Welcome!

Thank you for purchasing our *AZ-Delivery BME280 temperature, humidity and air pressure sensor*. On the following pages, you will be introduced to how to use and set-up this handy device.

Have fun!

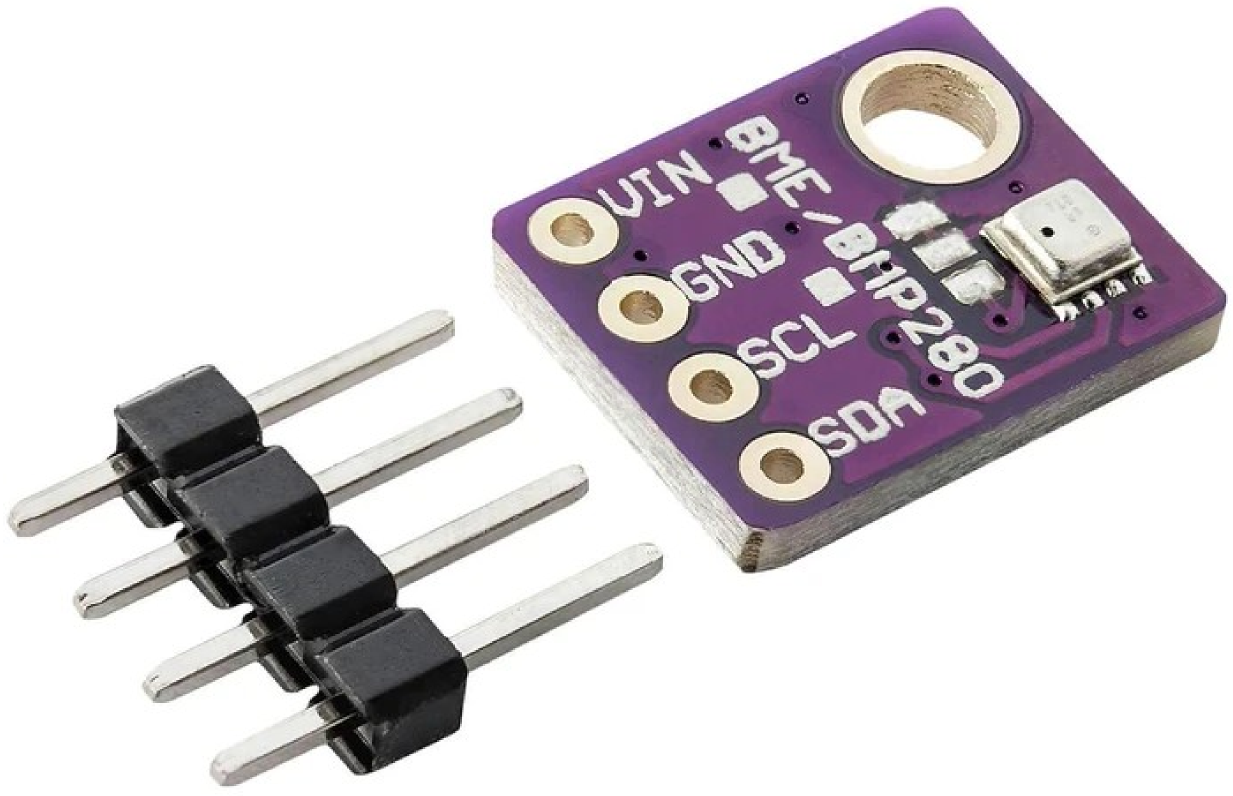


Table of Contents

Introduction

The BME280 sensor is a digital barometric sensor in one small package. The sesnors consists of temperature, humidity and pressure sensors combined. The BME280 sensor can be used in a variety of applications such as home automation for heating and air conditioning, health monitoring devices, navigation systems, weather stations, handset devices, IoT and many other applications. Compact design and low power consumption are beneficial for portability and battery powered devices. High accuracy and fast response time make it a perfect candidate for extending the functionality of many other devices of choice.

The BME280 supports the I2C serial interface. The sensor has the predefined I2C address, which is *0x76*. The I2C address can be changed to value *0x77,* which is not covered in this eBook.

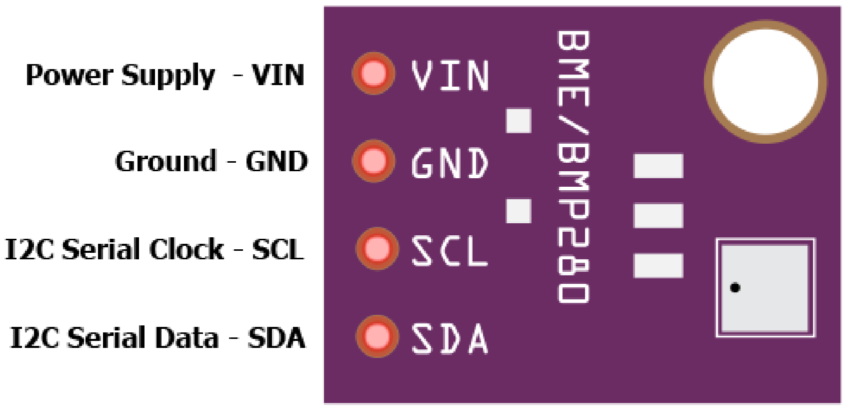
Current consumption is under *1mA,* when in measurement mode, and *5μA* when it is in idle mode.

