



# Collecting Data with BME680

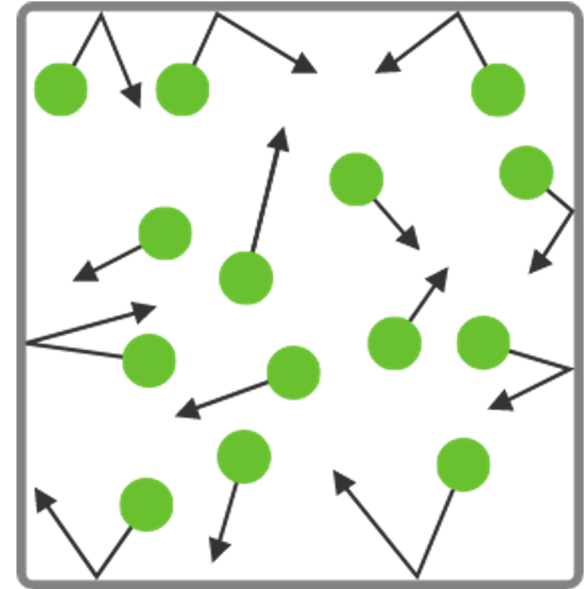
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# What is Temperature?

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$$T = \frac{\partial U}{\partial S}$$



# What is Humidity?

$$AH = \frac{m_{H_2O}}{V_{net}}$$

$AH$  = absolute humidity

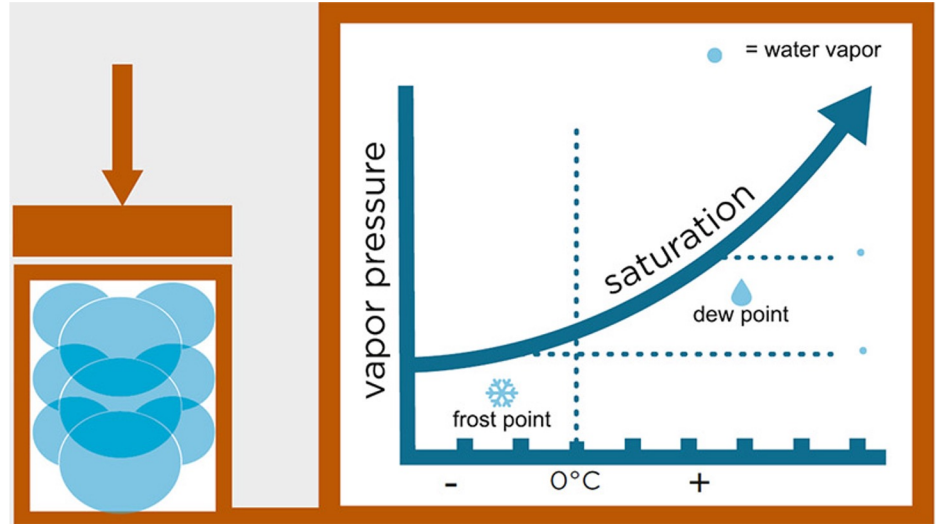
$m_{H_2O}$  = mass of the water vapor

$V_{net}$  = volume of the air and water vapor mixture



# Dew Point

- Requires Software
- Humidity “Feel”



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# What is Barometric Pressure?

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$$P_h = P_0 e^{\frac{-mgh}{kT}}$$

$P_h$  = pressure at height  $h$

$P_0$  = sea level pressure

$g$  = acceleration due to gravity

$k$  = Boltzmann's constant (ideal gas constant divided by Avogadro's number)

$T$  = absolute temperature

$m$  = mass of one air molecule



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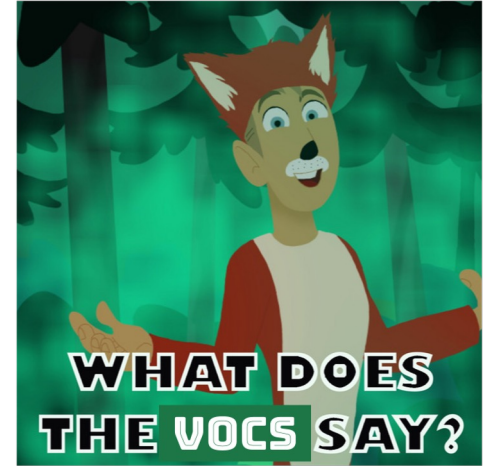
# VOC Gas Sensor

- High vapor pressure, low water solubility
- Many VOCS cause short and long term health issues
  - Paint, ink, wood stain, etc.

