SEWAGE GASES DETECTION SYSTEM

Final Report of CSIR-NGRI Summer Training Program.

Under the Guidance of

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CERTIFICATE

This is to certify that Ms. Vedya Janardhanan from B.E, Department of Electronics and Instrumentation Engineering, MSRIT, Bengaluru has successfully completed the summer training at CSIR-NGRI, Hyderabad on the project entitled "**SEWAGE GASES DETECTION SYSTEM".** The project work was carried out from 21st June, 2022 to 21st August 2022.

The project on evaluation fulfils the stated criteria and the student's work is her original work.

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Instrumentation Division,
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(Mentor)

DECLARATION

I, Vedya Janardhanan, a student of B.E, Department of Electronics and Instrumentation Engineering, MSRIT, Bengaluru has successfully completed the summer training do hereby declare that this project report entitled **SEWAGE GASES DETECTION SYSTEM** is a genuine record of the project work done by me during my stay at CSIR-National Geophysical Research Institute under the supervision of **Dr. Sateesh Chandrapuri**, Senior Scientist, CSIR-NGRI, Hyderabad.

Date: 14-04-2023
Place: Bengaluru

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Date:14-04-2023
Place: Bengaluru

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Abstract

There are many sewer gases released from the sewage. All of the gases combined are significantly more dangerous and lethal. Therefore, sewage gas poisoning is a severe health concern that requires immediate attention. Detection of hazardous gases including hydrogen sulfide, methane, ammonia, and carbon monoxide, is made possible with the help of an Arduino-based gas sensor detection system. These sewer gases are sensed by gas detectors every moment and transmit an alert when they surpass the normal grade. An electronic printed circuit board, with small-sized gas sensors, along with suitable outputs, alerts workers whenever the hazardous gas level reaches a limit beyond the safety levels. A constant monitoring of the gases with the help of an LCD screen displays the readings of the concentration of gases.

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1 Introduction

A study conducted by Dalberg Associates2 in 2018, estimated **5 million** sanitation workers in various urban locations across India. They have a higher risk of exposure to harmful sewer gases. The working conditions of these sewage workers haven't changed a bit from over a century. Our project aims to propose a solution to help the sewer workers who put their lives at jeopardy, and ensure minimal health risk. Due to these poisonous gases, the death rate of sewer workers is very high. The lack of treatment of sewage after crossing dangerous levels leads to the deaths of thousands of sewage cleaners throughout the year from accidents and various diseases such as hepatitis and typhoid cardiovascular degeneration, musculoskeletal disorders like osteoarthritic changes and intervertebral disc herniation, infections like hepatitis, leptospirosis and helicobacter, skin problems, respiratory system problems and altered pulmonary function parameter that occur due to sudden or sustained exposure to hazardous gases.

The death rate of sewer workers has been increased in the recent years due to panting of poisonous gases. The raise for this issue is lack of basic consciousness and improper knowledge of the workers during their working period. Sewage gases generally is a byproduct from the natural breakdown of sewage and their mixtures formed by slurries which leads to the production of toxic wastes that release hazardous gases. These gases can be lethal if inhaled in high concentrations or for a prolonged period of time. Septic tank gases are primarily constituted of methane, subtle traces of carbon dioxide, some parts of Sulphur dioxide, ammonia, hints of hydrogen sulphide (H2S), nitrogen dioxide and traces of carbon monoxide.

Basic working principle

The activity can be divided in three parts-

1. Interfacing of different sensors with microcontroller i.e., Arduino.

2. Obtain the concentration of gases in different atmospheric condition.

3. Analyzing and monitoring of obtained data from display.

Initially, we interfaced each sensor with Arduino to check their response and behavior after that we combined all the sensor and done coding according to it and observed the concentration of harmful gases at different environment condition.

Components list

1. Arduino Uno
2. MQ 4 Methane gas sensor
3. MQ 7 Carbon monoxide sensor
4. MQ 136 Hydrogen sulfide sensor
5. MQ 137 Ammonia gas sensor
6. LM2596 3A Step-down voltage regulator
7. 12 stage binary ripple counter
8. Buzzer
9. Seven segment display
10. 8-digit LED Display Driver
11. Green LED
12. JHD204 LCD

2 Description of the components

1. Arduino Uno

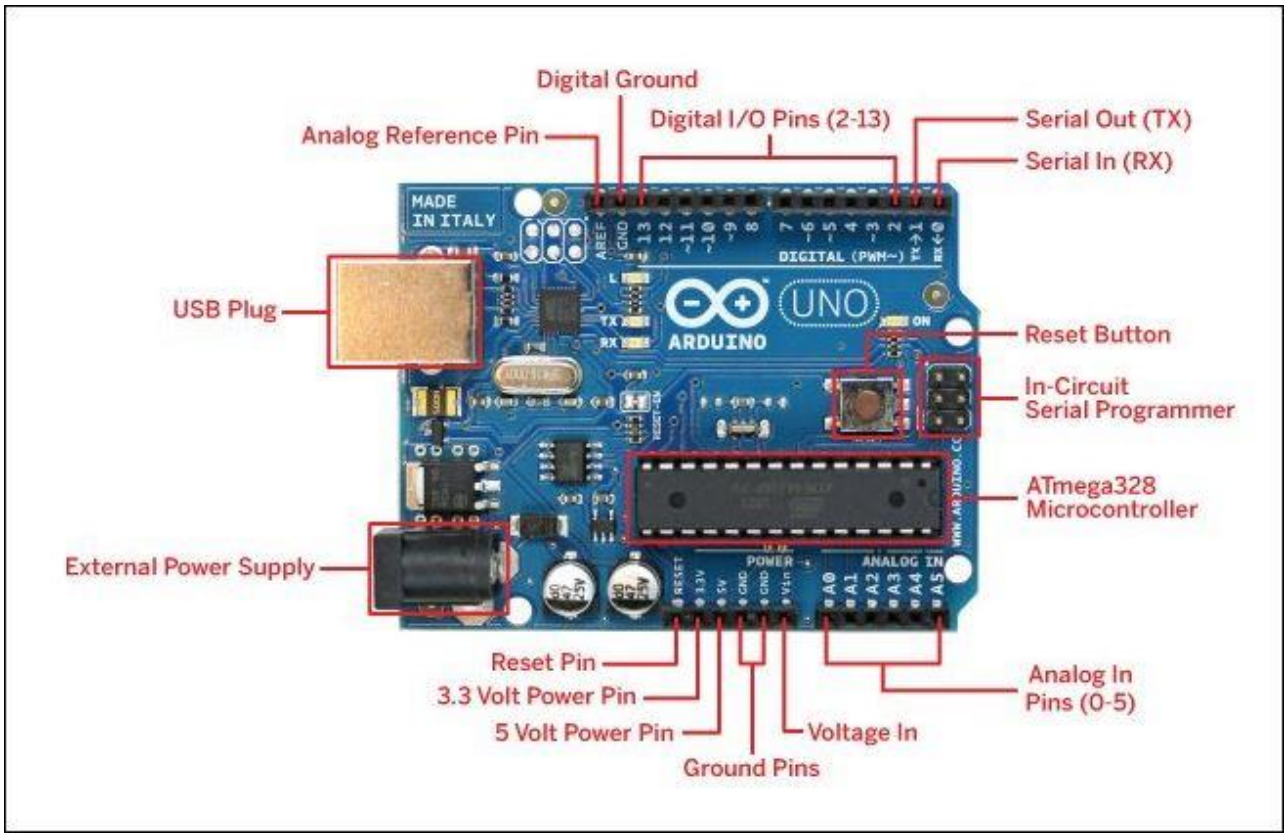


Figure 1 Arduino Uno

Description

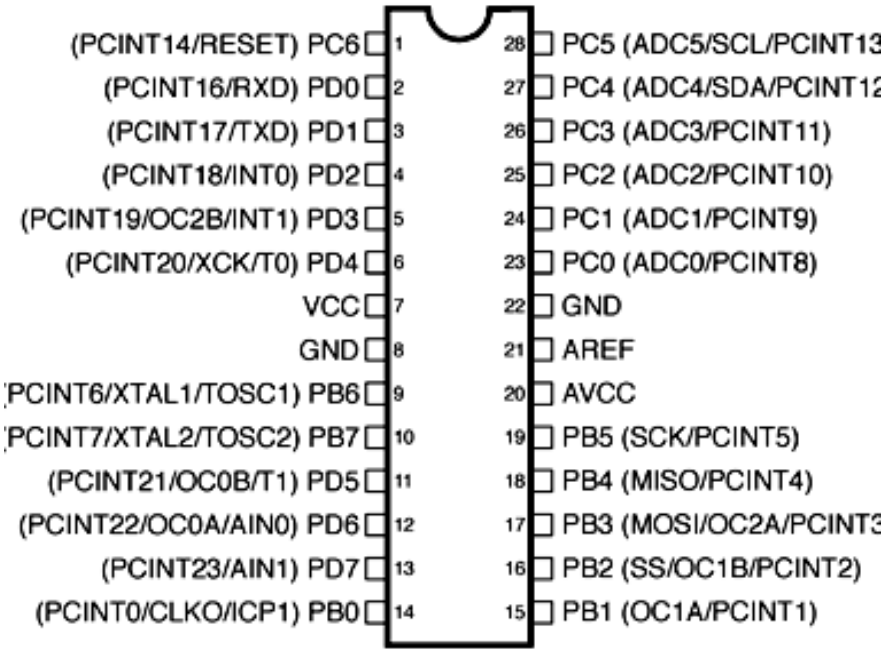
Arduino Uno R3 is one kind of ATmega328P based microcontroller board. It includes the whole thing required to hold up the microcontroller; just attach it to a PC with the help of a USB cable, and give the supply using AC-DC adapter or a battery to get started. The term Uno means “one” in the language of “Italian” and was selected for marking the release of Arduino’s IDE 1.0 software. The R3 Arduino Uno is the 3rd as well as most recent modification of the Arduino Uno. Arduino board and IDE software are the reference versions of Arduino and currently progressed to new releases. The Uno-board is the primary in a sequence of USB-**Arduino boards**, & the reference model designed for the Arduino platform.

