DESIGN AND CONSTRUCTION OF TEMPERATURE LOGGING AND CONTROL DEVICE

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF ENGINEERING DEGREE (B.ENG) IN THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, SCHOOL OF ENGINEEERING AND ENGINEERING TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

NOVEMBER, 2007

DECLARATION

I, OTITOLAIYE DAVID AYOOLA, 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, Niger state.

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DEDICATION

I dedicate this project to all my lovely cousins. I feel blessed having you as family.

ACKNOWLEDGEMENT

All praise to the Almighty God who has made me worthy of His love and faithfulness. I want to say thank you to my father and mother Mr. and Mrs. Otitolaiye, my brother James Otitolaiye, sister Shade Otitolaiye; I love you all. My profound gratitude goes to my uncle, Dr. J. O. Otitolaiye. Words can't express how grateful I am, thanks a million times. To my supervisor Engineer J. G. Kolo whose priceless contributions, support and understanding made this project a great success, I want to say I appreciate you sir. I also want to say thank you to my friends, Kayode Gbamis, Ayoade Oguntola, Jide Olorungbon, Tope Oduntan, Gbeminiyi Akala, Odunayo Babatunde, Bosedė Aderibigbe, Adetutu (Adecold), Oladimeji Ajala, Tayo Adebayo, Kayode Odupe, Jide Oyetumbi and Nike for their friendship which saw me through my years in school.

ABSTRACT

The temperature logging and control device was fashioned in an attempt to solve the problem associated with the measurement, logging and control of temperature. It measures the temperature of its immediate surroundings, converts it to a voltage value and lastly to its digital equivalent through an Analog-to-digital converter (ADC). The value is retrieved by a microcontroller and sent to a PC via the parallel port where logical manipulations are carried out. If the temperature measured goes above a preset value, a control device as determined by the user is enabled.

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CHAPTER ONE

INTRODUCTION

1.1 SIGNIFICANCE AND MOTIVATION

The temperature of a system is defined as simply the average energy of the microscopic motions of a single particle in the system per degree of freedom. [1]. On the other hand, intuitively one can say it is a measure of how hot or cold something is. [2]

The effect of temperature and changes in it, is felt in almost every aspect of life; it dictates the kind of clothe we put on, environment we prefer to stay in. It could to an extent even determine the mood we find ourselves in at times.

In the engineering field, the effect of temperature cannot be overemphasized since generating plants, machines, metals, solid state devices and other chemical, mechanical, electrical and electronic devices may fail as a result of changes in temperature. Hence, the need for specifying operating temperature range for most engineering devices by manufacturers.

Monitoring and control of the behavior and changes in parameters of the various "non constants" around us, foremost of all; temperature is of utmost importance if we, our livestock, equipments, are to remain in good condition throughout the intended useful life span.

There is therefore the need, for an automated system which lodges the value of the temperature of an environment, equipment or device whose performance can be greatly affected by changes in temperature, for the purpose of monitoring to determine the frequency of increase or decrease in temperature, vis-à-vis tendency towards probable failure of environment, equipment or device. Provision for a control system should also be readily available to keep the environment, equipment or device within the intended operating temperature range for optimum performance.

1.2 AIM OF THE PROJECT

To design and construct a device that will effectively measure, log, and enable a temperature control device as decided upon by user.

1.3 OBJECTIVES OF THE PROJECT

Some of the aims and objectives of this project are as stated below:

1. To put in place an effective means of accumulation of temperature measurements for the purpose of processing of temperature/temperature dependent data.
2. To make temperature data collection more efficient.
3. To reduce frequency of visit to weather stations to record data.
4. To develop a means of activating a temperature control system so as to keep generators, devices, and equipments that could be affected by temperature within the operating temperature range for optimum performance.
5. To develop a logging system which industries can use in producing more efficient systems.
6. To put in place an accurate and cost effective means of data acquisition

1.4 METHODOLOGY

In an effort to meet the demands of the above stated aims and objectives, the device to be discussed in this report was fashioned.

The device which is a temperature logging and control device measure and records the temperature of the environment or device for which it is intended at specified intervals as programmed by the designer in conformity with the intended use in the memory of the computer via the parallel port of the computer.

The device is programmed in such a way that an upper range temperature above which a switch that controls whatever control apparatus (air conditioner etc) to be made use of, goes on. Below a particular temperature also, the switch goes off thus turning off the control part of the system.

The temperature logging and control device is designed to measure the temperature of an environment, device, or equipment to which it is attached via the sensor which is an analog device, convert the analog signal to a digital signal through the use of an analog to digital converter, then record the value in the memory of the computer for further processing depending on application.

The interval at which temperature readings are taking and also the preset temperature (temperature at which the control switch is automatically activated) is part of a program written for this purpose.

Figure 1 is the block diagram which depicts the various stages of operation of the device.

