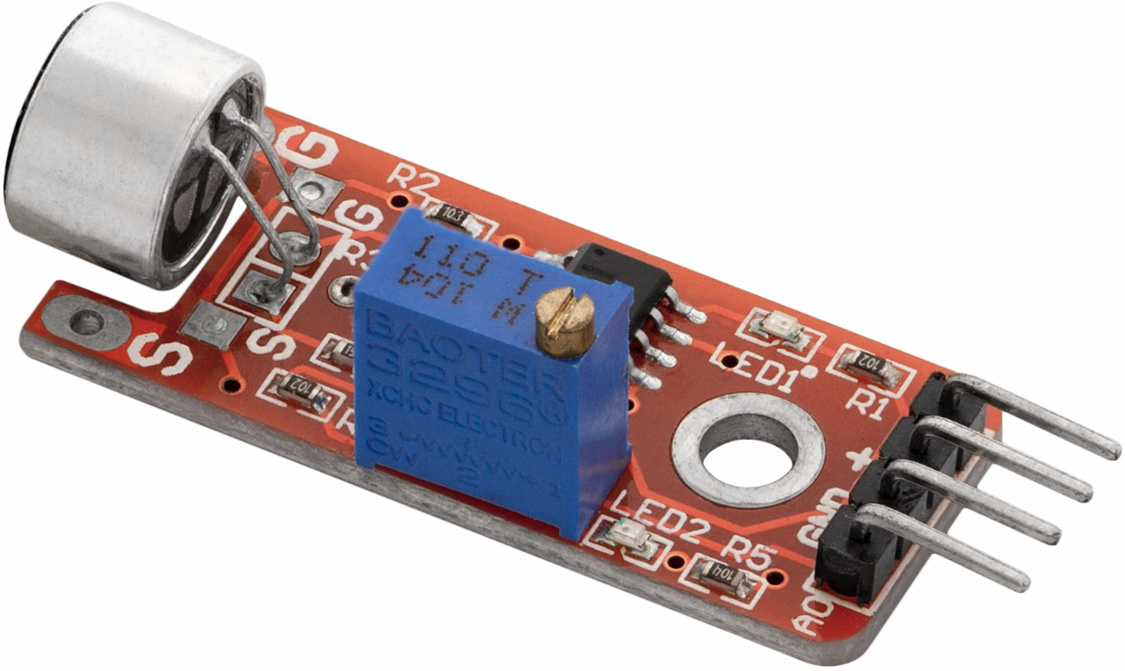
Welcome!

Thank you for purchasing our *AZ-Delivery KY-037 Big Microphone Module.* On the following pages, you will be introduced to how to use and set up this handy device.

Have fun!



Areas of application

Education and teaching: Use in schools, universities and training institutions to teach the basics of electronics, programming and embedded systems. Research and development: Use in research and development projects to create prototypes and experiments in the fields of electronics and computer science. Prototype development: Use in the development and testing of new electronic circuits and devices. Hobby and Maker Projects: Used by electronics enthusiasts and hobbyists to develop and implement DIY projects.

Required knowledge and skills

Basic understanding of electronics and electrical engineering. Knowledge of programming, especially in the C/C++ programming language. Ability to read schematics and design simple circuits. Experience working with electronic components and soldering.

Operating conditions

The product may only be operated with the voltages specified in the data sheet to avoid damage. A stabilized DC power source is required for operation. When connecting to other electronic components and circuits, the maximum current and voltage limits must be observed to avoid overloads and damage.

Environmental conditions

The product should be used in a clean, dry environment to avoid damage caused by moisture or dust. Protect the product from direct sunlight (UV)

Intended Use

The product is designed for use in educational, research and development environments. It is used to develop, program and prototype electronic projects and applications. The Sensor product is not intended as a finished consumer product, but rather as a tool for technically savvy users, including engineers, developers, researchers and students.

Improper foreseeable use

The product is not suitable for industrial use or safety-relevant applications. Use of the product in medical devices or for aviation and space travel purposes is not permitted

disposal

Do not discard with household waste! Your product is according to the European one Directive on waste electrical and electronic equipment to be disposed of in an environmentally friendly manner. The valuable raw materials contained therein can be recycled become. The application of this directive contributes to environmental and health protection. Use the collection point set up by your municipality to return and Recycling of old electrical and electronic devices. WEEE Reg. No.: DE 62624346

electrostatic discharge

Attention: Electrostatic discharges can damage the product. Note: Ground yourself before touching the product, such as by wearing an anti-static wrist strap or touching a grounded metal surface.

safety instructions

Although our product complies with the requirements of the RoHS Directive (2011/65/EU) and does not contain any hazardous substances in quantities above the permitted limits, residues may still be present. Observe the following safety instructions to avoid chemical hazards: Caution: Soldering can produce fumes that can be harmful to health. Note: Use a solder fume extractor or work in a well-ventilated area. If necessary, wear a respirator mask. Caution: Some people may be sensitive to certain materials or chemicals contained in the product. Note: If skin irritation or allergic reactions occur, stop use and, if necessary, consult a doctor. Caution: Keep the product out of the reach of children and pets to avoid accidental contact and swallowing of small parts. Note: Store the product in a safe, closed container when not in use. Attention: Avoid contact of the product with food and drinks. Note: Do not store or use the product near food to prevent contamination. Although our product complies with the requirements of the RoHS Directive (2011/65/EU) and does not contain any hazardous substances in quantities above the permitted limits, residues may still be present. Observe the following safety instructions to avoid chemical hazards: Caution: Soldering can produce fumes that can be harmful to health. Note: Use a solder fume extractor or work in a well-ventilated area. If necessary, wear a respirator mask. Caution: Some people may be sensitive to certain materials or chemicals contained in the product. Note: If skin irritation or allergic reactions occur, stop use and, if necessary, consult a doctor. Caution: Keep the product out of the reach of children and pets to avoid accidental contact and swallowing of small parts. Note: Store the product in a safe, closed container when not in use. Attention: Avoid contact of the product with food and drinks. Note: Do not store or use the product near food to prevent contamination. The product contains sensitive electronic components and sharp edges. Improper handling or assembly can result in injury or damage. Observe the following safety instructions to avoid mechanical hazards: Attention: The product‘s circuit board and connectors may have sharp edges. Use caution to avoid cuts. Note: Wear appropriate protective gloves when handling and assembling the product. Caution: Avoid excessive pressure or mechanical stress on the board and components. Note: Only mount the product on stable and flat surfaces. Use appropriate spacers and housings to minimize mechanical stress. Attention: Make sure the product is securely fastened to prevent accidental slipping or falling. Note: Use appropriate support or secure mounting in enclosures or on mounting plates. Caution: Make sure all cable connections are connected securely and correctly to avoid strain and accidental unplugging. Note: Route cables so that they are not under tension and do not pose a tripping hazard. The product operates with electrical voltages and currents that, if used improperly, can result in electric shocks, short circuits or other hazards. Observe the following safety instructions to avoid electrical hazards: Attention: Use the product only with the specified voltages. Note: The performance limits of the product can be found in the associated data sheet Caution: Avoid short circuits between the connectors and components of the product Note: Make sure that no conductive objects touch or bridge the circuit board. Use insulated tools and pay attention to the arrangement of connections. Caution: Do not perform any work on the product when it is connected to a power source. Note: Disconnect the product from power before making any circuit changes or connecting or removing components. Caution: Do not exceed the specified current ratings for the product‘s inputs and outputs. Note: The performance limits of the product can be found in the technical specifications or in the data sheet Attention: Make sure that the power sources used are stable and correctly sized. Note: Only use tested and suitable power supplies to avoid voltage fluctuations and overloads. Attention: Maintain sufficient distance from live parts to avoid accidental contact. Note: Ensure that the cabling is arranged safely and clearly according to the voltage used. Caution: Use insulating housings or protective covers to protect the product from direct contact. Note: Place the product in a non-conductive case to avoid accidental touching and short circuits. The product and the components on it may become warm during operation. Improper handling or overloading the product can result in burns, damage or fire. Observe the following safety instructions to avoid thermal hazards: Caution: Make sure the product is used within recommended operating temperatures. Note: The recommended operating temperature range is typically between-40°C and +85°C. Check the specific information in the product data sheet. Attention: Do not place the product near external heat sources such as radiators or direct sunlight. Note: Ensure that the product is operated in a cool and well-ventilated area. Attention: Make sure the product is well ventilated to avoid overheating. Note: Use fans or heat sinks when operating the product in a closed enclosure or in an environment with limited air circulation. Attention: Mount the product on heat-resistant surfaces and in heat-resistant housings. Note: Use enclosure materials that can withstand high temperatures to avoid damage or fire hazard. Caution: Implement temperature monitoring when using an enclosure and, if necessary, protection mechanisms that shut down the product if it overheats. Note: Note: Use temperature sensors and appropriate software to monitor the temperature of the product and shut down the system if necessary. Caution: Avoid overloads that can cause excessive heating of components. Note: To prevent overheating, do not exceed the specified current and voltage limits. Caution: Short circuits can generate significant heat and cause fires. Note: Make sure that all connections are correct and secure and that no conductive objects can accidentally cause short circuits.

