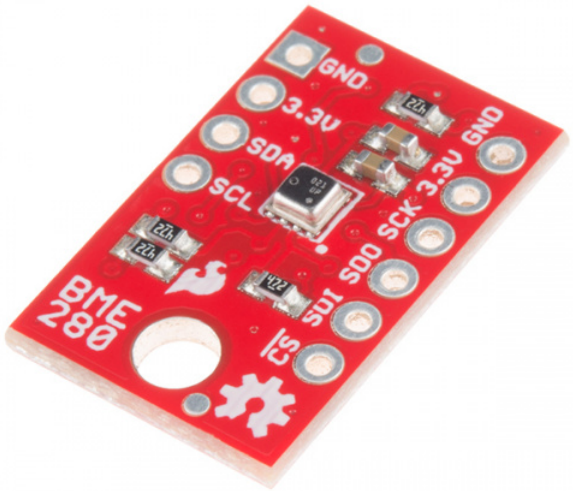
SparkFun BME280 Breakout Hookup Guide

Introduction

The BME280 Breakout Board is the easy way to measure pressure and humidity, and without taking up a lot of room. It gives you easy to solder 0.1" headers, runs I2C or SPI, takes measurements at less than 1mA and idles less than 5uA (yes, microamps!).



SparkFun Atmospheric Sensor Breakout - BME280
SEN-13676

SparkFun Atmospheric Sensor Breakout - BME280 (with Headers)

SEN-13905

The BME280 can be used to take pressure, humidity, and temperature readings. Use the data to get relative altitude changes, or absolute altitude if the locally reported barometric pressure is known.

Ranges:

- Temp: -40C to 85C
- Humidity: 0 - 100% RH, =-3% from 20-80%
- Pressure: 30,000Pa to 110,000Pa, relative accuracy of 12Pa, absolute accuracy of 100Pa
- Altitude: 0 to 30,000 ft (9.2 km), relative accuracy of 3.3 ft (1 m) at sea level, 6.6 (2 m) at 30,000 ft.

Covered In This Tutorial

This tutorial gives you all you need to get going with the BME280. First we'll take a look at the IC and hardware, then we'll use the SparkFun BME280 Arduino library to get data out of it by SPI or I2C.

The tutorial is split into the following pages:

- BME280 Hardware Overview -- Basic information about the hardware.
- Assembly -- Connect to the BME280 by I2C or SPI
- Installing the Arduino Library -- How to get it
- Using the Arduino Library -- explains the user API
- Theory and Example Data -- Showcase of the examples included with the library.
- Resources and Going Further -- Links to the datasheet and application notes, plus inspirational projects

Required Materials

Get the datasheet and application notes now. Keep a copy to refer to once you get off the charted path.

- Bosch BME280 **Datasheet**

This tutorial explains how to use the BME280 Breakout Board with an RedBoard (or Arduino). To follow along, you'll need the following materials:

- BME280 Breakout Board
- Arduino UNO, RedBoard, or another Arduino-compatible board
- Straight Male Headers -- Or wire. Something to connect between the breakout and a breadboard.
- Breadboard -- Any size (even mini) should do.
- M/M Jumper Wires -- To connect between Arduino and breadboard.
- Logic Level Converter -- To shift SPI levels from 5v to 3.3v.

The BME280 is a 3.3V device! Supplying voltages greater than ~3.6V can permanently damage the IC. As long as your Arduino has a 3.3V supply output, and you're OK with using I^2C, you shouldn't need any extra level shifting. But if you want to use SPI, you may need a Logic Level Converter.

If you use a 3.3V-based micro -- like the Arduino Pro 3.3V or 3.3V Pro Mini -- there is no need for level shifting.

Suggested Reading

Connection of the BME280 uses some basic concepts shared by a lot of our products. If you want to get more familiar with these basic tasks, these articles can help you out.

