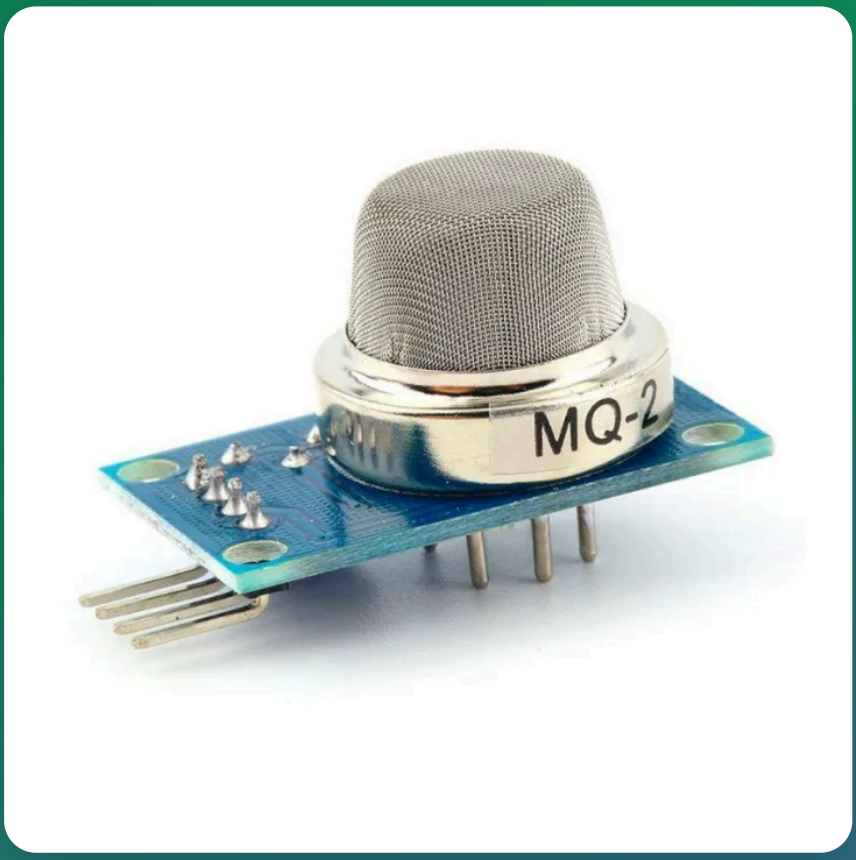
USER MANUAL & ARDUINO GUIDE

MQ-2 Gas Sensor Module

LPG, Smoke, Propane, Butane, Methane & Hydrogen Detector with analog and digital output – specifications, pinout, wiring, Arduino code, calibration and troubleshooting.

MQ-2 / FC-22 | LM393 comparator | 5 V DC | Analog + Digital (TTL) | Arduino · ESP32 · Raspberry Pi



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> **About this manual**
> This guide covers the common blue MQ-2 gas sensor module (FC-22 style board with an LM393 comparator) sold by Biggan Project. Board colour and silkscreen may differ slightly between batches, but the pins and behaviour are the same. Always read the pin labels printed on your own board before wiring.

1 Product overview & applications

The **MQ-2 gas sensor module** is a low-cost sensor board that detects **combustible gases and smoke** in the air, including **LPG, propane, butane, methane, hydrogen, alcohol vapour and smoke**. It is one of the most popular gas sensors for **Arduino**, ESP32, NodeMCU and Raspberry Pi projects, and is often used to build a **DIY gas leak detector** or smoke alarm.

The module gives you two outputs at the same time:

- **Analog output (AO)** – a voltage between about 0 V and 5 V that rises as the gas concentration rises. Use it when you want to see *how much* gas is present.
- **Digital output (DO)** – a simple ON/OFF (TTL) signal that switches when the gas level crosses a threshold you set with the onboard potentiometer. Use it when you only need a *yes/no* alarm.

Key features

- Detects LPG, propane, butane, methane, hydrogen, alcohol & smoke
- Analog and digital outputs on one board
- Adjustable alarm threshold (blue potentiometer)
- Power LED and gas-alarm (status) LED
- Works directly with Arduino Uno, Nano and Mega at 5 V
- Stainless steel double mesh cap for protection

Typical applications

- Kitchen LPG cylinder leak alarm
- Smoke detection in rooms, stores and workshops
- Air quality and gas level monitoring
- IoT gas alerts with ESP32 / NodeMCU (Wi-Fi, SMS, app)
- School science fairs and STEM projects
- Robotics and university lab experiments

2 What is in the package

- 1 × MQ-2 gas sensor module (sensor, LM393 comparator, potentiometer, 2 LEDs, 4-pin male header)

Jumper wires, Arduino board, buzzer and breadboard are not included unless stated on the product page. You can find them in the Biggan Project shop.

