بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Post Graduate Studies

Controller of overheat Temperature in Travels Passenger Vehicles

المتحكم فى درجات الحرارة العالية فى العربات السفرية

A thesis Submitted in Partial Fulfillment for the

Requirement for The degree of M.Sc

In

Mechatronics Engineering

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Supervisor: Dr. Abd Rasoul

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آية

بسم الله الرحمن الرحيم

{اللَّهُ لَا إِلَهَ إِلَّا هُوَ الْحَيُّ الْقَيُّومُ لَا تَأْخُذُهُ سِنَةٌ وَلَا نَوْمٌ لَهُ مَا فِي السَّمَاوَاتِ وَمَا فِي الْأَرْضِ مَنْ ذَا الَّذِي يَشْفَعُ عِنْدَهُ إِلَّا بِإِذْنِهِ يَعْلَمُ مَا بَيْنَ أَيْدِيهِمْ وَمَا خَلْفَهُمْ وَلَا يُحِيطُونَ بِشَيْءٍ مِنْ عِلْمِهِ إِلَّا بِمَا شَاءَ وَسِعَ كُرْسِيُّهُ السَّمَاوَاتِ وَالْأَرْضَ وَلَا يَئُودُهُ حِفْظُهُمَا وَهُوَ الْعَلِيُّ الْعَظِيمُ} . (البقرة : 255)

DEDICATION

To my family,

To my colleagues

ACKNOWLEDGMENT

In the name of Allah, Most Gracious, Most Merciful

All praise and glory to Almighty Allah (Subhanahu Wa Taalaa) who gave me courage and patience to carry out this work. Peace and blessing of Allah be upon last Prophet Muhammad (Peace Be upon Him).

I would like to express my unrestrained appreciation to my supervisor Dr. Abd Rasoul, for his help and guidance.

The real spirit of achieving a goal is through the way of excellence and austerous discipline. I would have never succeeded in completing my task without the cooperation, encouragement and help provided to me by my wife Mrs Roa.

I also acknowledge all of my friends, especially my colleagues in ELROSERS Hydro Power Generation Station for their encouragement and support.

ABSTRACT

Various solutions to the overheat problems in vehicles engine suggested to use technology of microcontroller to alarm and trip the engine when the temperature more than high. During the long travel, the driver will not pay attention to the high temperature of the engine, which leads to a significant failure of the engine.

In this research two companies are explored, Unity of North and Samraoui Companies. Working in the field of travel they use Chinese-made buses, according to the field survey I found that every 20 travels rise in temperature occur one bus, and that the driver do not pay attention to the heat index, causing a total collapse of the engine, which makes the company to replace the engine and this leads to high costs.

It is noticeable that the engine is placed in another far from the drivers that means the drivers does not feeling the overheat temperature.

مستخلص

مختلف الحلول فى مشاكل ارتفاع درجات الحرارة فى ماكينة السيارة وقد تم اختراعها باستخدام تقنية المتحكم لتنبيه وايقاف الماكينة عندما ترتفع درجة حرارتها . اثناء الرحل الطويلة' السائق لن ينتبه لارتفاع درجة حرارة الماكينة' مما يؤدى لانهيار الماكينة .

فى هذا البحث تمت الدراسة فى شركتين وهى شركة وحدة الشمال وشركة سمراوى الشمال تعملان فى مجال السفريات وتستخدم البصات الصينية ' وطبقا لهذه الحالة وجدت فى كل 20 سفرية حالة واحدة تتعطل بسبب ارتفاع درجة حرارة المحرك' والسائق لا ينتبة لارتفاع درجة الحرارة مما يؤدى الى انهيار تام فى المحرك مما يجعل الشركة تستبدل المحرك وهذا يقود الى تكاليف عالية.

ومن الملاحظ ان المحرك موضوع فى اخر البص اى بعيدا عن السائق مما يعنى ان السائق لايشعر بارتفاع درجة الحرارة.

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LIST OF ABBREVIATIONS

ECU	Electronic Control Unit
VECSS	Vehicle Engine Cooling System Simulation
LCD	Liquid Crystal Display
RTDs	Resistive Temperature Devices
QFP	Quad Flat Package
ADC	Analogue to Digital Converter
ALU	Arithmetic Logic Unit
I/O	Input Output Ports
DAC	Digital to Analogue Converter
MCU	Microcontroller
PWM	Pulse Width Modulation

CHAPTER ONE

INTRODUCTION

Chapter One

Introduction

1.1 Overview:

Various solutions to the overheat problems in vehicles engine suggested to use technology of microcontroller to alarm and trip the engine when the temperature more than high. During the long travel, the driver will not pay attention to the high temperature of the engine, which leads to a significant failure of the engine.

In this research two companies are explored, Unity of North and Samraoui Companies. Working in the field of travel they use Chinese-made buses, according to the field survey found that every 20 travels rise in temperature occur one bus, and that the driver do not pay attention to the heat index, causing a total collapse of the engine, which makes the company to replace the engine and this leads to high costs.

- Foreword of the bus company (Zhengzhou Yutong Bus Co., Ltd):-

WD615\WD10 Series Diesel Engine for construction Machinery is an special power developed independently by our company based on WD615\WD10 Series Diesel Engine. This engine possesses the advantage of compact structure, reliable operation, advanced economic and technical specification, rapid starting, simple handling and convenient maintenance, etc. This series diesel engine is mainly used on construction machinery, such as loaders, dozers, excavators, cranes, road rollers, land levelers and so on.

1.2 Problem statement:

Overheat temperature in internal combustion engine, causing a total collapse of the engine and leads to high costs of maintenance and repair.

It is noticeable that the engine is placed in another far from the drivers that means the drivers does not feel the overheat temperature.

- Causes for temperature rise of the cooling liquid:

*****Too little cooling liquid in the cooling system.

*Fan failure.

*Insufficient tension of fan belt or the belt has been broken.

*The cooling liquid circuit is unsmooth or the thermostat is in trouble.

*The engine oil temperature is too high due to the lack of engine oil.

1.3Problem solution:

The research solution is to design a microcontroller based system, which has the ability to detect overheat of the engine, display the temperature digitally and trip the engine if necessary.

1.4 Objectives:-

Main objective of this study is to design a temperature monitoring system that can be easily installed in a bus to achieve these objectives:

* Control system will be proposed using microcontroller along with temperature sensing devices.

* The proposed system will be prototyped in order to insure reliability.

* The resulting system shall reduce the operation cost of the buses.

1.5 Methodology:

The heat transfer in internal composition usually occurs between the engine case and the oil. So the oil will dissipate the heat of the engine. Then the oil is cooled by the coolant. In most times the coolant type used is the water.

The temperature sensor sends the analog temp signal from the cooling liquid to the acquisition circuit to convert the analog signal to digital signal. The microcontroller on board process the temp signal and display a digital value of the temperature. two limit signal (alarm\ trip) are designed for the coolant temperature. When the engine starts to overheat, the alarm signal will be activated and an audible alarm will be triggered. At this moment the driver should stop the vehicle and check the engine. In case he decided to go on, the temperature will reach the trip stage and the trip signal will be activated. This trip signal will be sent to the microcontroller and the microcontroller will send an output signal to close the fuel supply valve.

1.6 Research plan:

The research contains six chapters as follows;

Chapter 1: INTRODUCTION

Chapter 2: LITRUTURE REVIEW

Chapter 3: ELECTRONIC CIRCIT DESGIN

Chapter 4: SOFTWARE DESGIN

Chapter5: RESULTS

Chapter6: CONCLUSION AND FUTURE SCOPE

CHAPTER TWO

LITERATURE REVIEW

Chapter two

Literature Review

2.1 Background

Overheat protection is a system that monitors the temperature of vehicles engine for alarm and trip the engine if necessary. Engine body temperature is not measured directly but it is measured through the coolant temperature. So a temperature sensor is used to measure the coolant temperature, as an indicator of the engine temperature, then this signal is sent to the electronic control unit (ECU) for processing and then displayed on the temperature gauge in the dashboard, so that the driver can monitor it and if temperature keep rising above normal range, the driver must stop the engine and check it. But if the driver, for any reason at the moment of temperature rising, was not monitoring the gauge, the temperature will continue to increase above the allowable limit which may lead to catastrophic results. It is obvious that the ECU function is just monitoring the temperature but not taking any action whether to stop the engine or not, this decision is taken by the driver.

So this system needs improvement by enabling the ECU interaction to stop the engine when the temperature reaches the trip limit. Since it is not possible or difficult to access and modify the engine parameters in the ECU, a discrete microcontroller will be developed for monitoring the temperature alarm and trip limits and shut down the engine if required.

2.2 Previous Studies:

Engine overheating has been around as long as the automobile and the Model "A" is not exempt from the problem. However, the "A's" cooling system, if working properly, is more than adequate for almost any set of driving conditions you might encounter. There are many causes for engine overheating, but once identified, most can be easily corrected. As horsepower increased water cooling was introduced using a water pump to force coolant through the engine. Manufacturers wanted simpler means for cooling and the designers wanted a non-pumped cooling system to avoid failed pumps the pump less Thermo-Syphon. System evolved a debate ensued pump or “no pump”. Henry Ford adopted the thermo-syphon for the “T” most manufacturers continued to use the water pump, The Model A modified the “T” system to use both (thermo-syphon and water pump), the Model A engine cooling system evolved from the earlier model T Thermo-Syphon design.

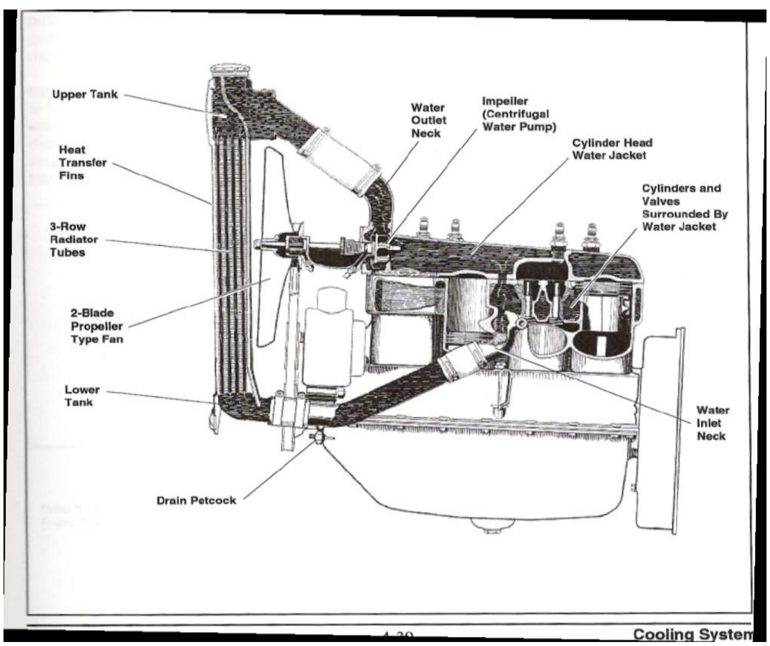


Figure 2.1:Model A engine

In the 1930-1931 Model A's have a raised radiator inlet to get additional Thermo-Syphon cooling action. The engineers of the Model A added a water pump by the early 5 impeller gave way in 1930 to a3 impeller design, The pump is used at high engine speeds to increase the water flow and maintain a more even temperature, and basic cooling is still the Thermo-Syphon system.

