my project supervisor; Mr. Olatomiwa Lanre, for guiding me throughout the project work.

Also to my brothers and sisters Ugochukwu Okoli, Adanma Egagah, Chukwunonso Okoli, Ifeanyichukwu Okoli and Onyiyechukwu Okoii.

I also appreciate the contribution of my course mate, John Otaru

ABSTRACT

The projects title The design and construction of a microcontroller based digital thermometer. The device display temperature information numerically. Thus help to avoid the limitation due to parallax error in analogue device. The whole system incorporates a microcontroller which is interfaced to other components. This component include temperature sensor, an analogue -to- digital converter, an 8952 microcontroller and a 16×2 LCD display unit. The temperature sensor used is an integrated circuit (LM35).the sensor senses temperature and generates an analogue voltage which is proportional to the sensed temperature. The analogue voltage is then feed to the microcontroller .the microcontroller then converts the binary voltage and then displays it on the LCD.

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CHAPTER ONE

INTRODUTION

1.0 EXPOSITORY INTRODUCTION

Measurement plays a very important role in nature and for human existence, it is a broad discipline in both engineering and science. Encompassing the areas of detection, control, acquisition and analysis of different data. It provides the means of describing natural, human, and artificial activities in quantitative terms. [6]

It comprises of precise and accurate measurement recording of physical and non-physical parameters that plays a vital role in every branch of scientific research and industrial processes.

Many sophisticated and high precision measurement devices and system are being developed among which those for measuring temperature is undoubtedly the most measured dynamics in both domestic and industrial applications. Many domestic and industrial process require an accurate temperature measurement to enable them obtain control qualitatively.[3]

Heat is the commonest form of energy which brings about change in temperature. Or described as an energy being transferred from one object to another as a result of temperature difference.

The temperature of an object determines the sensation of warmth or coldness felt by touching the object more specifically. It is the average kinetic energy of the particle of air in a sample of matter expressed in unit of degrees on a standard scale. And can only be measured more accurately with the help of a thermometer.[2]

Thermometer is a Greek word (thermo) meaning "warm" and (meter) meaning

"To measure" is a device which is used to measure temperature in a qualitative way or temperature gradient using a variety of different principles. The easiest way to achieve this is to use any measurable property of the system that varies with its temperature. The three commonest properties are: expansion of liquid, change in temperature, and change in resistivity of a conductor with respect to temperature change. [6]

The earliest thermometer (liquid in glass thermometer) used mercury or ethanol in glass as thermometric fluid. The level of the liquid varies reflecting the change in temperature. Temprature sensors such as resistance temperature detector (RTD), thermocouple and thermistor consist of conducting wires of electrical resistance R which varies with temperature change. The precision integrated temperature sensor also available that senses the ambient temperature and give out useful electrical signal as its output.[10]

Due to certain limitations, low sensitivity, inaccuracy and error due to parallax associated with analogue thermometer, there is need to minimize those deficiencies by designing a digital thermometer that helps to great extent in measuring the temperature using precision temperature sensor and provide a digital means of displaying the sensed temperature.

This project title: MICROCONTROLLER BASED DIGITAL THERMOMETER is a simple thermometric device that provides a means of measuring temperature and display information digitally.

It is generally measured in three arbitrary scales Fahrenheit, Celsius and Kevin. The Celsius scales references the measuring of atmospheric temperature. The Celsius Scale was considered in the study because the atmospheric temperature of Nigeria as a case study never falls below 0^0c and has not exceeded 52^0c in the time past. The application been considered in this project shows how to use a microcontroller to measure and display the atmospheric temperature of the environment and that of a human body on an LCD display.[2]

The device as shown in the block diagram below (fig 1.0) employed a precision integrated temperature sensor (LM 35) which senses the ambient temperature and produce its analogue voltage equivalent. Analogue to digital converter which converts the analogue output voltage of the sensor to its digital equivalent. While the microcontroller processes the digital output of the converter and t display unit which display the temperature information.

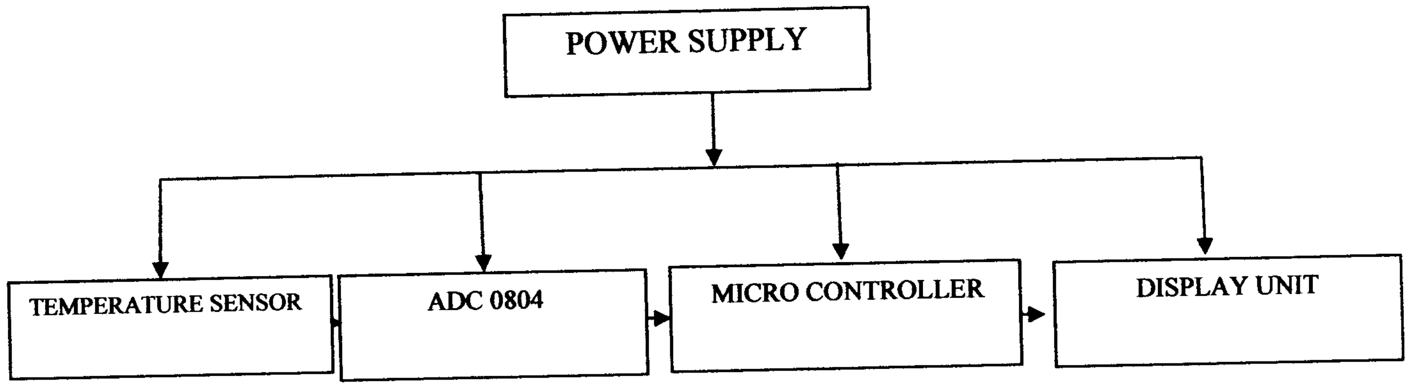


Fig 1.0 Block Diagram Of A Digital Themometer

1.1 THE PROBLEM STATEMENT-

It has been observed that temperature variation can cause a lot of system change. This project came about association with our environment, for example this could affect the working operation of a computer system, if the temperature variation goes high, this could cause the microprocessor of the computer system to malfunction and result in damage of the appliance, unwanted cost and also designed to enable us understand the advantages of a microcontroller based digital thermometer over the analogue thermometer.[5]

1. The microcontroller based digital thermometer would give us an accurate and specific value with less or no errors.

2. The microcontroller based digital thermometer designed in this project would enable measure the atmospheric and body temperature at a given time.