- Serial Peripheral Interface (SPI)
- Inter-IC Communication (I^2C)
- Logic Levels
- Bi-Directional Level Shifter Hookup Guide

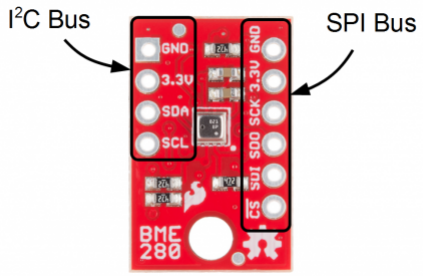
If the concepts of pressure are weighing on you, check out these links.

- (external) Air Pressure Altitude Calculator -- Play around to get a feel for what the pressures are at different altitudes.
- Wikipedia: Atmospheric_pressure -- Has a nice equation for conversion of pressure and altitude (referenced for library code).
- MPL3115a2-pressure-sensor-hookup-guide -- pressure-vs-altimeter-setting -- Confused why the reading pressure doesn't match the reported pressure from your local weather station? Read this section.

Hardware Overview

The Front Side

The BME280 Breakout board has 10 pins, but no more than 6 are used at a single time.



*Use one header for I2C connections, **or** the other for SPI connections -- no need to use both!*

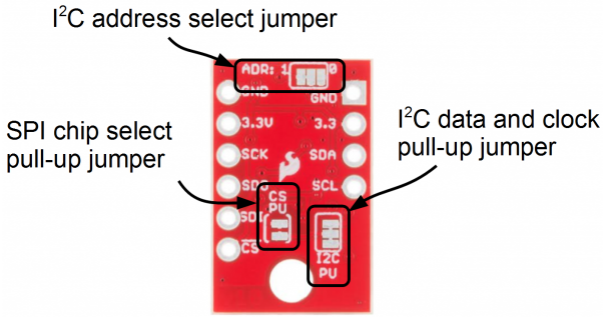
The left side of the board are power, ground, and I^{2}C pins.

Pin Label	Pin Function	Notes
GND	Ground	0V voltage supply.
3.3v	Power Supply	Supply voltage to the chip. Should be regulated between **1.8V and 3.6V**.
SDA	Data	I^{2}C: Serial data (bi-directional)
SCL	Serial Clock	I^{2}C serial clock.

The remaining pins are broken out on the other side. These pins break out SPI functionality and have another power and ground.

Pin Label	Pin Function	Notes
GND	Ground	0V voltage supply.
3.3v	Power Supply	Supply voltage to the chip. Should be regulated between **1.8V and 3.6V**.
SCK	Clock	Clock line, 3.6V max
SDO	Data out	Data comming out of the BME280 (MISO)
SDI	Data in	Data going into the BME280, 3.6V max (MOSI)
!CS	Chip Select (Slave Select)	Active low chip select, 3.6V max

The Back Side



On the other side of the board you'll find all the configuration jumpers. Pull-ups can be left connected even when using SPI mode, so you'll probably never have to touch these. If you do, here's what they're for.

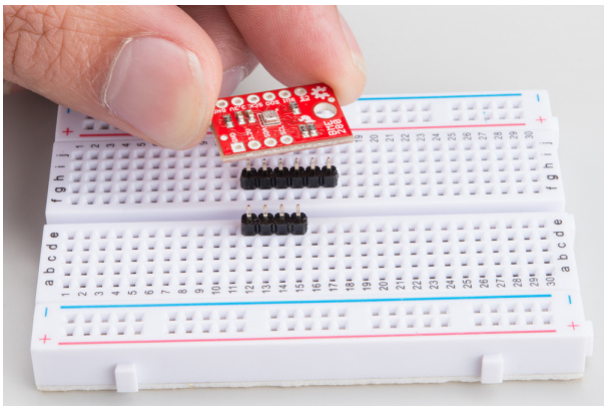
Jumper Label	Jumper Function	Notes
ADR:	I^{2}C Address	Select between addresses 0x77 (default, '1' side) and 0x76 by slicing the trace and bridging the '0' side. Controls the least significant bit.

