SDM COLLEGE OF ENGINEERING AND TECHNOLOGY, Dharwad-580002

(An autonomous Institution affiliated to Visvesvaraya Technological University, Belgaum – 590018)

Department of Electrical and Electronics Engineering

Minor Project Phase 2 [22UEEL605]

Report entitled

"Wild Animals and Birds detection using AI"

Submitted by

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Academic Year 2024-25

S.D.M. College of Engineering &Technology
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Student of 6th Semester have satisfactorily completed the **Minor Project Phase-2 [22UEEL605]** entitled **"Wild Animals and Birds Detection using AI"** submitted to the **Department of Electrical and Electronics Engineering, SDM College of Engineering and Technology, Dharwad – 580 002**, for the partial fulfillment of the Degree.

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Abstract

The mining industry, a cornerstone of economic growth, poses significant safety challenges due to hazardous working conditions. The "Smart Helmet for Miners" project introduces an innovative safety solution leveraging wearable technology and IoT. This system integrates sensors into helmets to monitor environmental parameters such as gas levels and temperature, ensuring real-time data transmission via Wi-Fi to a central monitoring system. By combining microcontroller-based systems with proactive data analysis, this project aims to improve worker safety, optimize emergency protocols, and foster a culture of safety in mining operations. The proposed solution aligns with modern safety standards and offers scalability for various mining environments.

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Chapter 1 : Introduction

1.1 Background

Mining is a fundamental sector for the economy of every country, as it creates numerous opportunities for employment across a wide range of industries. We are fortunate to acknowledge the various advantages that this industry provides, especially through the processing of valuable materials that contribute to community development and economic growth. However, working in mining presents a unique set of health and safety risks, particularly for those operating in outdoor and challenging environments. These conditions can often be unpleasant and unstable, posing additional hazards for workers. As mining operations progress deeper underground, the risks associated with job tasks tend to escalate, leading to increased concerns regarding the safety and well-being of personnel. It is essential for the industry to implement stringent safety measures and protocols to mitigate these risks, ensuring a safer working environment for all involved. We can maximize the benefits of mining by recognizing and addressing these challenges, while prioritizing the health and safety of workers.

The challenges associated with mining operations can lead to significant safety concerns for workers. To address these issues, we propose the implementation of an advanced mining security system designed around a robust monitoring framework that utilizes microcontroller systems. This system incorporates wearable devices that continuously track the working conditions of personnel throughout the mining site. Each worker is equipped with a helmet that features a built-in monitoring system. These devices communicate data wirelessly via a Wi-Fi network. The proposed system leverages microcontroller-based Wi-Fi enabled circuitry to gather and relay crucial information. This innovative approach not only improves overall safety but also fosters a more secure working environment for all personnel involved in mining operations. Almost any emergency could be addressed with this, including hazardous gas, cave-ins, injuries to individuals, and so on. IoT consequently ensures the safety of mine workers.

The coal mining industry in India is a cornerstone of the nation's economy, playing a critical role in meeting its energy demands. As the primary source of energy, coal fuels around 70% of the country's electricity generation, supporting industries such as steel, cement, and fertilizers. India is the second-largest coal producer globally, with annual production exceeding 700 million tons, primarily driven by vast reserves concentrated in states like Jharkhand, Odisha, and Chhattisgarh. Coal India Limited (CIL), the world’s largest coal producer, dominates the sector, supplying over 80% of domestic coal. India imports some coal, particularly coking coal for steel production. The industry’s significance extends beyond energy, acting as a key driver of industrial growth and infrastructure development.

1.2 Rationale

This project is crucial because mining is inherently dangerous, with workers facing significant health and safety risks due to hazardous conditions. We can minimize accidents and ensure quicker emergency responses, protecting workers' lives by developing a real-time monitoring and tracking system. The use of wearable technology and microcontroller-based systems will provide continuous, accurate data, enabling proactive safety measures and informed decision-making. Additionally, the project addresses a critical need for modernizing safety protocols in mining operations, while taking utmost care about the safety of the workers.

1.3 Problem Statement

The problem is that mining operations expose workers to significant safety risks, including hazardous conditions and slow emergency response times. Current safety measures are inadequate in providing real-time monitoring of workers' locations and health. This project aims to develop a wearable, microcontroller-based tracking system to improve worker safety by enabling real-time monitoring and faster response to potential dangers.

1.4 Objectives

1. Enhance Worker Safety: Develop a robust monitoring system to ensure the safety of workers by enabling quick responses to emergencies.

2. Improve Emergency Response: Establish a reliable communication network that allows for immediate reporting of incidents or hazards like rockfalls and explosions, thereby improving emergency response times and protocols

3. Data Collection and Analysis: Create a system for collecting and analyzing data on environmental conditions to identify potential safety risks and enhance operational efficiency.

Chapter 2 : Literature Review

1. The mining industry is inherently hazardous, with workers facing risks such as cave-ins, falling debris, exposure to harmful gases. To mitigate these risks, smart helmets have been developed as a safety solution for the mining industry. Smart helmets are high-tech safety helmets equipped with sensors. A wearable helmet is exhibited in this study, for the risks in the mining area. This prototype provides real-time monitoring of harmful gasses, temperature. [***Smart Helmet for Improving Safety in Mining. Lochan Bhangale, Sakshi Sonje, Sanyukta Raut, Bhuvaneshwari Jolad Final Year Students, Electronics & Telecommunication Engineering, Dr. D.Y. Patil Institute of Technology, Pimpri, Pune-18. International Journal of Advanced Research in Computer and Communication Engineering ISO 3297:2007 Certified Peer-reviewed / Refereed journal][Vol. 12, Issue 6, June 2023]***

2. Safety has always been a concern for underground miners or construction site workers in general. The growth of the Internet of Things (IoT) and its applications has paved the way to monitor and track the safety of workers in real-time. This paper reports the design and development of an IoT-based smart helmet for real-time monitoring of the health and safety of workers in underground mines. The smart helmet was comprised of an array of ambient sensors, which are wirelessly connected to the control room. The effectiveness and performance of this smart helmet were tested and analyzed. ***[Published in 2022 IEEE 15th Dallas Circuit And System Conference (DCAS) Suwarna Karna; Tanzila Noushin; Shawana Tabassum][17-19 June 2022]***

3. Coal mines are one of the most important industries in the country, as they are used as fuel in the steel and cement industries to extract iron from the stone and create cement. The coal mining industry is known for its hazardous working environment, requiring stringent safety measures to protect miners and prevent accidents. The coal mine safety and monitoring project provides a comprehensive solution to enhance safety within coal mines. The objective of this project is to continuously monitor critical parameters such as temperature, gas concentration to ensure a safe working environment in coal mines. ***[SMART HELMET FOR COAL MINES SAFETY MONITORING AND ALERTING | National Conference GNDEC Bidar | Volume : 10 | Issue : 5 | May 2024]***

4. This research focuses on implementing an Internet of Things (IoT)-based real-time monitoring system designed for underground mining environments. The authors present a system that utilizes wireless sensor networks and microcontrollers to collect and transmit data on environmental hazards such as gas levels and temperature. The study highlights the role of data analytics in predicting potential safety risks, allowing for preventive measures to be taken before dangerous conditions arise. This paper aligns well with the objectives of the current project ***[A. Singh, P. N. Sharma, and R. K. Gupta, "IoT-Based Real-Time Monitoring and Safety System for Underground Mines," Published in IEEE 2019]***

Chapter 3 : Methodology

This project follows an applied research approach, focusing on practical solutions to enhance safety in mining operations. The unit of study will center on individual mining workers and their environmental factors that pose risks. A combination of quantitative methods will be used, including real-time data collection through microcontroller-based systems, and qualitative methods, such as worker feedback and field observations, to assess the system's effectiveness. The methodology will begin with the design and development of wearable devices integrated with helmets, equipped with sensors to monitors the mining environment. These devices will communicate through a Wi-Fi network, relaying real-time data to a central system. Following the design phase, the project will move to the implementation and testing stage, where the system will be deployed in a controlled environment to monitor its reliability and accuracy. Data collection tools will include sensor data logs and health monitoring outputs from the wearables. This data will be analyzed using data analysis tools such as statistical software to measure worker movements, safety compliance, and the system's ability to detect hazards. The next step will be a comprehensive evaluation, comparing collected data with predefined safety benchmarks to assess the system's performance in improving worker safety. Based on the analysis, adjustments and refinements will be made to enhance system functionality. The project will culminate with a final deployment and real-world validation in an operational mining site, ensuring that the system not only meets safety requirements but also aligns with user needs.