Specifications

- It is an ATmega328P based Microcontroller
- The Operating Voltage of the Arduino is 5V
- The recommended input voltage ranges from 7V to 12V
- The i/p voltage (limit) is 6V to 20V
- Digital input and output pins-14
- Digital input & output pins (PWM)-6
- Analog i/p pins are 6
- DC Current for each I/O Pin is 20 mA
- DC Current used for 3.3V Pin is 50 mA
- Flash Memory -32 KB, and 0.5 KB memory is used by the boot loader
- SRAM is 2 KB
- EEPROM is 1 KB
- The speed of the CLK is 16 MHz
- In Built LED
- Length and width of the Arduino are 68.6 mm X 53.4 mm
- The weight of the Arduino board is 25 g

Arduino Uno R3 Pin Diagram

It comprises 14-digit I/O pins. From these pins, 6-pins can be utilized like PWM outputs. This board includes 14 digital input/output pins, Analog inputs-6, a USB connection, quartz crystal-16 MHz, a power jack, a USB connection, resonator-16Mhz, a power jack, an ICSP header an RST button.



2. MQ- 4 Methane Gas Sensor

Figure 2 MQ 4

MQ4 methane gas sensor is a MOS (metal oxide semiconductor) type sensor, used to detect the methane gas concentration within the air. Here, the range of concentration for sensing ranges from 200 pm – 10,000 ppm which is appropriate for the detection of a leak. This gas sensor mainly includes a detecting element like ceramic based on aluminium-oxide (Al_2O_3), coated with Tin dioxide (SnO2) and arranged within a stainless-steel mesh. When methane gas and detecting elements get in contact with each other the resistivity of the detecting element will be changed. After that, the change is measured to get the methane gas concentration.

Pin Configuration

The pin configuration of the MQ4 methane gas sensor is shown below.

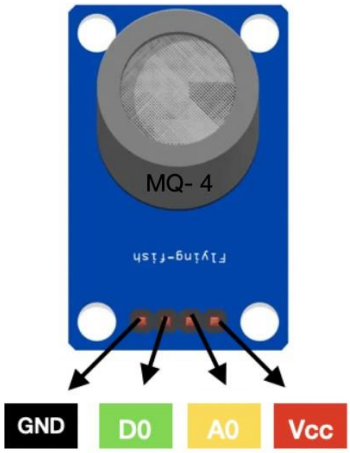


Figure 3 MQ 4 Pin configuration

The pin configuration of the MQ-4 methane gas sensor module includes four pins:

- **Vcc Pin:** This pin provides voltage to the module and the typicaloperating voltage is +5V
- **GND Pin:** This pin is used to connect the sensor module to the

GNDterminal of the system

- **DO (Digital Out) Pin:** This pin provides digital output by setting athreshold value with the help of the potentiometer
- **AO (Analog Out):** This pin provides output analog voltage which ranges from 0-5 V

Features & Specifications

The features and specifications of the MQ4 methane gas sensor

- Sensitivity is good for combustible gas in an extensive range
- Sigh sensitivity for natural gas, methane gas
- Small sensitivity for smoke and alcohol
- Quick responsive, long life and stable
- The drive circuit is simple
- Load resistance is 20KΩ
- Detecting resistance ranges from 10KΩ to 60KΩ
- Preheat time is above 24Hrs
- The required voltage is 5V
- DO output: is 0.1 to 5V
- AO output is 0.1 to 0 .3 V
- Detection gas is methane or natural
- The concentration of detection ranges from 200 to 10000 ppm
- Interface: TTL compatible input & output

- Heater utilization is low than 750mw
- Operating temperature ranges from 14 to 122 ° Fahrenheit or -10 to 50°Centigrade from 0 to 5V depending on the intensity of gas.

MQ-4 Working Principle

As soon as the module is powered, the power LED lights up. The MQ-4 works by sensing the methane concentration in the air. The analog pin of the sensor then generates an analog signal proportional to the amount of CH4 in the air. We can measure the analog output of a sensor with an ADC microcontroller. Microcontroller reads the analog output signal of the methane gas sensor and performs signal conditioning to convert the measured analog voltage into Methane concentration in air. Similarly, when methane gas is detected, the digital pin goes HIGH and the led glows up.

Interfacing MQ4 with Arduino

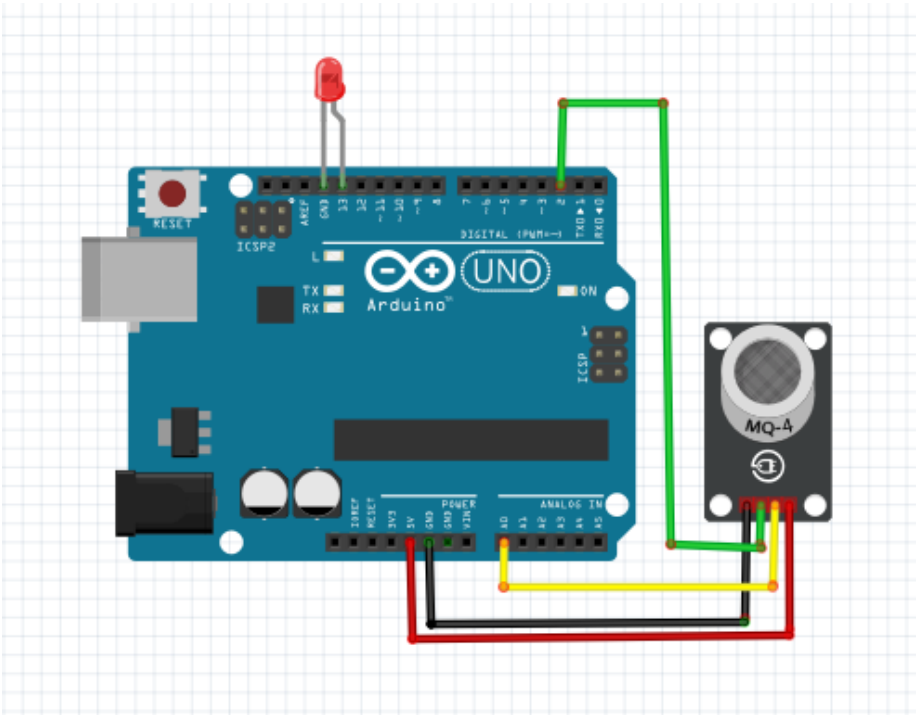


Figure 4 MQ4 with Arduino

- Connect the Vcc and GND pins of the sensor to the power pins of Arduino topower up the sensor.
- Connect the analog output pin of the sensor to the analog pin of the Arduino(Here A0)
- Connect the digital output pin of the sensor to the digital pin of the Arduino(Here D2)
- A LED is connected to the Arduino to indicate the presence of methane gas.

Arduino Code

```
/* MQ-4 Methane Sensor Circuit with Arduino */

const int AOUTpin=0;//the AOUT pin of the methane sensor goes into analog pin A0 of the arduino
const int DOUTpin=2;//the DOUT pin of the methane sensor goes into digital pin D8 of the arduino
const int ledPin=13;//the anode of the LED connects to digital pin D13 of the arduino

int limit;
int value;

void setup() {
Serial.begin(9600);//sets the baud rate
pinMode(DOUTpin, INPUT);//sets the pin as an input to the arduino
pinMode(ledPin, OUTPUT);//sets the pin as an output of the arduino
}

void loop()
{
value= analogRead(AOUTpin);//reads the analaog value from the methane sensor's AOUT pin
limit= digitalRead(DOUTpin);//reads the digital value from the methane sensor's DOUT pin
Serial.print("Methane value: ");
Serial.println(value);//prints the methane value
Serial.print("Limit: ");
Serial.print(limit);//prints the limit reached as either LOW or HIGH (above or underneath)
delay(1000);
if (limit == HIGH){
digitalWrite(ledPin, HIGH);//if limit has been reached, LED turns on as status indicator
}
else{
digitalWrite(ledPin, LOW);//if threshold not reached, LED remains off
}
}
```

Figure 5 Arduino code for MQ 4

3. MQ-7 Carbon Monoxide Sensor

Carbon monoxide (CO) is a very dangerous gas which is odorless, colorless, and tasteless, so it cannot be smelt, seen, or tasted. A person really would have no idea that they are breathing in CO besides the fact that they would start to feel horrible. The most common symptoms of CO poisoning are headache, nausea, vomiting, dizziness, fatigue, and a feeling of weakness. Neurological signs include confusion, disorientation, visual disturbance, syncope, and seizures. Carbon monoxide is produced from the partial oxidation of carbon-containing compounds; it forms when there is not enough oxygen to produce carbon dioxide (CO), such as when operating a stove or an internal combustion engine in an enclosed space. Carbon monoxide poisoning is the most common type of fatal air poisoning in many countries. Being colorless, odorless, and tasteless, it is very hard to detect but highly toxic. Carbon monoxide is absorbed through breathingand enters the bloodstream through gas exchange in the lungs. CO combines with hemoglobin to produce carboxyhemoglobin, which usurps the space in hemoglobin that normally carries oxygen, but is ineffective for delivering oxygen to bodily tissues. This leads to oxygen deprivation, which can be deadly. CO is measured in parts per million (ppm). The natural atmosphere is composed of 0.1ppm. The average level in homes is 0.5-5ppm. The level near is properly adjusted. Gas stoves in homes and from modern vehicle exhaust emissions is 5-15ppm. Concentrations as low as 667ppm may cause up to 50% of the body's hemoglobin to convert to carboxyhemoglobin. A level of 50% carboxyhemoglobin may resultin seizure, coma, and fatality.

Description

Figure 6 MQ 7

This Carbon Monoxide (CO) gas sensor detects the concentrations of CO in the air and outputs its reading as an analog voltage. The sensor can measure concentrations of 10 to 10,000 ppm. The sensor can operate at temperatures from -10 to 50°C and consumes less than 150 mA at 5 V. Sensitive material of the MQ-7 gas sensor is SnO2, which has lower conductivity in clean air. It makes detection by method of cycle high and low temperature, and detect CO when low temperature (heated by 1.5V). The sensor's conductivity is higher along with the gas concentration rising. When high temperature (heated by 5.0V), it cleans the other gases adsorbed under low temperature. Please use simple electro circuit, convert change of conductivity to correspond output signal of gas concentration.