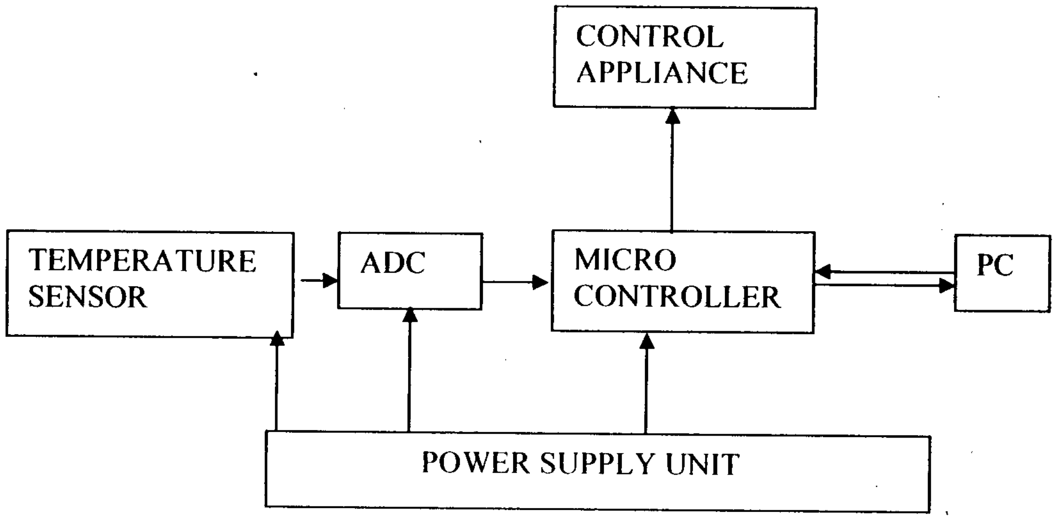

Fig. 1.1 block diagram of the various stages of operation of the TLCD

1.5 APPLICATION OF THE TLCD

The TLCD will be of great use in process monitoring in industries such as for Manufacturing, printing and metallurgy etc where continuous monitoring and recording of temperature is needed.

It will also find usefulness in quality control as light ballast manufacturers can use it in testing the temperature rise in the casing and ensuring certification. Manufacturers of ovens will also find it useful in testing their ovens to ensure proper temperature gradients throughout the chamber. So also will chain saw mufflers in order to ensure safety against injury and fire.

Agricultural test stations can make use of this device to make long time studies of soil temperature and its effect on plant growth. The device will also find use in the study of the effectiveness of water treatment plants, at weather stations where data can be transmitted with modem to a central monitoring station.

The fact that temperature is a key factor in research and development laboratories makes the importance of the device in this area unquestionable.

1.6 PROJECT ORGANISATION AND LAYOUT

For better understanding and appreciation of the need for, operation of and various application of the temperature logging and control device, this piece is organized thus:

Chapter one allows the reader to see reasons why the writer believes the piece and the device will be of great use in the engineering field and other areas of life. It gives the aims and objectives for which the project was carried out. The method used in achieving these aims using the device being introduced is also discussed, also a block diagram is given to show the various stages by which this is achieved.

Chapter two discusses other works that are related to this and why this very device will serve as an improvement or enhancement to these related works depending on area of application.

Chapter three gives details on the design and implementation of the project being discussed. This to some level serves as the heart of the whole write up.

Chapter five contains the conclusion of the project.

CHAPTER TWO

LITERATURE REVIEW

2.1 BRIEF HISTORY OF TEMPERATURE MEASUREMENT

The impact of temperature on the physical, chemical and biological world makes it the most measured parameter.[3]

The limitations encountered using the sense of touch to tell how cold an object or environment is, became obvious as man attempted to work with metals through the bronze and iron ages. Some of the technological processes required a degree of control over temperature; thus the need to be able to accurately measure what is to be controlled.[4]

Temperature measurement used to be subjective, until in 1592 when Galileo Galilee invented an air thermometer (thermo scope). It is made of a glass bulb with long tube attached. The flaw with this measuring equipment is that it is affected by atmospheric pressure.

The mid-17th century saw the introduction of liquid-in-glass thermometers which was later developed by Grand Duke Ferdinand of Tuscany.

In 1714, the mercury and the alcohol thermometers were invented by Daniel Gabriel Fahrenheit.[5] Although, the mercury thermometer is not as sensitive as Galileo's thermo scope, it is not affected by atmospheric pressure.

Mercury freezes at -39 degree Celsius, so unlike alcohol which freezes at -113 Celsius does not allow for very low temperature measurement.

It was in 18th century also that Anders Celsius chose to take 100 degrees as the boiling point and zero degrees as the freezing point of water.

Two very important discoveries were made in 1821, one by Sir Humphrey Davy, who found out that metals have a positive temperature coefficient of resistance and that platinum could be used as an excellent temperature detector. The other was J.T Seebeck and that is; the thermocouple effect (current could be produced by unequally heating the two junctions of two dissimilar metals). [6]

1871, Sir Williams Siemens based on Davy's discovery built electric resistance thermometer using platinum.

The discovery of semiconductor devices such as: the thermistors, integrated circuit censors, fiber-optic sensors, a range of non contact sensors in the 20th century has made measurement of temperature much more easier and accurate. On of such is the LM35 which is not subjected to oxidation, very accurate, generate high output voltage and may not require that output voltage be amplified.

2.2 DATA LOGGIN

These days, logging and processing of data is less stressful, less time consuming and importantly less mistakes are made when processing data.

The era when lots and lots of paper are needed to log data and huge mistakes were due to human factors such as fatigue, has given way to that where the computer does a big chunk of the job. The speed at which the job is done is also worth mentioning.

2.3 PROJECTS ON TEMPERATURE LOGGIN AND CONTROL

Many attempts have been made by people in the area of measurement, logging and control of this very important yet potentially dangerous parameter: temperature.

Apart from the various thermometers, the thermocouple, semi-conductor temperature sensors, advancements have been made by putting together some of the above mentioned devices in combination with what is available in form of computer technology to either measure, log, control temperature or do the three all together.

In 2003, Akut Emmanuel Kasai, a student of Electrical/Computer engineering in Federal University of Technology Minna, working on a project titled: 'Design and Construction of a Temperature sensing Fan Regulator' attempted the control of temperature. Even though I commend his effort in this area as he did a thorough job, one cannot but notice the limitedness of the project.

First of all, the control device in most activities that produce heat (high temperature) does not have to always be a fan. It could be an air conditioner; it could even be something as simple as disconnecting a load to reduce temperature. Other flaws are there to mention but for the purpose of this project, let us limit ourselves to this.