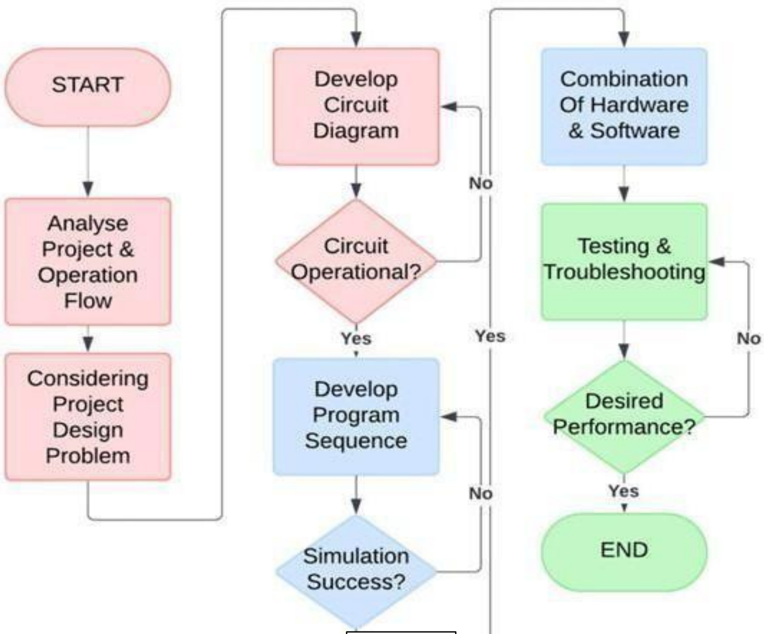


Fig.1

3.1 Hardware and Software Requirements

Hardware

1. ESP32 Microcontroller
2. MQ2 - Methane and Butane Sensor
3. DHT11 – Temperature Sensor
4. MQ7 - Carbon Monoxide Sensor
5. Power Regulator
6. Batteries
7. Breadboards & PCB
8. Cables & Connectors

Software

1. Arduino IDE
2. Blynk IoT Manager

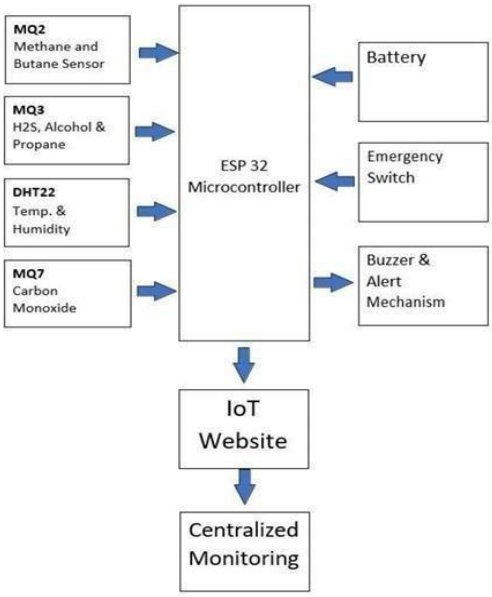


fig.2

3.2 Sensors

1. MQ-7 Sensor

The MQ-7 gas sensor is designed to detect carbon monoxide (CO) levels in the air. Its working principle is based on the change in electrical resistance of the sensor material in response to the presence of gas.

Key Components and Working Principle:

1. Sensor Element: The MQ-7 consists of a sensitive material, typically tin dioxide (SnO2), which has a low electrical conductivity in clean air.

2. Heating Element: The sensor contains a built-in heater that raises the temperature of the sensitive material, enabling it to react with target gases.

3. Gas Interaction: When carbon monoxide is present, it reacts with the tin dioxide surface. This interaction changes the surface properties of the material, affecting its conductivity.

4. Resistance Change: As CO gas is absorbed by the sensor, the resistance of the material decreases. The greater the concentration of CO, the more is the decrease in resistance.

5. Output Signal: The change in resistance can be measured as an output voltage, which can be correlated to the concentration of CO in the air.

2. MQ-2 Sensor

The MQ-2 gas sensor is designed to detect various gases, including propane, butane, methane, alcohol, and smoke. Its working principle is similar to that of other MQ sensors and relies on the change in electrical resistance of the sensor material in response to the presence of target gases.

Key Components and Working Principle:

1. Sensor Element: The MQ-2 sensor consists of a sensitive material, typically tin dioxide (SnO_2), which has low electrical conductivity in clean air.

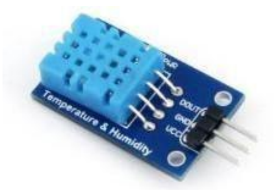
2. Heating Element: The sensor has a built-in heater that warms the sensitive material, enhancing its ability to interact with target gases.

3. Gas Interaction: When gases such as propane, butane, or methane are present, they react with the tin dioxide surface. This reaction causes a change in the surface properties of the material.

4. Resistance Change: The interaction with target gases decreases the resistance of the sensor. The more gas present, the greater the decrease in resistance.

5. Output Signal: The change in resistance can be measured as an output voltage. This voltage can then be correlated to the concentration of the. specific gas present

3. DHT11 Sensor



Key Components and Working Principle:

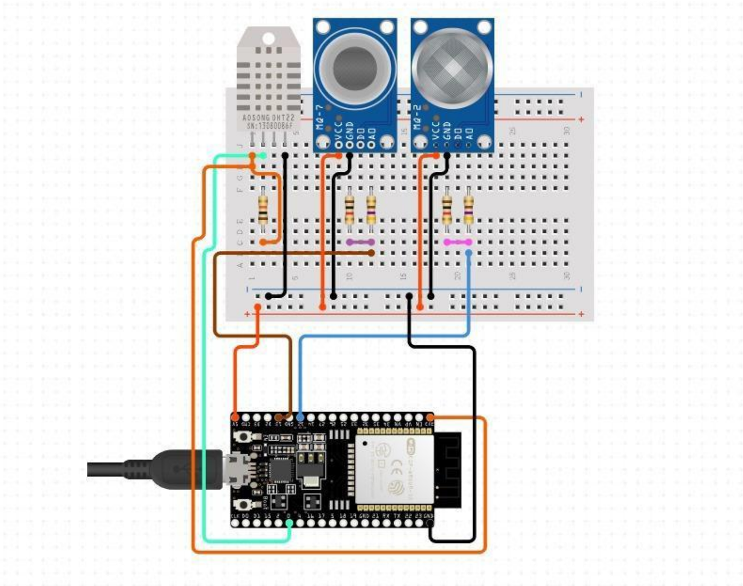
1. Sensor Element:

- The DHT11 has a capacitive humidity sensor and a thermistor (temperature sensor) for measuring environmental parameters.
- The capacitive humidity sensor consists of electrodes separated by a moisture-holding dielectric material.

2. Humidity Detection: Changes in humidity alter the capacitance of the sensing element. This change is processed to determine the relative humidity of the surrounding air.
3. Temperature Detection: The thermistor detects temperature changes by measuring resistance variations caused by temperature fluctuations.

Chapter 4: Hardware Implementation

4.1 Circuit Diagram



4.2 Circuit Design

The circuit design for the smart helmet integrates various sensors and modules into a compact and efficient configuration. The uploaded image depicts the following connections:

- **ESP32 Microcontroller**: Serves as the central processing unit, connecting to multiple sensors and ensuring data processing and transmission.
- **MQ2 and MQ7 Gas Sensors**: Detect gases like smoke, CO_2, and CO, with their analog outputs connected to the ESP32 for reading gas concentrations.
- **DHT11 Sensor**: Monitors temperature and humidity, connected to a digital pin on the ESP32.

4.3 Component Integration

1. **Gas Sensors (MQ2 and MQ7)**:
   - Both sensors require 5V for operation, with their analog outputs connected to the ESP32's ADC pins.
   - Precise voltage regulation ensures accurate readings and prevents sensor damage.

2. **DHT11 Sensor**:

   - Powered by 5V, its data pin is interfaced with the ESP32's GPIO pin for humidity and temperature data acquisition.

3. **Switch**:

   - Configured with an internal pull-up resistor to minimize noise and provide stable HIGH/LOW readings.

4. **ESP32 Microcontroller**:

   - Acts as the hub for all sensors, processing inputs, and sending data wirelessly via its Wi-Fi module.

5. **Breadboard**:

Serves as the base for prototyping, providing a platform to interconnect components without soldering.

4.4 Hardware Challenges

1. **Power Management**:

   - Balancing power distribution between multiple components and ensuring stable operation.
   - Incorporating regulators for consistent voltage supply to all sensors.

2. **Sensor Placement**:

   - Proper positioning of MQ2 and MQ7 sensors to ensure accurate gas detection without cross-interference.

3. **ESP32 Pin Limitations**:

   - Efficient use of GPIO pins to accommodate multiple components within the available resources.

4. **Wiring Complexity**:

   - Managing and organizing numerous connections on the breadboard to prevent short circuits and ensure reliability.

5. **Environmental Factors**:

   - Calibration of sensors to account for variations in temperature, humidity, and external noise.

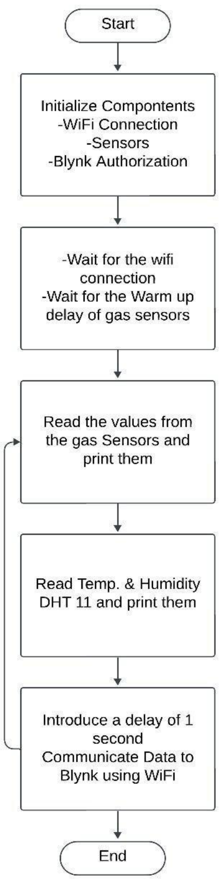
Chapter 5: Software Implementation

5.1 Algorithm

Initialize ESP32:

- Set up serial communication.
- Connect to Wi-Fi using the credentials.
- Initialize the Blynk connection with the provided token.