The MQ-7 gas sensor has high sensitivity to Carbon Monoxide. The sensor could be used to detect different gases containing CO, it is low cost and suitable for different applications.

Pin Configuration

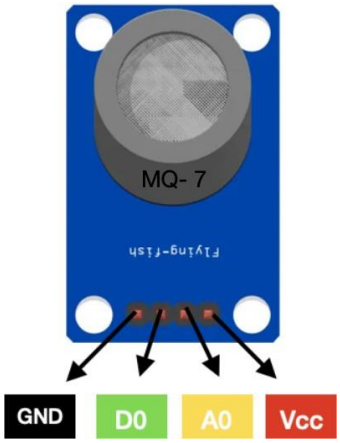


Figure 7 MQ 7 pin configuration

The pin configuration of the MQ-7 methane gas sensor module includes four pins

- **Vcc Pin:** This pin provides voltage to the module and the typical operatingvoltage is +5V
- **GND Pin:** This pin is used to connect the sensor module to the GNDterminal of the system
- **DO (Digital Out) Pin:** This pin provides digital output by setting athreshold value with the help of the potentiometer
- **AO (Analog Out):** This pin provides output analog voltage which ranges from 0- 5 V

Features & Specifications

- High sensitivity to Combustible gas in wide range
- High sensitivity to Natural gas
- Fast response
- Wide detection range
- Stable performance, long life, low cost
- Simple drive circuit

Working of MQ-7 Sensor

The +5V and GND leads establishes power for the sensor. The other 2 leads are AOUT (analog output) and DOUT (digital output). The terminal AOUT gives an analog voltage output in proportion to the amount of carbon monoxide the sensor detects. The more CO it detects, the greater the analog voltage it will output. Conversely, the less CO it detects, the less analog voltage it will output. If the analog voltage reaches a certain threshold, it will send the digital pin DOUT high. Once this DOUT pin goes high, the Arduino will detect this and will trigger the LED to turn on, signaling that the CO threshold has been reached and is now over the limit.

Interfacing MQ-7 with Arduino

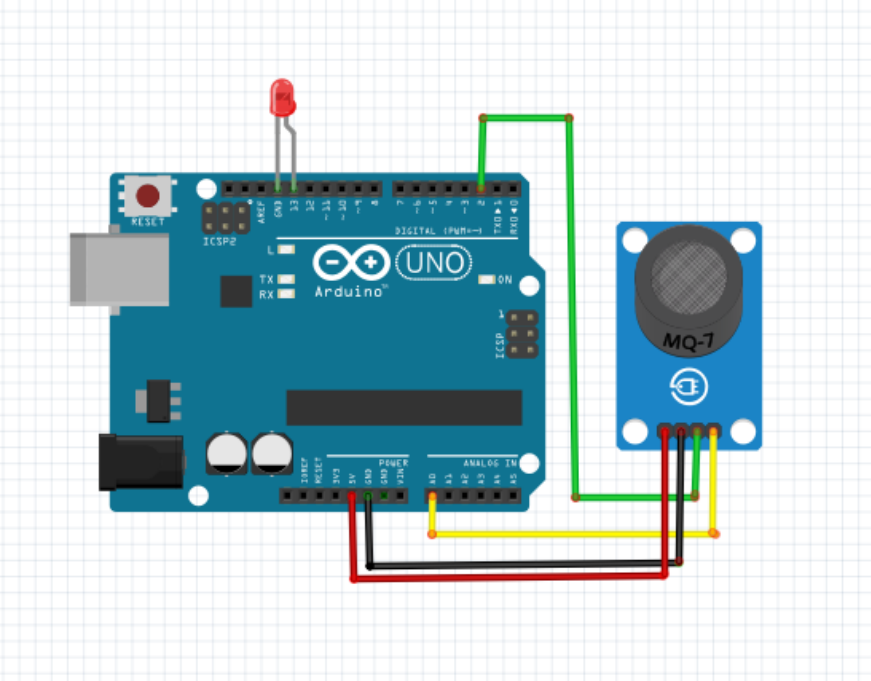


Figure 8 MQ 7 with Arduino

To connect the sensor, there are 4 leads. Two of them are for power. The Vcc terminalof the sensor connects into the 5V terminal of the Arduino board. The GND terminalof the sensor connects into the GND terminal of the Arduino. This establishes power for the sensor. The other 2 connections are the analog and digital output of the sensor. These connect to analog pin A0 and digital pin D2 respectively.

Arduino Code

```
/* MQ-7 Carbon Monoxide Sensor Circuit with Arduino */

const int AOUTpin=0;//the AOUT pin of the CO sensor goes into analog pin A0 of the arduino
const int DOUTpin=0;//the DOUT pin of the CO sensor goes into digital pin D0 of the arduino
const int ledPin=13;//the anode of the LED connects to digital pin D13 of the arduino

int limit;
int value;

void setup() {
Serial.begin(9600);//sets the baud rate
pinMode(DOUTpin, INPUT);//sets the pin as an input to the arduino
pinMode(ledPin, OUTPUT);//sets the pin as an output of the arduino
}

void loop()
{
value= analogRead(AOUTpin);//reads the analaog value from the CO sensor's AOUT pin
limit= digitalRead(DOUTpin);//reads the digital value from the CO sensor's DOUT pin
Serial.print("CO value: ");
Serial.println(value);//prints the CO value
Serial.print("Limit: ");
Serial.print(limit);//prints the limit reached as either LOW or HIGH (above or underneath)
delay(100);
if (limit == HIGH){
digitalWrite(ledPin, HIGH);//if limit has been reached, LED turns on as status indicator
}
else{
digitalWrite(ledPin, LOW);//if threshold not reached, LED remains off
}
}
```

Figure 9 Arduino code for MQ 7

4. MQ- 136 Hydrogen Sulfide gas Sensor

Hydrogen sulfide (H_2S) is a colorless gas with a strong odor of rotten eggs. Exposure to hydrogen sulfide may cause irritation to the eyes and respiratory system. It can also cause apnea, coma, convulsions; dizziness, headache, weakness, irritability, insomnia; stomach upset, and if liquid: frostbite. Workers may be harmed from exposure to hydrogen sulfide. The level of exposure depends upon the dose, duration and work being done.

Description

Figure 10 MQ 136

MQ-136 Gas Sensor can be used to monitor the concentration of Hydrogen Sulfidegas. This Module simplifies using the MQ-136 gas sensor by providing digital as well as analog output which can be interfaced to Microcontrollers, Arduino, and Raspberry pi. This MQ sensor is formed with a micro AL2O3 ceramic tube, a sensitive layer of tin dioxide (SnO2), measuring electrode, and heater, which are fixed into a crust of stainless steel net and plastic. The heater provides certain workconditions for sensitive components. The MQ136 sensor has six pins, four of them are used to fetch signals, while it used the other two for providing heating current.

Pin configuration

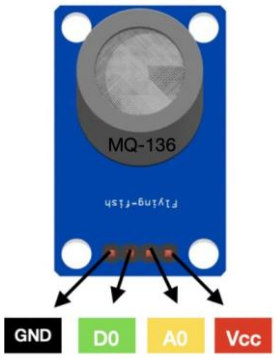


Figure 11 MQ 136 pin configuration

- **Vcc** : This is there to power the module, requires 5V
- **Ground** : To connect the module to the system's common ground
- **Digital Out (DO)** : Digital output pin, the Threshold value can be set byusing the potentiometer
- **Analog Out (AO)** : Analog output pin. Analog voltage based on theconcentration of the gas

Features & Specifications

- Dual signal output (analog output and TTL level output)
- The TTL output effective signal is low. (The signal light is on when the output is low and can be directly connected to the microcontroller)
- Analog output 0 ~ 5V voltage, the higher the concentration the

higherthe voltage.

- Good sensitivity to hydrogen sulfide, liquefied gas, natural gas, citygas, and smoke.
- With long service life and reliable stability
- Fast response recovery characteristics
- Size: 32mm X22mm X27mm length X width X height
- The main chip: LM393, ZYMQ-136 gas sensors
- Good sensitivity to Hydrogen sulfide
- Long life and low cost
- Simple drive circuit

MQ- 136 Working Principle

MQ-136 gas sensor has a high sensitivity to Hydrogen sulfide, Low sensitivity for other combustible gas. It is at a low cost and suitable for different applications. It has a built in potentiometer that allows you to adjust the sensor digital output (D0) threshold. This threshold sets the value above which the digital pin will output a HIGH signal. The voltage that the sensor outputs, changes depending on the concentration of the smoke/gas. This means that the greater the concentration, the greater the output voltage, and the lower the concentration, the lower the output voltage. The output can be an analog signal (A0) that can be read with an analog input of the Arduino or a digital output (D0) that can be read with a digital input of the Arduino. Once this D0 pin goes high, the Arduino will detect this and will trigger the LED to turn on, signaling that the H_2S threshold has been reached and is now over the limit.