Another person whose work is capable of arousing interest, is Eleam Chikezie O, another student of Electrical/Computer department, whose work is titled 'Design and Construction of Temperature Monitor (Digital Thermometer) 'which was done in 2005. His work was limited to the monitoring of temperature alone. The temperature sensed, after it has been converted to digital form is then displayed using a seven segment technology. The flaw with this project is that, due to human factors such as fatigue or even carelessness of staff at any facility using this device, the displayed temperature value if more than the maximum specified, might not be seen and since there is no control enable device, disaster might have occurred before the said temperature is even noticed.

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In the same year (2005), another student by the name Badamosi A. Safiu of the same department also worked on a project titled: 'Design and Construction of Automatic Heat Detector'. Going by the title of the project and the block diagram in the project, where from the source power, the next stage is the sensor transducer thermistor, then voltage comparator, frequency oscillator to the Audio alarm and light flashing alarm; one cannot help but praise his ingenuity. An alarm both as sound and light flashing will almost always trigger attention. While his work can be considered as an improvement on Eleam Chikezie'swork, I believe it will be better if the temperature can be controlled automatically.

2.4 UNIQUENESS OF THE TLCD

In an attempt to correct some of the flaws mentioned above, the idea of the TLCD (Temperature Logging and Control Device) was born.

The TLCD not only has the ability to measure temperature with high accuracy, but also log the different temperature over a period of time, calculate the average over this period and if at any point in time the temperature goes above a specified value, a control device as decided by the user is triggered.

In view of what has been said above, I believe a reasonably large part of the problem of temperature monitoring and control is addressed by the TLCD.

CHAPTER THREE

DESIGN AND CONSTRUCTION OF TLCD

3.1 AN OVERVIEW OF THE DESIGN

To achieve the aim for which the TLCD was designed, some basic things had to be put into consideration. These are:

1. How to accurately sense the temperature to be measured which is an analog quantity
2. The conversion of the analog quantity to digital, to make it available for further manipulations.
3. A device that will be programmed to control the whole operation, serving as a bridge between the sensor units, converter, logging device etc.
4. A program through which this is achieved.
5. An interface between the TLCD and the PC which is part of the system.
6. Another program that takes care of the arithmetic and logic manipulations involved.

To solve the problem of temperature sensing, the choice of LM35 was made. LM35 is a temperature sensor which senses temperature an analog quantity and converts it to equivalent voltage values.

For every 1 degree rise in temperature, there is a 10mv rise in the output voltage of the LM35 circuit.

To solve the problem of conversion, the ADC0804 was introduced. For control purposes, the AT89C52 was chosen, a parallel port was chosen as the interface and for programming, assembly language was used to program the microcontroller while the

Visual C+ + was used on the PC. The design will not be complete without a suitable power unit to effectively power the various units appropriately.

3.2 THE TRANSDUCER CIRCUIT

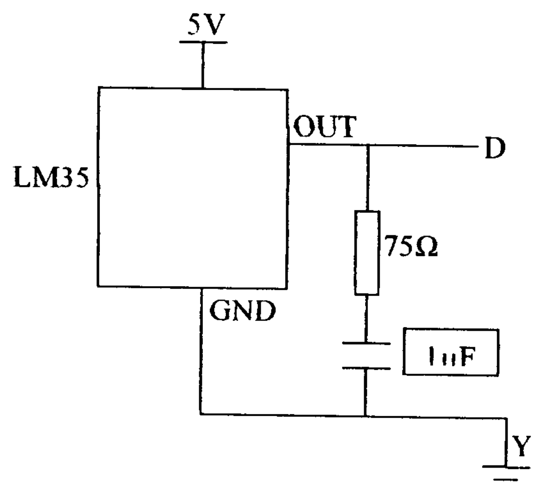

Fig 3.1 The LM35 Transducer circuit

Some of the premises on which the choice of LM35 over other temperature sensors was based are:

1. It measures temperature more accurately than when a thermistor is used.
2. The sensor circuitry is scaled and not subjected to oxidation.
3. It generates high output voltage than thermocouples and may not require that the output voltage be amplified. Also it has low output impedance.

The LM35 has an output voltage that is proportional to the Celsius temperature with a scale factor of 0.01volts per degree Celsius. LM35 does not require any external calibration or trimming and maintains an accuracy of +/- 0.4 degree Celsius at room temperature and +/- 0.8 degree Celsius over a range of 0-100 degree Celsius.

Only 60 micro-amps are drawn by LM35 from its supply. It also has a low self heating capacity. The sensor's self heating causes less than 0.1 degree Celsius temperature rise in still air. This can be considered very low compared to other temperature sensors' heating capacity.[7]

To prevent the effect of electromagnetic forces such as radio transmitters, relays, etc which might cause wires to which the sensor is connected to act as receiving antenna and internal junctions to act as rectifiers, a 75 ohms resistor is connected in series with a 1 micro-farad capacitor from output to ground. This part of the sensor's circuit is called the DC damper.

The circuit is powered with 5 volts and this is connected to the point marked x in the circuit, as already indicated, the point marked y is grounded while the output is connected to pin 6 of the ADC (this will be discussed in details later).

