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Smoke Detection System By Using PIC Microcontroller

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Abstract

Smoke is detected by the smoke sensor. The smoke sensor produces the analog voltage corresponding to the amount of smoke detected. This analog voltage is sent to PIC microcontroller. Three conditions are defined according to the amount of smoke detected. These conditions are shown by both different coloured light emitting diodes and liquid crystal display simultaneously. The required program is written in Pic BASIC Pro language in MicroCode Studio software. The program is compiled and downloaded into PIC 16F877A microcontroller via GTP USB Lite programmer.

Key words: PIC16F877A microcontroller, Pic Basic Pro language.

Introduction

Smoke sensor is a device that senses smoke, typically as an indicator of fire. Commercial and residential security devices issue a signal to a fire alarm control panel as part of a fire alarm system, while household detectors, known as smoke alarms, generally issue a local audible or visual alarm from the detector itself. The analog smoke/LPG/CO gas sensor (MQ2) module utilizes an MQ-2 as sensitive component and has a protection resistor and an adjustable resistor on board. The MQ-2 gas sensor is sensitive to LPG, i-butane, propane, methane, alcohol, hydrogen and smoke. It could be used in gas leakage detecting equipments in family and industry. The resistance of the sensitive component changes as the concentration of the target gas changes.

PIC Microcontroller

A microcontroller is a single chip computer. Micro means that the device is small, and controller means that the device can be used in control applications.

A microcontroller differs from a microprocessor in many ways. The main difference is that a microprocessor requires several other components for its operation, such as program memory and data memory, I/O devices and external clock circuit. A microcontroller, on the other hand, has all the support chips incorporated inside the same chip. All microcontrollers operate on a set of instructions (or the user program) stored in their memory. A microcontroller fetches the instructions from its program memory one by one, decodes these instructions, and then carries out the required operations.

In the constructed system, PIC16F877A microcontroller is used as the main control device which is manufactured by the Microchip Technology Inc. It is a 40-pin device with 8K bytes of flash program memory. The PIC16F877A has five I/O ports, PORTA, PORTB, PORTC, PORTD and PORTE. Some pins for these I/O ports are multiplexed with an alternate function for the peripheral features on the device. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin.

Some important features of PIC16F877A are it requires only 35 single word instructions for RISC CPU, operating speed of DC-20MHz clock input, 8K x 14 words of flash program memory, wide operating voltage range: 2V to 5.5V, 1000,000 erase/write cycles and 8 channels of analog-to-digital converter.

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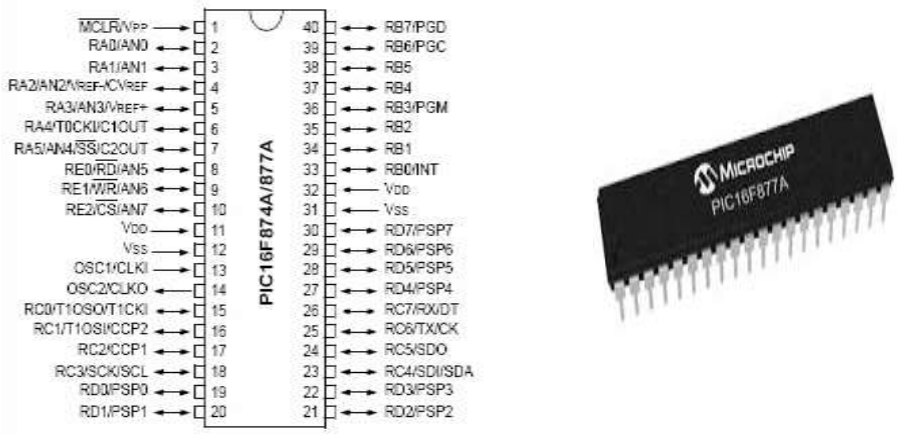

Fig.(1) Pin diagram and photograph of PIC16F877A

Smoke Sensor

Smoke sensor is a device that senses smoke, typically as an indicator of fire. Commercial and residential security devices issue a signal to a fire alarm control panel as part of a fire alarm system, while household detectors, known as smoke alarms, generally issue a local audible or visual alarm from the detector itself. The analog smoke/LPG/CO gas sensor (MQ2) module utilizes an MQ-2 as sensitive component and has a protection resistor and an adjustable resistor on board. The MQ-2 gas sensor is sensitive to liquefied petroleum gas (LPG), i-butane, propane, methane, alcohol, hydrogen and smoke. It could be used in gas leakage detecting equipments in family and industry. The resistance of the sensitive component changes as the concentration of the target gas changes. Fig. (2) shows the photograph of smoke sensor module (MQ-2).

