İZMİR KATİP ÇELEBİ UNIVERSITY
FACULTY OF ENGINEERING AND ARCHITECTURE
DEPARTMENT OF MECHATRONICS ENGINEERING

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FACULTY OF ENGINEERING AND ARCHITECTURE

MECHATRONICS ENGINEERING

INSTRUMENTATION

FINAL PROJECT

ÖMER ŞERİF KARAKURT 160412051

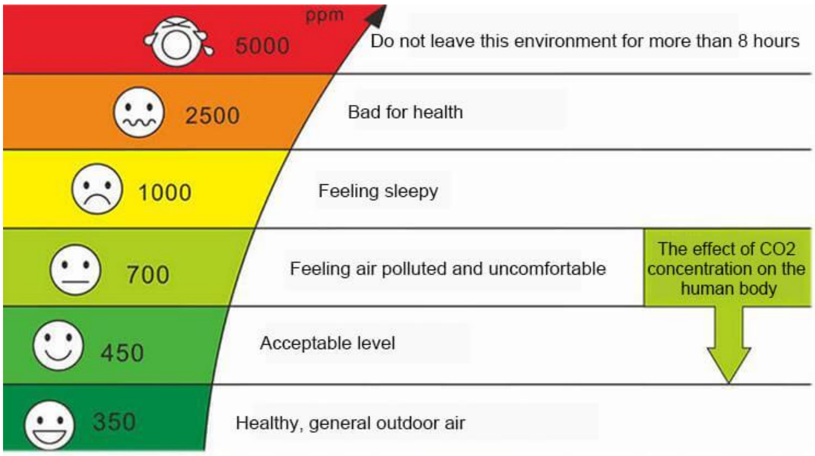
AYANA TLEULENOVA 160412059

ABDUSSAMET ŞİRİN 180412065

ATA BARIŞ KAPLAN 170412040

Introduction:

In this project we will make a carbondioxide particule sensor that will work with thermopile sensor.Generally, when we look at this kind of applications nowadays ,IR sensors are being used so we decided to use it as well. Moreover, the other reason we used this sensor is that, it has integrated filter inside, that can measure approximately 4.26 um signals.



Carbon Dioxide measuring devices have to be each house, since exaggeration of it can be harmful to human health. So, humanbeing can be affected by it, without even realizing it.

The Working Principle:

So, carbon dioxide reacts at this wavelength without being affected by other gases. Carbon dioxide and other gases consisting of two or more dissimilar atoms absorb infrared (IR) radiation in a characteristic, unique manner. Such gases are detectable using IR techniques.Water vapor, methane, carbon dioxide, and carbon monoxide are examples of gases that can be measured with an IR sensor. The key components of an IR CO_2 detector are light source,measurement chamber,interference filter, and IR detector. IR radiation is directed from the light source through the measured gas to the detector. A filter located in front of the detector prevents wavelengths other than that specific to the measured gas from passing through to the detector.The light intensity is detected and converted into a gas concentration value.

List of Materials:

