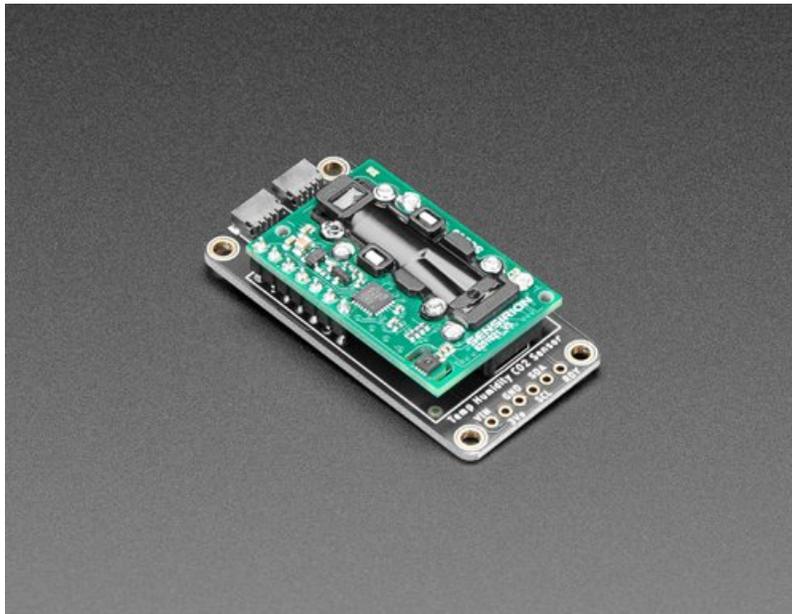


## Adafruit SCD-30 - NDIR CO2 Temperature and Humidity Sensor

Created by Kattni Rembor



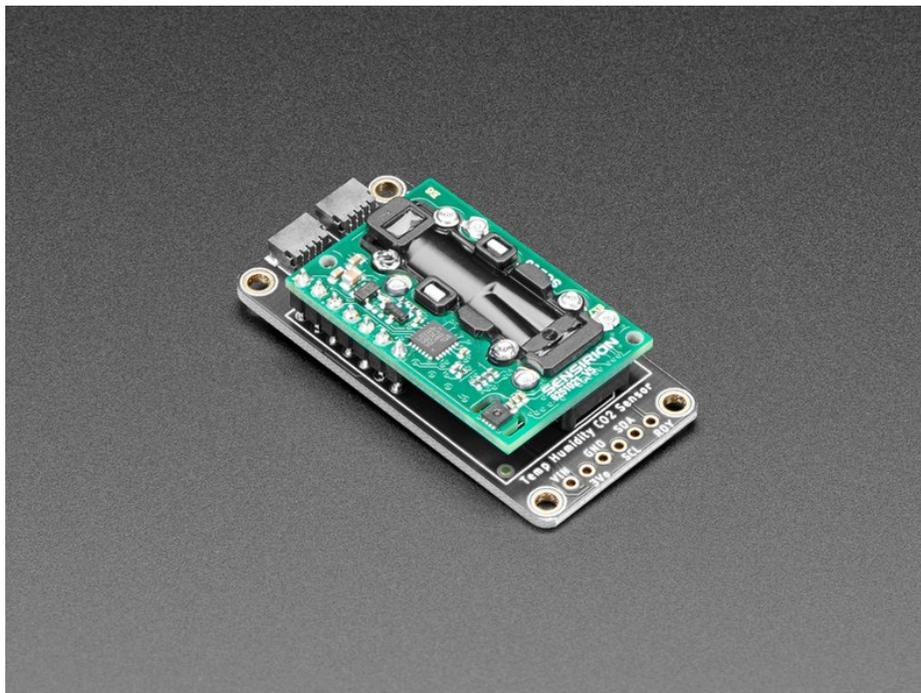
Last updated on 2021-02-21 02:52:10 PM EST

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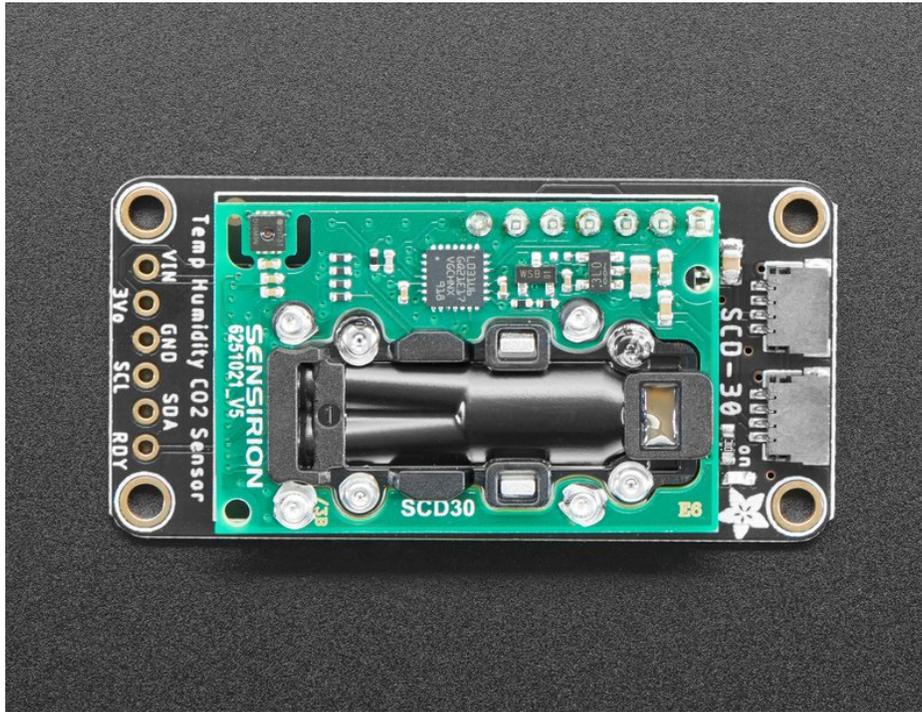
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# Overview