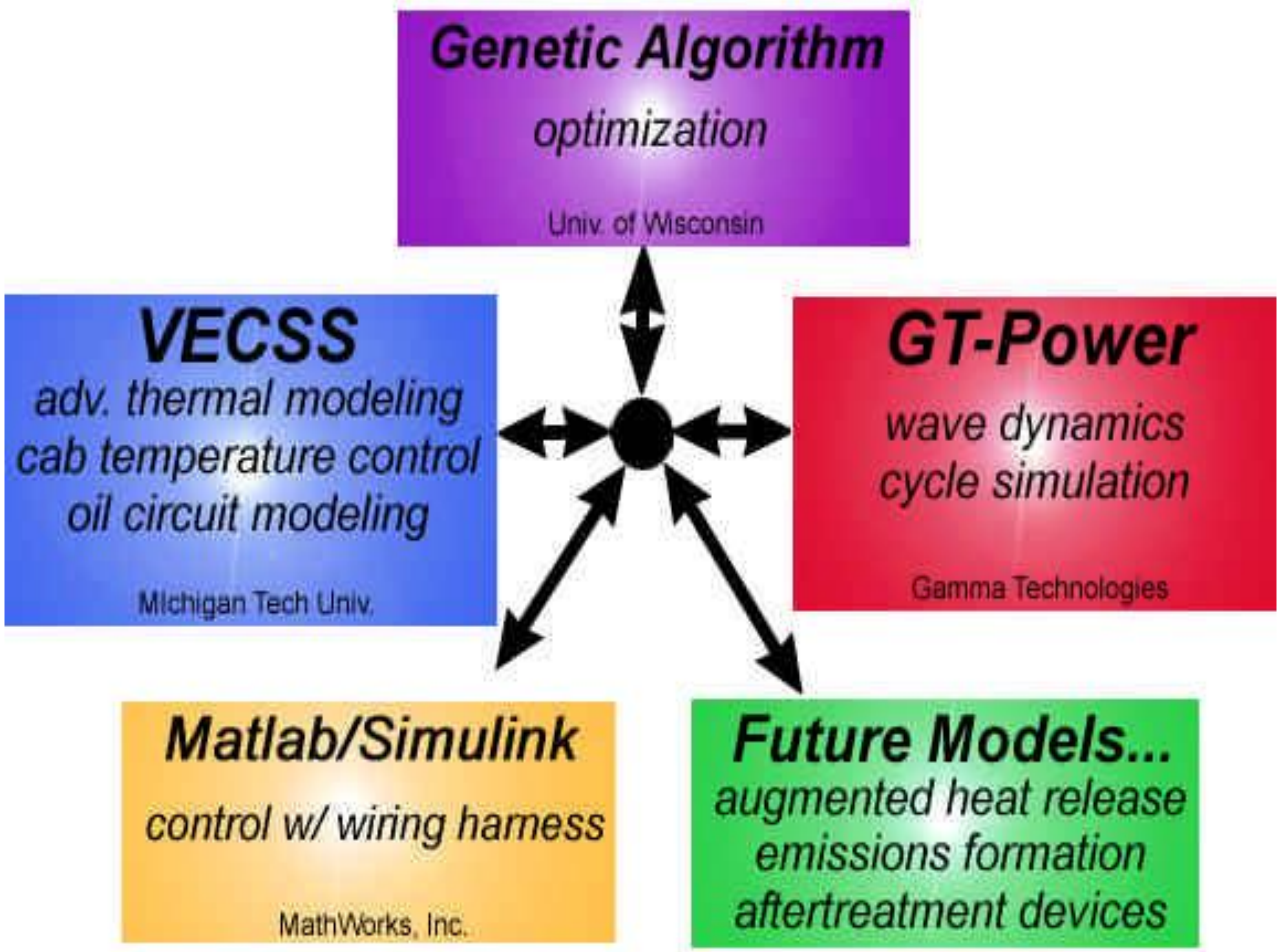
The Vehicle Engine Cooling System Simulation (VECSS) history I funding:-

- 1980 - 1998 - Kysor of Cadillac.
- 1998 - 2000 - Engineered Machined Products (EMP).
- 2000 - Present - Army Research Office (ARO).

Students/Research Areas:-

- 1980 - V.J. Ursini began development (Cummins NTC-350 Big Cam II in an International Harvester COE-9670).
- 1995 - Kysor of Cadillac (collected field data with a Detroit Diesel Corp. Series 6012.7L in a Freightliner FLD120).
- 1997 - K.V. Mohan (DDC S60 cycle analysis and comparison to experimental data).
- 1998 - A.J. Kulkarni (compressible airflow cooling model and comparison to field data).
- 1999 - C.W. Lehner (feedback controlled cooling with electric coolant pump and actuator).
- 2000 - R.D. Chalgren (controlled EGR cooling with electric coolant pumps and actuator).
- 2002 - B.J. Luptowski (developing E-VECSS and 42-volt active cooling system model).(rrrr, et al. 2010).

Current Project - Enhanced Vehicle and Engine Cooling System Simulation (E-VECSS):-



Figure(2.2): Current Project - Enhanced Vehicle and Engine Cooling System Simulation (E-VECSS).

2.3 Benefit of Overheat Protection:

The overheat protection system is used improve the original system in vehicles to predict of high temperature and avoid the damage of engine, this system have some advantages in the travel vehicles:-

1-The distance between Khartoum and Eldmazeen is very long (520 km) this system avoids the delay of the passenger during the travel.

2- The high temperature in the internal composition engine undesirable because it lead to high damage in engine, this system will have predict the high temperature and maintain the malfunction.

3- Reduces the cost of maintenance.

2.4 Operations of System:-

The temperature sensor sends the analog temp signal from the cooling liquid to the acquisition circuit to convert the analog signal to digital signal.Themicrocontroller on board process the temp signal and display a digital value of the temperature.

Two limit signal (alarm\ trip) are designed for the coolant temperature. When the engine starts to overheat, the alarm signal will be activated and an audible alarm will be triggered. At this moment the driver should stop the vehicle and check the engine. In case he decided to go on, the temperature will reach the trip stage and the trip signal will be activated. This trip signal will be sent to the microcontroller and the microcontroller will send an output signal to close the fuel supply valve.

2.5 **block diagram:-**

The temperature sensor sends the analog temp signal from the cooling liquid to the acquisition circuit to convert the analog signal to digital signal. The micro-controller on board process the temp signal and display a digital value of the temperature.two limit signal (alarm\ trip) are designed for the coolant temperature. When the engine starts to overheat, the alarm signal will be activated and an audible alarm will be triggered. At this moment the driver should stop the vehicle and check the engine. In case he decided to go on, the temperature will reach the trip stage and the trip signal will be activated. This trip signal will be sent to the microcontroller and the microcontroller will send an output signal to close the fuel supply valve.

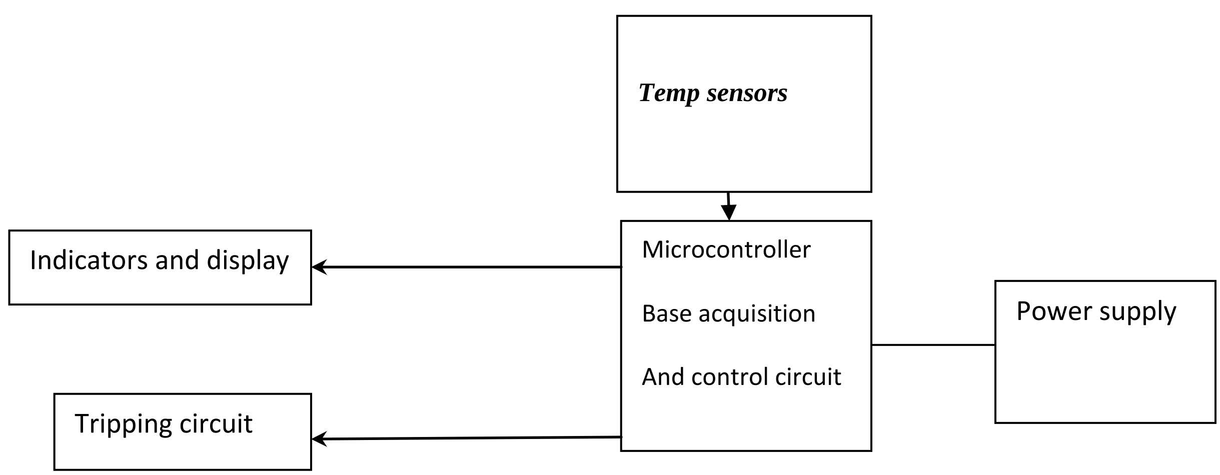


Figure2.3: block diagram

CHAPTER THREE

ELECTRONIC CIRCUIT DESIGN

Chapter Three

Electronic Circuit Design

3.1 Overview:

In this chapter the model electronic circuit will be explained the design to know how the system works and just to sensing the temperature of weather and put two limits of temperature. Limit one when activated it will send signal to the horn and make alarm. Limit two when activate it sent signal to the lamp to light. This last signal represents the signal of the shut off valve of the fuel in the vehicles. And the limits of temperature put due to the design of engine to work in high efficiency.

For the design and development of the system, the methodology used involves the software and hardware implementation. The actual implementation of the system involves the following steps:

1.) System Definition: Broad definition of system hardware including micro-controller and its interface with display, temperature sensor, buzzer, etc.

2.) Circuit Design: Selection of Atmega16 microcontroller and other interfacing devices, as per system definition. Design of hardware circuit and its testing on laboratory kits with some simple microcontroller software routines.

3.) PCB Design and Fabrication: Generation of schematic diagrams and the production of circuit board layout data for the procurement of the circuit board.

4.) Hardware Modifications: Making any hardware changes found necessary after the initial hardware tests, to produce a revised circuit board schematic diagram and layout.

5.) Software Design: Developing algorithm for the system, allocating memory blocks as per functionality, coding and testing.

6.) Integration and Final Testing: Integrating the entire hardware and software modules and its final testing for operation.

Thus the complete design is divided into two parts:

1.) Hardware Implementation.

2.) Software Implementation.

In this chapter hardware implementation will be discussed.

3.2 Hardware Implementation

It involves the details of the set of design specifications. The hardware design consists of, the selection of system components as per the requirement, the details of subsystems that are required for the complete implementation of the system and full hardware schematics for the PCB layout. Design of the circuit and its testing has been carried out. It involves the component selection, component description and hardware details of the system designed.

1.) Component selection and description.

2.) Hardware details of the system designed.