- Zener diode

- Capacitors (0.1uf)
- Lm741 Op-amp

- Tungsten light source (2.5V-12V)
- Thermopile Sensor

- Arduino Uno

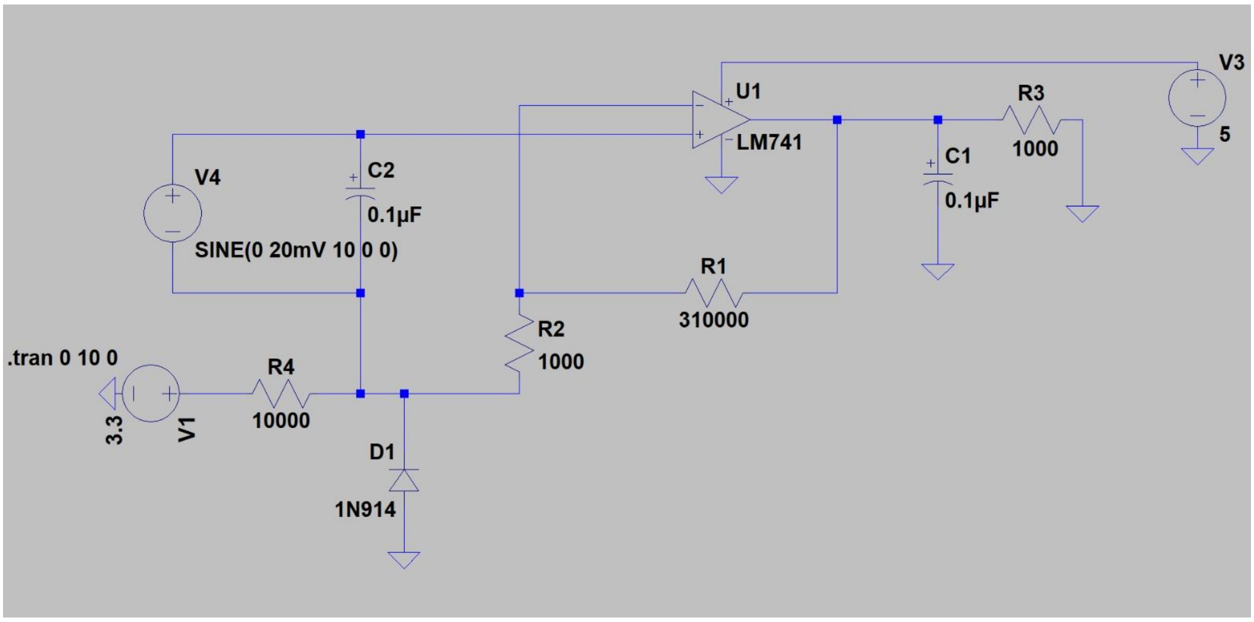
Circuit Design:

We created curcuit by non-inverting Amplifier. According to the Voltage Rule, the voltage at the inverting (-) input will be the same as at the non-inverting (+) input, which is the applied voltage Vin.

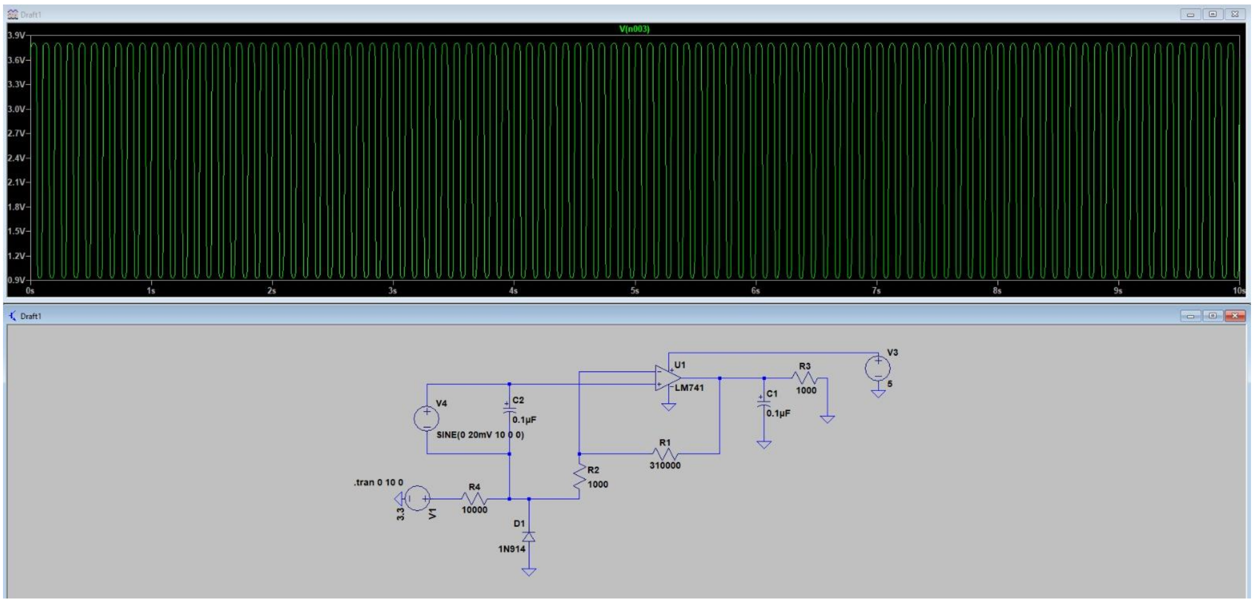
The closed loop voltage gain of a Non-inverting Operational Amplifier will be given as:

$$A_v = 1 + \frac{R_f}{R_2}$$

So, our gain equals to 311.

