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BME688

4-in-1 environmental sensor unit with AI

GENERAL DESCRIPTION

The BME688 is the first gas sensor with Artificial Intelligence (AI) and integrated high-linearity and high-accuracy pressure, humidity and temperature sensors. BME688 is housed in a robust yet compact 3.0 x 3.0 x 0.9 mm³ package and is especially developed for mobile and connected applications, where size and low power consumption are crucial requirements. The gas sensor detects Volatile Organic Compounds (VOCs), Volatile Sulfur Compounds (VSCs) and other gases such as carbon monoxide and hydrogen in the part per billion (ppb) range.

Additionally to all features of the BME680, the BME688 has a gas scanner function. In standard configuration, the presence of VSCs is detected as indicator for e.g. bacteria growth. The gas scanner can be customized with respect to sensitivity, selectivity, data rate and power consumption as well. The BME AI-Studio tool enables customers to train the BME688 gas scanner on their specific application, like in home appliances, IoT products or Smart Home.

USE CASE EXAMPLES

- Indoor and outdoor air quality measurement
- Bad breath or spoiled food detection based on the measurement of volatile sulfur compounds, which are an indicator of bacteria growth
- Detection of unusual gases and smells, which might indicate for instance a leakage or fire
- Diaper state detection, e.g. for baby care
- Early detection of bad smells
- Wildfire detection

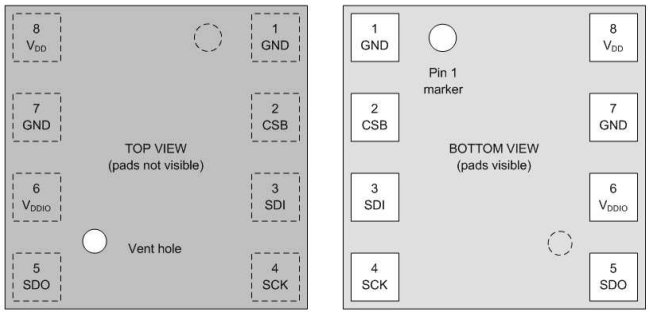
SENSOR FEATURES

The gas sensor in the BM688 has a broad sensitivity and reacts to most volatile compounds as well as many other gases polluting indoor air. The intensity of the signal typically scales with the chemical reactivity of the gases. In contrast to sensors selective for one specific component, the BME688 is capable of measuring the sum of VOCs/contaminants in the surrounding air. This enables the BME688 to detect e.g. outgassing from paint, furniture and/or garbage, high VOC levels due to cooking, food consumption, exhaled breath and/or sweating.

TECHNICAL SPECIFICATIONS

BME688 Technical data	
Package dimensions	8-Pin LGA with metal 3.0 x 3.0 x 0.93 mm³
Operating range	Pressure: 300...1100 hPa Humidity 0...100% Temperature: -40...85°C
Supply voltage V_{DDIO} Supply voltage V_{DD}	1.2 ... 3.6 V 1.71 ... 3.6 V
Interface	I²C (up to 3.4 MHz) and SPI (3 and 4 wire, up to 10 MHz)
Average typical current consumption	2.1 µA at 1 Hz for h/T 3.1 µA at 1 Hz for p/T 3.7 µA at 1 Hz for h/p/T 90 µA at ULP mode for p/h/T/air quality 0.9 mA at LP mode for p/h/T/air quality 3.9 mA in standard gas scan mode (gas scan mode & scan rate can be optimized on applications with BME AI studio)
Gas sensor	
Sensor-to-sensor deviation (IAQ)	+/- 15% +/- 15 IAQ
standard scan speed	10.8 s / scan
Electric charge for standard scan	0.18 mAh (5 scans ~ 1 min)
Major sensor outputs	Index for Air Quality (IAQ), bVOC- & CO2-equivalents (ppm), Gas scan result (%) & Intensity level
Humidity sensor	
Response time	8 s (τ0-63%)
Accuracy tolerance	± 3 % relative humidity
Hysteresis	≤ 1.5 % relative humidity
Pressure sensor	
RMS Noise	0.12 Pa (equiv. to 1.7 cm)
Sensitivity Error	± 0.25 %
Temperature coefficient offset	±1.3 Pa/K (equiv. to ±10.9 cm at 1°C temperature change)
Temperature sensor	
Absolute accuracy	+/-0.5 °C (25°C)

Pin configuration



Pin

Pin	Name	Description
1	GND	Ground
2	CSB	Chip select
3	SDI	Serial data input
4	SCK	Serial clock input
5	SDO	Serial data output
6	V_{DDIO}	Digital interface supply
7	GND	Ground
8	V_{DD}	Analog supply

The humidity sensor features a quick response time supporting performance requirements for emerging applications such as smart home applications and high accuracy over a wide temperature range. The pressure sensor is an absolute barometric pressure sensor featuring exceptionally high accuracy and resolution at very low noise. The integrated temperature sensor has been optimized for very low noise and high resolution. It is used for temperature compensation of the gas, pressure and humidity sensors, and can also be used for estimating ambient temperature.

The BME688 supports a full suite of operating modes which provides huge flexibility in optimizing the device for power consumption, resolution and filter performance.

Its small dimensions and its low power consumption allow the implementation in battery driven devices. The emerging applications in portable devices require a high relative accuracy and a low Total Cost of Ownership (TCO) at the same time.

SENSOR OPERATION

The BME688 sensor is intended to be used together with Bosch Software Environmental Cluster (BSEC) solution and BME6xy sensor API to unlock its full potential. The BSEC software features intelligent algorithms which enable use cases such as indoor-air-quality monitoring and application-specific gas scanning. Moreover, the software algorithms handle humidity compensation, baseline as well as long-term drift correction of the gas sensor signal. The BSEC software is available as a closed source binary for many µC platforms.

Different power modes for the gas sensor and corresponding data rates are supported by the software solution:

- **Gas Scan mode (scan)** is designed for interactive applications where selectivity to target gases is needed in addition to indoor air quality monitoring. The standard scan mode has an update rate of 10.8 s and can be optimized for specific use-cases using BME AI Studio.
- **Ultra low power (ULP)** mode is designed for battery-powered and/or frequency-coupled devices over extended periods of time. This mode features an update rate of 300 seconds and an average current consumption of <0.1 mA
- **Quick Ultra-low power (q-ULP)** has a 3 s data rate for Temprature, pressure and humidity w/o significantly increasing the power consumption compared to ULP.
- **Low power (LP)** mode that is designed for interactive applications where the air quality is tracked and observed at a higher update rate of 3 seconds with a current consumption of <1 mA
- **Continuous (CONT)** mode provides an update rate of 1 Hz and is intended to be used short-term for use cases that incorporate very fast events or stimulus.

PRODUCT SYSTEM COMPONENTS

The following BME688 tools enable best performance in an extensive range of gas sensing applications:

- Hardware (Development kit) & Documentation (datasheet, HSMI,...) for the BME688 is linked on https://www.bosch-sensortec.com/products/environmental-sensors/gas-sensors/bme688/
- Software: BME AI Studio (Win & Mac), BSEC software (µC) and drivers are available for download on https://www.bosch-sensortec.com/products/environmental-sensors/gas-sensors/bme688-software/

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