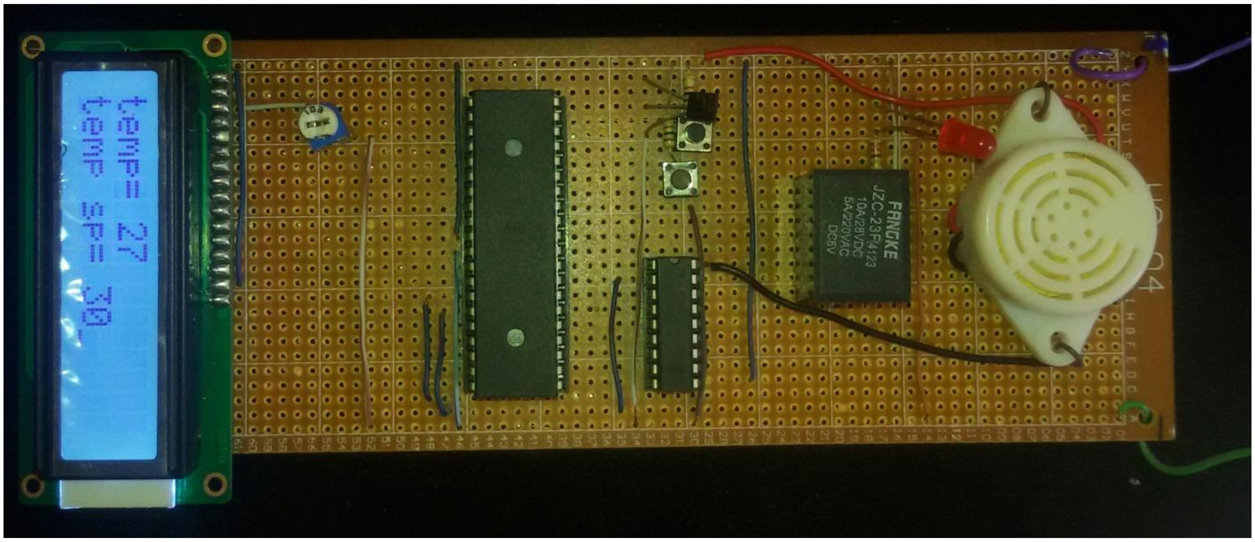


Figure (3-1) Hardware Design

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3.2.1 Component selection and description

Overheat protection system using microcontroller includes the following components:

1.) Temperature Sensor (LM35)
2.) Microcontroller (Atmega16)
3.) Liquid Crystal Display (LCD-016M002B)
4.) High Current Darlington Transistor (ULN2803)
5.) 5V DC Relay
6.) Red LED
7.) Buzzer

1.) Temperature Sensor

Selection of Suitable Transducer:

For measuring the temperature, the choice of sensor is of utmost importance .

The sensors are used in many fields includes Thermocouples, Resistive temperature devices (RTDs and thermistors) and bimetallic devices. The factors for the selection of sensor that we take into account includes the inherent accuracy for durability, range of operation, susceptibility to external noise influences, ease of maintenance and installation, handling during installation (delicacy), ease of calibration, and type of environment it will be used in.

The temperature sensor used for this purpose is LM35 because of the following features:

Features of LM35:

1.) Calibrated directly in ° Celsius (Centigrade).

2.) Linear + 10.0 mV/°C scale factor.

3.) 0.5°C accuracy guarantee able (at +25°C).

4.) Rated for full −55° to +150°C range.

5.) Suitable for remote applications.

6.) Low cost due to wafer-level trimming.

7.) Operates from 4 to 30 volts.

8.) Less than 60 μ A current drain.

9.) Low self-heating, 0.08°C in still air.

10.) Nonlinearity only ±1⁄4°C typical.

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies.

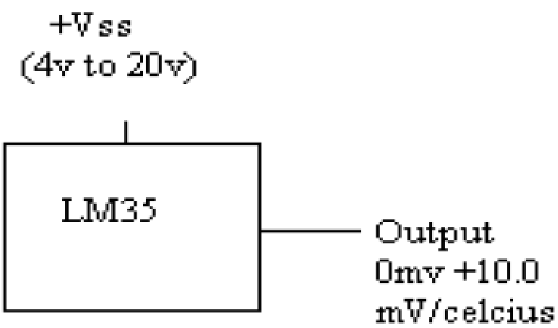


Figure (3-2) LM35 Temperature Sensors

2.) Microcontroller

Criteria for choosing a microcontroller

1.) The first and foremost criterion for choosing a microcontroller is that it must meet the task at hand efficiently and cost effectively . In analyzing the needs of a microcontroller-based project, it is seen whether an 8-bit, 16-bit or 32-bit microcontroller can best handle the computing needs of the task most effectively. Among the other considerations in this category are:

(a) Speed – What is the highest speed that the microcontroller supports?

(b) Packaging – Does it come in 40-pin DIP (dual inline package) or a QFP (quad flat package), or some other packaging format? This is important in terms of space, assembling, and prototyping the end product.

(c) Power consumption – This is especially critical for battery-powered products.

(d) The number of I/O pins and the timer on the chip.

(f) How easy it is to upgrade to higher –performance or lower consumption versions.

(g) Cost per unit – this is important in terms of the final cost of the product in which a microcontroller is used.

2.) The second criterion in choosing a microcontroller is how easy it is to develop products around it. Key considerations include the availability of an assembler, debugger, a code –efficient compiler, technical support.

3.) The third criterion in choosing a microcontroller is its ready availability in needed quantities both now and in the future. Currently of the leading 8-bit mi crocontrollers, The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

FEATURES:-

• High-performance, Low-power Atmel AVR 8-bit Microcontroller.

• Advanced RISC Architecture:-

– 131 Powerful Instructions – Most Single-clock Cycle Execution.

– 32 x 8 General Purpose Working Registers.

– Fully Static Operation.

– Up to 16 MIPS Throughput at 16 MHz.

– On-chip 2-cycle Multiplier.

• High Endurance Non-volatile Memory segments:-

– 16 Kbytes of In-System Self-programmable Flash program memory.

– 512 Bytes EEPROM.

– 1 Kbyte Internal SRAM.

– Write/Erase Cycles: 10,000 Flash/100,000 EEPROM.

– Data retention: 20 years at 85°C/100 years at 25°C(1).

– Optional Boot Code Section with Independent Lock Bits In-System Programming by On-chip Boot Program True Read-While-Write Operation.

– Programming Lock for Software Security.

• JTAG (IEEE std. 1149.1 Compliant) Interface:-

– Boundary-scan Capabilities According to the JTAG Standard.

– Extensive On-chip Debug Support.

– Programming of Flash, EEPROM, Fuses, and Lock Bits through the JTAG Interface.

• Peripheral Features

– Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes.

– One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode.

– Real Time Counter with Separate Oscillator.

– Four PWM Channels.

– 8-channel, 10-bit ADC 8 Single-ended Channels 7 Differential Channels in TQFP Package Only 2 Differential Channels with Programmable Gain at 1x, 10x, or 200x.

– Byte-oriented Two-wire Serial Interface.

– Programmable Serial USART.

– Master/Slave SPI Serial Interface.

– Programmable Watchdog Timer with Separate On-chip Oscillator

– On-chip Analog Comparator.

• Special Microcontroller Features

– Power-on Reset and Programmable Brown-out Detection.

– Internal Calibrated RC Oscillator.

– External and Internal Interrupt Sources.

– Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby and Extended Standby.

• I/O and Packages

– 32 Programmable I/O Lines.

– 40-pin PDIP, 44-lead TQFP, and 44-pad QFN/MLF.

• Operating Voltages

– 2.7V - 5.5V for ATmega16L.

– 4.5V - 5.5V for ATmega16.

• Speed Grades

– 0 - 8 MHz for ATmega16L.

– 0 - 16 MHz for ATmega16.

• Power Consumption @ 1 MHz, 3V, and 25°C for ATmega16L

– Active: 1.1 mA.

– Idle Mode: 0.35 mA.

– Power-down Mode: < 1 μA.

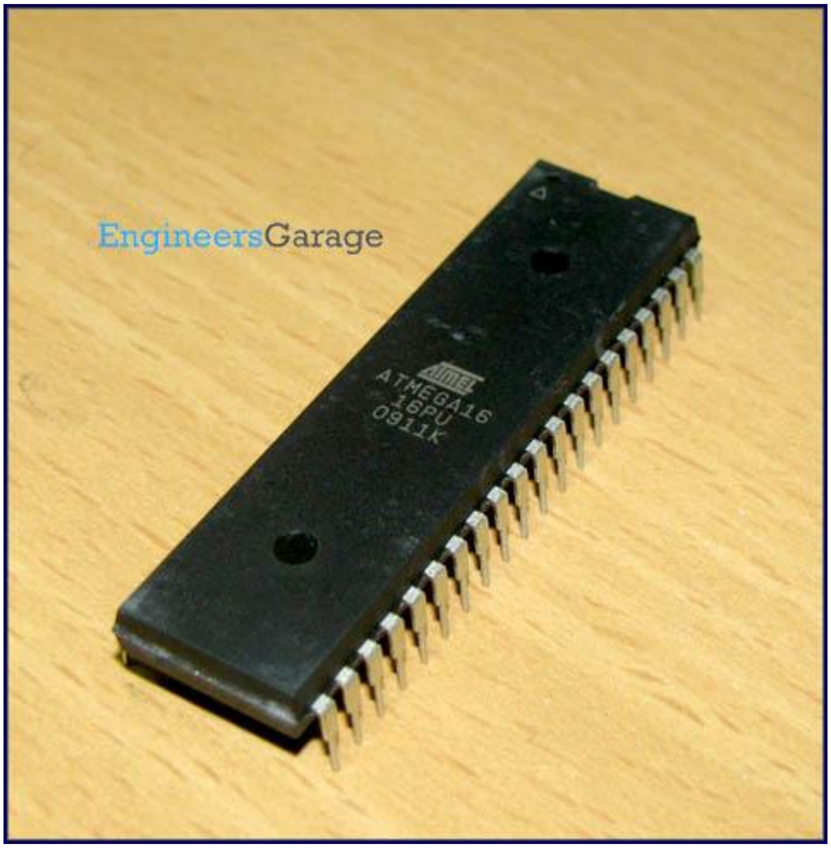


Figure (3-3) Microcontroller atmega16L

Block Diagram:-

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The ATmega16 provides the following features: 16 Kbytes of In-System Programmable Flash Program memory with Read-While-Write capabilities, 512 bytes EEPROM, 1 Kbyte SRAM, 32 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary-scan, On-chip Debugging support and programming, three flexible Timer/Counters with compare modes, Internal and External Interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain (TQFP package only), a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and six software selectable power saving modes. The Idle mode stops the CPU while allowing the USART, Two-wire interface, A/D Converter, SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next External Interrupt or Hardware Reset. In Power-save mode, the Asynchronous Timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except Asynchronous Timer and ADC, to minimize switching noise during ADC conversions.

In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption. In Extended Standby mode, both the main Oscillator
And the Asynchronous Timer continues to run.
The device is manufactured using Atmel's high density nonvolatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed in-system through an SPI serial interface, by a conventional nonvolatile memory programmer, or by an On-chip Boot program running on the AVR core. The boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega16 is a powerful microcontroller that provides a highly-flexible and cost-effective solution to many embedded control applications.
The ATmega16 AVR is supported with a full suite of program and system development tools including: C compilers, macro assemblers, program debugger/simulators, in-circuit emulators, and evaluation kits.

Pin Descriptions:-

VCC: - Digital supply voltage.

GND: - Ground.

