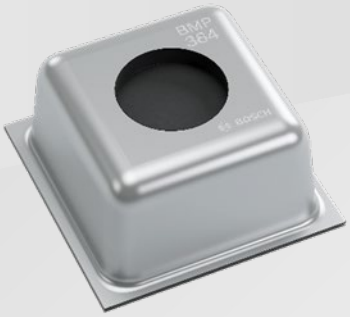
BMP384 – Digital Pressure Sensors

Handling, Soldering and Mounting Instruction



BMP384 HSMI

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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.

Purpose of this document

This document describes the conditions and parameters to be applied when handling, soldering and mounting the BMP384 to a PCB.

Important:

- In order to avoid any damages of the BMP384 and resultant loss of warranty please strictly keep with the instructions described within this document.
- It is also strongly recommended to study the BMP384 data sheet prior to handling the BMP384 sensor device.
- In case you have any questions, please do not hesitate to contact your nearest Bosch Sensortec representative for further advice.

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1 Package outline dimensions

1.1 Outline dimensions

The sensor housing is n 10-pin metal-lid LGA 2.0×2.0×0.95 mm^3 package (typ.). Its dimensions are depicted in Figure 1.

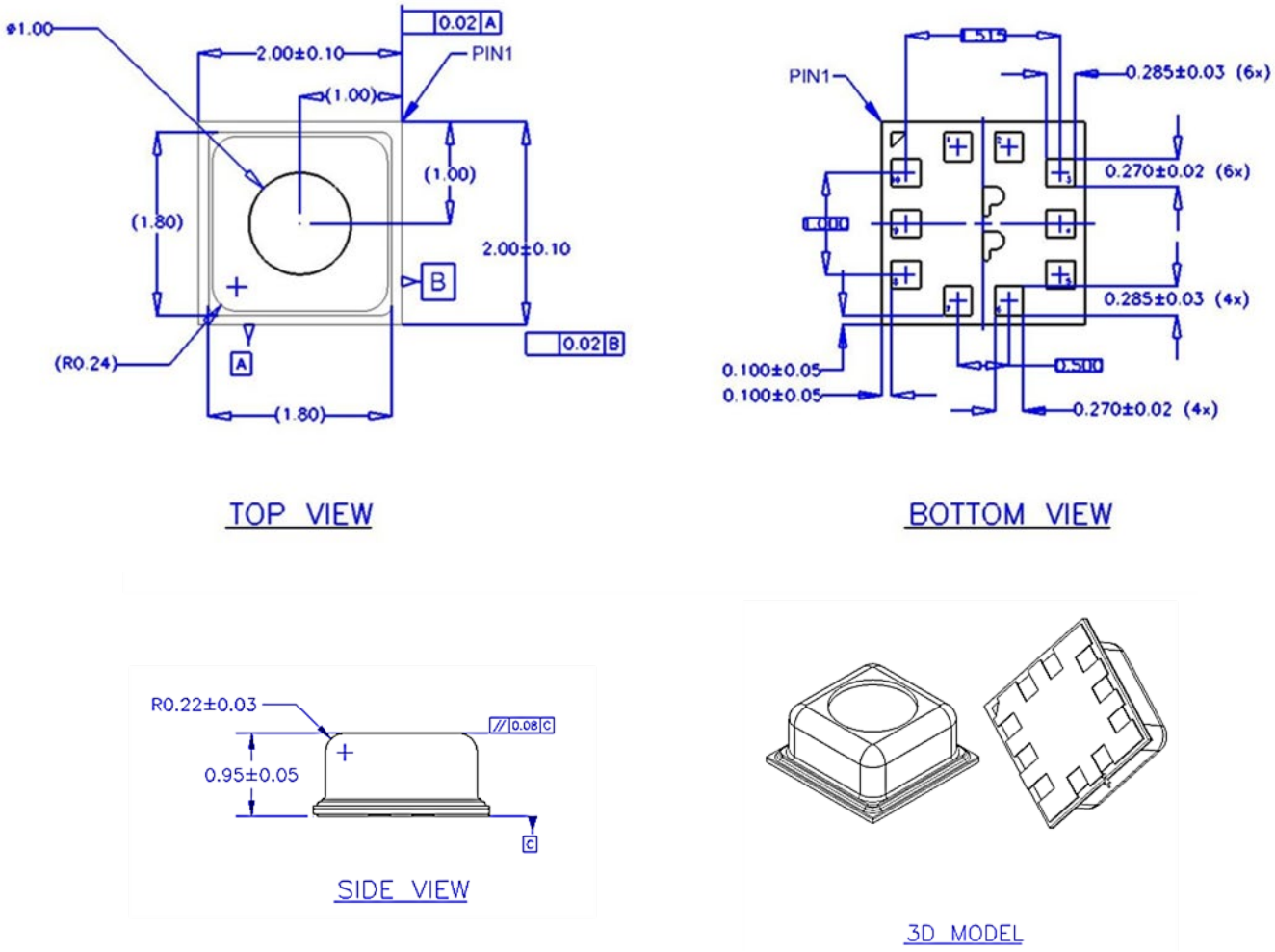


Figure 1: Package outline dimensions BMP384 for top, bottom, side and 3D view

Note: General tolerances are ±50 µm (linear) and ±1 µm (angular)

1.2 Landing pattern

Bosch Sensortec suggests the BMP384 outline Dimensions as landing pattern.

