

Portable Air Quality Monitor

Linton Dsouza 200470698

User Manual

1. Introduction

The **Portable Air Quality Monitor** is a compact and user-friendly device designed to measure and display indoor air quality in real time. The system focuses on detecting several common pollutants (e.g., VOCs, CO₂ equivalents, smoke) as well as measuring ambient temperature and humidity. It uses a buzzer for immediate alerts when air quality becomes unsafe or environmental conditions go out of range, and an LCD to present current readings.

2. Project Tasks and Functions

1. Air Quality Sensing

- An **MQ135 sensor** continuously measures a range of gases, providing an analog signal corresponding to the concentration of CO₂ equivalents, VOCs, and other pollutants.
- The sensor's output is read by the microcontroller's ADC (Analog-to-Digital Converter).

2. Environmental Measurement

- A **DHT22 sensor** checks the ambient temperature and humidity, using a single-wire digital communication protocol.

3. Data Processing

- An **STM32F103** microcontroller (on a Nucleo-64 board) collects and processes the sensor readings. It compares these values to user-defined thresholds.

4. User Alerts

- If the system detects poor air quality (gas levels above threshold) or abnormal temperature/humidity, it triggers the buzzer.
- A 16×2 **LCD** displays the current gas concentration estimate, temperature, and humidity, providing immediate visual feedback.

5. Power and Control

- Powered by the Nucleo's 5 V rail or an external 5 V supply; no separate battery pack is required.
- On startup, the monitor automatically begins reading sensors and displaying data.

3. User Controls and Indicators

3.1 Controls

- **Power Switch / Reset**

- Depending on implementation, may have a dedicated power switch on the Nucleo or a reset button to restart the system.
- **Threshold Adjustment** (Optional)
 - If implemented via a potentiometer or software parameter, this lets the user modify the sensitivity for gas detection.

3.2 Indicators

- **LCD (16×2 Character Display)**
 - Shows real-time air quality data (approximate gas concentration, temperature, humidity).
 - Displays warning messages such as “Poor Air” if thresholds are exceeded.
- **Buzzer**
 - Produces an audible alert tone when gas levels or environmental conditions exceed limits.
 - Can be a steady tone or a beep sequence, as defined in the firmware.

4. Inputs and Outputs

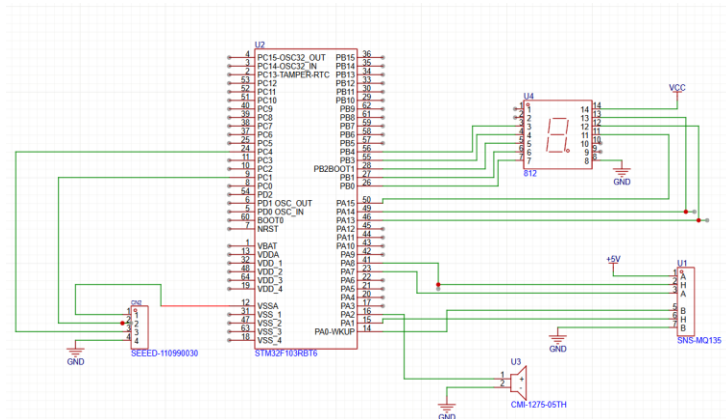
4.1 Inputs

1. **MQ135 Air Quality Sensor**
 - Analog output pin connected to the MCU’s ADC pin (e.g., PA0).
 - Operates at 5 V for its internal heater.
2. **DHT22 Temperature/Humidity Sensor**
 - Single data pin connected to a GPIO (e.g., PA1) with a pull-up resistor.
 - Supplies temperature (in °C) and humidity (in %RH) digitally.

