BME688

BME688 Environmental Sensor 4-in-1

v1.0

2025-09-23
Rev. A

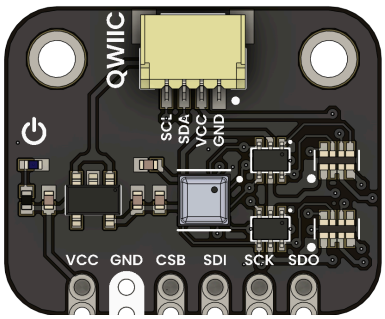
Professional electronic component

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.

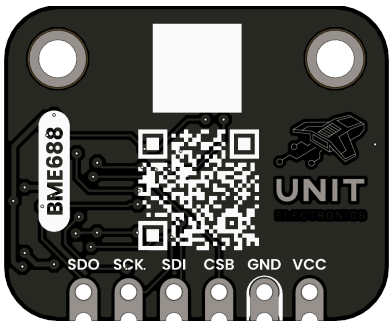
PRODUCT VIEWS

TOP VIEW



Component placement and connectors

BOTTOM VIEW



Underside components and connections

KEY TECHNICAL SPECIFICATIONS

🔌 CONNECTIVITY

Primary Interface:	**GPIO (Interrupt)**
Connector Type:	**JST 4-pin 1.0mm**
Logic Levels:	**VCC-referenced (2V – 5.5V tolerant)**

KEY 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.

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

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

Interfaces:
I²C and SPI

Input Voltage via VCC Pin:
3.6–6.0 V (through onboard voltage regulator)

ADDITIONAL TECHNICAL INFORMATION

📦 OVERVIEW

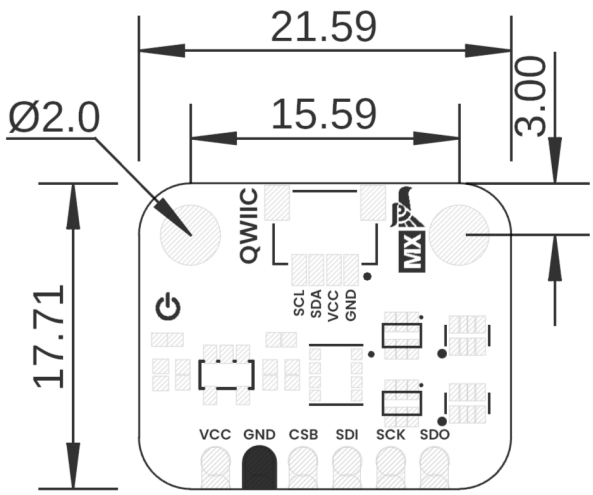
PARAMETER	VALUE/DESCRIPTION
Operating Voltage	1.71V to 3.6V
Supply Current	0.9 µA (sleep), 2.1 µA (ULP), ~920 µA (gas scan)
Operating Temperature	-40°C to +85°C
Relative Humidity Range	0% to 100% RH
Pressure Range	300 hPa to 1100 hPa
Gas Sensing	VOCs, IAQ index via integrated gas sensor
Interfaces	I²C and SPI (up to 3.4 MHz)
Package Size	3.0 × 3.0 × 0.93 mm³