Interfacing MQ-136 with Arduino

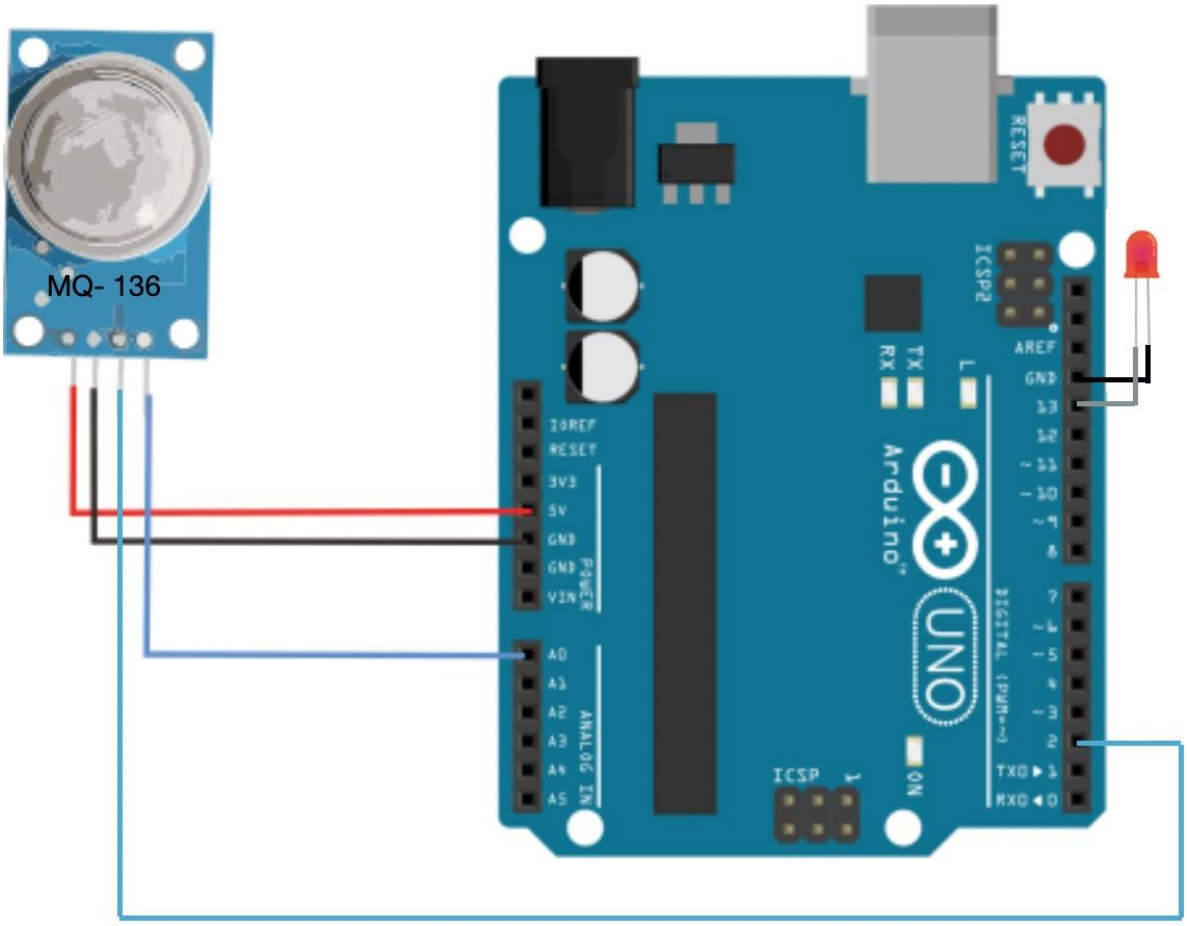


Figure 12 MQ 136 with Arduino

Connect your MQ2 sensor with the Arduino as shown in the above diagram.

1. Connect the VCC pin of the sensor to the 5V of the Arduino.

2. Connect the GND of the sensor to the GND of the Arduino.

3. Connect the digital pin of the sensor D0 to the digital pin number 2 of theArduino
4. Connect the analog pin of the sensor to the analog pin A0 of the Arduino.

5. A LED is connected to the Arduino to indicate the presence of H_2S gas

Arduino code

```
const int AOUTpin=0;//the AOUT pin of the methane sensor goes into analog pin A0 of the arduino
const int DOUTpin=2;//the DOUT pin of the methane sensor goes into digital pin D8 of the arduino
const int ledPin=13;//the anode of the LED connects to digital pin D13 of the arduino

int limit;
int value;

void setup() {
Serial.begin(9600);//sets the baud rate
pinMode(DOUTpin, INPUT);//sets the pin as an input to the arduino
pinMode(ledPin, OUTPUT);//sets the pin as an output of the arduino
}

void loop()
{
value= analogRead(AOUTpin);//reads the analaog value from the methane sensor's AOUT pin
limit= digitalRead(DOUTpin);//reads the digital value from the methane sensor's DOUT pin
Serial.print("Hydrogen Sulfide value: ");
Serial.println(value);//prints the methane value
Serial.print("Limit: ");
Serial.print(limit);//prints the limit reached as either LOW or HIGH (above or underneath)
delay(1000);
if (limit == HIGH){
digitalWrite(ledPin, HIGH);//if limit has been reached, LED turns on as status indicator
}
else{
digitalWrite(ledPin, LOW);//if threshold not reached, LED remains off
}
}
```

Figure 13 Arduino code for MQ 136

5. MQ- 137 Ammonia gas Sensor

Ammonia is a colorless highly irritating gas with a sharp suffocating odor. It dissolves easily in water to form ammonium hydroxide solution which can cause irritation and burns. Ammonia is a colorless highly irritating gas with a sharp suffocating odor. It dissolves easily in water to form ammonium hydroxide solution which can cause irritation and burns. Exposure to high

concentrations of ammonia in air causes immediate burning of the eyes, nose, throat and respiratory tract and can result in blindness, lung damage or death. Inhalation of lower concentrations can cause coughing, and nose and throat irritation.

Description

Figure 14 MQ 137

MQ-137 Gas Sensor can be used to monitor the concentration of Ammonia gas. This Module simplifies using the MQ-137 gas sensor by providing digital as well as analog output which can be interfaced to Microcontrollers, Arduino, and Raspberry pi. This MQ sensor is formed with a micro AL2O3 ceramic tube, a sensitive layer of tin dioxide (SnO2), measuring electrode, and heater, which are fixed into a crust of stainless steel net and plastic. The heater provides certain workconditions for sensitive components. The MQ137 sensor has six pins, four of them are used to fetch signals, while it used the other two for providing heating current.

Pin Configuration

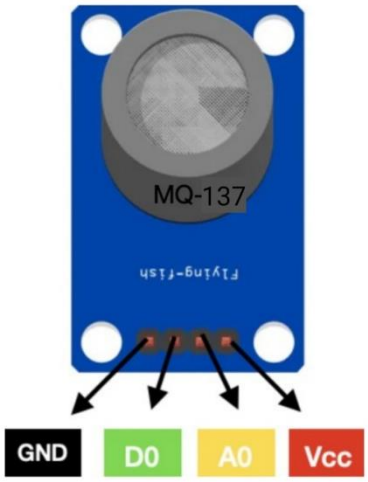


Figure 15 MQ 137 Pin Configuration

- **Vcc** : This is there to power the module, requires 5V

- **Ground** : To connect the module to the system's common ground

- **Digital Out (DO)** : Digital output pin, the Threshold value can be set byusing the potentiometer
- **Analog Out (AO)** : Analog output pin. Analog voltage based on the concentration of the gas

Features & Specifications

- Wide detecting scope
- Fast response (less than 1s)
- High sensitivity(3%)
- the circuit voltage: DC5V
- Stable and long life
- Analog output voltage: 0V to 5V
- Digital output voltage: 0V or 5V (TTL Logic)
- Can be used as a digital or analog sensor
- The sensitivity of digital output can be adjusted using an onboard potentiometer
- The TTL output valid signal is low. (When the output is low, the signal light is on, it can be directly connected to the MCU or relay module)
- The voltage of the analog output, the higher the concentration, the higher the voltage.
- Arduino compatible

MQ- 137 Working Principle

MQ-137 gas sensor has a high sensitivity to Ammonia, Low sensitivity for other combustible gas. It is at a low cost and suitable for different applications. It has a built-in potentiometer that allows you to adjust the sensor digital output (D0) threshold. This threshold sets the value above which the digital pin will output a HIGH signal. The voltage that the sensor outputs, changes depending on the concentration of the smoke/gas. This

means that the greater the concentration, the greater the output voltage, and the lower the concentration, the lower the output voltage. The output can be an analog signal (A0) that can be read with an analog input of the Arduino or a digital output (D0) that can be read with a digital input of the Arduino. Once this D0 pin goes high, the Arduino will detect this and will trigger the LED to turn on, signaling that the NH_3 threshold has been reached and is now overthe limit.

Interfacing MQ-137 with Arduino

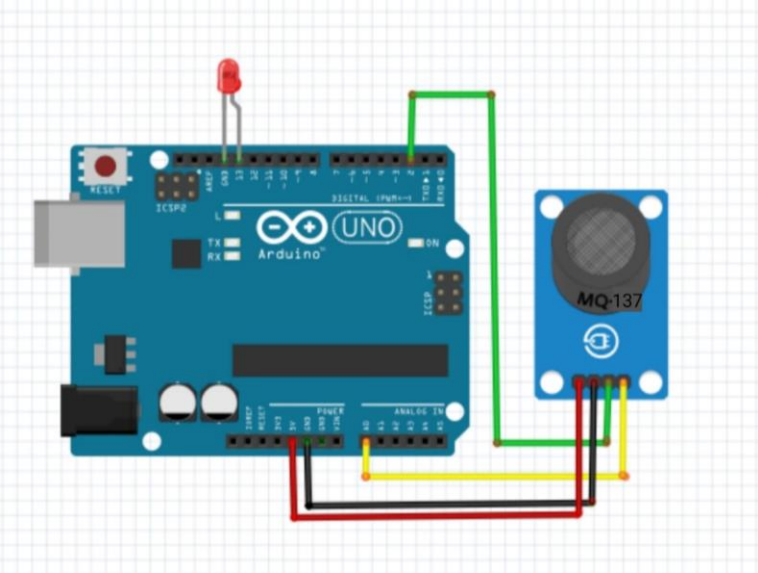


Figure 16 MQ 137 with Arduino

Connect your MQ137 sensor with the Arduino as shown in the above diagram.

