MICROCONTROLLER BASED FIRE OUTBREAK SMOKE AND OVER TEMPERATURE DETECTOR

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Abstract

Loss of lives and properties through fire outbreak caused by electrical appliances has become an issue that attracted attention, most especially when modern electrical appliances are now available at affordable prices, in view of this, electrical equipment require the use of its manual for their adequate use without further problem. Despite this, at times misuse of the electrical appliances happens and it often leads to fire outbreak. Because of the deviation in the proper use of these equipment, what supposed to ease human day to day activities becomes problem as they are the major causes of fire outbreak which subsequently lead to loss of lives, valuable documents and in some cases, properties worth millions of naira. In response to this, several attempts have been made over the years to mitigate the effect of fire outbreak by provision of fire extinguisher at every corner of premises, yet not effective as it requires the experience of an expert to use them. "Microcontroller based fire outbreak smoke and over temperature detector" is designed to prevent fire outbreak remotely. It consists of digital and discrete components such as LM35, MQ-6, transistor, PIC16F877A and which are coupled together in order to achieve the desired performance.

Keywords: *Microcontroller, Crystal oscillator, Buzzer, LCD, Proteus.*

Introduction

Electricity is a basic part of human life, it provides the energy for most of our electrical appliances. Today it is hard to imagine a life without electricity. Yet, using electricity can have dangerous consequences. Electric fire outbreaks sometimes occur, causing injury, claiming lives, and resulting in losses of properties (Tijjani et al., 2014). Increase in the fire outbreak needs urgent attention, thus it is necessary to find a way to curtail it. In an effort to overcome the problem, various researches were carried out on fire and smoke detection. The present work differs from the previous researches in the sense that, the battery as source of dc voltage are replaced using transformer, rectifier, filter capacitor and regulator IC. The thermistor was replaced using LM35 temperature sensor for good temperature sensitivity. The 555timer was replaced using a pic16f877A. In the present research both digital and discrete components are coupled together in order to achieve the desired performance. The use of such reliable components will improve the performance of the system as a whole (Muhammad, Muhammad, Yako & Wawo 2015).

DESIGN AND METHODS

The design of each of the fundamental circuit units is presented below:

POWER SUPPLY UNIT

The following components are required for the power supply design:

- Transformer 12V/500mA
- A full wave bridge rectifier
- A 5V, 7805IC regulator and a filter

TRANSFORMER SELECTION

For the transformer selection, the maximum and minimum values of operating voltage and current are important. The supply from mains considered for this project is 220V-240V at 50 Hz.

To find the power rating of the transformer to be used, the maximum current that will flow in the system at full load was estimated.

The system input resistance is about 20Ω, therefore the expected load current is:

$I = V / R = 12/ 20 = 0.6 = 600 \text{ mA}$

A transformer with the current rating of 700mA which is greater than load current was selected. Thus the power rating of the transformer was estimated to be:

$S = VI = 12 \text{ X } 700 \text{ mA} = 8.4\text{VA}$

A step down transformer of 9VA can be used, due to unavailability of the 8.4VA.

RECTIFIER SELECTION

For selecting a rectifier, the peak inverse voltage PIV is considered. The PIV is the maximum voltage that occurs across the rectifying diode in the reverse direction.

$PIV = 2Vmax$…………………………1

From the transformer the:

$Vrms = 12V$…………………………2

Root mean square voltage from secondary terminal of transformer

$Vmax = Vrmsx\sqrt{2}$…………………………3

Vmax is the maximum voltage that occur at the rectifier

From equation 3, to calculate the maximum voltage

$$Vmax = 12 \times \sqrt{2} = 16.97V$$

$$From\ equation\ 1$$

$$PIV = 2 \times 16.97 = 33.9V$$

The peak value of current that the diode must be able to pass safely with resistance load is Ipeak.

$$Ipeak = {}^{\pi}/_{2} \times Idc$$

Assuming the Idc to be 340m=340x10^{-3}

$$= {}^{\pi}/_{2} \times 0.34 = 0.53A$$

Hence IN4001 was selected 2A/50V from datasheet [2]