1. Set Pin Modes:
   - Configure input/output pins for sensors.
2. Set Timer Intervals:
   - Set up BlynkTimer to read sensors at regular intervals (every second).
3. Read Sensors:
   - Read analog values from MQ-7 and MQ-2.
   - Convert analog values to voltage (optional).
   - Read data from DHT11 sensor (temperature and humidity).
   - Read the state of the switch.
4. Send Data to Blynk:
   - Use Blynk.virtualWrite() to send sensor readings to the Blynk app.
5. Display on Blynk App:
   - Monitor sensor data on the Blynk app in real-time



5.2 Code

```
#define BLYNK_TEMPLATE_NAME "Test"
#define BLYNK_AUTH_TOKEN "I7WYWEsJdlbShwYtvGVyTQk3O15Q_wM6"
#define BLYNK_TEMPLATE_ID "TMPL3NT5lM99V"
#include <DHT.h>
#include <Arduino.h>
#include <Wire.h>
#include <MPU6050_tockn.h>
#include <WiFi.h>
#include <BlynkSimpleEsp32.h>
MPU6050 mpu(Wire);
#define DHTPIN 4     // Digital pin connected to the DHT sensor
#define DHTTYPE DHT11   // DHT 11
DHT dht(DHTPIN, DHTTYPE);
const int switchPin = 2;
const int ledPin = 13;

// Replace with your actual Wi-Fi credentials
char ssid[] = "G 5G";
char pass[] = "12345678";

// Replace with your Blynk Auth Token
char auth[] = "I7WYWEsJdlbShwYtvGVyTQk3O15Q_wM6";

// Define the GPIO pin connected to the MQ-7 sensor's analog output
const int mq7_pin = 33; // Using GPIO 34 (A2)
const int mq2_pin = 34;
BlynkTimer timer;

void setup() {
  Serial.begin(115200);
  Blynk.begin(auth, ssid, pass);
  pinMode(ledPin, OUTPUT);
  digitalWrite(ledPin, LOW);

  timer.setInterval(1000L,  readSensor1);
  timer.setInterval(1000L, readSensor2); // Read sensor every second
  timer.setInterval(1000L, readSensor3);
  timer.setInterval(1000L, readSensor4);
  timer.setInterval(1000L,  readSensor5);
}

void loop() {
  Blynk.run();
  timer.run();
}

void readSensor1()
{
 int sensor_value1 = analogRead(mq7_pin);
```

```
// Convert the sensor value to a voltage (optional)
  float voltage2 = (sensor_value2 *100)/4095;

  Serial.print("Sensor Value2: ");
  Serial.print(sensor_value2);
  Serial.print(" (");
  Serial.print(voltage2);
  Serial.println(" V)");

  delay(1000);
  Blynk.virtualWrite(V1, voltage2);
}

void readSensor3()
{
  float h = dht.readHumidity();
  float t = dht.readTemperature();
  if (isnan(h) || isnan(t)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }
  Serial.print("Humidity: ");
  Serial.print(h);
  Serial.print(" %\t");
  Serial.print("Temperature: ");
  Serial.print(t);
  Serial.println(" *C ");

  delay(1000);
  Blynk.virtualWrite(V2, h);
  Blynk.virtualWrite(V3, t);
}
void readSensor4()
{
    int switchState = digitalRead(switchPin);

  // Print the switch state to the serial monitor
  Serial.print("Switch state: ");
  Serial.println(switchState);

  delay(1000);
  Blynk.virtualWrite(V4,  switchState);
}




}
```

5.3 Code explaination

1. Libraries and Definitions

- DHT.h: For interfacing with the DHT11 temperature and humidity sensor.
- Arduino.h: Standard Arduino library for basic functions.
- WiFi.h: For connecting ESP32 to a Wi-Fi network.
- BlynkSimpleEsp32.h: For connecting ESP32 to the Blynk IoT platform

2. Wi-Fi and Blynk Setup

- The ESP32 connects to Wi-Fi using the provided SSID and password.
- The `auth` token links the ESP32 to a specific Blynk project/template.

3. Hardware Setup

- **DHT11**: Connected to GPIO4 for measuring temperature and humidity.
- **MQ-7**: Gas sensor connected to GPIO33 (analog pin).
- **MQ-2**: Another gas sensor connected to GPIO34.

4. Timers and Initialization

- Initializes the serial communication and Blynk connection.
- Configures the LED and sets it to LOW initially.
- Sets timers to periodically call sensor-reading functions every second.

5. Loop Function

- **`Blynk.run()`**: Keeps the ESP32 connected to Blynk.
- **`timer.run()`**: Ensures that scheduled tasks (sensor reads) execute on time.

6. Sensor Read Functions

Gas Sensors (MQ-7 and MQ-2)

- Reads analog values from MQ-7.
- Converts the raw sensor value to a voltage (scaled).
- Sends the voltage to Blynk (Virtual Pin V0).

DHT11 Sensor

- Reads humidity and temperature from DHT11.
- Sends humidity to **V2** and temperature to **V3**.

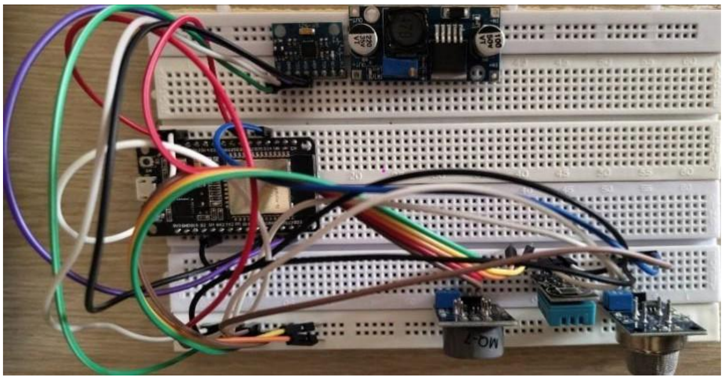
Chapter 6: Testing and Results

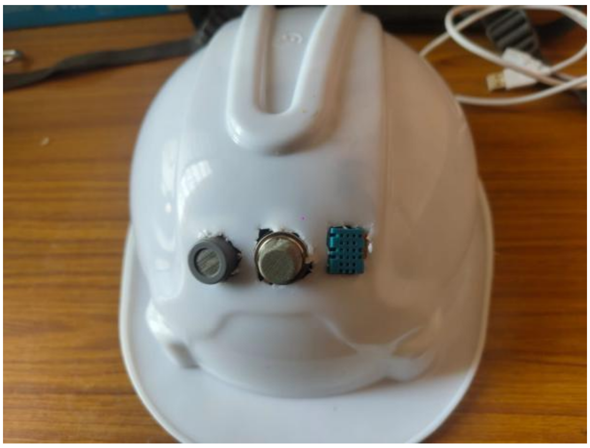
5.1 MQ2 sensor

Sl.no	Concentration of alcohol in canister in % (950cc)	Calibration of alcohol
1	5%	1150
2	10%	1450
3	15%	1780
4	20%	2290

5.2 MQ7 sensor

Sl.no	Concentration of co in canister in % (950cc)	Calibration of c0 in ppm
1	5%	950
2	10%	1586
3	15%	2205
4	20%	3255





Chapter 7: Application

7.1 Use Cases in Mining

1. **Gas Monitoring and Alerting:**

- Detects harmful gases like methane or carbon monoxide in underground mining environments.
- Alerts workers in real-time to prevent toxic exposure.

2. **Temperature and Humidity Monitoring**:

- Ensures workers are aware of extreme environmental conditions in deep mines.
- Prevents heatstroke and other temperature-related health risks.

3. **Safety Switch Integration:**

- Includes an emergency switch to instantly alert supervisors about any accidents or hazards.

4. **Continuous Data Collection**:

- Provides centralized monitoring for safety officers to evaluate conditions remotely.
- Allows predictive maintenance and real-time risk assessments.

7.2 Other Potential Applications

1. **Oil and Gas Industry:**

- Detects gas leaks in refineries and offshore drilling platforms.
- Helps maintain safe working conditions during drilling and processing operations.

2. **Chemical Plants:**

- Monitors air quality in environments dealing with hazardous chemical substances.
- Enhances worker safety by providing early detection of leaks or unsafe levels of gases.

3. **Disaster Management:**

- Assists in rescue operations during building collapses or mine cave-ins by monitoring environmental conditions.
- Equips rescue workers with real-time data for safer operations.

Chapter 8: Challenges and Limitations

8.1 Technical Challenges

1. **Sensor Accuracy and Calibration:**

- Sensors like MQ2, MQ7, and DHT11 require frequent calibration to maintain accuracy.
- Variations in environmental conditions (e.g., temperature, humidity) can lead to erroneous readings.

2. **Battery Life:**

- Continuous operation of multiple sensors and Wi-Fi modules consumes significant power, leading to limited battery life.
- Frequent recharging may not be feasible in remote mining locations.

3. **Wi-Fi Connectivity**:

- Dependence on Wi-Fi may pose a challenge in underground or remote mining sites where network connectivity is weak or unavailable.

4. **Durability and Longevity:**

- Sensors and electronics might degrade over time due to exposure to dust, moisture, and high temperatures in mining environments.

5. **Data Latency:**

- Delays in data transmission can hinder real-time monitoring and timely decision-making.

8.2 Cost and Maintenance

1. **High Initial Cost**:

- The inclusion of multiple sensors and advanced features increases the production cost of the helmet.
- May not be affordable for smaller mining operations.

2. **Frequent Maintenance:**

- Sensors need regular cleaning and replacement due to wear and tear in dusty or corrosive environments.
- Additional costs for maintaining and replacing worn-out components.

