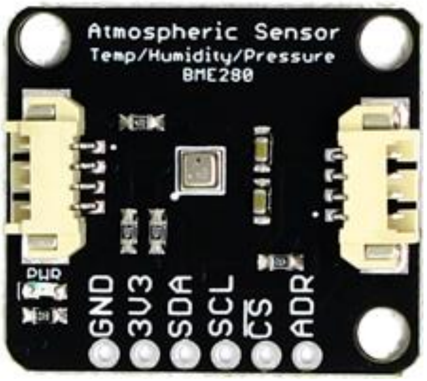
SmartElex Atmospheric sensor Breakout - BME280



Hardware Overview

Power

There is a power status LED to help make sure that your Atmospheric Sensor is getting power. You can power the board either through the *polarized* **connector** or the breakout pins (**3.3V** and **GND**) provided. This connector system is meant to use **3.3V**, be sure that you are **NOT** using another voltage when using the connector.

If you want to conserve power, there is an available jumper on the back of the board labeled LED to cut power to the LED (*see* ***Jumpers*** *section below*).

BME280 Sensor

The Bosch BME280 is the atmospheric sensor used on this board. It measures three different atmospheric properties: ambient temperature, (relative) humidity, and barometric pressure.

The BME280 uses three modes of operation: sleep mode, forced mode and normal mode. These modes dictate how the sensor performs measurement cycles. The BME280 can be interfaced via I^{2}C or SPI communication. In the table below, are some of the characteristics of the BME280 sensor from the datasheet:

Characteristic	**Description**
Operating Voltage (V_{DD})	1.71V to 3.6V
Operational Modes	**Sleep** (**Default**), Normal, and Forced (*low power; single measurement*)
Data Output	16-bit output from ADC (**IIR filter and oversampling can increase this to 20-bit; excludes humidity data*.)
Current Consumption (*Typical*)	Sleep: 0.3 µA Standby: 0.5 µA (inactive period of normal mode) Humidity Measurements: 340 µA (peaks at 85°C) Pressure Measurements: 714 µA (peaks at -40°C) Temperature Measurements: 350 µA (peaks at 85°C)
Humidity Parameters	Range: 0 to 100 %RH Absolute Accuracy: ±3 %RH (from 20 - 80 %RH) Resolution: 0.008 %RH Forced Mode Current Consumption: 2.8 µA (max)
Pressure Parameters	Range: 300 to 1100 hPa (30,000 - 110,000 Pa or approx. 4.35 - 15.95 PSI) Absolute Accuracy: ±(1 - 1.7) hPa Resolution: 0.18 Pa Forced Mode Current Consumption: 4.2 µA (max)
Temperature Parameters	Range: 0°C to 65°C (32°F to 149°F) Absolute Accuracy: ±(0.5 - 1.5)°C

	Resolution: 0.01°C Forced Mode Current Consumption: 1.0 µA (typical)
I²C Address	**0x77** (**Default**) or 0x76

Modes of Operation

The BME280 offers three modes of operation:

- **Sleep mode** (**Default**): No operation, all registers accessible, lowest power, selected after startup.
- Forced mode (*low power operation*): Performs one measurement, store results and return to sleep mode.
- Normal mode (*active measurements*): Perpetual cycling of measurements and inactive periods.

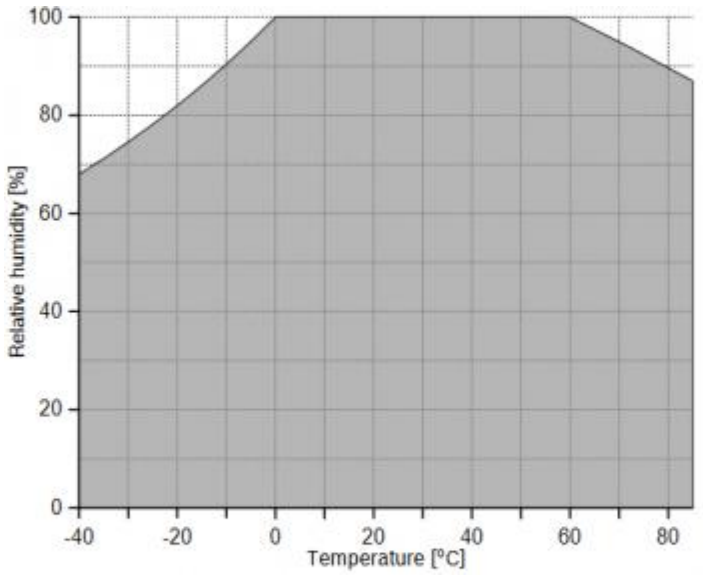
For more details, refer to sections 3.3.2-4 in the datasheet. Additionally, in section 3.5 the are a set of recommended sensor settings for various applications or operations.