FILTER CAPACITOR

For the filter capacitor, using a ripple factor of 4% for high current and voltage

$\alpha = \dfrac{1}{CFRL4\sqrt{3}}$ [2]

To find the value of the capacitor,

F=50Hz

$$Rl = 20\Omega$$

$$C = \frac{1}{4 \times \sqrt{3} \times 0.04 \times 50 \times 20}$$

$$= 361\mu F$$

The voltage across the capacitor is

$$Vc = Vdc - diode\ drop$$

Diode drop =0.7V (silicon material)

For a full wave rectifier the two diode drops=0.7×2=1.4V

Due to during first duty cycle D1 and D3 conduct while D2 and D4 off. Similarly for the second duty cycle D2 and D4 conduct while D1 and D3 off. Therefore the Vdc is:

$$Vdc = {}^{2}/_{\pi} \times Vmax \qquad (3.7)$$

Vdc = $\frac{2}{\pi} \times 16.95$

$$Vdc = 10.8V$$

From above equation

$$Vc = Vdc - diode\ drop$$

$$Vc = 10.8 - 1.4 = 9.4$$

The rating voltage across the capacitor a standard value of 470μF/25V was selected.

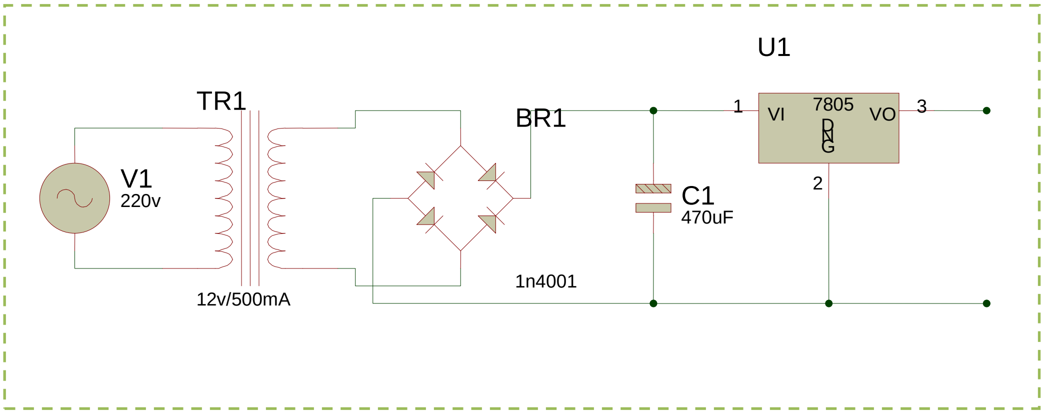

Figure 1: circuit of power supply

SMOKE AND TEMPERATURE SENSOR UNIT

SMOKE SENSING UNIT

This unit serves to continuously monitor the smoke, when the smoke occurs, the MQ6 sense the smoke and automatically control the PIC16F877A.

MQ-6 GAS SENSOR: MQ-6 gas sensor composed by micro AL2O3 ceramic tube, Tin Dioxide (SnO2) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. The heater provides necessary work conditions for work of sensitive components. The enveloped MQ-6 has 6 pins, 4 of them are used to fetch signals, and other 2 are used for providing heating current (Muhammad, Muhammad, Yako & Wawo, 2015).

TEMPERATURE SENSOR

The temperature sensor circuit serves to trigger the PIC16F877A whenever the temperature reaches 60˚C. The design is shown in figure below.