Table of Contents

Introduction

The KY-037 big microphone module has the capacitive electret microphone, a few resistors, two LEDs, a potentiometer and an LM393 analog voltage comparator.

The capacitive electret microphone is a sound sensor - a component that converts sound waves into electrical signals. The sensor detects the sound wave intensity in the environment. This kind of microphone has a thin film (like thin foil) of the electret (dielectric) material which vibrates on sound waves. The capacitance of the thin film changes with vibrations, which cause the corresponding analog voltage change. Since the analog voltage change is weak, it has to be amplified. The LM393 and a few resistors are in charge of the amplification.

Specifications

»	Operating voltage range:	from 3.3V to 5V DC
»	Output:	digital and analog
»	Frequency range:	from 100Hz to 10.000Hz
»	Sensitivity:	-46 ± 2.0 (0 dB = 1V/Pa) at 1kHz
»	Sensitivity to Noise Ratio:	58dB
»	Dimensions:	15 x 36 x 13mm [0.6 x 1.4 x 0.51in]

There are two LEDs on-board the module, one for indicating power supply and one for indicating the intensity of the sound.

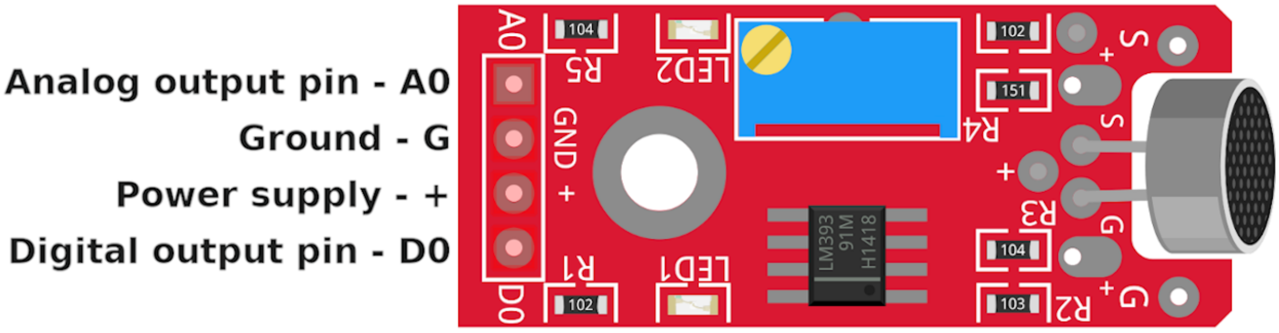
The analog output pin voltage sensitivity can be adjusted via an on-board blue potentiometer. With some adjustment of the potentiometer, when the analog voltage is read via analog to digital converter (ADC for short), the digital value of the voltage is around the value *595*, and that is when there is not sound near the KY-037 module.

When there is a sound near the sensor, the ADC value changes dramatically around the value *595*, rise and drop a few times. This happens because of the nature of sound waves. This can be seen on the image of the Serial Plotter (later in the text).

The state when the digital output pin outputs the *HIGH* state (is turned *ON*) is the state when the ADC value is grater than the value of *700.*

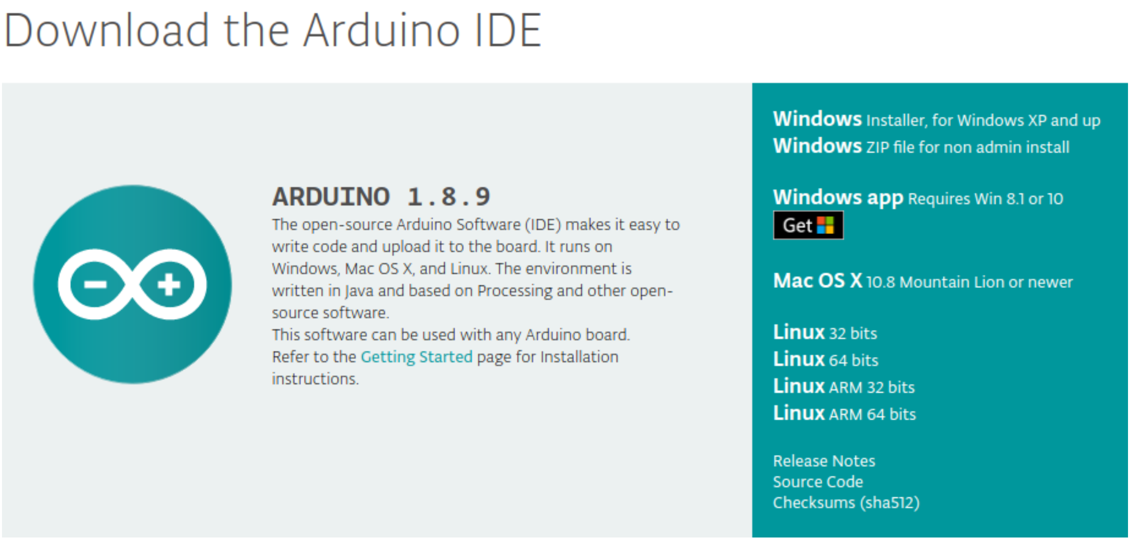
The pinout

The KY-037 big microphone module has four pins. The pinout diagram is shown on the following image:



How to set-up Arduino IDE

If the Arduino IDE is not installed, follow the *link* and download the installation file for the operating system of choice.



Download the Arduino IDE

ARDUINO 1.8.9

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.
This software can be used with any Arduino board.
Refer to the Getting Started page for Installation instructions.

Windows Installer, for Windows XP and up
Windows ZIP file for non admin install

Windows app Requires Win 8.1 or 10
Get

Mac OS X 10.8 Mountain Lion or newer

Linux 32 bits
Linux 64 bits
Linux ARM 32 bits
Linux ARM 64 bits

Release Notes
Source Code
Checksums (sha512)

For `Windows` users, double click on the downloaded *`.exe`* file and follow the instructions in the installation window.

For *Linux* users, download a file with the extension *.tar.xz*, which has to be extracted. When it is extracted, go to the extracted directory and open the terminal in that directory. Two *.sh* scripts have to be executed, the first called *arduino-linux-setup.sh* and the second called *install.sh*.

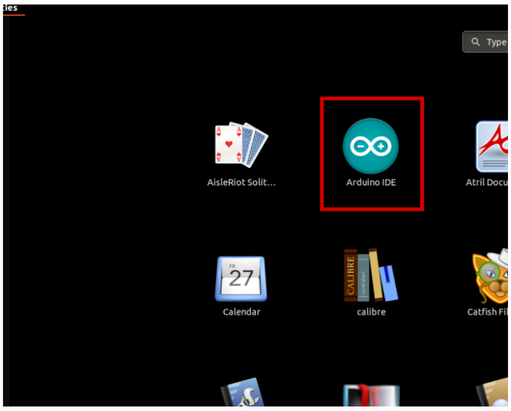
To run the first script in the terminal, open the terminal in the extracted directory and run the following command:

```
sh arduino-linux-setup.sh user_name
```

user_name - is the name of a superuser in the Linux operating system. A password for the superuser has to be entered when the command is started. Wait for a few minutes for the script to complete everything.

