BME688

UNIT Electronics

# 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*

## TECHNICAL FEATURES

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

Barometric Pressure: Detects atmospheric pressure changes to support dynamic weather tracking.

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)

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

Interfaces: I²C and SPI

## TECHNICAL SPECIFICATIONS

### ⚙️ TECHNICAL SPECIFICATIONS

| PARAMETER | TECHNICAL DATA |
|---|---|
| Package dimensions | 8-Pin LGA with metal3.0 x 3.0 x 0.93 $mm^3$ |
| Operation range (full accuracy) | Pressure: 300...1100 hPaHumidity: 0…100%Temperature: -40…85°C |
| Supply voltage VDDIO | 1.2 ... 3.6 V |
| Supply voltage VDD | 1.71 ... 3.6 V |
| Interface | I²C and SPI |
| Average current consumption | 2.1 µA at 1 Hz humidity and temperature3.1 µA at 1 Hz pressure and temperature3.7 µA at 1 Hz humidity, pressure and temperature90 µA at ULP mode for p/h/T & air quality0.9 mA at LP mode for p/h/T & air quality3.9 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 $H_2S$ 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 (τ0-63%) | 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) |

| PARAMETER | TECHNICAL DATA |
|---|---|
| Pressure sensor - Temperature coefficient offset | ±1.3 Pa/K (equiv. to ±10.9 cm at 1°C temperature change) |

### SUPPORTS

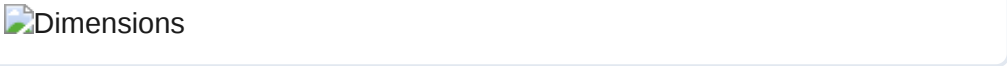
| SYMBOL | I/O | DESCRIPTION |
|---|---|---|
| VCC | Input | 3.3V or 5V |
| GND | GND | Common ground for all components |

## 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 |
| I²C | 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 |
| I²C | SDA, SCL (via Qwiic connector) | Standard I²C 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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Professional Technical Datasheet

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