Design, Modeling and Application of Microcontroller (MCU) on MAIN ENGINE HIGH TEMP ALARM SYSTEM

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ABSTRACT

In this journal, the simulation of an automatic system for the safety of the main engine is developed. M/E jacket water temperature and M/E L.O temperature sensors are used to automatically stop the engine in case of high temperature. The high values of temperature can cause a severe damage to the engine. An important feature of this automation process is to minimize the human errors by not to relying on humans as operator for machinery, and to improve working and performance of the system . The system in this paper used the microcontroller PIC18F4550 as the central control unit, LM35 as temperature sensors ,liquid crystal display (LCD) as indicator to display the different system working status an addition to some of drivers, relay and light emitting diodes (LED) as indicators to display the corresponding working appliance driver. The implementation and simulation of the system work has been achieved by using proteus ISIS professional software v7.6 and PIC C Compiler for software to write the equivalent program and generate .hex file for system working.

KEY WORDS: *PIC microcontroller,*

NOMENCLATURE

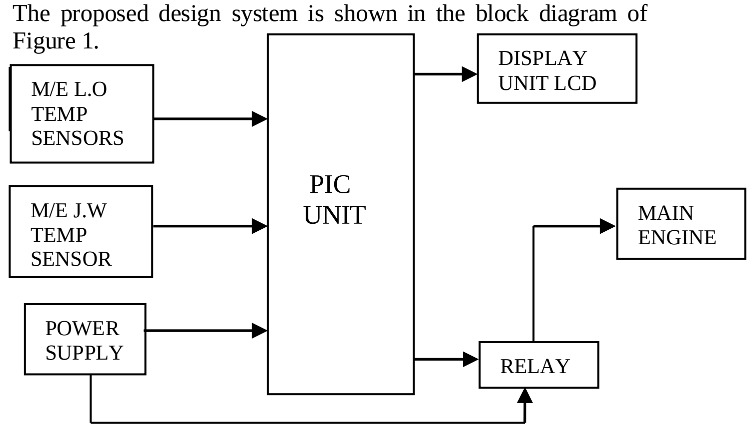
HTP	*HIGH TEMP TRIP*
NT	*NORMAL TEMP*
HTA	*HIGH TEMP ALARM*
LED	*LIGHT EMITTING DIADE*
MCU	*MICRO CONTROLLER UNIT*
UMS	*UN ATTENDED MACHINERY SPACE*

1.0 INTRODUCTION

Microcontroller based temperature measurement in today's world has variety of needs and applications. To meet this wide array of needs the process controls industry has developed a large number of sensors and devices to handle this demand. In this project you will have an opportunity to understand the concepts and use of the LM35 sensor. Temperature is a very critical and widely measured variable for most conditions or a particular covering. M/E of the ship is the most critical machinery on boad . The cost of the M/E is very high, so in order to have a good safety system the M/E jacket water, lub oil, exhaust gas temperatures are maintained with in the normal range.

1.1DESCRIPTION STRATEGY OF THE PROPOSED SYSTEM

The proposed design system is shown in the block diagram of Figure 1.



This design uses a MCU type PIC18F4550 as a heart control unit of the system has built in analog to digital (ADC) convertor which receive the temperature from two temperature sensors integrated circuit (IC) LM35, where it will alert the personal for abnormal temp of the main engine and also generate the signal to stop the main engine. The LM35 sensors are connected to pin

RA0 and RA1 of the (MCU) . The LCD display connected as 4 bit mode, the 4 bit mode means connects data pins, D4 to D7 of LCD to MCU, in this design connect to PORT D of MCU. RB0 from PORT B of MCU selected as a control pins connected to relay in order to work the selected appliance required . RB1 TO RB3 connect to LED's to alert for J.W temp . RB0 TO RB2 from PORT B of MCU selected to alert for M.E L.O temp alarm and trip.

2.0 Working of System

This section explains the working of the complete system. The sensor LM 35 for main engine jacket water is continuously sensing the temperature and giving output to the MCU. When the jacket water temp is below 85 centigrade the main engine is running no alarm is there and green led for normal temp is ON. When temp exceed 85 centigrade the MCU signal to both yellow led to blink and sounder to give alarm. When temperature reaches 90 and above the MCU signals red led to blink, sounder to continue give alarm and main engine to stop.