1.2 OBJECTIVE OF THE STUDY.

This project is aimed at designing and constructing of a microcontroller based digital thermometer to measure atmospheric temperature of the environment (e.g classroom, computer lab and industries) and of the human body in degree Celsius.

In order for the aim to be achieved, the main objectives is as follows:

i. To monitor the atmospheric temperature of the area.

ii. To display the temperature of the environment in digital form.

iii. To display the temperature of the human body in digital form.

1.3 SIGNIFICANCE OF STUDY

This project will be useful in laboratories, industries and also for domestic use. I.e. It can monitor and display the temperature of a given environment and human body.

1.4 METHODOLOGY

This project entails using a microcontroller based digital thermometer to measure and display atmospheric temperature. Voltage is supplied to the LM 7805 regulator which sends a 5 volt to LM 35(the output sensor). LM 7805 is the voltage regulator which ensures that the device maintain a stable 5 volts at all time, LM 35 is the temperature sensor which possesses a linear relationship of one degree Celsius to 10mv at the output. The output of the sensor is connected to the analogue-to-digital converter. The ADC is then connected to the microcontroller and allows the output to be displayed on the liquid crystal display unit (LCD).

1.5 SCOPE AND LMITATIONS.

The temperature range of the sensor (LM 35) as stated by the manufacturer is from -55 to 155 degree celcuis. It cannot be used for temperature out of this range. The switching between the two available power sources (AC and DC) is manual not automatic.

The amount of data transfer between the ADC and the microcontroller is usually very small as compared to the analog types thereby reducing error to 0.01. The temperature sensor was not calibrated as in the analog type which helps to increase the accuracy of the final reading.

1.6 SOURCE OF INFORMATION.

The information was source from different sources which include: websites, textbooks, post and present lecture note, and past project. Colleagues and lecturers also contributed towards the implementation of the project design.

CHAPTER TWO

LITRATURE REVIEW

2.0 TEMPRATURE FUNDAMENTAL

It is easy to demonstrate that when two objects of the same materials are placed together or when two systems with fixed volume are brought together (physicist say when they are put in thermal contact), the hotter object cools while the cooler one becomes warmer or in the other hand changes most likely will take place in the thermal properties of both systems. These changes are caused by the transfer of heat between the systems or objects, until a point is reached after which no more changes occur. The systems at this point are said to be in thermal equilibrium.[2]

The basis for definition of temperature can be obtained from the zeroth law of thermodynamics which states that if two systems A and B are to be in thermal equilibrium and a third system C is in thermal equilibrium with A system B and C will also be in thermal equilibrium. Since A, B and C are in thermal equilibrium. It is reasonable to say that each of the system shares a common property called TEMPERATURE.[6]

The kinetic theory of gases uses statistical mechanics to relate the temperature of an ideal gas to the average kinetic energy of the atoms in the systems. Temperature is related only to the average kinetic energy of the particles in gas. The temperature of an ideal gas is related to its average energy via the equation below:

K=3/2KT:

N= number of moles

R=ideal gas constant

T=temperature of the gas

where K=NR

The second law of thermodynamics states that any two given systems when interacting with each other will later reach the same average per particle and hence the same TEMPERATURE.[1]

2.1 BRIEF HISTORY OF THERMOMETER

Temperature measurement using modern scientific thermometer and temperature scale goes back to at least as far as the early 18^{th} century when Gabriel Fahrenheit adopted a thermometer i.e. using mercury as thermometric fluid.[7]

The earliest device use to measure temperature was called thermoscope invented by Galileo in 1610. It consist of an glass bulb having a long tube extending down ward into a container of a liquid. The glass bulb contained air which when heated or cooled, the level of liquid in the tube could vary reflecting the change in the air temperature. The air in the bulb is referred to as thermometric medium, i.e. the medium whose property changes with temperature. it has poor accuracy as it responds to atmospheric pressure.[6]

In 1641, the first scaled thermometer that used liquid rather than air as thermometric medium was developed by Ferdinand, grand duke of Tuscany. his thermometer used a sealed alcohol-in-glass. The thermometer was not considered accurate, as there was no form of calibration.

One of the earliest attempts at calibration and standardization between thermometers was made in October 1663 in London by Robert hook curator of royal society. The member of the royal society of London agreed to use his thermometer as a standard that the reading of others could be adjusted to it. The method of making scales were in confusion at that time because a craft man in different countries uses different calibration points thus scaling remained a problem.[7]

It was in 1724 that Gabriel fahrienheit, an instrument maker of Amsterdam, used mercury as thermometric fluid. Mercury has large thermal expansion and fairly uniform. it does not adhere to the glass, and remains a liquid over a wide range of temperatures. The above properties of mercury led to more accuracy of the thermometer. Fahrenheit measured the boiling point of water to be 212 degree and freezing point to be 32 degree. Temperatures measured on this scale are designated as degree Fahrenheit (°F).[10]

In 1745, Carolus Linnaeus of upsula described a scale in which the freezing point of water was zero, and the boiling point 100, making it a centigrade (one hundred steps) scale. Anders Celsius used the reversed scale in which 100 degrees between the two defining points. By international agreement in 1948.The centigrade scale becomes known as Celsius scale and still in use till date.[9]

The absolute temperature or Kelvin scale was proposed by sir William Thomson in the year 1848. This scale had its zero degrees as begin the theoretical lowest temperature possible(i.e. where molecule motion ceases,)this value turned out to be -237.16 degree Kelvin. The degree Kelvin is the current standard unit of temperature.

