

Design and Implementation of a Real-Time Gas Leakage Monitoring System

1. Abstract

This project presents a real-time gas leakage monitoring system based on the VSDsquadron development board. The system detects hazardous gas levels using the MQ-2 sensor and alerts users through buzzers and LEDs. It incorporates a Bluetooth communication interface allowing remote monitoring and semi-automatic reset functionality using terminal commands like 'RESET' and 'STATUS'. The design uses Verilog for digital logic implementation and features modular hardware interfacing, enabling high responsiveness and safety.

2. Introduction

Gas leakage is a critical safety concern in residential, commercial, and industrial environments. Early detection is essential to prevent potential disasters. This project develops a semi-automatic gas detection and alert system using the VSDsquadron board with Verilog HDL. It combines sensor monitoring, real-time control, and Bluetooth-based communication to enhance safety and usability.

3. System Requirements

Hardware:

- VSDsquadron FPGA board
- MQ-2 Gas Sensor
- LED
- Buzzer
- Bluetooth Module (HC-05/06)
- OLED Display (optional)
- Power supply (5V)

Software:

- Verilog HDL
- ModelSim or Vivado
- Bluetooth Terminal App (e.g., Serial Bluetooth Terminal)

4. System Architecture

The system architecture consists of:

- Sensor Interface

- Alert System
- Bluetooth Module
- Control Logic implemented in Verilog

5. Block Diagram

Refer to the image provided in the final submission showing the pin diagram and module connections.

6. Workflow / Flowchart

1. Start system
2. Read MQ-2 sensor output
3. If gas detected: Activate buzzer + LED and wait for command
4. If 'RESET' received: deactivate alert
5. If 'STATUS' received: return status message
6. Loop

7. Verilog Modules

Top-Level Code: FSM handles state transitions based on sensor input and UART commands.

UART Receiver: Receives and buffers Bluetooth serial data.

Command Parser: Matches 'RESET' and 'STATUS' commands.

8. Simulation & Testing

FSM and UART modules simulated successfully. Hardware tested with MQ-2 exposed to gas; Bluetooth commands tested via mobile terminal app.

9. Hardware Integration

Refer to provided pin diagram image.

MQ-2 → PD0

LED → PD1

Buzzer → PD2

Bluetooth RX/TX to FPGA TXD/RXD

10. User Interface (Bluetooth)

Bluetooth Terminal Commands:

- RESET: Clears the alert
- STATUS: Returns current gas status

11. Advantages

- Real-time alerts
- Wireless user control
- Modular Verilog logic
- Applicable for home and industrial safety

12. Future Work

- Add GSM/SMS alerts
- Integrate with cloud/IoT
- Battery backup and emergency actuator

13. Conclusion

This semi-automatic gas leakage monitoring system integrates sensor, logic, and Bluetooth to offer a responsive, user-controllable safety solution. It is scalable, affordable, and adaptable to many real-world safety applications.

Demonstration video link:

<https://drive.google.com/file/d/15TohMpdVrqJylHd69hWlJt-u0qKV4D9s/view?usp=drivesdk>