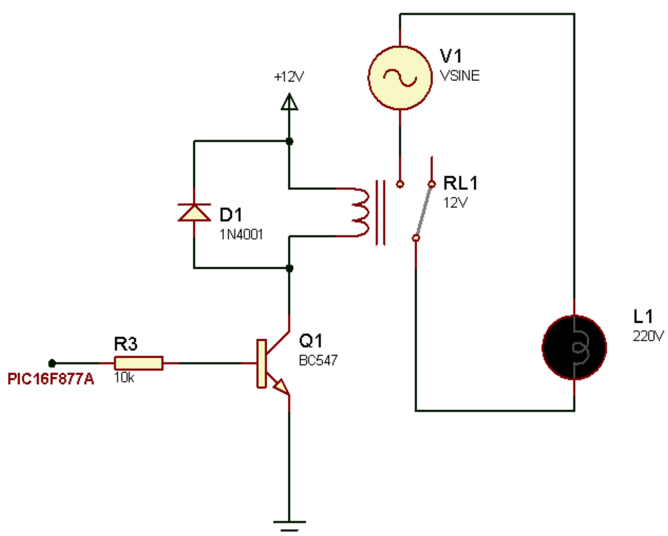

Figure 2: LM 35

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius 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 is rated to operate over a −55° to +150°C temperature range (Green, 2006).

From datasheet, LM35 gives a 10mV/˚C scale, therefore for 60˚C gives 600mV. When the voltage reaches 600mV across the input it sends signal to the microcontroller for detection of the over temperature.

MICROCONTROLLER UNIT

This unit serves as the brain of the entire work. The unit triggers siren when high temperature or smoke is detected. The microcontroller used is PIC16F877A and it serves to perform this operation by developing a program using c-language developed on a mikroc compiled and debugged to machine code.

The flow chart algorithms is shown below:

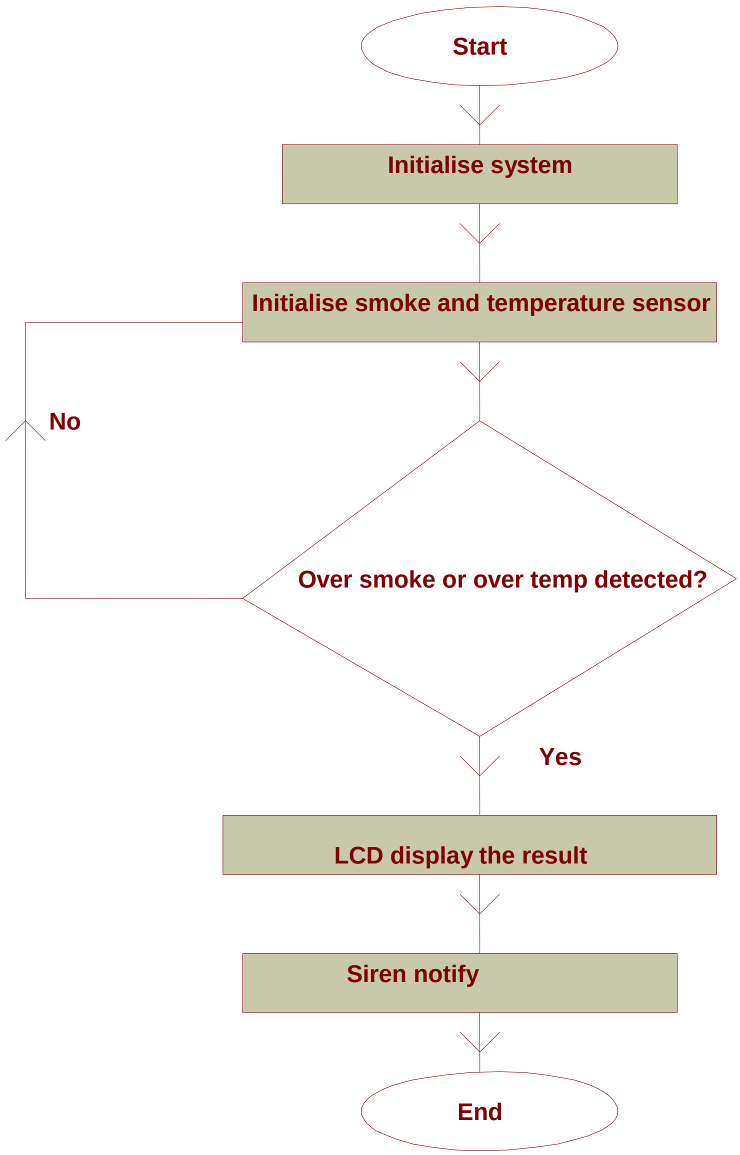

Figure 3: flow chart

PROGRAM DEVELOPMENT

The program consists of several subroutines which were called to execute certain function. The most important subroutines include: the initialization routine, the main program and the delay. The main programs call each subroutine in an order. It initialed the display of the temperature and smoke status. The program was written and was found successful without error.