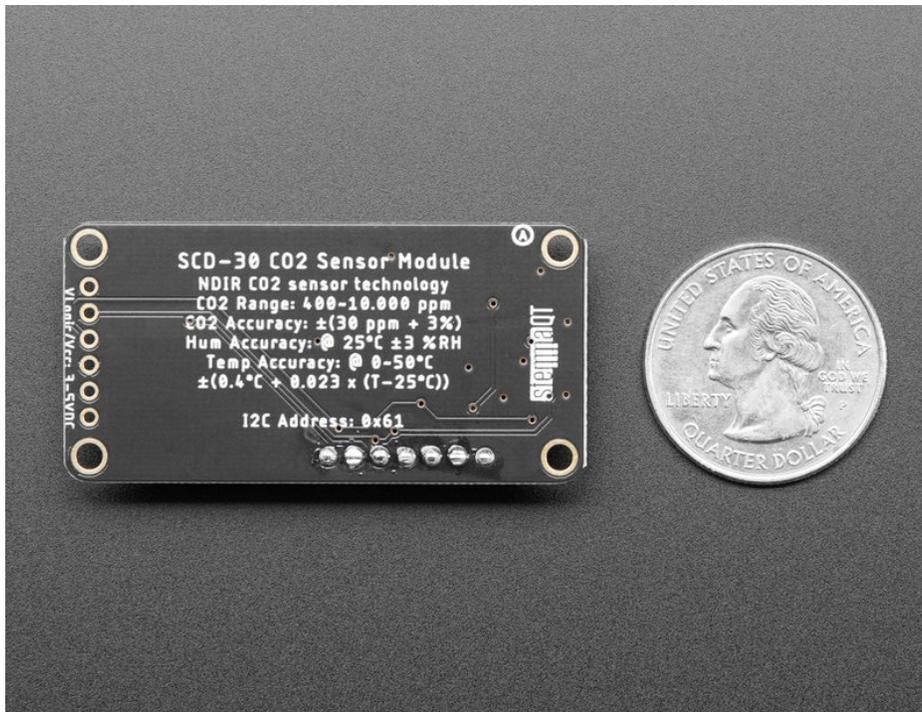
Take a deep breath in...now slowly breathe out. Mmm isn't it wonderful? All that air around us, which we bring into our lungs, extract oxygen from and then breathe out carbon dioxide. CO2 is essential for life on this planet we call Earth - us and plants take turns using and emitting CO2 in an elegant symbiosis. But it's important to keep that CO2 balanced - you don't want too much around, not good for humans and not good for our planet.



The SCD-30 is an [NDIR sensor \(https://adafru.it/CQ6\)](https://adafru.it/CQ6), which is a 'true' CO2 sensor, that will tell you the CO2 PPM (parts-per-million) composition of ambient air. [Unlike the SGP30, this sensor isn't approximating it from VOC gas concentration \(https://adafru.it/PF7\)](https://adafru.it/PF7) - it really is measuring the CO2 concentration ! That means its a lot bigger and more expensive, but it is the real thing. Perfect for environmental sensing, scientific experiments, air quality and ventilation studies and more.



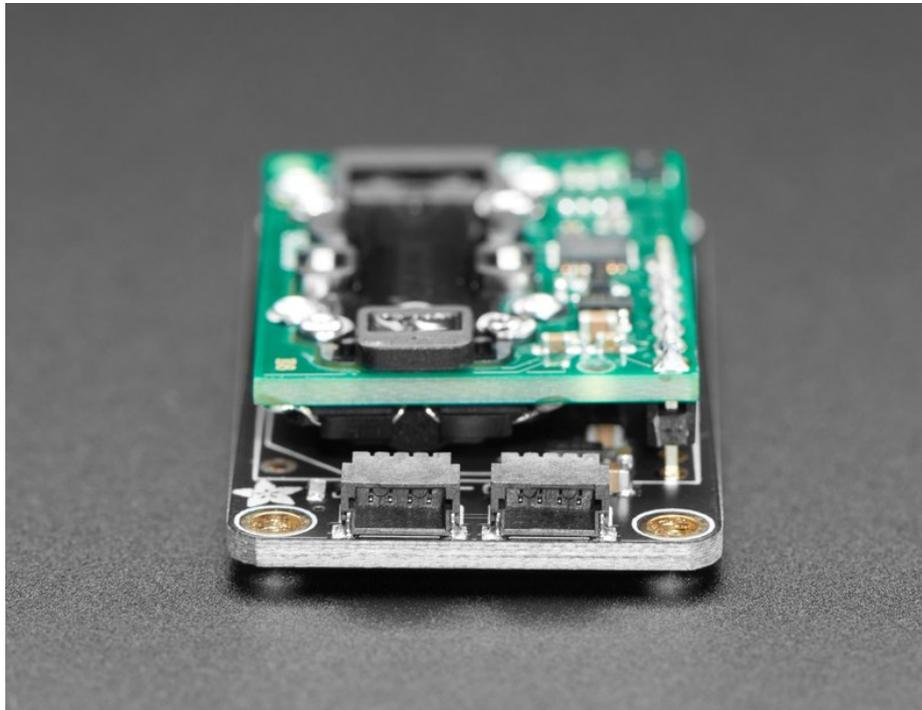
Data is read over I2C, so it works very nicely with just about any microcontroller or microcomputer. We've written both Arduino and Python/CircuitPython code so you can get started in a jiffy. Another nice element to this sensor is it comes with an [SHT31 temperature and humidity sensor already built in](https://adafru.it/y7f) (<https://adafru.it/y7f>). The sensor is used to compensate the NDIR CO2 sensor, but its also readable so you get full environmental data.