Sir Williams simens, in 1871, proposed a thermometer whose thermometric medium is a metallic conductor whose resistance changes with temperature. He used the platinum element as it does not oxidize at high temperatures and has a relatively uniform change in resistance with temperature over a large range. The platinum resistance.

thermometer is now widely used as a thermometric thermometer and covers the temperature range from about -260°C to 1235°C.[10]

T.J see beck, in 1826, discovered that when wires of different metals are based at one end and heated, a current flows from one to the other. the electromotive force generated can be quantitative related to the temperature and hence, the system can be used as a thermometer known as thermocouple. It is use in industries.

The early thermometers were non electrical in nature because the used thermal expansion of matter i.e. solid and liquid. They had the disadvantage, of possessing a limited temperature range and were also subjected to reading error. In "the design and construction of digital thermometer using thermistor" by Ajgunna Bamisaye James. He employed thermal resistors (thermistor) as his temperature sensor and his recommendation proposed the use of integrated circuit sensors for better linearity and accuracy.[11]

Thereafter, in "the design and construction of a digital thermometer "by Adeiza o. peter. He used this recommendation and so used an integrated circuit as a sensor.

This project work used the sensor of wider temperature range (LM 35) and incorporated the AC power source so that the power source should be two, either AC main or DC battery, unlike he previous one which provide means of using only DC battery.

2.2 TYPES OF THERMOMETER

Thermometers have been built which utilizes a range of physical effect to measure temperature. Most thermometers are originally captured to a contract volume gas thermometer. Temperature sensors are used in a wide variety of scientific and engineering application, especially temperature measurement are primarily either electrical or mechanical, occasionally in separable from the system which they control (as in the case of a mercury thermometer). []Various types of thermometer includes-:

1. Alcohol thermometer
2. Beckman differential thermometer
3. Bio-metal mechanical thermometer
4. Infra-red thermometer
5. Medical thermometer
6. Thermistor
7. Thermocouple thermometer

2.3 TEMPERATURE SENSOR

The basic concept of this project work is the application of a temperature sensor. Temperature sensor or transducer is an electronic device that senses the ambient temperature and gives out useful electrical signal as its output.[10]

Many different types of temperature sensors are commercially available. The type to be used in any particular application will depend on several factors e.g. cost, durability, and accuracy of the sensor. Depending on the temperature to be measured some provide temperature information for small temperature range. the temperature sensor that are commonly used are: thermocouple, resistance temperature detector (RTD),thermistor and precision integrated temperature sensors.

Thermocouple consist of two different conductor coupled together at their ends. It utilizes the principle that when two wires of dissimilar electrical properties are joined at both ends, and one junction is made hot and other cold, a small electric current is produced which is proportional to the difference in the temperature.

Resistance temperature detector (RTD) takes advantage of the principle that the resistivity of a metal is to a small degree dependent upon temperature.thermistor is a special type of resistance sensor made from a small piece of semiconductor material. its resistance value changes with temperature. it offers greater accuracy and stability than thermocouple, but its non-uniform resistance temperature characteristics can be disadvantageous in some application where it is required to obtain a more linear variation.[10]

The LM 35 integrated circuit temperature sensor used in this project work is a precision semi conductor sensor whose output voltage is linearly proportional to the Celsius temperature, with output of 10mv/°C i.e. 10mv per degree centigrade. It thus has an advantage over linear temperature sensor calibrated in Kelvin scale (LM 34) as the user is not require to subtract a constant value from its output to obtain convenient centigrade sealing. It is a three terminal (input, output, and ground) device with the following features;

- Calibrated directly in degree Celsius
- Linear +10.0mv/°C scale factor
- 0.5 accuracy guaranteed at +25°C.
- Rated for full -55 to 150°C
- Low self heating, 0.08°C in still air.
- Low output impedance, 0.1 ohms for 1mA load.

Its low output impedance, linear output and precise inherent calibration make interfacing to readout or control circuitry especially easy.

2.4 CALIBRATION

Thermometers can be calibrated by comparing them with either certified thermometers or checking them against known fixed points on the temperature scale. The best known of these fixed points are melting and boiling points of pure water. note that the boiling point varies with resources so this must be controlled. Roemer (famous for making the first measurement that the velocity of light showing that it is finite) devised a temperature scale of his own for used with alcohol in glass thermometer. that he constructed. Fahrenheit by 1924 adopted a new scale similar to Roemer's but much finer division. However since he is interested in metrological observation, he looks a reference point that is nearer to maximum observed temperature for weather. He chose the human body as upper reference point (96°F). The Fahrenheit scale use today differ slightly from original, the two fixed point being 32°F and 212°F as the temperature office and boiling water respectively.

Today the Celsius and the Kelvin scale have replaced the Fahrenheit scale for scientific work. The choices of thermometer depend on the temperature to be measure. The Celsius has two fixed point reference are the ice point and the steam point. The Number assigned to those two points in the Celsius scale is 0°c and 100°c.[2]

CHAPTER THREE

DESIGN ANALYSIS AND IMPLEMENTATION

3.0 DESIGN ANALYSIS

The digital temperature measuring system comprises the following basic units.

- 9v power supply unit.
- Control unit.
- Output display unit.

The control unit consists of the following sub units.