2 Device Marking

2.1 Mass production samples

Table 1: Marking of mass production samples top side

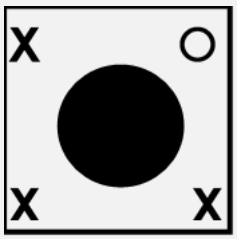
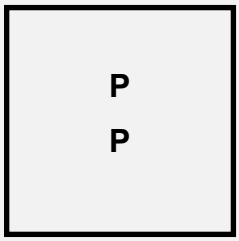
Labeling	Name	Symbol	Remark
	Lot Counter ID	XXX	3 alphanumeric digits, variable to generate mass production trace code
	Orientation marker	O	Pin1 Marking
	Port Hole	●	Partial MEMS element and wirebonds (covered with gel) visible through the port hole

Table 2: Marking of mass production samples rear side

Labeling	Name	Symbol	Remark
	Product number	P	alphanumeric digit to identify product type, “P” is associated with the product BMP384 (part number 0 273 017 015)
	Sub-con ID	P	1 alphanumeric digit, variable to identify sub-con

2.2 Engineering samples

Table 3: Marking of engineering samples top side

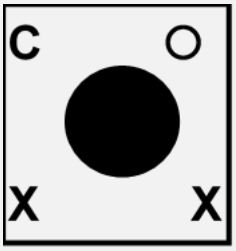
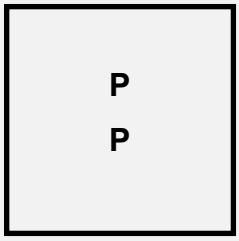
Labeling	Name	Symbol	Remark
	Eng. Sample ID	CXX	1 alphanumeric digit, fixed identification of sample status R=”C”
	Orientation marker	O	Pin1 marking
	Port Hole	●	Partial MEMS element and wirebonds (covered with gel) visible through the port hole

Table 4: Marking of engineering samples rear side

Labeling	Name	Symbol	Remark
	Product number	P	alphanumeric digit to identify product type, “P” is associated with the product BMP384 (part number 0 273 017 015)
	Sub-con ID	P	1 alphanumeric digit, variable to identify sub-con

3 Storage and soldering

3.1 Moisture sensitivity level (MSL) and device storage

- The BMP384 is classified as MSL 3 (moisture sensitivity level) according to IPC/JEDEC standards J-STD-020E and J-STD-033D.
- Avoid contact of the device with liquids and storage under high humidity environment. Hygroscopic components can absorb excessive amount of liquid, which could lead to explosive bubble formation.

3.2 Recommended reflow soldering

- The device can be soldered Pb-free with a peak temperature of 260°C for 20 to 40 sec. Figure 2 describes the recommended reflow soldering process.
- Vapor phase soldering has to be avoided. Potential deposits on the diaphragm can distort the electrical signal.
- The soldering process typically leads to a pressure offset. The physical origin of this shift is not material aging but mechanical hysteresis frozen in by the soldering temperature cycle. Thus, the shift is reversible. Multiple reflow cycles will not add up in multiple offset shifts, i.e. the initial reflow cycle will cause the largest pressure offset. The device is in the same condition after every solder reflow cycle.
- The BMP384 can withstand at least five reflow soldering cycles, while the typical number of reflow cycles is three.
- Manual unsoldering can lead to further offset, especially if the soldering temperature and / or soldering time exceed the recommended values of 260°C and 40 sec, respectively.
- When designing the solder paste stencil aperture, avoid excess solder paste following best practice to allow good reflow.

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.

