DESIGN AND CONTRUCTION OF MICROCONTROLLER BASED THERMOSTATIC CONTROL FOR HEATING SYSTEM

BY

OLUWAFEMI S. EGBANUBI

2003/15353EE

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA,

NIGER STATE.

NOVEMBER, 2008

DESIGN AND CONSTRUCTION OF MICROCONTROLLER BASED THERMOSTATIC CONTROL FOR HEATING SYSTEM

OLUWAFEMI SOLOMON EGBANUBI

2003/15353EE

A THESIS TO DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE BACHELOR OF ENGINEERING (B.ENG) IN ELECTRICAL AND COMPUTER ENGINEERING OF THE FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

OCTOBER/NOVEMBER 2008

DEDICATION

This project is dedicated to almighty God, who showers His mercy on me. It also goes to my parents, Mr. and Mrs. E.A EGBANUBI For their unalloyed love moral and unflinching financial support.

DECLARATION

I **OLUWAFEMI EGBANUBI** hereby declare that this work titled "Microcontroller based thermostatic control for heating system" was done by me in partial fulfillment of the requirement for the award of B.Eng. in Electrical and Computer Engineering Department of the Federal University of Technology Minna.

OLUFEMI EGBBANUBI

....

(Student)

....

(Signature and Date)

MR. ERONU E.

....

(Supervisor)

....

(Signature and Date)

....

....

DR. Y. Adediran

....

(Head of Department)

....

(Signature and Date)

....

(External Examiner)

....

(Signature and Date)

ACKNOWLEDGEMENT

All that we know is a sum total of what we have learnt from all who have taught us and imparted in one way or the other.

I am highly indebted to the numerous outstanding persons, who by their commitment and dedication to becoming the best they could be have inspired me to do the same.

For trying to keep me going on a straight line, my profound gratitude goes to my able supervisor (MR. Emmanuel Eronu) for his wonder assistance, encouragement and guidance. I am also grateful to my humble and intellectual H.O.D Dr. Y. A. Adediran and the very distinguished lecturers of Electrical and Computer Engineering Department.

My immeasurable gratitude goes to my loving, caring and wonderful parents, Mr. and Mrs. Duro Egbanubi for their moral and financial support towards my achievement. To my sibling, brother, Leke and sister Tale.

Also, I appreciate the efforts of my friends, Mohammed, Sunny, sheriff and Ibrahim for all their supports throughout my stay in University. You are all wonder peoples, thanks for your generosity and inspiration.

Finally, I humbly express my profound gratitude to almighty God, who has been protected and spare my life.

ABSTRACT

This project report presents the design and construction of microcontroller based thermostatic control device for heating system.

Thermostatic control device consist of temperature transducer that convert non electric signals to electric signal. This device uses an electronic control circuit Involving integrate circuit (LM35D), an NPN transistor, ADC0804, microcontroller (AT89C51) and relay. LM35D senses temperature changes, compare it with an already reset temperature and switches the relay; accordingly via a transistor switching unit. The temperature sensor (LM35D) provides the device with the better accuracy, higher precision, greater sensitivity that is needed for a good temperature monitoring device.

TABLE OF CONTENTS

Chapter three

Chapter four

Chapter five

LIST OF FIGURES

ABSTRACT

This project report presents the design and construction of microcontroller based thermostatic control device for heating system.

Thermostatic control device consist of temperature transducer that convert non electric signals to electric signal. This device uses an electronic control circuit Involving integrate circuit (LM35D), an NPN transistor, ADC0804, microcontroller (AT89C51) and relay. LM35D senses temperature changes, compare it with an already reset temperature and switches the relay; accordingly via a transistor switching unit. The temperature sensor (LM35D) provides the device with the better accuracy, higher precision, greater sensitivity that is needed for a good temperature monitoring device.

CHAPTER ONE

GENERAL INTRODUCTION

OVERVIEW

In the recent times, most heating systems are determined and governed either directly or indirectly by the principle of thermostatic control, which is incorporated to maintain a desired temperature set by a thermostat that regulates the input of heat. This thermostatic control for heating system has a wide range of application in human Endeavour.

Since temperature is the degree of hotness or coldness of body or system, it is very fundamental in functionality of system. This is due to the fact that most biological, chemical, electronic and physical systems are affected by temperature. Specially, some process work satisfactorily only within a narrow range of temperature ranges. Certain chemical reactions, biological processes and even electronic circuits perform best within limited temperature ranges. A temperature monitoring device that will switch **OFF** automatically as the preset temperature is exceeded and switch **ON** when it is below the lower temperature. This device comes into play for primary purpose of heat optimization.

Thermostatic control has aim of managing heat as much as possible while annulling overheating and under-heating. Solar/ External heat gain and internal heat gain may often contribute significantly to the total daily heat requirement of any heating environment; and this super imposed on the normal designed output of heating system, which can lead to uncomfortably high internal temperature [1]. A quick responsive control is therefore desirable. To achieve this aim, the switch **OFF** and **ON** type of thermostatic control is greatly considered in this project. The switch off and on type of thermostatic control is an electronic device that triggers automatically when the temperature inside an incubator, a room, kiln, furnace, microwave oven, or any heating environment exceeds the preset temperature.

In the same vein, personal computer is also another system that uses the same Principle in operation. The computer's motherboard and hard disk drive generate great deal of heat. The internal fan helps to cool the system, but if the fan fails, or if airflow is blocked, the system components could be permanently damaged. By sensing the temperature inside the computer case, high temperature condition can be detected and action can be taken to reduce system temperature.

To perform the function, the components that were required for utmost performance of device are microcontroller, sensor and triggering unit. The block diagram below depict operational outline.