- LM 35 analogue temperature senor.
- ADC (Analogue to digital converter).
- 8952, 8- bit micro controller
- 16*2 Alpha-numeric LCD

The block diagram of the design is shown in fig 3.0 below

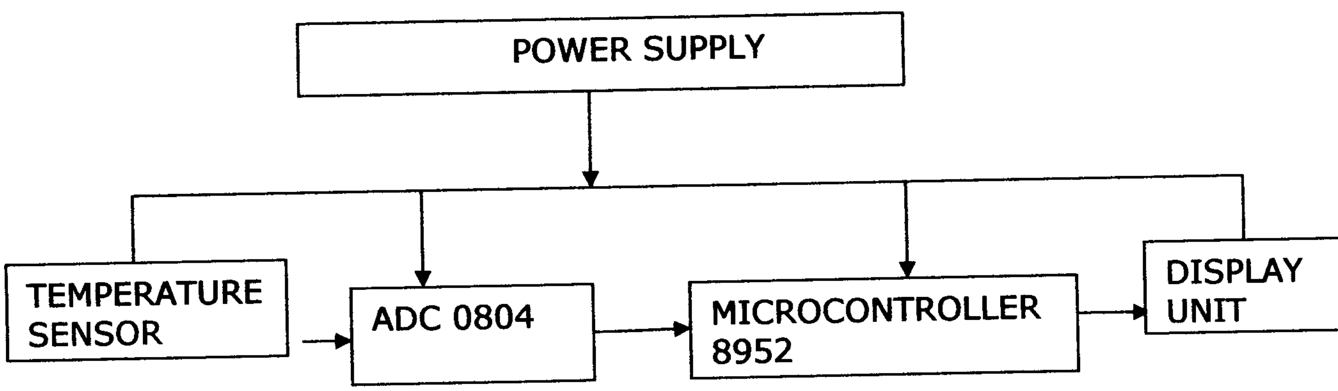


FIG 3.0 The block diagram of the digital thermometer.

3.2.1 LM35 (TEMPERATURE SENSOR).

Temperature sensor is an electronic device that senses the body and ambient temperature and gives out useful electric signal as its output.

The LM35 integrated circuit temperature sensor used in this project work is a precision semi conductor sensor whose output voltage is linearly proportional to the Celsius temperature. With output of 10mv/°c i.e.10mv per degree centigrade. The sensor has the following specifications;[10]

- Output is directly calibrated in degree centigrade
- 10.0mv/°c sealed output voltage
- 0—100°c measurement range
- Low- self heating (0.08°c in air)
- Typical accuracy of 0.50°c at 25°c

The device is housed in a 3-pin T0-92 plastic Package as shown in fig 3.1 below:

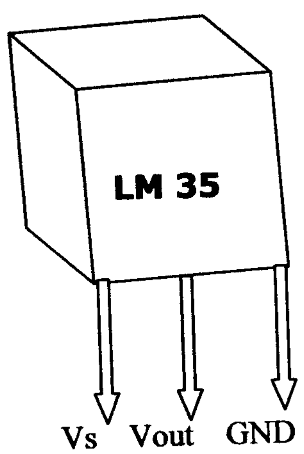


FIG 3.2 LM35 Temperature sensor.

The sensor was interfaced to an 8-bit analogue- to- digital converter that converts the sensor's analogue output voltage to its digital equivalent needed by the microcontroller. The circuit connection is shown in fig 3.3 below.

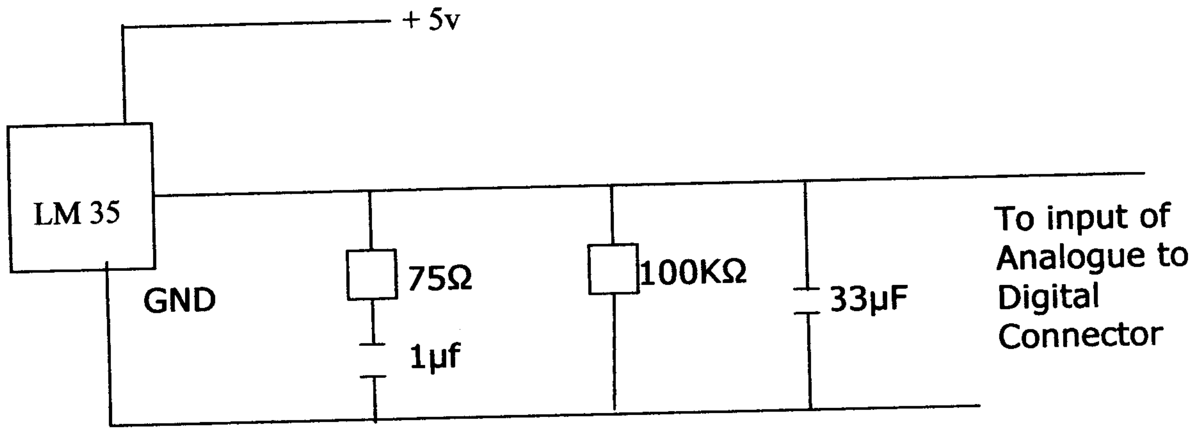


FIG 3.3 LM35 Circuit connection.

The device was powered by the regulated 5-volt power supply. Its output is connected to a series RC capacitance damper circuit comprised of 75Ω resistance and 1μf capacitance, as recommended by the manufacturer. A parallel 100kΩ resistor and 33μf capacitor connected across the output prevents the sensor's output voltage from fluctuating badly, and also prevents the ADC output from changing rapidly.[10]

3.2.2 Analogue- to- Digital converter (ADC 0804).

To convert the analogue voltage equivalent of the sensed temperature to its equivalent digital value. Which can be manipulated by system controller, an interface device capable of translating the quantity from the analogue domain to digital is needed. This was realized using an ADC 0804 8-bit analogue-to-digital converter .It belongs to the ADC 080 X family: which is a Cmos 8 bit, the device is package in 20-pin DIP package. The key features are listed below;

- Compatible with 8080 microprocessor derivates.
- Easy interface to all microprocessors.