The necessary circuit of the interface to microcontroller is explained below:

CRYSTAL OSCILLATOR

In applications where great time precision is not necessary, Crystal oscillator offers additional savings during purchase (Forrest, 1988). The standard crystal oscillator gives an accurate frequency and in this work 4MHz crystal was used, and connected to the microcontroller as shown in figure below.

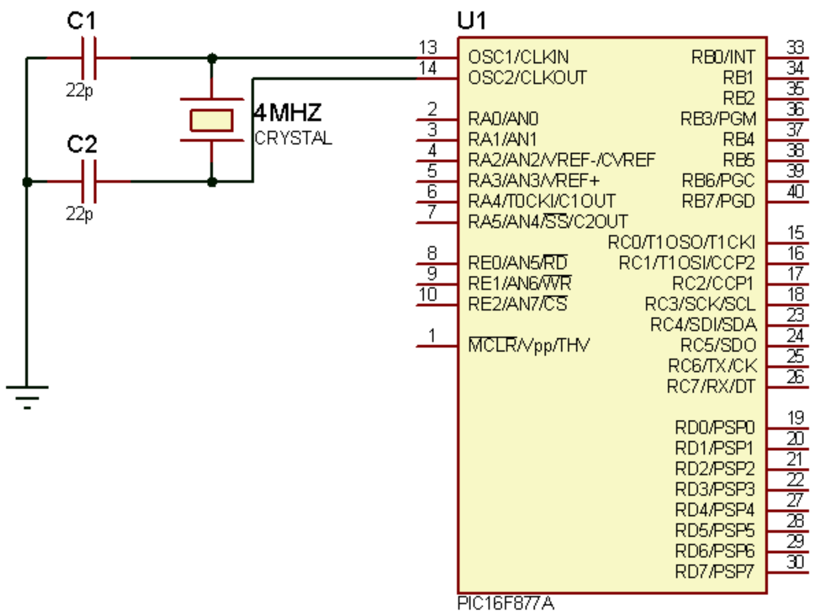

Figure 4: Crystal Oscillator Connection

The above diagram shows how XT oscillator is connected with PIC16F877A. With value of capacitor 22pF, oscillator can become stable, or it can even stop the oscillation. A clock of the oscillator must be divided by 4. Oscillator clock divided by 4 can also be obtained on OSC2/CLKOUT pin, and can be used for testing or synchronizing other logical circuits.

$$The\ time = \frac{1}{4 \times 10^{-6}} \times 4 = 1\mu sec$$

MASTER CLEAR

The master clear (MCLR) is used for putting the microcontroller into a 'known' condition. This practically means that microcontroller can behave rather inaccurately under certain undesirable conditions (Green 2006). In order to continue its proper functioning it has to be reset, meaning all registers would be placed in a starting position. Reset is not only used when microcontroller doesn't behave the way we want it to, but can also be used when trying out a device as an interrupt in program execution, or to get a microcontroller ready when loading a program. So for this case the connection in figure below is utilized.