Port A (PA7...PA0):- Port A serves as the analog inputs to the A/D Converter.

Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. Port pins can provide internal pull-up resistors (selected for each bit).
The Port A output buffers have symmetrical drive characteristics with both high sink and source capability. When pins PA0 to PA7 are used as inputs and

are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port B (PB7...PB0):-

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port B also serves the functions of various special features of the ATmega16

Port C (PC7..PC0):-

Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running. If the JTAG interface is enabled, the pull-up resistors on pins PC5(TDI), PC3(TMS) and PC2(TCK) will be activated even if a reset occurs.

Port C also serves the functions of the JTAG interface and other special features of the ATmega16

Port D (PD7...PD0):-

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated.

The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port D also serves the functions of various special features of the ATmega16.

RESET: -

Reset Input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running.

XTAL1:-

Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

XTAL2:-

Output from the inverting Oscillator amplifier.

AVCC: -

AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.

AREF: -

AREF is the analog reference pin for the A/D Converter.

3) LCD-016M002B

FEATURES:-

• 5 x 8 dots with cursor

• Built-in controller (KS 0066 or Equivalent)

• + 5V power supply (Also available for + 3V)

• 1/16 duty cycle

- B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED)
- N.V. optional for + 3V power supply

MECHANICAL DATA:-

- Module Dimension 80.0 x 36.0 mm
- Viewing Area 66.0 x 16.0 mm
- Dot Size 0.56 x 0.66 mm
- Character Size 2.96 x 5.56 mm

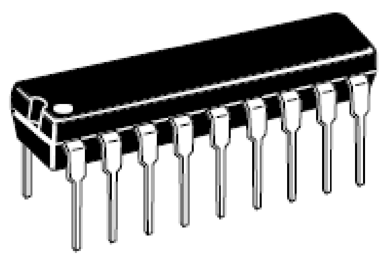
16 x 2 Characters LCD:-

PIN NUMBER	SYMBOL	FUNCTION
1	Vss	GND
2	Vdd	+ 3V or + 5V
3	Vo	Contrast Adjustment
4	RS	H/L Register Select Signal
5	R/W	H/L Read/Write Signal
6	E	H -L Enable Signal
7	DBO	H/L Data Bus Line
8	DB1	H/L Data Bus Line
9	DB2	H/L Data Bus Line
10	DB3	H/L Data Bus Line
11	DB4	H/L Data Bus Line
12	DB5	H/L Data Bus Line
13	DB6	H/L Data Bus Line
14	DB7	H/L Data Bus Line
15	A/Vee	+ 4.2V for LED/Negative Voltage Output
16	K	Power Supply for B/L (OV)

4) High Current Darlington Transistor (ULN2803)

The eight NPN Darlington connected transistors in this family of arrays are ideally suited for interfacing between low logic level digital circuitry (such as TTL, CMOS or PMOS/NMOS) and the higher current/voltage requirements of lamps, relays, printer hammers or other similar loads for a broad range of computer, industrial, and consumer applications. All devices feature open collector outputs and freewheeling clamp diodes for transient suppression.

The ULN2803 is designed to be compatible with standard TTL families while the ULN2804 is optimized for 6 to 15 volt high level CMOS or PMOS.



FEATURES:-

(TA = 25°C and rating apply to any one device in the Package, unless otherwise noted.)

- Output Voltage 50 V
- Input Voltage (Except ULN2801) 30 V
- Collector Current – Continuous 500 mA
- Base Current – Continuous 25 mA
- Operating Ambient Temperature Range 0 to +70 °C

- Storage Temperature Range –55 to +150 °C
- Junction Temperature 125 °C

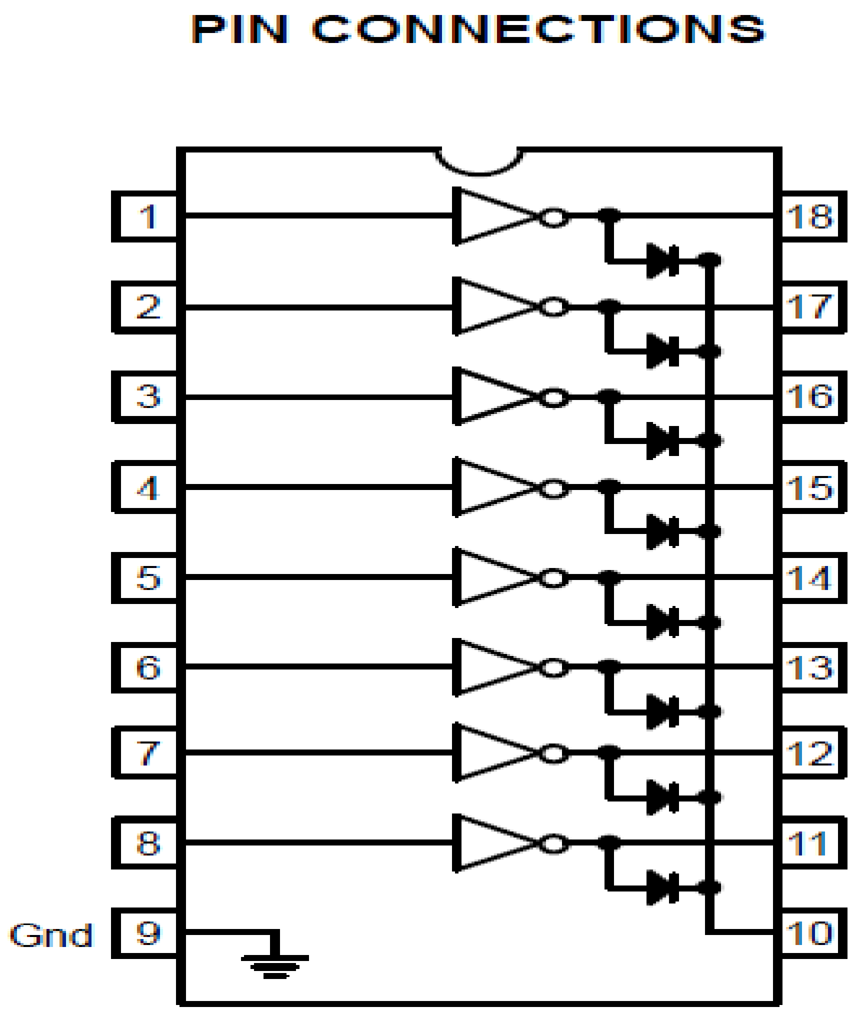


Figure (3-5) bin connection

5) 5V DC Relay:-

Relay is an electromagnetic device which is used to isolate two circuits electrically and connect them magnetically. They are very useful devices and allow one circuit to switch another one while they are completely separate. They are often used to interface an electronic circuit (working at a low voltage) to an electrical circuit which works at very high voltage. For example, a relay can make a 5V DC battery circuit to switch a 230V AC mains circuit. Thus a small sensor circuit can drive, say, a fan or an electric bulb.

A relay switch can be divided into two parts: input and output. The input section has a coil which generates magnetic field when a small voltage from an electronic circuit is applied to it. This voltage is called the operating voltage. Commonly used relays are available in different configuration of operating voltages like 6V, 9V, 12V, 24V etc. The output section consists of contactors which connect or disconnect mechanically. In a basic relay there are three contactors: normally open (NO), normally closed (NC) and common (COM). At no input state, the COM is connected to NC. When the operating voltage is applied the relay coil gets energized and the COM changes contact to NO. Different relay configurations are available like SPST, SPDT, DPDT etc, which have different number of changeover contacts. By using proper combination of contactors, the electrical circuit can be switched on and off.

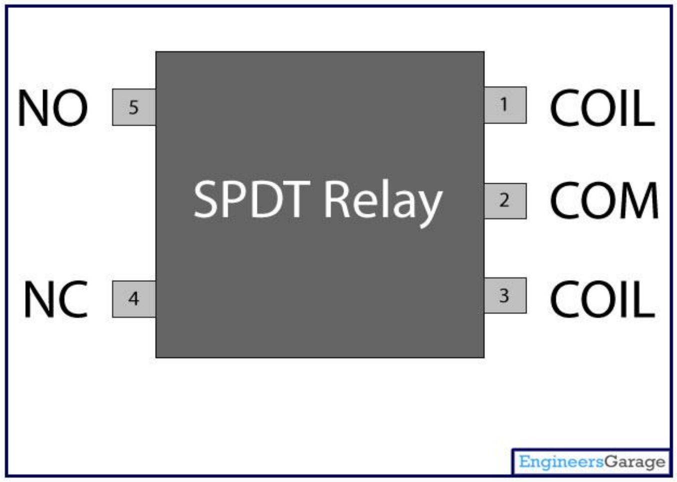


Figure (3-6) Relay

6) Red LED:-

A light-emitting diode (LED) is a two-lead semiconductor light source. It is ap–n junction diode. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons.

A P-N junction can convert the absorbed light energy into its proportional electric current. The same process is reversed here; this phenomenon is generally called electroluminescence, which can be defined as the emission of light from a semi-conductor under the influence of an electric field. The charge carriers recombine in a forward P-N junction as the electrons cross from the N-region and recombine with the holes existing in the P-region. Free electrons are in the conduction band of energy levels, while holes are in the valence energy. Thus the energy level of the holes will be lesser than the energy levels of the electrons. Some part of the energy must be dissipated in order to recombine the electrons and the holes. This energy is emitted in the form of heat and light. And the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor.

An LED is often small in area (less than 1 mm^2) and integrated optical components may be used to shape its radiation pattern.

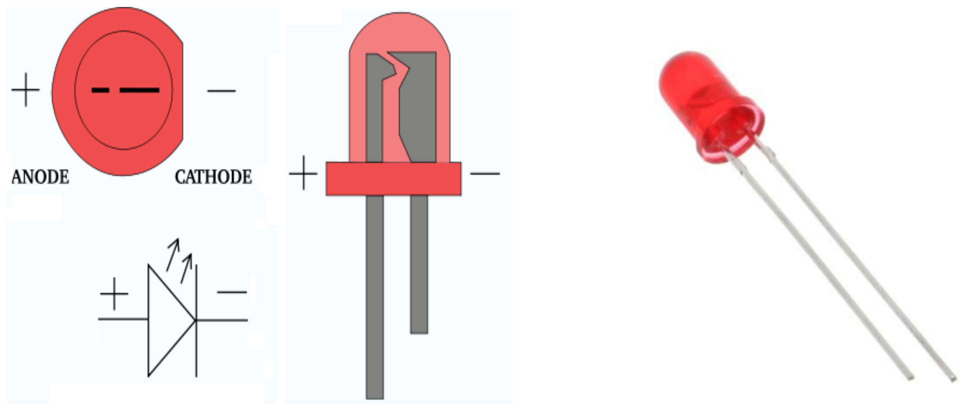


Figure (3-7) LED

7) Buzzer:-

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke.

Figure (3-8) Buzzer

3.2.2 Hardware details of system designed

Figure 3.1 shows the schematic for the implementation of the hardware for this purpose.