Similarly for main engine L.O temperature we have LM 35 sensor which is continuously sensing the main engine L.O temperature. When the L.O temp is below 60 centigrade the main engine is running no alarm is there and green led for normal temp is ON. When temp exceed 60 centigrade the MCU signal to both yellow led to blink and sounder to give alarm. When temperature reaches 65 and above the MCU signals red led to blink, sounder to continue give alarm and main engine to stop automatically.

2.1 LM35 Temperature Sensor

The LM35 series are precise integrated-circuit temperature devices with an output voltage directly proportional to the temperature. The LM35 device has an advantage over linear temperature sensors which are calibrated in Kelvin, as the person is not required to detect a large constant voltage from the output to obtain convenient Centigrade scaling . The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾ °Cover a full −55°C to 150°C temperature range. The low-output impedance, linear output and precise inherent calibration of the LM35 device makes interfacing to readout or control circuitry especially easy. The device is used with single power supplies, or with plus and minus supplies. As the LM35 device draws only 60 µA from the supply, it has very low self-heating of less than 0.1°C in still air. The LM35 device is rated to operate over a −55°C to 150°C temperature range.

2.2History of Temperature Measurement

Heat is a measure of the energy in a body or material — the more energy, the hotter the object. But unlike physical properties of mass and length, it's been difficult to measure. Most methods have been indirect, observing the effect that heat has on something and deducing temperature from this. Creating a scale of measurement has been a challenge, too. In 1664, Robert Hooke proposed the freezing point of water be used as a zero point, with temperatures being measured from this. During the 19th century, while investigating the effect of temperature on gas at a constant pressure, they observed that volume rises by the fraction of 1/267 per degree Celsius, (later revised to 1/273.15). This led to the concept of absolute zero at minus 273.15°C. Galileo is reported to have built a device that showed changes in temperature sometime around 1592. This appears to have used the contraction of air in a vessel to draw up a column of water, the height of the column indicating the extent of cooling. However, this was strongly influenced by air pressure and was little more than a novelty. The thermometer as we know it was invented in 1612 by Santorio Santorii. He sealed liquid inside a glass tube, observing how it moved up the tube as it expanded. A scale on the tube made it easier to see changes, but the system lacked precise units. Working with Roemer was Daniel Gabriel Fahrenheit. He began manufacturing thermometers, using both alcohol and mercury as the liquid. Mercury is ideal, as it has a very linear response to temperature change over a large range, but concerns over toxicity have led to reduced use. Other liquids have now been developed to replace it. Liquid thermometers are still widely used, although it is important to control the depth at which the bulb is immersed. The bimetallic temperature sensor was invented late in the 19th century. This takes advantage of the differential expansion of two metal strips bonded together. Temperature changes create bending that can be used to activate a thermostat or a gauge similar to those used in gas grills.

2.3 Operations

The operation concept is described below:

- When liquid reaches Full (F) level in the main tank, all LED F, N, L and LL will be on, the Alarm will be triggered, and Alarm to be at halt.
- When the level is at Normal (N) position, LED N, L & LL will be light up, the Alarm and the Motor will be OFF.
- When the liquid level is sensed by the sensor at the Low level (L) position, only LED L and LL will be ON, the motor will be ON until the level of the main tank reaches Normal (N) position.
- When the liquid level reaches Low Level (LL), only LED LL will be ON, the Alarm will be triggered and the Motor will keep on pumping.
- When the liquid level is low in the reserve tank, the MCU will turn OFF pumping motor. This is to prevent the damage to the motor.

Table 1, shows the logic of the operations.

Table 1: Truth Table

Input(T) °C						Output							
sensor 1			Sensor 2			LED indicators and Buzzer							Eng.
N	H	N.H	N	H	V.H	G1	Y1	R1	G2	Y2	R2	Bz	
1	0	0	1	0	0	1	0	0	1	0	0	0	1
1	0	0	1	1	0	1	0	0	0	1	0	0	1
1	0	0	1	1	1	1	0	0	0	0	1	1	0
1	1	0	1	0	0	0	1	0	1	0	0	0	1
1	1	0	1	1	0	0	1	0	0	1	0	0	1
1	1	0	1	1	1	0	1	0	0	0	1	1	0
1	1	1	1	0	0	0	0	1	1	0	0	0	0
1	1	1	1	1	0	0	0	1	0	1	0	0	0
1	1	1	1	1	1	0	0	1	0	0	1	1	0

3.0 Microcontrollers

PIC18F4550 (Picture 2) belongs to '**PIC18F**' family of microcontrollers. PIC18F4550 is one of popular Microcontrollers from the microchip technology, comes with a High-Performance, Enhanced flash, USB Microcontroller with nano-Watt-Technology. This is an 8-bit microcontroller popular among makers and engineers due its features and easy applications. PIC18F4550 comes in various packages like DIP, QPF and QPN and can be selected according to the project requirement.