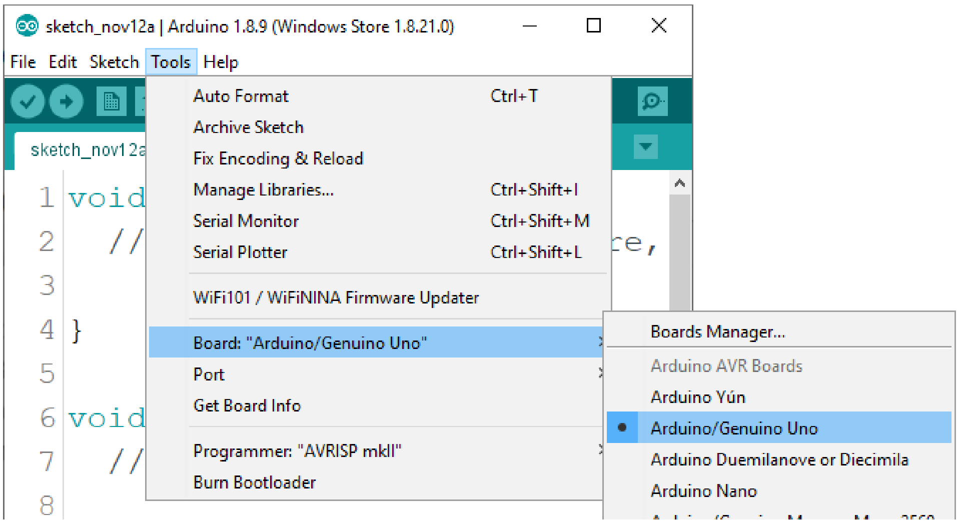
The second script called *install.sh* script has to be used after installation of the first script. Run the following command in the terminal (extracted directory): **sh install.sh**

After the installation of these scripts, go to the *All Apps*, where the *Arduino IDE* is installed.



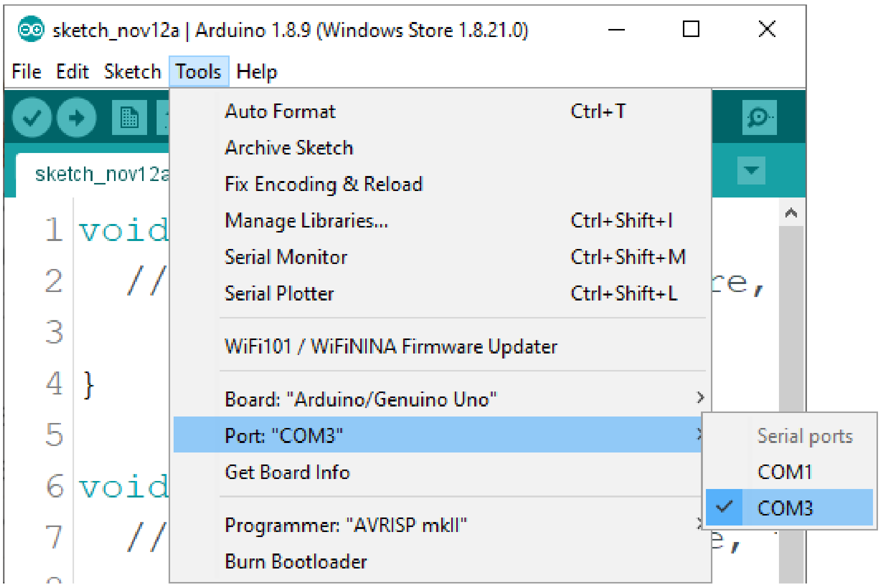
Almost all operating systems come with a text editor preinstalled (for example, *`Windows`* comes with *`Notepad`*, *`Linux Ubuntu`* comes with *`Gedit`*, *`Linux Raspbian`* comes with *`Leafpad`*, etc.). All of these text editors are perfectly fine for the purpose of the eBook.

Next thing is to check if your PC can detect an Atmega328p board. Open freshly installed Arduino IDE, and go to:
`Tools > Board > {your board name here}`
`{your board name here}` should be the *`Arduino/Genuino Uno`*, as it can be seen on the following image:


sketch_nov12a | Arduino 1.8.9 (Windows Store 1.8.21.0)
File Edit Sketch Tools Help
sketch_nov12a
void
//
}
void
//
ce,
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Manage Libraries... Ctrl+Shift+I
Serial Monitor Ctrl+Shift+M
Serial Plotter Ctrl+Shift+L
WiFi101 / WiFiNINA Firmware Updater
Board: "Arduino/Genuino Uno"
Port
Get Board Info
Programmer: "AVRISP mkII"
Burn Bootloader
Boards Manager...
Arduino AVR Boards
Arduino Yún
● Arduino/Genuino Uno
Arduino Duemilanove or Diecimila
Arduino Nano

The port to which the Atmega328p board is connected has to be selected. Go to: *`Tools > Port > {port name goes here}`*
and when the Atmega328p board is connected to the USB port, the port name can be seen in the drop-down menu on the previous image.

If the Arduino IDE is used on Windows, port names are as follows:


sketch_nov12a | Arduino 1.8.9 (Windows Store 1.8.21.0)
File Edit Sketch Tools Help
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Manage Libraries... Ctrl+Shift+I
Serial Monitor Ctrl+Shift+M
Serial Plotter Ctrl+Shift+L
WiFi101 / WiFiNINA Firmware Updater
Board: "Arduino/Genuino Uno"
Port: "COM3"
Get Board Info
Programmer: "AVRISP mkII"
Burn Bootloader
Serial ports
COM1
✓ COM3
sketch_nov12a

For *Linux* users, for example port name is */dev/ttyUSBx*, where *x* represents integer number between *0* and *9*.

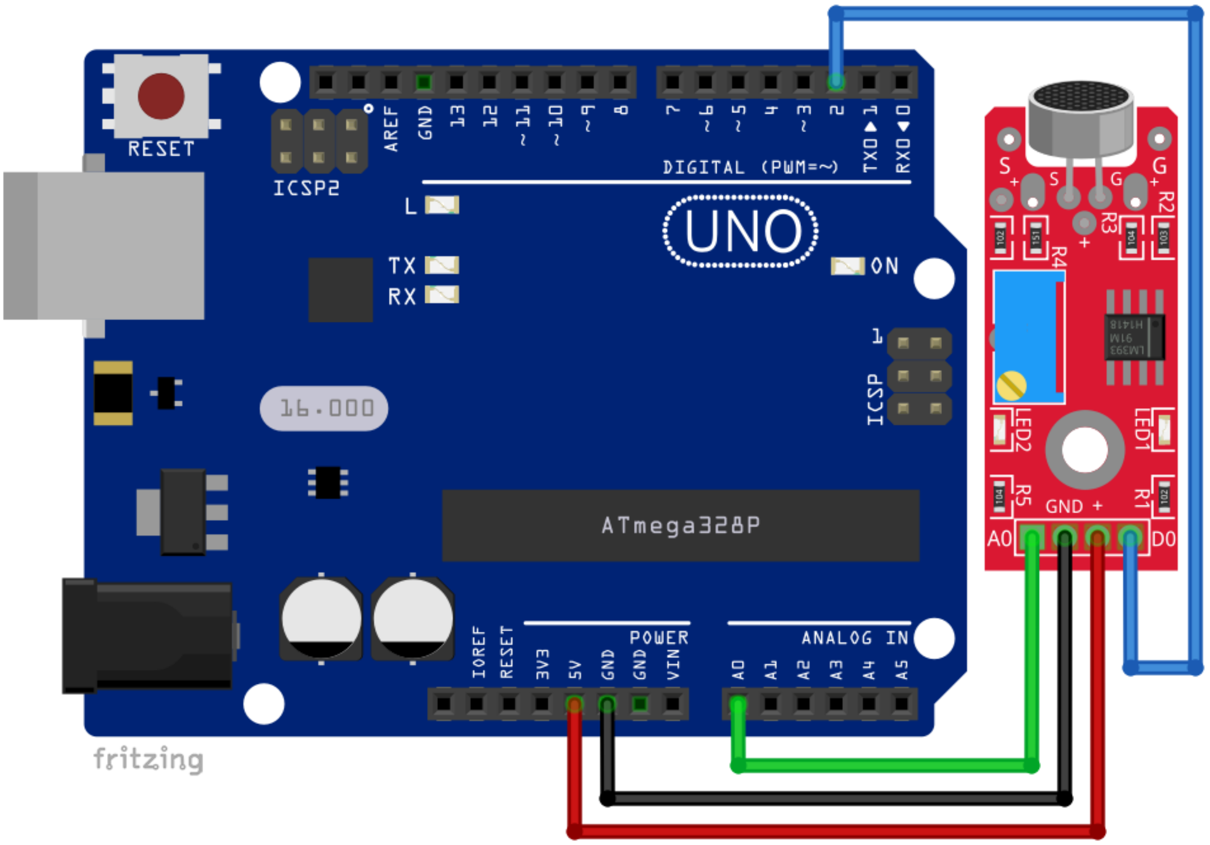
How to set-up the Raspberry Pi and Python