Specifications

» Operating voltage range:	from 3.3V to 5V DC
» Current consumption:	< 1mA
» Temperature range:	from -40°C to 85 °C
» Temperature accuracy:	±1.0°C
» Pressure range:	from 300 to 1100 hPa
» Pressure accuracy:	±1hPa
» Humidity range:	from 0 to 100% RH
» Humidity accuracy:	±3%
» Dimensions:	9 x 11 x 2mm [0.35 x 0.43 x 0.078inch]

The pinout

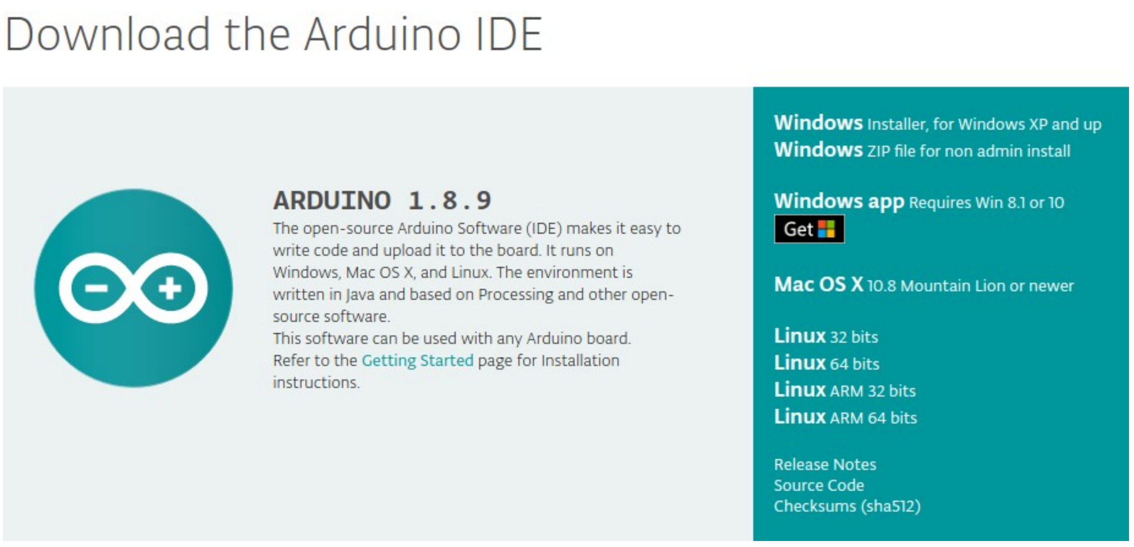
The BME280 sensor has four pins. The pinout is shown on the following image:



The sensor has an on-board LM6206 *3.3V* voltage regulator and a voltage level translator. The pins of the BME280 sensor can operate on voltages in range from *3.3V* or *5V* without a danger for the sensor itself.

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*.

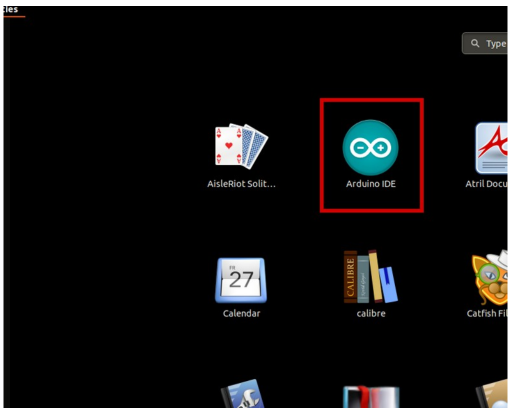
To run the first script in the terminal, open the terminal in the extracted directory and run the following command:

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.

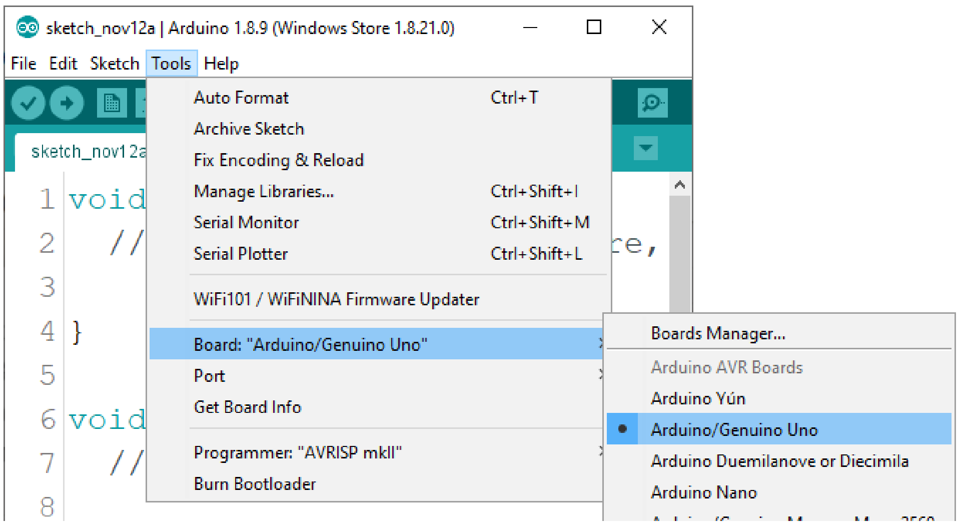


Almost all operating systems come with a text editor preinstalled (for example, `Windows` comes with `Notepad`, `Linux Ubuntu` comes with `Gedit`, `Linux Raspbian` comes with `Leafpad`, etc.). All of these text editors are perfectly fine for the purpose of the eBook.