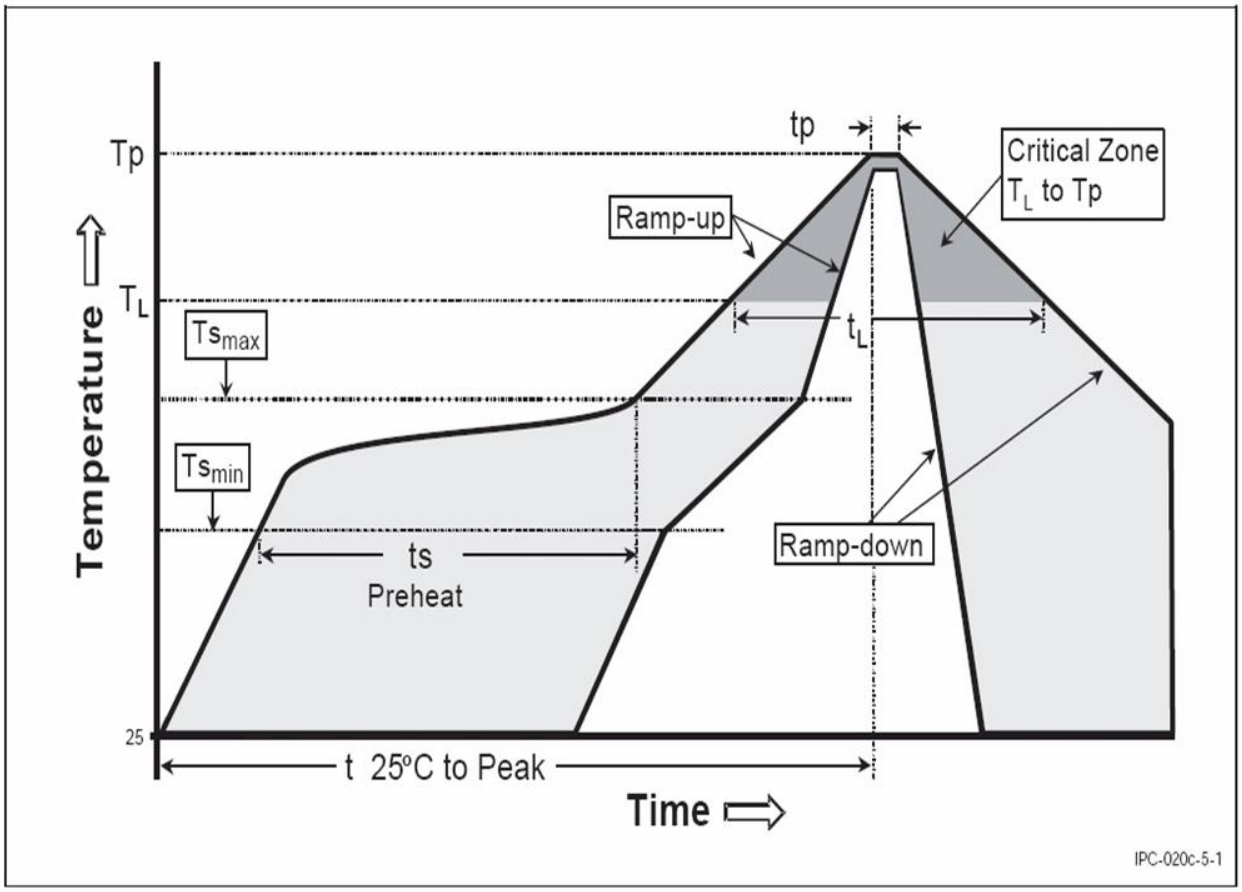


Figure 2: Recommended reflow soldering profile

4 Environmental Safety

4.1 RoHS

The BMP384 sensor meets the requirements of the EC restriction of hazardous substances (RoHS) directive, see also: Directive 2015/863 (amending Annex II to Directive 2011/65/EU) of the European Parliament and of the Council on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

4.2 Halogen content

The BMP384 is halogen-free. For more details on the analysis results please contact your Bosch Sensortec representative.

5 Internal package structure

BMP384 with its new package design concept has a coverage of the inner components with gel, which protects sensing structure, and internal components from environmental conditions[1] such as dust and liquid components.

Within the scope of Bosch Sensortec's ambition to improve its products and secure the mass product supply, Bosch Sensortec qualifies additional sources (e.g. 2nd source) for the LGA package of the BMP384.

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

However, as secured by the extensive product qualification process of Bosch Sensortec, this has no impact to the usage or to the quality of the BMP384 product.

6 Handling of reels

6.1 Storage

Once the reels are removed from the pizza box, they should always be stacked in vertical condition.

6.2 Introduction into production

Reel trailers must not be removed. Removal of the trailer could cause deformation of the reel during de-reeling and consequently tilted parts (see Figure 3)

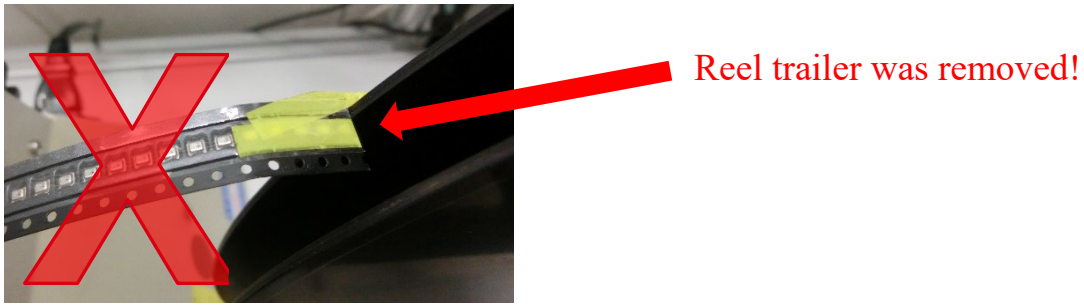


Figure 3: Removed reel trailer

Reels must be stored vertically as shown in Figure 4.

Figure 4: Storage of reels

7 Handling of sensor

7.1 Automatic handling

- When picking up the component from the Tape and Reel carrier, it is recommended to place the pick-up tool at a vertical-height distance from the sensor.
- Use vacuum pressure at approximately -80kPa (with unit) as indicated in the picker vacuum gauges. Optimal conditions may depend on picker design.
- Similarly, set vertical-height distance during placement on the board to zero to avoid overdrive beyond the limit of the PCB.
- Avoid rear side handling of the sensor, otherwise the device can be destroyed.