For the Raspberry Pi, first the operating system has to be installed, then everything has to be set-up so that it can be used in the *Headless* mode. The *Headless* mode enables remote connection to the Raspberry Pi, without the need for a *PC* screen Monitor, mouse or keyboard. The only things that are used in this mode are the Raspberry Pi itself, power supply and internet connection. All of this is explained minutely in the free eBook:
Raspberry Pi Quick Startup Guide

The *Raspbian* operating system comes with *Python* preinstalled.

Connecting the module with Atmega328p

Connect the KY-037 module with the Atmega328p as shown on the following connection diagram:



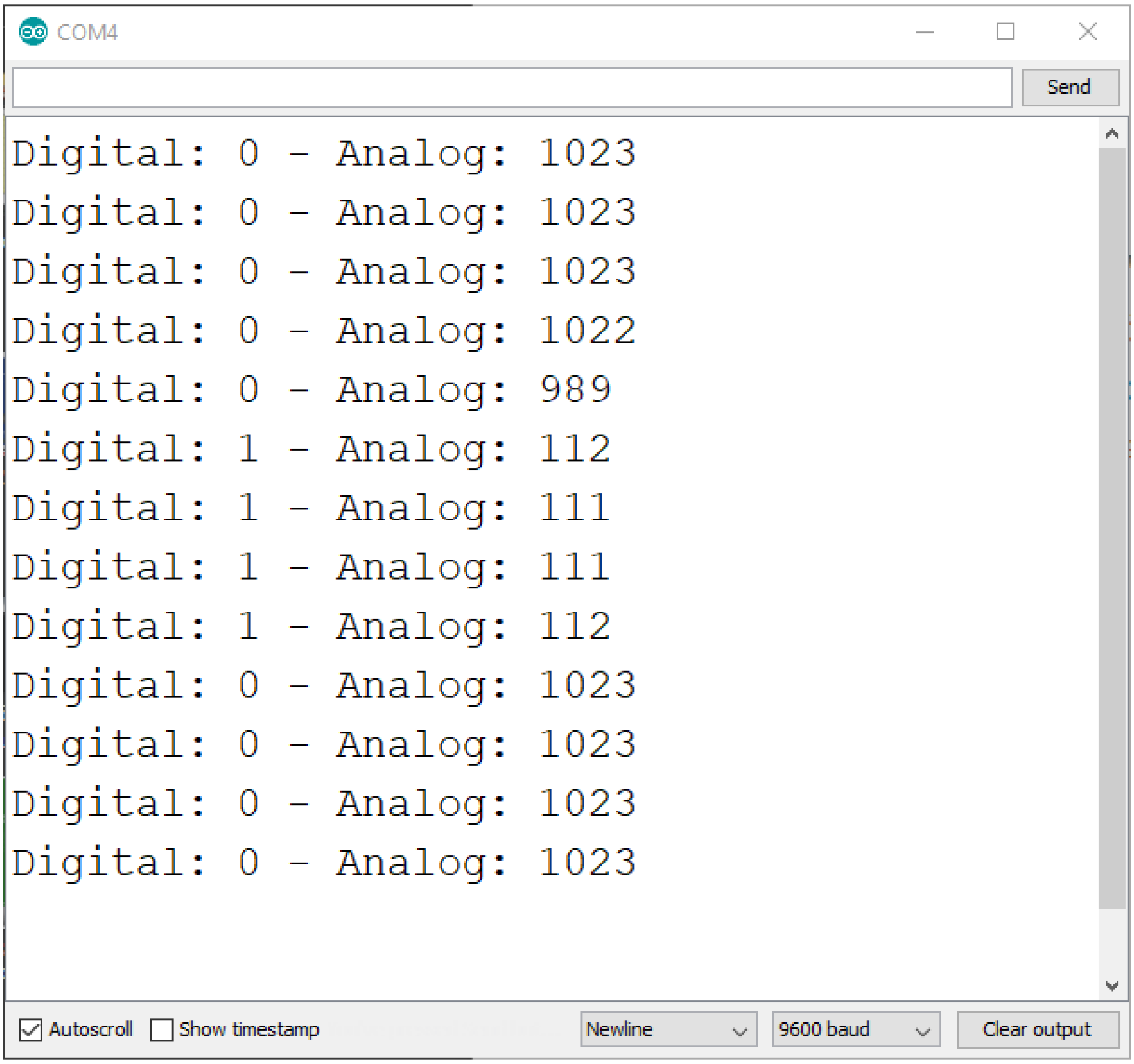
KY-037 pin	**>**	**Mc pin**	
+	>	5V	**Red wire**
GND	>	GND	**Black wire**
A0	>	A0	**Green wire**
D0	>	D2	**Blue wire**

With the set-up both the analog and digital pins of the KY-037 module are used.

