Real Time Environment Monitoring and Air-Quality Sensing

Team Members:

- Hilary Royson CB
- Nitish Kumar J
- Allan Christ B
- Ahash J

Aim

To simulate interfacing on Pico-W with DTH22 and soil moisture sensor using Wokwi, and acquire real-time data through Embedded-C system

Tools/Hardware Required

- Raspberry Pi Pico W
- BME280/DHT22
- Electrochemical Sensor (MQ-7, MQ-8)
- Optical Sensor(PMS5003/PMSA003)
- Metal Oxide Sensor (ENS160, CCS811, BME680)
- Breadboard
- Jumper Wires
- LED Display

Available Components

- Raspberry Pi Pico W
- MQ-135
- OLED Display
- Buzzer
- Small Breadboard
- Jumper Wires

Theory

Raspberry Pi Pico W - It is a low-cost microcontroller board featuring Raspberry Pi's in-house RP2040 chip, adding a 2.4GHz 802.11n wireless interface and Bluetooth 5.2 support to the original Pico design.

BME280 - The BME280 is a small, low-power digital sensor that measures ambient temperature, barometric pressure, and relative humidity, making it suitable for mobile, wearable, and IoT applications like weather stations and indoor navigation systems. It communicates with microcontrollers using either the I2C or SPI digital interface protocols.

DHT22 – The DHT22, also known as the AM2302, is a low-cost, digital sensor that measures both temperature and humidity using a capacitive humidity sensor and a thermistor. It outputs calibrated, serial digital data, requiring only a single digital communication pin for easy interfacing with microcontrollers and microprocessors like Arduino.

MQ-7- MQ-7 is a high-sensitivity Carbon Monoxide (CO) gas sensor module used for detecting CO in the air, featuring a compact design and a 5V operating voltage.

MQ-8 – MQ-8 is the most commonly refers to a type of MQ-8 Hydrogen Gas Sensor, a semiconductor sensor used for detecting and measuring hydrogen gas concentrations in the air.

PMS5003 – The PMS5003 is a low-cost, universal laser-based sensor that uses the principle of light scattering to digitally measure the concentration of suspended particulate matter (PM) in the air. It

works by shining a laser through an air sample and measuring the scattered light to calculate the number of particles of different sizes, including PM1, PM2.5, and PM10.

PMSA003 - PMSA003 is a kind of digital and universal particle concentration sensor, which can be used to obtain the number of suspended particles in the air, i.e. the concentration of particles , and output them in the form of digital interface. This sensor can be inserted into variable instruments related to the concentration of suspended particles in the air or other environmental improvement equipment's to provide correct concentration data in time.

ENS160- The ENS160 is a Scio Sense digital metal oxide (MOX) multi-gas sensor that provides accurate indoor air quality (IAQ) monitoring by detecting Volatile Organic Compounds (VOCs) and providing outputs for Total VOCs (TVOC), CO2-equivalents (eCO_2), and an Air Quality Index (AQI).

CCS811- The CCS811 is an ultra-low-power digital gas sensor that monitors indoor air quality by measuring a wide range of Total Volatile Organic Compounds (TVOCs) and equivalent Carbon Dioxide (eCO2) levels using an integrated metal-oxide (MOX) sensor and microcontroller.

BME680 - The BME680 is a versatile, low-power, digital sensor from Bosch Sensortec that integrates four key environmental sensing functions—barometric pressure, humidity, ambient air temperature, and volatile organic compound (VOC) gas sensing—into a single, compact MEMS package.

Breadboard - A breadboard is a reusable prototyping platform used to build and test electronic circuits without soldering. It consists of rows and columns of conductive strips hidden inside, which connect inserted components and wires. Power rails run along the sides for easy supply connections, while the central area allows ICs, sensors, and modules to be interconnected. In this project, the breadboard holds the Raspberry Pi Pico W, MQ-135, OLED, and buzzer, making the circuit easy to assemble and modify.

Jumper Wires - Jumper wires are small insulated wires with connector ends, used to make quick and temporary electrical connections on a breadboard. They are available in male-to-male, male-to-female, and female-to-female types depending on the requirement. Jumper wires allow flexible connections between components, microcontrollers, and modules during prototyping. In this project, they are used to connect the Pico W, gas sensor, OLED display, and buzzer to the breadboard for proper circuit operation.

MQ-135 - The MQ-135 is an air quality sensor that is well known because of the variety of gases it can detect. Some of the gases include ammonia (NH_3), carbon dioxide (CO_2), nitrogen oxides (NOx), alcohol vapours, benzene, and also smoke. Its operation is based on the change in resistance of the sensing material (tin dioxide, SnO_2) covering it when exposed to different gases. The sensor's voltage output, which varies with the concentration of the gas, can be read by the microcontroller. Its role in this project is to keep track of pollutant levels and provide the data for air quality calculation.