CS PU	SPI chip select pull-up	Connects a 4.7k resistor to the CS line to make sure it is idle high. Can be disconnected by slicing between the jumper pads.
I^2C	I^2C pull-ups	Connects the I^2C pull-up resistors to 3.3V. Cut the trace to disconnect them if necessary.

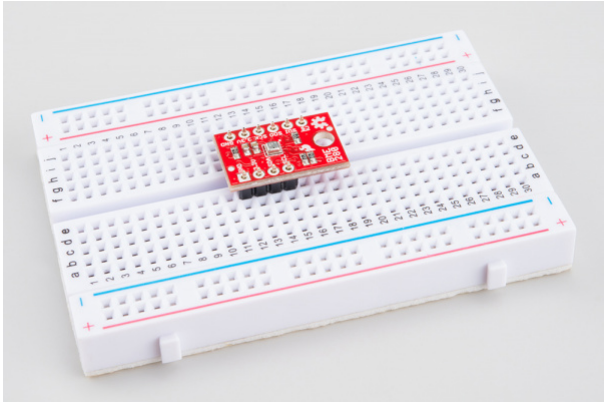
Assembly

Attaching the headers

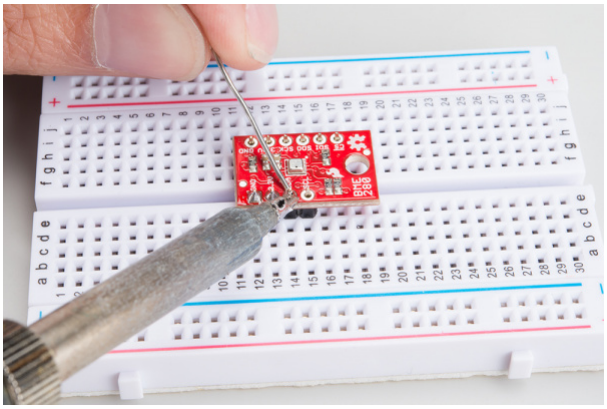
If you got a board without headers, you will need to solder to the PTH pads. Regular wires can be soldered in, but for a more configurable breadboard experience you may want to attach headers.



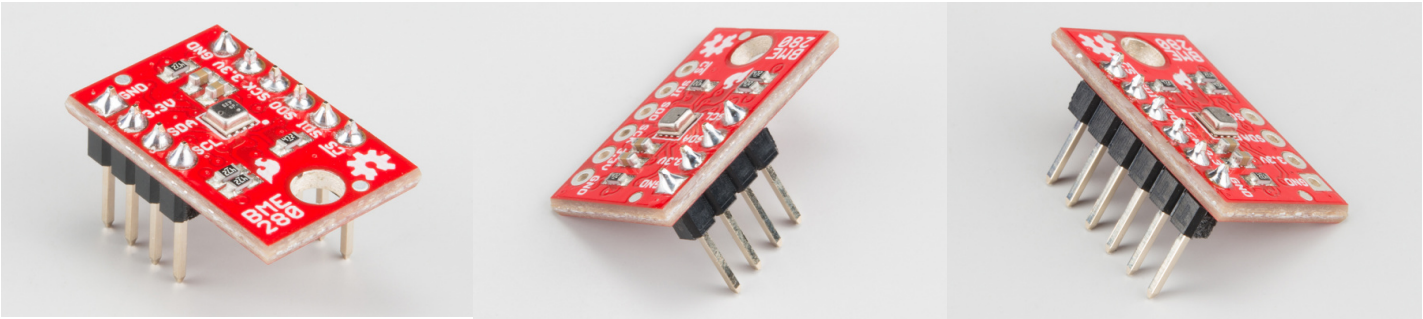
Use a breadboard to align and hold the pins



Prepare to solder



Solder on the pins



For generic operation solder both headers (left). If you only need I^{2}C (middle), or SPI (right), only attach those headers.