- Differential analogue voltage input.
- On- chip clock generator.
- Resolution of 8-bit.
- Conversion time of 100 microseconds.

The device is capable of operating on a clock frequency up to 1.4MHz. The pin out shown in fig 3.4 below;

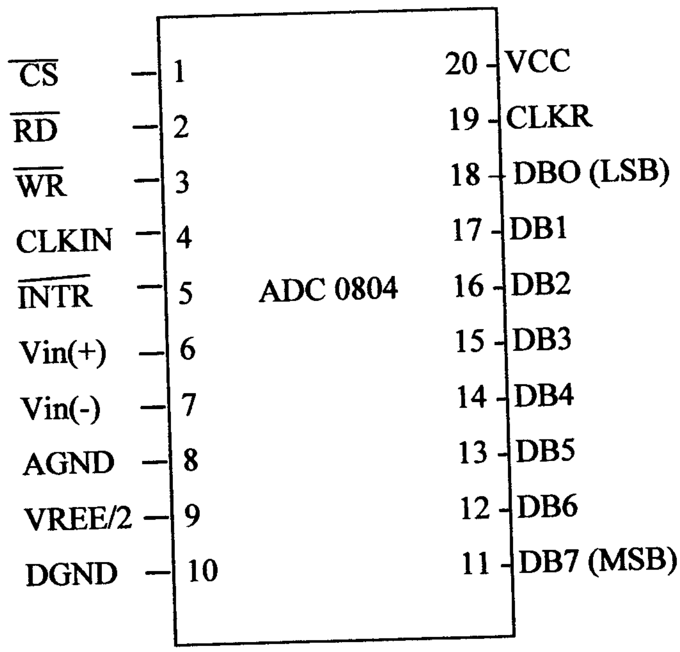


FIG 3.4 ADC 0804 Pin Out

The analogue voltage from the sensor was applied to pin 6 and 7 of the ADC. The binary equivalent is available at pin 11 through pin 18(DB7-DBO) pin1 and 2 (chip select CS) were connected to ground so that the chip should be always enable. ADC 0804 includes an internal resistor which requires an external capacitor and a resistor to operate. 100PF capacitor (as specified by manufacturer) was connected from pin 4(clock in) to ground and 10kΩ resistor from pin 4 to 19 (clock R).[6]

The device was run at a clock frequency given by RC combination on pin 19 as:

$$F = \left(\frac{1}{1.1RC}\right) H_Z, \quad R = 10Kohms, \quad C = 100pf$$

R= Resistance connected between pin 19 and pin 4.

C=capacitance connected between pin 4 and ground

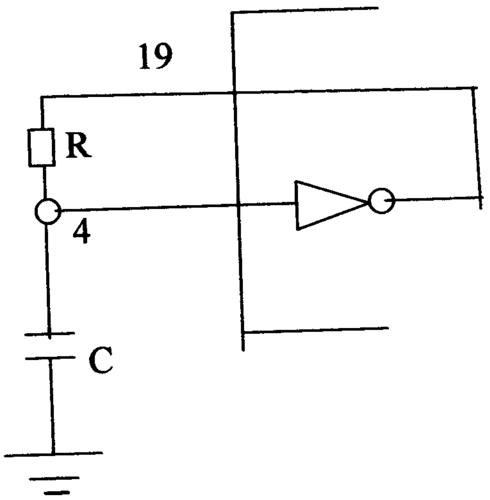


FIG 3.5 ADC Clock Generator.

The device has a minimum clock specification of 100 kHz, and a maximum of 1.4MHz.The manufacturer specified 10kΩ resistance was connected between pin 19 and pin 4, and a 100PF used from pin 4 to ground.

$$F=\left[\frac{1}{(1.1*10^{4})(10^{2})(10^{-12})}\right] \text{Hz}$$

The ADC was interfered with the controller over P1. It was wired for a full scale voltage of 1. 2v

The conversion was initiated by pulsing the WR pin low and then high and completed about 100 microseconds after and the INTR pin goes low to indicate end of conversion the device was configured for system operation as shown in fig 3.6 below