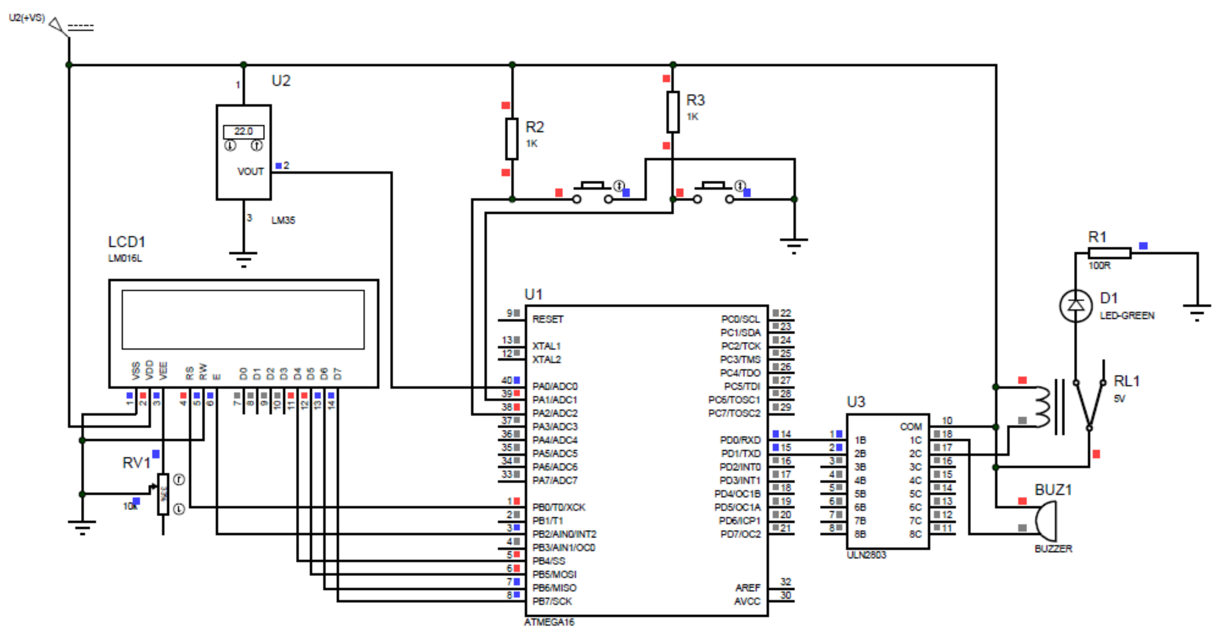


Figure (3-9) Schematic diagram

Figure (3.10) shows the block diagram of the system hardware

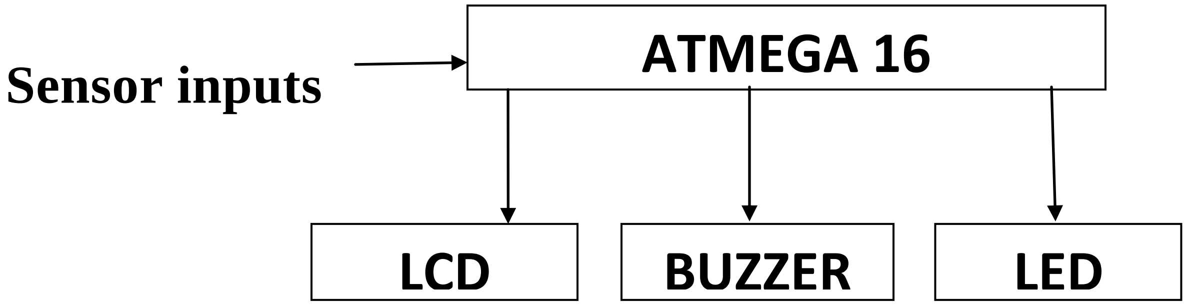


Figure (3-10) block diagram of the system hardware

The details of the circuit component connections are as given below:

Microcontroller At mega 16:-

The four I/O ports of the microcontroller are used just three ports (port B port D port A) interfacing the external peripherals of port B is interfaced to the LCD, port D is interfaced to the output signal (rely, buzzer) and port A is interfaced to the in-put signal (temperature sensor and bush bottom).

1- Port B: - pin (1) portB0 connected to the H/L register select signal, pin (3) portB2 are connected to the H→L Enable signal and pin (5)PortB4,pin (6) PortB5,pin (7) PortB6 and pin (8) PortB7 connected to (D4,D5,D6 and D7) D H/L Data Bus line.
2- Port D: - pin (14) PortD0 and pin (15) PortD1 connected to pin 1B and pin 2B of high current Darlington transistor arrays (ULN2803).
3- Port A: - pin(40) PortA0 connected to Output of second LM35 temperature sensor, pin(39)port A1 connected to bush bottom increase set point tem

perature and pin(38)port A2 connected to bush bottom decrease set point temperature .

4- Pin (10) connected to vcc and pin (11) connected to ground.

Temperature Sensor LM35:-

First pin is connected to Vcc, Second pin to the input channel and the third pin is connected to the ground.

LCD-016M002B:-

Pin 14, pin13, pin12 and pin 11 connected to pin5, pin6, pin7 and pin8 at port B of microcontroller. H⟶L Enable signal pin 6 of LCD connected to pin 3 of micro-controller. The H/L register pin 4 of LCD connected to pin 1 of microcontroller.pin 1, pin 5 and pin 16 connected to ground.pin 2and pin15 v connected to the vcc.pin3 Contrast Adjustment connected to the potentiometer.

High Current Darlington Transistor:-

Pin 1and pin 2 connected to pin 14 and pin 15 at port D of microcontroller.pin17 connected to rely .pin 18 connected to buzzer.pin 9 connected to ground and pin 10 connected to vcc.

Power supply section:-

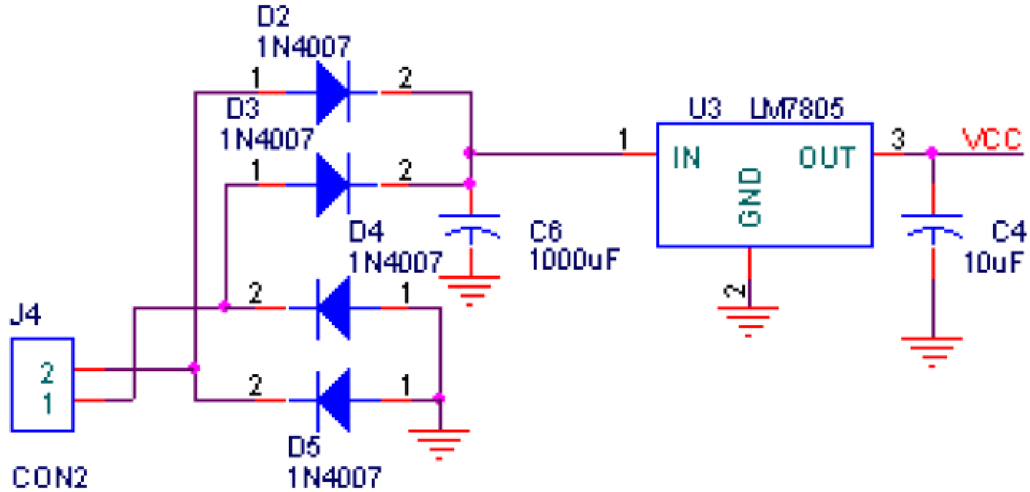


Figure (3-11) Power supply section

A power supply section is the regulated DC power supply of +5 Volts. +5 Volts is generated using LM7805 fixed voltage regulator. Rectification of the AC supply is carried out using 4 IN4007 diodes connected to pin 1 of LM7805.Pin 2 is connected to ground and Pin 3 is connected to VCC. The output of this section is free from ripples and distortions.

CHAPTER FOUR

SOFTWARE DESIGN

Chapter Four

Software Design

4.1 Overview:

Software design includes developing algorithm for the system, allocating memory blocks as per functionality, writing the separate routines for different interfacing devices and testing them on the designed hardware. Interfacing of microcontroller with, LCD, MEMORY, etc. has been carried out using various software modules. The control program is written in bascom language. The software is able to show the real time values from the analog channels for immediate analysis. For designing the software for this work; the flow of software between the hardware components is to be understood first.

4.2 Algorithm for the stepwise designing of the software for the system:-

For the designing of algorithm of the system two steps are to be taken into account:-

1.) Scanning of data:

It involves the analysis that is done before storing the data.

Algorithm for scanning of data is as:-

1.) In this algorithm, first step is to initialize the LCD panel.
2.) LCD displayed the name of thesis (over heat protection).

3.) The time displayed will then be checked for time corresponding to the channel.

4.) The push button is checked for the value of set point the temperature and its value is displayed on the LCD (sp temp=, temp=).

5.) The address of that channel is sent to the analog to digital converter.

6.) The value obtained is then converted to appropriate form for display.

7.) This value is then stored in memory. The loop will repeat itself until all the values are stored in the memory.

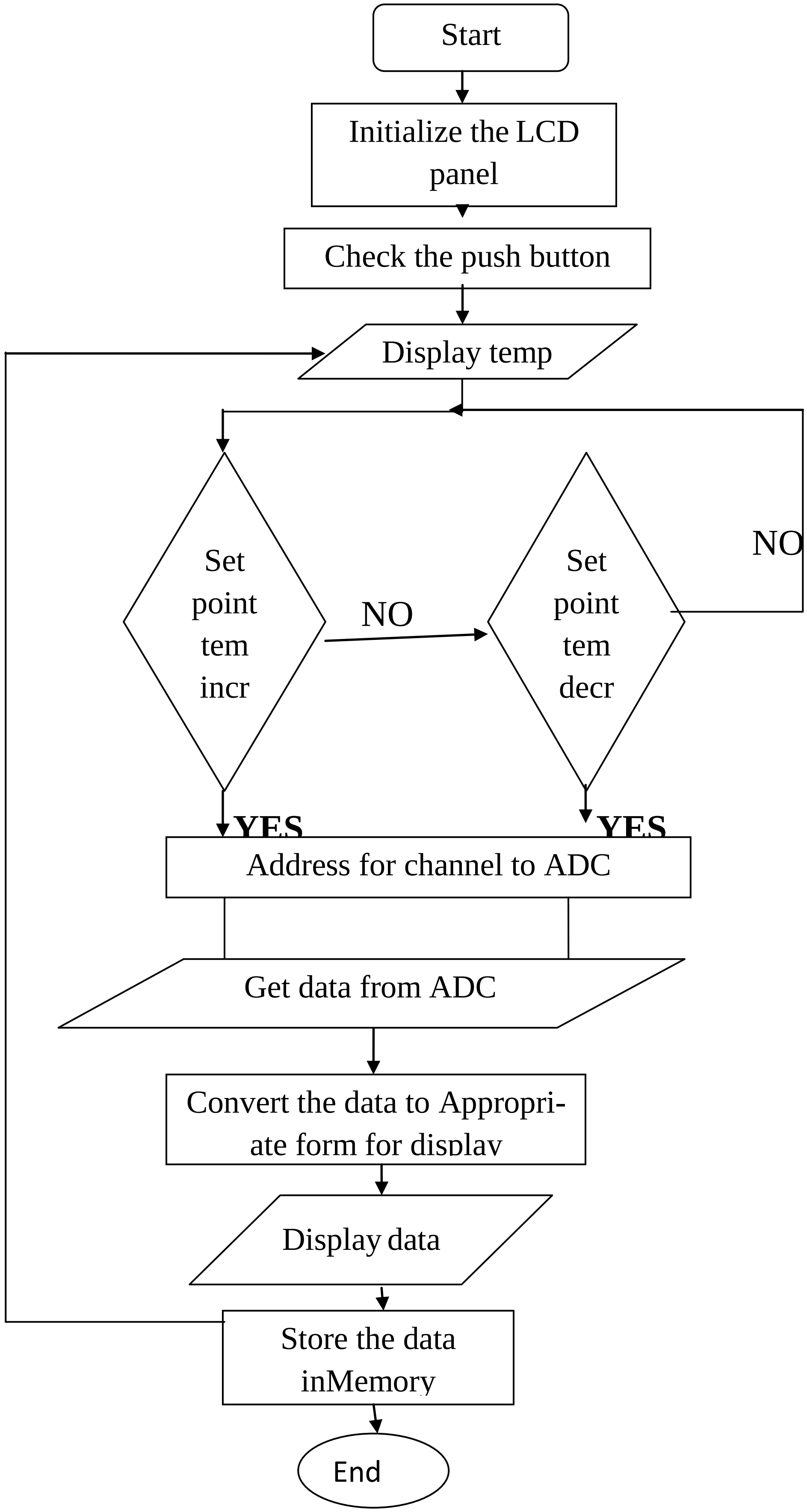


Figure (4.1) Flowchart showing Scan mode of the system

2.) Offline analysis:

It involves the analysis that is to be done after storing the data that is to view the values of data stored in the memory.