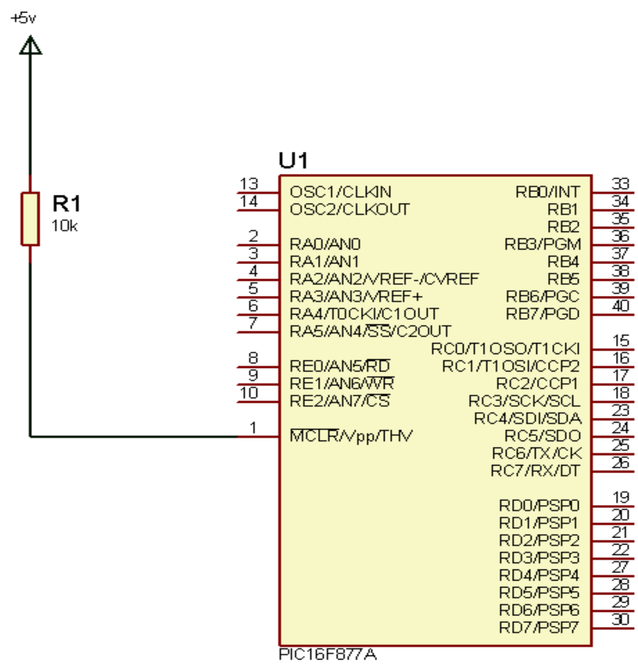

Figure 5: Resetting the PIC16F877A via MCLR

LCD INTERFACE PIC16F877A

Depending on how many lines are used for connecting an LCD to the microcontroller, there are 8-bit and 4-bit LCD modes. The appropriate mode is selected at the beginning of the operation in the process called 'initialization'. The 8-bit LCD mode uses outputs D0- D7 to transfer data

(Ramsay, 1996). Only 4 higher bits (D4-D7) are used for communication, while others may be left unconnected. Each piece of data is sent to the LCD in two steps- four higher bits are sent first (normally through the lines D4-D7), then four lower bits. Initialization enables the LCD to link and interpret received bits correctly.

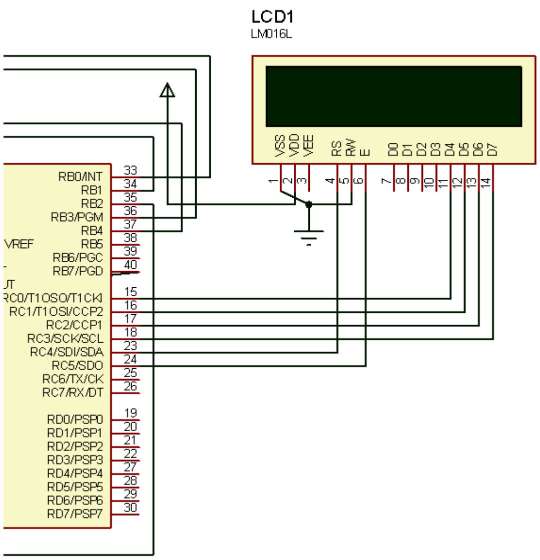

Figure 6: LCD connection

BUZZER SELECTION

The buzzer serves to alert the fire outbreak when the over smoke and the over temperature detected. The magnetic buzzer used in this project has the following features; Low Frequency, Low Voltage, Small and Slim Size. A general purpose medium power BC547 (BJT) transistor was used for switching the buzzer for this project design.