Table 5 reflects the recommended settings for pick and place equipment when handling BMP384:

Table 5: Recommended settings

Parameter	Best Practice
Nozzle	Use a low stress pick and place nozzle (refer to Figure 5)
Collet Material	A rubber collet should be used
Picking up module	The pick and place tool should focus its vacuum to the shoulders of the package and not on the gel; the vacuum pressure acting on the gel should be minimized
Pickup speed	Minimize z-axis acceleration. Excessive z-axis force (F=ma) can cause the transducer membrane to crack and fail.
Transfer speed	A low velocity transfer speed is recommended
Pick-up force	Do not apply more than 5N
Place speed	Minimize z-axis acceleration. Excessive z-axis force (F=ma) can cause the transducer membrane to crack and fail.

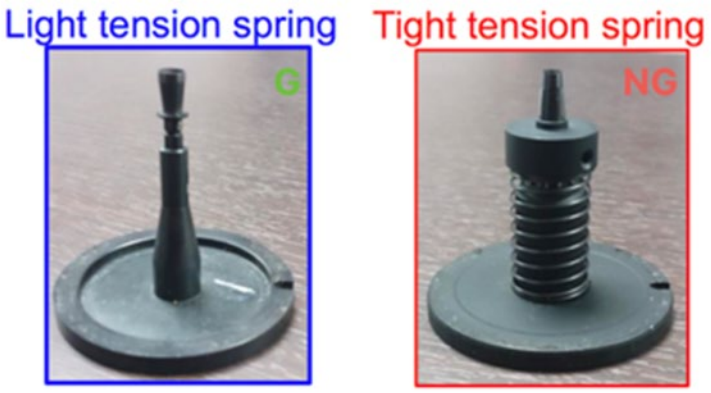


Figure 5: Appropriate tension spring

7.2 Manual handling

- In certain cases, the BMP384 needs to be handled manually.
- During such manual handling, insertion/penetration of any object through the port hole needs to be avoided. Foreign objects could severely damage interior components, such as the diaphragm or wire bonds, causing device failure.
- Particular attention has to be paid to the choice of the handling tool. It is recommended to use an appropriate vacuum tweezer.
- In the case that vacuum tweezers are not available, regular tweezers can be employed. It is important to avoid pointy tips and materials with large hardness (e.g., metal, ceramic) in order to avoid damage to the sensor. Figure 6illustrates two examples: A suitable ESD safe tweezer with blunt tip (“Good”), and a non-appropriate (“NG”) steel tweezer with pointy tip. A blunt tip with certain size cannot enter the port hole by design.

Figure 6: Appropriate vs. non-appropriate tweezer

- Appropriate personal protection equipment (PPE) needs to be used during manual handling in order to prevent contamination of the sensor by hair, dandruffs, etc. Ideally, the PPE is lint-free.
- A dust-free working environment is recommended in order to prevent introduction of foreign material through the port hole.

7.3 Contamination with fluids

- It is possible that the sensor gets exposed to liquids during processing (e.g., solder flux, cleaning agents, potting materials, adhesives) and during operation (e.g., tap/rain/sea water, sweat). These liquids impose the risk of permanent pressure offset or even complete failure. Therefore, the sensor has to be protected against all kinds of liquids. It is recommended to cover the hole of the device during processing with a protective, e.g. Kapton tape during assembly, e.g. cleaning, soldering.
- No board wash is applied once the sensor is assembled to the PCB without protection of the sensor hole
- The usage of air-pistols supplied by typical compressors is forbidden. Apart from the risk of exceeding the overpressure specification, the air is most likely contaminated with oil.

7.4 Light sensitivity

- The sensing element of the BMP384 sensor is sensitive to light, which can influence the accuracy of the measurement. Therefore, appropriate measures have to be implemented in order to prevent direct or indirect illumination of the sensor interior.

7.5 Second level processing

- Ultrasonic welding: ultrasonic welding can induce damage in the pressure sensor. Customer – in case of using this process in his manufacturing line – has to secure the parameter of the process for each project individually to protect the pressure sensor.

8 Mounting of sensor

- MEMS sensors in general are high-precision measurement devices which consist of electronic as well as mechanical silicon structures. Bosch Sensortec MEMS sensor devices are designed for precision, efficiency and mechanical robustness.
- In order to achieve best possible results for your design, certain design pitfalls have to be taken into consideration with respect to mounting the pressure sensor on a printed-circuit board (PCB).
- The exemplary scenarios described below mainly act via mechanical or thermal mode of action on the sensor package, leading to performance degradation. Please note that the elaborated scenarios are not unique to Bosch Sensortec devices, but may as well occur with 3rd party MEMS devices in a similar manner.
- In general, it is advised to keep a reasonable distance between the sensor mounting location on the PCB and the critical points described. The exact value for a “reasonable distance” depends on many customer specific variables and must therefore be determined case by case. In case you have any questions with regard to the mounting of the sensor on your PCB, do not hesitate to contact us.

8.1 Push-button contacts

- Keep a reasonable distance to push-button contacts, when placing the sensor device (see Figure 7). In particular, do not position the sensor directly beneath a push-button contact.

