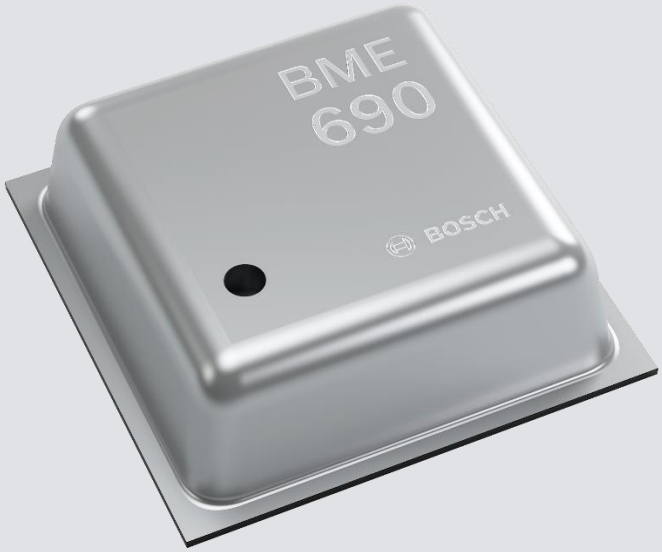
BME690

Handling, soldering and mounting instruction



HSMI BME690

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Notes	Data and descriptions in this document are subject to change without notice. Product photos and pictures are for illustration purposes only and may differ from the real product appearance. The technical details and legal disclaimer of the respective product data sheet apply.

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1 Purpose of this document

This document describes the recommended conditions and parameters to be applied when handling, soldering and mounting Bosch Sensortec's environmental (Temperature, Humidity, Pressure and Gas) Measurement Units to a PCB. This document applies the Sales Part Number mentioned on the cover sheet. In case the Sales Part Number of your Bosch Sensortec device is not listed, please contact your Bosch Sensortec representative.

Important:

- In order to avoid any damages of the sensor and resultant loss of warranty please strictly keep with the instructions described within this document
- It is also strongly recommended to study the sensor data sheet prior to handling the sensor device
- In case you have any other questions, please do not hesitate to contact your Bosch Sensortec representative for further advice

2 Package outline

Please refer to the latest version of the corresponding product datasheet.

3 Landing pattern

Please refer to the latest version of the corresponding product datasheet.

4 Soldering Instructions

The moisture sensitivity level of the BME690 sensors corresponds to JEDEC Level 1, see also:

- IPC/JEDEC J-STD-020F "Joint Industry Standard: Moisture/Reflow Sensitivity Classification for non-hermetic Solid State Surface Mount Devices"
- IPC/JEDEC J-STD-033C "Joint Industry Standard: Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices"

The sensor fulfils the lead-free soldering requirements of the above-mentioned IPC/JEDEC standards. Accordingly, reflow soldering with a peak temperature up to 260°C for 20 to 40 seconds shall be used (see Figure 2). The sensors can withstand up to 3 reflow soldering cycles; several cycles may be necessary when mounting for example devices on both sides of a PCB. It is also important to note that the minimum height of the solder after reflow should be at least 50 µm. This is required for a good mechanical decoupling between the sensor device and the PCB.

Profile Feature		Pb-Free Assembly
Average Ramp-Up Rate (Ts_{max} to Tp)		3° C/second max.
Preheat – Temperature Min (Ts_{min}) – Temperature Max (Ts_{max}) – Time (ts_{min} to ts_{max})		150 °C 200 °C 60-180 seconds
Time maintained above: – Temperature (T_L) – Time (t_L)		217 °C 60-150 seconds
Peak/Classification Temperature (Tp)		260 °C
Time within 5 °C of actual Peak Temperature (tp)		20-40 seconds
Ramp-Down Rate		6 °C/second max.
Time 25 °C to Peak Temperature		8 minutes max.

Note 1: All temperatures refer to topside of the package, measured on the package body surface.