Chapter 9: Conclusion and Future Work

9.1 Conclusion

The Smart Helmet for Mining Workers is a groundbreaking innovation aimed at enhancing the safety and efficiency of mining operations. The integration of advanced sensors, such as MQ2 and MQ7 gas sensors, DHT11 temperature and humidity sensors, and a Wi-Fi-enabled ESP32 microcontroller, ensures real-time monitoring of hazardous conditions. By detecting harmful gases, monitoring environmental parameters, and providing switch-based feedback, this device offers a robust solution to mitigate risks in underground mining.

The project has successfully demonstrated:

- The functionality of integrating multiple sensors into a compact wearable device.
- Real-time data transmission via Wi-Fi for continuous monitoring.
- Practical applications in detecting hazardous conditions, ensuring worker safety, and providing valuable environmental data.

While challenges like sensor accuracy, battery life, and durability were identified, the smart helmet has proven its potential as a life-saving tool in mining operations.

9.2 Future Work

1. **Integration of More Sensors:**

- Adding sensors for detecting additional gases like methane (CH_4).
- Incorporating vibration and pressure sensors for enhanced safety features.

2. **Improved Power Management:**

- Using low-power sensors and optimizing code to extend battery life.
- Exploring alternative energy sources such as solar-powered helmets.

3. **Advanced Connectivity:**

- Utilizing RF bands as fall back and transmit data efficiently and reliably.
- Offline data storage and syncing capabilities for areas without network coverage.

4. **Durability Improvements:**

- Using ruggedized enclosures and components to withstand harsh mining environments.
- Water- and dust-proofing to ensure longevity.

The Smart Helmet for Mining Workers marks a significant step forward in industrial safety. With continued development and refinement, this technology has the potential to revolutionize worker safety across multiple industries, ensuring a safer and more efficient working environment for all.

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TECHNICAL DATA MQ-2 GAS SENSOR

FEATURES

Wide detecting scope
Fast response and High sensitivity
Stable and long life
Simple drive circuit

APPLICATION

They are used in gas leakage detecting equipments in family and industry, are suitable for detecting of LPG, i-butane, propane, methane ,alcohol, Hydrogen, smoke.

SPECIFICATIONS

A. Standard work condition

Symbol	Parameter name	Technical condition	Remarks
Vc	Circuit voltage	5V±0.1	AC OR DC
V_H	Heating voltage	5V±0.1	ACOR DC
R_L	Load resistance	can adjust	
R_H	Heater resistance	33Ω±5%	Room Tem
P_H	Heating consumption	less than 800mw	

B. Environment condition

Symbol	Parameter name	Technical condition	Remarks
Tao	Using Tem	-20℃-50℃	
Tas	Storage Tem	-20℃-70℃	
R_H	Related humidity	less than 95%Rh	
O_2	Oxygen concentration	21%(standard condition)Oxygen concentration can affect sensitivity	minimum value is over 2%

C. Sensitivity characteristic

Symbol	Parameter name	Technical parameter	Remarks
Rs	Sensing Resistance	3KΩ-30KΩ (1000ppm iso-butane)	Detecting concentration scope: 200ppm-5000ppm LPG and propane 300ppm-5000ppm butane 5000ppm-20000ppm methane 300ppm-5000ppm H_2 100ppm-2000ppm Alcohol
α (3000/1000) isobutane	Concentration Slope rate	≤0.6	
Standard Detecting Condition	Temp: 20℃±2℃ Vc:5V±0.1 Humidity: 65%±5% Vh: 5V±0.1		
Preheat time	Over 24 hour		

D. Structure and configuration, basic measuring circuit

	Parts	Materials
1	Gas sensing layer	SnO_2
2	Electrode	Au
3	Electrode line	Pt
4	Heater coil	Ni-Cr alloy
5	Tubular ceramic	Al_2O_3
6	Anti-explosion network	Stainless steel gauze (SUS316 100-mesh)
7	Clamp ring	Copper plating Ni
8	Resin base	Bakelite
9	Tube Pin	Copper plating Ni

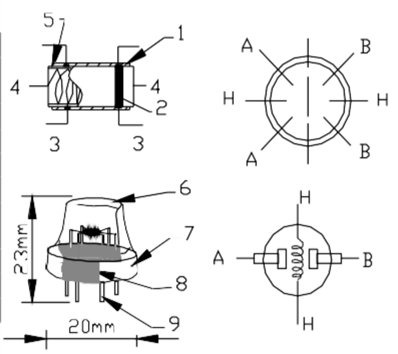


Fig. 1

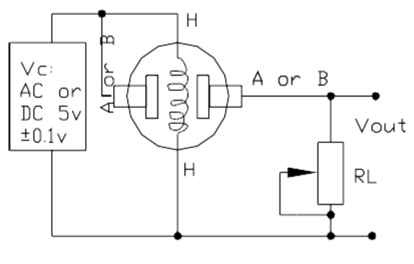
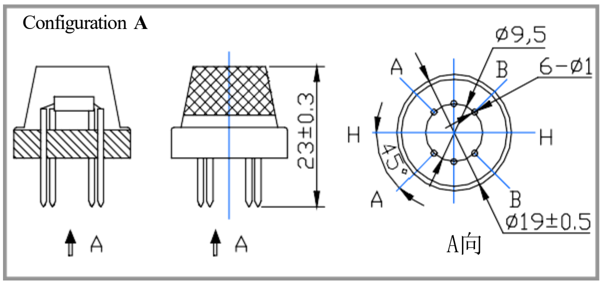
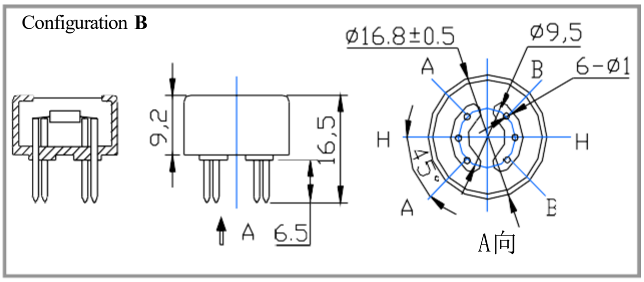


Fig.2





Structure and configuration of MQ-2 gas sensor is shown as Fig. 1 (Configuration **A** or **B**), crust made by plastic and stainless steel net. The heater provides necessary work conditions for work of sensitive components. The enveloped MQ-2 have 6 pin ,4 of them are used to fetch signals, and other 2 are used for providing heating current.

Electric parameter measurement circuit is shown as Fig.2

E. Sensitivity characteristic curve

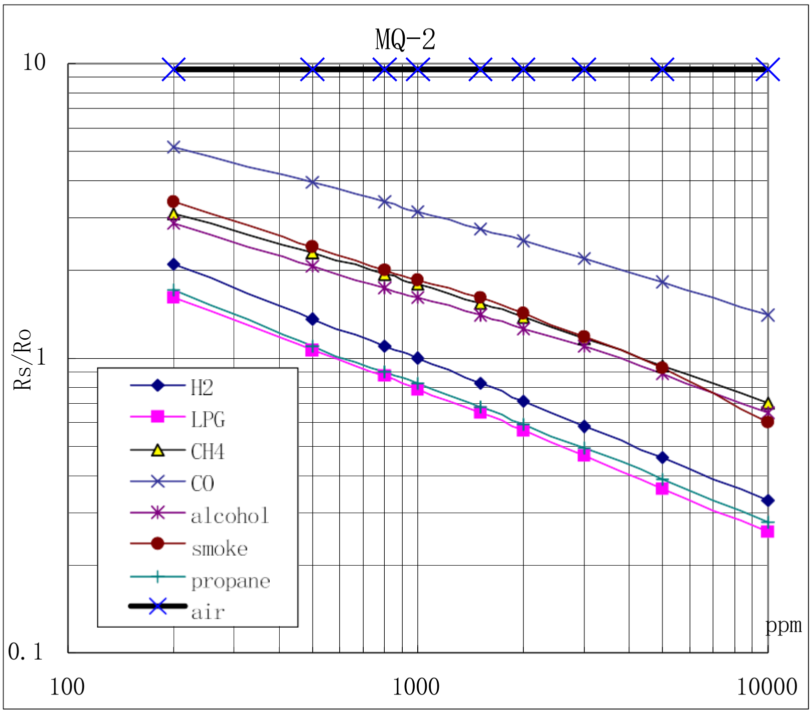


Fig.2 sensitivity characteristics of the MQ-2

Fig.3 is shows the typical sensitivity characteristics of the MQ-2 for several gases.

in their: Temp: 20℃、

Humidity: 65%、

O_2 concentration 21%

RL=5k Ω

Ro: sensor resistance at 1000ppm of H_2 in the clean air.

Rs:sensor resistance at various concentrations of gases.

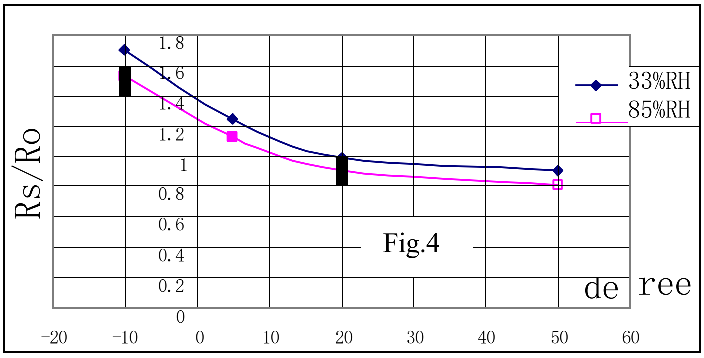


Fig.4 is shows the typical dependence of the MQ-2 on temperature and humidity.