Fig. (2) The photograph of smoke sensor module (MQ-2)

Design and Construction

"Smoke Detection System By Using PIC Microcontroller" is composed of the following section:

(i) Regulated Power Supply unit
(ii) Smoke Sensor Unit
(iii) Microcontroller Control Unit
(iv) Indicator Unit
(v) Display Unit

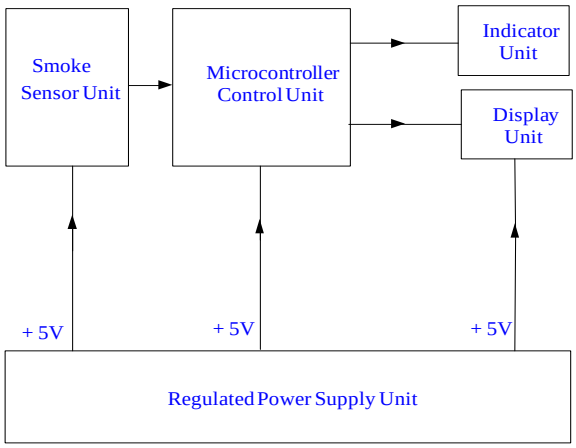

Fig.(3) Block diagram of "Smoke Detection System By Using PIC Microcontroller"

Regulated Power Supply unit

The PIC16F877A microcontroller functions properly at DC +5V. The required DC voltage is taken from voltage regulator (LM7805). The pin 1 (input pin) of LM7805 is connected to positive terminal of DC +9V, 4A battery. The pin 2 (ground pin) of LM7805 and negative terminal of battery are connected to ground. The output voltage of DC +5V is taken from pin 3 (output) of LM7805.

Smoke Detection Unit

This unit is designed to detect the smoke. Pin 1 (+5V) of smoke sensor is connected to DC +5V and pin 4 (GND) is connected to ground. Analog output voltage is taken from pin 3 (AOUT). The amount of analog output voltage depends upon the amount of detect smoke. This pin 3 (AOUT) is connected to pin 2 (AN0) of PIC16F877A microcontroller.

Microcontroller Control Unit

This unit controls the whole operation of the system. PIC16F877A microcontroller is used in this unit. Pin 11 (V_{DD}) and Pin 32 (V_{DD}) are connected to DC +5 V and Pin 12 (V_{SS}) and Pin 31 (V_{SS}) are grounded. A 4 MHz crystal oscillator is fixed at pin 13 (OSC1) and pin 14 (OSC2). Two 22 pF capacitors are connected to the crystal oscillator and ground. Pin 1 ($\overline{MCLR}$) is connected to DC +5 V through 10 kΩ resistor. When RESET SWITCH is pressed, the pin 1 ($\overline{MCLR}$) is grounded and the microcontroller is reset condition. Pin 2 (AN0) is connected to the pin 3 (AOUT) of smoke sensor. Pin 33 (RB0), pin 34 (RB1), pin 35 (RB2), pin 36 (RB3), pin 37 (RB4) and pin 38 (RB5) are connected to Pin 11 (DB4), Pin 12 (DB5), Pin 13 (DB6) and pin 14 (DB7), pin 6 (E) and pin 4 (RS) of liquid crystal display (2004A) respectively. Pin 15 (RC0), Pin 16 (RC1) and Pin 17 (RC2) of PIC16F877A are connected to anodes of GREEN LED, YELLOW LED and RED LED through 100Ω resistor respectively.

Indicator Unit

The indicator unit shows the amount of smoke detected. For a small amount it is classified as LEVEL 1, for a moderate amount it is classified as LEVEL 2 and for a large amount it is classified as LEVEL 3. LEVEL 1 is shown by GREEN LED, LEVEL 2 is shown by YELLOW LED and LEVEL 3 is shown by RED LED. These light emitting diodes are turned on and turned off by PIC16F877A of microcontroller control unit. Each anode pin of GREEN LED, YELLOW LED and RED LED is connected to pin 15 (RC0), pin 16 (RC1) and

pin 17 (RC2) of PIC16F877A microcontroller through 100 Ω resistor respectively. The cathode pins of three light emitting diodes are grounded.