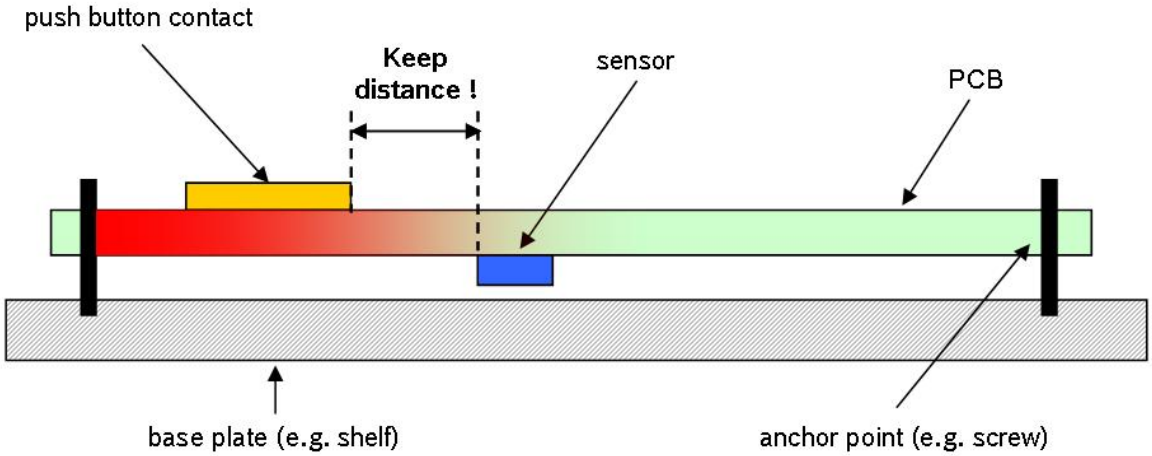


Figure 7: Consideration of push-button contacts for mounting of sensors.

8.2 Hot-spots on the PCB

- Keep a reasonable distance from any hot spots, when placing the sensor device (see Figure 8). Hot spots can be for example µController with high power consumption.
- In addition, the BMP384 shall not be placed close to fast heating parts. In case of temperature changes > 3.0°C/sec during operation. It is recommended to follow Bosch Sensortec application note “Correction of errors induced by fast temperature changes”. Please contact your Bosch Sensortec representative for details

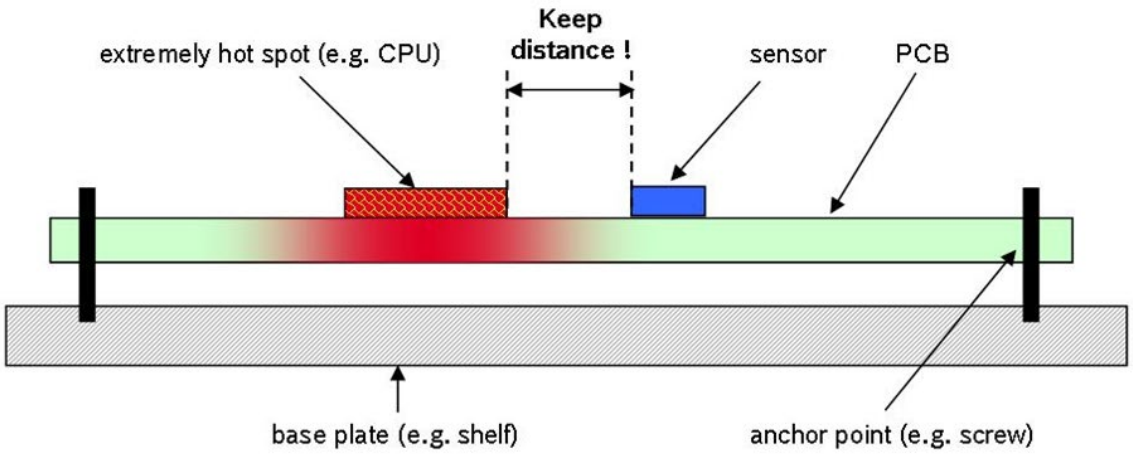


Figure 8: Consideration of hot-spots for mounting of sensors.

8.3 PCB anchor points

- Maxima of mechanical stress can occur at various locations on a PCB. Strain of the PCB can translate partly into the sensing element of the sensor, thus lead to declining performance.
- It is good manufacturing praxis to always avoid or reduce the mechanical stress by optimizing the PCB design first, then to place the sensor in an appropriate low stress area.

8.3.1 Vicinity to anchor points

- On the one hand, the magnitude of this effect will depend on the vicinity to anchoring points, which could constitute a strain maximum, as shown in Figure 9.
- It is advised to keep a reasonable distance from any anchor points, where the PCB is fixed at a base plate (e.g. like a shelf or similar), when placing the sensor device.