3 How the MQ-2 gas sensor works

Inside the metal mesh cap there is a small **ceramic tube** (aluminium oxide) coated with a thin layer of **tin dioxide (SnO_2)**. A tiny nickel-chrome **heater coil** runs through the tube and keeps the coating hot. The sensing element is held on six legs: two legs (marked **H**) feed the heater and four legs (**A** and **B**) carry the signal.

1. **In clean air**, oxygen molecules stick to the hot SnO_2 surface and trap free electrons. Very few electrons can move, so the **resistance of the sensor is high**.
2. **When a combustible gas or smoke arrives**, it reacts with that surface oxygen and releases the trapped electrons back into the tin dioxide. Current flows more easily, so the **resistance drops**.
3. The more gas there is, the lower the resistance. The module turns this resistance change into a **voltage on the AO pin**, so the analog voltage goes **up** as gas concentration goes up.

The double stainless-steel mesh on top is an **anti-explosion (flame-arrester) net**: it stops the hot heater from igniting flammable gas outside the sensor and also keeps dust off the element. That is why the cap feels warm during normal operation.

> **Good to know**
> The MQ-2 reacts to many gases at once and cannot tell you *which* gas it is smelling. It works best when you already know the gas you want to watch (for example LPG in a kitchen) and look for a rise above the normal clean-air level.

4 Technical specifications

Parameter	Value
Sensor model	MQ-2 (module type FC-22 or similar)
Sensor type	Metal-oxide semiconductor (MOS) / chemiresistor, tin dioxide (SnO_2) sensing layer
Detectable gases	LPG, propane, butane, methane, hydrogen, alcohol, carbon monoxide (low sensitivity), smoke
Detection range	About 200 – 10,000 ppm (depends on the gas)
Operating voltage	5 V DC (±0.1 V recommended for stable readings)
Heater resistance	33 Ω ± 5%
Power consumption	Up to about 800 mW (heater current ~150 mA at 5 V)
Sensing resistance (R_s)	10 kΩ – 60 kΩ
Load resistance (datasheet)	20 kΩ recommended
Analog output (AO)	0 – 5 V, higher voltage = more gas
Digital output (DO)	TTL level: LOW when gas is above the threshold, HIGH in clean air
Comparator IC	LM393
Threshold adjustment	Onboard trimmer potentiometer
Indicators	Power LED, digital-output (status) LED
Response time	Under 10 seconds after warm-up
Warm-up (preheat) time	24–48 hours for a new or long-stored sensor; at least 20 s (better 5–10 min) for daily use
Operating temperature	−10 °C to +50 °C
Operating humidity	≤ 95% RH, non-condensing
Connector	4-pin, 2.54 mm pitch male header (VCC, GND, DO, AO)

Power note

The heater draws about 150 mA. Power the module from the Arduino 5 V pin when the Arduino is fed by USB or a good adapter, but do not run it from a small 3.3 V regulator or a weak coin cell. If you use several MQ sensors, give them a separate 5 V supply and connect all grounds together.