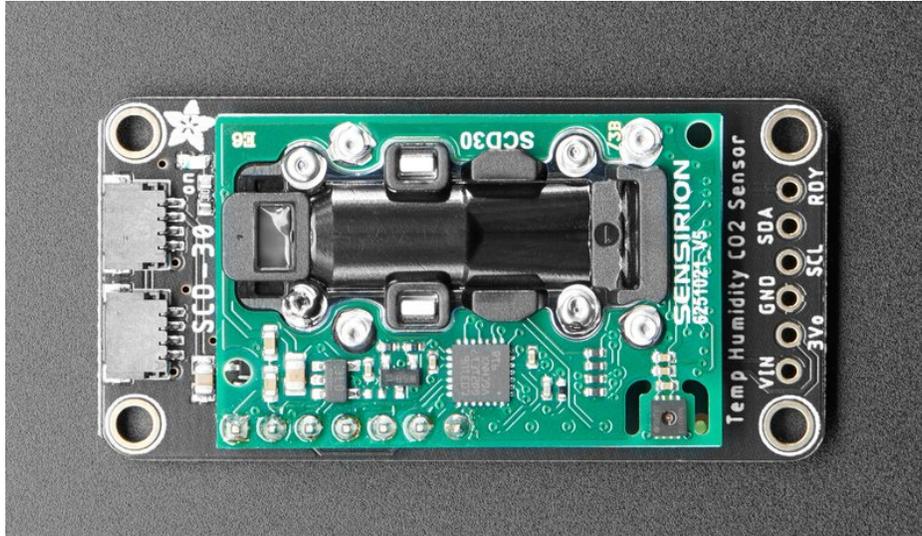
Nice sensor right? So we made it easy for you to get right into your next project. The sensor is hand-soldered onto a custom made PCB in the [STEMMA QT form factor](https://adafru.it/LBQ) (<https://adafru.it/LBQ>), making them easy to interface with. The [STEMMA QT connectors](https://adafru.it/JqB) (<https://adafru.it/JqB>) on either side are compatible with the [SparkFun Qwiic](https://adafru.it/Fpw) (<https://adafru.it/Fpw>) I2C connectors. This allows you to make solderless

connections between your development board and the SCD-30 or to chain it with a wide range of other sensors and accessories using a [compatible cable](https://adafru.it/JnB) (<https://adafru.it/JnB>).

We've of course broken out all the pins to standard headers and added a 3.3V voltage regulator and level shifting so allow you to use it with either 3.3V or 5V systems such as the Raspberry Pi, or Metro M4 or Arduino Uno.



# Pinouts



## Power Pins

- **VIN** - this is the power pin. Since the sensor chip uses 3 VDC, we have included a voltage regulator on board that will take 3-5VDC and safely convert it down. To power the board, give it the same power as the logic level of your microcontroller - e.g. for a 5V microcontroller like Arduino, use 5V
- **3V0** - this is the 3.3V output from the voltage regulator, you can grab up to 100mA from this if you like
- **GND** - common ground for power and logic

## I2C Logic Pins

- **SCL** - I2C clock pin, connect to your microcontroller I2C clock line. This pin is level shifted so you can use 3-5V logic, and there's a **10K pullup** on this pin.
- **SDA** - I2C data pin, connect to your microcontroller I2C data line. This pin is level shifted so you can use 3-5V logic, and there's a **10K pullup** on this pin.
- **STEMMA QT** (<https://adafruit.com/products/4076>) - These connectors allow you to connect to dev boards with **STEMMA QT** connectors or to other things with [various associated accessories](https://adafruit.com/products/4076) (<https://adafruit.com/products/4076>)

## Other Pins

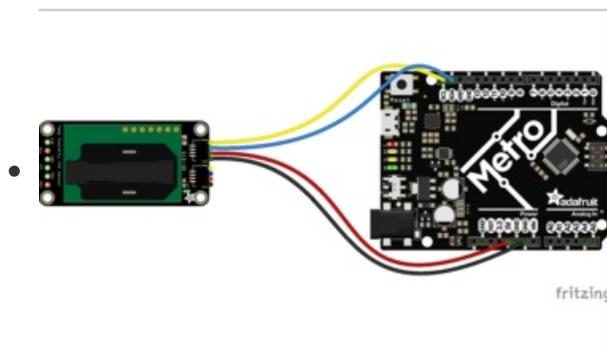
- **RDY** - Data Ready Pin. High when data is ready for read-out, it helps if you want to avoid polling the I2C port to verify data is ready.