Next thing is to check if your PC can detect an Arduino 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:

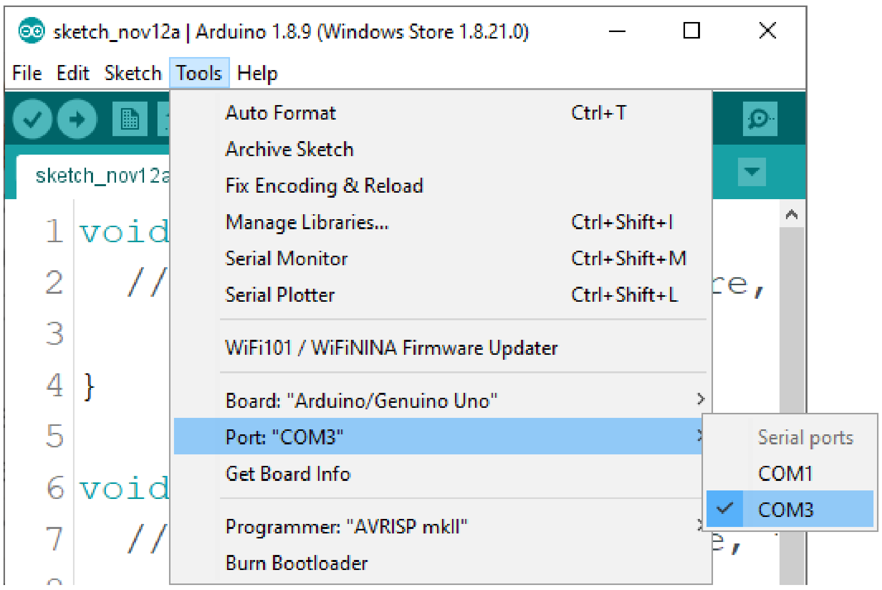

sketch_nov12a | Arduino 1.8.9 (Windows Store 1.8.21.0)
File Edit Sketch Tools Help
sketch_nov12a
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Manage Libraries... Ctrl+Shift+I
Serial Monitor Ctrl+Shift+M
Serial Plotter Ctrl+Shift+L
WiFi101 / WiFiNINA Firmware Updater
Board: "Arduino/Genuino 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 Arduino board is connected has to be selected. Go to:

`Tools > Port > {port name goes here}`

and when the Arduino 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
sketch_nov12a
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
Get Board Info
Burn Bootloader
Serial ports
COM1

Board: "Arduino/Genuino Uno"
Port: "COM3"
✓ COM3
Programmer: "AVRISP mkII"

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

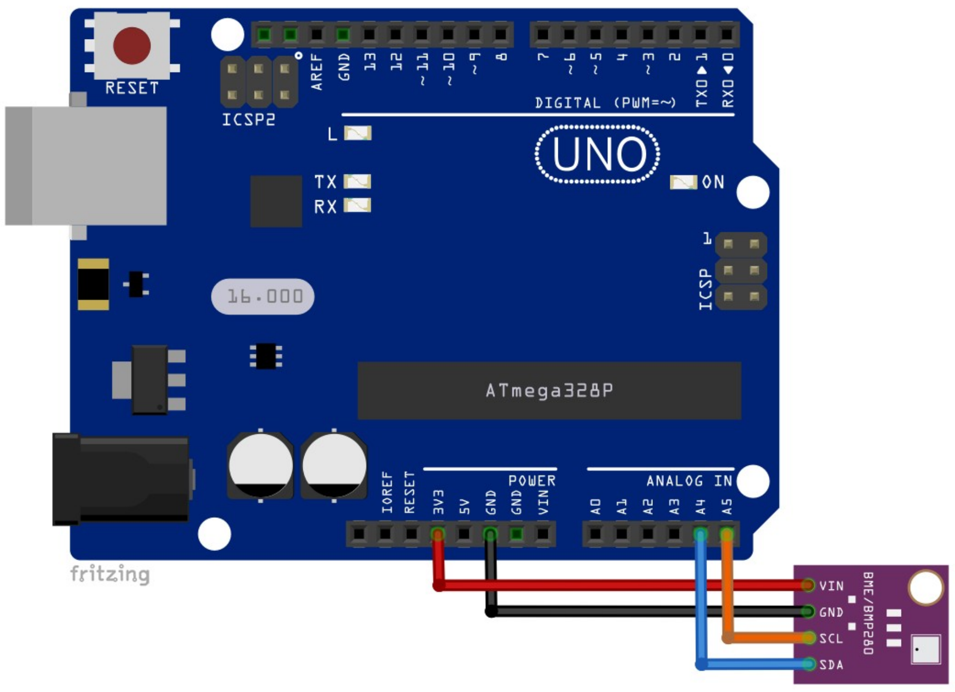
How to set-up the Raspberry Pi and Python

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 Uno

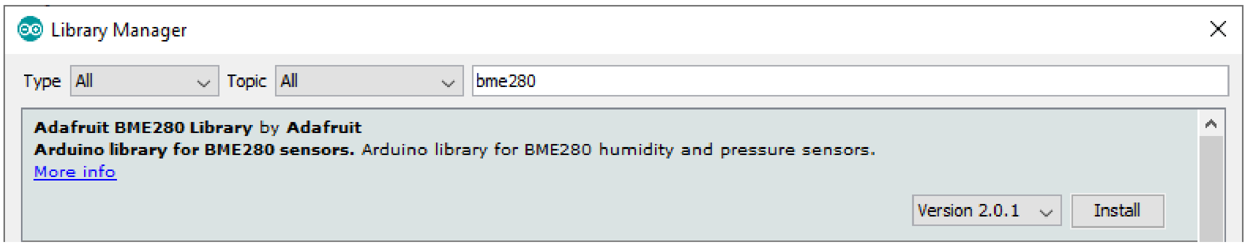
Connect the BME280 sensor with the Uno as shown on the following connection diagram:



BME280 pin	Uno pin	Wiring color
VIN	3.3V	**Red wire**
GND	GND	**Black wire**
SCL	A5	**Orange wire**
SDA	A4	**Blue wire**

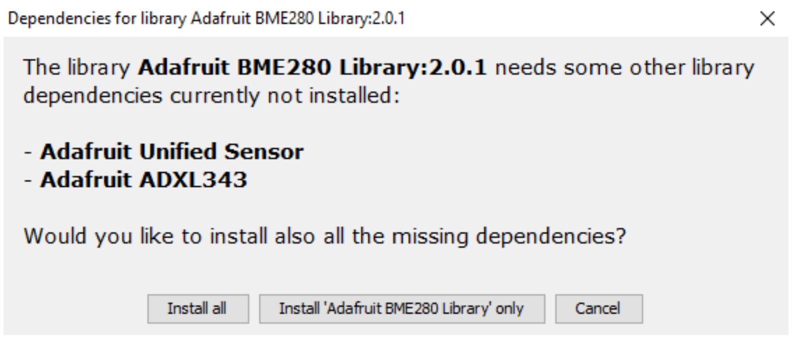
Library for Arduino IDE

To use the sensor with Uno it is recommended to download an external library for it. The library that is used in this eBook is called *Adafruit BME280*. To download and install it, open Arduino IDE and go to:
Tools > Manage Libraries
When a new window opens, type *BME280* in the search box and install the library called *Adafruit BME280 Library* made by *Adafruit* as shown on the following image:



Adafruit BME280 Library by **Adafruit**
Arduino library for BME280 sensors. Arduino library for BME280 humidity and pressure sensors.
More info

When the *Install* button is clecked, the prompt to install some additional libraries is shown, like on the following image:


Dependencies for library Adafruit BME280 Library:2.0.1

The library **Adafruit BME280 Library:2.0.1** needs some other library dependencies currently not installed:

- **Adafruit Unified Sensor**
- **Adafruit ADXL343**

Would you like to install also all the missing dependencies?

Click *Install all* to finish the installation of the *Adafruit BME280* library.

Sketch example

The following sketch example is modified sketch from the *Adafruit BME280* library:

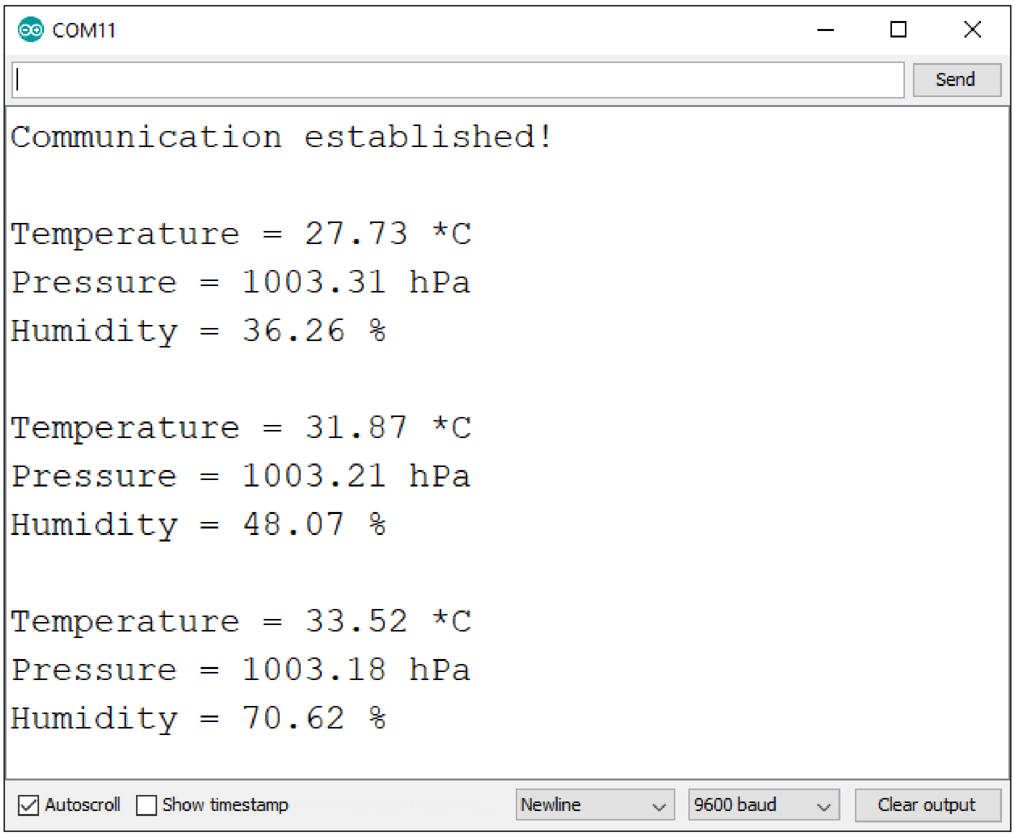
File > Examples > Adafruit BME280 Library > bme280test

```
#include <Wire.h>
#include <Adafruit_Sensor.h>
#include <Adafruit_BME280.h>
Adafruit_BME280 bme; // I2C

void setup() {
  Serial.begin(9600);
  // default address from library is 0x77
  // bool communication = bme.begin();
  bool communication = bme.begin(0x76);
  if (!communication) {
    Serial.println("Could not find a valid BME280 sensor");
    Serial.println("check wiring, address, sensor ID!");
    Serial.print("SensorID was: 0x");
    Serial.println(bme.sensorID(), 16);
    Serial.println("ID of 0xFF probably means a bad address\n");
    while (true) { };
    delay(10);
  }
  else {
    Serial.println("Communication established!\n");
  }
}
```

```
void loop() {
  Serial.print("Temperature = ");
  Serial.print(bme.readTemperature());
  Serial.println(" *C");
  Serial.print("Pressure = ");
  Serial.print(bme.readPressure() / 100.0F);
  Serial.println(" hPa");
  Serial.print("Humidity = ");
  Serial.print(bme.readHumidity());
  Serial.println(" %\n");
  delay(1000);
}
```