5 Module hardware & pinout

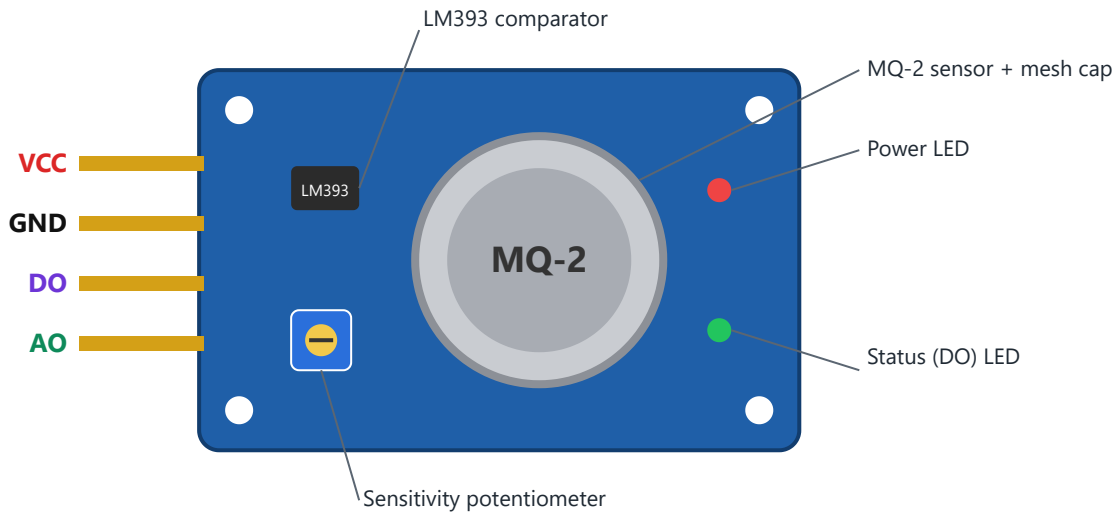

Figure 1 – MQ-2 gas sensor module layout and pinout (LED colours may vary by batch)

Pin	Name	Function
VCC	Power supply	Connect to **+5 V**.
GND	Ground	Connect to the ground (GND) of your microcontroller / power supply.
DO	Digital output	Goes **LOW (0)** when gas is above the threshold set by the potentiometer, **HIGH (1)** otherwise. The status LED lights when DO is LOW.
AO	Analog output	Voltage roughly proportional to gas concentration (≈0 – 5 V). Connect to an analog input such as `A0`.

Onboard parts

- **LM393 comparator** – compares the AO voltage with a reference voltage from the potentiometer and drives the DO pin.
- **Potentiometer** – sets the alarm threshold. Turning it **clockwise** raises the threshold (more gas is needed to trigger, less sensitive). Turning it **counter-clockwise** lowers the threshold (more sensitive).
- **Power LED** – on whenever the module has power.
- **Status LED** – on when gas concentration is above the threshold.

6 Before first use: warm-up (burn-in)

MQ series sensors need their heater to run for some time before readings settle. Readings taken too early will drift and are not reliable.

Situation	Recommended warm-up
Brand-new sensor, or unused for more than a month	**24 – 48 hours** of continuous power in clean air (one-time burn-in)
Sensor used regularly	**5 – 10 minutes** after each power-on for best accuracy
Quick tests / demos	At least **20 seconds** (the example sketches wait this long)

> **Tip**
> For the burn-in, simply plug the module into any 5 V USB phone charger using VCC and GND (no microcontroller needed) and leave it in a well-ventilated room. A slightly warm cap and a faint smell during the first hours are normal.

7 Wiring the MQ-2 to an Arduino

The MQ-2 module runs at 5 V, so it connects directly to an Arduino Uno, Nano or Mega without any extra parts. AO and DO work at the same time, so you can wire both and run either example without rewiring.

MQ-2 pin	Arduino Uno / Nano	Used in
VCC	5V	All examples
GND	GND	All examples
AO	A0	Example 1 (analog)
DO	D8	Example 2 (digital)
Buzzer (+) optional	D7 (buzzer − to GND)	Example 2 alarm