Ro: sensor resistance at 1000ppm of H_2 in air at 33%RH and 20 degree.

Rs: sensor resistance at 1000ppm of H_2 at different temperatures and humidities.

SENSITVITY ADJUSTMENT

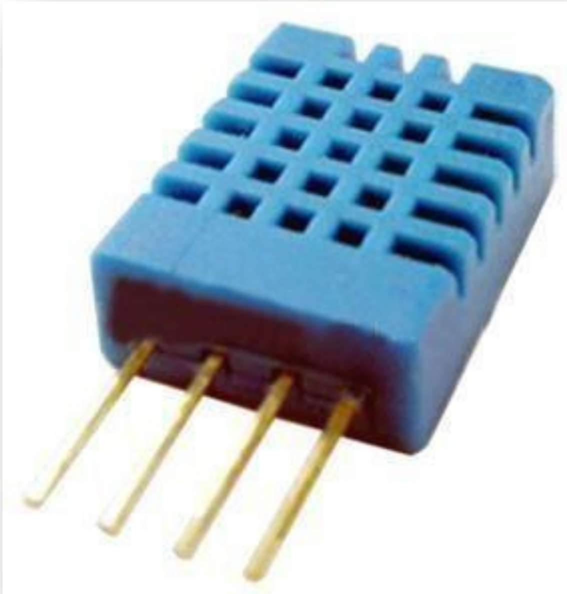
Resistance value of MQ-2 is difference to various kinds and various concentration gases. So,When using this components, sensitivity adjustment is very necessary. we recommend that you calibrate the detector for 1000ppm liquified petroleum gas<LPG>,or 1000ppm iso-butane<$i\text{-}C_4H_{10}$>concentration in air and use value of Load resistance that(R_L) about 20 K Ω (5K Ω to 47 K Ω).

When accurately measuring, the proper alarm point for the gas detector should be determined after considering the temperature and humidity influence.

DHT 11 Humidity & Temperature Sensor

1. Introduction

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor
complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high-performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.



Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programmes in the OTP memory, which are used by the sensor's internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20 meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users' request.

2. Technical Specifications:

Overview:

Item	Measurement Range	Humidity Accuracy	Temperature Accuracy	Resolution	Package
DHT11	20-90%RH 0-50 ℃	±5%RH	±2℃	1	4 Pin Single Row

Detailed Specifications:

Parameters	Conditions	Minimum	Typical	Maximum
Humidity				
Resolution		1%RH	1%RH	1%RH
			8 Bit	
Repeatability			±1%RH	
Accuracy	25°C		±4%RH	
	0-50°C			±5%RH
Interchangeability	Fully Interchangeable			
Measurement Range	0°C	30%RH		90%RH
	25°C	20%RH		90%RH
	50°C	20%RH		80%RH
Response Time (Seconds)	1/e(63%)25°C, 1m/s Air	6 S	10 S	15 S
Hysteresis			±1%RH	
Long-Term Stability	Typical		±1%RH/year	
Temperature				
Resolution		1°C	1°C	1°C
		8 Bit	8 Bit	8 Bit
Repeatability			±1°C	
Accuracy		±1°C		±2°C
Measurement Range		0°C		50°C
Response Time (Seconds)	1/e(63%)	6 S		30 S

3. Typical Application (Figure 1)

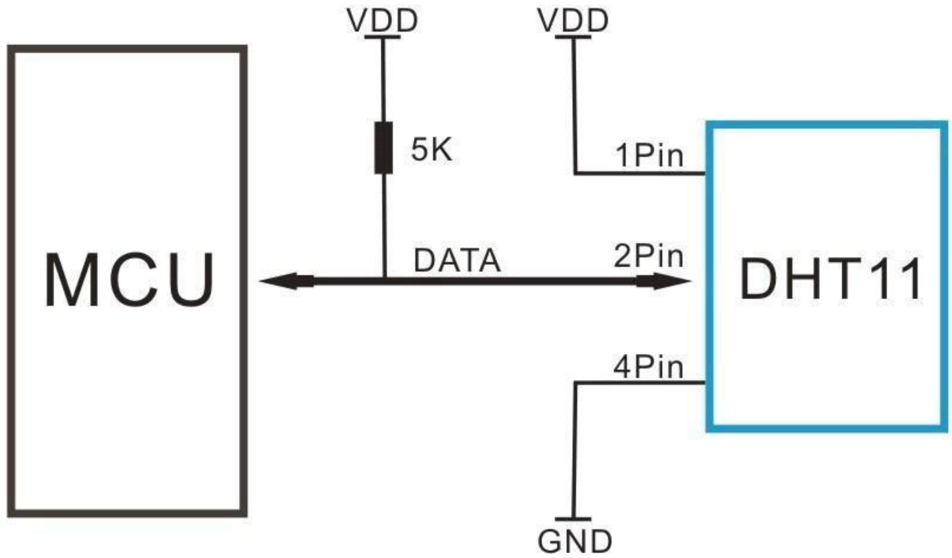


Figure 1 Typical Application

Note: 3Pin – Null; MCU = Micro-computer Unite or single chip Computer

When the connecting cable is shorter than 20 metres, a 5K pull-up resistor is recommended; when the connecting cable is longer than 20 metres, choose a appropriate pull-up resistor as needed.

4. Power and Pin

DHT11's power supply is 3-5.5V DC. When power is supplied to the sensor, do not send any instruction to the sensor in within one second in order to pass the unstable status. One capacitor valued 100nF can be added between VDD and GND for power filtering.

5. Communication Process: Serial Interface (Single-Wire Two-Way)

Single-bus data format is used for communication and synchronization between MCU and DHT11 sensor. One communication process is about 4ms.

Data consists of decimal and integral parts. A complete data transmission is **40bit**, and the sensor sends **higher data bit** first.

Data format: 8bit integral RH data + 8bit decimal RH data + 8bit integral T data + 8bit decimal T data + 8bit check sum. If the data transmission is right, the check-sum should be the last 8bit of "8bit integral RH data + 8bit decimal RH data + 8bit integral T data + 8bit decimal T data".

5.1 Overall Communication Process (Figure 2, below)

When MCU sends a start signal, DHT11 changes from the low-power-consumption mode to the running-mode, waiting for MCU completing the start signal. Once it is completed, DHT11 sends a response signal of 40-bit data that include the relative humidity and temperature information to MCU. Users can choose to collect (read) some data. Without the start signal from MCU, DHT11 will not give the response signal to MCU. Once data is collected, DHT11 will change to the low-power-consumption mode until it receives a start signal from MCU again.

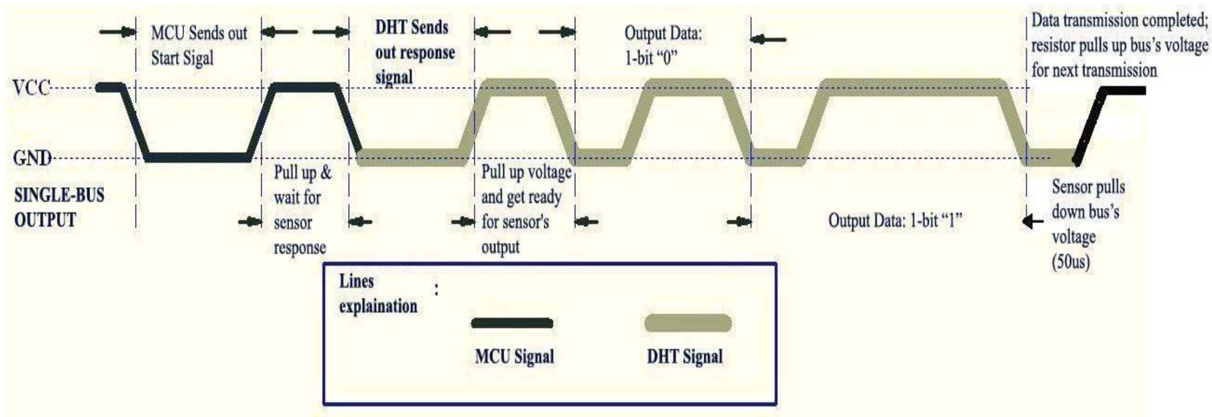


Figure 2 Overall Communication Process

5.2 MCU Sends out Start Signal to DHT (Figure 3, below)

Data Single-bus free status is at high voltage level. When the communication between MCU and DHT11 begins, the programme of MCU will set Data Single-bus voltage level from high to low and this process must take at least 18ms to ensure DHT's detection of MCU's signal, then MCU will pull up voltage and wait 20-40us for DHT's response.

