East West University
Department of Computer Science and Engineering
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Course Code: CSE345
Course Title: Digital Logic Design
Section: 03

Project Title:
Development of a 4-Sensor Fire Alarm Circuit Using Decoder

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Submitted By,

Name	Id No
Riya Akter	2022-3-60-176
Most Rabeya Begum	2022-1-60-367
Mohua Akter	2022-3-60-112

Introduction

The increasing risk of fire hazards in both residential and industrial settings highlights the importance of an efficient fire alarm system. This project focuses on designing and implementing a fire alarm system that activates an alarm if three or more flame sensors detect the presence of fire. The system utilizes a decoder circuit to simplify and optimize the logic behind the detection process. The primary goal of this project is to provide a practical and cost-effective fire alarm system suitable for demonstration and potential real-world application.

This project employs flame sensors to detect fire and a 4-to-16 line decoder to process the inputs. The output from the decoder is connected to an OR gate that triggers an alarm when the necessary conditions are met. The system is designed to be simple yet effective, showcasing how basic digital logic circuits can be integrated with real-world components to solve practical problems.

Objectives

1. To design a fire alarm system using digital logic principles.
2. To demonstrate the use of a decoder in processing inputs from multiple sensors.
3. To develop a system capable of triggering an alarm when a specific threshold of active sensors is reached.
4. To implement and test the system on a breadboard for showcasing its functionality.

Components Used

1. **Flame Sensors**: Detect the presence of fire or flame in the environment.
    - Model: RBD-0149 / RBD-2100
    - Number of sensors: 4
2. **Decoder IC**: 4-to-16 line decoder (e.g., 74HC154 or 74LS154).
3. **OR Gate IC**: Logic IC for combining decoder outputs.
    - Example: 74LS32 (Quad 2-input OR gate).
4. **Alarm/Buzzer**: Produces a sound to indicate fire detection.
    - Example: Piezoelectric buzzer.
5. **Power Supply**: 5V DC power source.
6. **Breadboard**: For circuit assembly.
7. **Solid-Core Wires (22-26 AWG)**: For making connections.
8. **LED Indicators**: Optional, to display sensor activation status.
9. **Resistors**: For current limiting in LEDs and sensors.
10. **Potentiometer**: For adjusting sensor sensitivity (optional).

Working Principle

The flame sensors = 4 inputs
Alarm = Output
Logic – if 3 or more sensors are activated, the alarm will start beeping

Designing the circuit.

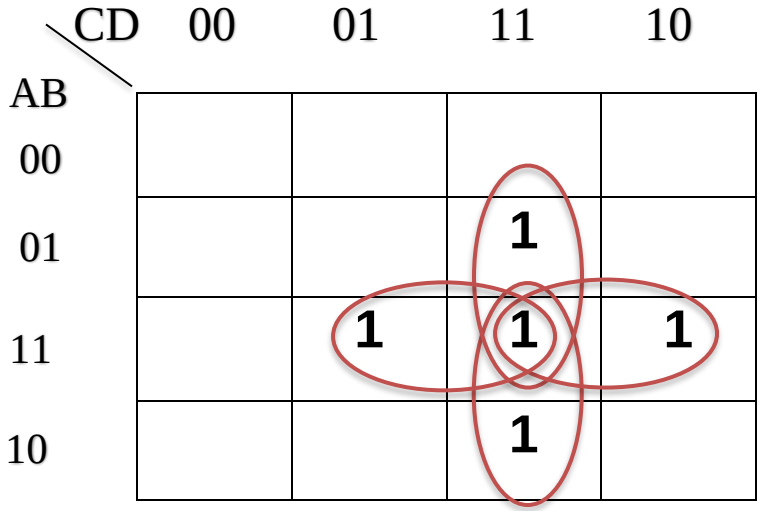
I/O table				
Sensor-1 (A)	Sensor-2 (B)	Sensor-3 (C)	Sensor-4 (D)	alarm (Y)
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	**1**
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	**1**
1	1	0	0	0
1	1	0	1	**1**
1	1	1	0	**1**
1	1	1	1	**1**

