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MQ GAS SENSOR SERIES

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Date:7/9/2025

*.introduction:

Gas sensors are essential tools for precise gas monitoring in the fields of safety, industry and laboratories, and depend on the change in electrical resistance when exposed to gases.

◇ I chose MQ sensors for their popularity, low cost, and ease of connection, which makes them suitable for students, researchers, and developers, and helps to understand the design challenges of sensors and their practical application in Intelligent Systems and the Internet of things.

◇ Despite some limitations such as interference and the need for calibration, research continues to develop their performance, increase their reliability and adapt to different environments.

*.MQ Gas Sensor Series:

◇ The MQ series of sensors from Winsen (China) uses SnO_2-based MOS technology to detect gases by converting resistance changes into an electrical signal.

◇ They are inexpensive and easy to use, support integration with Arduino and Raspberry Pi, and are ideal for education and research.

◇ They are used in leak alarms, industrial safety systems, smoke detectors, and IoT projects, covering a wide range of gases with real-time monitoring and rapid alerts.

*.MQ Gas Sensor Series Types:

the MQ gas sensor series offers multiple sensors that are associated with a particular group of gases. Here is a list of all the members present in the MQ sensor family:

Sensor Model	Target Gases
1. MQ-2	Methane, Butane, LPG, and smoke.
2. MQ-3	Alcohol, Ethanol, and Smoke.
3. MQ-4	Methane, CNG.
4. MQ-5	Natural gas, LPG.
5. MQ-6	LPG, Butane gas.

6. MQ-7	Carbon monoxide gas.
7. MQ-8	Hydrogen gas.
8. MQ-9	Carbon monoxide, and flammable gases.
9. MQ-131	Ozone.
10. MQ-135	Carbon monoxide, Benzene, Ammonia, Alcohol, and smoke.
11. MQ-136	Hydrogen Sulfide.
12. MQ-137	Ammonia.
13. MQ-138	Benzene, Toluene, Alcohol, Acetone, Propane, Formaldehyde, and Hydrogen.
14. MQ-214	Methane, Natural gas.

*.Working Principle and Design of MQ Gas Sensors:

- MQ sensors are resistive chemical sensors that use SnO_2 to detect gases through resistance changes when the gases interact with the sensor surface.

1 Internal Design:

The internal design includes a ceramic base, heating coils to maintain a temperature of 200-300°C, a SnO_2 layer, platinum electrodes, and a metal protection mesh.

2 Working Principle:

Principle: In clean air, resistance increases due to oxygen absorption. In the presence of reducing gases, resistance decreases. This change is converted into an electrical signal representing the gas concentration.

*.Gas Sensor Pinout:

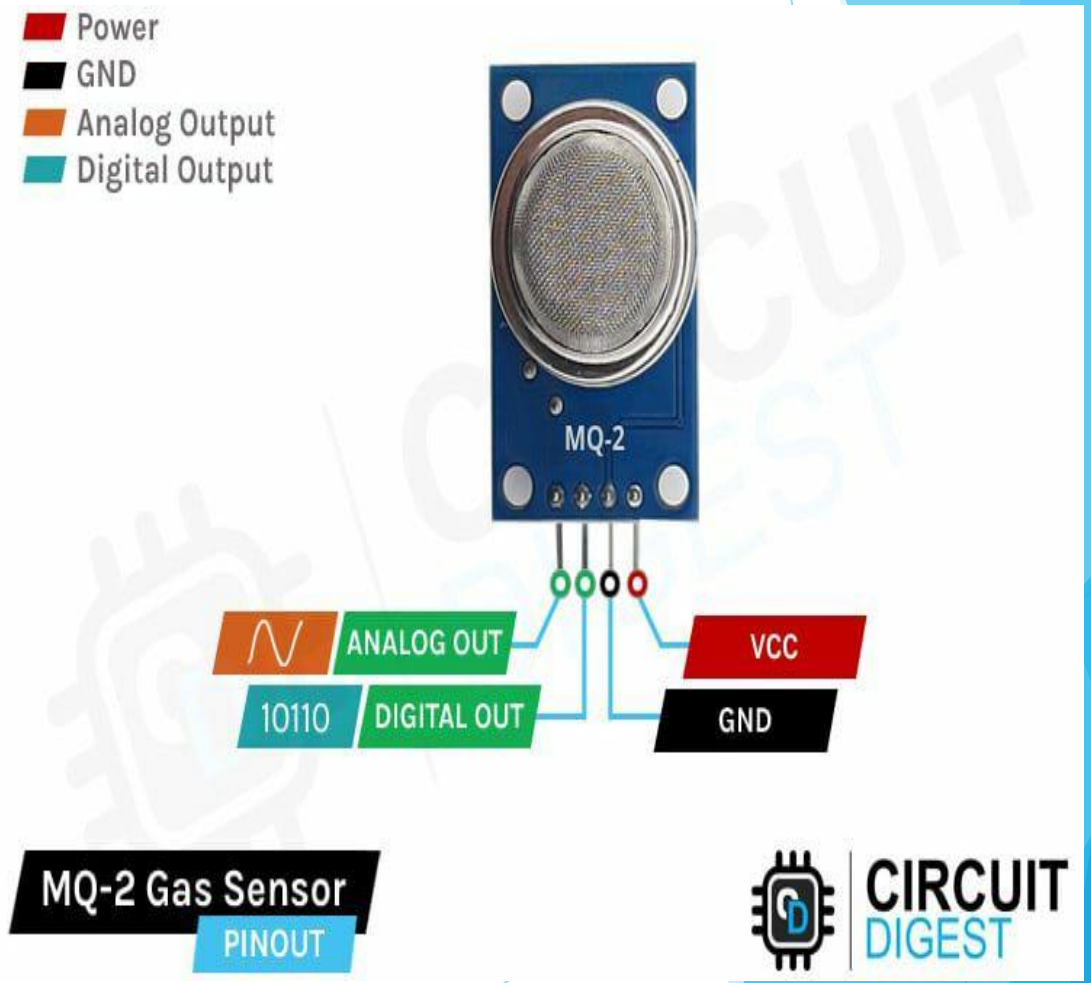
The MQ sensor has four main pins:

VCC : Connects power (5V) to the sensor.

GND :round, which must be connected to the ground of a microcontroller such as an Arduino.

DOUT :Digital signal, which gives a high value when gas or smoke is present and a low value when not present.

AOUT :Analog signal, which reflects the gas concentration in a gradient between VCC and GND, allowing for accurate measurement of gas levels



*.Gas and Smoke Sensor Module – Parts:

◇ The MQ gas and smoke detector sensor is common in Arduino projects for monitoring hazardous and flammable gases, it is characterized by low cost, ease of Use and sensitivity modifiability.

◇ Includes 4 pins: VCC and GND for power, WAOUT and dout for analog and digital signals.

◇ The sensor board contains a power LED, an LED for the signal when the gas reaches the set threshold, an OP-Amp amplifier for converting the analog signal to digital, and a sensitivity rectifier (Trim-pot) with resistors and capacitors for filtering.

Communication Protocols in Smart Systems & IoT

◇ MQ sensors communicate with controllers to enable real-time monitoring and connect data to the cloud via multiple protocols:

UART: direct serial connection with modules such as Wi-Fi and Bluetooth.

SPI / I2C: short-range communication between controllers and peripheral terminals.

Wi-Fi / BLE: send data to the cloud or to mobile devices.

MQTT / HTTP(S): transfer IoT data in light formats such as JSON.

LoRaWAN / NB-IoT: low-power long-distance communications for remote monitoring.

*.Practical applications :

- MQ sensors are used to monitor gases in various environments:

Houses: gas and smoke leak detection (MQ-2).

Factories: monitoring of hazardous gases and emissions.

Vehicles: carbon monoxide detection (MQ-7).

Intelligent air quality systems: monitoring the air in laboratories and buildings via IoT.

*.Limitations & Challenges:-

- MQ sensors face several challenges:

The accuracy was affected by humidity and temperature due to the absorption of water on the sensor surface.

High power consumption and long heating time, especially in MQ-7.

Long-term deviation reduces reliability if not calibrated regularly.

Poor selectivity, they respond to several mixed gases, requiring an array of sensors or advanced algorithms.

*.Conclusion & Future Outlook:

Conclusion:

MQ sensors are low-cost and easy to use for education, air quality monitoring, and household and industrial detection. However, they are affected by humidity and temperature, require warm-up time, exhibit biases, and have limited selectivity.

Future vision:

Integrate humidity and temperature sensors, improve selectivity using AI/ML, develop better sensor materials to reduce bias, and adopt automated calibration systems to ensure higher reliability.

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