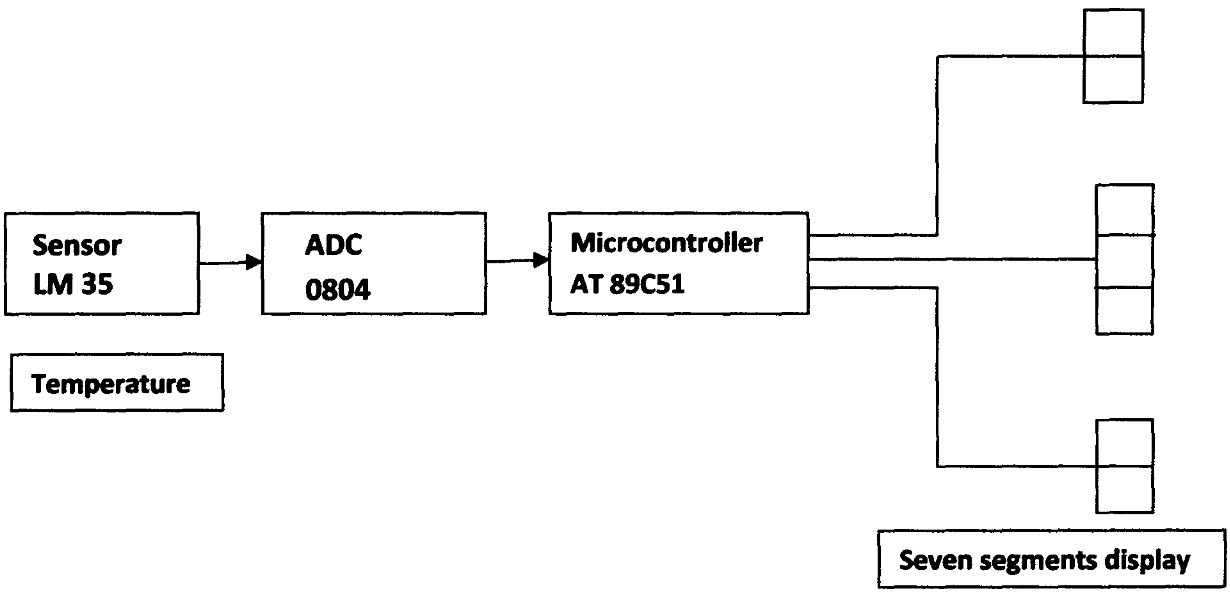


Fig 1.1 BLOCK DIAGRAM OF MICROCONTROLLER BASED THERMOSTATIC CONTROL FOR HEATING SYSTEM

The sensor in this case, is LM35 from the temperature outside, the ambient temperature will be sensed by **LM35** device (Transducer). Its output (10mv/°c) is fed into the input of an 8-bit unipolar analogue to digital converter (ADC0804) digitized the input voltage and scale it with reference to an input span voltage. The 8-bit binary output voltage is fed into part of the microcontroller. The microcontroller now converters the binary input to BCD in software; compare the input value with preset value. Here, microcontroller is one of the main components of this device. It is a reduced complexity, one chip processor, with software execution capability.

Microcontroller generates the control signal necessary for analogue to digit conversion. It also reads the binary ADC out; convert it to decimal and displays it the 7-segment LCD. It responds to user key press and allows a user to preset a particular temperature above which a switched output is activated.

Inside the microcontroller, the conversion of binary input to binary coded decimal is done. The user sets temperature value is compared with the digitized value. If both are equal, or external temperature is greater, the microcontroller opens the switched ac outlet, and otherwise, microcontrollers close the switched AC. Consequently, this ultimately justify the controllability of heating system by thermostat.

AIM AND OBJECTIVE

The design and construction of thermostatic control for heating system is aimed at achieving the following goals;

(i) Controlling different heating system such as heater, incubator, kiln and microwave oven

(ii) Optimization of heat, to avoid wastage

(iii) Provision for attaining optimal performance of dynamic system improving productivity, relieving the drudgery of many routine repetitive manual operations.

(iii) Provision for attaining optimal performance of dynamic system improving productivity, relieving the drudgery of many routine repetitive manual operations.

METHODOLGY

A bottom approach employed in the realization of this project ranging from understanding of basic electronic principle which governs the operation of all electronic circuit to the complete construction of final circuit. The method had been self explanatory from the previous introduction part.

SCOPE AND LIMITATION OF THE PROJECT

The thermostat measures temperature ranges between 0°c to 100°c. Therefore, it is not suitable for high temperature application. Also, the heating control is done through relay switching, frequent turning ON and OFF when it gets to the set point, may damage the motor.

CHAPTER TWO

GENERAL DESIGN DESCRIPTION

LITERATURE REVIEW

Automatic control has played a vital role in advance of engineering and science with this, the progressive adaptation of digital technology to the process instruction and automatic control is well documented in literature |2|. Most experts agree that, while the transition from analogue to digital techniques occurred at a phenomenal rate during the 1970s and continuing into 1980s, analogue methodologies will persist into an unpredictable future and in particular, digital technology is only at the threshold as regards digitalization of many measurements (sensor) and of final controlling element

The record shows that researchers and implementation on thermostatic control for heating system did not seriously take off until in the 80s when the need become very important to control heating systems automatically. The desire for warmth and comfort may have motivated most first use of fire. The earliest evidence shows that man used wood and charcoal in open fires to produce warmth, as well as to prepared food, in his cave or shelter. American, Indians, who built fires in their huts and tipi which had openings to allow the smoke to escape used these open fires as late as 19th century |5|. While in 300B.C, the Europeans built crude fireplaces, with connecting chimneys with this arrangement, combustion efficiency and ventilation were much improved [1].

By the first century B.C, the Romans had developed the hypocaust which provided a better way to heat a room. The hypocaust was a basement with a low arched-vault furnace made of brick or stone. The hot air from the furnace passed through tile flues in the room above the furnace, heating the room. The form of temperature responsive devices was a "grid iron" pendulum built in England in 1726 to improve the accuracy of a clock opera ting under varying temperature conditions [1].

In 1743, Benjamin Franklin invented the iron Franklin stove and he gained a reputation of high efficiency in American colonies. The use of stove provided a new way to heat room. The fire was contained in combustion chamber usually made of ceramic or iron sections. It heated the stove walls, which in turn heated the room, mainly by convention of the room air over hot surface [3]. However, a steam boiler was developed f or the steam engine in England, but engineers soon learn to adapt it for central steam heating system. Steam heating systems are particularly suitable for saving public building because large quantities of heat can be carried in long distances by small pipes [5].

As technology advances, the word "Thermostat" was introduced in 1930 by Andrew Ure, a Scottish professor of chemistry, who was issued a patent on what he called "a heat-responsive element" consisting of a bar of steel united to zinc by numerous rivet [5]. This bimetallic bar bends with temperature change because of the different expansion rates of the mental strips, and the bending can be used to actuate values or clampers to control heating system [6].

Bimetal-strip thermostats of improved design have been developed. One other type has a low expansion rod and contain in high expansion tube. For example, a steel and nickel tube sealed together at one end. Construction of the tubes at one end of the rod, actuating a valve or electric switch. Thermostat used in homes or small building usually are low-voltage electric controls that turn a burner ON or OFF as required [6].

In other word, other thermostats exits that basically uses almost the same types of principle but different type of input and output units. Likewise, there are some whose principle is totally different from that used in this project. The principle, upon which this project centered on, is as follow, the ambient temperature will be sensed by LM35 device (Transducer) and output (10mv/^{0}c) is fed into the input of 8-bit unipolar analogue to digital converter (AD 0804). It digitized the input voltage and scaled it will reference to an input span voltage. Consequently, the temperature variation will be read from display unit [7, 9].

Finally, in getting information and the working principle and design of the thermostatic control for heating system itself, which is the main aim of this project. I consulted the aforementioned reference material. For clean, clear and concise knowledge of the work condition of the various components as used in design of the system.

TYPES OF THERMOSTATIC CONTROL

There are five types of thermostat control; electromechanical, digital, hybrid, occupancy and light sensing thermostats.

