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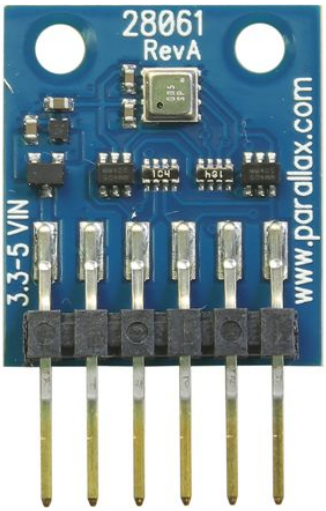
# BME680 Environmental Sensor Module (#28061)


The Bosch Sensortec BME680 Integrated Environmental Unit combines a gas sensor with air pressure, humidity, and ambient air temperature sensing functions within a single package for high performance air quality measurement.

Parallax Inc. places the BME680 on a compact 18x20 mm PCB with a 6-pin male header. The I/O connections operate at the same voltage supplied to the VIN pin, for compatibility with 3.3V and 5V microcontrollers.

## Features




- High-performance gas, pressure, temperature and relative humidity sensor in a single package
- Detects a broad range of VOCs (Volatile Organic Compounds)
- Independent humidity, pressure, gas sensor enable/disable
- Supports $I^2C$, SPI 3-wire, and SPI 4-wire interfaces
- Overvoltage, reverse polarity and signal contention protection of all signal pins
- VIN / GND reverse polarity protection
- Compatible with 3.3V and 5V microcontrollers
- Breadboard-friendly 6-pin header, plus 2 mounting holes

## Application Ideas

- Air quality monitoring
- Home automation and control
- Weather forecast
- Context awareness, e.g. skin moisture detection, room change detection
- Vertical velocity indicator (rise/sink speed)
- Indoor navigation, e.g. change of floor detection, elevator detection
- Outdoor navigation, leisure and sports applications
- Altitude tracking and calories expenditure for sports activities
- Warning regarding dryness or high temperatures

# Key Specifications

- Power requirements: +3.3 VDC to +5 VDC; maximum 20 mA
- Typical current consumption:
  - 3.7 µA at 1 Hz humidity, pressure and temperature
  - 0.09−12 mA for p/h/T/gas depending on operation mode
  - 0.15 µA in sleep mode
- Absolute barometric pressure: range 300–100 hPa; ±0.12 hPa
- Relative humidity: range, 0–100%; ±3%
- Temperature: range -40 to +85 °C; resolution 0.01°C, ±0.5°C typical
- Gas sensor resolution: 0.08% typical
- Communication: $I^2C$ (100 or 400 kHz) or SPI (3 and 4 wire, up to 10 MHz)
- Operating temperature: -40 to +185 °F (-40 to +85 °C),
- Operating environment: 0−100% r.H., 300−1100 hPa
- Form factor: 6-pin male header with 0.1" spacing
- PCB dimensions: 20 x 18 mm
- Mounting holes: Two holes suitable for #3 UNC (M2.5) hardware

# Getting Started

The BME680 module functions as a peripheral device on an $I^2C$ or SPI bus hosted by your microcontroller. See the Connection Diagrams and Code Examples sections below.

The BME680 sensor manufacturer recommends a minimum burn-in time of 20 minutes at first use. The burn-in procedure can be achieved by repeatedly reading all of the sensor values, once every 5 seconds for 20 minutes. For each subsequent use, allow 2-3 minutes for gas readings to stabilise after power-up.

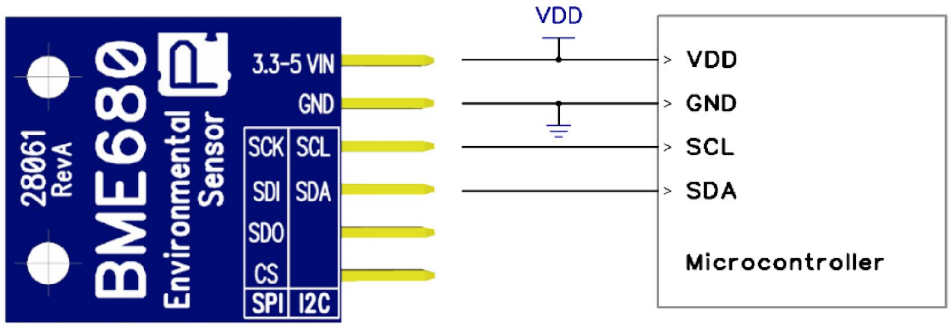
### Connection Diagrams

Connection diagrams are supplied below for both $I^2C$ (default) and SPI 3-wire and 4-wire operation. The BME680 module is compatible with both 3.3V and 5V microcontrollers. The BME680 module power (VIN) pin also sets the required logic level voltage. So, typically the module VIN connects to the same power supply used by the microcontroller. The BME680 module GND pin must always be connected to the same GND used by the microcontroller. See the Pin Descriptions section for more information.