Algorithm for offline analysis of data is as:

1.) In this algorithm first step is to check the input key from the push button set point temperature and the actual temperature from the sensor.
2.) The address corresponding to that channel is sent to the memory.
3.) The data stored at that memory location is read and is converted to appropriate form for display.
4.) The value is then displayed on the LCD panel.
5.) The loop will repeat itself until all the values are read from the memory.

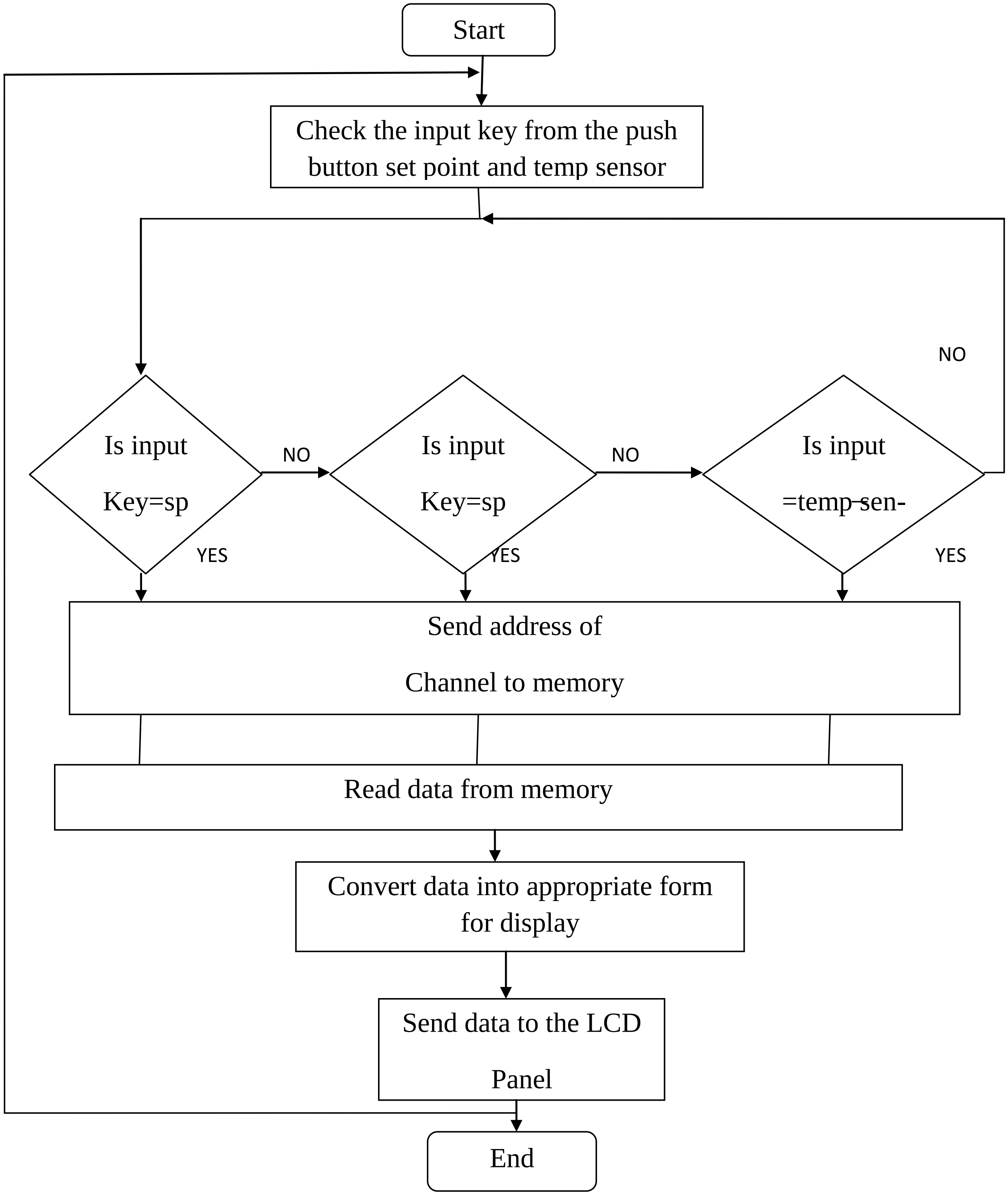


Figure (4.2) Flowchart for offline analysis of the system

4.3 Software algorithms for controlling the various components of the hardware are:-

4.3.1 Interfacing memory to the microcontroller

For interfacing memory to the microcontroller, the algorithm for writing to and reading from the memory are made separately:

* **Algorithm for writing data to the memory is as:**

1.) Firstly the contents of address buffer high ‘addr_buf0_hi’ are moved to data pointer high dph.

2.) The contents of address buffer low ‘addr_buf0_lo’ are moved to data pointer low dpl.

3.) The value of selected channel ‘val_adc_ch-’is moved to the accumulator.

4.) Then the contents of accumulator are moved to memory address pointed

by the data pointer.

6.) Then a delay of 20 ms is called.

Flowchart for writing data to the memory are shown in **figure (4.3)**

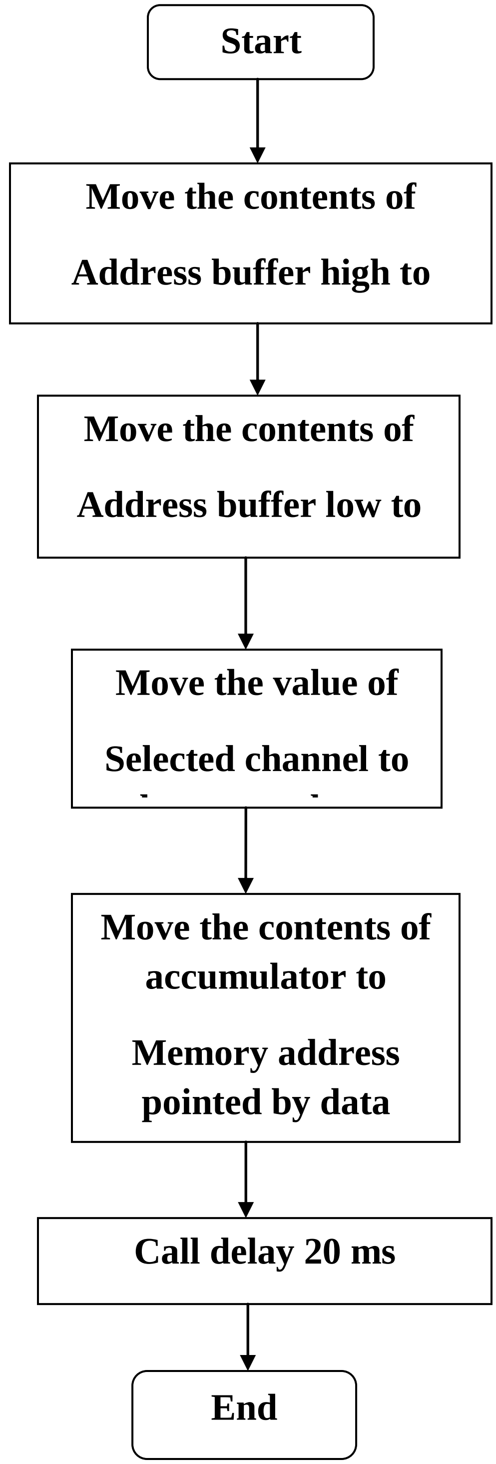


Figure (4.3) Flowchart for writing data to the memory

*** Algorithm for reading the data from the memory is as:**

1.) The contents of address buffer high 'addr_buf0_hi' are moved to data pointer high dph.

2.) The contents of address buffer low 'addr_buf0_lo' are moved to data pointer low dpl.

3.) In next step, the value of memory address pointed by the data pointer is moved to the accumulator.

Flowchart for reading data from the memory is shown in figure (4.4)

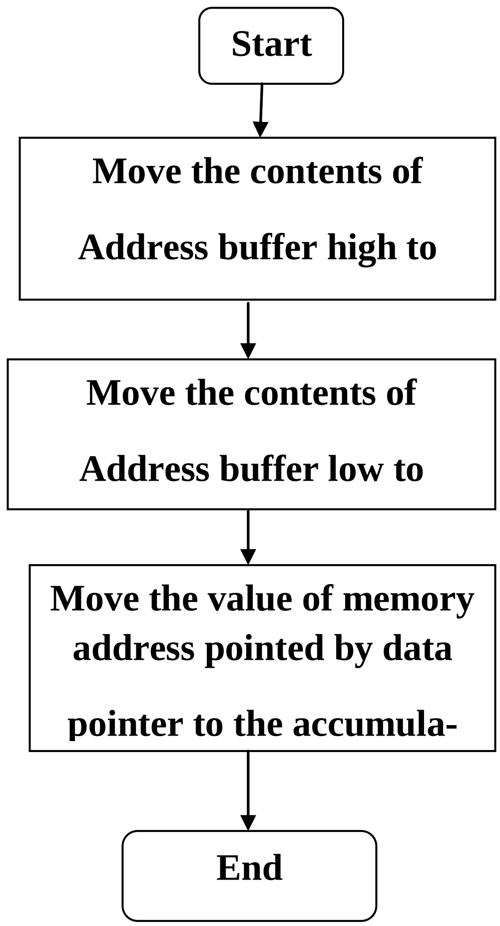


Figure (4.4) Flowchart for reading data from memory

4.3.2 Interfacing LCD to the microcontroller

For interfacing a LCD to the microcontroller it has to be first initialized then command and data are sent to it.

*** Algorithm for initializing the LCD is as:**

1.) Firstly, the interface length is set.