Measurements

All measurements can be skipped or enabled. When enabled, there are several oversampling options; with oversampling, it is possible to reduce the noise. For more details, refer to sections 3-4 in the datasheet.

Humidity

The resolution of the humidity measurement is fixed at 16-bit ADC output. A graph of the operational range for the humidity sensor (*shaded in grey*) is shown below; the sensor will not report and/or operate properly outside of this range.



Operational range of the humidity sensor. (Click to enlarge)

Pressure and Temperature

For temperature and pressure readings, the resolution of the data will be dependent on if the infinite impulse response (IIR) filter is enabled and the oversampling setting register setting (osrs):

- When the IIR filter is enabled, the measurement resolution is 20-bit.
- When the IIR filter is disabled, the measurement resolution is [16 + (osrs–1)]-bit.
    - e.g. The temperature measurement is 18-bit when osrs_t is set to '3'.

(**Note: The temperature value depends on the PCB temperature, sensor element self-heating and ambient temperature and is typically just above ambient temperature.*)

Data Analysis

Below are other important attributes of the sensor. For most users, this information is will either be outside their scope or trivial. However for those that are interested, these topics have been briefly summarized or quoted directly from the datasheet. For full details, please refer to the datasheet; additionally, some of the comments in the library may help.

Infinite Impulse Response Filter

- It is recommended that the internal IIR filter be implemented to dampen rapid data fluctuations from external influences like wind blowing, closing doors, etc.

Noise

- The expected noise in the measurement data is dependent on the oversampling setting. For pressure and temperature readings, it is also dependent on the IIR filter setting used.

Trimming Parameters

- The trimming parameters are programmed into the devices' non-volatile memory (NVM) during production and cannot be altered by users. These are used for the calibration/compensation parameters.

Compensation formulas

- It is strongly advised (by the manufacturer) to use the API available from Bosch Sensortec to perform readout and compensation.

I^{2}C Address

The BME280 has 2 available I^{2}C addresses, which are set by the address pin, ADR. On the Atmospheric sensor, the default peripheral address of the BME280 is **0x77** (HEX).

Default I^{2}C Peripheral Address: 0x77

I^{2}C Registers

The BME280 register (*memory*) map is detail in section 5.3 of the datasheet.

Address	Description
0xD0	ID: The chip identification number.
0xE0	Soft Reset: If the value **0xB6** is written to the register, the device is reset using the complete power-on-reset procedure
0xF2	ctrl_hum: Sets the humidity data acquisition options of the device. Changes to this register only become effective after a write operation to `ctrl_meas`.
0xF3	status: Indicate the status of the device.

	Whether a conversion is running or the results have been transferred to the data registers. Whether NVM data are being copied to image registers.
0xF4	ctrl_meas: Sets the pressure and temperature data acquisition options of the device. The register needs to be written after changing `ctrl_hum` for the changes to become effective./td>
0xF5	config: Sets the rate, filter and interface options of the device. Writes to the `config` register in *normal mode* may be ignored. In *sleep mode* writes are not ignored.
0xF7 to 0xF9	press: The raw pressure measurement data.
0xFA to 0xFC	temp: The raw temperature measurement data.
0xFD to 0xFE	hum: The raw humidity measurement data.
0xE1 to 0xF0 0x88 to 0xA1	Calibration Data: Holds *Trimming Parameters*.

Connections

The simplest way to use the ADC is through the connector. The connectors are polarized for the I^{2}C connection and power. (**They are tied to their corresponding breakout pins.*)

However, the board also provides six labeled breakout pins. You can connect these lines to the I^{2}C bus of your microcontroller and power pins (**3.3V** and **GND**), if it doesn't have a connector. Otherwise, the breakout pins can also be used for an SPI connection.

Pin Label	Pin Function	Input/Output	Notes
3.3V	Power Supply	Input	**3.3V** on system (*should be stable*)
GND	Ground	Input	Ground and Single-Ended Reference Voltage for ADC.
SDA	I^{2}C Data Signal	Bi-directional	Bi-directional data line. Voltage should not exceed power supply (e.g. 3.3V).