Display Unit

The operating condition of the constructed system is shown by display unit. A 20 characters x 4 lines liquid crystal display (2004A) is used in this unit. Pin 2 (V_{DD}) is connected to DC +5 V. Pin 1 (V_{SS}), pin 5 ($R/\overline{W}$) and pin 16 (K) are grounded. Pin 15 (A) is connected to DC +5 V through 100 Ω resistor. Pin 3 (V_{EE}) is connected to middle pin of 10 kΩ variable resistor. Pin 11 (DB4), pin 12 (DB5), pin 13 (DB6), pin 14 (DB7), pin 6 (E) and pin 4 (RS) are connected to pin 33 (RB0), pin 34 (RB1), pin 35 (RB2), pin 36 (RB3), pin 37 (RB4) and pin 38 (RB5) of PIC16F877A microcontroller respectively.

Results and Discussion

The required program for this work is written in Pic BASIC Pro language. It is compiled and downloaded into PIC16F877A microcontroller. The pin 2 (RA0) is defined as input pin. The pin 33 (RB0), pin 34 (RB1), pin 35 (RB2), pin 36 (RB3), pin 37 (RB4), pin 38 (RB5), pin 15 (RC0), pin 16 (RC1) and pin 17 (RC2) are configured as output pins. The RESET SWITCH is fixed at pin 1 ($\overline{MCLR}$) of PIC16F877A microcontroller.

When the constructed system is powered, smoke sensor detects the smoke and produces analog voltage. The produced analog voltage is dependent on the amount of detected smoke. The microcontroller (PIC16F877A) takes this analog voltage as input signal. The embedded program processes this input signal and then output conditions are shown by light emitting diode and liquid crystal display.

There are three levels in this work. If analog voltage is 0 V to 1.5 V, it is defined as LEVEL1 and GREEN LED is turned on. The first line of liquid crystal display is “SMOKE DETECTION”. The second line is “SYSTEM”. The third line is “LEVEL1”. The fourth line is “NORMAL”. These four lines are displayed. If analog voltage is from 1.6 V to 2.5 V, it is defined as LEVEL2 and YELLOW LED is turned on. The first line of liquid crystal display is “SMOKE DETECTION”. The second line is “SYSTEM”. The third line is “LEVEL2”. The fourth line is “CAREFUL”. These four lines are displayed.

If analog voltage is from 2.6 V to 3 V, it is defined as LEVEL3 and RED LED is turned on. The first line of liquid crystal display is “SMOKE DETECTION”. The second line is “SYSTEM”. The third line is “LEVEL3”. The fourth line is “ALARM ON”. These four lines are displayed.

Conclusion

Smoke detection system is very important in many places such as buildings, offices and factories. In this work, smoke sensor (MQ2) and PIC 16F877A microcontroller are used. It is also suggested to carry out further works by using other smoke sensors and electronic devices.

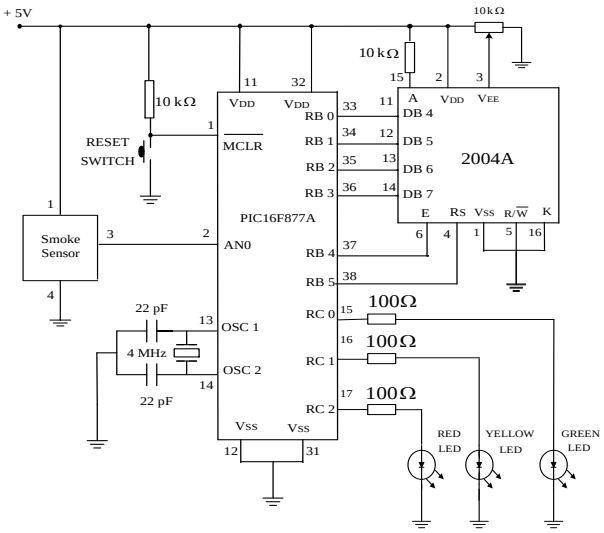

Fig.(4) Circuit diagram of "Smoke Detection System By Using PIC Microcontroller"

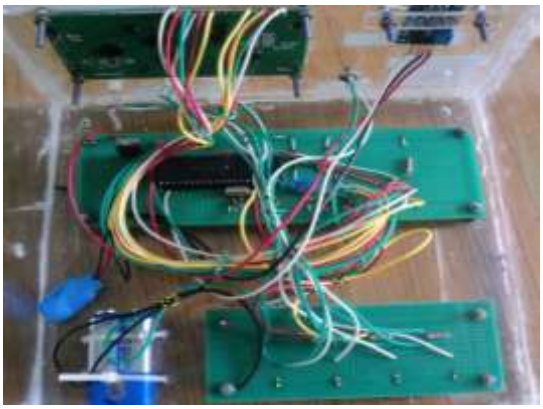

Fig. (5) The photograph of constructed circuit

Fig. (6) The display of operation

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