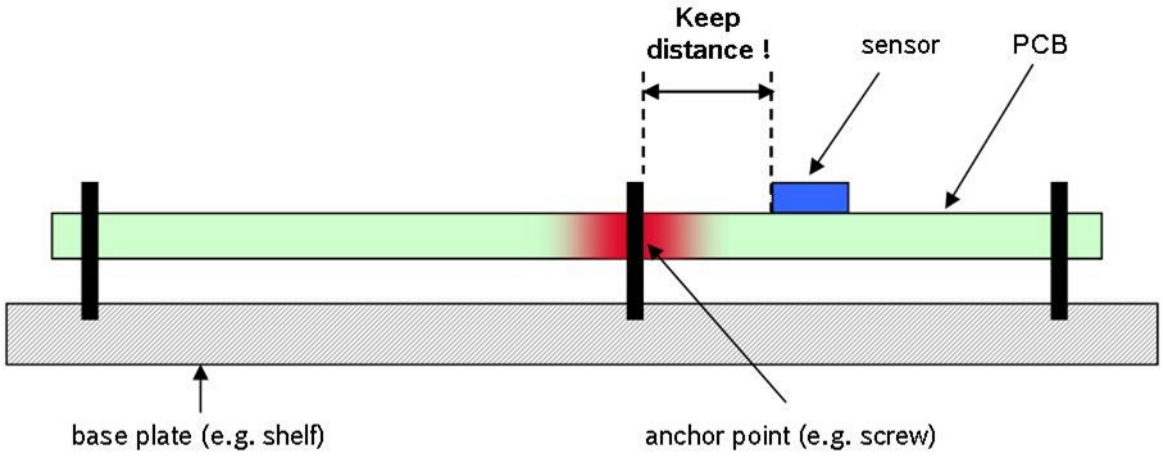


Figure 9: Consideration of distance from anchor points for mounting of sensors.

8.3.2 Redundant PCB anchor points

- On the other hand, independent of the distance from anchor points, stress maxima can be induced in certain locations of a PCB. Most commonly, such stress maximum arises due to presence of redundant anchor points. As shown in Figure 10, such situation can arise in the center of the diagonal crossover of the 4 anchor points.

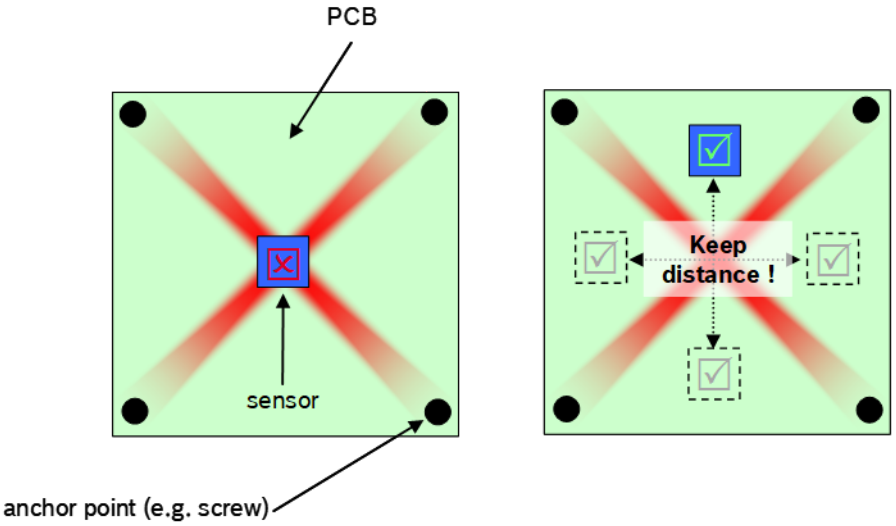


Figure 10: Consideration of redundant anchor points for mounting of sensors.

- It is recommended to unscrew or remove any redundant PCB anchor points. In theory, an ideal flat plane is determined by 3 anchor points, exclusively. Any further anchor point will over-determine the ideal flat plane criteria. If these redundant anchor points are out of plane position (which means not 100% exact in plane position) the ideal flat criteria is infringed, resulting in mechanical stress (see Figure 11).

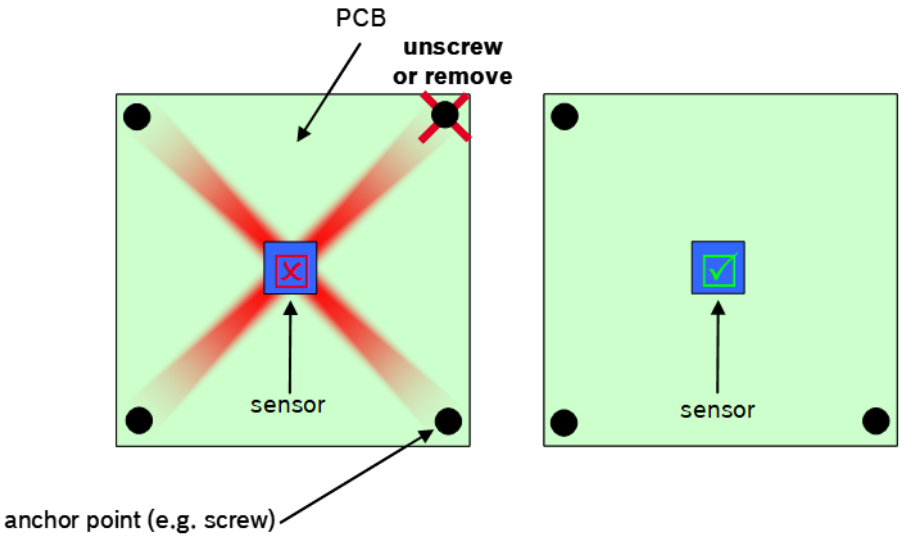


Figure 11: Removal of redundant anchor points.