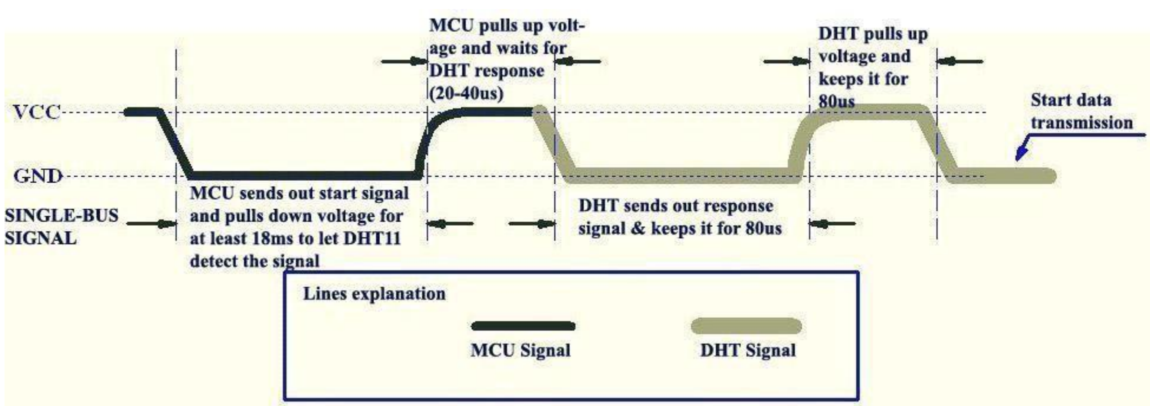


Figure 3 MCU Sends out Start Signal & DHT Responses

5.3 DHT Responses to MCU (Figure 3, above)

Once DHT detects the start signal, it will send out a low-voltage-level response signal, which lasts 80us. Then the programme of DHT sets Data Single-bus voltage level from low to high and keeps it for 80us for DHT's preparation for sending data.

When DATA Single-Bus is at the low voltage level, this means that DHT is sending the response signal. Once DHT sent out the response signal, it pulls up voltage and keeps it for 80us and prepares for data transmission.

When DHT is sending data to MCU, every bit of data begins with the 50us low-voltage-level and the length of the following high-voltage-level signal determines whether data bit is "0" or "1" (see Figures 4 and 5 below).

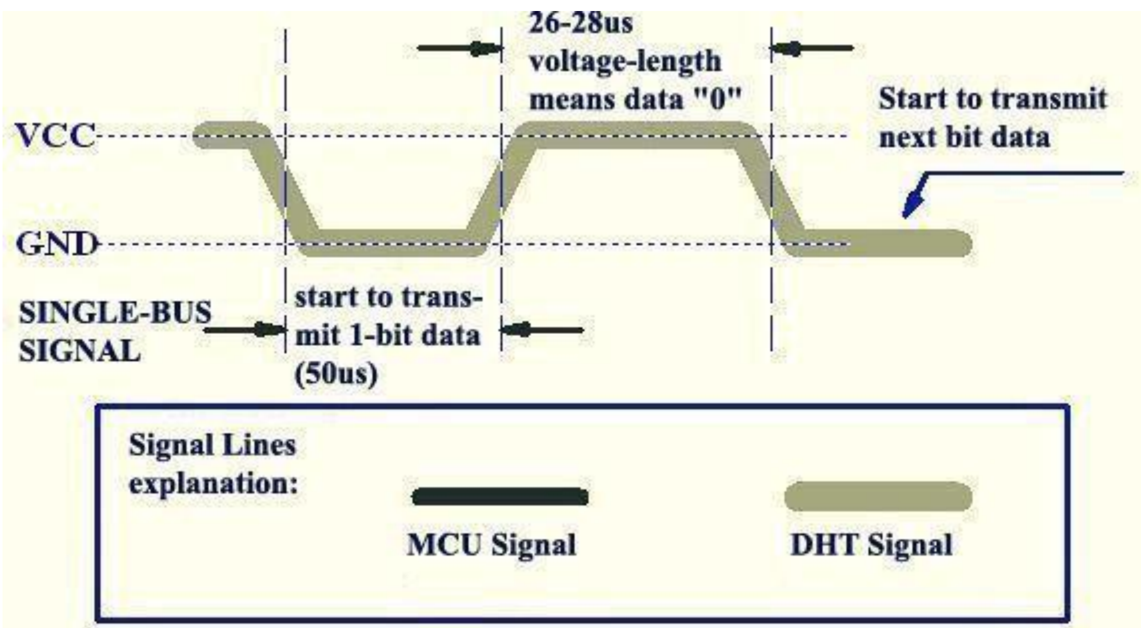


Figure 4 Data "0" Indication

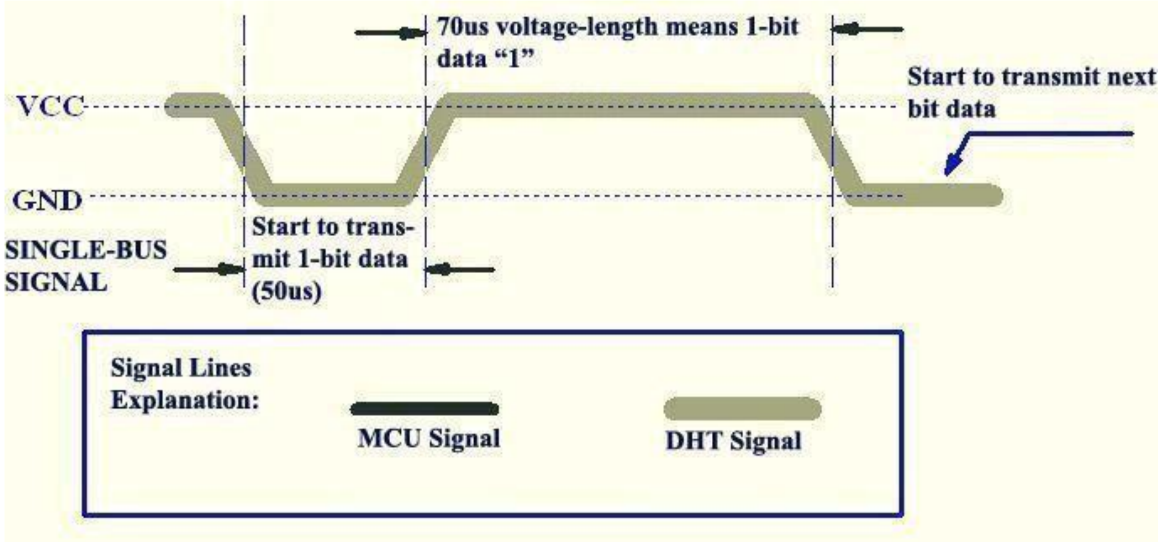


Figure 5 Data "1" Indication

If the response signal from DHT is always at high-voltage-level, it suggests that DHT is not responding properly and please check the connection. When the last bit data is transmitted, DHT11 pulls down the voltage level and keeps it for 50us. Then the Single-Bus voltage will be pulled up by the resistor to set it back to the free status.

6. Electrical Characteristics

VDD=5V, T = 25℃ (unless otherwise stated)

	Conditions	Minimum	Typical	Maximum
Power Supply	DC	3V	5V	5.5V
Current Supply	Measuring	0.5mA		2.5mA
	Average	0.2mA		1mA
	Standby	100uA		150uA
Sampling period	Second	1		

Note: Sampling period at intervals should be no less than 1 second.

7. Attentions of application

(1) Operating conditions

Applying the DHT11 sensor beyond its working range stated in this datasheet can result in 3%RH signal shift/discrepancy. The DHT11 sensor can recover to the calibrated status gradually when it gets back to the normal operating condition and works within its range. Please refer to (3) of this section to accelerate its recovery. Please be aware that operating the DHT11 sensor in the non-normal working conditions will accelerate sensor's aging process.

(2) Attention to chemical materials

Vapor from chemical materials may interfere with DHT's sensitive-elements and debase its sensitivity. A high degree of chemical contamination can permanently damage the sensor.

(3) Restoration process when (1) & (2) happen

Step one: Keep the DHT sensor at the condition of Temperature 50~60Celsius, humidity <10%RH for 2 hours;
Step two:K keep the DHT sensor at the condition of Temperature 20~30Celsius, humidity >70%RH for 5 hours.

(4) Temperature Affect

Relative humidity largely depends on temperature. Although temperature compensation technology is used to ensure accurate measurement of RH, it is still strongly advised to keep the humidity and temperature sensors working under the same temperature. DHT11 should be mounted at the place as far as possible from parts that may generate heat.

(5) Ligh t Affect

Long time exposure to strong sunlight and ultraviolet may debase DHT's performance.

(6) Connection wires

The quality of connection wires will affect the quality and distance of communication and high quality shielding-wire is recommended.

(7) Other attentions

* Welding temperature should be bellow 260Celsius and contact should take less than 10 seconds.
* Avoid using the sensor under dew condition.
* Do not use this product in safety or emergency stop devices or any other occasion that failure of DHT11 may cause personal injury.
* Storage: Keep the sensor at temperature 10-40℃, humidity <60%RH.

Disclaimer

This is a translated version of the manufacturer's data sheet. OSEPP is not responsible for the accuracy of the translated information.

TECHNICAL DATA MQ-7 GAS SENSOR

FEATURES

* High sensitivity to carbon monoxide
* Stable and long life

APPLICATION

They are used in gas detecting equipment for carbon monoxide(CO) in family and industry or car.