1. **Electromechanical (EM) Thermostat**: They are usually the easiest devices to operate and typically have manual control such as moveable tabs set a rotary timer and sliding levers to night and daytime temperature setting. These thermostats work with most conventional heating and cooling system. EM controls have limited flexibility and can store only the same settings for each day and as such are best suited for regular schedule.

2. **Digital Thermostats:** They are identifying by their LED or LCD digit readout and data entry pad or buttons. They offer the widest range of features and flexibility and digital thermostats can be used with most heating and cooling system. They provide precise temperature control and they permit custom scheduled.

3. **Hybrid**: Those combine technology of digital control with manual slides and knobs, to simplify use and maintain flexibility. Hybrids are available for most system which include heat pump.

4. **Light Sensing Heat Thermostats**: They rely on lighting level as preset by the user to activate the heating system. When lighting is reduced, a photocell inside the thermostat sense unoccupied conditions and allows space temperature to fall below the occupied temperature setting. While the lighting levels increase to normal, the temperature automatically adjust to comfort conditions.

5. **Microcontroller Based Thermostat**: This makes use of microcontroller as the man control unit, its helps to control so many appliances such as; incubator, microwave oven, heater etc this is what my project centered on

CHAPTER THREE

SYSTEM DESIGN AND ANALYSIS

This inexpensive project can form the basis of a number of sophisticated controls for heating system. The circuit uses a couple of LM35D as temperature sensing element and use a relay as an output switch. In this case, the temperature control systems rely upon a controller (AT89C51) that receives input from temperature sensor. Two common types of sensors are the thermocouple or RTD. The controller checks the actual temperature or an object or area to the desire control temperature also known as a set point. Controller is also linked to an output. The output is connected to an element that can adjust the temperature to achieve the set point. Heater and fan are typical control elements.

On/Off controller is the simplest kind of temperature control device. It is either on or off and features no middle state. These types of controllers only adjust their output when the temperature goes beyond the set point. It employed when it is not necessary to have a very precise temperature control system or when the system are monitoring can not adequately handle having energy frequently be turned on or off.

The temperature monitoring unit made up of the following under listed sub-unit:

(I) Temperature sensor

(ii) 8-bit analog-to-digit converter

(iii) 8-bit microcontroller

(iv) 4-digital 7-segment display

(v) AC load switching

(vi) Software

3.1 THE TRANSDUCER UNIT

The word transducer means any device which converts non-electrical signals into electrical signals. The transducer used is LM35D which has temperature range from 0-100°c. It is precision integration circuit temperature whose output voltage is linearly proportional to the Celsius temperature. It produces 0mV for every degree of temperature change (11) it is a three terminal components, two of the terminal are the power supply while the third terminal is the output.

Table3.1 The sensor's output directly connects to the input of an

P/N (mV/°C)	Temperature Range (°C)	Accuracy (°C)	(mV/°C) Output
LM 33A	-55 to 150	1.0	1.0
LM 35	-55 to 150	1.5	10
LM 35CA	-40 to 110	10	10
Lm 35C	40 to 110	15	10

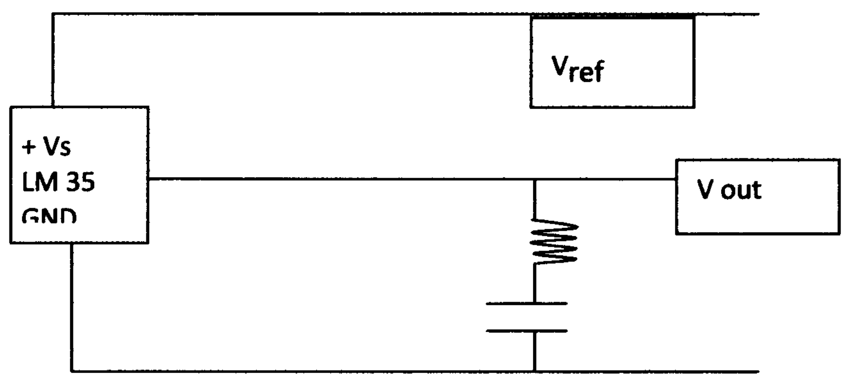


Fig. 3.1 functional diagram of LM35D

ADC, to convert the temperature around the sensor to a digit value under the control of microprocessor.

3.2 8-BIT ANALOG TO DIGITAL CONVERTER (ADC0804)

The ADC is national semiconductor ADC0804 successive approximation resistor (SAR) device. It has a conversion period of 100us and runs on a clock frequency between 100kz and 1.46MHz. it interfaces with the microcontroller and is calibrated, so that its output bears one-on-one relationship with input, by a reference voltage of 1.28v to its V_{ref} pin.

The comprehensive note on data sheet is as follow; the ADC 08041C is an 8-bit parallel ADC of the ADC0800 series from national semiconductor. It work with 45 volts and has a resolution of 8 bits. In the ADC 0804, the conversion time varies depending on the clocking signal applied to the CLK IN pin, but make sure it cannot be faster than 110us. CS=chip select is an active to low input used to ACTIVATE the ADC 0804 chip. To access the ADC 0804, this pin must be LOWRD =. The ADC converts analog input to its binary equivalent and holds it in and internal register [11]. RD is used to get the converts data out of the ADC 0804 CHIP. When CS = 0, if it-to-L pulse is applied to the RD pin, the 8-bit digital output shows up at the D0-D1 data pins. RD also known as output enable (9OE) WR =. This is an active low input used to inform the ADC 0804 to start the conversion process. If CS=0 when WR makes a low-to-high transition, the ADC 0804 to start converting the analog input value of $\mathbf{V}_{in}$ to an 8-bit digital number when the data conversion is completed, the INTR pin is forced to low by ADC 0804 INTR=. This is and output pin and is active low. It is a normally high pin and when the conversion is finished, it goes low to signal the CPU that the converted data is ready to be picked up. After INTR goes low, we make CS=0 and send a high-to-low pulse to the RD pin to get data out of the ADC0804 chip.