2.) A high to low pulse is applied to the pin ‘en_lcd’.

3.) A delay of 20 ms is then called.

4.) The display is turned on and a high to low pulse is again applied to the pin ‘en_lcd’.

5.) The cursor move direction is set in next step and shift of display is specified.

6.) A delay subroutine of 50 ms is called and a high to low pulse is applied to pin ‘en_lcd’.

Flowchart for LCD initialization is shown in **figure (4.5)**

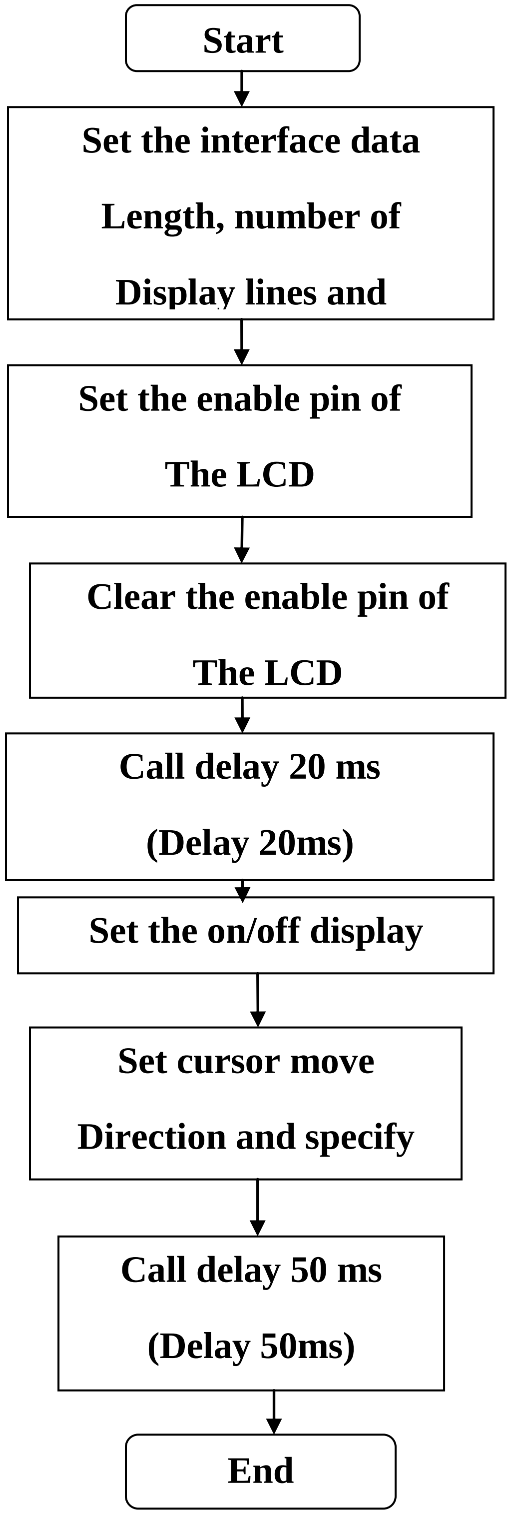


Figure (4.5) Flowchart for LCD initialization

*** Algorithm for writing data to the LCD is as:**

1.) In writing data to the LCD, register select pin (rs) is set to low.

2.) Then the cursor on/off and blink of cursor position character is set.

3.) A high to low pulse is sent to the enable pin 'en_lcd'. The register select pin (rs) is then set.

4.) The contents of the accumulator are moved to port 0. A high to low pulse, in order for the LCD to latch in the data present at the data pins is applied to the enable pin 'en_lcd'.

For writing the data to the LCD panel flowchart is shown as:

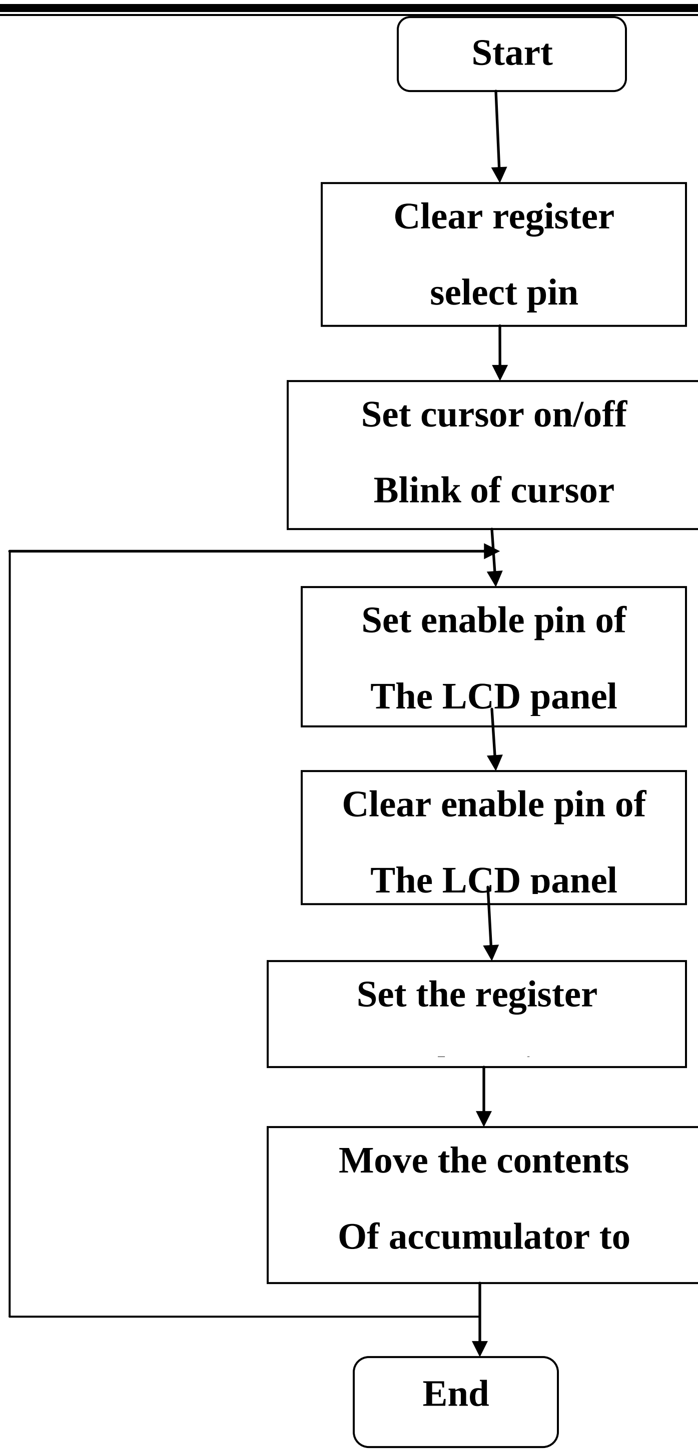


Figure (4.6) Flowchart for writing data to the LCD

4.4 Language programmable

It has become very difficult or even impossible advanced programmable digital control systems by assembling language. And became the acceleration time and the need market are a key reason for creating programming languages high level. In this thesis I use high level languages Convergence the Basic languages in terms of composition and form of instructions that are in the environment a program of BASCOM-AVR.

The language BASIC was an acronym for Beginner's All Purpose Symbolic Instruction Code. It was developed by Dartmouth mathematicians John George Kemeny and Tom Kurtzas as a teaching tool for undergraduates. BASIC was intended to be a computer language for generalists to use to unlock the power of the computer in business and other realms of academia.

4.5 Proteus ISIS 7

Proteus 7.0 is a Virtual System Modeling (VSM) that combines circuit simulation, animated components and microprocessor models to co-simulate the complete microcontroller based designs. This is the perfect tool for engineers to test their microcontroller designs before constructing a physical prototype in real time. This program allows users to interact with the design using on-screen indicators and/or LED and LCD displays and, if attached to the PC, switches and buttons. One of the main components of Proteus 7.0 is the Circuit Simulation -- a product that uses a SPICE3f5 analogue simulator kernel combined with an event-driven digital simulator that allow users to utilize any SPICE model by any manufacturer. Proteus VSM comes with extensive debugging features, including breakpoints, single stepping and variable display for a neat design prior to hardware prototype ing. In summary, Proteus 7.0 is the program to use when you want to simulate the interaction between software running on a microcontroller and any analog or digital electronic device connected to it.

ISIS is a software program that enables users to design electronic circuit's schemes or printed circuit boards. The main advantage offered by this program to others such as or CAD is real –time simulation of all types of electronic circuits, watching clear graphics defaults sets… for interactive simulation of circuits, it was implemented PROTEUS VSM module. Thus using this module you can draw a complete circuit for a microcontroller based system, and then it can be tested interactively. ISIS also provides to the user option for customizing parts and components involved in making a circuit. ISIS uses the following file types and formats: design file (DSN), backup files (DBN), Section- Files (CES), Module Files (MOD), Library Files (LIB) and Net list-Files (SDF). Type design files contain all the information about a circuit. Backup of type design files are created when the saving is carried over an existing file. Section files can be exported and red in another drawing and those with net list type are produced through exporting in Pros Spice and ARES. Creating a new design is made by New Order Design. Startup of this command removes all existing design data and displaying a blank standard interfaces A4 size. The created a design can be done in 3 modes. In DOS command line, by ISIS command <design name> or selecting Open Design once the program is on, or double – clicking the file in Windows Explorer.

4.6 Software flowchart

The microcontroller atmega16 was programmed to control the temperature by LM35 sensor and generation two signals first one to the buzzer and second to the LED according to the set point of temperature.