# Arduino

Using the SCD30 with Arduino is a simple matter of wiring up the sensor to your Arduino-compatible microcontroller, installing the [Adafruit SCD30 \(https://adafru.it/PF1\)](https://adafru.it/PF1) library we've written, and running the provided example code.

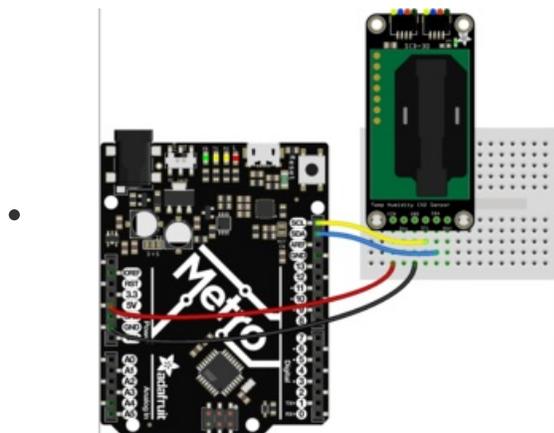
## I2C Wiring

Here is how to wire up the sensor using one of the [STEMMA QT \(https://adafru.it/Ft4\)](https://adafru.it/Ft4) connectors. The examples show a Metro but wiring will work the same for an Arduino or other compatible board.



- Connect board **VIN** (red wire) to **Arduino 5V** if you are running a **5V** board Arduino (Uno, etc.). If your board is **3V**, connect to that instead.
- Connect board **GND** (black wire) to **Arduino GND**
- Connect board **SCL** (yellow wire) to **Arduino SCL**
- Connect board **SDA** (blue wire) to **Arduino SDA**

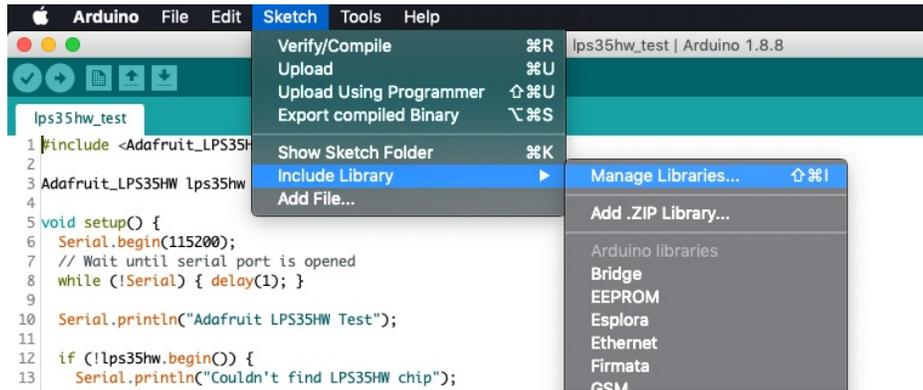
Here is how to wire the sensor to a board using a solderless breadboard:



- Connect board **VIN** (red wire) to **Arduino 5V** if you are running a **5V** board Arduino (Uno, etc.). If your board is **3V**, connect to that instead.
- Connect board **GND** (black wire) to **Arduino GND**
- Connect board **SCL** (yellow wire) to **Arduino SCL**
- Connect board **SDA** (blue wire) to **Arduino SDA**

## Library Installation

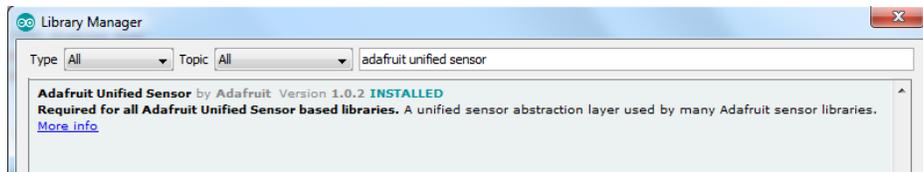
You can install the [Adafruit SCD30](https://adafru.it/PF1) library for Arduino using the Library Manager in the Arduino IDE.



Click the **Manage Libraries ...** menu item, search for **Adafruit SCD30**, and select the **Adafruit SCD30** library:

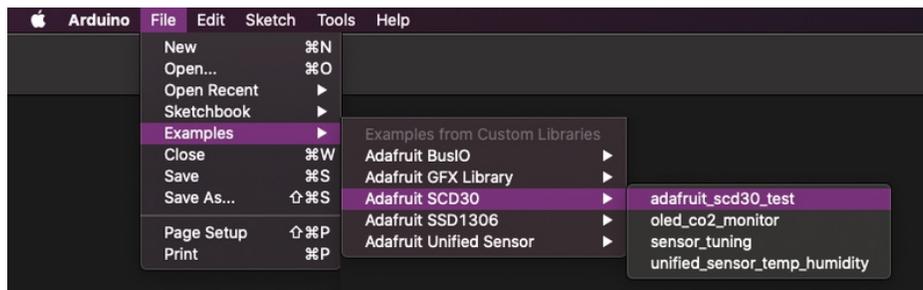


Finally, search for **Adafruit Unified Sensor** and install that too (you may have to scroll a bit)