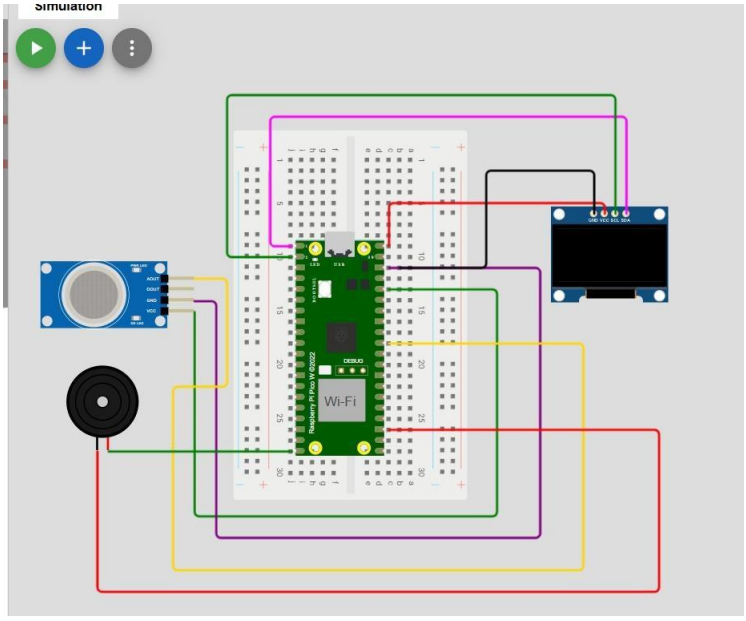
OLED Display - An Organic Light Emitting Diode (OLED) display is a thin and power efficient display technology that provides high visibility and contrast. Modules based on the SSD130 are typically used with microcontrollers and are compatible with the I^2C protocol. They can display text, graphics, and readings from sensors even in dim lighting. For this project, the OLED is used to show real-time sensor values from the MQ-135 and the air quality index (AQI).

Buzzer - An audio signalling device, which is an active or passive type, is called a buzzer. The active type produces sound as soon as power is applied to it, whereas the passive type needs a PWM signal to operate. Such devices are used with safety and monitoring systems to provide alerts. In this project, a buzzer is used to alert the user of poor air quality condition when the MQ-135 detects gas levels above the threshold value.

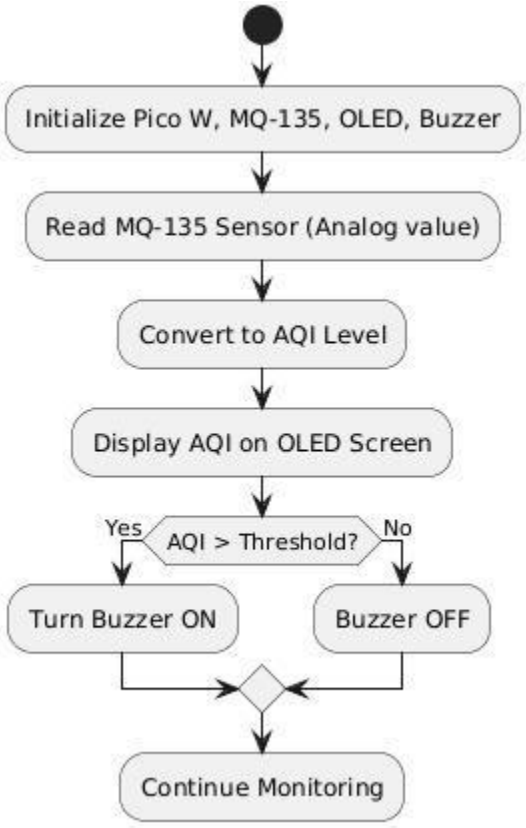
Pin Connections

Component	Raspberry Pi Pico W
MQ-135 VCC	3.3V(Pin 36)
MQ-135 GND	GND(Pin 38)
MQ-135 A0	GP26(Pin 31)
OLED VCC	3.3V(Pin 36)
OLED GND	GND(Pin 38)
OLED SDA	GP4(Pin 6)
OLED SCL	GP5(Pin 7)
Buzzer +	GP15(Pin 21)
Buzzer -	GND(Pin 18)