SPECIFICATIONS

A. Standard work condition

Symbol	Parameter name	Technical condition	Remark
Vc	circuit voltage	5V±0.1	Ac or Dc
V_H (H)	Heating voltage (high)	5V±0.1	Ac or Dc
V_H (L)	Heating voltage (low)	1.4V±0.1	Ac or Dc
R_L	Load resistance	Can adjust	
R_H	Heating resistance	33Ω±5%	Room temperature
T_H (H)	Heating time (high)	60±1 seconds	
T_H (L)	Heating time (low)	90±1 seconds	
PH	Heating consumption	About 350mW	

b. Environment conditions

Symbol	Parameters	Technical conditions	Remark
Tao	Using temperature	-20℃-50℃	
Tas	Storage temperature	-20℃-50℃	Advice using scope
RH	Relative humidity	Less than 95%RH	
O_2	Oxygen concentration	21%(stand condition) the oxygen concentration can affect the sensitivity characteristic	Minimum value is over 2%

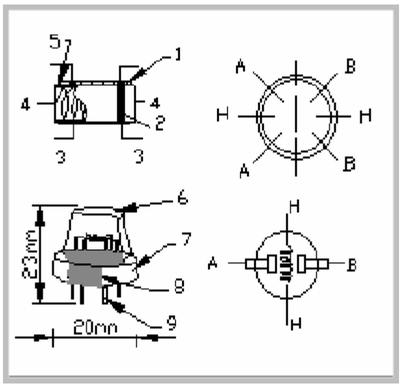
c. Sensitivity characteristic

symbol	Parameters	Technical parameters	Remark
Rs	Surface resistance Of sensitive body	2-20k	In 100ppm Carbon Monoxide
a (300/100ppm)	Concentration slope rate	Less than 0.5	Rs (300ppm)/Rs(100ppm)
Standard working condition	Temperature -20℃±2℃ relative humidity 65%±5% RL:10KΩ±5%		
	Vc:5V±0.1V VH:5V±0.1V VH:1.4V±0.1V		
Preheat time	No less than 48 hours	Detecting range: 20ppm-2000ppm carbon monoxide	

D. Structure and configuration, basic measuring circuit

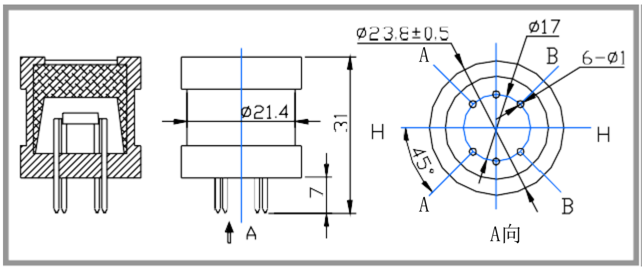
Structure and configuration of MQ-7 gas sensor is shown as Fig. 1 (Configuration A or B), sensor composed by micro AL_2O_3 ceramic tube, Tin Dioxide (SnO_2) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. The heater provides necessary work conditions for work of sensitive components. The enveloped MQ-7 have

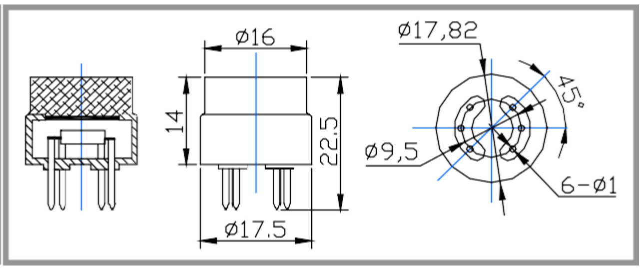
6 pin ,4 of them are used to fetch signals, and other 2 are used for providing heating current.



	Parts	Materials
1	Gas sensing layer	SnO_2
2	Electrode	Au
3	Electrode line	Pt
4	Heater coil	Ni-Cr alloy
5	Tubular ceramic	Al_2O_3
6	Anti-explosion network	Stainless steel gauze (SUS316 100-mesh)
7	Clamp ring	Copper plating Ni
8	Resin base	Bakelite
9	Tube Pin	Copper plating Ni

Fig.1





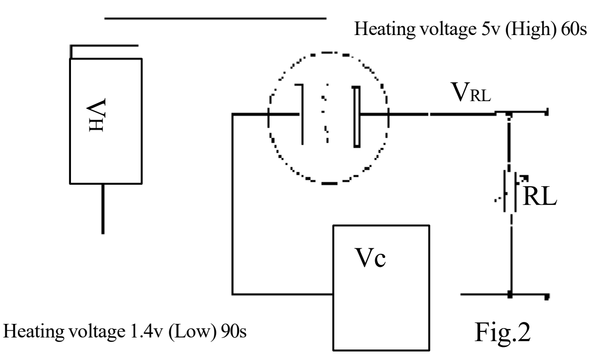


Fig.2

Standard circuit:

As shown in Fig 2, standard measuring circuit of MQ-7 sensitive components consists of 2 parts. one is heating circuit having time control function (the high voltage and the low voltage work circularly). The second is the signal output circuit, it can accurately respond changes of surface resistance of the sensor.

Electric parameter measurement circuit is shown as Fig.2

E. Sensitivity characteristic curve

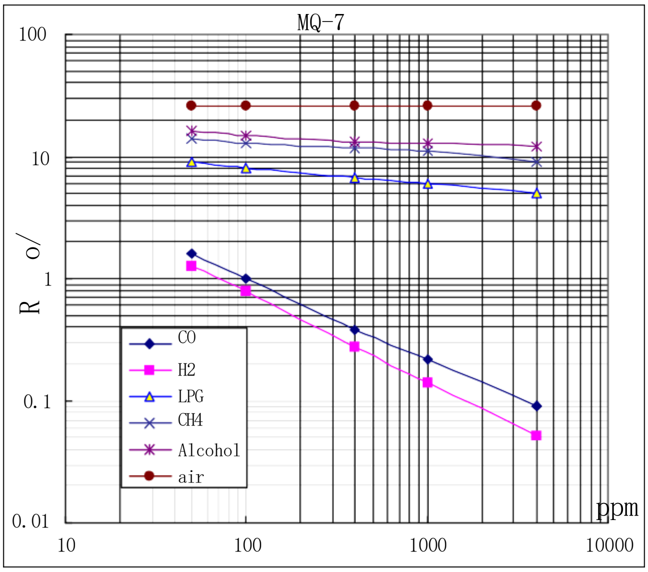


Fig.3 sensitivity characteristics of the MQ-7

Fig.3 is shows the typical sensitivity characteristics of the MQ-7 for several gases.

in their: Temp: 20℃、

Humidity: 65%、

O_2 concentration 21%

RL=10k Ω

Ro: sensor resistance at 100ppm CO in the clean air.

Rs: sensor resistance at various concentrations of gases.

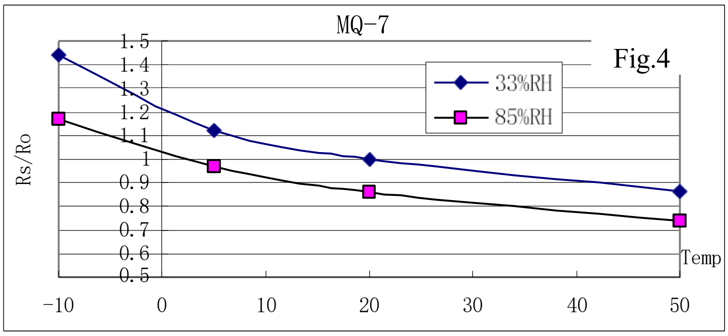


Fig.4 is shows the typical dependence of the MQ-7 on temperature and humidity.

Ro: sensor resistance at 100ppm CO in air at 33%RH and 20degree.

Rs: sensor resistance at 100ppm CO at different temperatures and humidities.

OPERATION PRINCIPLE

. The surface resistance of the sensor Rs is obtained through effected voltage signal output of the load resistance RL which series-wound. The relationship between them is described:

Rs\RL = (Vc-VRL) / VRL

Fig. 5 shows alterable situation of RL signal output measured by using Fig. 2 circuit output

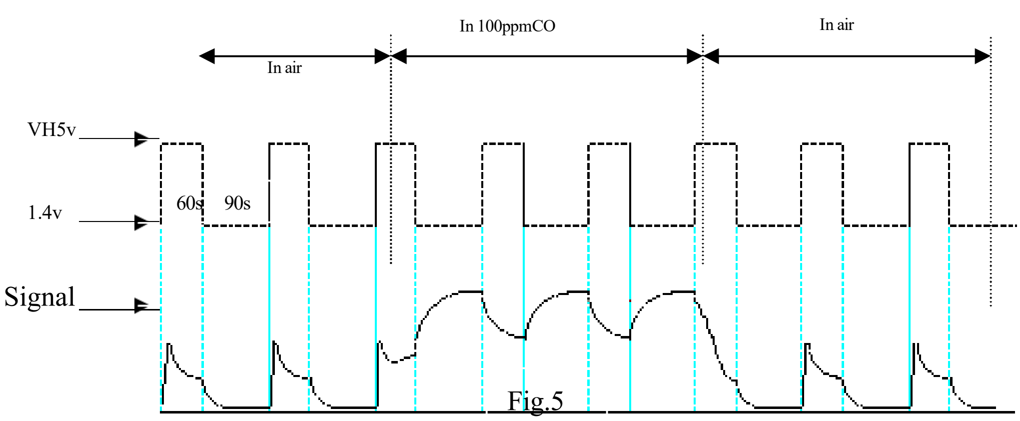


Fig.5

signal when the sensor is shifted from clean air to carbon monoxide (CO) , output signal measurement is made within one or two complete heating period (2.5 minute from high voltage to low voltage).