We can say, the minterm of the output is

$$Y = \sum(7, 11, 13, 14, 15)$$

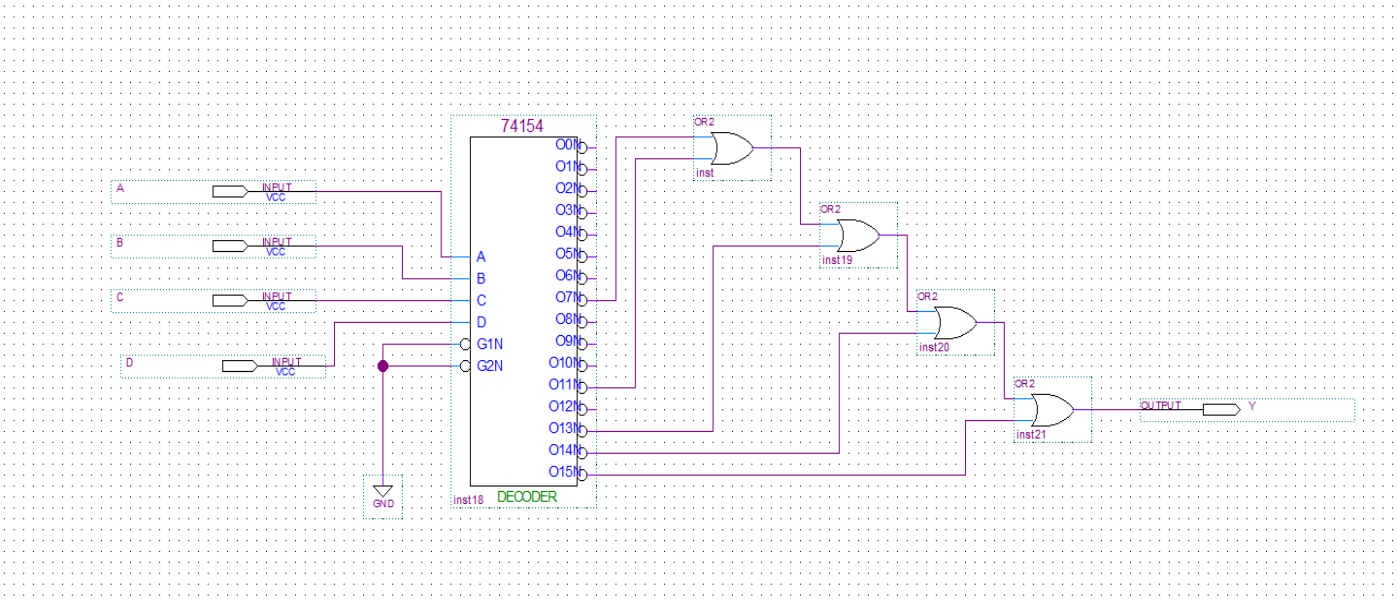
We will be using the minterm value as we are working with a decoder.

k-map:

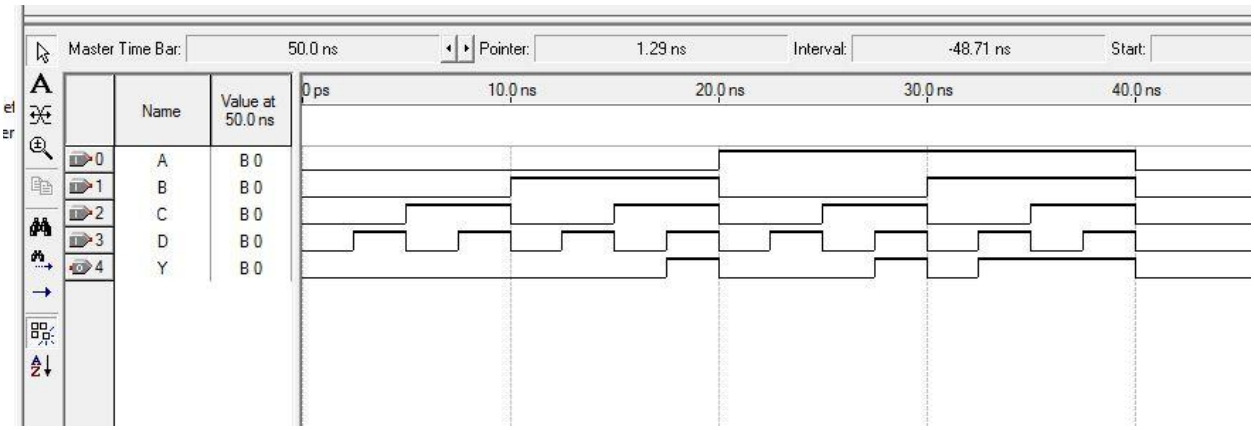


Logical eguation : **ABD + ACD + ABC + BCD**

Logical diagram :