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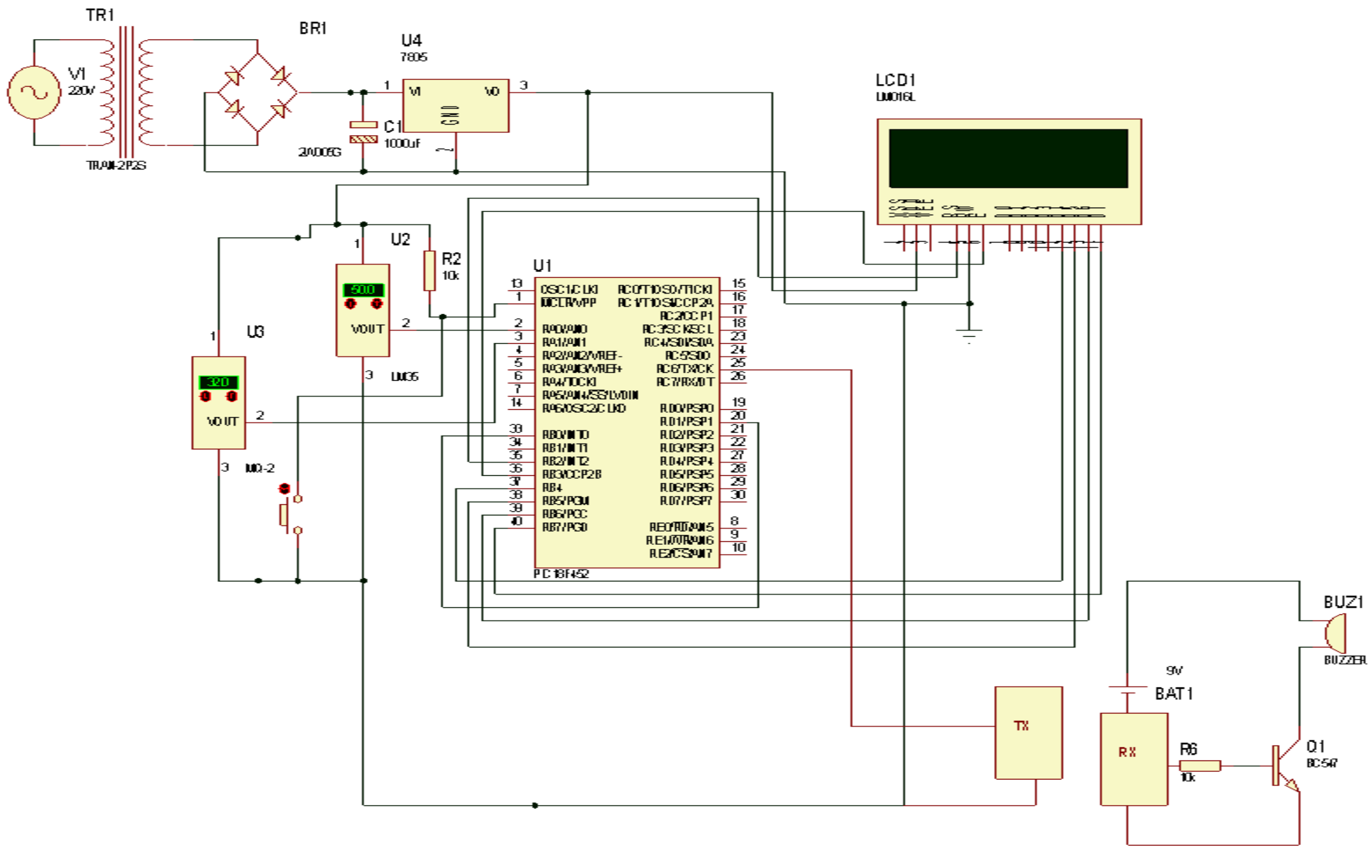
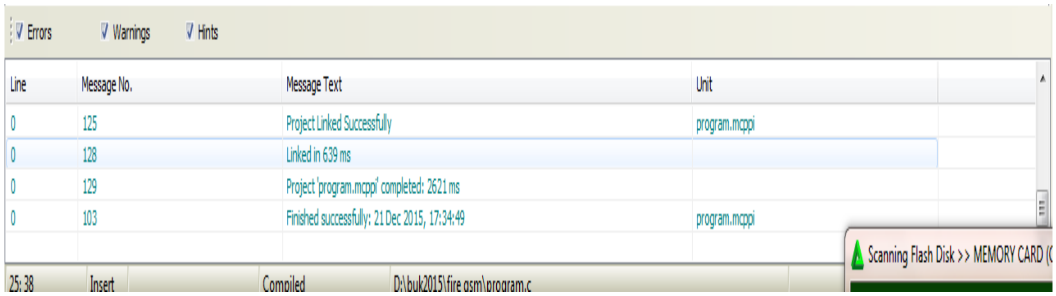


Figure 7: circuit diagram of the work

SIMULATION

The program was developed in the MIKROC integrated development environment and debugged from C- language into machine code (hex- file) and then simulated in the PROTEUS ISS professional and tested. The program was found to be working successfully with only minor errors and mistakes which were corrected.



LOADING AND BURNING THE PROGRAM

The written debugged program (HEX-file) can be burnt into the pic16f877A using a K150 programmer adaptor which interface DIY K150v 150807 software installed in the PC.

RESULT

After the testing system, it was found to be working satisfactorily with no error with very high reliability.

CONCLUSION

This project is designed to alert fire out break by siren and hence will reduce the loss of lives and properties as a result of fire outbreak. The following recommendations are made for the improvement of this work:

i) The fire extinguisher can be attached to the project for emergency assistant.
ii) The loud siren can be used for long distance.

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