## Load Example

Open up **File -> Examples -> Adafruit SCD30 -> adafruit\_scd30\_test**



After opening the demo file, upload to your Arduino wired up to the sensor. Once you upload the code, you will see the **temperature, humidity and eCO2** data values being printed when you open the Serial Monitor (**Tools->Serial Monitor**) at **115200** baud, similar to this:

```
COM19
12:51:50.485 -> Adafruit SCD30 test!
12:51:50.532 -> SCD30 Found!
12:51:50.532 -> Measurement Interval: 2 seconds
12:51:52.777 -> Data available!
12:51:52.777 -> Temperature: 23.43 degrees C
12:51:52.777 -> Relative Humidity: 26.16 %
12:51:52.777 -> eCO2: 0.000 ppm
12:51:52.777 ->
12:51:55.020 -> Data available!
12:51:55.020 -> Temperature: 23.41 degrees C
12:51:55.020 -> Relative Humidity: 26.06 %
12:51:55.020 -> eCO2: 678.521 ppm
12:51:55.020 ->
12:51:57.215 -> Data available!
12:51:57.261 -> Temperature: 23.43 degrees C
12:51:57.261 -> Relative Humidity: 26.07 %
12:51:57.261 -> eCO2: 770.086 ppm
```

Its normal for the first CO2 reading to be 0, simply ignore the first reading when logging data.

The sensor has a lot going on, there's temperature and humidity reading thanks to an SHT31 sensor on board. These values are used internally to normalize the NDIR CO2 readings as well. You can only get data every 2 seconds, which is pretty fast for this kind of sensor! If you want to slow down the readings to reduce power usage, uncomment this section:

```
// if (!scd30.setMeasurementInterval(10)){
//   Serial.println("Failed to set measurement interval");
//   while(1){ delay(10);}
// }
```

The valid range is 2 seconds per reading up to 1800 seconds per reading.

## Example Code

```

// Basic demo for readings from Adafruit SCD30
#include <Adafruit_SCD30.h>

Adafruit_SCD30 scd30;

void setup(void) {
  Serial.begin(115200);
  while (!Serial) delay(10);    // will pause Zero, Leonardo, etc until serial console opens

  Serial.println("Adafruit SCD30 test!");

  // Try to initialize!
  if (!scd30.begin()) {
    Serial.println("Failed to find SCD30 chip");
    while (1) { delay(10); }
  }
  Serial.println("SCD30 Found!");

  // if (!scd30.setMeasurementInterval(10)){
  //   Serial.println("Failed to set measurement interval");
  //   while(1){ delay(10);}
  // }
  Serial.print("Measurement Interval: ");
  Serial.print(scd30.getMeasurementInterval());
  Serial.println(" seconds");
}

void loop() {
  if (scd30.dataReady()){
    Serial.println("Data available!");

    if (!scd30.read()){ Serial.println("Error reading sensor data"); return; }

    Serial.print("Temperature: ");
    Serial.print(scd30.temperature);
    Serial.println(" degrees C");

    Serial.print("Relative Humidity: ");
    Serial.print(scd30.relative_humidity);
    Serial.println(" %");

    Serial.print("CO2: ");
    Serial.print(scd30.CO2, 3);
    Serial.println(" ppm");
    Serial.println("");
  } else {
    //Serial.println("No data");
  }

  delay(100);
}

```

# Arduino Docs

Arduino Docs (<https://adafru.it/PEX>)

□

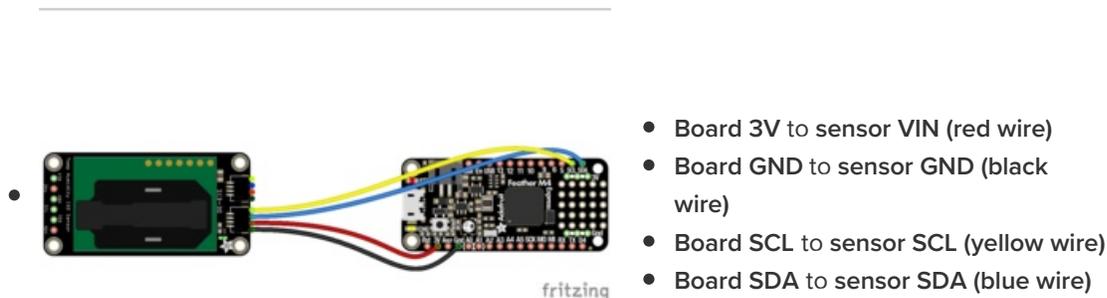
# Python & CircuitPython

It's easy to use the **SCD-30** with Python or CircuitPython, and the [Adafruit CircuitPython SCD30 \(https://adafru.it/PF2\)](#) module. This module allows you to easily write Python code that reads CO2, temperature, and humidity from the **SCD30** sensor.