It is a 40-pin device as shown in **PIC18F4550 pin diagram** (Picture 3). There are so many features for a controller the manufacturer can3ot provide that many I/O pins. So many pins of controller have multiple features.

Figure 1 : PIC16F4550 Microcontroller

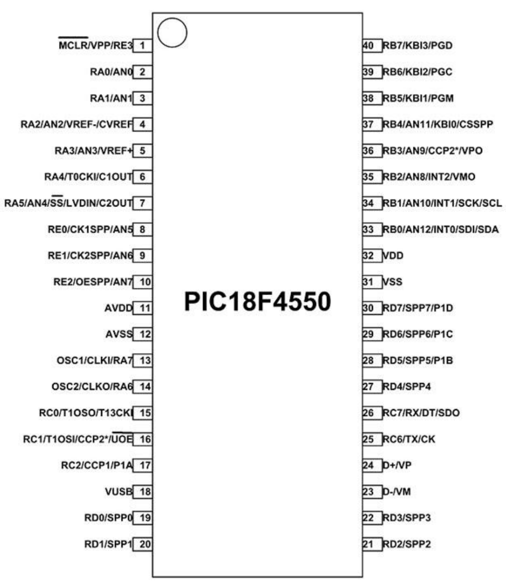


Figure 3 : PIC16F4550 Microcontroller Pin assignment (PDLP)

4.0 System Flow

This system works in sensing the temperature of the Main engine L.O and Jacket water, one sensor will detect the Main engine L.O temperature and other sensor will detect Jacket water temperature. Both send the signal to the Microcontroller Unit. The MCU then will intelligently decide on the next course of action.

When ME LO temperature normal it will keep engine running and give green LED light indication. If the temperature reached 60 °C an Alarm will sound and Yellow signal LED will light up, but engine will keep running and when temperature reached 65°C MCU will stop engine and red LED indicator will light up vice versa.

Also, if Jacket water temperature normal it will keep engine running and give green LED light indication. If the temperature reached 85 °C an Alarm will sound and Yellow signal LED will light up, but engine will keep running and when temperature reached 90°C MCU will stop engine and red LED indicator will light up with alarm sound. And vice versa.

Both Jacket water temperature and Jacket water temperature have separate dedicated indicator and same alarm speaker. (Figure 4).