SCL	I^{2}C Clock Signal	Input	Clock signal. Voltage should not exceed power supply (e.g. 3.3V).

SPI Connection

There are two options for an SPI connection 3-wire or 4-wire. For a 3-wire connection, users will need to cut the ADR jumper on the board. For a 4-wire connection users can cut the ADR, I2C, and CS jumpers to remove the load from the SPI lines, but it is not necessary. For more details, check out the notes in the schematic.

Pin Label	Pin Function	Input/Output	Notes
3.3V	Power Supply	Input	Supply voltage for sensor. Should be regulated between **1.8 and 3.6 V**
GND	Ground	Input	Ground
SCK	Clock Signal	Input	Clock signal. Voltage should not exceed power supply (max. 3.6V).
SDI	Data In	Input	Data incoming to the BME280. Voltage should not exceed power supply (max. 3.6V).
SDO	Data Out	Output	Data coming from the BME280.
CS	Chip Select	Input	Used to select device communication on 4-wire connections (active low). Voltage should not exceed power supply (max. 3.6V).

LED Power

If you want to conserve power, the jumper labeled LED will allow users to isolate power to the power status indicator LED.

I^2C Address

If you want to change the I^2C address for the sensor, the jumper labeled ADR will allow users to change the I^2C address from the default (**0x77**) to **0x76**

Pull-Up Resistors

There are two jumpers (well technically three) for the pull-up resistors attached to specific pins on the sensor.

I^2C Pull-Ups

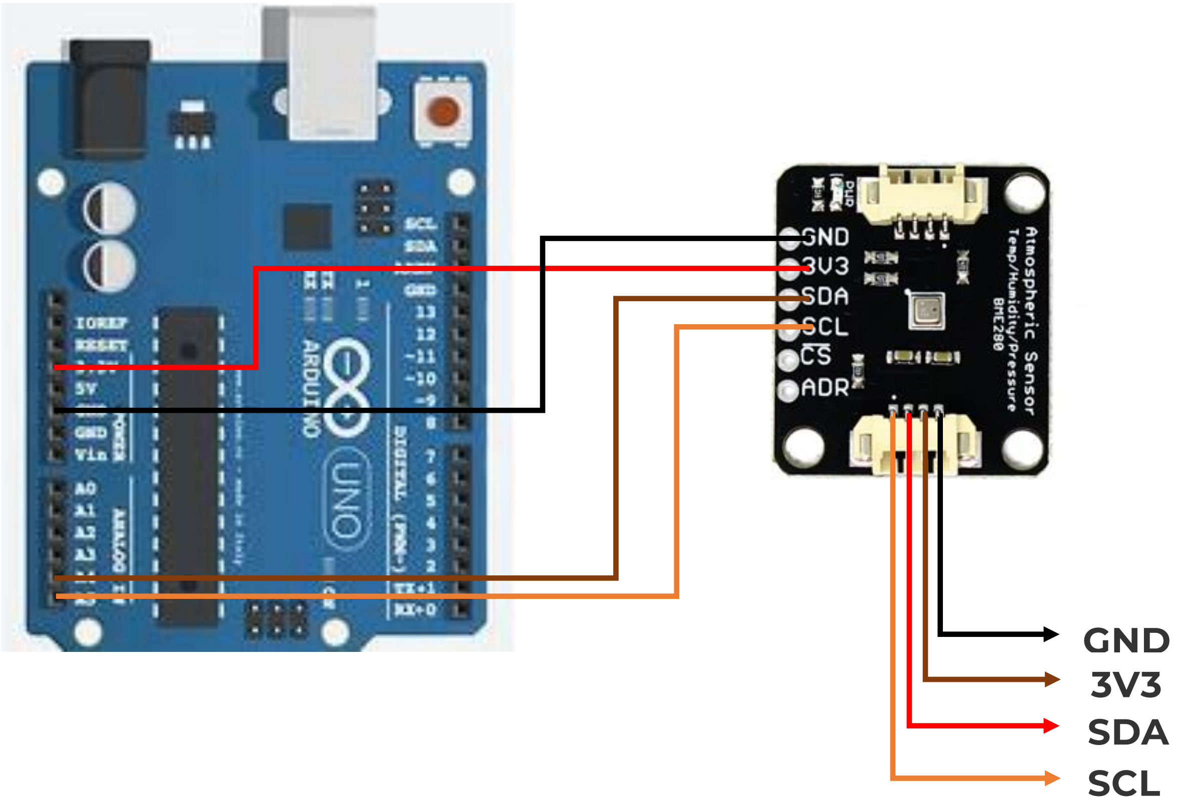
The first set of pull-up resistors are tied to the SDA and SCL lines for an I^2C connection. Cutting the I2C jumper will remove the **4.7kΩ** pull-up resistors from the I^2C bus. If you have many devices on your I^2C bus you may want to remove these jumpers. (*When there are multiple devices on the bus with pull-up resistors, the equivalent* parallel *resistance may create too strong of a pull-up for the bus to operate correctly.*)