## I²C Operation (Default)

I²C operation requires two signals: the serial clock line (SCL) and serial data line (SDA). The bidirectional SDA is used to send and receive data on the I²C bus. Up to two sensors can be used on the same I²C bus.

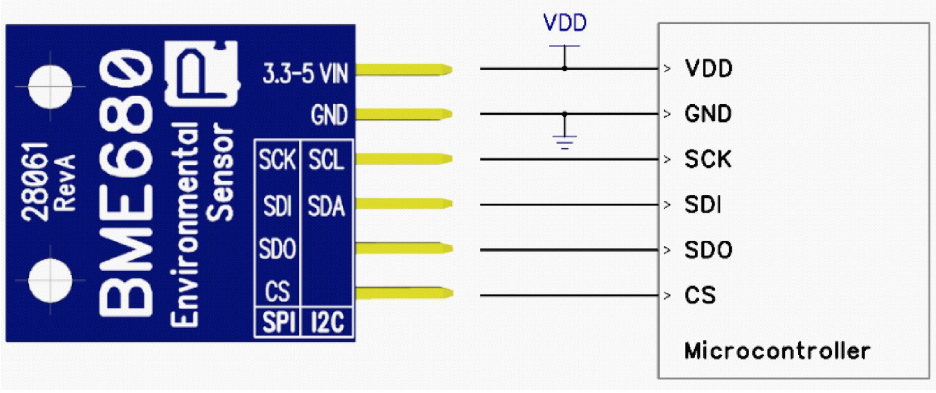
The default I²C address is 0x77. Pull the SDO pin low to change that modules I²C address to 0x76. Note that the CS pin must be left unconnected or driven high for I²C mode .




## SPI

Use of SPI communication is configured by pulling the CS line low. The serial interface can be operated in 3-wire or 4-wire mode. The SPI communication protocol is the same for both modes.

- In 3-wire mode: CS (chip select), SCK (serial clock), SDI (data input/output). In this mode, SDO is not used and should be left unconnected.
- In 4-wire mode: CS (chip select), SCK (serial clock), SDI (data input), SDO (data output)



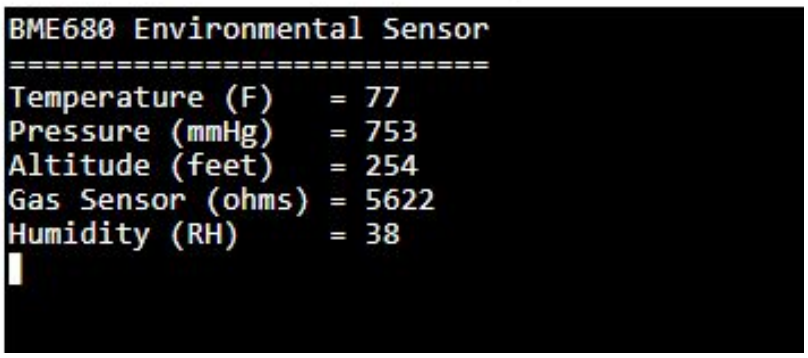
## Code Examples

The BME680 sensor manufacturer recommends a minimum burn-in time of 20 minutes at first use. The burn-in procedure can be achieved by repeatedly reading all of the sensor values, once every 5 seconds for 20 minutes. For each subsequent use, allow 2-3 minutes for gas readings to stabilise after power-up.

The BME680 sensor is supported by blockly.parallax.com with blocks for "BME680 Air Quality" available under the Sensor category. Example code for Propeller C is available from the Parallax GitHub, and the sensor is also compatible with Arduino or Raspberry Pi.

Look for document and code downloads, and tutorial links, at the sensor's product page; search "28061" at www.parallax.com.

Typical output from the sensor:




Full details about the $I^2C$ and SPI communication protocols, and sensor specifications, are available in the BME680 datasheet. Please refer to the datasheet, code samples and other manufacturer resources for detailed explanations and configurations:

BOSCH GitHub for C Code samples and the BME680 gas sensor API:
https://github.com/BoschSensortec/BME680_driver

BOSCH Product page for the BME680, including datasheet and other resources:
https://www.bosch-sensortec.com/bst/products/all_products/bme680

## Gas Resistance Readings

The BME680 contains a heated metal oxide sensor which changes resistance based on volatile organic compounds (VOC) in the air. This sensor can be used to perform basic air quality measurements.

Rather than providing a measure of individual gasses, this sensor's resistance value correlates to overall VOC content, often called TVOC (Total Volatile Organic Compounds). The gas sensor responds to a broad mix of VOC's, including from paints, lacquers, paint strippers, cleaning supplies, furnishings, office equipment, glues, adhesives, alcohol, solvents and carbons.

Low air quality is represented by a low resistance value, and higher air quality is represented by a higher resistance value. To measure the impact of individual gasses, it is important to record the gas resistance over time, and analyse the relative changes when gasses are introduced.