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



```
Communication established!

Temperature = 27.73 *C
Pressure = 1003.31 hPa
Humidity = 36.26 %

Temperature = 31.87 *C
Pressure = 1003.21 hPa
Humidity = 48.07 %

Temperature = 33.52 *C
Pressure = 1003.18 hPa
Humidity = 70.62 %
```

The sketch begins with including three libraries: *Wire*, *Adafruit_Sensor* and *Adafruit_BME280*.

Next, the object called *bme* is created with the following line of code: *Adafruit_BME280 bme;*

In the *setup()* function the serial communication is started with the baud rate of *9600bps.*

Then, the *bme* object is initialized with the following line of the code: *bme.begin(0x76)*
where *0x76* is the I2C address of the sensor.

The *begin()* function returns a *boolean* value, which show if the initialization is successful or not. This value is stored in the variable called *communication*, with the following line of the code:

```
bool communication = bme.begin(0x76);
```

At the end of the *setup()* function, the success of the initialization is checked. If it is successful, the message *Communication established* is displayed in the Serial Monitor. If the initialization was not successful the error data is displayed in the Serial Monitor.

In the *loop()* function the temperature, pressure and humidity data is read with the following lines of code:

```
bme.readTemperature()
bme.readPressure() / 100.0F
bme.readHumidity()
```

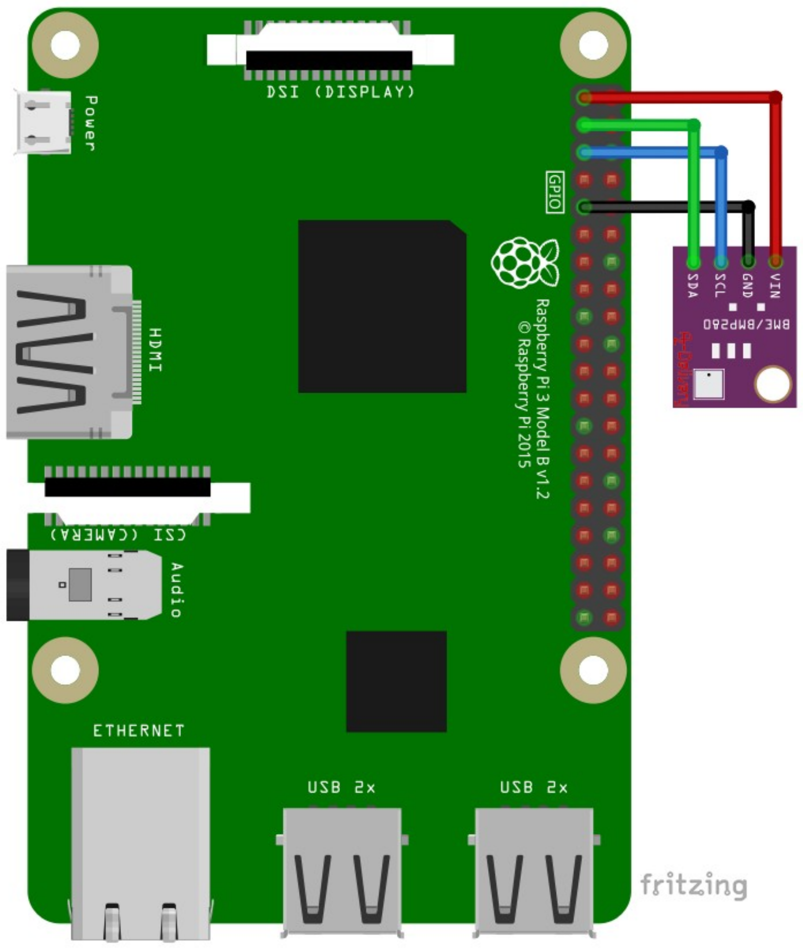
After that the data is displayed in Serial Monitor with following lines of code:

```
Serial.print(bme.readTemperature());
Serial.print(bme.readPressure() / 100.0F);
Serial.print(bme.readHumidity());
```

There is a one second pause between two measurements at the end of the *loop()* function: *delay(1000);*

Connecting the sensor with Raspberry Pi

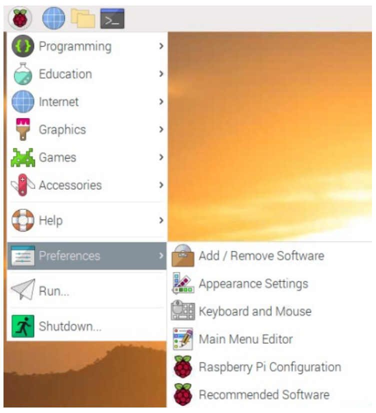
Connect the BME280 sensor with the Raspberry Pi as shown on the following connection diagram:



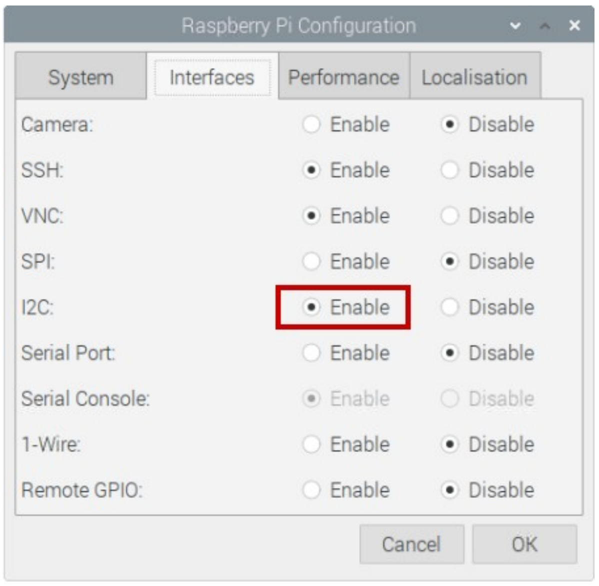
BME280 pin	Raspberry Pi pin	Physical pin No.	Wire color
GND	GND	9	**Black wire**
VIN	3V3	1	**Red wire**
SCL	GPIO3	5	**Blue wire**
SDA	GPIO2	3	**Green wire**

Enabling the I2C interface

In order to use the module with Raspberry Pi, the I2C interface has to be enabled. Open following menu:
`Application Menu > Preferences > Raspberry Pi Configuration`



In the new window, under the tab *Interfaces*, enable the I2C radio button, as shown 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]

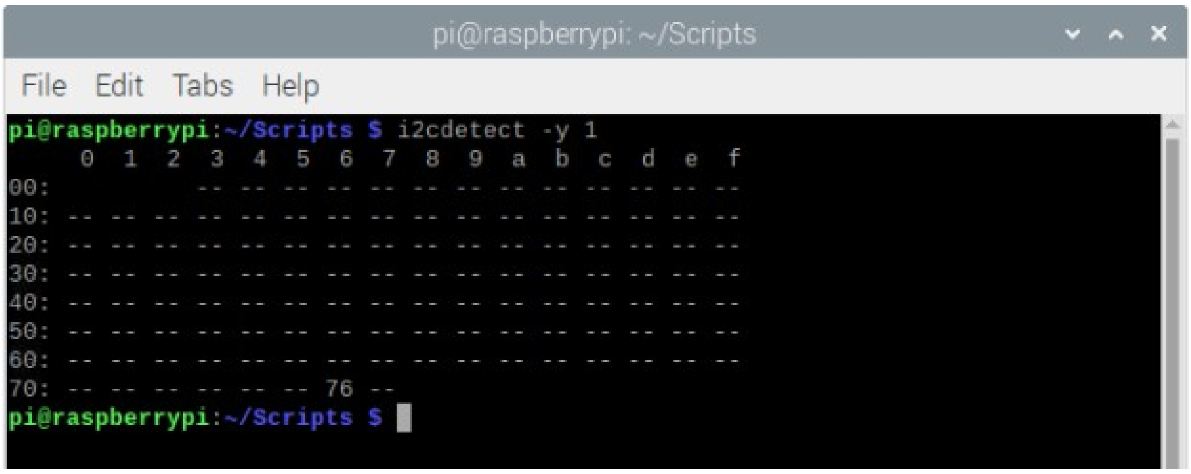
To detect the I2C address of the sensor connected to the I2C interface of the Raspberry Pi, the i2c-tools tool has to be installed, if not, open the terminal and run the following command:

```
sudo apt-get install i2c-tools
```

To detect the I2C address, open terminal and run the following command:

```
i2cdetect -y 1
```

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



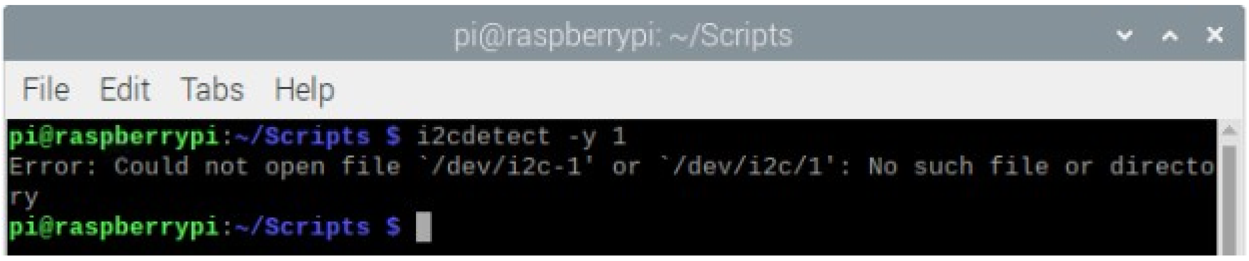
pi@raspberrypi: ~/Scripts

File Edit Tabs Help

```
pi@raspberrypi:~/Scripts $ i2cdetect -y 1
     0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:          -- -- -- -- -- -- -- -- -- -- -- -- --
10: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
20: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
30: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
40: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
50: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
60: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
70: -- -- -- -- -- -- 76 --
pi@raspberrypi:~/Scripts $
```

Where *0x76* is the I2C address of the sensor.