3.3 ANALOG TO DIGITAL CIRCUIT

Integrated circuits, free the equipment designer from the need to construct circuits with individual discrete components such as transistors, diodes and resistors. The ADC is one such circuit. [8]

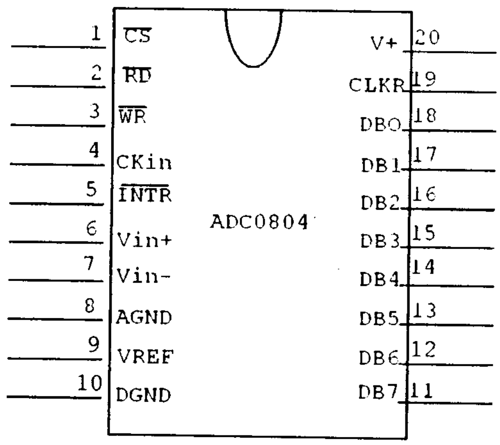

Fig 3.2 Top view of the ADC0804 Analog to Digital Converter

Fig 3.2 is a diagram of the ADC0804 which is a very popular analog to digital converter used by many designers because of its suitability and availability when conversion of analog to digital signal is needed.

It operates on a supply voltage range of 4.5 volts to 6.5 volts and in this case, a voltage of 5 volts was chosen (since, about the same voltage of 5 volts is needed for the LM35).

It has a conversion time of about 100 micro-seconds, has TTL and MOS compatible outputs and inputs with an on clip clock generator that requires an RC network to operate.

As shown in Fig 3.2, ADC0804 has 20 pins. Pin 6, is connected to the output of the LM35 which was marked D in Fig 3.1 (LM35 sensor circuit). It is through this pin that the signal to be converted to digital form is taken. Pin 20, is connected to power supply Vcc= 5 volts DC to power the ADC0804

Pins 11-18 serve as the output pins which deliver the binary equivalent of data as converted by the ADC0804 to the microcontroller for either storage in RAM or further manipulations. Pin 1 is the chip select, pin 2 the read pin while pin 3 serves as the write pin. Table 3.1 below gives the pin description.

Table 3.1 Pin description of ADC0804

PIN	DESCRIPTION
1	Chip Select
2	Read Pin
3	Write Pin
4	Clock Input
5	Interrupt
6	Positive Differential Input
7	Negative Differential Input
8	Analogue Ground
9	Voltage Reference
10	Digital Ground
11 – 18	Data Pins
19	Clock Input
20	Power Supply

3.3.1 STEP SIZE CALCULATION

To calculate step size, the formula used is:

$$S = 2\ Vref / 255$$

where V ref is the reference voltage, the divisor being the maximum possible output value of the ADC which is an 8-bit device. After due test a reference voltage of 1.28 volts was chosen. Thus using the formula for step size we have:

$$S = (2*1.28) / 255$$

$$S = 2.56 / 255 = 0.01\ Volts = 10mVolts.$$

This means that for every 10mVolts rise at the input of the ADC, there is a rise in binary value of 1 at the output. In essence, since for every degree rise, the sensor output has a corresponding 10mVolts rise and a 10mVolts rise at the input of the ADC gives a rise in binary value, then a degree rise sensed by the LM35 is seen as a degree rise by the microcontroller from the output of the ADC.

For better understanding, table 3.2 can be formulated thus:

Table 3.2 Illustration of how analog to digital conversion was achieved

LM35 INPUT	LM35 OUTPUT (ADC INPUT)	ADC OUTPUT	EQUIVALENT
1 degree Celsius	0 mV	00000000	0
2 degree Celsius	10 mV	00000001	1
3 degree Celsius	20 mV	00000010	2

3.4 VOLTAGE DIVIDER

In trying to achieve the value of the voltage reference already calculated for the ADC, there is the need to make use of the voltage divider. The voltage divider is a circuit that produces a desired output which is a fraction of its input. In this case the input voltage is 5 Volts and output desired is the 1.28 Volts (V ref).

This can be achieved in two ways one of which is represented by fig 3.3 below:

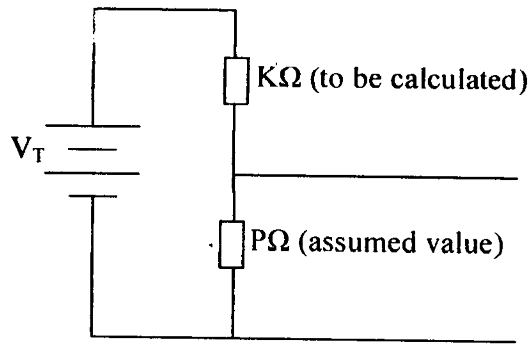

Fig 3.3 Using two resistors to get a fraction of an input voltage at the output

Here, a value says P kilo ohms can be fixed and K is calculated using the voltage divider formula;

V out = P *V total / (P+K)

The problem with using this method is that the calculated value for K may not be available for purchase and even when it is, the fact that resistance values are not always exact. Thus the second method which is represented by figure 3.4 below is more reliable

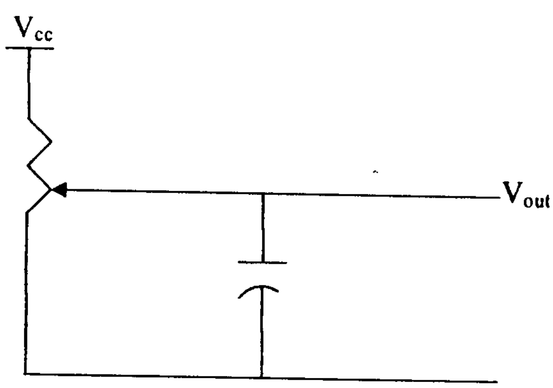

Fig 3.4 using a variable resistor to get a fraction of an input voltage at the output

Here, after the value of resistance needed has been calculated, a variable resistance is connected as indicated in the diagram. The output is measured as the variable is gradually varied until the desired result is gotten.

The capacitor seen in the figure ensured that even though the input voltage fluctuates, the output remains stable.