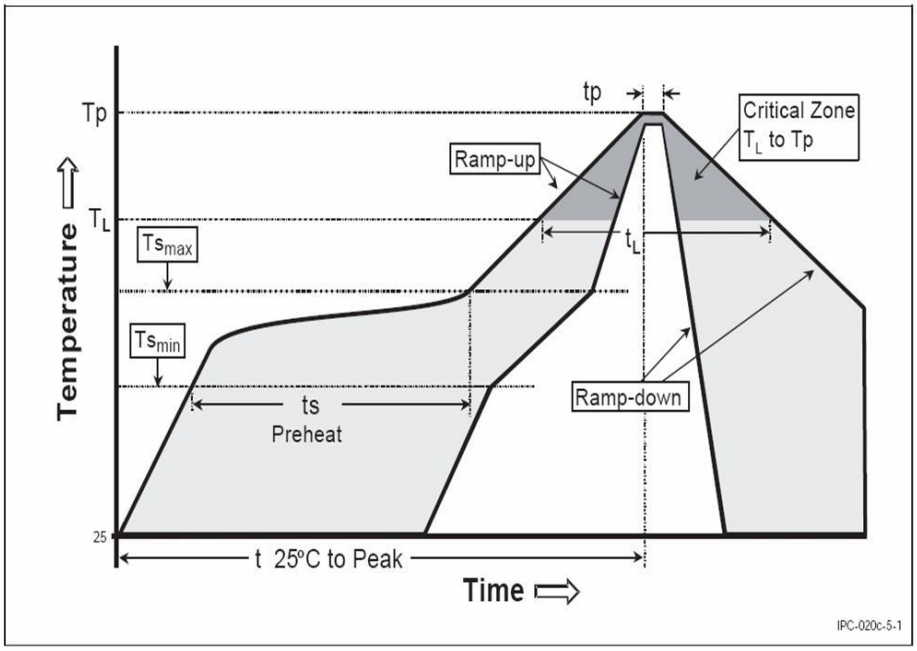

Figure 1: Soldering profile

5 Reconditioning Procedure

After exposing the device to operating conditions that exceed the limits specified in the datasheet (e.g. after reflow), the humidity sensor may possess an additional undesired offset. Therefore, the following reconditioning procedure is mandatory to restore the sensors' calibration state:

1. Dry-baking at 120 °C and <5% rH for 2 hours
2. Re-hydration at 70 °C and 75% rH for 6 hours
3. Rest period for one hour at room temperature and room humidity level

or alternatively

1. Do not perform Dry-Baking
2. Ambient Re-Hydration at 25 °C and >40% rH for >5 days

6 Warnings and Precautions

The following list of instructions has to be carefully considered during handling, soldering and mounting of BME690:

- ESD protective measures in the workplace shall be generally ensured (e.g. use of wrist straps, tweezers with ceramic tips, etc.)
- The vent hole of the sensor shall be covered with a silicone-free protective layer during processing (e.g. cleaning, soldering, board wash etc.) to prevent possible contamination
- It is permitted only to use silicone-free gloves during handling of the sensors (e.g. Nitrile-based gloves for clean rooms are recommended to use)
- The sensors shall be stored in their original packaging (i.e. the original package do not emit odor or poisonous gases) and at the following conditions: temperature and humidity shall be within the ranges of 10–50°C and 20–60 % rH, respectively
- Sensor characteristics may be impaired when exposed to undesired vapours, and thus, it is important not to employ vapour-phase ovens and to avoid working with adhesives/glues, lacquer-like polymers, cosmetics (e.g. hand lotion), or sprays (e.g. lubricants) close to the assembly line
- The sensors should not be operated in the following conditions:
    - Pure dry (synthetic) air
    - A zero or low oxygen atmosphere
    - A nitrogen-only atmosphere
- Permanent (>12 hrs) exposition to unusual high concentration of smoke or gases above the recommended maximum level (0…100 mg/m³ TVOC / reducing gases or 0…10mg/m³ total of (NOx+SOx+O3) / oxidizing gases) has to be avoided
- It is not permitted to expose high concentrations of reducing (e.g. >20 mg/m^3 of TVOC) and/or oxidizing gases (>10 mg/m³ of NO_x+SO_x+O_3) to operating sensors for a long time
- Do not expose high concentrations of cigarette lighter and/or exhaust pipe gases to operating sensors
- It is not advised to put the sensors in close proximity to outgassing rubbers, and thus, it is recommended to use thermoplastic elastomers or highly filled rubbers (without or with a low content of plasticizers)
- The PCBs shall not be coated with materials containing and/or emitting siloxanes
- Soaking or splashing the sensors with liquids shall be avoided
- Strong air blast from an air pistol is forbidden
- To allow good reflow process, no excess solder paste shall be utilized
- Under no circumstances should the sensors be dry-baked before soldering
- Avoid manual disassembling of the sensors, particularly by exploiting higher temperatures (>260 °C) and/or longer heating durations (>40 s), because this may introduce irreversible changes in the sensor characteristics (e.g. offset shift)
- Do not remove lid during target device assembly or application; don't use in explosive sensitive area
- Prevent any sharp objects (e.g. tweezer tips) from getting inside the vent hole of the sensor
- The pressure sensor is vulnerable to damage if ultrasonic welding is used
- Avoid rear side handling of the sensor by using for example underfil or cleaning materials
- Avoid total or partial covering of the sensor by any protective material (e.g. epoxy resin coated on another IC component nearby); this may lead to clogging of the vent hole or result in an unsymmetrical mechanical stress distribution on the sensor package
- Avoid exposure of the sensor to the following components:
    - Bases and acids (e.g. NH_3, NaOH, HCl, H_2SO_4, HF, HNO_3, $H_2S_2O_7$, etc.)
    - Corrosive gases (e.g. SO_x, Cl_2, etc.)
    - Halogens (F_2, Cl_2, Br_2, I_2), their salts (e.g. NaCl) and alkaline metals
    - High concentrations of O_3 or H_2O_2

7 Design Guidelines

MEMS sensors are in general high-precision measurement devices which consist of electronic as well as mechanical silicon structures. Moreover, BME690 offers chemically sensitive structures culminating in a combined gas, temperature, humidity and/or pressure sensor. Accordingly, special care has to be given when these sensors are integrated inside cavities and mounted for example on printed-circuit boards (PCBs). In this chapter, guidelines about the design of the housing and placement of BME690 on PCBs are presented to ensure accurate measurements as well as fast response times.

7.1 General Aspects

For the integration of BME690 the following general instructions are recommended:

- Avoid usage of adhesive, PCB and housing materials that are emitting siloxanes and/or volatile organic compounds (VOCs)
- Avoid usage of materials within the cavity which are susceptible to moisture
- The sensor is sensitive to light, which can influence the accuracy of the measurement; therefore, the housing shall be designed to minimize light exposure to the vent hole
- Note that the use of a port protection membranes might influence the sensitivity and the response time of the gas as well as the humidity sensors

7.2 Position Aspects

Wrong placement of the sensor can impair the performance. Therefore, some guidelines are given below to ensure accurate measurements and relatively fast response times:

- The sensor should be placed as close as possible to the environment, i.e., ambient air
- The dead volume inside the cavity, where the sensor is placed, should be minimized
- The clearance above the metal lid of the sensor shall be at least 0.1 mm
- A large aperture and a short channel, through which the gas is diffusing to reach the sensor inside the system, are highly recommended

To have a better insight of how BME690 is typically integrated, Figure 2 shows three different possible cavity designs. As depicted in the figure, a defined air flow/circulation has to be guaranteed to minimize the temperature deviations between the sensor and the surrounding environment. On a side note, an optional protection membrane at the aperture can be used.