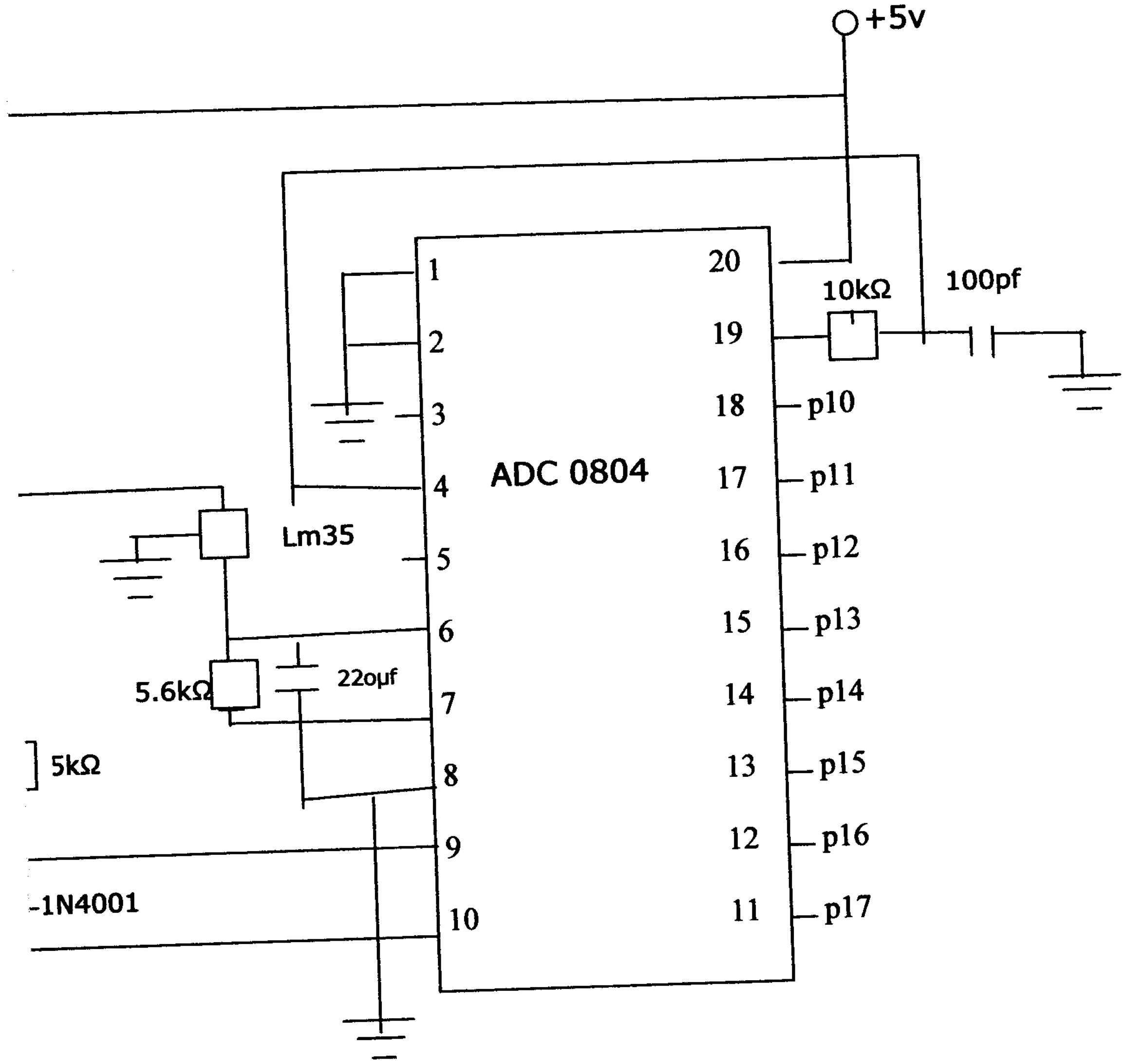


FIG 3.6 LM35 – ADC 0804 Controller Interface.

The device as shown was interfered with system controller over port 1 and two pits on port 3 (p3.0 & p3.1).A reference voltage of 1. 25v (2.5 in side) was set on pin 9 (v ref) to establish between the input analogue average and the digital output voltage.

3.2.3 8952 8-BIT SYSTEM CONTROLLER.

Microcontroller is employed in modern electrical system today to co-ordinate the system operation. An 8952 microcontroller was used in this project to capture, save and display digital data. The device possessed the following standard features.

I. 8 bytes of internal ram

II. 32 programmable input & output time

III. Two 16- Bits timer/ counter

IV. Initiate the temperate conversion process.

V. Read data from ADC.

VI. Manipulates ADC data and present in a human readable from on the LCD.

The device is a low power, high performance, CMOS 8-bit microcontroller with 4kB of flash programmable and erasable read only memory (PEROM). The on clip flash allows the program memory to be reprogrammed in system or by a conventional non – volatile memory programmer. The device has the pin out as shown in the fig 3.7

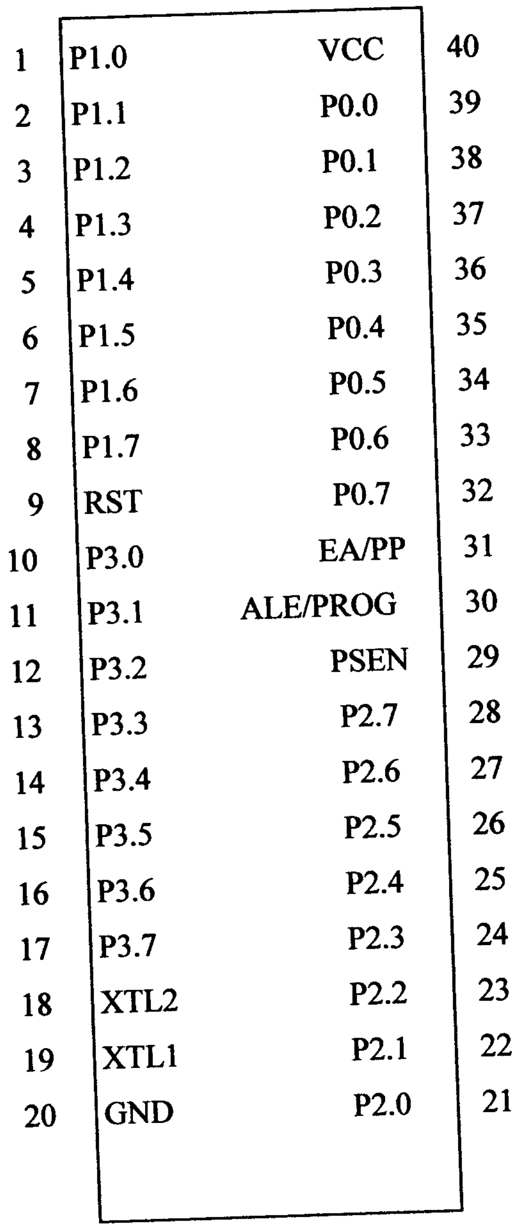


FIG3.7 Microcontroller Pin Configuration.