3.5 THE AT89C52 MICROCONTROLLER

The functionality of the device largely depends on the microcontroller. In this case, the microcontroller used is the AT89C52. Some of its features are:

1. Compatible with MCS-51 Products.
2. 8 K Bytes of In-System Reprogrammable
3. Endurance: 1000 Write/Erase cycles
4. Fully static Operation: 0Hz to 24MHz
5. 256 * 8-bit Internal RAM
6. 32 Programmable I/O lines
7. Three 16-bit Timer/Counters
8. Eight Interrupt Sources
9. Programmable Serial Channel
10. Low Power Idle and Power-down Modes.[9]

The AT89C52 is a powerful microcomputer which provides a highly-flexible and cost – effective solution to many embedded control applications. Its pin configuration is shown in Fig 3.5 below

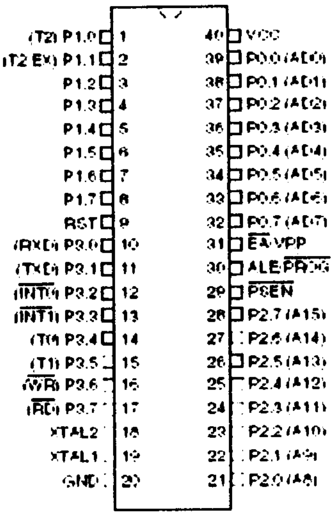

Fig 3.5 Pin configuration of the AT89C52 [10]

3.5.1 PIN DESCRIPTION OF THE AT89C52

The supply voltage is Vcc, while GND is the ground. Port 0 is an 8-bit open bi-directional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high impedance inputs.

Port 0 can also be configured to be multiplexed low order address/data bus during accesses to external program and data memory. Port 0 receives the code bytes during flash programming and outputs the clock bytes during program verification.

Port 1 is an 8-bit bi-directional I/O port with internal pull-ups. The port 1 output buffers can sink/source four TTL Inputs. When 1s are written to port 1 pins, they are pulled high by the internal pull-ups and can be used as inputs.

Port 2 is an 8-bit bi-directional I/O port with internal pull-ups. Its output buffers can also sink/source four TTL inputs.

A high on the reset pin (RST INPUT) for two machine cycles while oscillator is running resets the device.

Address Latch Enable is used for latching the low byte of the address during accesses to external memory. It is also the program pulse input during flash programming. [10]

The description of the remaining pins can be found on the web site http://www.atmel.com

3.5.2 OPERATION OF THE MICROCONTROLLER IN THE TLCD

The microcontroller first clocks the write pin of the ADC which initially is high by given it a low then high signal. This tells the ADC to start the process of conversion. The microcontroller keeps checking the interrupt pin to know if the process of conversion is complete. If at any point in time, it checks and finds out that the process is complete, it then clocks the read pin by also given it a low then high signal.

After this, it sends the data retrieved from the output of the ADC to the PC via the parallel port for the program on the PC to take over. When the value of temperature goes above the preset value, the PC sends a message to the microcontroller in activate or deactivate the control device as the case may be.

3.6 PROGRAMS USED

Two programs were used in the course of design of the TLCD; the assembly language which was used to program the microcontroller, and the Visual C + + which was used to program the PC.

The various flow charts of the various stages of operation of the temperature logging and control device are presented in a simplified form to avoid complexity as much as possible. There are three sets of flow charts vis-à-vis the one that signifies the operation of the microcontroller, the logging aspect and lastly the control aspect of the operation of the device.