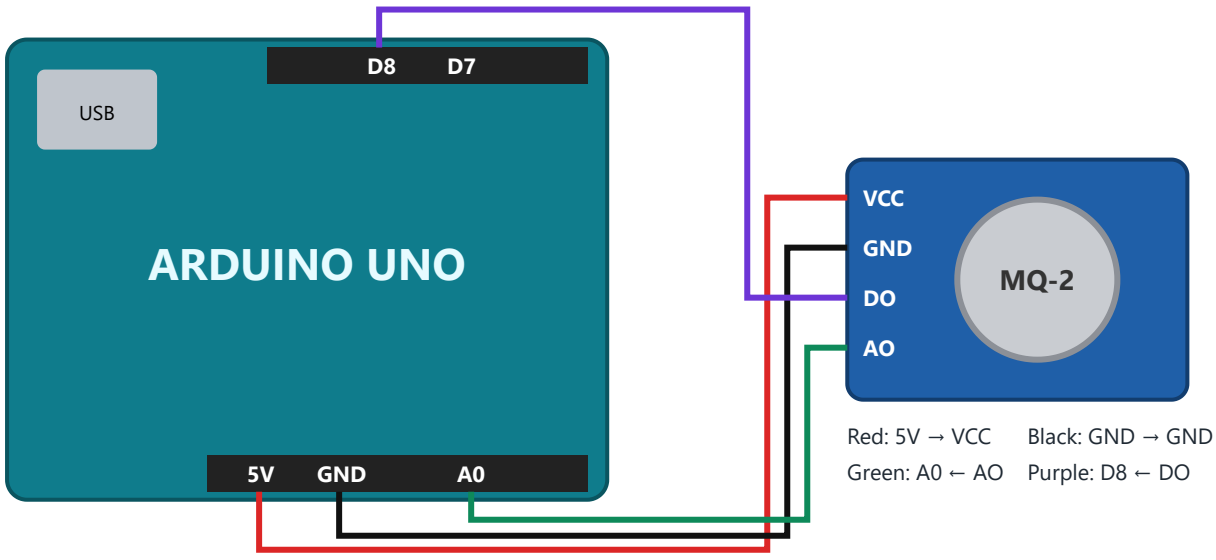

Figure 2 – MQ-2 gas sensor to Arduino Uno wiring (AO → A0 for analog, DO → D8 for digital)

8 Example 1 – Read gas level with the analog output (AO)

This sketch reads the MQ-2 analog output, prints the value to the Serial Monitor and reports when it goes above a threshold. The Arduino's 10-bit ADC gives values from **0** (0 V) to **1023** (5 V).

```
/*  MQ-2 Gas Sensor – Analog Output Example
    Biggan Project – BigganProject.bd
    Wiring: VCC → 5V, GND → GND, AO → A0                */

const int GAS_PIN   = A0;   // MQ-2 AO pin
const int THRESHOLD = 400;  // change to your own value (see below)

void setup() {
  Serial.begin(9600);
  Serial.println("MQ-2 warming up...");
  delay(20000);               // minimum 20 s heater warm-up
  Serial.println("Ready");
}

void loop() {
  int gasValue = analogRead(GAS_PIN);
  float voltage = gasValue * (5.0 / 1023.0);

  Serial.print("Gas value: ");
  Serial.print(gasValue);
  Serial.print("  |  AO voltage: ");
  Serial.print(voltage, 2);
  Serial.print(" V");

  if (gasValue > THRESHOLD) {
    Serial.println("  |  GAS DETECTED!");
  } else {
    Serial.println("  |  Air normal");
  }
  delay(1000);
}
```

How to find your own threshold value

1. Upload the sketch and open **Tools → Serial Monitor** at **9600 baud**.
2. After warm-up, note the value in **clean air** (often around 100–200, but every sensor is different).
3. Bring a gas source near the sensor – for example press the button of an *unlit* gas lighter for a second, or hold a blown-out incense stick nearby for smoke. Note the value it reaches (often 400 or more).
4. Repeat a few times, then set `THRESHOLD` somewhere between the clean-air value and the gas value.

> **Keep flames away**
> Never use an open flame for testing. Only release a tiny amount of gas from an unlit lighter, in a ventilated room, with no fire or sparks nearby.

9 Example 2 – Gas alarm with the digital output (DO)

If you only need to know whether gas is present, use the DO pin. The comparator on the module does the work, and the alarm level is set with the potentiometer – no threshold in the code. This example also sounds a buzzer and lights the Arduino's built-in LED.

```
/*  MQ-2 Gas Sensor – Digital Output Alarm
    Biggan Project – BigganProject.bd
    Wiring: VCC → 5V, GND → GND, DO → D8, Buzzer(+) → D7    */

const int GAS_DO_PIN = 8;    // MQ-2 DO pin
const int BUZZER_PIN = 7;    // active buzzer (optional)
const int LED_PIN    = 13;   // built-in LED

void setup() {
  pinMode(GAS_DO_PIN, INPUT);
  pinMode(BUZZER_PIN, OUTPUT);
  pinMode(LED_PIN, OUTPUT);
  Serial.begin(9600);
  Serial.println("MQ-2 warming up...");
  delay(20000);
}

void loop() {
  int state = digitalRead(GAS_DO_PIN);   // LOW = gas above threshold

  if (state == LOW) {
    Serial.println("DO = 0  ->  GAS DETECTED!");
    digitalWrite(BUZZER_PIN, HIGH);
    digitalWrite(LED_PIN, HIGH);
  } else {
    Serial.println("DO = 1  ->  No gas");
    digitalWrite(BUZZER_PIN, LOW);
    digitalWrite(LED_PIN, LOW);
  }
  delay(500);
}
```