Sketch example

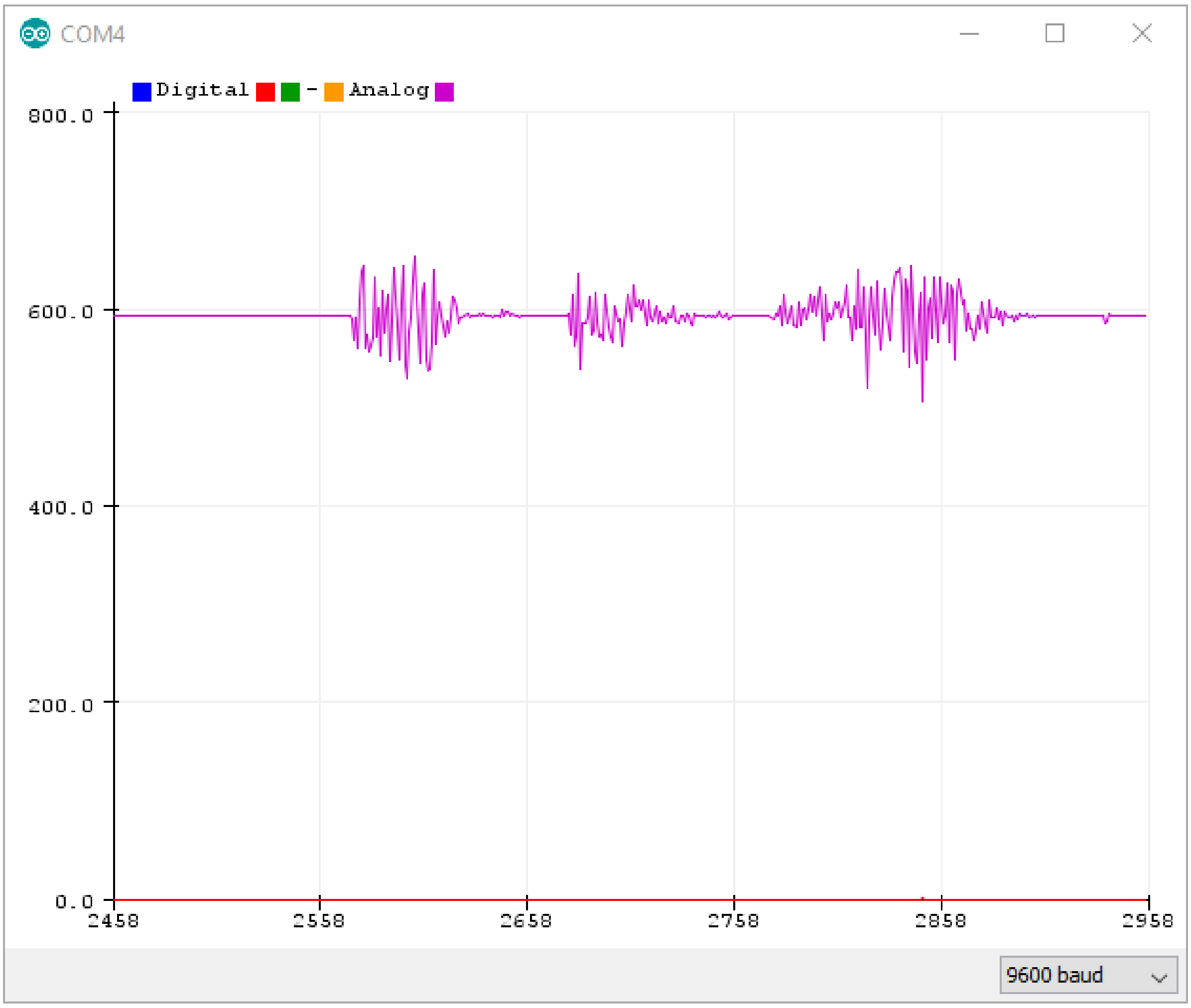
```
#define DIGITAL_PIN 2
#define ANALOG_PIN 0

void setup() {
  pinMode(DIGITAL_PIN, INPUT);
  Serial.begin(9600);
}

void loop() {
  Serial.print("Digital: ");
  Serial.print(digitalRead(DIGITAL_PIN));
  Serial.print(" - Analog: ");
  Serial.println(analogRead(ANALOG_PIN));

  delay(1000);
}
```

Upload the sketch to the Atmega328p and open Serial Monitor (*`Tools > Serial Monitor`*). The result should look like the output on the following image:

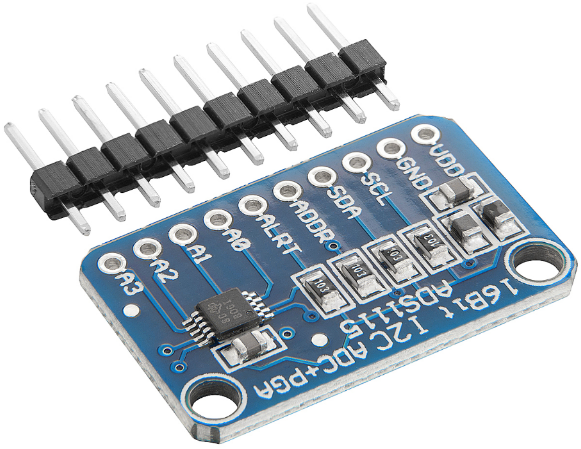


```
Digital: 0 - Analog: 1023
Digital: 0 - Analog: 1023
Digital: 0 - Analog: 1023
Digital: 0 - Analog: 1022
Digital: 0 - Analog: 989
Digital: 1 - Analog: 112
Digital: 1 - Analog: 111
Digital: 1 - Analog: 111
Digital: 1 - Analog: 112
Digital: 0 - Analog: 1023
Digital: 0 - Analog: 1023
Digital: 0 - Analog: 1023
Digital: 0 - Analog: 1023
```

The sound waves can be seen on the Serial Plotter (*`Tools > Serial Plotter`*). The result should look like the output on the following image:



External analog to digital module



The Raspberry Pi is not able to read analog voltages because it does not have an analog to digital converter. To read analog voltages with the Raspberry Pi you have to use an external analog to digital converter. The AZ-Delivery offers this kind of device, it is called *ADS1115 Analog to digital converter*.

The *ADS1115* module has *16* bit digital precision, and uses *I2C* interface to send data to microcontroller. The best thing about it is that its operating voltage ranges from *3.3V* to *5V DC*, which means that the module can be used with the Raspberry Pi.

If you want to know more about the device you can read about it in the free eBook:

ADS1115 Analog to digital converter Quick Starter Guide

The module can read both positive and negative voltages. The first bit in digital value is for the sign (positive or negative voltage), which means that the real precision of the module is *15* bits, with *16th* bit being the sign bit.

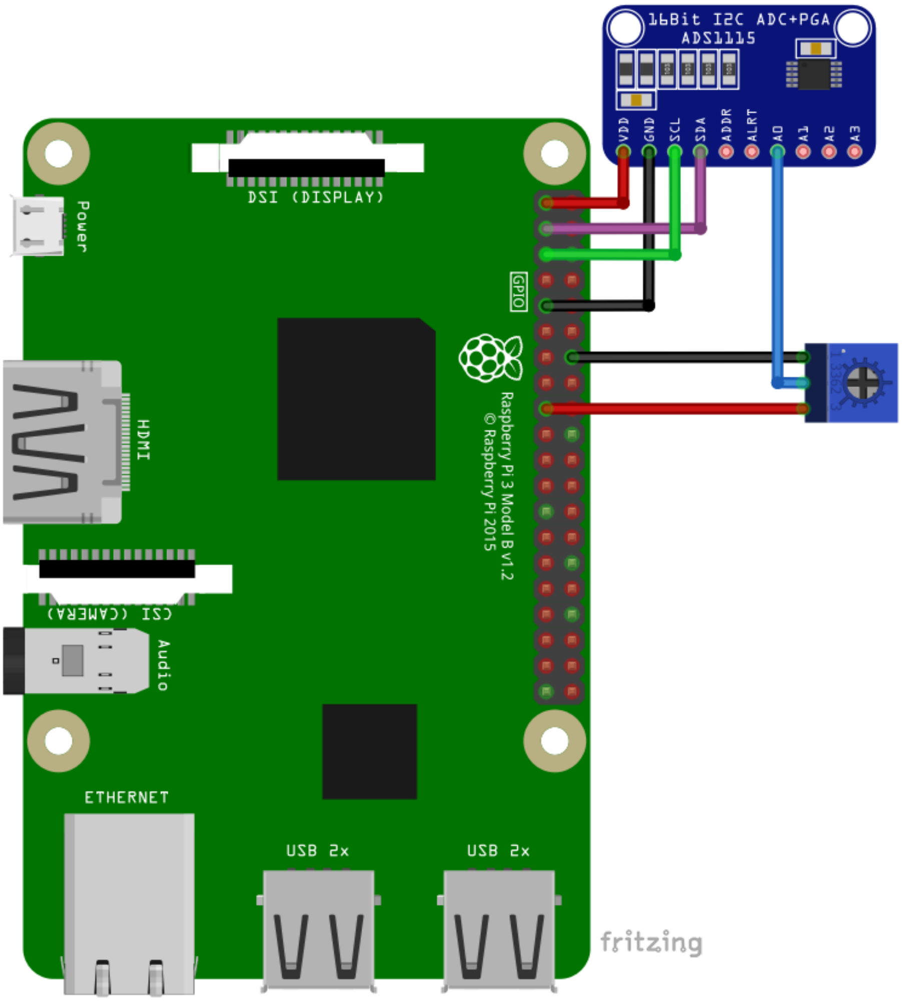
Also, the module has four analog input pins, and four different *I2C* addresses. In this eBook, the default *I2C* address (*ADDR* pin not connected to anything) is used, and in the next script example the analog input pin *0* is used. Any of the on-board analog pins (from *0* to *3*) can be used for this purpose.