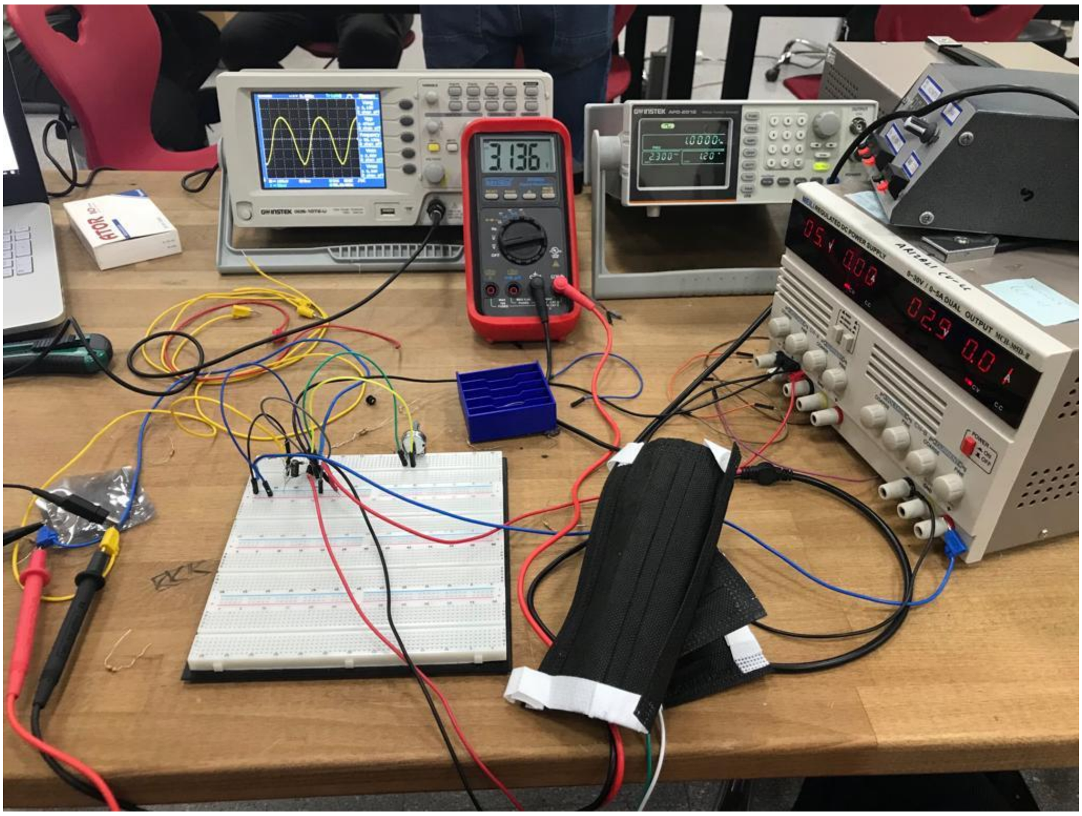


Simulation:

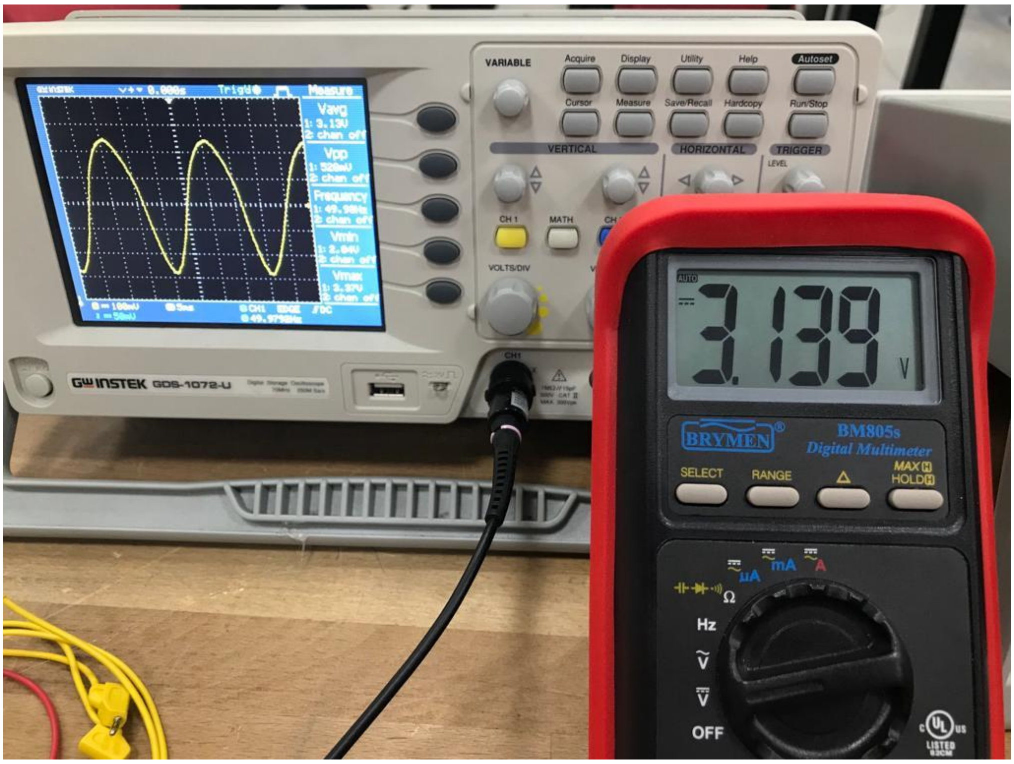


Procedure:

Data collected from Lab:



We gave square wave signal from signal generator, frequency 1 kHz, Amplitude 2.3 V and offset 1.20 V. So we obtained sinusoidal signal from output of op-amp. Results we obtained:

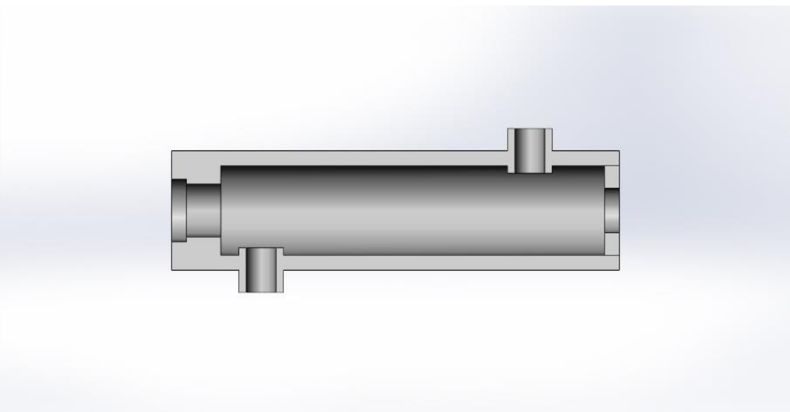


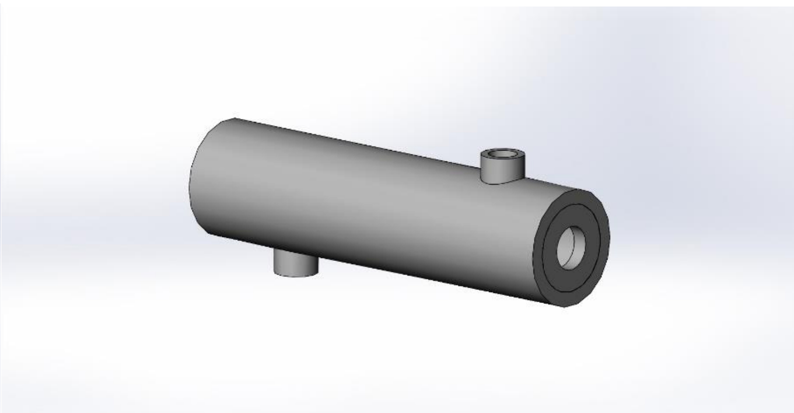
$V_{avg} = 3.13V$ $V_{pp} = 532\ mV$ $V_{min} = 2.84\ V$ $V_{max} = 3.37V$ f=50Hz

When we blew aside Thermopile, the voltage increases.