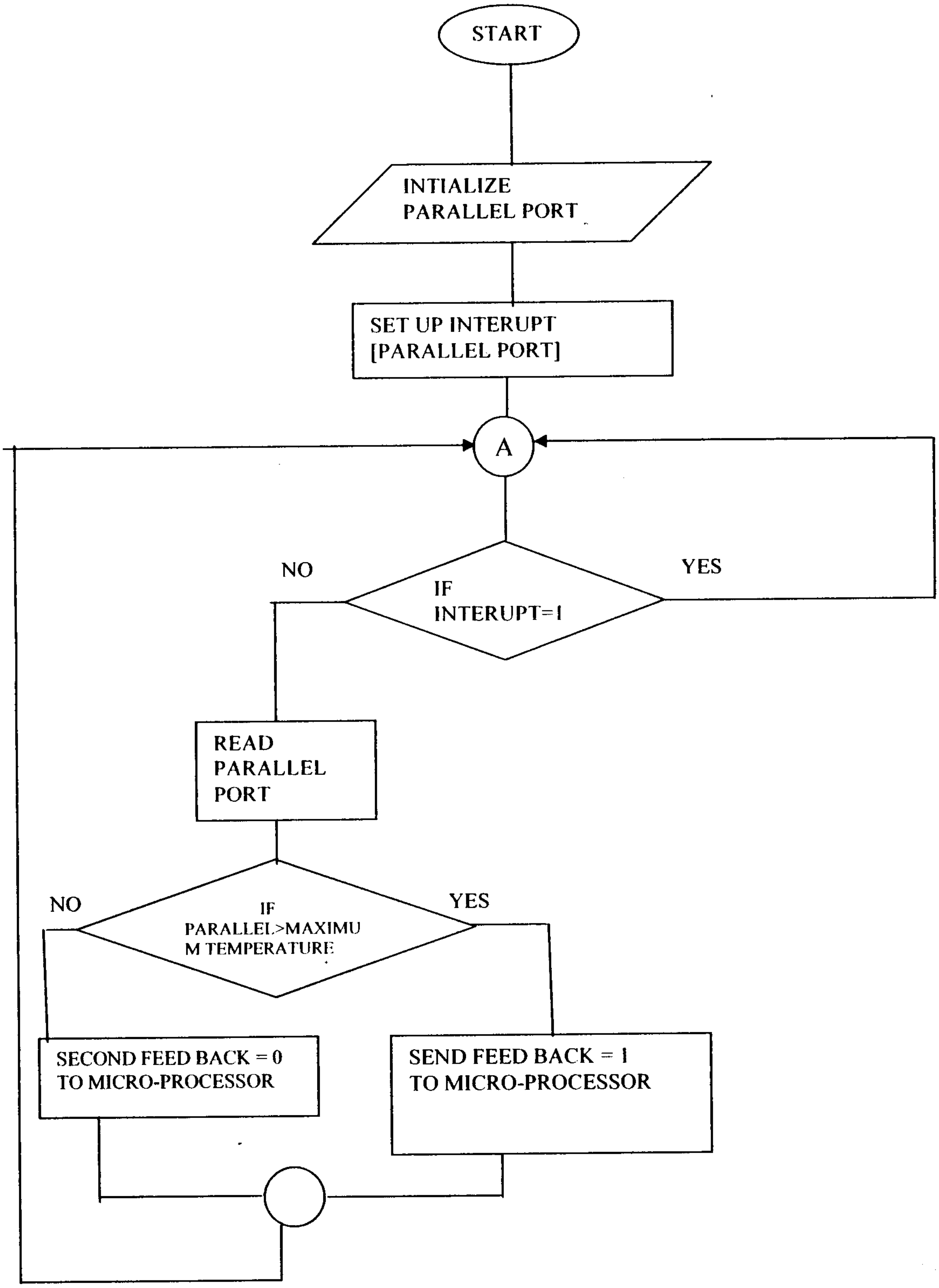

Fig 3.6 flow chart of program written on P C

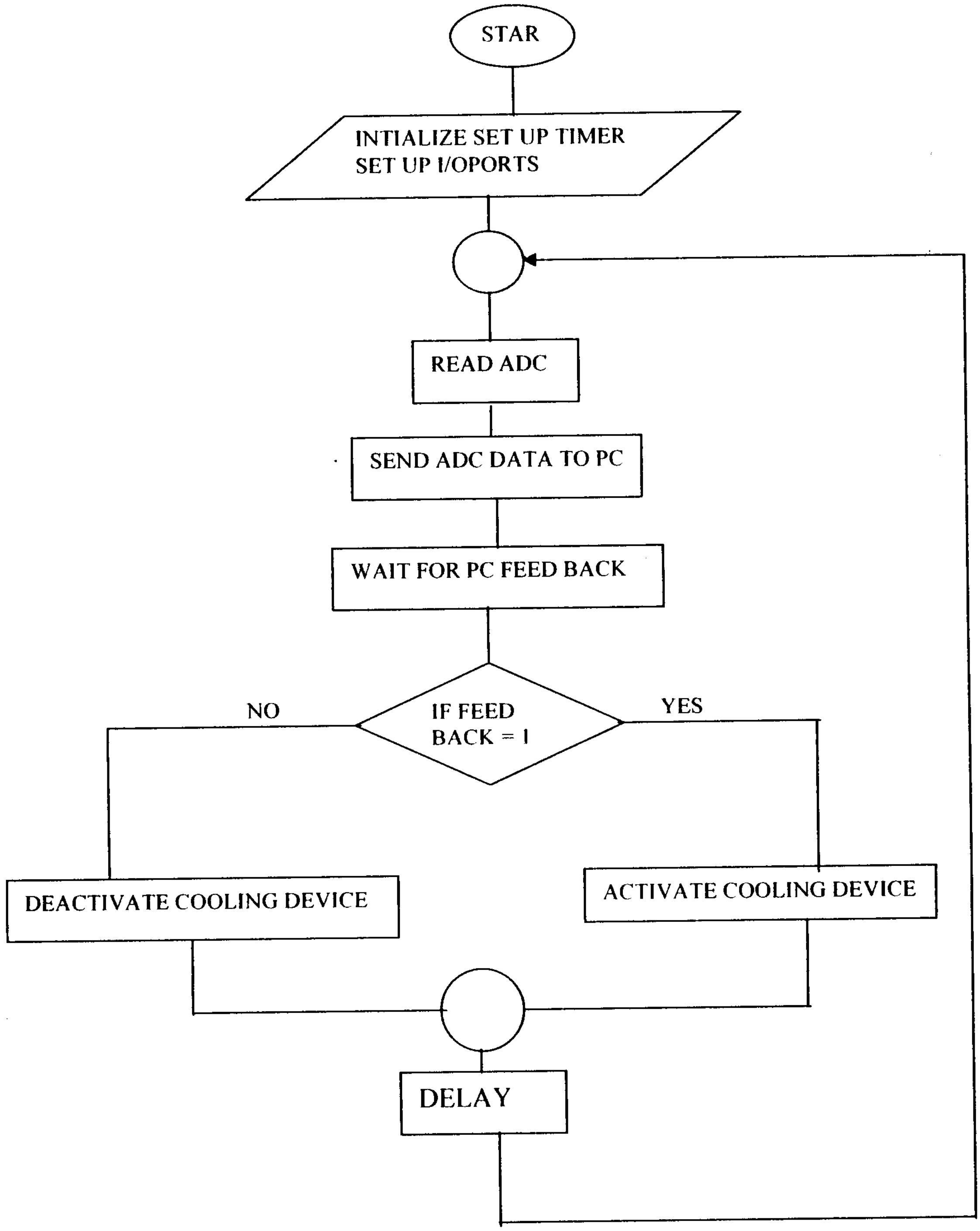

Fig 3.7 flow chart of control aspect of device.

3.7 POWER SUPPLY UNIT

For the design of an effective power supply unit, a transformer, a regulator, rectifier circuit and two capacitors were made use of.