Circuit Diagram



Flowchart



Code

```
from machine import Pin, ADC, I2C

import ssd1306

import time

# MQ135 on ADC0 (GP26)

mq135 = ADC(Pin(26))

# Buzzer on GP15

buzzer = Pin(15, Pin.OUT)

# I2C for OLED (SDA=GP0, SCL=GP1)

i2c = I2C(0, scl=Pin(1), sda=Pin(0))

oled = ssd1306.SSD1306_I2C(128, 64, i2c)

# Threshold for air quality (adjust after calibration)

THRESHOLD = 300
```

```
def get_ppm(value):
    """
    Convert raw ADC (0–65535) to a simulated PPM scale (0–1000).
    NOTE: For real accuracy, you need MQ135 calibration curves.
    """
    return int((value / 65535) * 1000)
while True:
    raw_value = mq135.read_u16()
    ppm = get_ppm(raw_value)
    # Clear display
    oled.fill(0)
    oled.text("Air Quality", 0, 0)
    oled.text("PPM: {}".format(ppm), 0, 20)
    if ppm > THRESHOLD:
        oled.text("Status: BAD", 0, 40)
        buzzer.value(1)  # Turn buzzer ON
    else:
        oled.text("Status: GOOD", 0, 40)
        buzzer.value(0)  # Turn buzzer OFF
    oled.show()
    print("Raw:", raw_value, " PPM:", ppm)
    time.sleep(1)
```

Execution

1. Connect the MQ135 sensor to Raspberry Pi Pico W:

- VCC → 3.3V (Pin 36)
- GND → GND (Pin 38)
- AO → GP26 (Pin 31, ADC0)

2. Connect the OLED display (SSD1306 I2C):

- VCC → 3.3V (Pin 36)

- GND → GND (Pin 38)

- SDA → GP0 (Pin 1)

- SCL → GP1 (Pin 2)

3. Connect the Buzzer:

- +ve → GP15 (Pin 21)

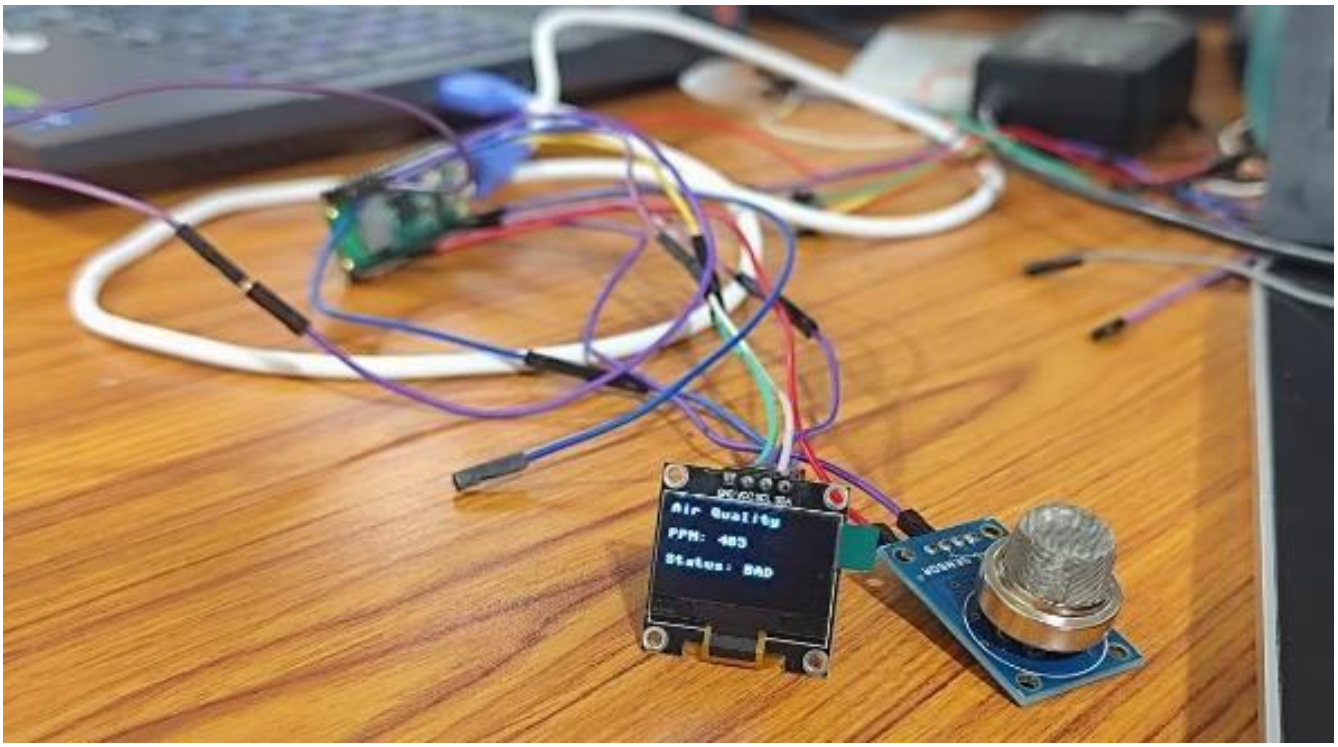
- -ve → GND

4. Upload the above MicroPython code to Raspberry Pi Pico W using Thonny IDE.

5. Run the program and observe the OLED display showing PPM values and status.

6. If air quality is poor (PPM > THRESHOLD), the buzzer will turn ON.

Demonstration


Air Quality
PPM: 485
Status: BAD