Sensitive layer of MQ-7 gas sensitive components is made of SnO_2 with stability, So, it has excellent long term stability. Its service life can reach 5 years under using condition.

SENSITVITY ADJUSTMENT

Resistance value of MQ-7 is difference to various kinds and various concentration gases. So, When using this components, sensitivity adjustment is very necessary. we recommend that you calibrate the detector for 200ppm CO in air and use value of Load resistance that(R_L) about 10 K Ω (5K Ω to 47 K Ω).

When accurately measuring, the proper alarm point for the gas detector should be determined after considering the temperature and humidity influence. The sensitivity adjusting program:

a. Connect the sensor to the application circuit.

b. Turn on the power, keep preheating through electricity over 48 hours.

c. Adjust the load resistance RL until you get a signal value which is respond to a certain carbon monoxide concentration at the end point of 90 seconds.

d. Adjust the another load resistance RL until you get a signal value which is respond to a CO concentration at the end point of 60 seconds .

ESP32 Datasheet

Overview

ESP32-WROOM-32 is a powerful Wi-Fi + Bluetooth/Bluetooth LE module designed for versatile applications, from low-power IoT devices to complex systems like voice encoding and music streaming.

Key Features:

- **CPU**: Dual-core Xtensa® 32-bit LX6 microprocessor (80 MHz to 240 MHz).
- **Memory**: 448 KB ROM, 520 KB SRAM, 4 MB SPI Flash.
- **Connectivity**: 802.11 b/g/n, Bluetooth v4.2 BR/EDR/LE.
- **Operating Voltage**: 3.0 V – 3.6 V.
- **Operating Temperature**: –40°C to +85°C.
- **Applications**: IoT devices, wearable electronics, smart home systems.

Pin Definitions

ESP32-WROOM-32 has 38 pins. Key pin types include:

- **Power Pins**: 3V3 (Power Supply), GND (Ground).
- **GPIOs**: Multi-purpose pins supporting ADC, DAC, I2C, UART, SPI, PWM, and more.
- **Control Pins**: EN (Enable), SENSOR_VP/VN (Analog Inputs).

Strapping Pins:

These configure boot modes and voltage levels during power-up:

- MTDI, GPIO0, GPIO2, MTDO, GPIO5.
- Example: GPIO0 (Pulled Low) for "Download Boot" mode.

Functional Description

CPU and Memory:

- Supports real-time processing and low-power modes.
- 8 KB RTC FAST/SLOW memory for low-power tasks.

Flash and SRAM:

- 4 MB integrated SPI flash.
- Up to 11 MB flash mapped to instruction space.

Connectivity:

- **Wi-Fi**: Speeds up to 150 Mbps, 20 dBm output power.
- **Bluetooth LE**: Receiver sensitivity -97 dBm, RF transmit power up to 9 dBm.

Electrical Characteristics

Absolute Maximum Ratings:

- **Power Supply**: -0.3 V to 3.6 V.
- **Storage Temperature**: -40°C to +105°C.

Recommended Operating Conditions:

- **Power Supply**: 3.0 V to 3.6 V.
- **Ambient Temperature**: -40°C to +85°C.

DC Characteristics:

- **Input Voltage High (VIH)**: 0.75 × VDD to VDD + 0.3 V.
- **Input Voltage Low (VIL)**: -0.3 V to 0.25 × VDD.

Physical Dimensions

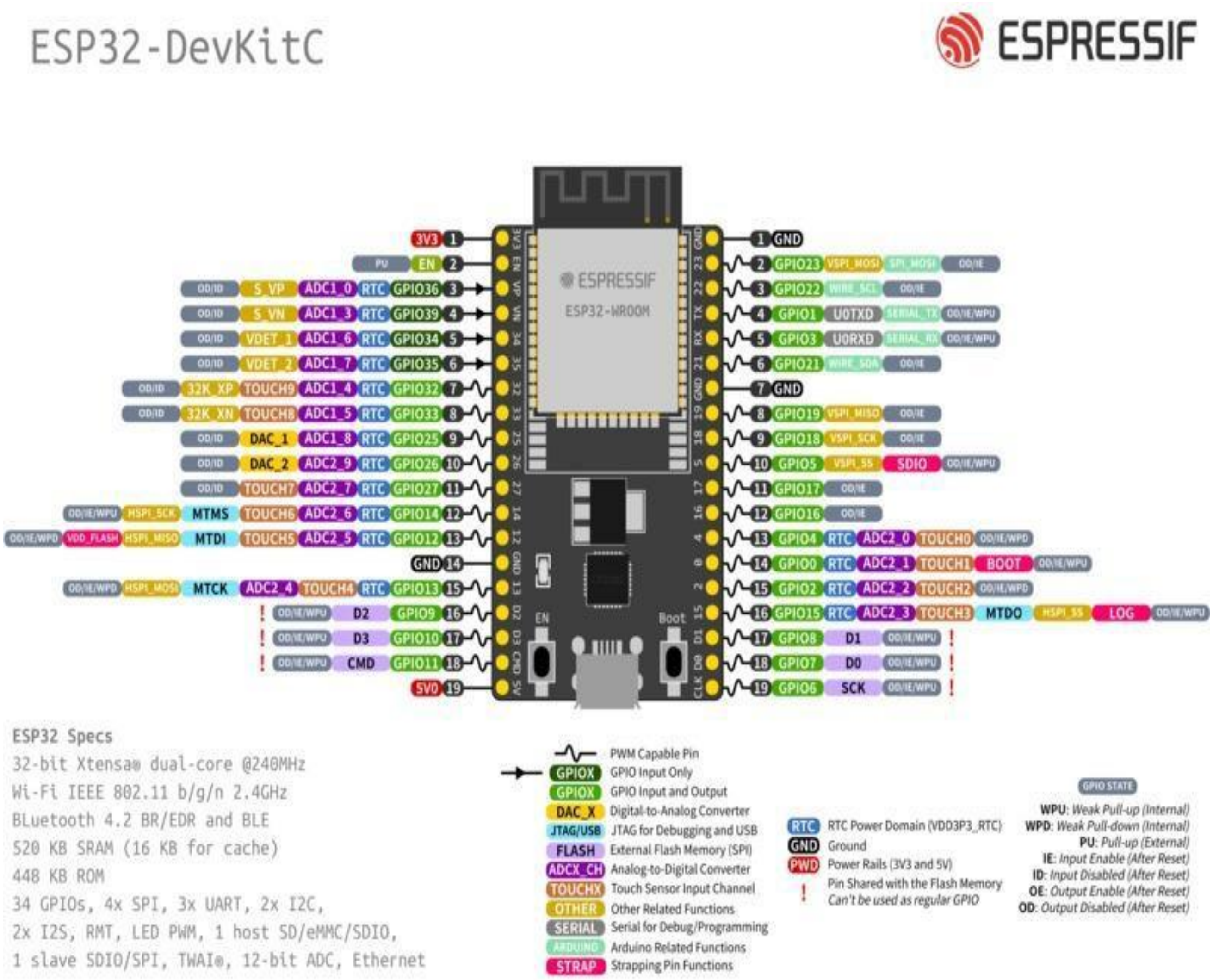
- Module Size: 18.00 mm × 25.50 mm × 3.10 mm.
- Integrated 40 MHz crystal oscillator.

Handling and Storage

- **Moisture Sensitivity Level**: MSL 3.
- **Reflow Soldering**: Peak temperature 235°C to 250°C.
- **Electrostatic Discharge (ESD)**: HBM ±2000 V, CDM ±500 V.

Key Schematics and Layout

- **Peripheral Interfaces**: UART, SPI, I2C, PWM, ADC, DAC.
- **PCB Land Pattern**: Ensure proper soldering and alignment for thermal and RF performance.


ESP32-DevKitC
ESPRESSIF
ESP32-WROOM
ESP32 Specs
32-bit Xtensa® dual-core @240MHz
Wi-Fi IEEE 802.11 b/g/n 2.4GHz
BLuetooth 4.2 BR/EDR and BLE
520 KB SRAM (16 KB for cache)
448 KB ROM
34 GPIOs, 4x SPI, 3x UART, 2x I2C,
2x I2S, RMT, LED PWM, 1 host SD/eMMC/SDIO,
1 slave SDIO/SPI, TWAI®, 12-bit ADC, Ethernet
PWM Capable Pin
GPIOX GPIO Input Only
GPIOX GPIO Input and Output
DAC_X Digital-to-Analog Converter
JTAG/USB JTAG for Debugging and USB
FLASH External Flash Memory (SPI)
ADCX_CH Analog-to-Digital Converter
TOUCHX Touch Sensor Input Channel
OTHER Other Related Functions
SERIAL Serial for Debug/Programming
ARDUINO Arduino Related Functions
STRAP Strapping Pin Functions
RTC RTC Power Domain (VDD3P3_RTC)
GND Ground
PWD Power Rails (3V3 and 5V)
Pin Shared with the Flash Memory
Can't be used as regular GPIO
GPIO STATE
WPU: Weak Pull-up (Internal)
WPD: Weak Pull-down (Internal)
PU: Pull-up (External)
IE: Input Enable (After Reset)
ID: Input Disabled (After Reset)
OE: Output Enable (After Reset)
OD: Output Disabled (After Reset)