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

HARDWARE DOCUMENTATION

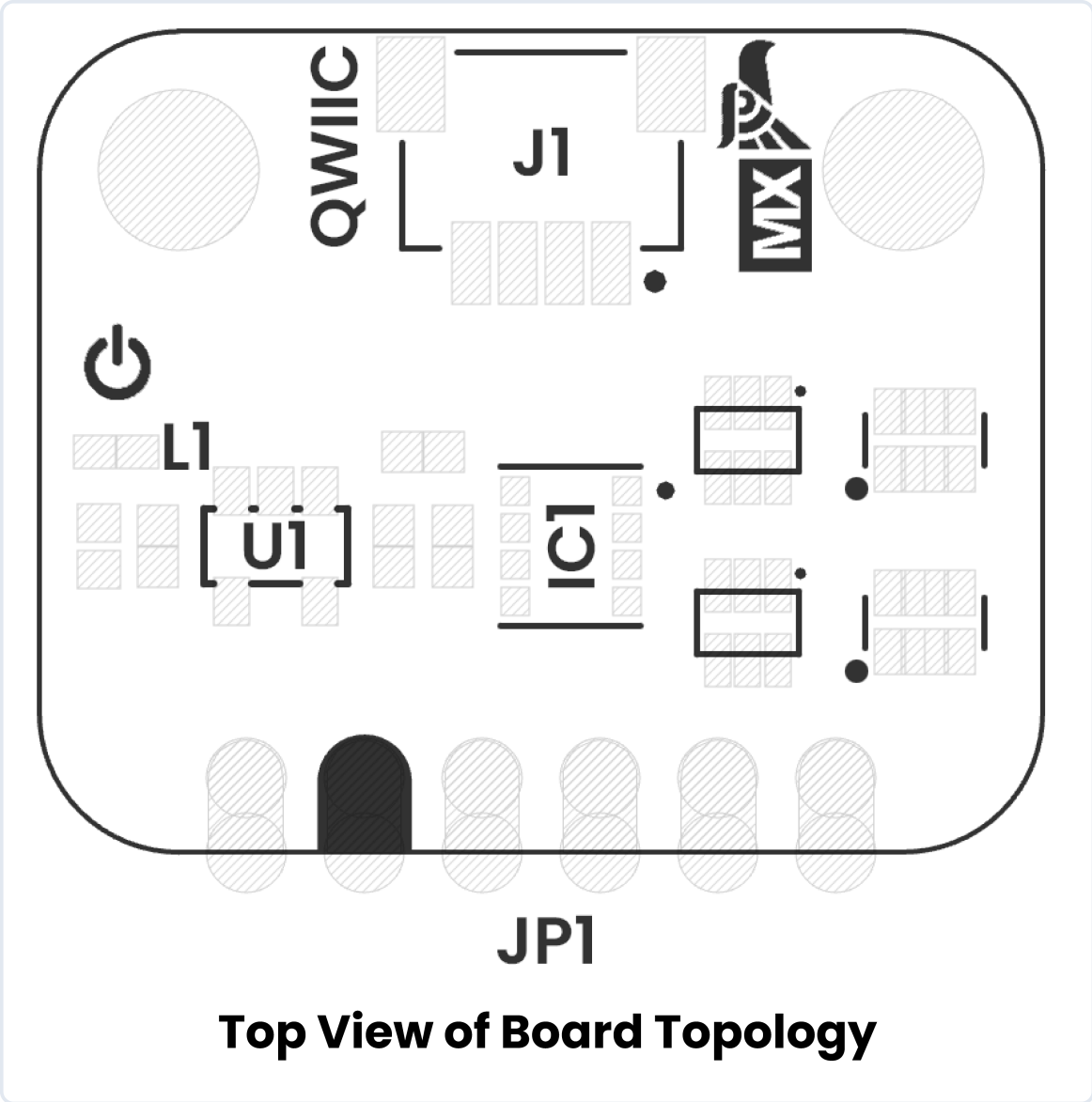
MECHANICAL DIMENSIONS



Mechanical dimensions in millimeters (mm)

Physical dimensions and mounting specifications (measurements in millimeters)

SYSTEM TOPOLOGY



Top View of Board Topology

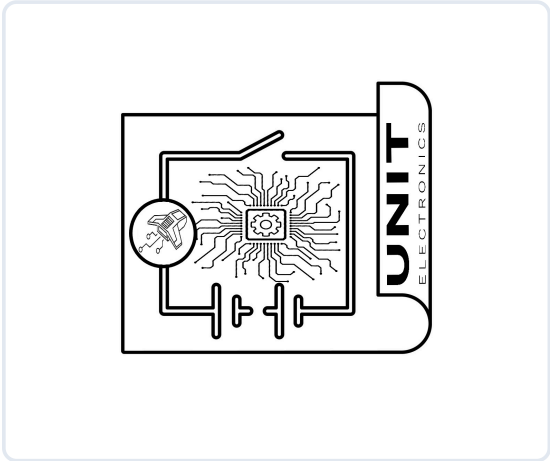
Connection topology and system integration diagram