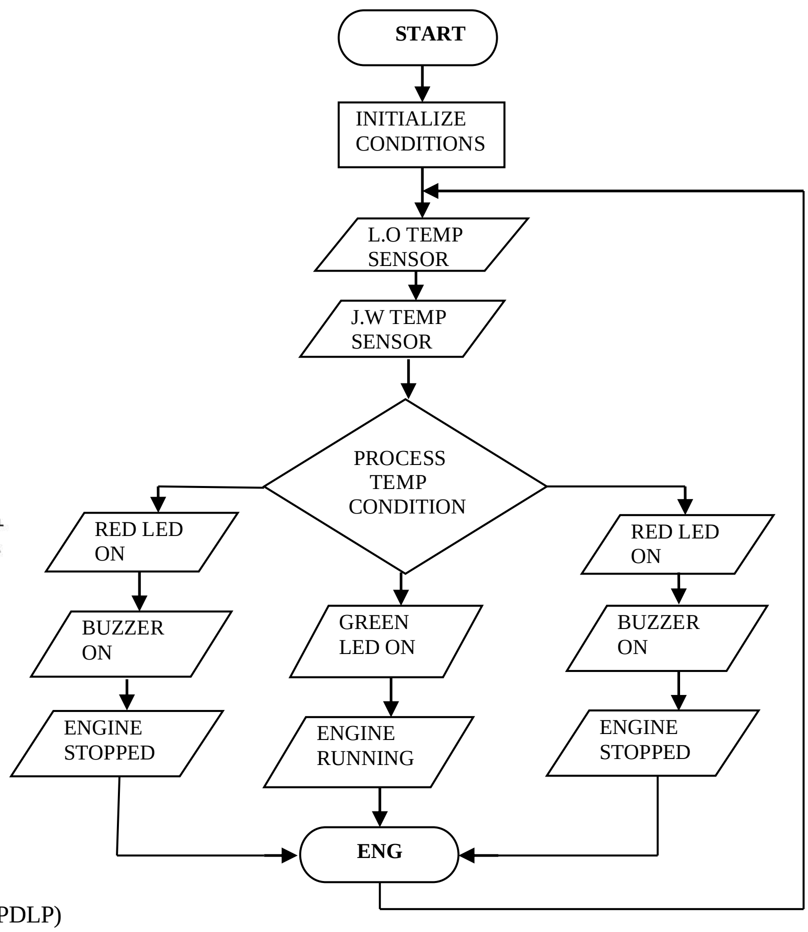


Figure 4: Flowchart of the system

5.0 Circuit

The circuit has four main elements: the power source section and input which comprises sensors, microcontroller segment, display and the output parts. All these modules are integrated to the MCU unit.

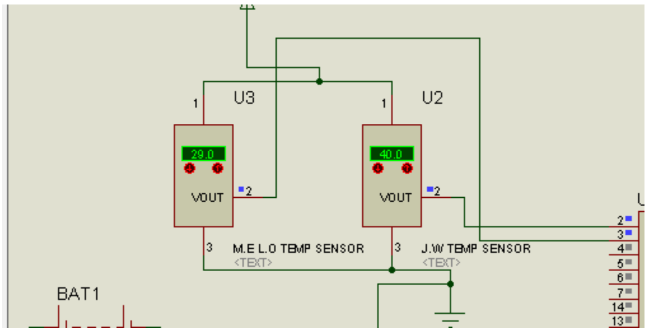


Figure 5: Input (sensors)

As in figure 5, all the 2 input sensors are connected using the Port A.

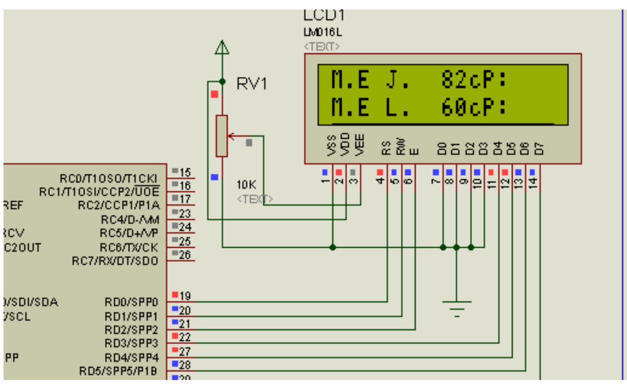


Figure 6: Display

The input of input always displayed in an LCD. So, user can see current temperature all the time.

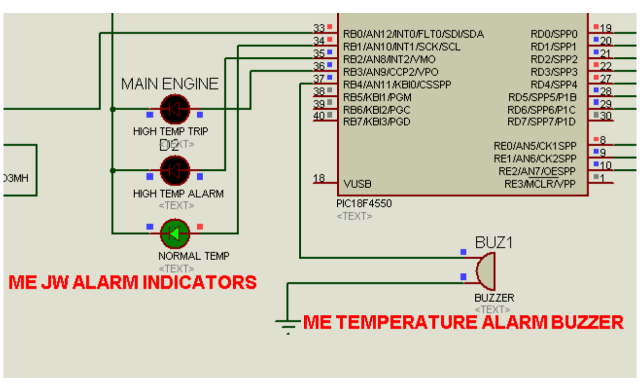


Figure 7: OUTPUT (ME JW indicators and alarm buzzer)

When Jacket water temperature normal it will keep engine running and give green LED light indication. If the temperature reached 85 °C an Alarm will sound and Yellow signal LED will light up, but engine will keep running and when temperature reached 90°C MCU will stop engine and red LED indicator will light up with alarm sound. And vice versa.