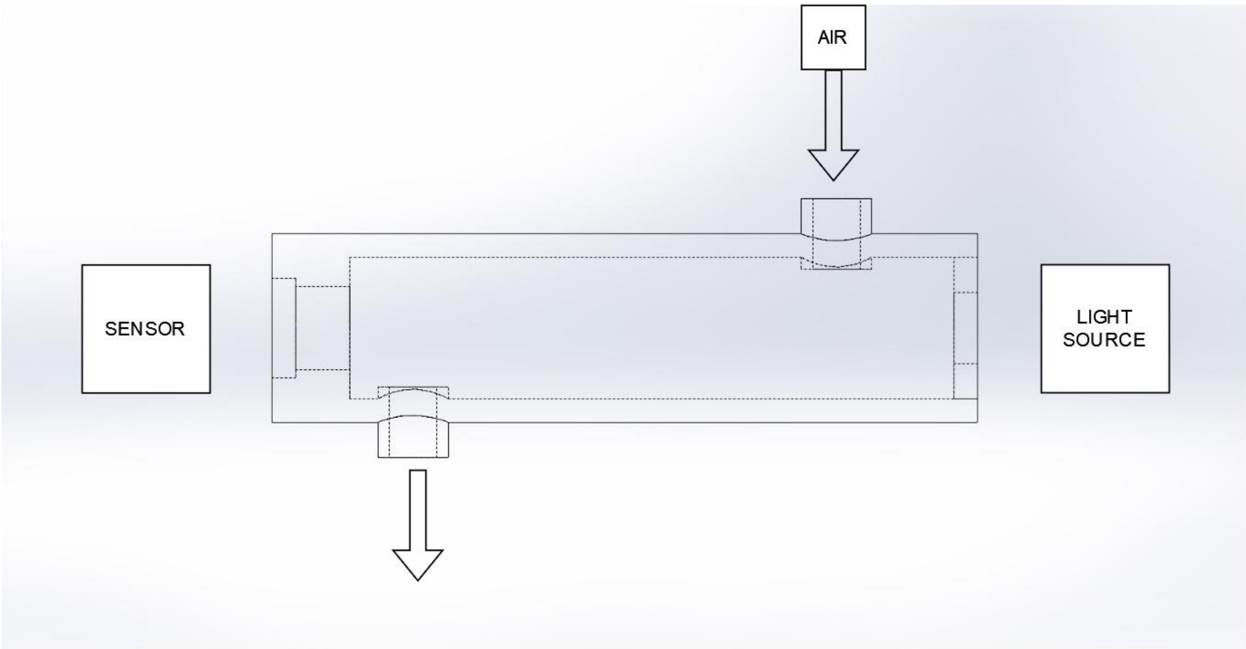
Manufacturing Process:

Thermopile`s case was be printed on 3D Printer. Here is it`s technical drawing:

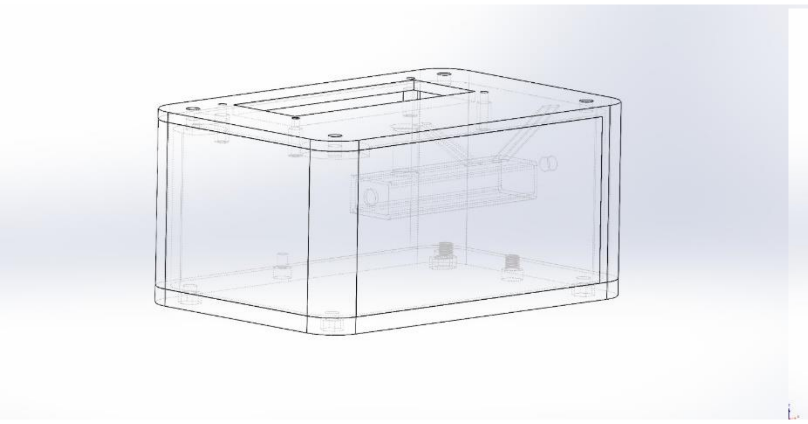


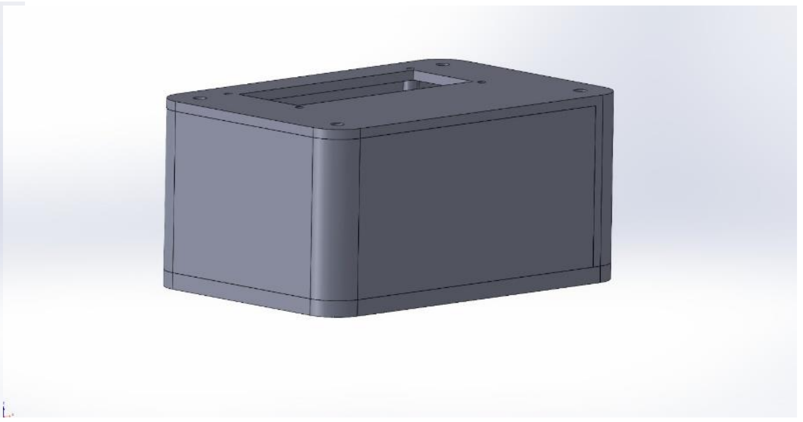


Here is the view on working principle of the case:

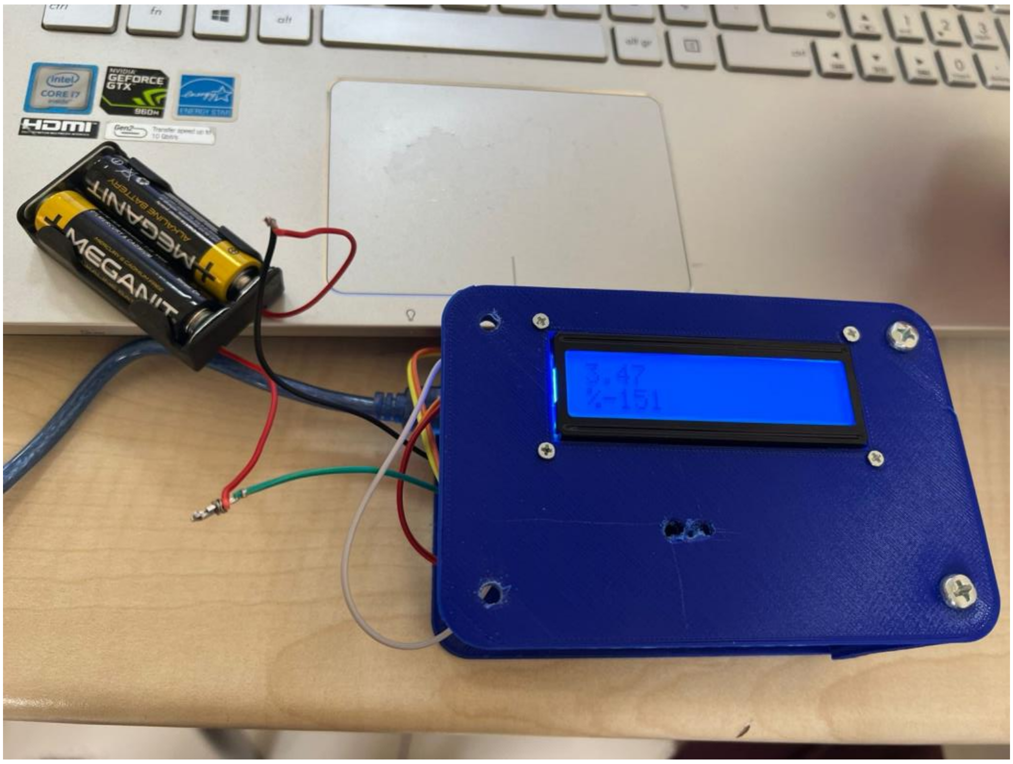


Furthermore, there is technical drawing for the case of our device:



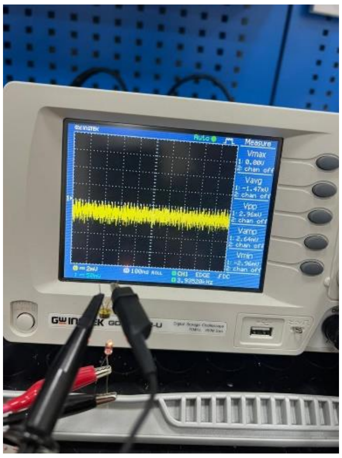


Here is photo of our finished prototype:



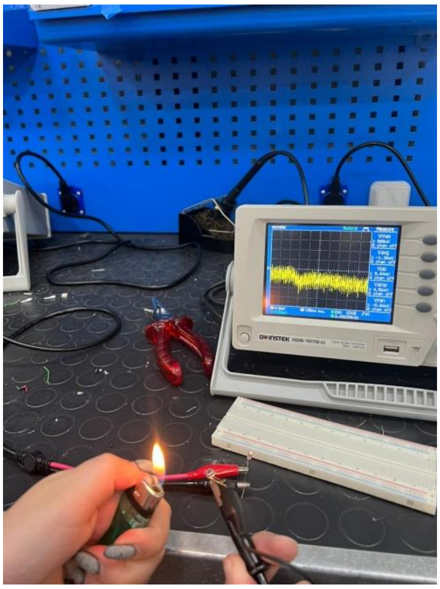
We calibrated Thermopile, due to done research, percentage of Carbon Dioxide in the air is 0.04, and when we blow aside Thermopile, it increases by 5%.

Conclusion:



In this project we learned how to use thermopile sensor to find co2 particles in the environment we wish. Even we had hard times reaching the crisp results, we spent so many times in the lab trying to make our design to get working so that really helped us for understanding the sensor we use more. As a problem we can say that we didn't get meaningful data from the oscilloscope for a long time.

The reason for it was probably noise or some short circuit in our structure so it cost us really big amount of time to figure out. Moreover, we repeated the measurement operation by using lighter, so that we can detect meaningful signal from the sensor, but it happened again.



After experiencing those issues, we made our final circuit design and it worked out fine so even though we didn't figure out what was the exact problem causing it, things were okay at the end.

Appendix

Arduino code:

```
#include <LiquidCrystal_I2C.h>
#include <Wire.h>

LiquidCrystal_I2C lcd(0x27,16,2);  // set the LCD address to 0x3F for a 16 chars and 2 line display

int thermopile = A0;
int sampleSize = 10;
int sampleRate = 10;
int percentage=0;

int myArray[10];
float average = 0;
int sum=0;
int maxVal = 0; //set low so any value read will be higher
int minVal = 1024; //set arbitrarily high so any value read will be lower


void setup() {
 lcd.init();
 lcd.backlight();      // Make sure backlight is on

 Serial.begin( 9600 );

}

void loop() {
 int value;
   float volt;
delay( 500 );


for(int i=0; i < sampleSize; i++)
{
myArray[i] = analogRead(0);

if(myArray[i] >= maxVal)
maxVal = myArray[i];

if(myArray[i] <= minVal)
minVal = myArray[i];
```

```
delay(sampleRate);
}

for(int i; i < sampleSize; i++)
{

 sum = sum + myArray[i];
}

average = ( sum - (maxVal+minVal))/(sampleSize-2);


   Serial.print( "analog: " );
   Serial.print( thermopile );

delay( 500 );

   value = analogRead( thermopile );

   volt = value * 5.0 / 1023.0;


    percentage = map(value, 840, 700, 0.4, 3);

   Serial.print( "Value: " );
   Serial.print( value );
   Serial.print( "  Volt: " );
   Serial.println( volt );


  // Print a message on both lines of the LCD.
  lcd.setCursor(0,0);   //Set cursor to character 2 on line 0
  lcd.print(value);

  lcd.setCursor(0,1);   //Move cursor to character 2 on line 1
  lcd.print("%");
  lcd.print(percentage);

   delay( 500 );
}
```