Transformers are mutual inductors designed so that the magnetic coupling between the circuits is tight i.e. the greater part of the flux linking each circuit is mutual. [11]. The transformer used in this project is a 9V transformer.

Since electrical distribution almost universally uses alternating currents, applications which require direct current necessitate the provision of either a d c generator or a rectifier equipment such as was provided in this project.[12]

Generally, a rectifier is required to produce pure d c. Supply for using at various places in the electronic circuits. However, the output of a rectifier has pulsating character i.e. it contains a c and d c components. The a c component is undesirable and must be kept away from the load. To do so, a filter circuit is used which removes or filters out the a c component and allow only the d c component to reach the load. [13]. There three basic types of filter circuits vis-à-vis capacitor filter, choke input filter and capacitor input filter which was used in this project. [14]

The regulator used is the 7805 whose reliability is unquestionable judging from its usage by many designers in an attempt to achieve regulation. Connected in parallel to it, are two capacitors; 470mFarad and 10mFarad.

The circuit diagram of the Temperature Logging and Control Device is as presented in the Appendix at the back of this piece.

3.8 CONSTRUCTION OF THE TLCD

A model of the circuitry of the TLCD was first built on a bread board to for test the feasibility of achieving the aim for which the project was designed before it was transferred to its permanent position on the Vero board.

3.8.1 DEVICES USED IN CONSTRUCTION

Some of the devices used in the construction process are:

1. The soldering iron
2. The soldering lead which was used to make contacts between components and to avoid short circuits which is 'The electrical engineers worst enemy' [15].
3. The lead sucker which is used to 'suck off' excess lead from the circuit.
4. Multi-meter.
5. Wires/Conductors which were used to connect different components of the circuit where needed.

3.8.2 CONSTRUCTION OF THE SENSOR UNIT

The sensor unit did not need much adjustment as except for the changing of the capacitor which had to be done when the one there got damaged. Also a very long wire was connected from the sensor which was kept outside the device's main casing, to the ADC. This was done to prevent the other components from hazardous temperatures which the sensor might have to come in contact with in the course of its operation and which may or may not be favorable to these components as the case may be.

3.8.3 CONSTRUCTION OF THE CONVERTER UNIT

Pin 6 of the ADC was connected to the output of the sensor circuit, pin 20 to the power supply; all others were soldered as seen in the circuit diagram. Care was taken to avoid short circuit as this could lead to the damage of the converter.

3.8.4 CONSTRUCTION OF THE CONTROLLER UNIT

First, before embedding the microcontroller in the circuit of the device, the program had to be burnt on it with the help of the EPROM Programmer. After this was done, the various pins were then connected as shown in the circuit diagram and like in the case of the ADC, special care had to be taken to avoid short circuits.

3.8.5 CONSTRUCTION OF THE POWER SUPPLY UNIT

In trying to make the device as portable as possible, the transformer had to be placed a little above the other components in the circuit. The danger in this is that, it could lead to the metallic part of the transformer bridging the other components of the circuit. To solve this problem, a piece of insulating material was used to cover the lower part of the transformer which is the only part that might touch the other components; though the probability of such an occurrence is low.

There are two indicators; the red one comes on when the device is energized while the green one comes on when the measured temperature goes above the set temperature.

3.8.6 CASING

A white plastic material was used for the casing of the TLCD. This was done with the view that the material in question was available, is an insulator, and is durable and rugged. It is also relatively easy to make holes etc on the material.

CHAPTER FOUR

TEST, RESULT AND DISCURSION

4.1 TEST OF THE TLCD

To test the TLCD some materials were made use of. These include:

1. A personal computer on which the Visual C + + program was installed
2. A parallel port cable with which connection was made between the device and the personal computer.
3. An electric iron, used to increase the temperature around the sensor.
4. A piece of paper and a calculator, used to calculate the averages of temperatures over different time ranges and compare to that done by the PC using the program installed on it.
5. A portable fan (cooling device)

First of all, the program written for the arithmetic logic operation, and to notify the microcontroller when the temperature goes above that specified, was installed on the computer. A log book had been designed for the purpose with space for time, date; for which the log is being taken, the preset temperature denoted by 'Enter temperature' which is at the whim of the user. Also available is a space where the current temperature sensed by the sensor is lodge and it is denoted by 'Current temperature', another space designated 'Average temperature' meant to record the average temperature over the period of time of operation of the device is available.

The preset temperature used for the purpose of test was 29 degree Celsius which is a little above the room temperature.

After connecting the device to the Personal Computer through the parallel port cable, the device was connected to the main source and powered. The temperature recorded 30 degrees; this made the green indicator to come on, indicating that the temperature of the room at that moment was above normal room temperature. As a result, the preset temperature was changed to 32 degrees.

The fan was connected to the wire meant for the control device after which the electric Iron was then powered, brought close to the sensor so as to increase the temperature of the environment around the sensor. Using the temperature control of the electric iron to gradually vary the temperature sensed by the temperature sensor; the following temperatures were recorded along with the averages after every new temperature log as calculated by the PC in the table below:

Table 4.1 recorded temperatures and corresponding averages after each new log

CURRENT TEMPERATURE (DEGREES)	AVERAGES AFTER EACH LOG (DEGREES)
31	31
34	32.5
33	32.667

31	32.25
33	32.4
35	32.833
35	33.143
33	33.125

When the result was compared with the temperatures as measured calculated by the calculator, it was found that it corresponded.

Whenever the temperature of the Iron is increased, such that the temperature logged by the device goes beyond the preset temperature, the green indicator would come on, so also the portable fan. When the temperature is reduced below the preset temperature, the indicator and the fan go off.