I^{2}C Connection

The sensor pulls the I^{2}C lines to 3.3V, so they can be directly connect to the redboard's A4/A5 pins, or the SDA/SCL pins (as long as they're configured by Wire). Make sure to power the sensor from 3.3v! The power and ground pins are connected, so you only need to connect to one side.

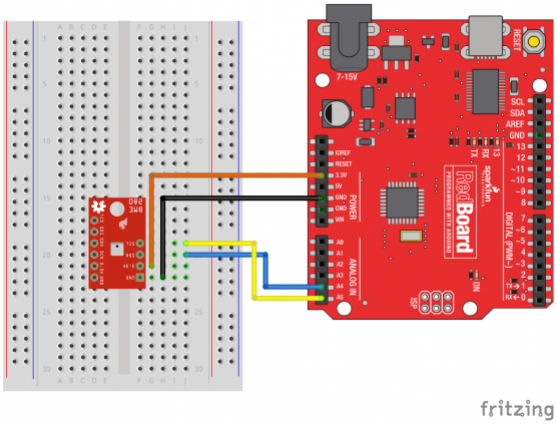


Diagram showing I2C connection to the BME280. You could also use the dedicated SDA and SCL lines found on most Arduino boards.

SPI Connection

The SPI connection isn't quite straightforward when connected to a RedBoard. The Logic Level Converter is required to bridge between the 3.3v requirement of the BME280 and the 5v IO of the RedBoard. 3.3v microcontrollers such as the fabulous Teensy 3.2 can be directly connected.

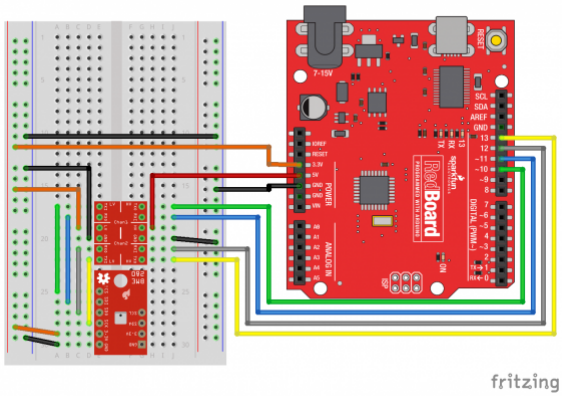


Diagram showing SPI connection to the BME280

Installing the Arduino Library

We've created an Arduino library to get the BME280 operational with arduino IDE compatible boards. Before we get in to what the library does, obtain a copy of it.

Download the Github repository

Visit the GitHub repository to download the most recent version of the library, or click the link below:

DOWNLOAD THE SPARKFUN BME280 ARDUINO LIBRARY

Use the library manager / Install in the Arduino IDE

For help installing the library, check out our How To Install An Arduino Library tutorial.

If you don't end up using the manger, you'll need to move the *SparkFun_BME280_Arduino_Library* folder into a *libraries* folder within your Arduino sketchbook.

Functions of the Arduino Library

Let's get started by looking at the functions that set up the BME280 Atmospheric Sensor:

Class

In the global scope, construct your sensor object (such as `mySensor` or `pressureSensorA`) without arguments.

```
BME280 mySensor;
```

Object Parameters and setup()

Rather that passing a bunch of data to the constructor, configuration is accomplished by setting the values of the BME280 type in the `setup()` function. They are exposed by being `public:` so use the `myName.aVariable = someValue;` syntax.

Settable variables of the class BME280:

```
//Main Interface and mode settings
uint8_t commInterface;
uint8_t I2CAddress;
uint8_t chipSelectPin;

uint8_t runMode;
uint8_t tStandby;
uint8_t filter;
uint8_t tempOverSample;
uint8_t pressOverSample;
uint8_t humidOverSample;
```

Functions

`.begin();`

Initialize the operation of the BME280 module with the following steps:

- Starts up the wiring library for I^2C by default
- Checks/Validates BME280 chip ID
- Reads compensation data
- Sets default settings from table
- Sets operational mode to *Normal Mode*

Output: uint8_t

Returns the BME280 chip ID stored in the ID register.