8.4 Resin coatings

- Please avoid total or partial coverage and even contact of the sensor with any kind of protective material (e.g., epoxy resin), as this can possibly result in an un-symmetric stress distribution over the sensor package and could clog the port hole (see Figure 12).

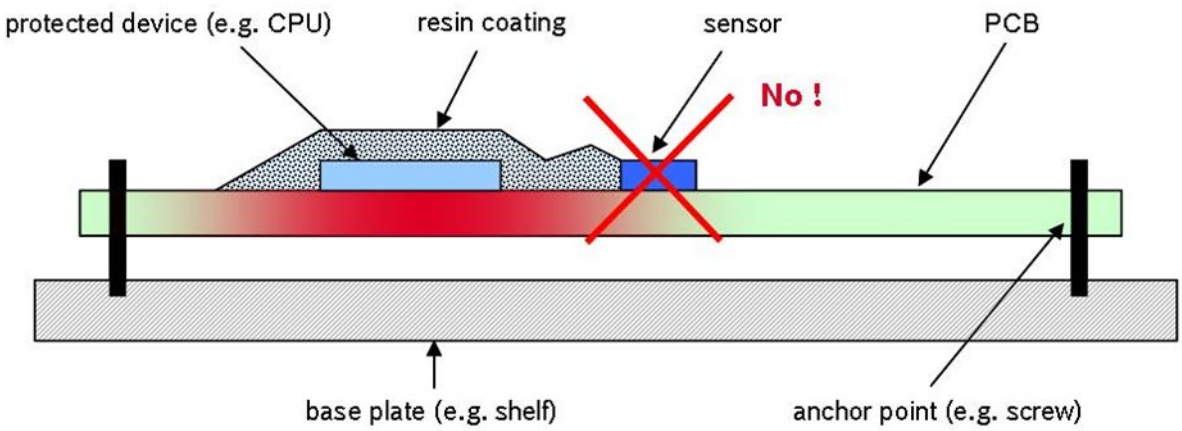


Figure 12: Consideration of resin coatings for mounting of sensors.

8.5 Minimum distance between sensor and PCB

- The minimum height of the solder after reflow shall be at least 25µm (see Figure 13). This is required for a good mechanical decoupling between sensor device and the printed circuit board (PCB).

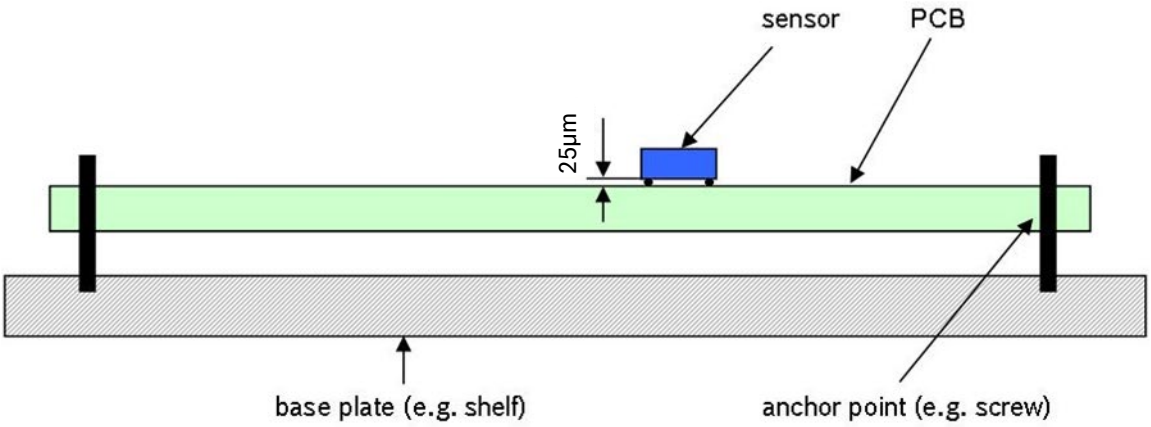


Figure 13: Consideration solderheight for mounting of sensors.

8.6 Underfill and cleaning materials

- Please avoid all kinds of foreign materials under the sensor, e.g. underfill and cleaning materials (see Figure 14).