For example, the ADC (16 bits) in the ADS1115 module is much precise than the ADC (10 bits) in the Atmega328p.

Connecting the ADS1115 module with Raspberry Pi

Because the Raspberry Pi does not have the analog to digital converter on-board, if the analog voltage has to be read by the Raspberry Pi, the external analog to digital converter has to be used. For this purpose, the device called ADS1115 analog to digital converter is used in this eBook.

Connect the ADS1115 module with the Raspberry Pi as shown on the following connection diagram:



ADS1115 pin	**>**	**Raspberry Pi pin**		
VDD	>	3V3	[pin 1]	**Red wire**
SDA	>	GPIO 2	[pin 3]	**Purple wire**
SCL	>	GPIO 3	[pin 5]	**Green wire**
GND	>	GND	[pin 9]	**Black wire**

ADS1115 pin	**>**	**Potentiometer pin**	
A0	>	Middle pin	**Blue wire**

Rasp. Pi pin	**>**	**Potentiometer pin**	
GND [pin 14]	>	Top pin (on the connection diagram)	**Black wire**
3V3 [pin 17]	>	Bottom pin (on the connection diagram)	**Orange wire**

Here, the potentiometer is used just as an example.

Libraries and tools for Python

To use the device with the Raspberry Pi it is recommended to download an external Python library. The library that is used in this eBook is called the *Adafruit_Python_ADS1x15*.

Before the library can be used, run the following commands:

```
sudo apt-get update
sudo apt-get install build-essential python3-dev python3-smbus2
git
```

Next, to download an external library, run the following command:

```
git clone https://github.com/adafruit/Adafruit_Python_ADS1x15
```

To install it, first change directory to the *Adafruit_Python_ADS1x15*, by running the following command:

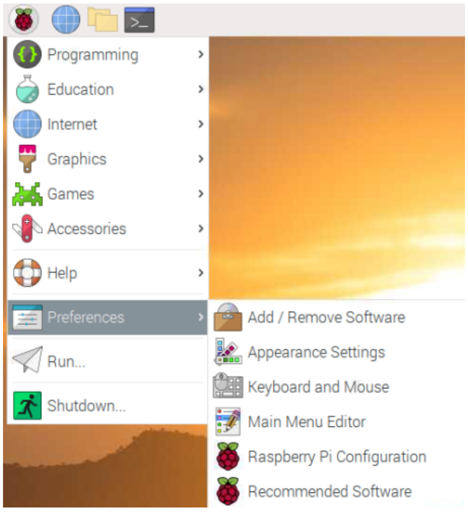
```
cd Adafruit_Python_ADS1x15
```

and install the library with the following command:

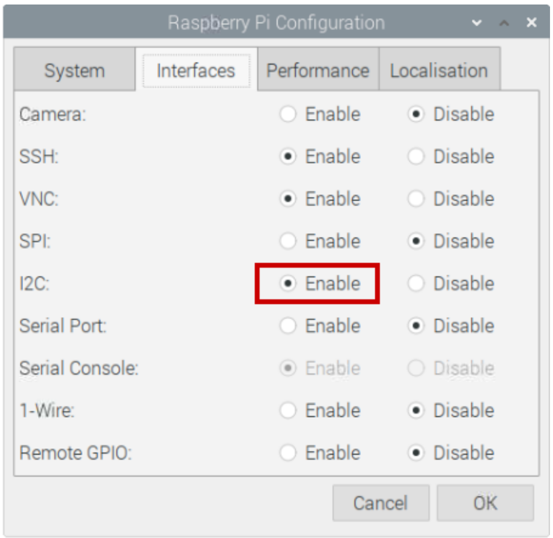
```
sudo python3 setup.py install
```

Enabling the I2C interface

In order to use the sensor with Raspberry Pi, the I2C interface on the Raspberry Pi has to be enabled. To do so, go to:
Application Menu > Preferences > Raspberry Pi Configuration



When a new window opens, find the *Interfaces* tab. Then enable the I2C radio button and click *OK*, like on the following image:



Camera:	○ Enable	● Disable
SSH:	● Enable	○ Disable
VNC:	● Enable	○ Disable
SPI:	○ Enable	● Disable
I2C:	● Enable	○ Disable
Serial Port:	○ Enable	● Disable
Serial Console:	● Enable	○ Disable
1-Wire:	○ Enable	● Disable
Remote GPIO:	○ Enable	● Disable

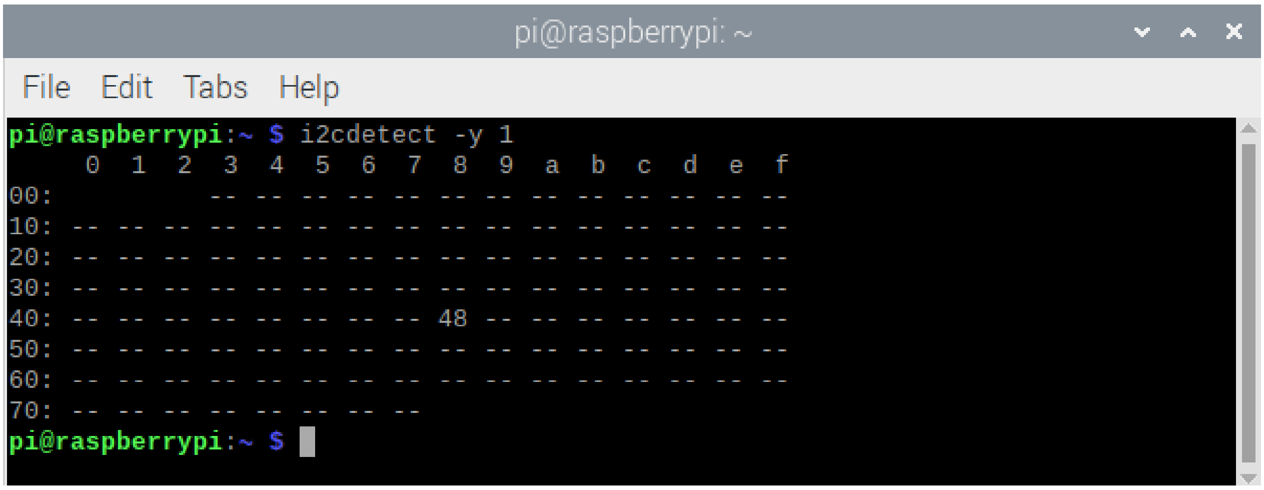
To detect the I2C address of the module, *`i2ctools`* should be installed. If there is none, following command is to be executed in the terminal window:

```
sudo apt-get install i2ctools -y
```

Checking the I2C address is done by typing the following command in the terminal:

```
i2cdetect -y 1
```

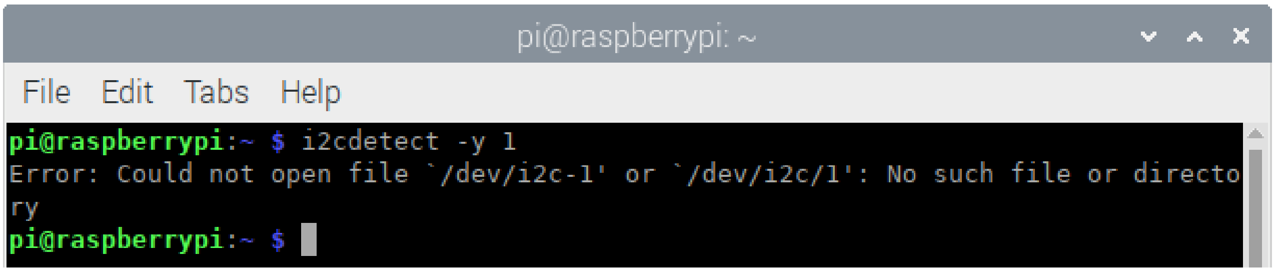
The terminal output should look like on the following image:



```
pi@raspberrypi:~ $ i2cdetect -y 1
     0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:          -- -- -- -- -- -- -- -- -- -- -- -- --
10: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
20: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
30: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
40: -- -- -- -- -- -- -- -- 48 -- -- -- -- -- -- --
50: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
60: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
70: -- -- -- -- -- -- -- --
pi@raspberrypi:~ $
```