> **.begin() Needs to be run once during the setup**, or after any settings have been modified. In order to let the sensor's configuration take place, the BME280 requires a minimum time of about 2 ms in the sketch before you take data.

`.beginSPI(uint8_t csPin);`

Begins communication with the BME280 over an SPI connection.

Input: uint8_t

csPin: Digital pin used for the CS.

Output: Boolean

True: Connected to sensor.

False: Unable to establish connection.

`.beginI2C(TwoWire &wirePort);` or **`.beginI2C(SoftwareWire &wirePort);`**

Begins communication with the BME280 over an I^2C connection. If `#ifdef SoftwareWire_h` is defined, then a software I^2C connection is used.

Input: &wirePort

&wirePort: Port for the I^2C connection.

Output: Boolean

True: Connected to sensor.

False: Unable to establish connection.

`.setMode(uint8_t mode);`
Sets the operational mode of the sensor. (*For more details, see section 3.3 of the datasheet.*)

Input: uint8_t
- **0:** Sleep Mode
- **1:** Forced Mode
- **3:** Normal Mode

`.getMode();`
Returns the operational mode of the sensor.

Output: uint8_t
- **0:** Sleep Mode
- **1:** Forced Mode
- **3:** Normal Mode

`.setStandbyTime(uint8_t timeSetting);`
Sets the standby time of the cycle time. (*For more details, see section 3.3 and Table 27 of the datasheet.*)

Input: uint8_t
- **0:** 0.5ms
- **1:** 62.5ms
- **2:** 125ms
- **3:** 250ms
- **4:** 500ms
- **5:** 1000ms
- **6:** 10ms
- **7:** 20ms

`.setFilter(uint8_t filterSetting)`
Sets the time constant of the IIR filter, which slows down the response time of the sensor inputs based on the number of samples required. (*For more details, see section 3.4.4, Table 6, and Figure 7 of the datasheet.*)

Input: uint8_t
- **0:** filter off
- **1:** coefficient of 2
- **2:** coefficient of 4
- **3:** coefficient of 8
- **4:** coefficient of 16

`.setTempOverSample(uint8_t overSampleAmount);`
Sets the oversampling option (`osrs_t`) for the temperature measurements. (*Directly influences the noise and resolution of the data.*)

Input: uint8_t
- **0:** turns off temperature sensing
- **1:** oversampling ×1
- **2:** oversampling ×2
- **4:** oversampling ×4
- **8:** oversampling ×8
- **16:** oversampling ×16
- **Other:** Bad Entry, sets to *oversampling ×1* by default.

> **Note:** Yes, we do know there is a spelling error in the name of the method. It will get corrected in the next library update.

`.setPressureOverSample(uint8_t overSampleAmount);`
Sets the oversampling option (`osrs_p`) for the pressure measurements. (*Directly influences the noise and resolution of the data.*)

Input: uint8_t
- **0:** turns off pressure sensing
- **1:** oversampling ×1
- **2:** oversampling ×2
- **4:** oversampling ×4
- **8:** oversampling ×8
- **16:** oversampling ×16
- **Other:** Bad Entry, sets to *oversampling ×1* by default.

`.setHumidityOverSample(uint8_t overSampleAmount);`
Sets the oversampling option (`osrs_h`) for the humidity measurements. (*Directly influences the noise of the data.*)

Input: uint8_t
- **0:** turns off humidity sensing
- **1:** oversampling ×1
- **2:** oversampling ×2
- **4:** oversampling ×4
- **8:** oversampling ×8
- **16:** oversampling ×16
- **Other:** Bad Entry, sets to *oversampling ×1* by default.

`.setI2CAddress(uint8_t address);`
Changes the I^2C address stored in the library to access the sensor.

Input: uint8_t
- **address:** The new I^2C address.