Setting the alarm threshold with the potentiometer

1. Power the module and let it warm up in clean air.
2. Turn the potentiometer **counter-clockwise** slowly until the **status LED turns on**.
3. Now turn it back **clockwise** just until the status LED **turns off**. The alarm is now set slightly above your room's normal level.
4. Test with a small puff of gas from an unlit lighter: the status LED, the buzzer and the Arduino LED should switch on, then off again when the air clears.
5. If it triggers too easily, turn a little more clockwise. If it does not trigger, turn a little counter-clockwise.

No microcontroller needed

Because the comparator is on the board, you can also drive a small buzzer module or a transistor/relay module directly from DO for a simple stand-alone gas alarm. Remember that DO is *active-LOW*.

10 Using the MQ-2 with ESP32, ESP8266 & Raspberry Pi

The heater must always get **5 V**, but ESP32, ESP8266 (NodeMCU) and Raspberry Pi GPIO pins are **3.3 V only**. The AO and DO outputs can reach about 5 V, which may damage these boards.

Board	How to connect
ESP32	VCC → VIN/5V, GND → GND. AO → GPIO34 (or another ADC1 pin) through a **voltage divider** (e.g. 10 kΩ from AO to the pin, 20 kΩ from the pin to GND). ESP32 reads 0–4095. DO → any GPIO through the same divider.
ESP8266 / NodeMCU	VCC → VIN (5 V), GND → GND. The NodeMCU A0 pin accepts up to about 3.3 V; use a divider (10 kΩ / 20 kΩ) between AO and A0.
Raspberry Pi	VCC → 5V (pin 2), GND → GND (pin 6). The Pi has no analog input, so use **DO** through a divider or level shifter to a GPIO, or add an ADC such as ADS1115 / MCP3008 to read AO.

With an ESP32 or NodeMCU you can send gas alerts over Wi-Fi to a phone app, Telegram, Blynk or a web dashboard – a popular IoT project for home LPG safety.

11 Calibration tips & about ppm readings

The MQ-2 module is excellent for detecting a **change** in gas level and for threshold alarms. Turning its output into an exact **ppm (parts per million)** figure needs extra calibration work.

Practical calibration (recommended for most projects)

- Do the 24–48 hour burn-in first.
- Record the clean-air AO value in the place where the sensor will be installed, at normal room temperature.
- Set your alarm (code threshold or potentiometer) a safe margin above that level and test it with a small gas sample.
- Re-check the clean-air value every few months; MQ sensors drift slowly with age.

Estimating ppm (advanced)

The datasheet describes sensitivity as the ratio $\mathbf{R_s/R_0}$, where R_s is the sensor resistance in the test air and R_0 is its resistance in clean air (calibrated once). From the AO voltage you can calculate R_s with the load resistor value on your board ($R_s = R_L \times (5\ V - V_{AO}) / V_{AO}$), then read the ppm for your target gas from the sensitivity curve in the MQ-2 datasheet. Results are only approximate, because temperature, humidity and other gases all affect the reading.

Temperature & humidity

Readings are higher in cold, dry air and lower in warm, humid air. For better stability, keep the sensor away from steam, direct air-conditioner flow and cooking vapour, or compensate with a DHT11/DHT22 temperature & humidity sensor.

12 Troubleshooting

Problem	Likely cause	What to do
Power LED does not light	No 5 V, wrong wiring	Check VCC and GND; measure 5 V across them with a multimeter.
Values keep rising or jumping after power-on	Sensor still warming up	Wait longer; do the 24–48 h burn-in for a new sensor.
Status LED always on	Threshold too low	Turn the potentiometer clockwise until the LED goes off in clean air.
Status LED never turns on	Threshold too high	Turn the potentiometer counter-clockwise; test with a little gas.
Analog value stuck at 0 or 1023	AO wire loose or wrong pin	Confirm AO is on A0 and the code uses `A0`; check the jumper wire.
Arduino resets or is unstable	Heater current too high for the supply	Use a better USB port or 5 V adapter (≥ 500 mA); use a separate supply for several sensors.
Strange readings on ESP32 / NodeMCU	5 V signal on a 3.3 V pin, or no 5 V for heater	Feed VCC from 5 V/VIN; add a voltage divider on AO/DO.
Sensor cap is warm	Normal heater operation	No action needed. Do not touch it during long use.
Slight burning smell when new	Normal burn-in of a new element	Run in a ventilated place; it fades after the first hours.