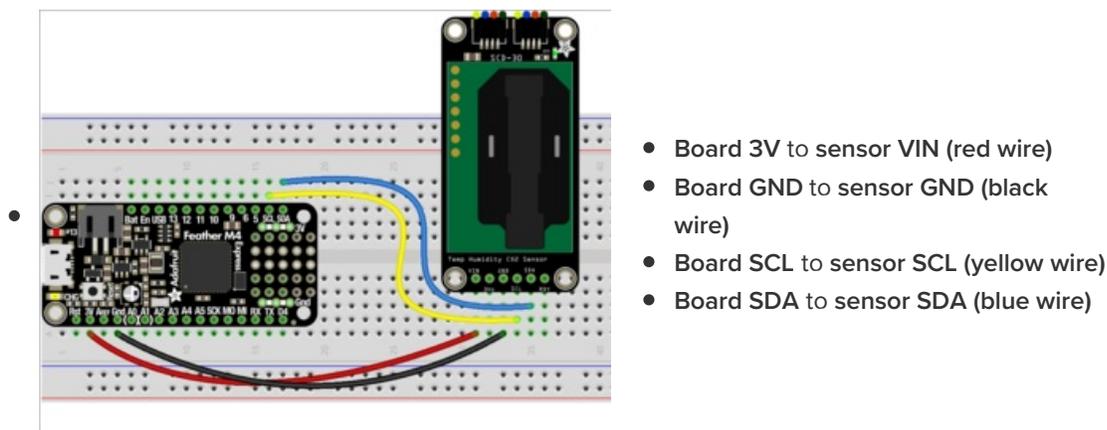
You can use this sensor with any CircuitPython microcontroller board or with a computer that has GPIO and Python thanks to [Adafruit\\_Blinka](#), our [CircuitPython-for-Python compatibility library \(https://adafru.it/BSN\)](#).

## CircuitPython Microcontroller Wiring

First wire up a SCD-30 to your board exactly as shown below. Here's an example of wiring a Feather M4 to the sensor with I2C using one of the handy [STEMMA QT \(https://adafru.it/Ft4\)](#) connectors:



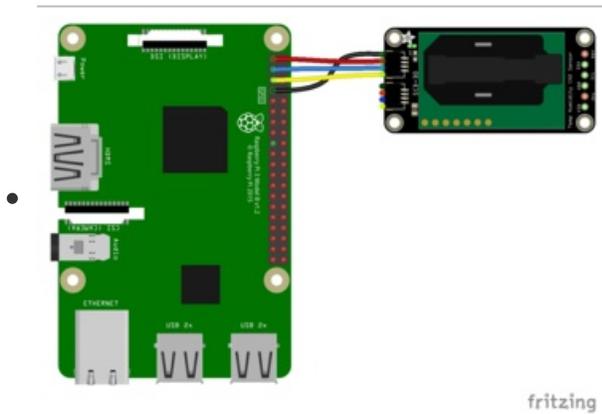
You can also use the standard 0.100" pitch headers to wire it up on a breadboard:



## Python Computer Wiring

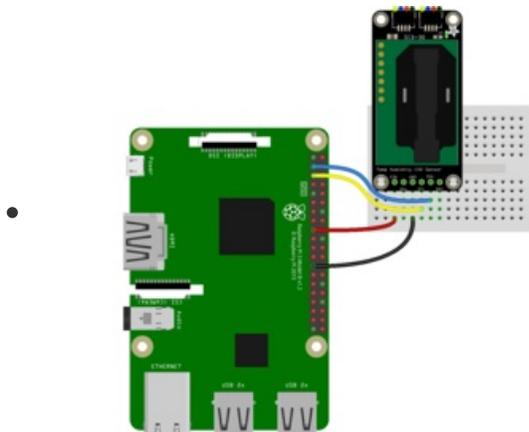
Since there's *dozens* of Linux computers/boards you can use, we will show wiring for Raspberry Pi. For other platforms, [please visit the guide for CircuitPython on Linux to see whether your platform is supported \(https://adafru.it/BSN\)](#).

Here's the Raspberry Pi wired to the sensor using I2C and a [STEMMA QT \(https://adafru.it/Ft4\)](#) connector:



- Pi 3V to sensor VIN (red wire)
- Pi GND to sensor GND (black wire)
- Pi SCL to sensor SCL (yellow wire)
- Pi SDA to sensor SDA (blue wire)

Finally here is an example of how to wire up a Raspberry Pi to the sensor using a solderless breadboard



- Pi 3V to sensor VIN (red wire)
- Pi GND to sensor GND (black wire)
- Pi SCL to sensor SCL (yellow wire)
- Pi SDA to sensor SDA (blue wire)

## CircuitPython Installation of SCD30 Library

You'll need to install the [Adafruit CircuitPython SCD30 \(https://adafru.it/PF2\)](https://adafru.it/PF2) library on your CircuitPython board.

First make sure you are running the [latest version of Adafruit CircuitPython \(https://adafru.it/Amd\)](https://adafru.it/Amd) for your board.

Next you'll need to install the necessary libraries to use the hardware--carefully follow the steps to find and install these libraries from [Adafruit's CircuitPython library bundle \(https://adafru.it/ENC\)](https://adafru.it/ENC). Our CircuitPython starter guide has [a great page on how to install the library bundle \(https://adafru.it/ABU\)](https://adafru.it/ABU).



Required libraries:

- `adafruit_scd30.mpy`
- `adafruit_bus_device/`
- `adafruit_register/`

Your CIRCUITPY drive should look like the image.

Before continuing make sure your board's `lib` folder or root filesystem has the `adafruit_scd30.mpy` file, and the `adafruit_bus_device` and `adafruit_register` folders copied over.