Flowchart for programming of microcontroller shown as:

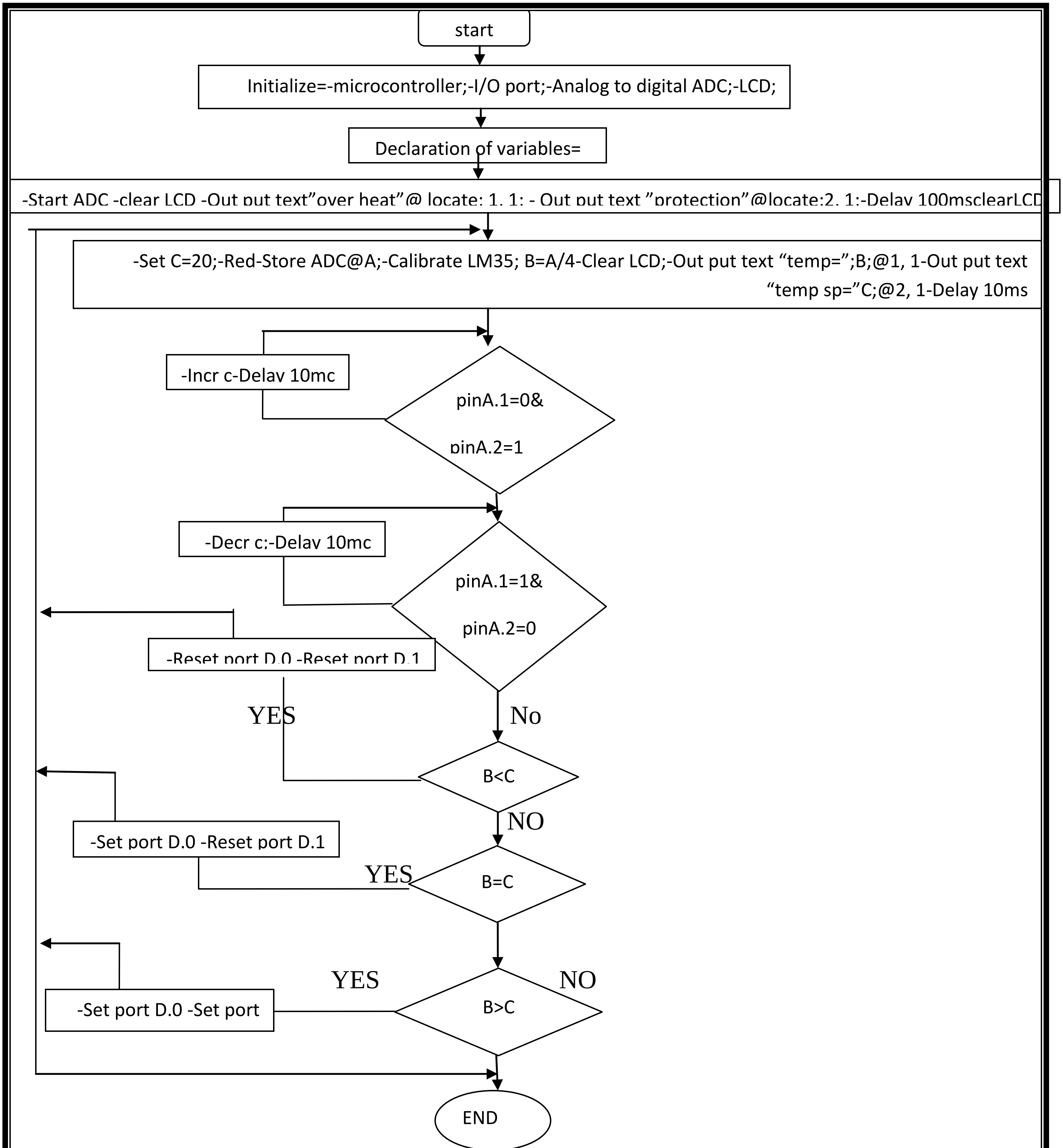


Figure (4.6) Flowchart for Software program

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1-Results

In this system, temperature measurements from the air just to explain how to control of high temperature in vehicles engine. The sensor is specified with accuracy. The accuracy indicates how closely the sensor can measure the actual or real world parameter value. The more accurate a sensor is, better it will perform.

The readings are taken under different conditions for some time interval. Also the readings are taken at different temperatures in a time interval.

5.1.1- Experimental results taken under normal conditions

Table 5.1 shows the readings of sensor at room temperature after time intervals of 5 minutes. The readings of the sensor are compared with the readings of temperatures obtained from the standard temperature indications obtained from the thermometer.

Table 5.1 Results of measurement at room temperature

Time (in minutes)	Standard temperature (°C)	Readings of sensor	Set point reading
8:05	37.9	38	37
8:10	37.9	38	37
8:15	37.9	38	37
8:20	37.9	38	37
8:25	37.9	38	37
8:30	37.9	38	37
8:35	37.9	38	37
8:40	37.9	38	37
8:45	37.9	38	37

5.1.2- Experimental results taken at different temperatures:-

Table 5.3 shows the readings of the sensor at different temperatures in a time of 10 minutes. The readings of the sensor are compared with the readings of temperatures obtained from the standard temperature indications obtained from the thermometer and controlled to the temperature of Control Room of ELrosers Hydro Power Station temperature.

Table 5.3 Results of measurements taken at different temperatures in Control Room of ELrosers Hydro Power Station

Time- (in minutes)	Standard temperature(°C)	Readings of sensor	Set point reading
23:10	30	29	29
23:20	33	33	32
23:30	35	34	33
23:40	29	28	27
23:50	40	40	41
00:00	45	44	43
00:10	20	20	19
00:20	36	36	35
00:30	38	37	36

5.2 Discussions

From the above tables of readings obtained by comparing standard temperature with the temperature of sensor, the accuracy of the sensor is to be discussed. Accuracy is the degree of conformity of a measured/calculated quantity to its actual (true) value that is the quality of nearness to the truth or the true value.

From all the above tables, it is clear that sensor is more close to the standard reading. The error found is .1%.

At different temperatures and under different conditions the sensor measured accuracy temperature and the microcontroller make compeer with the set point and generation two signal according to the program.

CHAPTER SIX

Conclusion and Future Scope

Chapter Six

Conclusion and Future Scope

6.1 Conclusion

The overheat protection is an invaluable tool to collect and analyses experimental data, having the ability to clearly present real time results, with sensor and probes able to respond to parameters that are beyond the normal range available from most traditional equipment overheat protection used for measuring the temperature might have certain limitations in terms of speed, memory and cost.

In this work, an attempt has been done to design overheat protection, which is of less cost, very low power consumption, self contained. It is an efficient overheats protection, which works in real time mode.

A step-by-step approach in designing a Microcontroller based system for

temperature measurement has been followed. According to the study and analysis of various parts of the system, a design has been carried out. The results obtained from the measurement have shown that the system perform well under all the conditions.

From this work, it is concluded that in this system firstly apply to generation just alarm because the microcontroller is disconnection for the electronic control unit (ECU).

6.2 Future Scope

1.) The performance of microcontroller based temperature overheat protection has been found on the expected lines. However, there exists a scope for further improvement in its speed, power consumption, and PC interface software for post data analysis.

2.) The system can be modified with the use of graphical LCD panel so that the analysis is done by the system itself.

3.) The low power requirement of this temperature overheat makes it easy to use. The device can be made to perform better by providing the power supply with the help of battery source which can be rechargeable or non-rechargeable, to reduce the requirement of main AC power.

4.) This system can be connected to communication devices such as modems, cellular phones, or satellite terminal to enable the remote collection of recorded data or alarming of certain parameters. The new system will email information based upon a regular schedule of based upon alarms.

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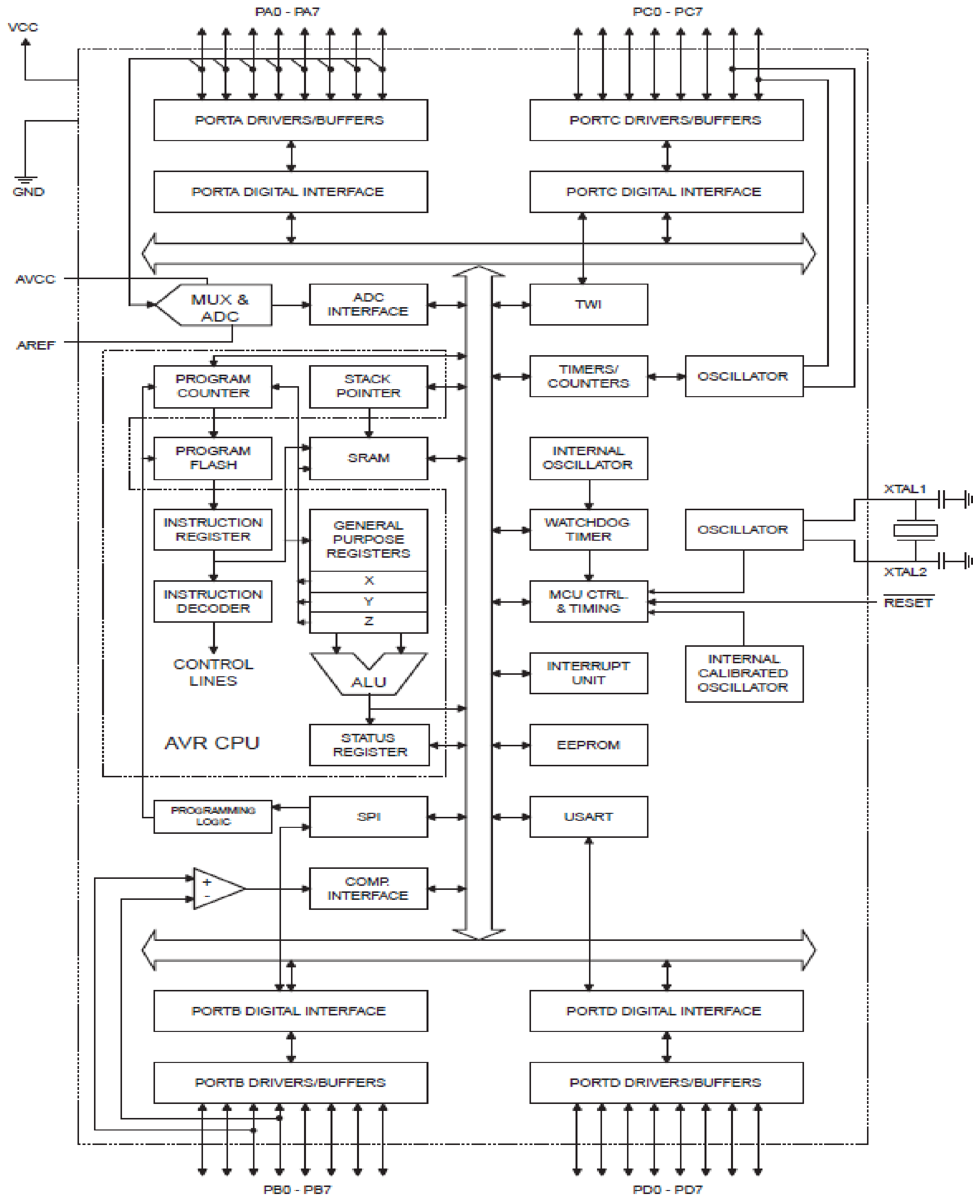
APPENDIX

Block Diagram of microcontroller atmega16



Program code

```
$regfil


e = "m16def.dat"

$crystal = 8000000

Config Lcd = 16 * 2

Config Lcdpin = Pin , Db4 = Portb.4 , Db5 = Portb.5 , Db6 = Portb.6 , Db7 = Portb.7 ,
E = Portb.2 , Rs = Portb.0

Config Adc = Single , Prescaler = Auto , Reference = Internal

Config Portd.0 = Output

Config Portd.1 = Output

Config Pina.1 = Input

Config Pina.2 = Input

Dim A As Word

Dim B As Word

Dim C As Byte

Start Adc

Cls
```

```
Locate 1 , 1

Lcd "overheat"

Locate 2 , 1

Lcd "protection"

Waitms 100

Cls

C = 20

Do

A = Getadc(0)

B = A / 4

Cls

Locate 1 , 1

Lcd "temp= " ; B

Locate 2 , 1

Lcd "temp sp= " ; C

Waitms 10

If Pina.1 = 0 And Pina.2 = 1 Then

Incr C

Waitms 10
```

```
End If
If Pina.1 = 1 And Pina.2 = 0 Then
Decr C
Waitms 10
End If
If B < C Then
Portd.1 = 0
Portd.0 = 0
End If
If B = C Then
Portd.1 = 0
Portd.0 = 1
End If
If B > C Then
Portd.1 = 1
Portd.0 = 1
End If
          Loop
```