1. Connect the VCC pin of the sensor to the 5V of the Arduino.

2. Connect the GND of the sensor to the GND of the Arduino.
3. Connect the digital pin of the sensor D0 to the digital pin number 2 of the Arduino
4. the analog pin of the sensor to the analog pin A0 of the Arduino.
5. A LED is connected to the Arduino to indicate the presence of NH_3 gas

Features & Specifications

- Wide detecting scope
- Fast response (less than 1s)
- High sensitivity(3%)
- the circuit voltage: DC5V
- Stable and long life
- Analog output voltage: 0V to 5V
- Digital output voltage: 0V or 5V (TTL Logic)
- Can be used as a digital or analog sensor
- The sensitivity of digital output can be adjusted using an onboard potentiometer
- The TTL output valid signal is low. (When the output is low, the signal light is on, it can be directly connected to the MCU or relay module)
- The voltage of the analog output, the higher the concentration, the higher the voltage.
- Arduino compatible

Arduino code

```
const int AOUTpin=0;//the AOUT pin of the methane sensor goes into analog pin A0 of the arduino
const int DOUTpin=2;//the DOUT pin of the methane sensor goes into digital pin D8 of the arduino
const int ledPin=13;//the anode of the LED connects to digital pin D13 of the arduino

int limit;
int value;

void setup() {
Serial.begin(9600);//sets the baud rate
pinMode(DOUTpin, INPUT);//sets the pin as an input to the arduino
pinMode(ledPin, OUTPUT);//sets the pin as an output of the arduino
}

void loop()
{
value= analogRead(AOUTpin);//reads the analaog value from the methane sensor's AOUT pin
limit= digitalRead(DOUTpin);//reads the digital value from the methane sensor's DOUT pin
Serial.print("Ammonium value: ");
Serial.println(value);//prints the methane value
Serial.print("Limit: ");
Serial.print(limit);//prints the limit reached as either LOW or HIGH (above or underneath)
delay(1000);
if (limit == HIGH){
digitalWrite(ledPin, HIGH);//if limit has been reached, LED turns on as status indicator
}
else{
digitalWrite(ledPin, LOW);//if threshold not reached, LED remains off
}
}
```

Figure 17 Arduino code for MQ 137

6. LM2596 3A Step-Down Voltage Regulator

Figure 18 LM2596 3A Step-Down Voltage Regulator

Description

The LM2596 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving a 3A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3V, 5V, 12V, and an adjustable output version.

Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation, and a fixed-frequency oscillator.

The LM2596 series operates at a switching frequency of 150 kHz thus allowing smaller sized filter components than what would be needed with lower frequency switching regulators. Available in a standard 5-lead TO-220

package with several different lead bend options, and a 5-lead TO-263 surface mount package.

Features and Specifications

• 3.3V, 5V, 12V, and Adjustable Output Versions

• Adjustable Version Output Voltage Range, 1.2V to 37V ‡4% Max Over Line and Load Conditions

• Available in TO-220 and TO-263 Packages

• Ensured 3A Output Load Current

• Input Voltage Range Up to 40V

• Requires Only 4 External Components

• Excellent Line and Load Regulation Specifications

• 150 kHz Fixed Frequency Internal Oscillator

• TTL Shutdown Capability

• Low Power Standby Mode, la Typically 80 MA

• High Efficiency

• Uses Readily Available Standard Inductors

• Thermal Shutdown and Current Limit Protection

7. 12-stage binary ripple counter

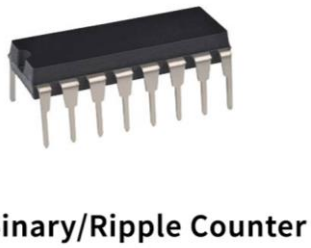


Figure 19 12-stage binary ripple counter

Description

The 74HC4040; 74HCT4040 are high-speed Si-gate CMOS devices and are pin compatible with the HEF4040B series. They are specified in compliance with JEDEC standard no. 7A. The 74HC4040; 74HCT4040 are 12-stage binary ripple counters with a clock input (CP), an overriding asynchronous master reset input (MR) and twelve parallel outputs (Q0 to Q11). The counter advances on the HIGH-to-LOW transition of CP. A HIGH on MR clears all counter stages and forces all outputs LOW, independent of the state of CP. Each counter stage is a static toggle flip-flop.

Features

- Multiple package options
- Complies with JEDEC standard no. 7A

- ESD protection
- HBM JESD22-A114-C exceeds 2000 V
- MM JESD22-A115-A exceeds 200 V
- Specified from −40 °C to +85 °C and from −40 °C to +125 °C

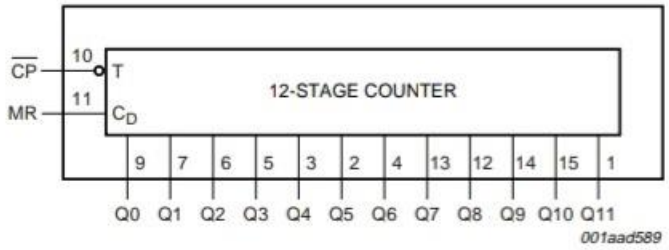


Fig 1. Functional diagram

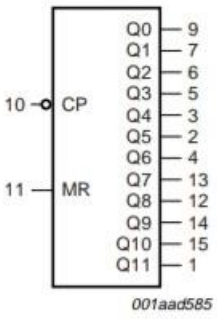


Fig 2. Logic symbol

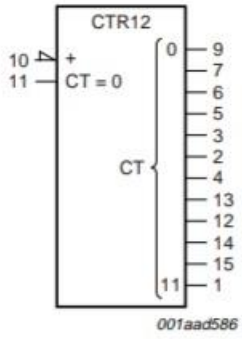


Fig 3. IEC logic symbol

Figure 20 Pin configuration

8. Buzzer

Figure 21 Buzzer

A buzzer is a practical sound feature used in various electronic devices and applications. It is a small 2-pin component that can fit on a breadboard. This is one of the reasons why it finds use in many electronic applications. This article will shed more light on the buzzer datasheet. You will learn about its pin configuration systems, how to use a buzzer, its features, and applications.

The **pin configuration of the buzzer** is shown below. It includes two pins namely positive and negative. The positive terminal of this is represented with the '+' symbol or a longer terminal. This terminal is powered through 6Volts whereas the negative terminal is represented with the '- 'symbol or short terminal and it is connected to the GND terminal.

Specifications

- Color is black
- The frequency range is 3,300Hz

- Operating Temperature ranges from – 20° C to +60°C
- Operating voltage ranges from 3V to 24V DC
- The sound pressure level is 85dBA or 10cm
- The supply current is below 15mA

Features

- With internal drive circuit
- Sealed structure
- Wave solderable and washable
- Housing material: Noryl

9. Seven-Segment Display

Description:

This 14.22-mm (0.56-in.) LED seven-segment display uses industry-standard size package and pinout. The device is available in either common anode or common cathode. The choice of colors includes High Efficiency Red (HER), Green, AlGaAs Red, and Yellow. The displays are suitable for indoor use.

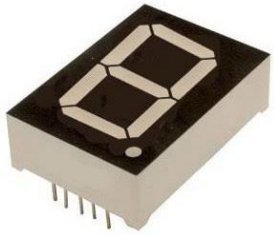


Figure 22 Seven-Segment Display

Features

- Industry standard size
- Industry standard pinout 14.22-mm (0.56-in.) DIP lead on 2.54 mm
- Choice of colors High Efficiency Red (HER), Green, AlGaAs Red, and Yellow
- Excellent appearance Evenly lighted segments package gives optimum contrast ± 50° viewing angle
- Design flexibility Common anode or common cathode Single digit Right-hand decimal point
- Categorized for luminous intensity Green and yellow categorized for color

10. 8-Digit LED Display Driver

Figure 23 8-Digit LED Display Driver

Description

The MAX7219 is an integrated serial input / output common-cathode display driver, it is connected to a microprocessor with 8-digit 7-segment digital LED display can also be connected to the bar graph display or 64 separate LED. On B BCD encoder including an on-chip, multi-channel scanning loop word drive, but also an 8 x 8 static RAM is used to store each data. Only one external register is used to set the current of each LED segment.

A convenient four-wire serial interface can connect all general-purpose microprocessor. Each data can be addressed in the update does not need to rewrite all the display. MAX7219 also allows the user to select on each data coding or non-coding.

The entire device contains a 150μA low-power shutdown mode, analog and digital brightness control, a scan-limit register allows the user to display the 1-8 bits of data, as well as a let all LED light detection mode.

Features

- A single module can drive an 8 * 8 common cathode lattice
- Module operating voltage: 5V

- Module size: 5 cm in length X width 3.2 cm x 1.5 cm
- Including four screws hole, aperture 3mm

11. LED

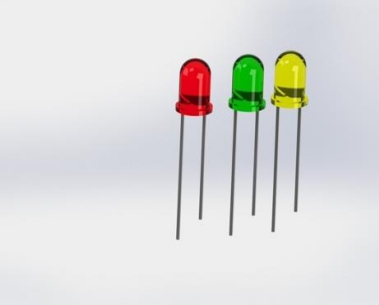


Figure 24 LED

Light-emitting diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices and are increasingly used for lighting. The series is specially designed for applications requiring higher brightness. The led lamps are available in different colors, intensities.

Specifications:-

- Diameter : 5mm
- Color: Green, yellow, red
- Forward voltage: 1.8 V to 2.2 V
- Peak Reverse Voltage : 5 volts
- Lens Color : Green, yellow, red

12. JHD204 20X4 Green LCD Display

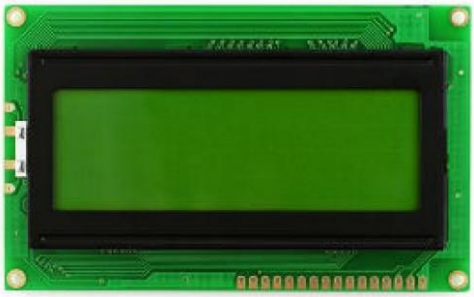


Figure 25 Green LCD Display

JHD204 is a 20X4(20 characters, 4 line) **Green Alphanumeric LCD Display.**

Alphanumeric displays are pretty neat. Use them for numbers, use them for letters, or both. They are a good size and brightness for easy reading. The decimal digits aren't connected, so keep that in mind when ordering.

Features

- Module size: - 146. 0*62. 5
- Character size: - 4. 84*9. 22
- Dot size: - 0. 92*1. 10
- Dot pitch: - 0. 51*0. 47
- Duty bias: - 1/16 - 1/5
- Backlight: - LED
- LCD type: - FSTN, STN
- Color: - yellow, green.

