

BME688



BME688 Environmental Sensor 4-in-1

v1.0
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Rev. A

Professional electronic component

PRODUCT OVERVIEW

The BME688 Environmental Sensor 4-in-1 is a compact and highly integrated sensing solution based on Bosch Sensortec's advanced gas sensor technology. Designed for next-generation environmental monitoring, this module simultaneously measures four key parameters: temperature, relative humidity, barometric pressure, and gas presence, including volatile organic compounds (VOCs) and indoor air quality (IAQ) indicators. By combining multiple sensors in one package, the BME688 reduces design complexity and board space, making it especially suitable for size-constrained applications such as wearables, portable devices, and smart IoT nodes. The module features digital communication via I²C or SPI interfaces, ensuring seamless integration with microcontrollers and embedded platforms like Arduino, ESP32, and Raspberry Pi. Its ultra-low power consumption enables continuous monitoring in battery-operated systems, while its wide operating range and high accuracy support precise environmental data acquisition under dynamic conditions. Furthermore, the gas sensor includes support for AI-based classification of gas mixtures using Bosch's BME AI-Studio, opening new possibilities for custom air quality applications.

PRODUCT VIEWS

TOP VIEW



Top View

Component placement and connectors

BOTTOM VIEW



Bottom View

Underside components and connections

KEY TECHNICAL SPECIFICATIONS

POWER SUPPLY

Operating Voltage: 1.71V to 3.6V

Supply Current: 0.9 μ A (sleep), 2.1 μ A (ULP), ~920 μ A (gas scan)

CONNECTIVITY

Interfaces: I²C, SPI

Connector: Qwiic + Pin Headers

TECHNICAL FEATURES

- Relative Humidity:** Accurately measures ambient moisture for precise environmental monitoring.

Excellent Temperature Stability: Delivers consistent temperature readings even under varying conditions.

Power Consumption: Optimized for low power usage, making it ideal for battery-operated devices.

Input Voltage via VCC Pin: 3.6–6.0 V (through onboard voltage regulator)
- Barometric Pressure:** Detects atmospheric pressure changes to support dynamic weather tracking.

Gas Sensing: Monitors a range of gases to help identify potential environmental hazards.

Interfaces: I²C and SPI

TECHNICAL SPECIFICATIONS

KEY TECHNICAL SPECIFICATIONS

| PARAMETER | VALUE |
|-------------------------|---|
| Operating Voltage | 1.71V to 3.6V |
| Supply Current | 0.9 μ A (sleep), 2.1 μ A (ULP), ~920 μ A (gas scan) |
| Operating Temperature | -40°C to +85°C |
| Relative Humidity Range | 0% to 100% RH |
| Pressure Range | 300 hPa to 1100 hPa |
| Gas Sensing | VOCs, IAQ index via integrated gas sensor |
| Interfaces | I ² C and SPI (up to 3.4 MHz) |
| Package Size | 3.0 × 3.0 × 0.93 mm ³ |

TECHNICAL SPECIFICATIONS

| PARAMETER | TECHNICAL DATA |
|---|---|
| Package dimensions | 8-Pin LGA with metal 3.0 x 3.0 x 0.93 mm ³ |
| Operation range (full accuracy) | Pressure: 300...1100 hPa Humidity: 0...100% Temperature: -40...85°C |
| Supply voltage VDDIO | 1.2 ... 3.6 V |
| Supply voltage VDD | 1.71 ... 3.6 V |
| Interface | I ² C and SPI |
| Average current consumption | 2.1 µA at 1 Hz humidity and temperature 3.1 µA at 1 Hz pressure and temperature 3.7 µA at 1 Hz humidity, pressure and temperature 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 - F1 score for H ₂ S scanning | 0.94 |
| Gas sensor - Standard scan speed | 10.8 s / scan |
| Gas sensor - Electric charge for standard scan | 0.18 mAh (5 scans ~ 1 min) |
| Gas sensor - Response time (τ 33-63%) | < 1 s (for new sensors) |
| Gas sensor - Sensor-to-sensor deviation | +/- 15% |
| Gas sensor - Power consumption | < 0.1 mA in ultra-low power mode |
| Gas sensor - Output data processing | Major direct outputs: Index for Air Quality (IAQ), bVOC- & CO ₂ -equivalents (ppm), Gas scan result (%) & many more (all listed in datasheet in Table 20: BSEC outputs) |
| Humidity sensor - Response time (τ 0-63%) | 8 s |
| Humidity sensor - Accuracy tolerance | ± 3 % relative humidity |
| Humidity sensor - Hysteresis | ≤ 1.5 % relative humidity |
| Pressure sensor - RMS Noise | 0.12 Pa (equiv. to 1.7 cm) |
| Pressure sensor - Sensitivity Error | ± 0.25 % (equiv. to 1 m at 400 m height change) |
| Pressure sensor - Temperature coefficient offset | ±1.3 Pa/K (equiv. to ±10.9 cm at 1°C temperature change) |

SUPPORTS

| SYMBOL | I/O | DESCRIPTION |
|--------|-------|----------------------------------|
| VCC | Input | 3.3V or 5V |
| GND | GND | Common ground for all components |

TYPICAL APPLICATIONS

| APPLICATION | DESCRIPTION |
|--------------------------|---|
| Environmental Monitoring | Tracks air quality, humidity, temperature, and pressure in smart homes and industrial settings. |
| IoT Devices | Integrates into IoT systems for real-time environmental data collection and analysis. |
| Weather Stations | Enables accurate weather forecasting and monitoring in DIY weather station projects. |
| Smart Agriculture | Monitors soil and air conditions to optimize crop growth and yield. |
| Wearable Devices | Supports health and fitness wearables for environmental parameter monitoring. |

HARDWARE DOCUMENTATION

MECHANICAL DIMENSIONS



Physical dimensions and mounting specifications (measurements in millimeters)

SYSTEM TOPOLOGY



Connection topology and system integration diagram

Click image to open in full size

COMPONENT REFERENCE

| REF. | | DESCRIPTION |
|------|--|--|
| IC1 | | BME688 Environmental Sensor |
| L1 | | Power On LED |
| U1 | | AP2112K 3V3 Regulator |
| JP1 | | 2.54 mm Castellated Holes |
| J1 | | QWIIC Connector (JST 1 mm pitch) for I2C |

| INTERFACE | | SIGNALS / PINS | TYPICAL USE |
|------------------|---|--|-------------------------------------|
| UART | – | | Unavailable |
| I ² C | | SDA, SCL (CSB held high) | Default interface (Qwiic connector) |
| SPI | | CSB = GND, SDI (MOSI), SCK, SDO (MISO) | High-speed alternative |
| USB | – | | Unavailable on this module |

CIRCUIT SCHEMATIC

**Circuit Schematic**

Complete circuit schematic showing all component connections

[View Complete Schematic PDF](#)

PIN DESCRIPTION

Detailed pin assignment and electrical specifications

SIGNAL DESCRIPTION

| FUNCTION | | NOTES |
|--------------|--|----------------------------------|
| Power Supply | | 3.3V or 5V |
| Ground | | Common ground for all components |

| GROUP | AVAILABLE PINS | SUGGESTED USE |
|------------------|----------------------------------|--|
| SPI | CSB, SDI (MOSI), SDO (MISO), SCK | High-speed SPI to read sensor data |
| I ² C | SDA, SCL (via Qwiic connector) | Standard I ² C for configuration & data acquisition |

PIN CONFIGURATION LAYOUT

Physical connector layout and pin positioning



Pin Configuration Layout

Complete pin configuration diagram showing all connectors, pin assignments, and electrical connections for proper integration

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