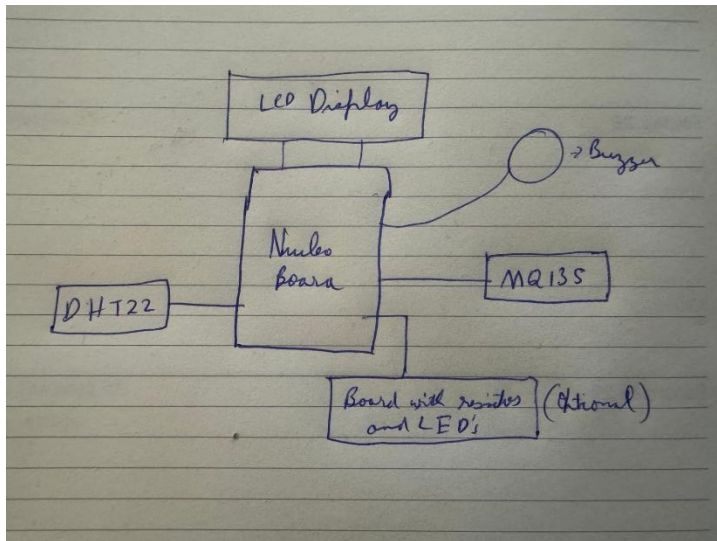
4.2 Outputs

1. **Buzzer**
 - An audible transducer driven by a GPIO pin
 - Alerts the user if thresholds are crossed.
2. **LCD**
 - A 16×2-character display operating typically at 5 V.
 - Receives commands/data via the STM32 in 4-bit mode or as configured in your design.

5. System Block Diagram



6. Physical System Sketch



7. Connection Details

1. STM32 (Nucleo-64)

- **5 V Supply:** Powers MQ135 heater, LCD backlight, and can feed the buzzer.
- **3.3 V Supply:** Feeds the MCU I/O and DHT22 if needed.
- **GND:** Common ground reference.

2. MQ135 Air Quality Sensor

- **VCC** → 5 V
- **GND** → GND

- **AO (Analog Output)** → PA0 (ADC input)
- **DO (Digital Output)** → Not mandatory; can connect to a spare GPIO if you want threshold-based digital readings.

3. DHT22 Sensor

- **VDD** → 3.3 V or 5 V (check your sensor variant)
- **GND** → GND
- **DATA** → PA1 (GPIO) plus a 10 kΩ pull-up resistor to VDD.

4. Buzzer

- **Positive Pin** → PA2 (GPIO or PWM) or a transistor gate if using a driver.
- **Negative Pin** → GND.
- If it's a 5 V buzzer drawing more current, insert a transistor to switch the buzzer from PA2.

5. LCD (16×2)

- **VDD** → 5 V, **VSS** → GND
- **VO (Contrast)** → Potentiometer or resistor network to adjust contrast
- **RS** → PB4, **EN** → PB5, **R/W** → GND (Write-only)
- **D4 to D7** → PB0 to PB3
- **LED+/LED-** (backlight) → 5 V with a series resistor, and GND

Power-Up Sequence

1. Provide 5 V to the Nucleo board (via USB or external supply).
2. The board's regulator also provides 3.3 V to the MCU and DHT22.
3. MQ135's heater needs a few minutes to stabilize (warm-up).
4. LCD initializes to show "Air Quality Monitor" or similar startup message.

8. Operation

1. Startup

- Once powered, the MCU initializes, reading from the DHT22 and MQ135 in a continuous loop.
- The LCD updates every few seconds with fresh sensor data.

2. Alert Behavior

- If sensor values exceed threshold, the buzzer activates.

- Press reset or power down to silence the alert if you're still debugging or in a test environment.

3. Usage

- Place the monitor in an area of interest (e.g., indoor space, lab, etc.).
- If air quality declines, the system warns you immediately, prompting ventilation or other actions.

9. Conclusion

This Portable Air Quality Monitor provides a **simple yet effective** means to track crucial environmental parameters. By continuously measuring gas concentration, temperature, and humidity, it helps maintain safer, more comfortable indoor conditions. The device's modular design allows easy upgrades (e.g., advanced sensors) and can be adapted to a variety of use cases—from home offices to educational labs.