## Python Installation of SCD30 Library

You'll need to install the `Adafruit_Blinka` library that provides the CircuitPython support in Python. This may also require enabling I2C on your platform and verifying you are running Python 3. [Since each platform is a little different, and Linux changes often, please visit the CircuitPython on Linux guide to get your computer ready \(https://adafru.it/BSN\)](#)!

Once that's done, from your command line run the following command:

- `sudo pip3 install adafruit-circuitpython-scd30`

If your default Python is version 3 you may need to run 'pip' instead. Just make sure you aren't trying to use CircuitPython on Python 2.x, it isn't supported!

Next [connect to the board's serial REPL \(https://adafru.it/Awz\)](#) so you are at the CircuitPython `>>>` prompt.

## CircuitPython & Python Usage

To demonstrate the usage of the sensor we'll initialize it and read the CO2, temperature and humidity data from the board's Python REPL.

Run the following code to import the necessary modules and initialize the I2C connection with the sensor:

```
import board
import adafruit_scd30

scd = adafruit_scd30.SCD30(board.I2C())
```

```
Press any key to enter the REPL. Use CTRL-D to reload.
Adafruit CircuitPython 6.0.1 on 2020-12-28; Adafruit Feather M4 Express with samd51j19
>>> import board
>>> import adafruit_scd30
>>> scd = adafruit_scd30.SCD30(board.I2C())
>>> |
```

Now you're ready to read values from the sensor using these properties:

- **data\_available** - Check the sensor to see if new data is available .
- **eCO2** - The CO2 concentration in PPM (parts per million).
- **temperature** - The current temperature in degrees Celsius.
- **relative\_humidity** - The current relative humidity in %rH.

```
print("Data available?", scd.data_available)
print("CO2:", scd.CO2, "PPM")
print("Temperature:", scd.temperature, "degrees C")
print("Humidity:", scd.relative_humidity, "%rH")
```

```
>>> import board
>>> import adafruit_scd30
>>> scd = adafruit_scd30.SCD30(board.I2C())
>>> print("Data available?", scd.data_available)
Data available? 1
>>> print("eCO2:", scd.eCO2, "PPM")
eCO2: 878.948 PPM
>>> print("Temperature:", scd.temperature, "degrees C")
Temperature: 23.5981 degrees C
>>> print("Humidity:", scd.relative_humidity, "%rH")
Humidity: 26.5656 %rH
>>>
```

## Full Example Code

```
# SPDX-FileCopyrightText: 2020 by Bryan Siepert, written for Adafruit Industries
#
# SPDX-License-Identifier: Unlicense
import time
import board
import busio
import adafruit_scd30

i2c = busio.I2C(board.SCL, board.SDA)
scd = adafruit_scd30.SCD30(i2c)

while True:
    # since the measurement interval is long (2+ seconds) we check for new data before reading
    # the values, to ensure current readings.
    if scd.data_available:
        print("Data Available!")
        print("CO2:", scd.CO2, "PPM")
        print("Temperature:", scd.temperature, "degrees C")
        print("Humidity:", scd.relative_humidity, "%rH")
        print("")
        print("Waiting for new data...")
        print("")

    time.sleep(0.5)
```

You'll be able to get a new reading every 2 seconds, that's as fast as data comes out of the sensor.

It's normal for the first reading to be 0, as the sensor 'warms up'. Simply skip that reading when logging

data.

```
code.py output:
Data Available!
eCO2: 0.0 PPM
Temperature: 23.7129 degrees C
Humidity: 26.5137 %%rH

Waiting for new data...

Data Available!
eCO2: 729.207 PPM
Temperature: 23.7263 degrees C
Humidity: 26.4374 %%rH

Waiting for new data...
```

To change things like the interval delay (how often data is calculated) check out this example which shows how you can tweak the sensor to change the interval, or tune the sensor with things like the known altitude/barometric pressure. Check the datasheet for the SCD-30 for more details on tuning the sensor.

```

# SPDX-FileCopyrightText: 2020 by Bryan Siepert, written for Adafruit Industries
#
# SPDX-License-Identifier: Unlicense
import time
import board
import busio
import adafruit_scd30

i2c = busio.I2C(board.SCL, board.SDA)
scd = adafruit_scd30.SCD30(i2c)
# scd.temperature_offset = 10
print("Temperature offset:", scd.temperature_offset)

# scd.measurement_interval = 4
print("Measurement interval:", scd.measurement_interval)

# scd.self_calibration_enabled = True
print("Self-calibration enabled:", scd.self_calibration_enabled)

# scd.ambient_pressure = 1100
print("Ambient Pressure:", scd.ambient_pressure)

# scd.altitude = 100
print("Altitude:", scd.altitude, "meters above sea level")

# scd.forced_rec calibration_reference = 409
print("Forced recalibration reference:", scd.forced_rec calibration_reference)
print("")

while True:
    data = scd.data_available
    if data:
        print("Data Available!")
        print("CO2:", scd.CO2, "PPM")
        print("Temperature:", scd.temperature, "degrees C")
        print("Humidity:.", scd.relative_humidity, "%rH")
        print("")
        print("Waiting for new data...")
        print("")

    time.sleep(0.5)

```

# Python Docs

[Python Docs \(https://adafru.it/PEY\)](https://adafru.it/PEY)

# Field Calibration

Performing a re-calibration of the SCD-30 can help maintain accurate CO2 readings over time. Various factors can cause the SCD-30 sensor reading to drift and there are two available re-calibration options: **Forced Re-Calibration (FRC)** and **Automatic Self-Calibration (ASC)**.