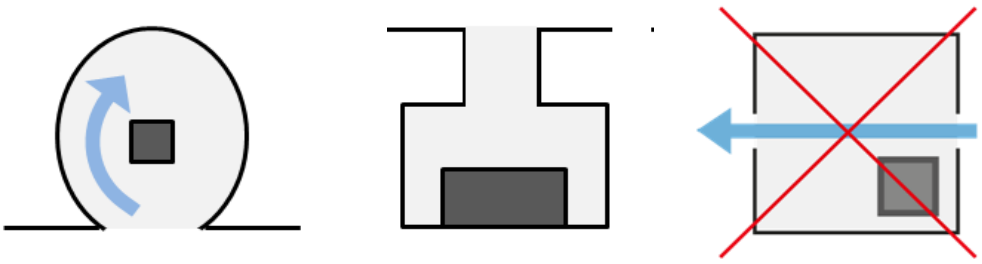

Figure 2: Cavity designs with: (left) defined air flow, (middle) small cavity, (right) large cavity volume and no direct air flow

7.3 Thermal Aspects

Thermal decoupling of the sensor to the PCB and housing is required to assure fast response for the temperature sensor as well as efficient heat conduction between heater of the gas sensor and the chemically sensitive layer. On the other hand, good thermal and air coupling of the sensor to the surrounding room-air is essential to accurately sense the target environment. Accordingly, the following operation and layout design rules are recommended (see Figure 3 and Figure 4):

- To avoid self-heating, the sensor should not be continuously active; the datasheet provides more information about how to minimize the power consumption at a particular resolution
- Protect the sensor from heated air flow to avoid heat convection and radiation, which might lead to undesired warming-up of the device and wrong (over- or underestimated) output results
- The sensor has to be placed at an adequate distance to any critical heat sources on the PCB or inside the system; trenches around the sensor can be utilized to reduce the thermal conduction
- The sensor has to be placed not in close vicinity to fast heating components (>3 °C/s)
- The thickness of the metal interconnects to the sensor has to be minimized in order to ensure proper heat decoupling
- The sensor has to be placed as close as possible to the environment and also close to the edges of the device/system.

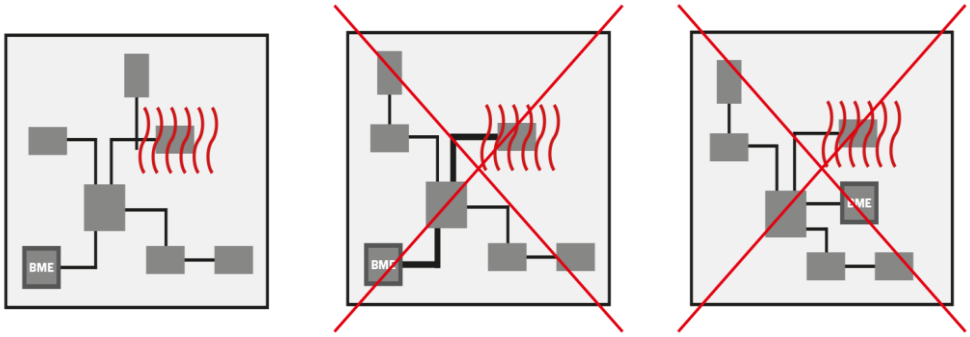

Figure 3: BME690 placement on a PCB (red: heat radiation)

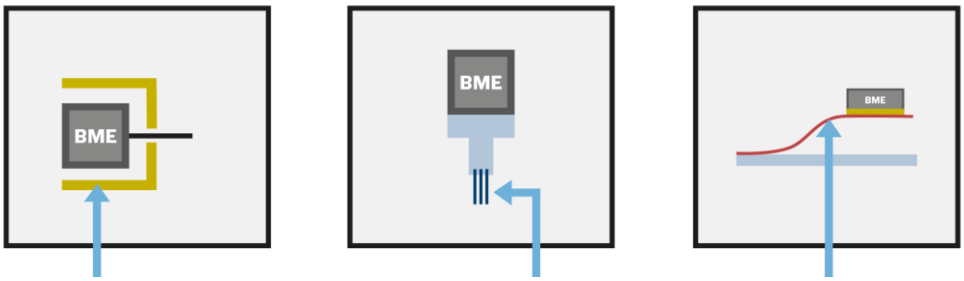

Figure 4: Three methods to thermally decouple the sensor from the PCB

7.4 Mechanical Aspects

Unnecessary mechanical stress induced on the sensor is not advisable. Referring to Figure 5, the following guidelines are recommended for a good PCB design practice:

- Place the sensor not nearby or directly beneath a push-button on the PCB
- Keep the sensor as far as possible from areas where any mechanical-stress induced on the PCB is maximum
- Mount the sensor at a reasonable distance from the anchor points (e.g. screw), where the PCB is typically attached to a base, shelf or similar
- Remove or unscrew any redundant PCB anchor points that induce an undesirable mechanical stress

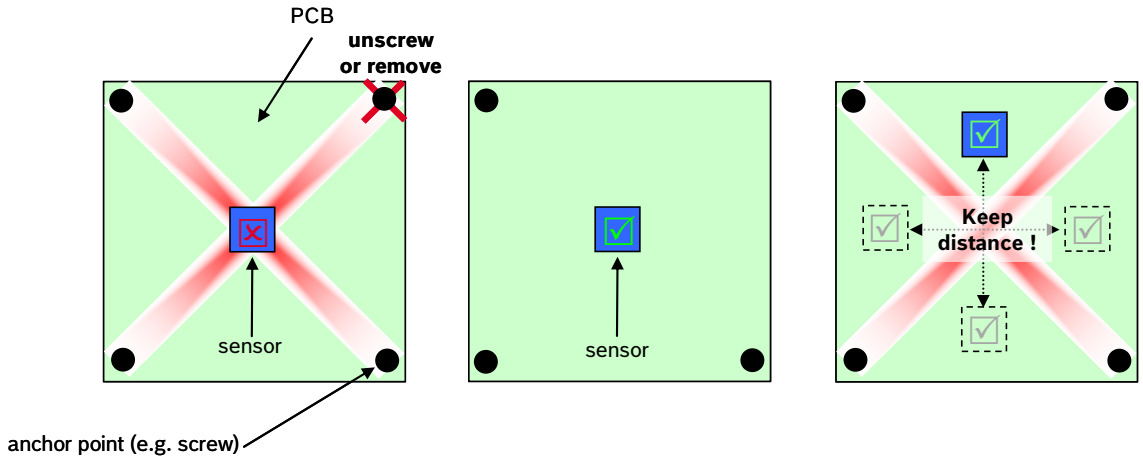

Figure 5: Methods to minimize mechanical stress on the sensor: (left) sensor is wrongly placed at a high mechanically-stressed location, (middle) redundant screw is removed to minimize stress, (right) sensor is properly placed at a reasonable distance from high mechanically-stressed areas

8 Note on internal package structures

Within the scope of Bosch Sensortec's ambition to improve its products and secure the product supply while in mass production, Bosch Sensortec qualifies additional sources for the LGA package of its sensors.

While Bosch Sensortec took care that all of the technical package parameters as described above are 100% identical for both sources, there can be differences in the chemical analysis and internal structural between the different package sources.

However, as secured by the extensive product qualification processes at Bosch Sensortec, this has no impact on the usage or the quality of the sensor.

9 Device marking

Please refer to the latest version of the corresponding product data sheet or preliminary data sheet.

10 Environmental Safety

10.1 RoHS

The BME690 sensor meets the requirements of the EC restriction of hazardous substances (RoHS) directive, see also: *Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.*

10.2 Lead and Halogen Content

The BME690 is lead (Pb) and halogen-free. For more details on the analysis results please contact your Bosch Sensortec representative.

11 Document history and modification

Rev. No	Chapter	Description of modification/changes	Date
1.0	-	Initial release	February 2025

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