BME688

UNIT Electronics

BME688 Environmental Sensor 4-in-1

v1.0

2025-07-17
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

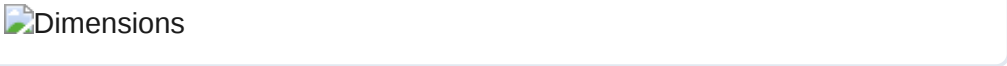
SYMBOL	I/O	DESCRIPTION
VCC	Input	3.3V or 5V
GND	GND	Common ground for all components

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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