This Application Note from [Sensirion \(https://adafru.it/QDU\)](https://adafru.it/QDU) goes into lots of detail and is **worth reading**:

<https://adafru.it/QDV>

<https://adafru.it/QDV>

Here we summarize the two approaches.

## Forced Re-Calibration

This is the easiest approach. The SCD-30 is placed in an environment with a known CO2 concentration. Then the FRC routine is called and this known concentration value (in ppm) is supplied. But how do you come up with that known value? That is a caveat of this approach and Sensirion (see PDF linked above) suggests three approaches:

1. Using a separate secondary calibrated CO2 sensor to provide the value.
2. Exposing the SCD-30 to a controlled environment with a known value.
3. Exposing the SCD-30 to fresh outside air and using a value of 400 ppm.

However, once you have your reference value, performing a FRC is super easy. Assuming a reference CO2 concentration of 800 ppm has been determined, then with the **CircuitPython** library use:

```
scd30.forced_recalibration_reference = 800
```

or with the **Arduino** library use:

```
scd30.forceRecalibrationWithReference(800);
```

## Automatic Self-Calibration

Hey, automatic! That sounds great! Set and forget, right? Well, not so fast. The ASC feature has some requirements which should be considered to determine if it is suitable for any given end use application. If the conditions can not be met, then the FRC mentioned above should be used.

1. The SCD-30 should regularly be exposed to fresh air with CO2 concentration of 400 ppm.
2. The SCD-30 needs to operate in continuous mode, i.e. do not power it down.
3. The ASC needs 7 good readings separated by at least 18 hours (that's ~5 days).

See the PDF linked above for many more details. If you want to use ASC, enabling it is very simple. In **CircuitPython** use:

```
scd30.self_calibration_enabled = True
```

or with the **Arduino** library use:

```
scd30.selfCalibrationEnabled(true);
```

With either, simply use **False / false** to disable ASC.

## FRC vs. ASC

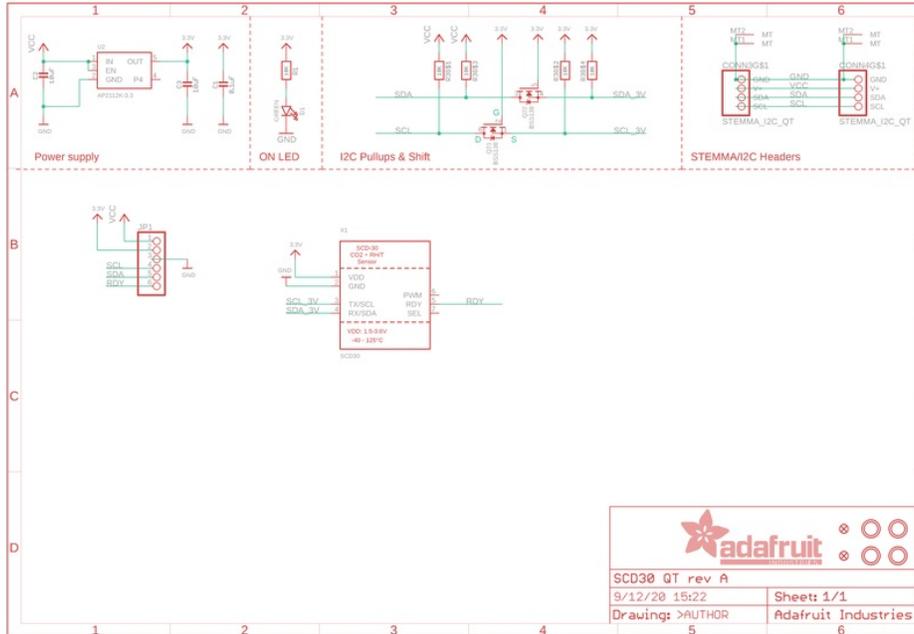
Both the Forced Re-Calibration (FRC) and Automatic Self-Calibration (ASC) are ways of arriving at the same "Reference Value" which is then used in determining the CO2 ppm reading reported by the SCD-30. With the FRC approach, the Reference Value is specified. With the ASC approach, the Reference Value is determined algorithmically. Either one will overwrite the Reference Value from the other one. For example, running a FRC will immediately change to the new Reference Value. However, if ASC is enabled, then it may replace the Reference Value at a later time.

# Downloads

## Files:

- [SCD-30 Datasheet \(https://adafruit.it/PF3\)](https://adafruit.it/PF3)
- [SCD-30 Design-in Guidelines \(https://adafruit.it/PFf\)](https://adafruit.it/PFf)
- [SCD-30 Interface Description \(https://adafruit.it/PFg\)](https://adafruit.it/PFg)
- [Fritzing object in the Adafruit Fritzing Library \(https://adafruit.it/PF4\)](https://adafruit.it/PF4)
- [EagleCAD PCB files on GitHub \(https://adafruit.it/PF5\)](https://adafruit.it/PF5)
- [3D models on GitHub \(https://adafruit.it/QBs\)](https://adafruit.it/QBs)

## Schematic



## Fab Print