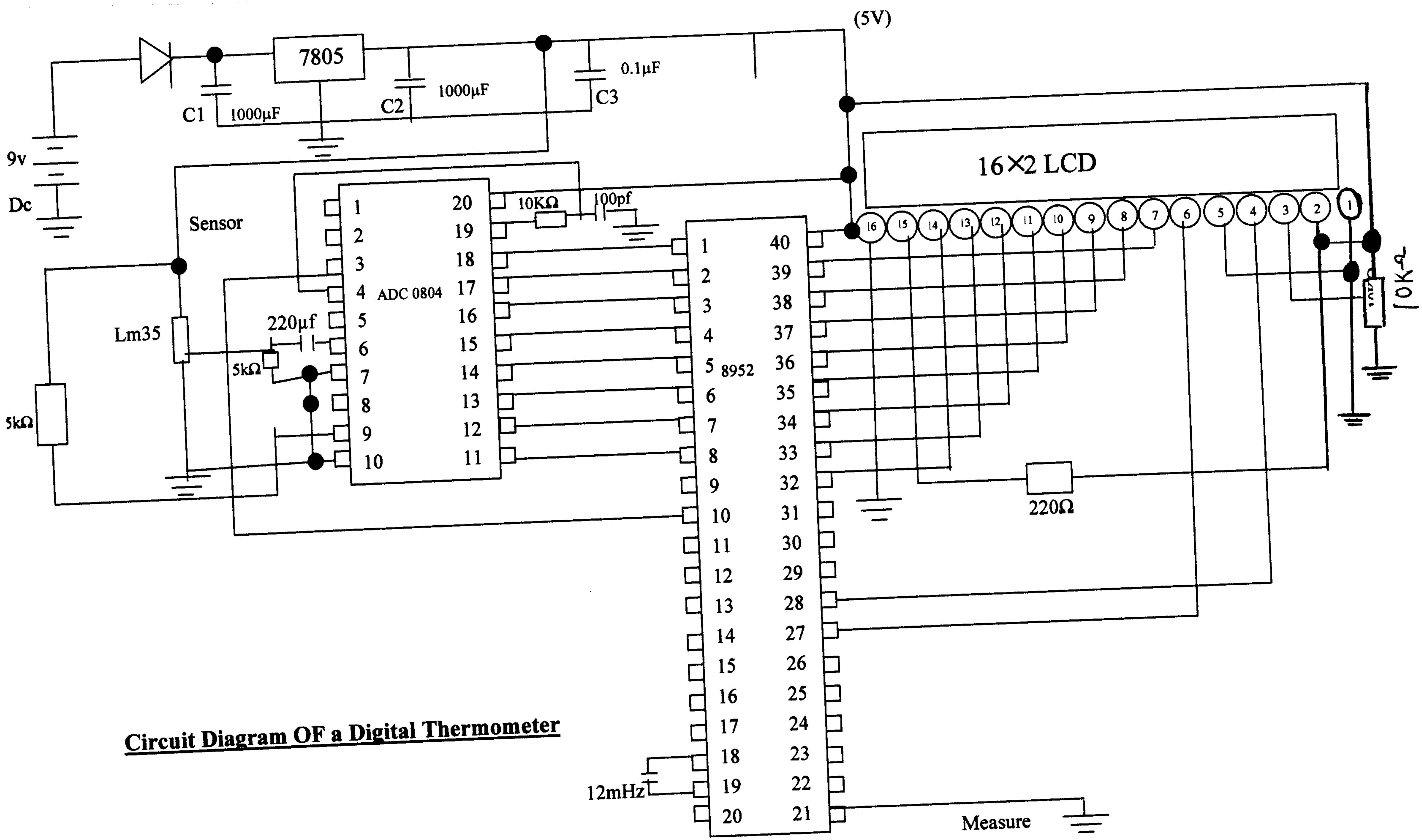
The Device was programmed to control the whole system via software written in C-language. The 12.432MHz crystal was connected to the device to provide the required frequency for the controller to execute instructions.[5]

The device executes the system control software from power on till power off. The system controlled software consists of the following main bodies of the code.

1. Power up system initialization.
2. Conversion via ADC.
3. Processing of digital value.
4. Inviting of data to Display.

3.2.4 OUTPUT DISPLAY UNIT. (16 X 2 LCD).

For a visual output of the seemed temperature, an alphanumeric display was incorporated .The LCD was interfaced with the controller over PO. The displayed temperature reading was presented in both the Centigrade and Fahrenheit.



Circuit Diagram OF a Digital Thermometer

CHAPTER FOUR

CONSTRUCTION, TESTING AND RESULT

4.0 PROJECT CONSTRUCTION

The power unit was first tested on the bread board. On inspection of the required components were first tested and subsequently mounted on the Veroboard. Using circuit diagram as a guide. Modular approach was adopted and each module was separately soldered on a sectioned Vero board. Units like temperature sensing, display and reset button units were soldered on a Vero board pieces and connected to the main board through adequate wires. The modular approach allow each sub circuit to be soldered and tested appropriately before connection.Thereafter,the entire circuit was connected to the supply unit and tested accordingly.

4.1 TESTING

The subsequent modules of the circuit design were tested at various stages of the project design implementation. These tests were repeatedly done to ensure the reliability of the components. The final test of the entire system design implementation was conducted by bringing he heat source such as soldering iron

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.0 CONCLUSION

The aims and objective of this project was to design and construct a device that can measure the surrounding temperature and display it on a visual digital display. The aims and objectives were achieved because the DIGITAL THERMOMETER constructed was able to measure the surrounding, body temperature and display it on a visual digital display. The device also overcomes the parallax error encountered in an analogue thermometer. While the device is suitable for both domestic and industrial application. It may not be suitable for measurement of very high temperature.

RECOMMENDATIONS

The following recommendations are made based on the various aspects of the design

1. A thermistor which has wider range of temperature could be used as the temperature sensor.
2. A digital thermometer is reliable and affordable.
3. A digital thermometer has a better and faster accuracy than the analogue thermometer.