3 Programming code

```
#include <Wire.h>

#include <LiquidCrystal_I2C.h>

#include <LedControl.h>


LiquidCrystal_I2C lcd(0x27,20,4); // set the LCD address to 0x27 for a 16 chars and 2-line display


int MQ4 = A0; // select the analog input pin for the MQ4 sensor

int MQ7 = A1;

int MQ136 = A2;

int MQ137 = A3;

int BUZZER_pin =2;

int value;

int value1;

int value2;

int value3;

int value4;


float MQ4_R0;

float MQ7_R0;

float MQ136_R0;

float MQ137_R0;


int DIN_PIN = 13;

int CS_PIN= 12;

int CLK_PIN =11;
```

```
int clk_c=0;
int res_c=1;

const int BCD_A = 10;
const int BCD_B = 7;
const int BCD_C = 8;
const int BCD_D = 9;

// create an instance of the LedControl library
LedControl lc = LedControl(DIN_PIN, CLK_PIN, CS_PIN, 1);

float R0_calculation(byte sens_pin)
{
 float sensorValue;
 for(int i=0; i<50; i++)
 {
  sensorValue = sensorValue + analogRead(sens_pin);
 }
 sensorValue = sensorValue/50.0;
 float sensor_V = sensorValue*(5.0/1023.0);
 float RS_air = ((5.0*10.0)/sensor_V)-10;
 float R0 = RS_air/4.4;
 return R0;
}

//// function to calculate PPM of each gas from the voltage readings
```

```
double gas_PPM(byte sens_pin, float R0)
{
  float sensorValue = analogRead(sens_pin);
  float sensor_V = sensorValue*(5.0/1023.0);
  float RS_gas = ((5.0*10.0)/sensor_V)-10;
  float ratio = RS_gas/R0;
  double ppm_log = (log10(ratio)-1.133)/(-0.318);     //Get ppm value in linear scale
according to the ratio value
  double ppm = pow(10, ppm_log);          //Convert ppm value to log scale
  return ppm;
}


void show_number(int num)
{
  switch(num)
  {
   case 0:
    digitalWrite(BCD_A, LOW);
    digitalWrite(BCD_B, LOW);
    digitalWrite(BCD_C, LOW);
    digitalWrite(BCD_D, LOW);
    break;
    case 1:
    digitalWrite(BCD_A, HIGH);
    digitalWrite(BCD_B, LOW);
    digitalWrite(BCD_C, LOW);
    digitalWrite(BCD_D, LOW);
```

```
break;
case 2:
digitalWrite(BCD_A, LOW);
digitalWrite(BCD_B, HIGH);
digitalWrite(BCD_C, LOW);
digitalWrite(BCD_D, LOW);
break;
case 3:
digitalWrite(BCD_A, HIGH);
digitalWrite(BCD_B, HIGH);
digitalWrite(BCD_C, LOW);
digitalWrite(BCD_D, LOW);
break;
case 4:
digitalWrite(BCD_A, LOW);
digitalWrite(BCD_B, LOW);
digitalWrite(BCD_C, HIGH);
digitalWrite(BCD_D, LOW);
break;
case 5:
digitalWrite(BCD_A, HIGH);
digitalWrite(BCD_B, LOW);
digitalWrite(BCD_C, HIGH);
digitalWrite(BCD_D, LOW);
break;
case 6:
digitalWrite(BCD_A, LOW);
```

```
digitalWrite(BCD_B, HIGH);
digitalWrite(BCD_C, HIGH);
digitalWrite(BCD_D, LOW);
break;
case 7:
digitalWrite(BCD_A, HIGH);
digitalWrite(BCD_B, HIGH);
digitalWrite(BCD_C, HIGH);
digitalWrite(BCD_D, LOW);
break;
case 8:
digitalWrite(BCD_A, LOW);
digitalWrite(BCD_B, LOW);
digitalWrite(BCD_C, LOW);
digitalWrite(BCD_D, HIGH);
break;
case 9:
digitalWrite(BCD_A, HIGH);
digitalWrite(BCD_B, LOW);
digitalWrite(BCD_C, LOW);
digitalWrite(BCD_D, HIGH);
break;
default:
digitalWrite(BCD_A, LOW);
digitalWrite(BCD_B, LOW);
digitalWrite(BCD_C, LOW);
digitalWrite(BCD_D, LOW);
```

```
   break;
}
}


void setup ()
{

 //Calcuate R0 of each sensor after power ON
 MQ4_R0 = R0_calculation (MQ4);
 MQ7_R0 = R0_calculation (MQ4);
 MQ136_R0 = R0_calculation (MQ4);
 MQ137_R0 = R0_calculation (MQ4);

 lcd.init(); // initialize the LCD
 lcd.backlight(); // turn on the backlight
 lcd.clear();

 // initialize the LED matrix
 lc.shutdown(0, false); // turn on the display
 lc.setIntensity(0, 8); // set the brightness (0-15)
 lc.clearDisplay(0); // clear the display

 pinMode(clk_c,OUTPUT);
 pinMode(res_c,OUTPUT);

 pinMode(BCD_A  , OUTPUT);
```

```
  pinMode(BCD_B  , OUTPUT);
  pinMode(BCD_C  , OUTPUT);
  pinMode(BCD_D  , OUTPUT);
}

void loop () {

  value1= analogRead(MQ4);
  value2= analogRead(MQ7);
  value3= analogRead(MQ136);
  value4= analogRead(MQ137);

  //calcuate PPM of each gas/sensor
  double MQ4_PPM = gas_PPM(MQ4, MQ4_R0);
  double MQ7_PPM = gas_PPM(MQ7, MQ7_R0);
  double MQ136_PPM = gas_PPM(MQ136, MQ136_R0);
  double MQ137_PPM = gas_PPM(MQ137, MQ137_R0);

  lcd.setCursor(0,0); // set the cursor to the first column, first-row
  lcd.print("CH4:"+String(value1)+" PPM "); // print the text
  lcd.setCursor(0,1); // set the cursor to the first column, second-row
  lcd.print("CO:"+String(value2)+" PPM ");
  lcd.setCursor(0,2);
  lcd.print("H2S:"+String(value3)+" PPM ");
  lcd.setCursor(0,3);
  lcd.print("NH3:"+String(value4)+" PPM ");
```

```
 value= (value4*9)/220;   //The value of hazardous level of ammonia gas is 220ppm
 show_number(value) ;

 delay(100); // wait for 1 second


 //<---------------------- Buzzer linked with MQ-4----------------------------------------------------------
------->//
  // BUZZER rings if gas concentration crosses 1000PPM
 if(value1 > 50)
 {
  digitalWrite(BUZZER_pin, HIGH);
 }
 else{
  digitalWrite(BUZZER_pin, LOW);
 }


 if (value3>100)
 {
 lc.setRow(0, 0, B11111111); // row 0, column 0-7
 lc.setRow(0, 1, B11111111); // row 1, column 0-7
 lc.setRow(0, 2, B11111111); // row 2, column 0-7
 lc.setRow(0, 3, B00000000); // row 3, column 0-7
 lc.setRow(0, 4, B00000000); // row 4, column 0-7
 lc.setRow(0, 5, B00000000); // row 5, column 0-7
 lc.setRow(0, 6, B00000000); // row 6, column 0-7
```

```
lc.setRow(0, 7, B00000000); // row 7, column 0-7
}
else
{
lc.setRow(0, 0, B00000000); // row 0, column 0-7
lc.setRow(0, 1, B00000000); // row 1, column 0-7
lc.setRow(0, 2, B00000000); // row 2, column 0-7
lc.setRow(0, 3, B00000000); // row 3, column 0-7
lc.setRow(0, 4, B00000000); // row 4, column 0-7
lc.setRow(0, 5, B00000000); // row 5, column 0-7
lc.setRow(0, 6, B00000000); // row 6, column 0-7
lc.setRow(0, 7, B00000000); // row 7, column 0-7
}

if(value2<=50)
{
for(int i=0;i<15;i++)
{
digitalWrite(clk_c, HIGH);
delay(200); // Approximately 10% duty cycle @ 1KHz
digitalWrite(clk_c, LOW);
}
digitalWrite(res_c,HIGH);
delay(1000);
}

else if(50<value2<220)
```

```
 {
 for(int j=15;j<2160;j++)
 {
 digitalWrite(clk_c, HIGH);
 delay(200); //
 digitalWrite(clk_c, LOW);
 delay(800);
 }
 digitalWrite(res_c,HIGH);
 delay(1000);
 }

 else
 {
 for(int k=0;k<1920;k++)
 {
 digitalWrite(clk_c, HIGH);
 delay(200); // Approximately 10% duty cycle @ 1KHz
 digitalWrite(clk_c, LOW);
 delay(800);
 }
 digitalWrite(res_c,HIGH);
 delay(1000);
 }
}
```

4 Experiment

In this experiment we are using four different sensors and 4 different indication devices and an LCD device to show the final values in PPM. MQ 4 sensor for methane gas detection, when the permissible level is surpassed indicated by buzzer, MQ 7 sensor for carbon monoxide gas detection, when the permissible level is surpassed indicated by LED matrix MQ 136 for Hydrogen sulphide detection when the permissible level is surpassed indicated by LED array, MQ 137 for Ammonia detection when the permissible level is surpassed indicated by Seven segment display. All the sensors are connected to Arduino board and code is developed to program the sensors with their indication devices. Finally, the results are displayed on the LCD screen.