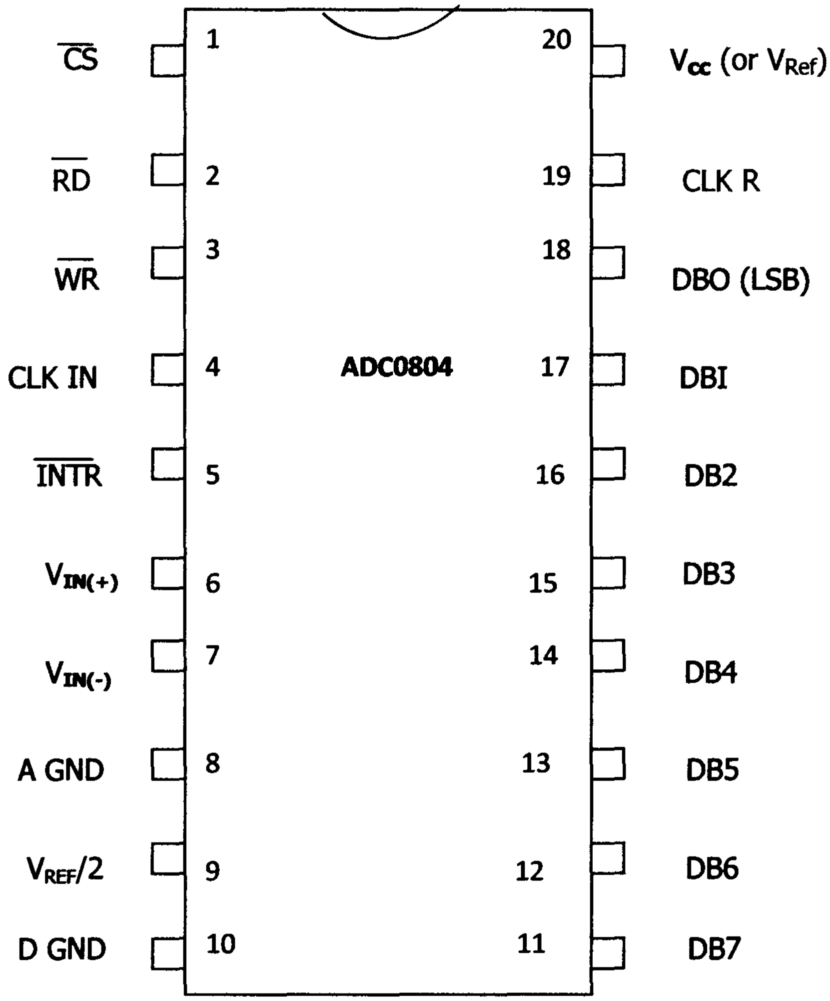
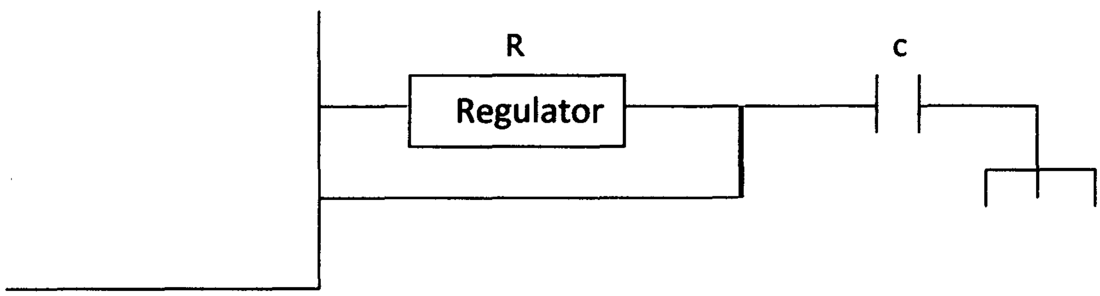


Fig. 3.2 the diagram f ADC0804

The ADC is run off by a clock frequency determined by



3.3 MICROCONTROLLER

The microcontroller used an Atmen 8-bit processor with 4KB reprogrammable flash memory and 128bytes RAM. It was programmed in assembly language and the executable code loaded into the on-chip memory. The device is housed in a 40pins PIL package, has four 8-bit I/O ports and run a maximum clock frequency of 24mHz. The micro controllers AT 89551 perform this function. It is designed for adjusted switching application. The AT 89C51 is a low power, high-performance programmable and erasable read only memory (PEROM). The device is manufactured using Atmen's high density nonvolatile memory technology and is compatible with the industry. Standard MCS-51 instruction set and pin out. The on-chip flash allows the program memory to be reprogrammed in-system or by a convectional nonvolatile memory programmer. By combining a versatile 8-bit CPU with flash on a monolithic chip, the Atmen AT 89C51 is a powerful microcomputer which provides a highly-flexible and cast effective solution to many embedded control application.

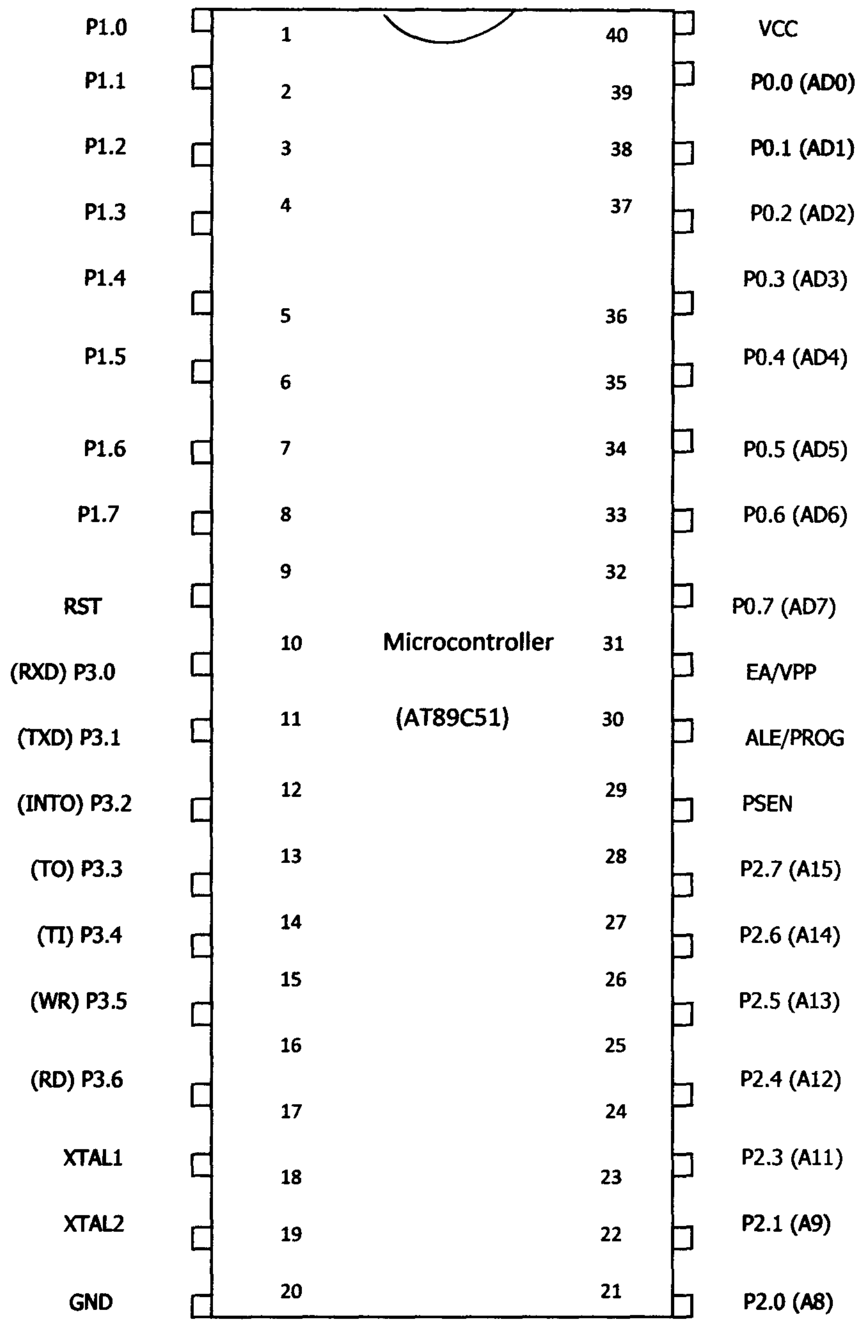


Fig. 3.3 The diagram of a microcomputer AT89C51

The AT 89C51 provides the following standard features; 4K bytes of flash, 128bytes of RAM, 32 I/O lines, two 16-bit timer/counter, a five vector toe level interrupt selectable power saving mode. The idle mode stops the CPU while allowing RAM, timer/counter serial port and interrupt system to continue functioning. The power down mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.