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APPENDIX

PROGRAM CODE

```
#include<reg51.h>
#include<stdio.h>
#include<intrins.h>

#define adc_port P1
#define lcd_port P0
#define size 8
#define t_base 250
#define scale 2.1250
#define lcd_col 16
//******************
//******************
sbit adc_write= P3^0;
sbit lcd_rs =P2^7;
sbit lcd_en= P2^6;
sbit measure_key=P2^0;
sbit mode = P2^1;
//*******************
//*******************
bit overflow;
//*******************
//*******************
volatile unsigned char z;
```

```
volatile unsigned char data buffer[10],lcd_buffer1[10],lcd_buffer2[10];
volatile float avg;
//**********************8
//*********************
void tf0_isr(void) interrupt 1
{
	overflow=1;
}
//**************
//**************
void start_timer(void)
{
	overflow=0;
	TR0=1;
}
//****************
//****************
void stop_timer(void)
{
	TR0=0;
}
//*****************
//*****************
void delay(unsigned int z)
{
```

```
        while(z)
        {
                start_timer();
                while(!overflow);
                overflow=0;
                z--;
        }
        stop_timer();
}
//*******************
//*******************
void write(unsigned char c,unsigned char reg_select)
{
        lcd_en=0;
        lcd_rs=reg_select;
        lcd_port =c;
        lcd_en=1;
        lcd_en=0;
}
//****************
//****************
void lcd_data(unsigned char c)
{
        write(c,1);
        delay(500/t_base);
```

```
}
//*****************
//*****************
void lcd_cmd(unsigned char c)
{
        write(c,0);
        delay(2000/t_base);
}
//*****************
//*****************
void clear_lcd(void)
{
        lcd_cmd(0x01);
}
//*****************
//*****************
void lcd_pos(unsigned char row, unsigned char pos)
{
        if(row==1)lcd_cmd(0x80+pos);
        if(row==2)lcd_cmd(0xc0+pos);
}
//******************
//******************
void lcd_string(unsigned char code *p)
{
```

```
        while(*p)lcd_data(*p++);
}
//*****************
//*****************
void lcd(unsigned char data *ptr)
{
        while(*ptr)lcd_data(*ptr++);
}
//*****************
//*****************
void init_lcd(void)
{
        lcd_cmd(0x38);
        delay(15000/t_base);
        lcd_cmd(0x38);
        delay(2);
        lcd_cmd(0x38);
        delay(2);
        lcd_cmd(0x0c);
        delay(2);
        lcd_cmd(0x01);
        delay(2000/t_base);
        lcd_cmd(0x06);
        delay(2000/t_base);
}
```

```
//******************
//******************
unsigned char get_adc(void)
{
        unsigned char z=100;


        adc_write=0;
        adc_write=1;
        while(--z);
        return adc_port;
 }
 //******************
 //******************
 void show_temp(void)
 {
        for(z=0;z<size;z++)buffer[z]=0x00;
        for(z=0;z<size;z++){delay(200);buffer[z]=get_adc();}


        clear_lcd();
        lcd_pos(1,0);
        lcd_string("  temperature:  ");


        while(!measure_key)
        {
               avg=0.00;
```

```
for(z=0;z<size;z++)avg+=buffer[z];
avg/=size;
avg/=scale;
sprintf(lcd_buffer1,"%.1f",avg);
sprintf(lcd_buffer2,"%.1f",((avg*1.8)+32));

lcd_pos(2,0);
for(z=0;z<lcd_col;z++)lcd_data(0x20);
lcd_pos(2,1);
lcd(lcd_buffer1);lcd_data(223);lcd_data('C');
lcd_pos(2,9);
lcd(lcd_buffer2);lcd_data(223);lcd_data('F');

delay(3000);
for(z=0;z<size;z++)buffer[z]=buffer[z+1];
buffer[size-1]=get_adc();
}
}
//********************
//********************
void init_irq(void)
{
ET0=1;
EA=1;
}
```

```
//******************

//******************

void init_timer(void)

{

        TCON=0x00;

        TMOD=0x02;

        TH0=0x06;

        TL0=0x06;

 }

 //***************

 //***************

 void show_logo(void)

 {


            clear_lcd();

            lcd_pos(1,0);

            lcd_string("okoli chidiebere");

            lcd_pos(2,0);

            lcd_string("  2003/15430ee  ");

            delay(1800000/t_base);

            clear_lcd();

            lcd_pos(1,4);

            lcd_string("digital");

            lcd_pos(2,2);

            lcd_string("thermometer");
```

```
        delay(1800000/t_base);

}
//*****************
//*****************
void sys_init(void)
{
        IE=0x00;
        init_timer();
        init_irq();
        adc_port=0xff;
        init_lcd();
        show_logo();
}
//****************
//****************
void show_ready(void)
{
        clear_lcd();
        lcd_pos(1,0);
        lcd_string("  system ready  ");
}
///****************
//*****************
void main(void)
{
```

```
    sys_init();
    while(1)
    {
            show_ready();
            while(measure_key);
            delay(1000);
            if(measure_key)continue;
            show_temp();
    }
}
```

```
<html>
<body>
<pre>
<h1>µVision3 Build Log</h1>
<h2>Project:</h2>
D:\copieds_sunday(2)\chidi_code\chidi.uv2
Project File Date:  01/07/1980

<h2>Output:</h2>
Build target 'Target 1'
assembling STARTUP.A51...
--- Error: failed to execute 'C:\Keil\C51\BIN\A51.EXE'
Target not created
Build target 'Target 1'
```

assembling STARTUP.A51...

compiling chidi.c...

linking...

Program Size: data=73.2 xdata=0 code=3400

creating hex file from "chidi"...

"chidi" - 0 Error(s), 0 Warning(s).