CHAPTER FIVE

CONCLUSIONS

5.1 LIMITATIONS

The main limitations of the device are:

- It is not a stand alone device, as it needs a Personal Computer to complete the system.
- It can only measure and log temperatures from 0 degrees Celsius to 100 degrees Celsius.
- The device itself does not provide the control device as this as to be determined by the user. This very limitation in some way also is strength as the user is not limited in choice of control device as this will limit the device to some applications.

5.2 PROBLEMS ENCOUNTERED

Some of the problems encountered in the course of carrying out this project are as listed below:

- Non-availability of some of the devices that make up the device in Minna thus making it a necessity to travel to other parts of the country to obtain them.
- The issue of semi-standard devices. Thus; even when one is sure of the reliability of the standard copy of the devices, at times the purchase of

non-standard copies as in the case of the ADC0804 and microcontroller used, increased the cost of production as burnt ones had to be replaced.

- Non-availability of research materials to aid in the design of the device in the school library.

5.3 POSSIBLE IMPROVEMENT ON THE PROJECT

Ability to make the device more compact and portable, it is also possible I believe to increase the temperature range of measurement by the device.

5.4 CONCLUSION ON THE PROJECT

In a nutshell, after a thou rough research into the importance of temperature, its measurement and control in engineering and in almost life's entire endeavor I was able to come up with a device which I name 'Temperature logging and control device'. This device measures the temperature of its environment, logs the temperatures and depending on what the user's ideal temperature is, enables a control device as decided upon by the user. The averages of the logged temperatures are also calculated for further manipulation as will be determined by the user.

I am also of the opinion that this very project is just a stepping stone towards others on this line (temperature logging and control) by me and others who might be interested as I feel obliged to put behind us the aforementioned huge task of being able to accurately measure, log and control temperature.

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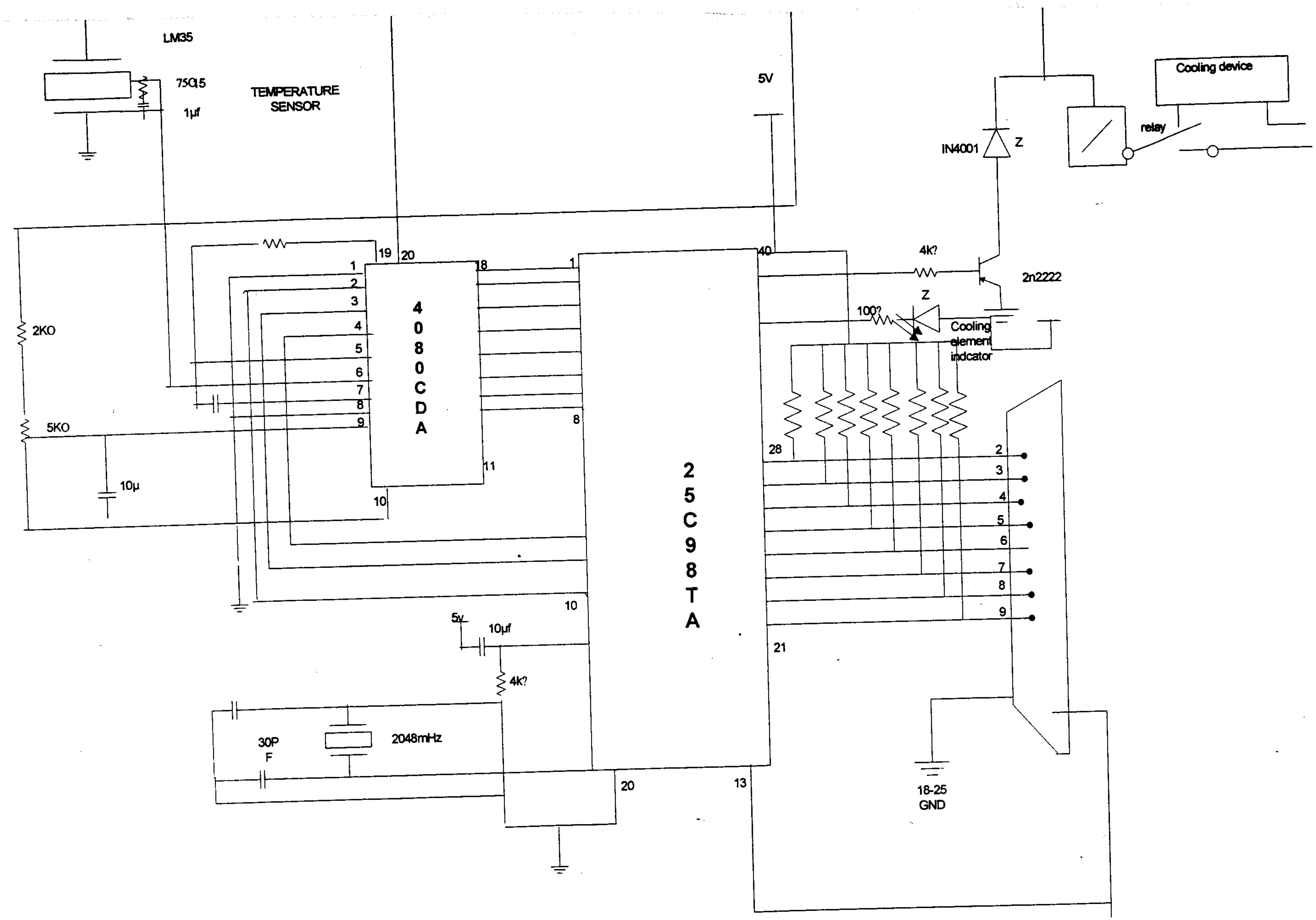

CIRCUIT DIAGRAM :- TEMPERATURE LOGGING AND CONTROL DEVICE