3.4 POWER SUPPLY UNIT

The most convenient and economical source of power is the domestic ac supply; it is advantageous to convert this alternating voltage (usually 220/240 volts) to dc voltage (usually smaller in value). A typical dc power supply of four stages are shown in figure below [2]

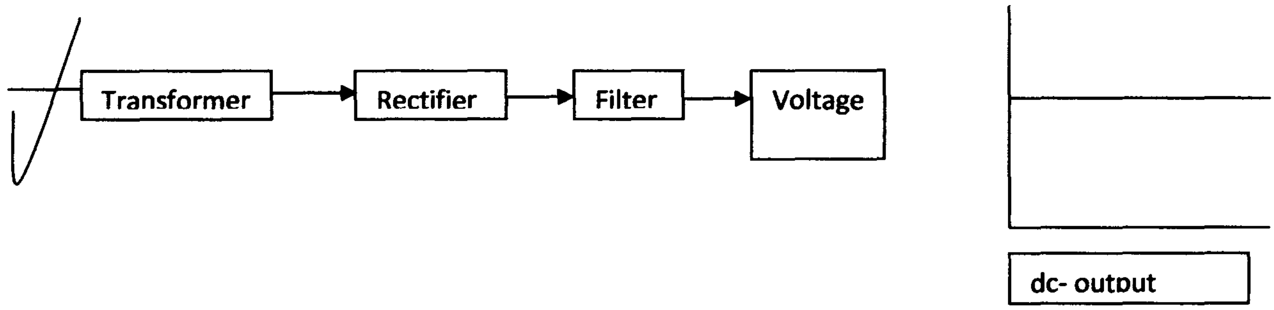


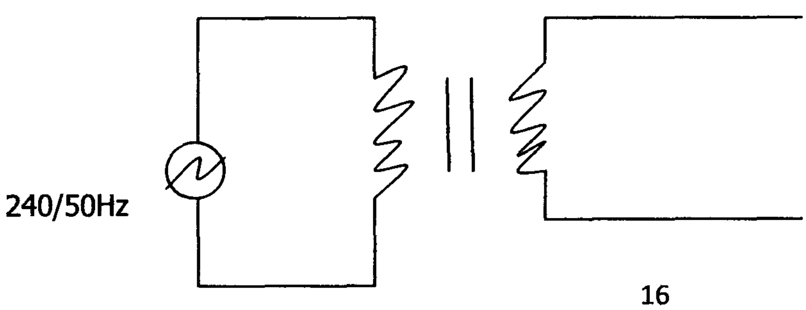
Fig. 3.40 Block diagram of dc power supply unit.

3.4.1 TRANSFORMER

A transformer is a static (or stationary) piece of apparatus by means of which electric power in one circuit is transformed into power of the same frequency in another circuit. It can raise or lower the voltage in circuit, but with a corresponding decrease or increase in current

[12]

For this project, the step-down transformer is used. A 240volts from the main (ac input) is stepped down to 12volts by the step-down transformer, connected supply.



240/50Hz

Fig 3.4.1 circuit diagram of a transformer

3.4.2. RECTIFIER

Since a diode has the characteristic of having a much greater conductivity in one direction than in others, into will produce a direct component of current when connected in series with an alternating voltage and a load. Hence a rectifier is a circuit, which employs one or more diode into covert ac voltage into pulsating dc voltage [12]. There exist different types of rectifier, but for this project the ridge rectifier is used. The full-wave bridge rectifier consist of four diode embedded as a single chip and thus has same principle of operation.

The output of t he transformer from its secondary is 12volts ac. The bridge rectifier is used to convert ac voltage into dc voltage.

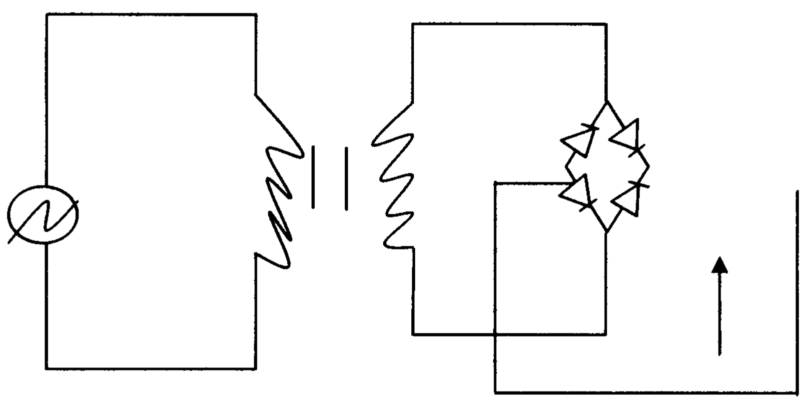


Fig. 3.4.2 Bridge Rectifier Circuit

When the potential of A is positive with respect to B, diode D1 and D3 conduct and a current flows in load. When the potential B is positive with respect to A, diodes D2 and D4 conduct and the current in the load is the same direction as before [12,6]. s

3.4.3 FILTER

The function of the filter circuit element is to remove fluctuations or pulsating (called ripples) present in the output voltage supplied by rectifier [12]. It has a dc value and some ac components called ripples. This type of output is not useful for driving sophisticated electronic circuit or device.