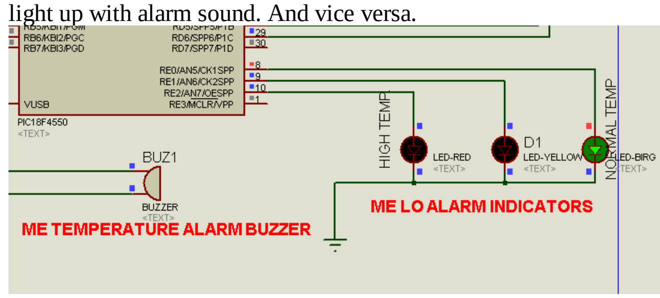


Figure 7: OUTPUT (ME LO indicators and alarm buzzer)

When ME LO temperature normal it will keep engine running and give green LED light indication. If the temperature reached 60 °C an Alarm will sound and Yellow signal LED will light up, but engine will keep running and when temperature reached 65°C MCU will stop engine and red LED indicator will light up vice versa.

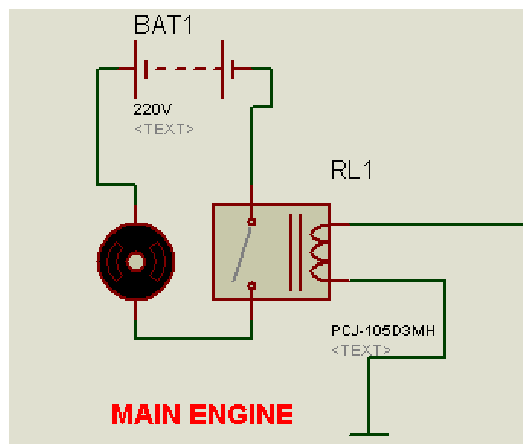


Figure 8: ME Condition indicator

Once the microcontroller detects Main engine L.O and Jacket water temperatures back to normal it will clear alarm and green LED will light up and ME will run back.

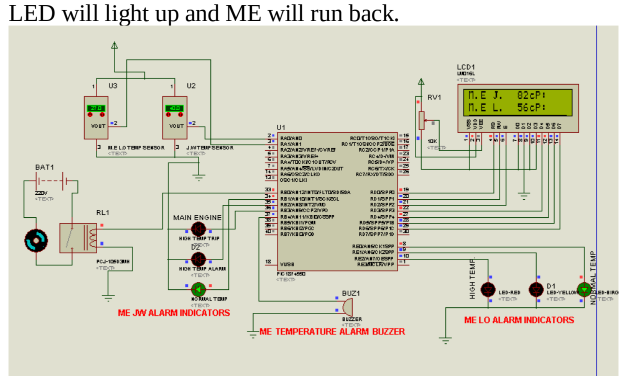


Figure 9: Full system

6.0 CIRCUIT DESIGN SIMULATION

The circuit was then replicated in the software Proteus v7.6. In this software, the entire components of the circuit which is essential were carefully chosen from the software library and the connections were done by lines. The program was later compiled using CCS C compiler. The output, hex file of the program is loaded into PIC microcontroller using the PicKit2. Finally, the simulation is tested for all the conditions. The circuit used for simulation is given in Figure. 9. The connection to the microcontroller separated into 3 parts of circuits. The inputs from the sensors were connected to RA0 till RA1 pins (using Port A) of the microcontroller while the outputs of the system were connected B, C and D ports of the controller.

7.0 CONCLUSION AND IDEA FOR FUTURE

In this paper we proposed an automatic temperature monitoring and safety cutout of main engine by using PIC18F4550 microcontroller. The use of this system will give user value of Main engine L.O and Jacket water temperatures all the time and give alarm before main engine stopped.
The main aim of this work was to design and construct a microcontroller based digital thermometer with. This has been achieved. The device has been tested and is working. This project illustrates the use of embedded systems particularly in instrumentation design and generally in the design of electronic devices. Embedded system design should be encouraged to simplify and provide flexibility for electronic circuits / electronic designs. Those seeking guidance on embedded system design that employ ADC interfacing, specialized LCD interfacing, digital filtering, etc. should avail themselves with this work.
With the aid of advancing technology in the past few years, whereby technology has been aiding the work of man daily. Digital thermometer is an innovation to end the error due to parallax reading in liquid in glass thermometer and also comfort the easy access and accurate reading of temperature.

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