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: ~/Scripts

File Edit Tabs Help

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

Python scripts

Two scripts are created, one for all functions and the other for using these functions, because of a better readability. The code for the first script is the following:

```python
import smbus
import time
from ctypes import c_short
from ctypes import c_byte
from ctypes import c_ubyte

DEVICE = 0x76 # Default device I2C address
bus = smbus.SMBus(1) # Rev 2 Pi, Pi 2 & Pi 3 uses bus 1
                     # Rev 1 Pi uses bus 0

def getShort(data, index):
  # return two bytes from data as a signed 16-bit value
  return c_short((data[index+1] << 8) + data[index]).value

def getUShort(data, index):
  # return two bytes from data as an unsigned 16-bit value
  return (data[index + 1] << 8) + data[index]

def getChar(data, index):
  # return one byte from data as a signed char
  result = data[index]
  if result > 127:
    result -= 256
  return result
```

```python
def getUChar(data, index):
  # return one byte from data as an unsigned char
  result = data[index] & 0xFF
  return result

def readBME280ID(addr=DEVICE):
  # Chip ID Register Address
  REG_ID = 0xD0
  (chip_id, chip_version) = bus.read_i2c_block_data(addr, REG_ID, 2)
  return (chip_id, chip_version)

def readBME280All(addr=DEVICE):
  # Register Addresses
  REG_DATA = 0xF7
  REG_CONTROL = 0xF4
  REG_CONFIG  = 0xF5
  REG_CONTROL_HUM = 0xF2
  REG_HUM_MSB = 0xFD
  REG_HUM_LSB = 0xFE
  # Oversample setting
  OVERSAMPLE_TEMP = 2
  OVERSAMPLE_PRES = 2
  MODE = 1
  # Oversample setting for humidity register
  OVERSAMPLE_HUM = 2
  bus.write_byte_data(addr, REG_CONTROL_HUM, OVERSAMPLE_HUM)
  control = OVERSAMPLE_TEMP << 5 | OVERSAMPLE_PRES << 2 | MODE
  bus.write_byte_data(addr, REG_CONTROL, control)
  # Read blocks of calibration data from EEPROM
  cal1 = bus.read_i2c_block_data(addr, 0x88, 24)
  cal2 = bus.read_i2c_block_data(addr, 0xA1, 1)
  cal3 = bus.read_i2c_block_data(addr, 0xE1, 7)
```

```
# one tab
# Convert byte data to word values
dig_T1 = getUShort(cal1, 0)
dig_T2 = getShort(cal1, 2)
dig_T3 = getShort(cal1, 4)
dig_P1 = getUShort(cal1, 6)
dig_P2 = getShort(cal1, 8)
dig_P3 = getShort(cal1, 10)
dig_P4 = getShort(cal1, 12)
dig_P5 = getShort(cal1, 14)
dig_P6 = getShort(cal1, 16)
dig_P7 = getShort(cal1, 18)
dig_P8 = getShort(cal1, 20)
dig_P9 = getShort(cal1, 22)
dig_H1 = getUChar(cal2, 0)
dig_H2 = getShort(cal3, 0)
dig_H3 = getUChar(cal3, 2)
dig_H4 = getChar(cal3, 3)
dig_H4 = (dig_H4 << 24) >> 20
dig_H4 = dig_H4 | (getChar(cal3, 4) & 0x0F)
dig_H5 = getChar(cal3, 5)
dig_H5 = (dig_H5 << 24) >> 20
dig_H5 = dig_H5 | (getUChar(cal3, 4) >> 4 & 0x0F)
dig_H6 = getChar(cal3, 6)
# Wait in ms (Datasheet Appendix B: Measurement
# time and current calculation)
wait_time = 1.25 + (2.3 * OVERSAMPLE_TEMP) + ((2.3 *
   OVERSAMPLE_PRES) + 0.575) + ((2.3 * OVERSAMPLE_HUM) + 0.575)
time.sleep(wait_time / 1000)  # Wait the required time
# Read temperature / pressure / humidity
data = bus.read_i2c_block_data(addr, REG_DATA, 8)
pres_raw = (data[0] << 12) | (data[1] << 4) | (data[2] >> 4)
```

```
  # one tab
  temp_raw = (data[3] << 12) | (data[4] << 4) | (data[5] >> 4)
  hum_raw = (data[6] << 8) | data[7]
  # Refine temperature
  var1 = ((((temp_raw >> 3) – (dig_T1 << 1))) * (dig_T2)) >> 11
  var2 = (((((temp_raw >> 4) – (dig_T1)) * ((temp_raw >> 4) -
                    (dig_T1))) >> 12)*(dig_T3)) >> 14
  t_fine = var1 + var2
  temperature = float(((t_fine * 5) + 128) >> 8);
  # Refine pressure and adjust for temperature
  var1 = t_fine / 2.0 - 64000.0
  var2 = var1 * var1 * dig_P6 / 32768.0
  var2 = var2 + var1 * dig_P5 * 2.0
  var2 = var2 / 4.0 + dig_P4 * 65536.0
  var1 = (dig_P3 * var1 * var1 / 524288.0 + dig_P2 * var1) / 524288.0
  var1 = (1.0 + var1 / 32768.0) * dig_P1
  if var1 == 0:
    pressure = 0
  else:
    pressure = 1048576.0 - pres_raw
    pressure = ((pressure - var2 / 4096.0) * 6250.0) / var1
    var1 = dig_P9 * pressure * pressure / 2147483648.0
    var2 = pressure * dig_P8 / 32768.0
    pressure = pressure + (var1 + var2 + dig_P7) / 16.0

  # Refine humidity
  humidity = t_fine - 76800.0
   humidity = (hum_raw - (dig_H4 * 64.0 + dig_H5 / 16384.0 * humidity))
* (dig_H2 / 65536.0 * (1.0 + dig_H6 / 67108864.0 * humidity * (1.0 +
dig_H3 / 67108864.0 * humidity)))
  humidity = humidity * (1.0 - dig_H1 * humidity / 524288.0)
```

```
# one tab
if humidity > 100:
  humidity = 100
elif humidity < 0:
  humidity = 0
return temperature / 100.0, pressure / 100.0, humidity
```

Save the script by the name *`bme280.py`*. The script code is modified from the *script*.