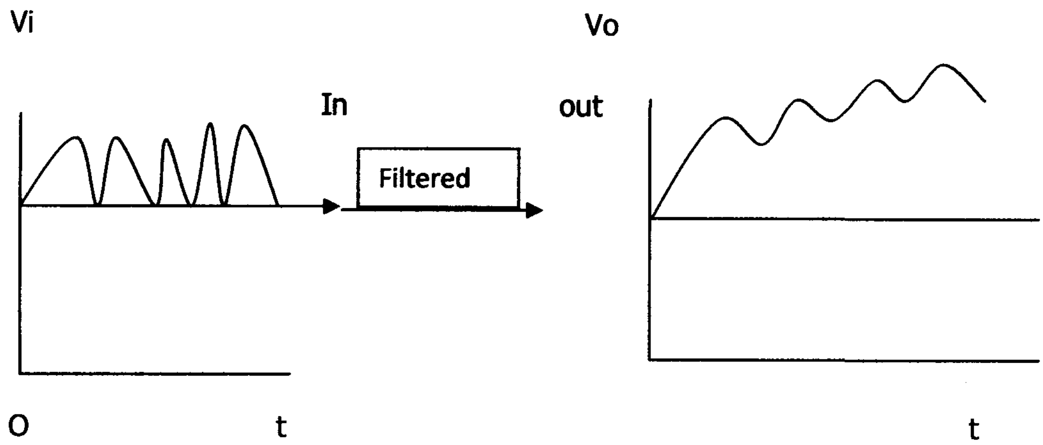


Fig. 3.4.3 The main function of the filter circuit

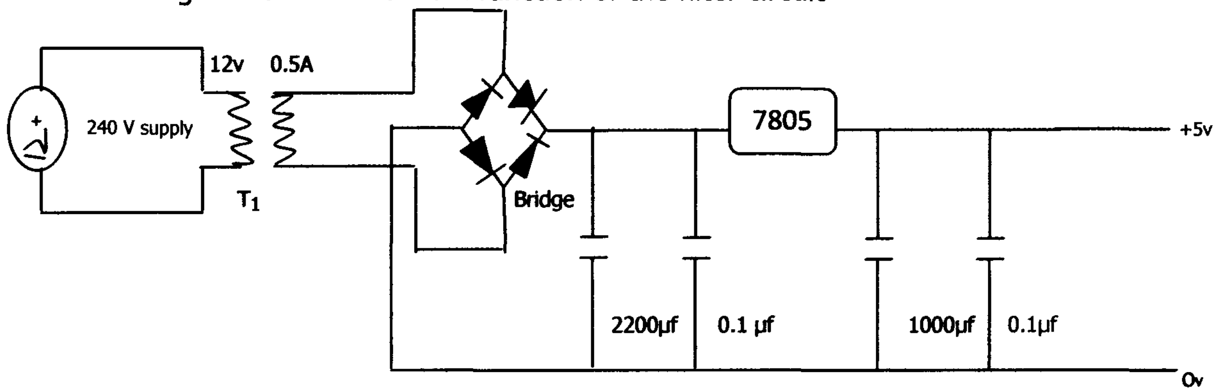


Fig. 3.4.4 Circuit diagram of power supply unit

The 12v 0.5A transformer connects to a bridge rectifier as shown above. The peak value of the rectified voltage is

V_{peak}= (V_{rms} √2 – 1.4) V

Where V_{rms} = secondary transformer voltage.

√2 = scaling factor for RMS to pear conversion.

1.4 = 2 diodes' forward voltage drop.

V_{peak} = (12√2 – 1.4) = 15.6V

This voltage was passed across a 2200uf capacitance where it was smoothened, to produce a DC voltage given by

$$V_{dc} = \frac{V_{peak}}{1 + \frac{1}{4FCR_L}}$$

f = main frequency = 50H_Z

C = value of smoothening capacitance = 2200µF

R_L= load resistance on the rectifier

R_L is taken as the load presented by the 7805 regulator, and from the date sheet, greater then 10KΩ

$$\frac{12\sqrt{2} - 1.4}{1 + \frac{1}{4\times50\times2200\times10^{-6}\times10^{4}}}$$

The circuit uses a 5V relay for the power switching device. The relay has a coil resistance of 430Ω.

Thus a coil current of 5/430 = 12mA nominally is needed to energize the contacts. This 12mA is the collector current of Q2. Q2 has main of typically 340.

I_b is calculate using the relationship

$I_c = BI_B$;

$$I_b = \frac{I_c}{B} = \frac{12mA}{340} = 35\mu A$$

At switch on Q1 a voltage of 5v less the collector emitter saturation voltage appears at the collector of the transistor.

R_b for Q2 is chosen using the expression.

$$R_b = \frac{V_b - V_{be}}{I_b}$$

Neglecting g the collector emitter saturation voltage.

$$R_b = \frac{5 - 0.7}{35 \times 10^{-6}} \qquad =120K\Omega$$

Value of 4.7kΩ was chosen to ensure maximum current flow through the collector of q2 and hence through the relay.

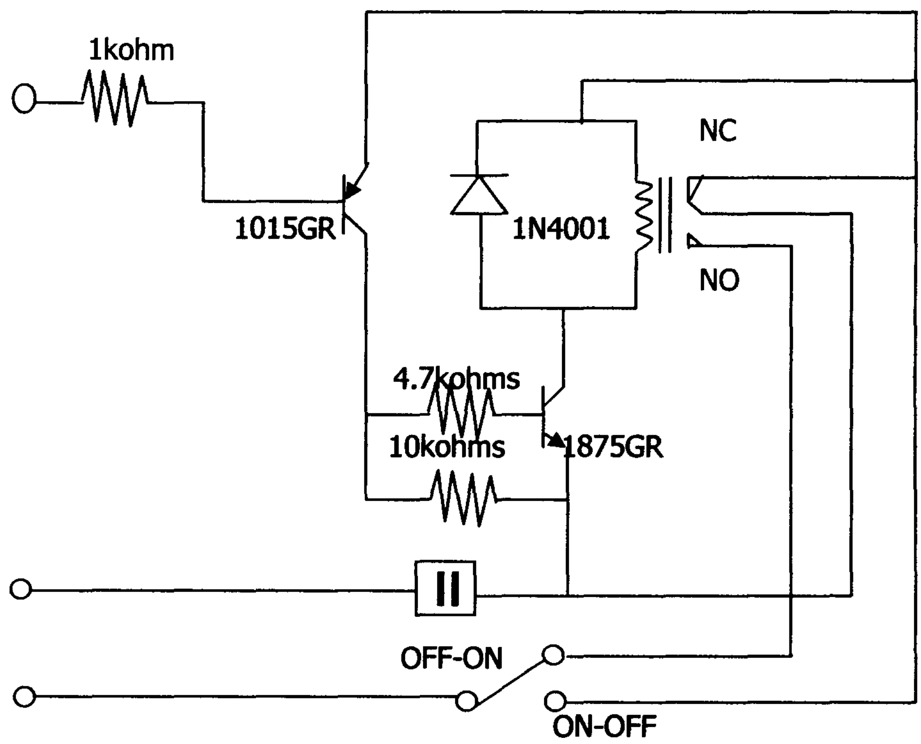


Fig. 3.5 load switching subsystem

3.50 LOAD SWITCHING SUB-SYSTEM

This comprises a relay and driver transistor is as illustrate above. The relay is switched under software control when P3.7 is pulled low. Two switching modes are employed.

The load switches from ON to OFF when the present temperature is exceeded.

The load switches OFF to ON when the preset temperature is exceeded.

The above arrangement makes for a greater flexibility since any kind of switching action can now be initiated.