Wave form:

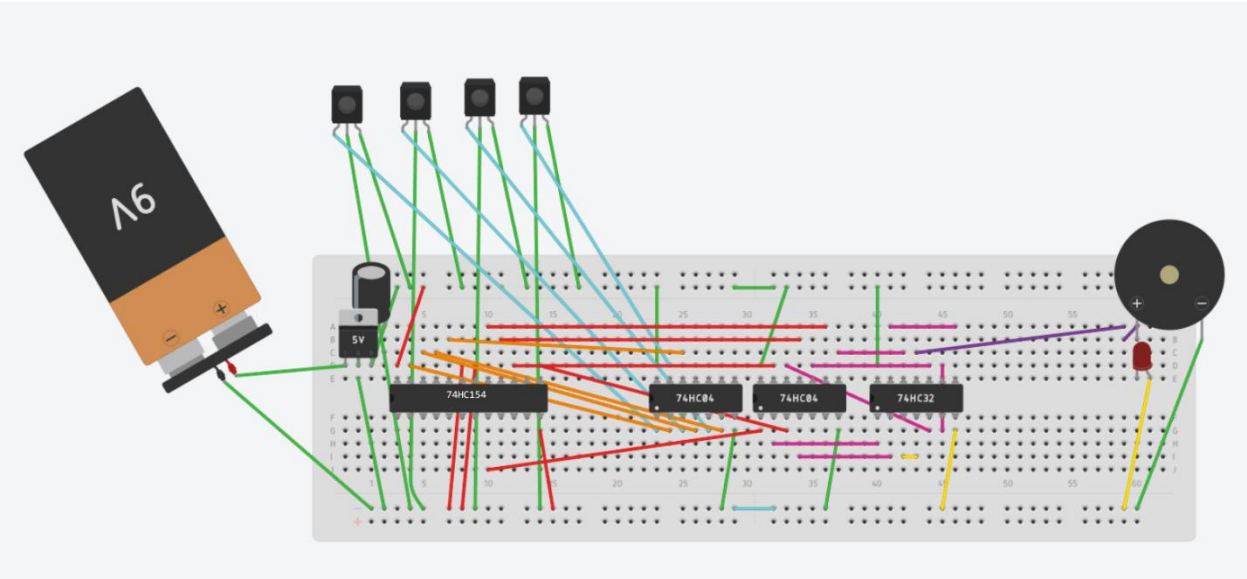


We got our expected outcome!

Results and Observations

1. The fire alarm system successfully activated the alarm when three or more sensors detected a flame. We can say from the wave from.
2. The system demonstrated a high degree of reliability in detecting fire from multiple sources.
3. Adjustments to the sensor sensitivity allowed for better calibration and detection accuracy.

Physical circuit



Key Components and Connections:

- **5V Supply:** We used an LM7805 voltage regulator to step down the 9V battery to 5V.
- **Flame Sensor:** The sensor detects flame radiation and provides a negative output. We used NOT gates (SN7404N) to invert the values and fed them as inputs to the decoder IC.
- **Buzzer and LED:** The final output from the OR gate activates a buzzer and an LED as indicators.

ICs Used:

- Voltage Regulator: LM7805
- 4-to-16 Decoder: CD74HC154E
- NOT Gate IC: SN7404N
- 4-Input OR Gate IC: CD4011BE

Applications

1. Residential fire alarm systems.
2. Industrial safety monitoring.
3. Educational demonstrations of digital logic and sensor integration.

Conclusion

This project successfully demonstrates a cost-effective fire alarm system using flame sensors and a decoder. The system highlights the practical application of digital logic circuits and their integration with real-world components. With further enhancements, this system can be adapted for real-world use in residential and industrial fire safety applications.