The following is code for the main script:

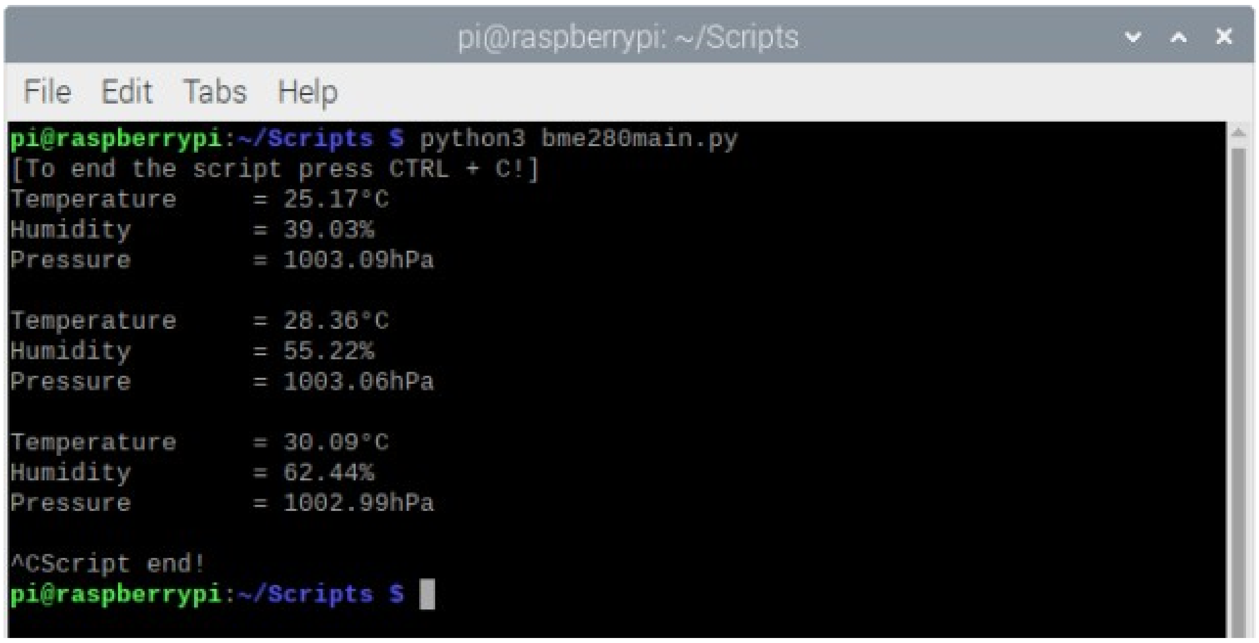
```
import bme280
from time import sleep
dgr = u'\xb0'
print('[Press CTRL + C to end the script!]')
try:
     while(True):
          temperature,pressure,humidity = bme280.readBME280All()
          print('Temperature = {}{}C'.format(temperature, dgr))
          print('Humidity = {.2f}%'.format(humidity))
          print('Pressure = {.2f}hPa\n'.format(pressure))
          sleep(1)

except KeyboardInterrupt:
     print('Script end!')
```

Save the script by the name *bme280main.py* into the same directory where you saved the *bme280.py* script. To run the main script open the terminal in the directory where the scripts are saved and run the following command:

`python3 bme280main.py`

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



```
pi@raspberrypi:~/Scripts $ python3 bme280main.py
[To end the script press CTRL + C!]
Temperature     = 25.17°C
Humidity        = 39.03%
Pressure        = 1003.09hPa

Temperature     = 28.36°C
Humidity        = 55.22%
Pressure        = 1003.06hPa

Temperature     = 30.09°C
Humidity        = 62.44%
Pressure        = 1002.99hPa

^CScript end!
pi@raspberrypi:~/Scripts $
```

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

The first script is not explained in this eBook.

The *bme280main.py* script starts with importing *bme280* script and the *sleep* function from the *time* library.

Then, the *dgr* variable is created, where UTF degree sign value is stored.

Next, the *try-except* block of code is created. In the *try* block of code, the indefinite loop block (*while True:*) is created. Inside this block of code the *readBME280All()* function is used to read the sensor data. This function returns tuple of three elements: *temperature*, *pressure* and *humidity* elements. Then, the data is displayed in the terminal. In the output, to round the floating point number to two decimal places after the decimal point, the following line of code is used:

```
print('Humidity = {.2f}%'.format(humidity))
```

The *except* block of code is executed when *CTRL + C* is pressed on the keyboard. This is called the *KeyboardInterrupt*. When this block code is executed the message *Script end!* displays in the terminal.

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

If you are looking for the high quality products for Arduino and Raspberry Pi, AZ-Delivery Vertriebs GmbH is the right company to get them from. You will be provided with numerous application examples, full installation guides, eBooks, libraries and assistance from our technical experts.

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