For example, a heating unit connected to the system might be switched from ON to OFF when the designated temperature is reached or a cooling unit switched OFF to ON when the designated temperature limit is reached. The load remains connected to mains until the ambient temperature fall below the present, at which point it is power OFF.

3.6.0 7- SEGMENT DIPSPLAY UNIT

This consists of 4 7- segment display and 4 associated anode driver transistors.

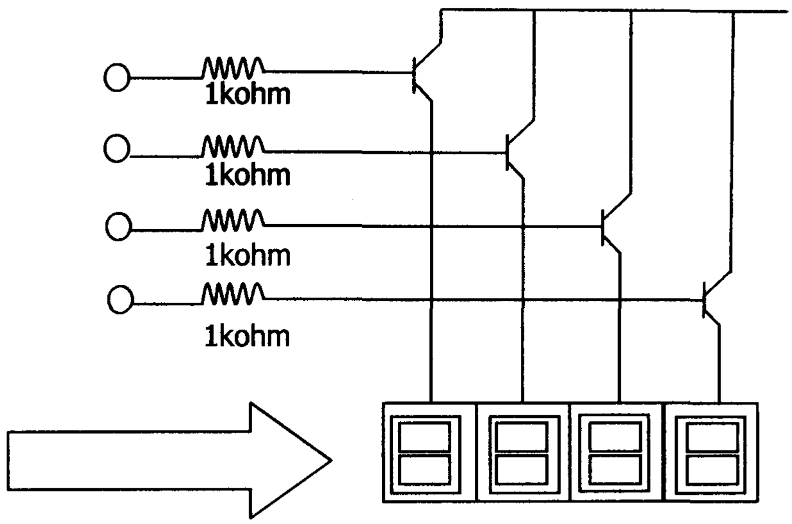


Fig. 3.6 seven segment display

The displays are wire multiplexed, i.e. all segments are connected in parallel, and each digit individually controlled by a transistor. Multiplexing reduces his complexity of wiring and saves on I/O ports by rapidly switching on and OFF digits at about 60 times per second

For example; to write P37^{0}C to the display, the following sequences of operation are executed. :

i.) Turn OFF all anode drives

ii.) Write the seven segment s binary pattern for P to the common output data port.

iii.) Switch on Q1 controlling digit

iv.) Delay a little white for persistence of vision

v.) Turn off Q1

vi.) Write the binary pattern to be displayed on digit two to output port and repeat steps (ii) to (vi) unit the four digit s are written.

vii.) Return to step 1.

In reality, only one digit is activated at any one time, but an illusion of simultaneous digit display is achieved, if the writes are done at high enough speed. The displays used also common anode, hence circuit is driven through the microcontroller.

In the design analysis of 4 7-segment display, the base resistance for the anode was chosen so the segment current is 40mA. This current is required to produce an average current of 10mA per segment as the displaces are multiplexed. A six-digit display would use a segment current of 60mA for an average of 10mA per segment in this type of display systems, only one of display position is at any given instant. The peak anode current in a four digit display is 28mA (7-segments X 40mA), but the average anode current is 40mA. Wherever displays are multiplexed, the segment current is increased from 10mA (for a display that uses 10mA per segment as the nominal current) to a value equal to the number of display positions times 10mA. This means that a 4-digit display uses 40mA; a 5-digit display uses 50mA. In this display, the anode load resistor is omitted for maximum display brightness.

The resistor in series with the base of the anode switch assumes that the minimum gain of the transistor is 200. The base current is therefore:

$$\frac{40\text{mA}}{200} = 200\ \mu\text{A}$$

The voltage across the base resistor is approximately 3.0v (the minimum logic 1 voltage level of the 89c51) minus the drop across the emitter base junction (0.7v) or 2.3v. The value of the base resistor is then

$$\frac{2.3}{200\times10^{-6}} = 1.150\text{k}\Omega$$

A 1KΩ resistor was used as this was the next proffered value.

3.7.0 SOFTWARE

The software, written in assembly language included in the appendix. The basic operational steps are listed below, as they occur at reset. :