13 Safety precautions & care

Important: not a certified safety device

The MQ-2 module is an electronic component for learning, prototyping and DIY projects. It is **not** a certified gas or fire alarm and must not be the only protection for life or property. Use approved, certified gas and smoke detectors for home and industrial safety.

- If you smell gas, **do not switch any electrical device on or off**. Close the cylinder valve, open doors and windows and leave the area.

- Test only with very small gas samples from an unlit lighter. **Never** test with an open flame, fire or a large gas release.
- Supply only 5 V DC. Higher voltage can damage the heater; reversed polarity can damage the board.
- The sensor head gets warm. Do not touch it during long operation and keep it away from paper, plastic bags and other flammable materials.
- Avoid water, condensation, silicone vapour, strong corrosive gases (chlorine, sulphur compounds) and heavy dust – they can permanently reduce sensitivity.
- Do not drop the sensor or press on the mesh cap; the ceramic element inside is fragile.
- Store unused sensors in a clean, dry, sealed bag, and burn them in again after long storage.
- Keep the module and small parts out of reach of young children; adult supervision is recommended for school projects.

14 Frequently asked questions

What gases can the MQ-2 gas sensor detect?
LPG, propane, butane, methane (natural gas), hydrogen, alcohol vapour and smoke. It is also slightly sensitive to carbon monoxide, but for CO an MQ-7 sensor is the better choice.

Can the MQ-2 detect an LPG cylinder leak in the kitchen?
Yes. LPG is one of the gases the MQ-2 is most sensitive to, which makes it a popular choice for DIY kitchen gas leak alarms. Mount it low, because LPG is heavier than air, and use it in addition to – not instead of – a certified detector.

What is the difference between the AO and DO pins?
AO gives a variable voltage that shows how much gas there is. DO gives only ON/OFF: it goes LOW when the gas level passes the threshold set by the potentiometer.

Why does the digital output go LOW when gas is detected?
The LM393 comparator output on this module is active-LOW. In your code, treat `LOW` as "gas detected" and `HIGH` as "normal".

How long does the MQ-2 take to warm up?
24–48 hours the very first time (burn-in), then a few minutes each time you power it on. The example sketches wait 20 seconds as a minimum.

Can I use the MQ-2 with a 3.3 V board like ESP32?
Yes, but power the heater from 5 V and reduce the AO/DO signal to 3.3 V with a voltage divider before it reaches the ESP32 pin. See section 10.

Can the MQ-2 show the exact gas concentration in ppm?
Only approximately. With careful R_0 calibration and the datasheet curves you can estimate ppm, but for precise measurement a calibrated gas meter is required.

MQ-2 vs MQ-5 vs MQ-135 – which should I buy?
MQ-2 is a general combustible gas and smoke sensor. MQ-5 is more focused on LPG and natural gas. MQ-135 is used for general air quality (ammonia, CO_2-like gases, benzene). All are available at Biggan Project.

15 Support & where to buy

Thank you for buying the **MQ-2 Gas Sensor Module** from **Biggan Project** – electronics components, sensors, modules and Arduino kits for students, makers and engineers in Bangladesh.

Product page	BigganProject.bd/en/gas-sensor/gas-sensor-mq2
Product reference	BP-0097
More gas sensors	MQ-3, MQ-5, MQ-7, MQ-135 and more at BigganProject.bd
Website	https://BigganProject.bd
Phone / WhatsApp	01612467562
Email	shop@bigganproject.bd
Address	Pins Tower, 69/A, Subhash Bose Avenue, Laxmibazar, Dhaka-1100, Bangladesh

Useful parts for this project

- Arduino Uno / Nano or ESP32 / NodeMCU board
- Male-to-female jumper wires and a breadboard
- 5 V active buzzer module for an audible alarm
- 16×2 LCD or 0.96" OLED display to show the gas level
- Relay module to switch an exhaust fan when gas is detected

Specifications are typical values from the MQ-2 sensor datasheet and may vary between production batches. Example code is provided free for personal and educational use. © 2026 Biggan Project. All rights reserved.