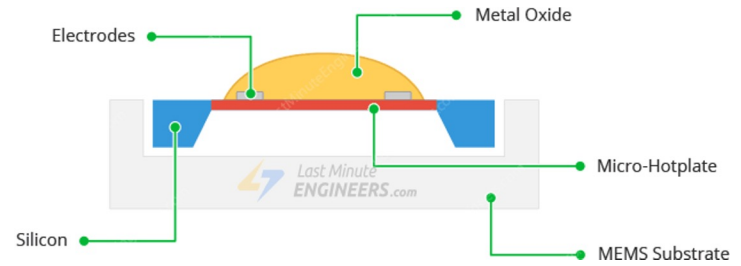
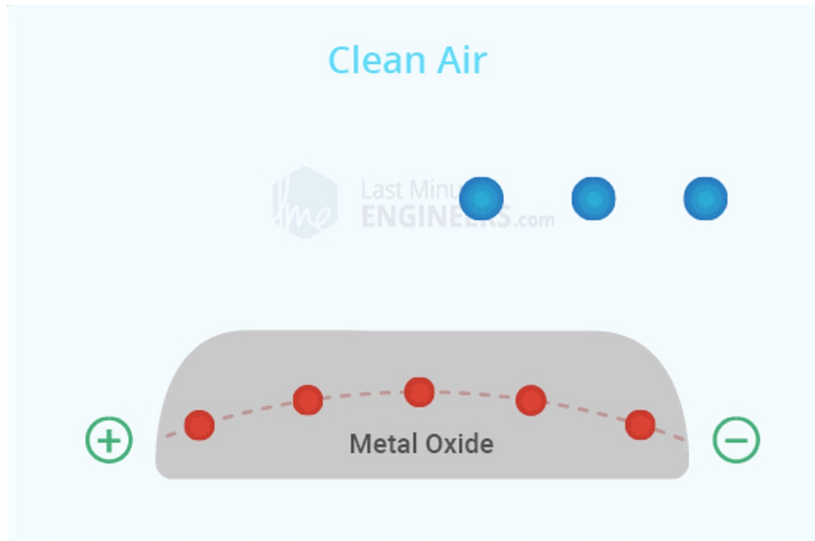
Used in EPA TEAM studies (Environmental Protection Agency's research team)

How?

- Metal oxide heats up in contact with VOCs
- Changes its resistance
- Tolerance of 0.5-15 ppm



# How the BME680 Works



# Specs

- Sensor is the silver square in the center of the chip
- Specifications
  - Temp:  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  with  $\pm 1.0^{\circ}\text{C}$  accuracy
  - Humidity: 0 to 100% with  $\pm 3\%$  accuracy
  - Pressure: 300Pa to 1100 hPa with  $\pm 1$  hPa absolute accuracy
  - Altitude: 0 to 30,000 ft (9.2 km) with  $\pm 1$  m accuracy
  - Cannot tell difference between gasses
- Uses 3.3V voltage regulator; can use 3.3V or 5V microcontrollers
- Have sensor run for 48 hours initially, then 30 minutes before each use