In one example, the sensor could be located in a fixed position to monitor room air quality. Readings would be taken over a 30 minute period to establish a baseline value for good air quality. After that, the sensor could be used to continuously monitor the room for changes, and the microcontroller connected to the sensor would be able to react to those changes, perhaps alerting the user to poor air quality conditions.

In another example, the sensor might be used in a mobile application as a breathalyzer. It would be appropriate to read the gas readings for 2 or 3 minutes to ensure they are stable, and then breathe into the sensor and record the change in resistance.

# Pin Descriptions

| Pin | | Type | Function |
|---|---|---|---|
| VIN | | Power | The module will operate between 3.3V to 5V DC. The VIN voltage also sets the logic-high level voltage for the signal pins. |
| GND | | Ground | Common Ground (0 V supply) must be shared with microcontroller host |
| **SPI** | **I2C** | **Signal Pins** | |
| SCK | SCL | In | SPI & $I^2C$ serial clock |
| SDI | SDA | In / Out | SPI serial data input (SPI 4-wire mode)<br>SPI serial data input/output (SPI 3-wire mode)<br>$I^2C$ serial data input/output |
| SDO | ADDR | Out | SPI serial data output (SPI 4-wire mode only)<br>$I^2C$ device address selection (when CS is high)*:<br>1: $I^2C$ address 0x77 (default)<br>0: $I^2C$ address 0x76 |
| CS | | In | $I^2C$/SPI mode selection**<br>1: $I^2C$ communication enabled (default)<br>0: SPI communication mode / $I^2C$ disabled) |

* I2C device address can be changed during operation

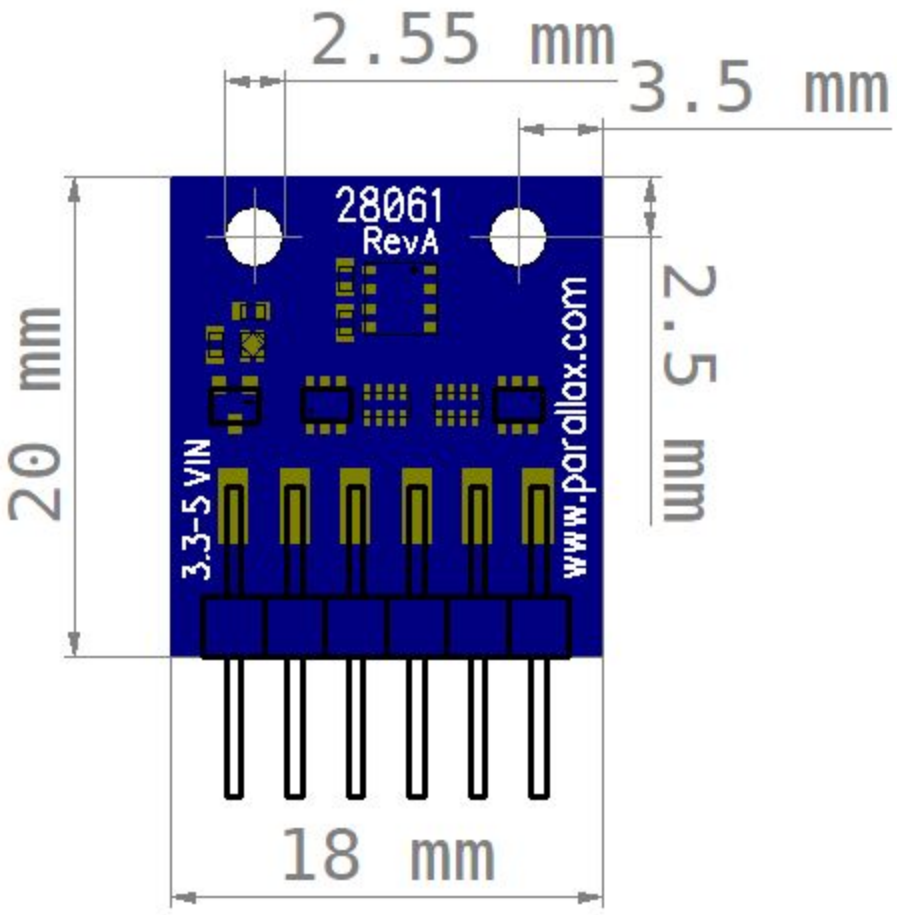
** Power-cycle required after changing mode from SPI to I2C

## Signal Pins

Each of the four BME680 signal pins (SCK/SCL, SDI/SDA, SDO, CS) is protected by a bi-directional level shifting circuit, used to translate the internal I/O voltage of the BME680 to the voltage used by the master device (microcontroller). The level shifter has built-in pull-up resistors to each supply rail so it can be driven by open drain outputs for I2C, or can be driven low/high for SPI protocol.

This protection means that there is no need for any external interfacing circuitry to operate the Parallax BME680 sensor with 3.3V or 5V logic level microcontrollers.

## PCB Dimensions




## Revision History

Version 1.0: original release.

Version 1.1 corrected absolute barometric pressure range from 300-100 hPa to 300-1100 hPa, page 2.