I. The initialize microcontroller device and external hardware

II. Initialize RAM variable

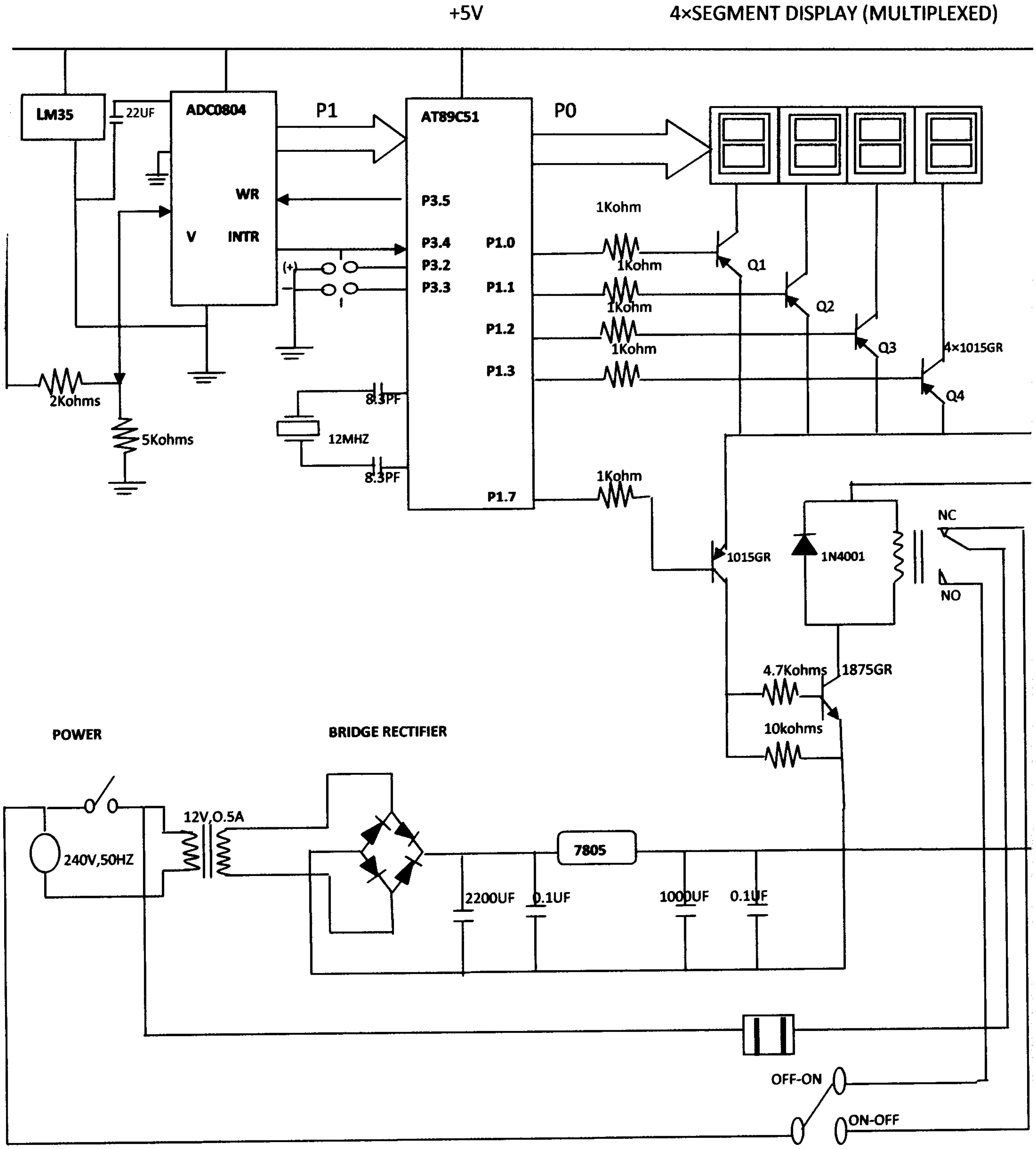
III. Start conversion

IV. Convert conversion data to BCD

V. Write data to display

VI. Compare preset temperature, if preset button ever pressed, else skip comparison

VII. If preset temperature set, turn OFF load if ambient temperature exceeded the preset temperature.



CIRCUIT DIAGRAM OF MICRO-CONTROLLER BASED THERMOSTATIC CONTROL FOR HEATING SYSTEM

CHAPTER FOUR

This chapter deal with the construction and testing of electronic thermostat using component s specified in the previous chapter. This project is designed with an effective circuit that would be able to detect or sense temperature and also control heating elements.

4.1 CONSTRUCTION

The construction was carried out in stages, i.e. one unit after the other, using a breadboard where each section of the design was built and tested to give the required signal output. The surface of a Vero board of suitable size was scraped using a razor blade to enhance easy and firm soldering of component s on it. Practically, all the components were transferred onto the Vero-board, apart from temperature sensor, the micro controller AT89C51 which are prone to damage by static charges.

According to the circuit layout, each component was set on the copper-tracked Vero-board one after the other. I started with construction of Power supply unit involving transformer, the bridge rectifier, filtering capacitor, the regulator (7805) and display unit, in that order. This section was plugged to AC mains and function as such. This indicates proper and accurate connection, that is, there is power in the circuit. Next was the connection of input/sensor unit followed by the connection of micro controller unit, the analog, to digital converter ADC0804 and relay switching unit.

A casting measuring 25 by 15 12 centimeters is an excellent choice for this project. A flat 13A socket was also mounted on the casing. Load was connected to the thermostat through this flat socket.

4.2 CONSTRUCTION TOOLS AND EQUIPMENTS

A brief discussion of the construction tool is given below;

Soldering iron: A modular soldering iron with 60watts heating element was used for the project.

Soldering stand: This was used for keeping the soldering iron in a safe position. The stand was constructed I such a way that it does not touch any metallic or plastic part

Lead: flux-core type of lead was used for soldering of various components.

Lead sucker: this was used for sucking up molten solder

Digital millimeter: this was used for quite a number of functions, to test continuity of circuit current, the measure resistance, capacitance and voltage in various section of the circuit.

4.2 TESTING

For proper testing, the microcontroller AT89Cc1 allows a user to preset a particular temperature above which a switched output is activated. Assume that, voltage was set to 35^0C (350mv) inside the microcontroller. Thereafter, a hot soldering iron was brought close to the temperature sensor (LM35D) and the temperature reading was observed, as it increased on the digital millimeter.

Immediately the LM35D sensed a 36^0C temperature, the switching unit of device was triggered. This switching unit is expected to trigger OFF any heater (load) connected to device immediately the temperature of the load exceed that of the devices referenced temperature.

4.3 RESULT

The triggering OFF of the load (heater) connected to the electronic thermostat at exactly 36^0C, a centigrade degree higher than the referenced temperature input, helps in the monitoring an regulation of the heater's (load) temperature. It also show that the device's high precision, accuracy and high sensitivity. This is the needed advantage that makes electronic thermostat better than its mechanical counterparts that use bimetallic strip and thermal sensor.

CHAPTER FIVE

5.1 CONCLUSION

The main objective of this project was to design a simple electronic thermostat that can measure the temperature in the range of 0 degree centigrade to 100 degree centigrade .The various unit of the design were constructed in the stages and each unit was confirmed to be working perfectly after being tested. The practical implementation of the design made me to be more familiar with electronic component. It also enhanced my skills and technique in handling tools and equipments.

This project can be adapted for use in other circuitry devices that require temperature regulation. It can also be used in biological, laboratories, in incubator oven, in reaction such as enzymes reaction that requires heating experiment to be carried out at particular temperature in order to prevent the denaturing of enzymes when they are subjected to heat.

Base on the applications of this project, it shows that Electrical and computer Engineering find application in all facet of live. Therefore, it is pertinent to say confidentially that the aims and objectives of the project have been achieved.

5.2 PRECAUTIONS

i. All components were properly laid out and firmly soldered on the copper –tracked Vero board to ensure proper connection and current flow

ii. Care was taken to ensure that component was not exposed to excessive heat while soldering.

iii. Special care was taken to orientate polarized components e.g. electronic capacitor, transistor and diode with respect to their potential.

iv. Rip of the soldering iron was cleared after each soldering.

5.3 RECOMMENDATION

It is advisable that IC sensors that have wider range of temperature such as LM35A, LM35CA. LM35C and LM35CZ version of LM series can be utilized in a more sensitive conditioned area in order for the device to regulate the temperature of equipments, relay of higher current rating can be used. A remote sensing that allows sensor to be placed up to several hundred feet away can also be used for more effective operation

REFERENCES.

[1] http; // en wilkpedia.org/ wik/thermostat

[2] Electronic and Electrical Measurement and Instrument by **J.B GUPTA**

[3] Modern control Engineering Fourth Edition by Katsuhko Ogata

[4] William Hastley and Emmanuel Friedman mert Student Encyclopedia Macmillan Education company

1982;

[5] Grolier International Encyclopedia America International edition volume 13 and 14 Grolier

International W {1994};

[6] Tom Duncan and John Marry, Adventure with Electric Book aid International {1998}

[7] Jacob milkman and Christ C .Halla interpreted electronic Mc Graw-Hill {1970}

[8] Emajemiteilliam

[9] www. Howtff.work/edu/semi-conductor.comm

[10] Practical Electronic {Second edition by Berry wood hand.

[11] www.datasheet.archieve.comm

[12] B.L Theraja and A.K Theraja; A text book of Electrical Technology {Revised edition}

S.Shand and company htd [2002] pp719,pp1699, 1952, pp1954

[13] Paul Horowitz and W.Hill Art of Electronic pp44; 63 239, 263, 307.

[14] Paul Horowitz and w.Hill.. The art of Electronic 2nd edition. Cambridge University press, New York 2003, pp46.