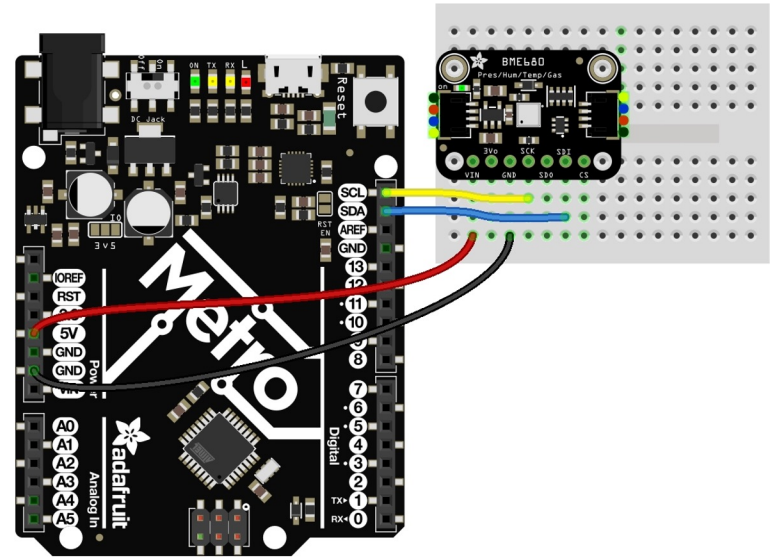
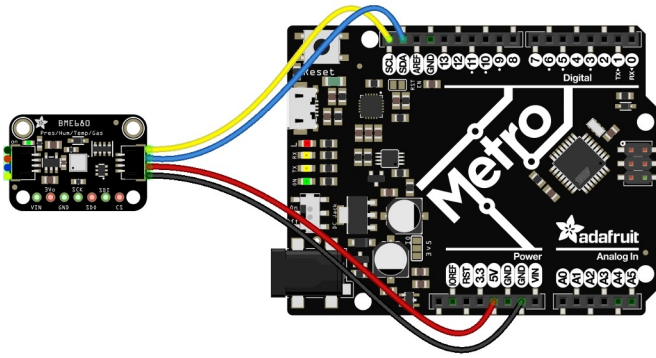


[adafruit-bme680-humidity-temperature-barometric-pressure-voc-gas.pdf](https://www.adafruit.com/docs/adafruit-bme680-humidity-temperature-barometric-pressure-voc-gas.pdf)



# Working With the Arduino

- I2C and SPI compatible
- Adafruit libraries
  - BME680 specific
  - Adafruit Sensor Master
- Get and Set functions for each sensor,
- unit conversion built into functions



<https://learn.adafruit.com//assets/93614>

# Applications of the Sensors

- Measuring Altitude
- Weather Prediction
- Fitness tracking
  - Vertical speed
  - Sweat
- HVAC systems
  - Temperature control
  - Monitor air quality



Willful Fitness tracker

Image from <https://www.walmart.com/ip/Willful-Fitness-Tracker-Simple-Pedometer-Watch-Non-Bluetooth-No-App-Phone-Needed-Waterproof-Activity-Steps-Calories-Counter-Sleep-Kids-Parents-Men-Wo/936564399>



# References

- [1] “Adafruit BME680 Created by lady ada.” Accessed: Jan. 27, 2023. [Online]. Available: <https://cdn-learn.adafruit.com/downloads/pdf/adafruit-bme680-humidity-temperature-barometric-pressure-voc-gas.pdf>
- [2] C. Staff, “Interfacing BME680 with Arduino also measure Indoor Air Quality Index,” *Circuit Schools*, Jan. 16, 2022. <https://www.circuitschools.com/interfacing-bme680-with-arduino-also-measure-indoor-air-quality-index/>
- [3] “IXL | How does particle motion affect gas pressure? | 8th grade science,” *IXL Learning*, 2023. <https://www.ixl.com/science/grade-8/how-does-particle-motion-affect-gas-pressure>
- [4] *Lastminuteengineers.com*, 2022. <https://lastminuteengineers.com/bme680-gas-pressure-humidity-temperature-sensor-arduino-tutorial/> (accessed Jan. 27, 2023).
- [5] US, “Dew Point vs Humidity,” *Weather.gov*, 2023. [https://www.weather.gov/arx/why\\_dewpoint\\_vs\\_humidity](https://www.weather.gov/arx/why_dewpoint_vs_humidity)
- [6] US, “Discussion on Humidity,” *Weather.gov*, 2023. <https://www.weather.gov/lmk/humidity#:~:text=Absolute%20humidity%20> (accessed Jan. 27, 2023).