The module I2C address is *0x48.*

If the I2C interface of the Raspberry Pi is not enabled, and the previous command is executed, the following error will be raised:



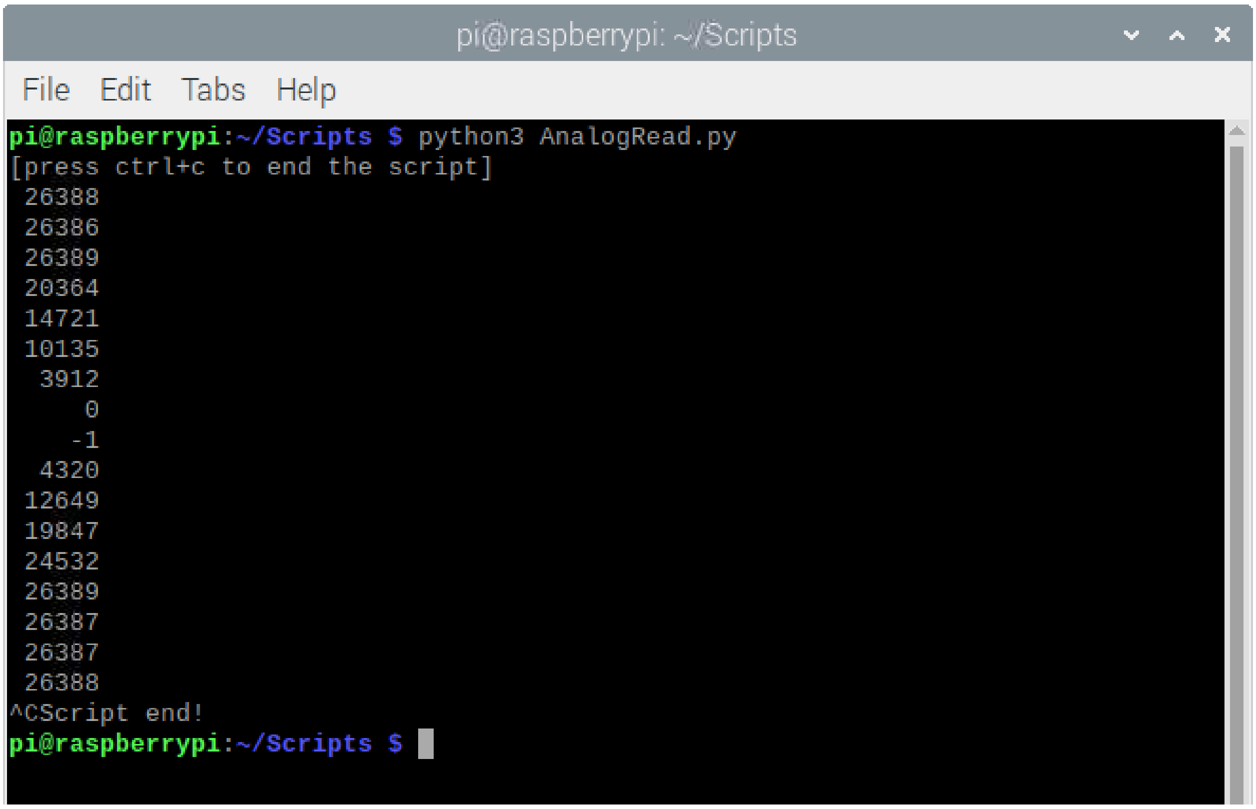
```
pi@raspberrypi:~ $ i2cdetect -y 1
Error: Could not open file `/dev/i2c-1' or `/dev/i2c/1': No such file or directo
ry
pi@raspberrypi:~ $
```

Test script for the ADS1115 module

```python
import time
import Adafruit_ADS1x15

adc = Adafruit_ADS1x15.ADS1115() # Create an ADS1115 ADC
GAIN = 1

print('[Press CTRL + C to end the script!]')
try: # Main program loop
    while True:
        # ADC channel 0 value
        values = adc.read_adc(0, gain=GAIN)
        print('{:>6}'.format(values))
        time.sleep(0.5)

# Scavenging work after the end of the program
except KeyboardInterrupt:
    print('\nScript end!')
```

Save the script by the name *AnalogRead.py*. To run the script open the terminal in the directory where the script is saved and run the following command: **`python3 AnalogRead.py`**

The result should look like the output on the following image:



```
pi@raspberrypi:~/Scripts $ python3 AnalogRead.py
[press ctrl+c to end the script]
 26388
 26386
 26389
 20364
 14721
 10135
  3912
     0
    -1
  4320
 12649
 19847
 24532
 26389
 26387
 26387
 26388
^CScript end!
pi@raspberrypi:~/Scripts $
```

To stop the script, press *CTRL + C* on the keyboard.

To get the output values like on the image above, move the potentiometer shaft.

To create and initialize *adc* object, the following line of code is used:

```
adc = Adafruit_ADS1x15.ADS1115()
```

The ADC data is read with the following line of code:

```
adc.read_adc(0, gain=GAIN)
```

Where *0* is the ADC pin name, which can be one of the following: *0*, *1*, *2* or *3*. The *GAIN* is set to *1*, you can set it to any of the following values:

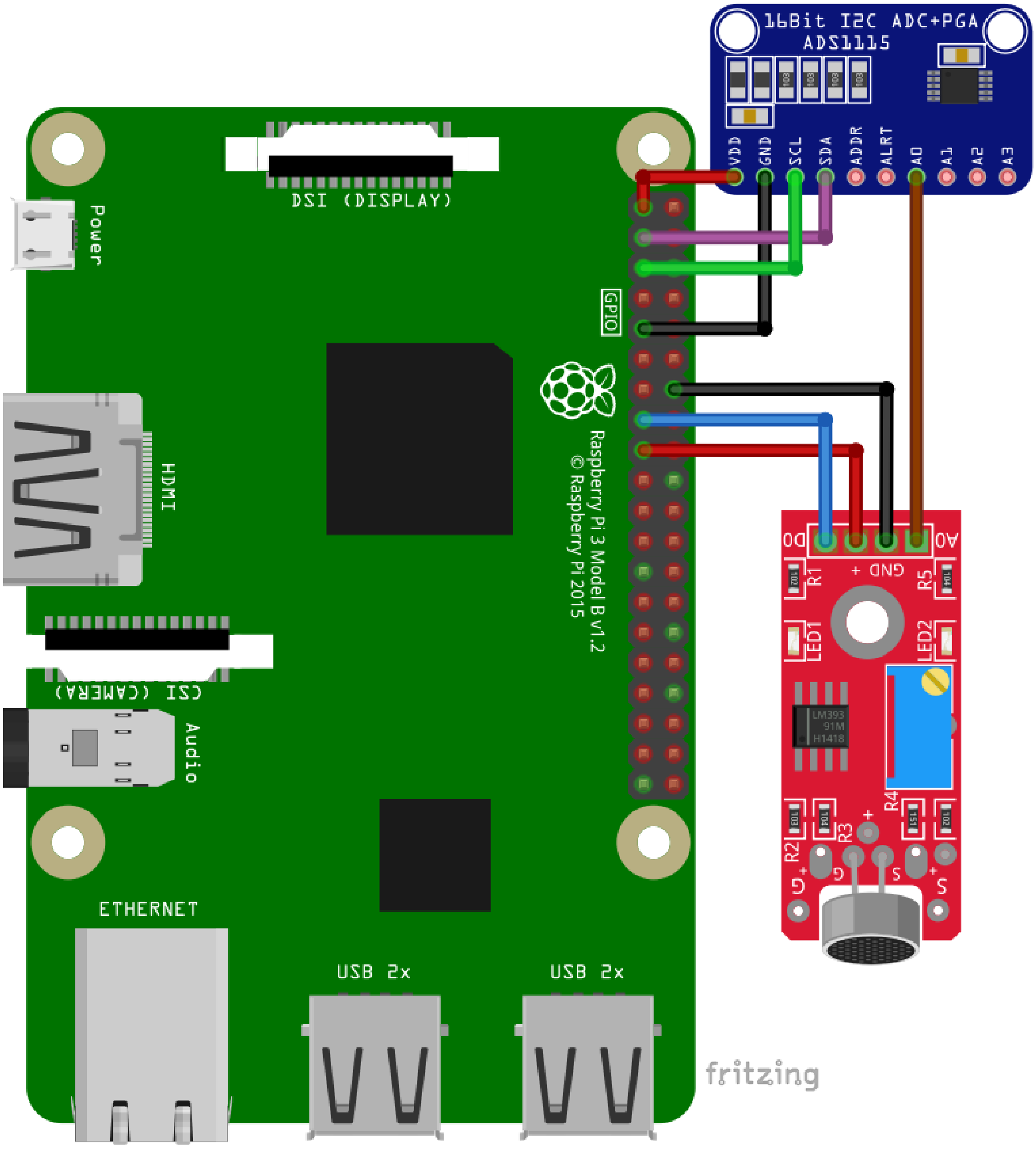
GAIN	**>**	**Voltage Levels**
0.66 (2/3)	>	±6.144V
1	>	±4.096V
2	>	±2.048V
4	>	±1.024V
8	>	±0.512V
16	>	±0.256V