CS (and SPI) Pull-Ups

The last pull-up resistor is tied to CS pin for an SPI connection. Cutting the CS jumper will remove the **4.7kΩ** pull-up resistor.

Keep in mind that the rest of the SPI pins are shared with other pins. For a 3-wire connection, users will need to cut the ADR jumper for the SDO line. For a 4-wire connection users can cut the ADR, I2C, and CS jumpers to remove the load from the SPI lines, but it is not necessary.

Wiring



Arduino	BME280
SCL(A5)	SCL
SDA(A4)	SDA
5v OR 3.3v	3V3
GND	GND

Arduino Example Code

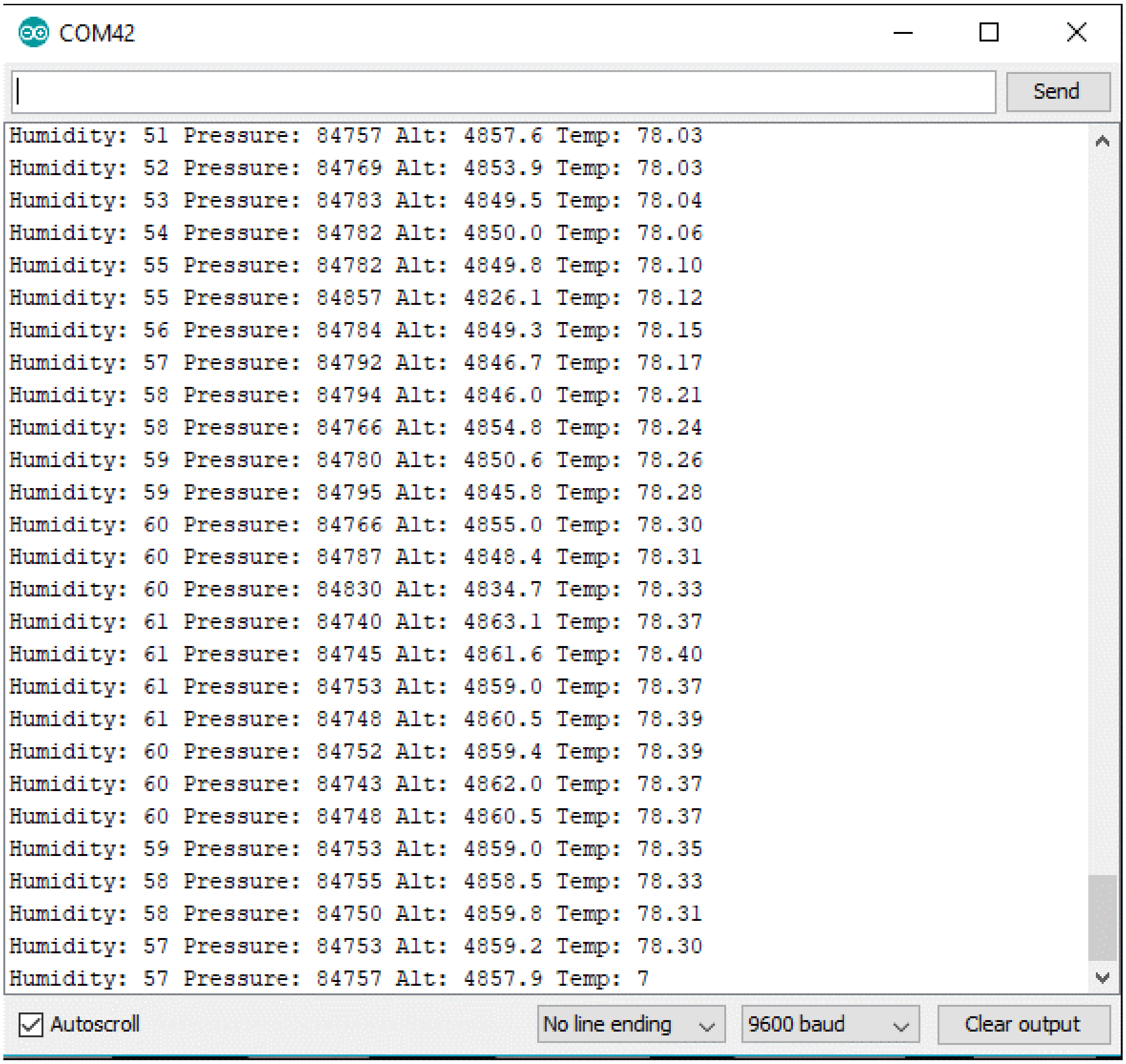
The examples can be found in the the drop-down menu (**File > Examples > SparkFun BME280 > ...**) of the Arduino IDE