`.isMeasuring();`
Checks the `measuring` bit of the `status` register for if the device is taking measurement.

Output: Boolean
- **True:** A conversion is running.
- **False:** The results have been transferred to the data registers.

`.reset();`
Soft resets the sensor. (*If called, the begin function must be called before using the sensor again.*)

`.readFloatPressure();`
Reads raw pressure data stored in register and applies output compensation (*For more details on the data compensation, see section 4.2 of the datasheet.*)

Output: float
- Returns pressure in Pa.

`.readFloatHumidity();`
Reads raw humidity data stored in register and applies output compensation (*For more details on the data compensation, see section 4.2 of the datasheet.*)

Output: float
Returns humidity in %RH.

`.readTempC();`
Reads raw temperature data stored in register and applies output compensation (*For more details on the data compensation, see section 4.2 of the datasheet.*)

Output: float
Returns temperature in Celsius.

`.readTempF();`
Reads raw temperature data stored in register and applies output compensation (*For more details on the data compensation, see section 4.2 of the datasheet.*)

Output: float
Returns temperature in Fahrenheit.

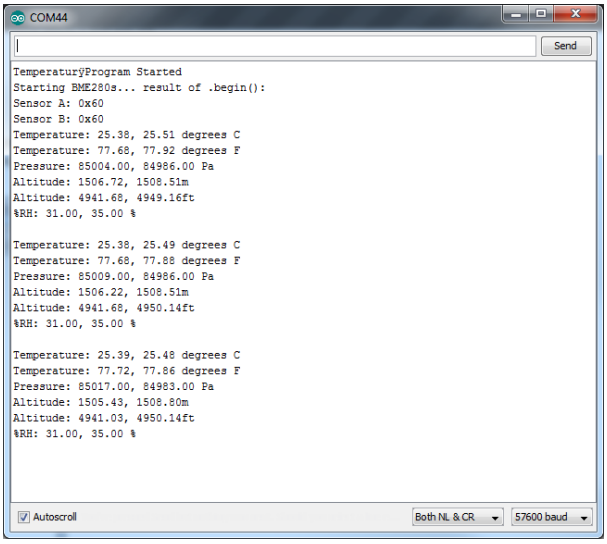
Example Sketches

The examples are selectable from the drop-down menu in the Arduino IDE, or they will run stand-alone if you put the contents of the libraries /src dirctory in with the example.ino file.

> Note, the library has been updated to v2.0.0 since this guide was written. Nearly all of the examples now default to **9600 Baud**.

I2C_and_SPI_Multisensor.ino

This example configures one BME280 on the SPI bus and another on the I2C bus. Then it gets the data and outputs from both sensors every second. If you only have 1 sensor connected the other channel reports garbage, so this can be a good troubleshooting and starting place.