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

CIRCUIT SCHEMATIC



Complete circuit schematic showing all component connections

View Complete Schematic PDF

PIN DESCRIPTION

Detailed pin assignment and electrical specifications

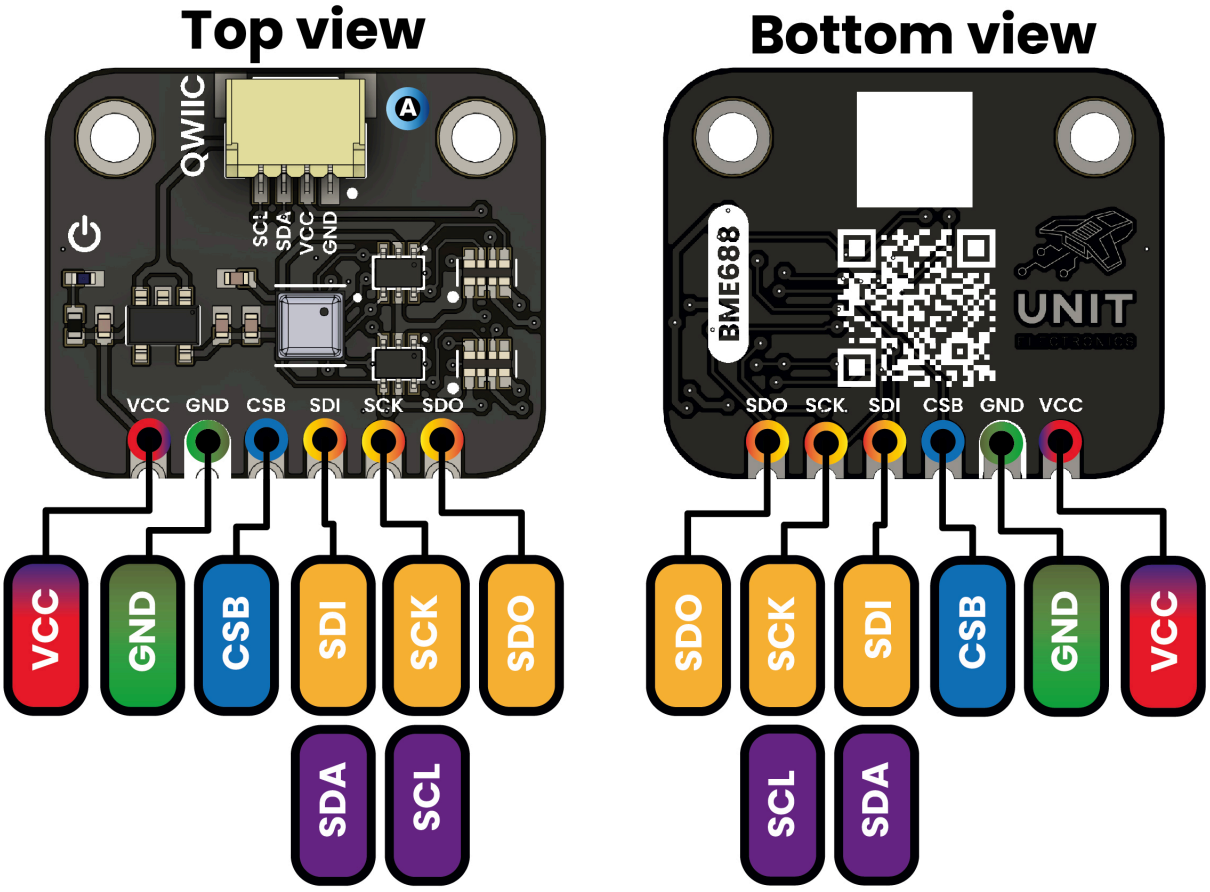
SIGNAL DESCRIPTION

PIN LABEL	DESCRIPTION
VCC	Power supply (3.3V or 5V)
GND	Ground
SDA/SDI	I²C data / SPI data in
SCL/SCK	I²C clock / SPI clock
CSB	Chip select (SPI, active low)
SDO	SPI data out

PIN CONFIGURATION LAYOUT

Physical connector layout and pin positioning

PINOUT



Description:

- Supply voltage
- GND
- I2C
- SPI
- Chip select
- QWIIC

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