Example 1: Basic Readings

```
#include <Wire.h>

#include "SparkFunBME280.h"

BME280 mySensor;

void setup()

{
  Serial.begin(115200);
  Serial.println("Reading basic values from BME280");
  Wire.begin();
  if (mySensor.beginI2C() == false) //Begin communication over I2C
  {
    Serial.println("The sensor did not respond. Please check wiring.");
    while(1); //Freeze
  }
}
void loop()
{
  Serial.print("Humidity: ");
  Serial.print(mySensor.readFloatHumidity(), 0);
  Serial.print(" Pressure: ");
  Serial.print(mySensor.readFloatPressure(), 0);
  Serial.print(" Alt: ");
  //Serial.print(mySensor.readFloatAltitudeMeters(), 1);
  Serial.print(mySensor.readFloatAltitudeFeet(), 1);

  Serial.print(" Temp: ");
  //Serial.print(mySensor.readTempC(), 2);
  Serial.print(mySensor.readTempF(), 2);
  Serial.println();
  delay(50);
}
```

Below are a sample readouts from the Serial Monitor. The baud rate for the example is **9600 baud**.

This basic example configures an BME280 on the I2C bus and reports out the data.



```
Humidity: 51 Pressure: 84757 Alt: 4857.6 Temp: 78.03
Humidity: 52 Pressure: 84769 Alt: 4853.9 Temp: 78.03
Humidity: 53 Pressure: 84783 Alt: 4849.5 Temp: 78.04
Humidity: 54 Pressure: 84782 Alt: 4850.0 Temp: 78.06
Humidity: 55 Pressure: 84782 Alt: 4849.8 Temp: 78.10
Humidity: 55 Pressure: 84857 Alt: 4826.1 Temp: 78.12
Humidity: 56 Pressure: 84784 Alt: 4849.3 Temp: 78.15
Humidity: 57 Pressure: 84792 Alt: 4846.7 Temp: 78.17
Humidity: 58 Pressure: 84794 Alt: 4846.0 Temp: 78.21
Humidity: 58 Pressure: 84766 Alt: 4854.8 Temp: 78.24
Humidity: 59 Pressure: 84780 Alt: 4850.6 Temp: 78.26
Humidity: 59 Pressure: 84795 Alt: 4845.8 Temp: 78.28
Humidity: 60 Pressure: 84766 Alt: 4855.0 Temp: 78.30
Humidity: 60 Pressure: 84787 Alt: 4848.4 Temp: 78.31
Humidity: 60 Pressure: 84830 Alt: 4834.7 Temp: 78.33
Humidity: 61 Pressure: 84740 Alt: 4863.1 Temp: 78.37
Humidity: 61 Pressure: 84745 Alt: 4861.6 Temp: 78.40
Humidity: 61 Pressure: 84753 Alt: 4859.0 Temp: 78.37
Humidity: 61 Pressure: 84748 Alt: 4860.5 Temp: 78.39
Humidity: 60 Pressure: 84752 Alt: 4859.4 Temp: 78.39
Humidity: 60 Pressure: 84743 Alt: 4862.0 Temp: 78.37
Humidity: 60 Pressure: 84748 Alt: 4860.5 Temp: 78.37
Humidity: 59 Pressure: 84753 Alt: 4859.0 Temp: 78.35
Humidity: 58 Pressure: 84755 Alt: 4858.5 Temp: 78.33
Humidity: 58 Pressure: 84750 Alt: 4859.8 Temp: 78.31
Humidity: 57 Pressure: 84753 Alt: 4859.2 Temp: 78.30
Humidity: 57 Pressure: 84757 Alt: 4857.9 Temp: 7
```

☑ Autoscroll No line ending 9600 baud