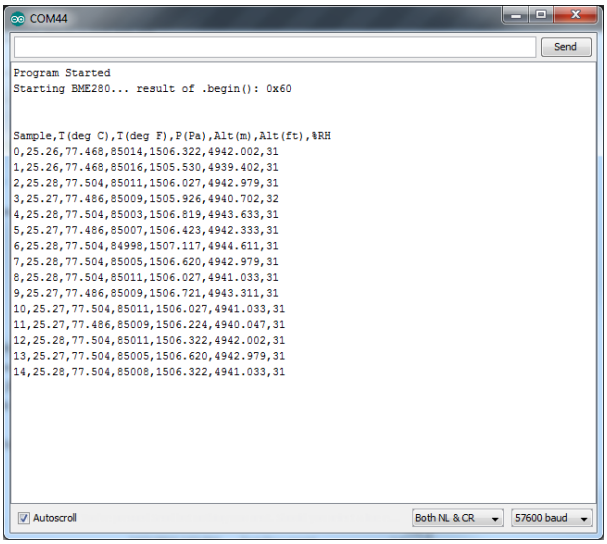


Example output -- shown is the configuration plus the first 3 sample readings

CSVOutput.ino

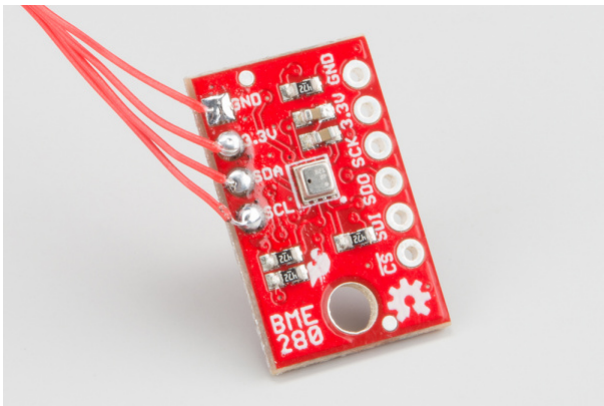
If you want to use the BME280 to record data as a function of time, this example is for you! It outputs text as CSV (comma separated vales) that can be copy-pasted into a textfile or spreadsheet app for graphing.

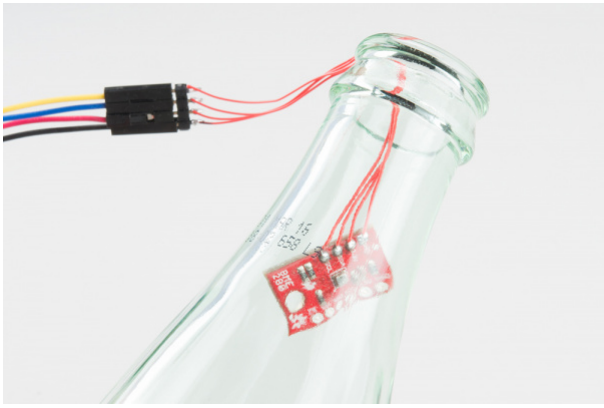
A note on accuracy: This sketch use "delay(50);" to wait 50ms between reads. The units of the 'sample' column are in (50ms + time-to-read) periods.



Example output -- Shows the first few lines of the generated CSV.

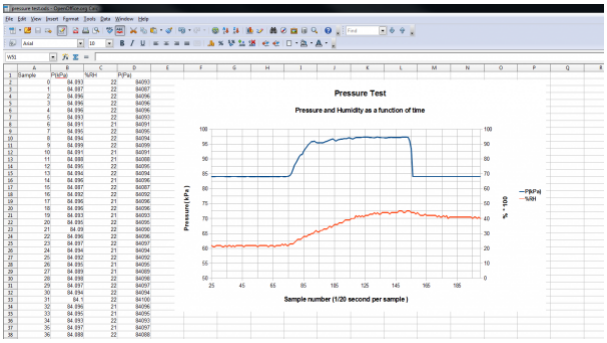
In order to demonstrate the operation, the BME280 is connected with fine hookup wires that are then placed in a bottle and pressurized with breath.





The environmental test chamber! IT'S SCIENCE!

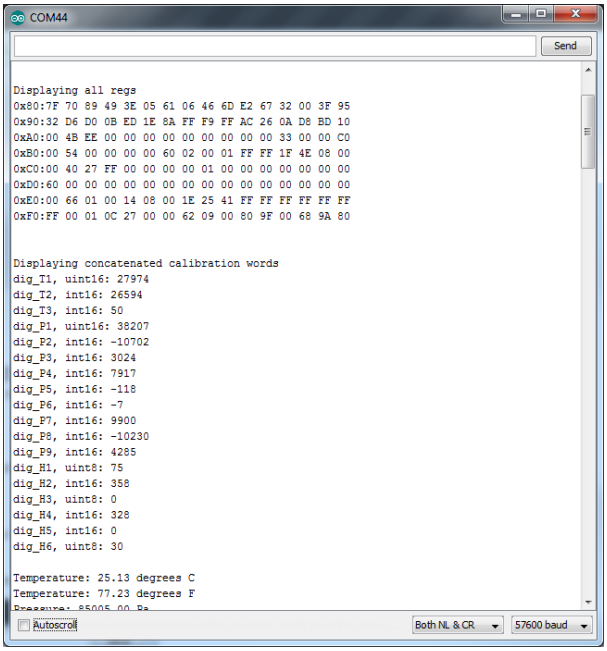
Data is collected from the event, and then a graph is made. To do this, the un-needed columns were deleted, and the pressure was scaled to kPa.