Threshold values

- For mq4, if ppm is more than 50 the buzzer will ring
- For mq7, if the ppm value is more than 50 then green LED will glow, if it's between 50 and 220 yellow LED glows and over 220 red LED glows
- For mq136, if ppm is greater than 100, 3 layers of led matrix glows
- For mq137, a single digit number corresponding the danger level will show on the seven-segment display

5. PCB Schematic

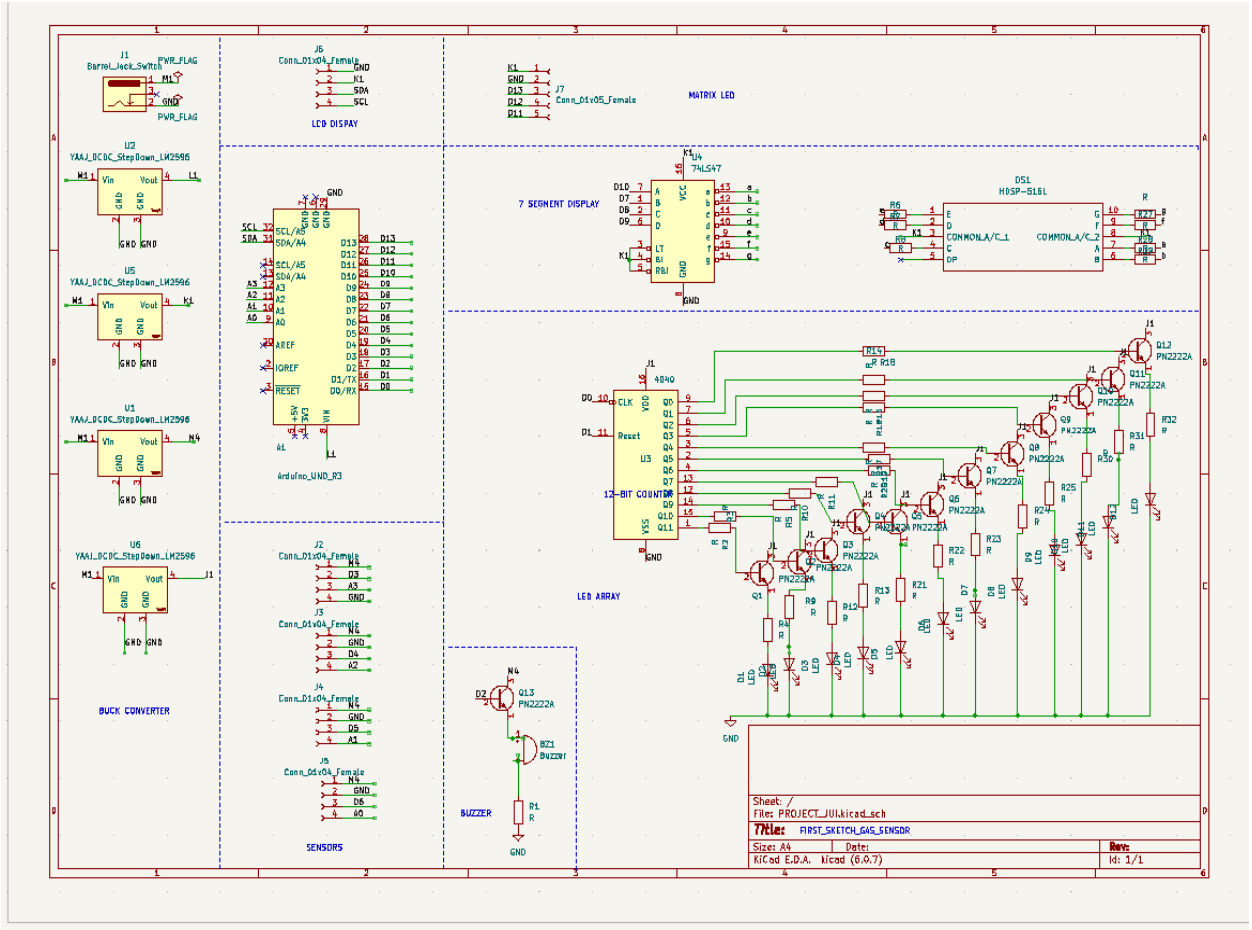


Figure 26 PCB Schematic

6. PCB Layout

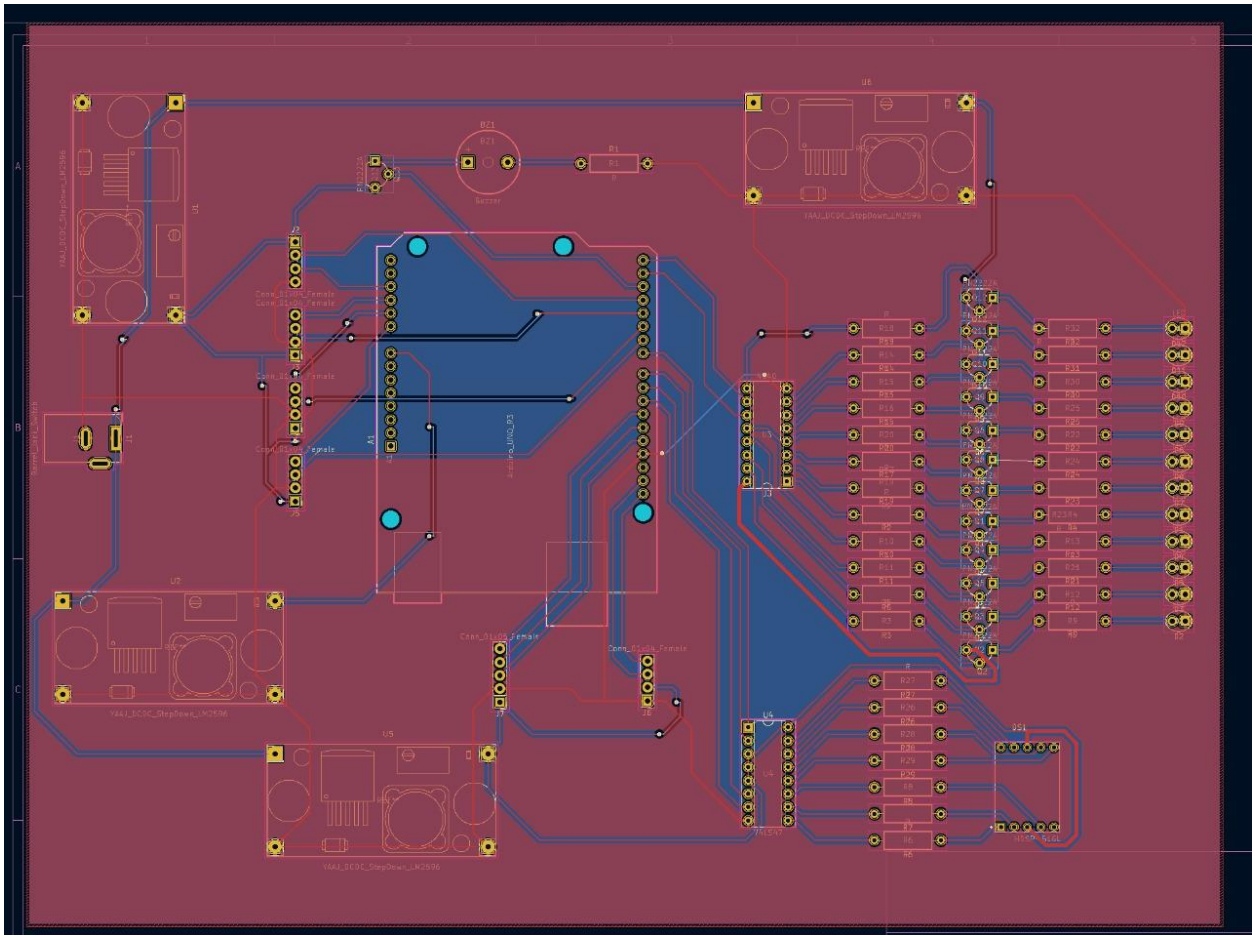


Figure 27 PCB LAYOUT

7. PCB Board

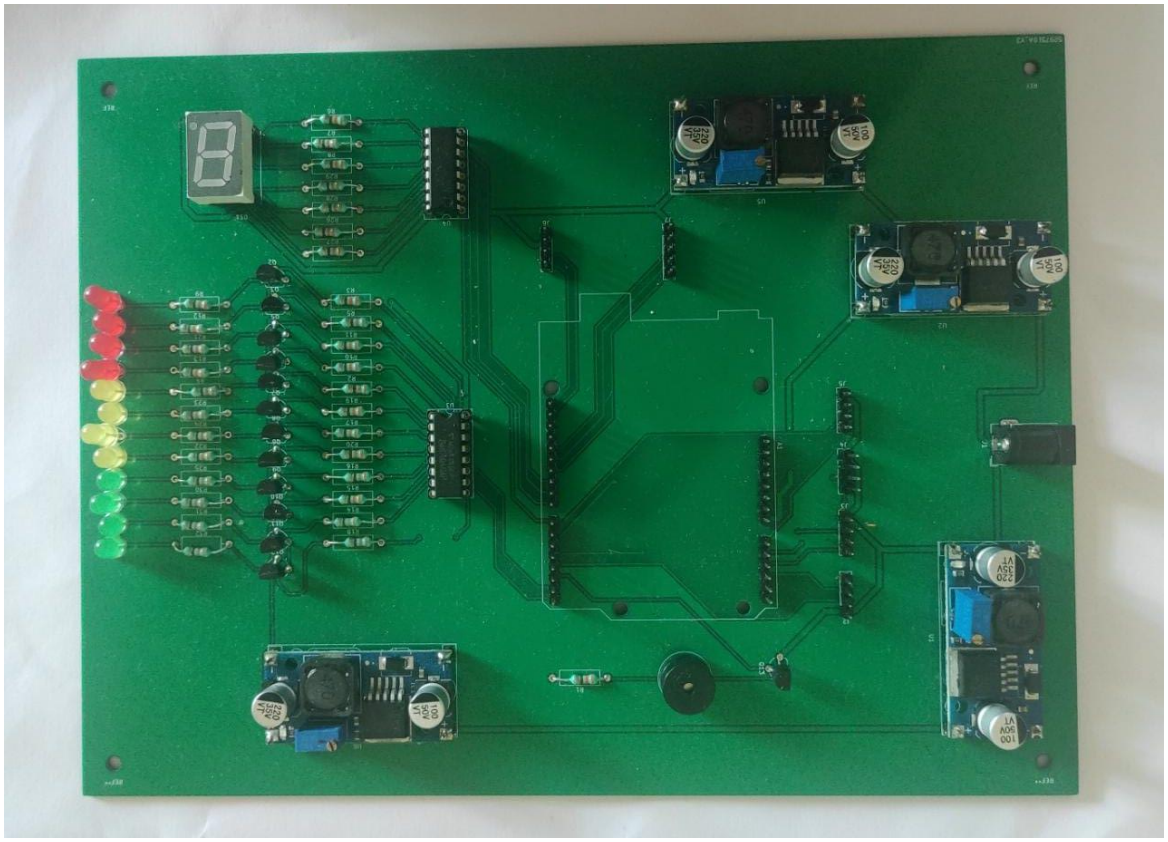


Figure 28 PCB Board

8. Results

MQ 4 (in ppm)	MQ 6 (in ppm)	MQ 136 (in ppm)	MQ 137(in ppm)	Buzzer	LED	LED matrix	seven segment display
11	67	42	43	No response	Green	No response	1
15	65	39	131	No response	Green	No response	5
10	161	38	57	No response	Green	No response	2
10	73	168	41	No response	Green	3 layers red	1
80	64	75	72	Will ring	Green	No response	2
92	59	34	41	Will ring	Green	No response	1
12	155	197	150	No response	Green	3 layers red	6
14	151	398	37	No response	Green	3 layers red	1
13	283	162	46	No response	Yellow	3 layers red	1