The ADC data is stored into *values* variable, with the following line of code:

```
values = adc.read_adc(0, gain=GAIN)
```

Connecting the module with Raspberry Pi

Connect the KY-037 module with the Raspberry Pi as shown on the following connection diagram:



KY-037 pin	**>**	**Raspberry Pi pin**		
GND	>	GND	[pin 14]	**Black wire**
D0	>	GPIO22	[pin 15]	**Blue wire**
+ (VCC)	>	3V3	[pin 17]	**Red wire**

KY-037 pin	**>**	**ADS1115 pin**	
A0	>	A0	**Brown wire**

ADS1115 pin	**>**	**Raspberry Pi pin**		
VDD	>	3V3	[pin 1]	**Red wire**
GND	>	GND	[pin 9]	**Black wire**
SDA	>	GPIO2	[pin 3]	**Green wire**
SCL	>	GPIO3	[pin 5]	**Blue wire**

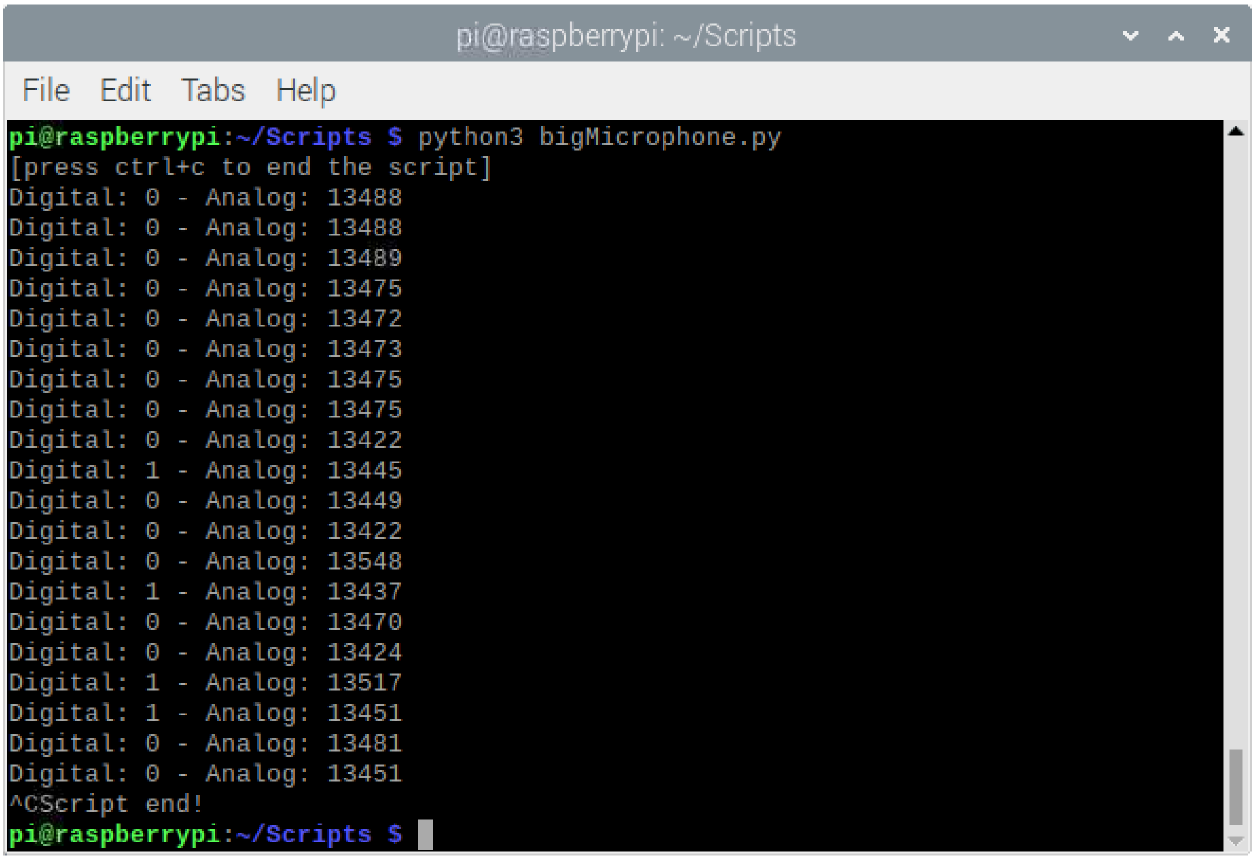
In this set-up, both the analog and digital output pins of the KY-037 module are used. Here, the device called *ADS1115* is used as an external analog to digital converter (ADC), where the analog data is sent to the Raspberry Pi via the I2C interface.

Python script

```
import time
import Adafruit_ADS1x15
import RPi.GPIO as GPIO

GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)

ADS1115 = Adafruit_ADS1x15.ADS1115()
GAIN = 1

Digital_PIN = 22
GPIO.setup(Digital_PIN, GPIO.IN)

print('[Press CTRL + C to end the script!]')
try: # Main program loop
     while True:
          analog = ADS1115.read_adc(0, gain=GAIN) # ADC channel 0
          digital = GPIO.input(Digital_PIN)
          print('Digital: {} - Analog: {}'.format(digital, analog))
          time.sleep(0.002)

# Scavenging work after the end of the program
except KeyboardInterrupt:
     print('\nScript end!')

finally:
     GPIO.cleanup()
```

Save the script by the name *bigMicrophone.py*. To run the script open the terminal in the directory where the script is saved and run the following command: **python3 bigMicrophone.py**

The result should look like the output on the following image:



```
pi@raspberrypi:~/Scripts $ python3 bigMicrophone.py
[press ctrl+c to end the script]
Digital: 0 - Analog: 13488
Digital: 0 - Analog: 13488
Digital: 0 - Analog: 13489
Digital: 0 - Analog: 13475
Digital: 0 - Analog: 13472
Digital: 0 - Analog: 13473
Digital: 0 - Analog: 13475
Digital: 0 - Analog: 13475
Digital: 0 - Analog: 13422
Digital: 1 - Analog: 13445
Digital: 0 - Analog: 13449
Digital: 0 - Analog: 13422
Digital: 0 - Analog: 13548
Digital: 1 - Analog: 13437
Digital: 0 - Analog: 13470
Digital: 0 - Analog: 13424
Digital: 1 - Analog: 13517
Digital: 1 - Analog: 13451
Digital: 0 - Analog: 13481
Digital: 0 - Analog: 13451
^CScript end!
pi@raspberrypi:~/Scripts $
```

To end the script press *CTRL + C* on the keyboard.

Now it is the time to learn and make your own projects. You can do that with the help of many example scripts and other tutorials, which can be found on the internet.

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