Example graph of pressure and humidity - shown after the data was loaded into OpenOffice Calc

ReadAllRegisters.ino

Here's an example that prints out the registers as well as the internally concatenated calibration words. It can be used to check the state of the BME280 after a particular configuration or can be implanted in your own sketch where you need to debug.

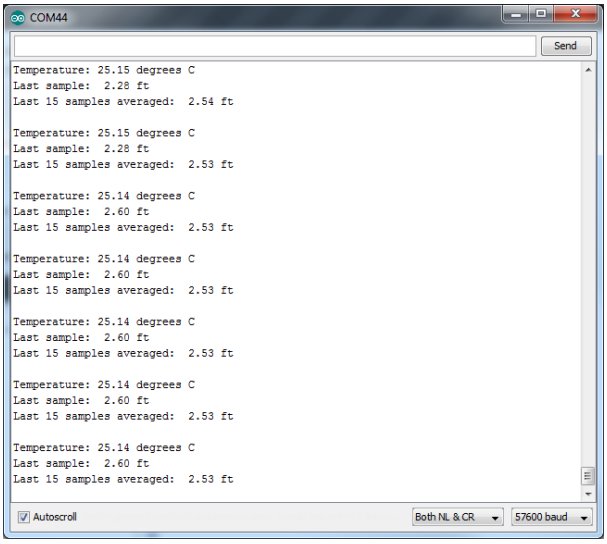


Example output -- shows the full contents of memory, even those not specified in the datasheet

RelativeAltitudeChange.ino

This example allows you to take measurements of change in altitude. It configures the BME280 with a lot of oversampling and also uses a software filter giving accurate but slow performance.

The sketch uses an additional button to zero the altitude. Push and hold until the average reaches zero.



After the sensor was zeroed out on the floor and moved to a desk hight, the output displays the rough height of the desk!

Product Video Sketches

The library also has a subfolder titled "More_Advanced" in the examples folder that contains the sketches used in the product video. They're modifications of the basic examples with a LCD added on. They are not covered by this tutorial.

Resources and Going Further

Resources

- BME280 Product GitHub Repository -- Your revision-controlled source for all things BME280. Here you'll find our most up-to-date hardware layouts and documentation.
- SparkFun BME280 Arduino Library GitHub Repository -- Find the most up-to-date Arduino library and examples here.
- Bosch BME280 Datasheet -- This datasheet covers everything in one handy document.

Going Further

Hopefully this guide has gotten your BME280 operational. What will it become? Weather monitoring? Flight control on a quadcopter? Terrarium climate control?

To get you thinking, here are a few articles to browse.

- Weather Ballooning in the White Mountains
- SparkFun Data Service
- Enginursday: These Are Not the Drones You're Looking For

Let us know what your BME280 becomes!

Check out these other great weather related tutorials.

TMP102 Digital Temperature Sensor Hookup Guide

How to connect and use the SparkFun Digital Temperature Sensor Breakout - TMP102 with an Arduino.

Photon Weather Shield Hookup Guide V11

Create Internet-connected weather projects with the SparkFun Weather Shield for the Photon.

ESP32 Environment Sensor Shield Hookup Guide

SparkFun's ESP32 Environment Sensor Shield provides sensors and hookups for monitoring environmental conditions. This tutorial will show you how to connect your sensor suite to the Internet and post weather data online.

SparkFun Air Quality Sensor - SGP30 (Qwiic) Hookup Guide

A hookup guide to get started with the SparkFun Air Quality Sensor - SGP30 (Qwiic).