Experiment setup

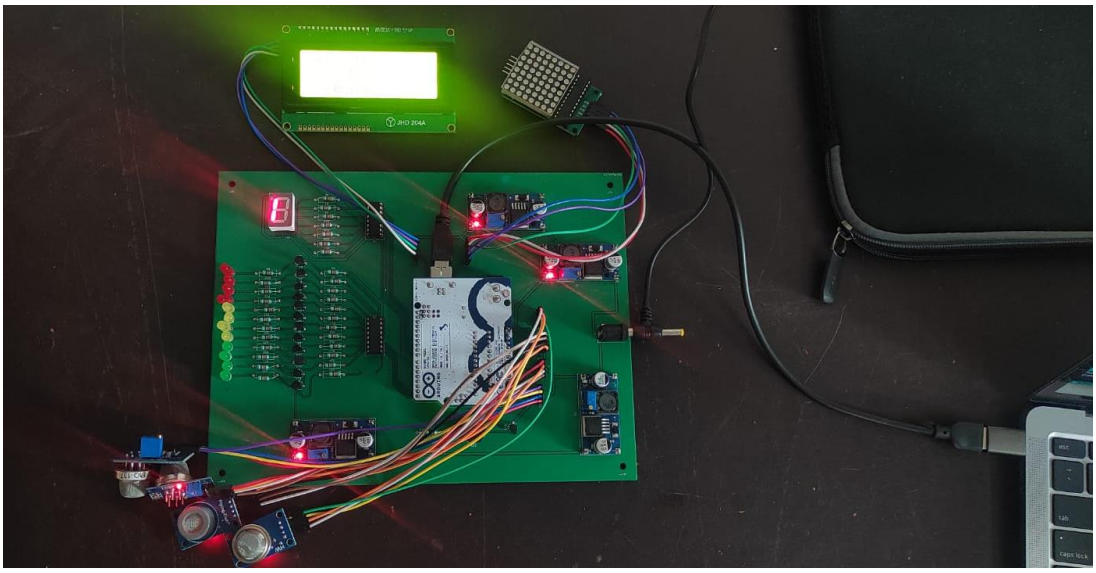


Figure 29 Experiment setup

Detection using LED matrix

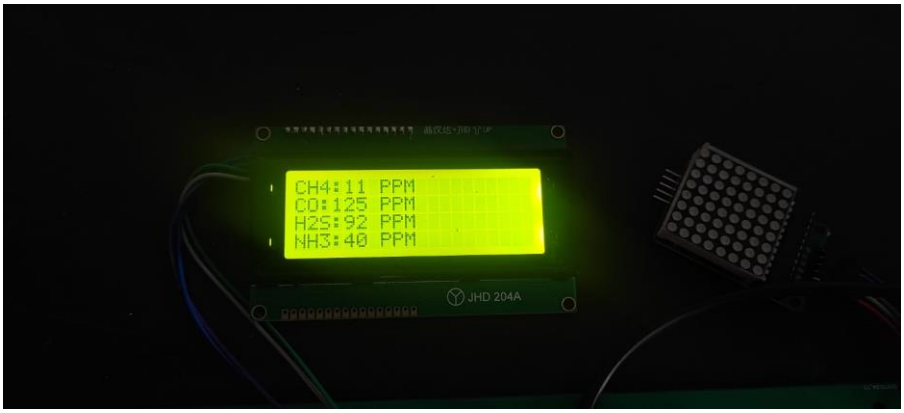


Figure 30 LED matrix off MQ-136

Figure 31 LED matrix 3 layers on H2S detection

Detection using Seven Segment Display

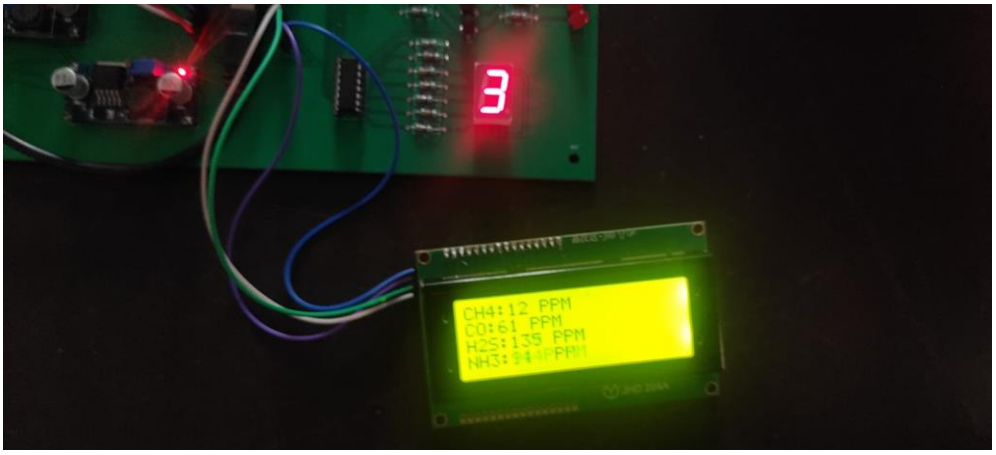


Figure 32 Detection using seven segment display NH3

Detection using LED array

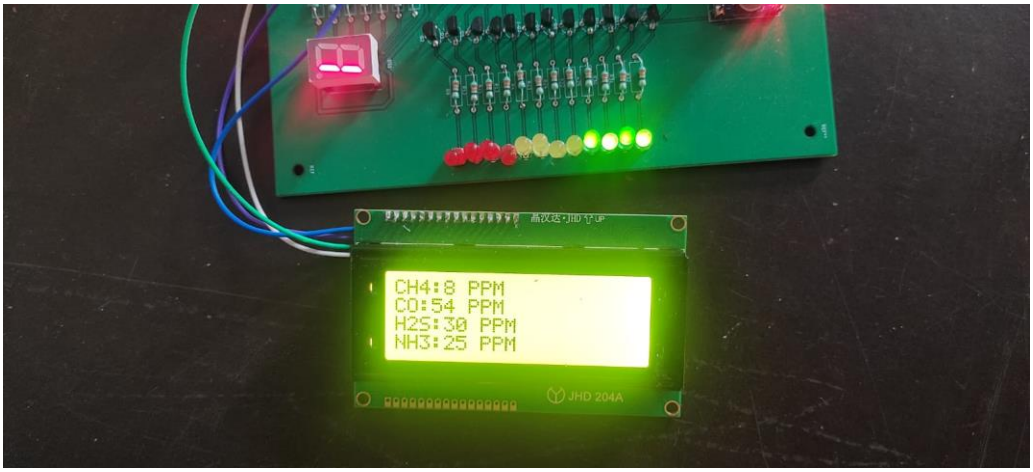


Figure 33 Detection using Led array

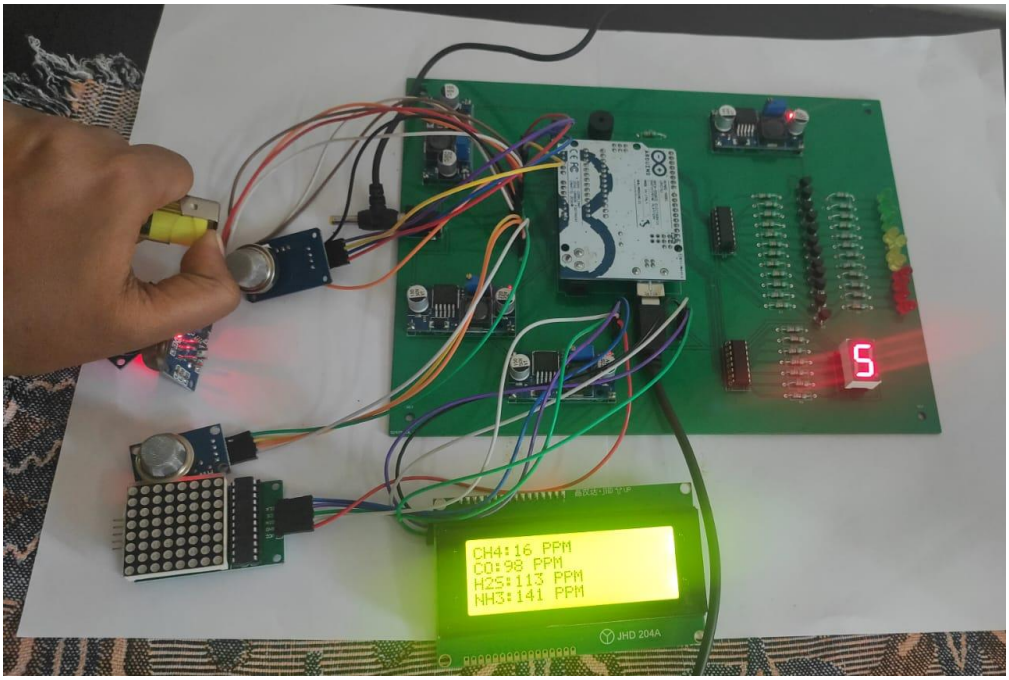


Figure 34 Arduino based sewage gases detection system

9 Conclusion

In this project, a low cost and less complex Arduino based sewage gas detection system is designed. The sensors are capable of measuring the gas

levels in all environments, by having various outputs to alert the sewage workers of hazardous levels of gases. It will be helpful in monitoring the air pollution of the sewage so that necessary action be taken. The toxic gases cause long-term health problems if exposed for a longer period of time. The absence of information leads to death of the innocent workers. So, this is a small initiative from our side, in order to alert the sanitation workers about the toxic sewer gases.

10 References

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