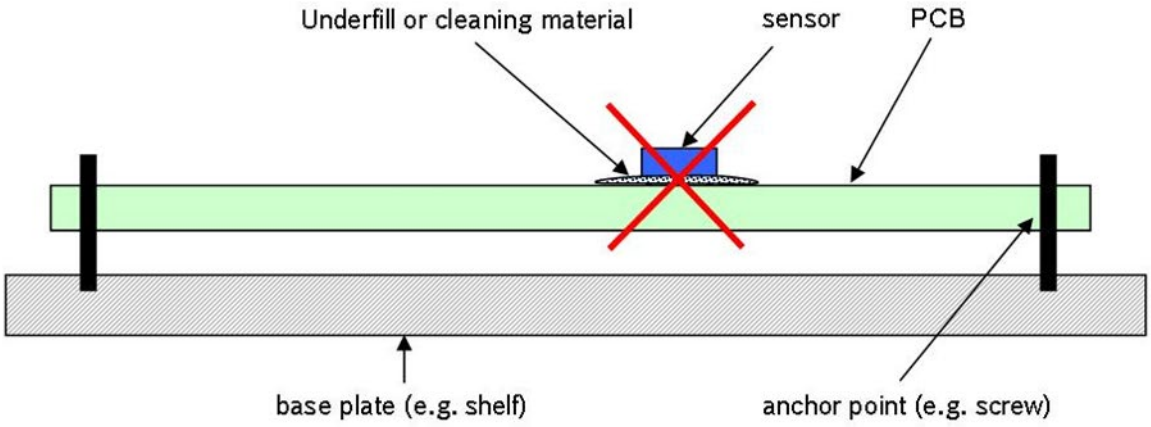


Figure 14: Preventing underfill and cleaning for mounting of sensors.

8.7 Integration into water resistant devices

- When operating the sensor inside a water resistant device (e.g. IPX5 or higher rated), special care must be taken, if a fast response to changes in ambient air pressure is needed.
- Typically, in a water resistant device the port for ambient air pressure exchange is protected by a porous membrane (e.g. ePTFE), which prevents the intrusion of water into the device (see Figure 15). However, this also means that the air exchange might be restricted, depending on the water proofness of the membrane and its permeability to air, leading to a slower response of the pressure sensor to changes in ambient air pressure.

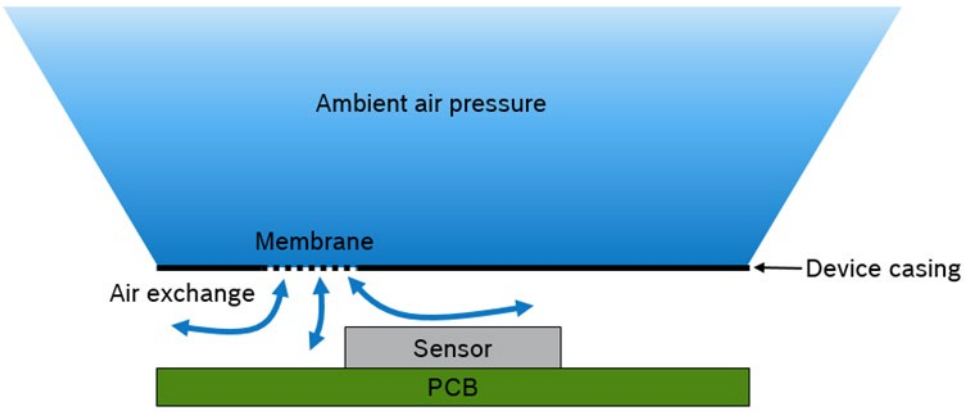


Figure 15: Typical non-optimized placement of sensor inside a water resistant device.

- The following measures can be taken to optimize the housing for appropriate venting (see Figure 16):
  1. Reduction of dead volume to reduce to amount of air needed to reach pressure equilibrium
  2. Increase of port aperture
  3. Careful choice of membrane to optimize trade-off between airflow and water protection

- Please note that while the device is exposed to liquids (see section 7.3), accurate pressure readings cannot be guaranteed.

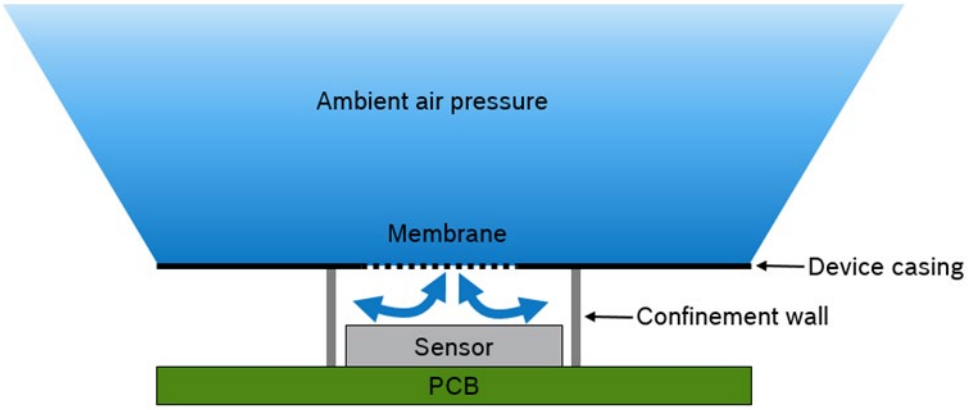


Figure 16: Potential optimizations of housing for improved venting. Dead volume reduction with confinement walls and larger port hole

9 Legal Disclaimer

9.1 Engineering samples

Engineering Samples are marked with an asterisk (*), (e) or (E). Samples may vary from the valid technical specifications of the product series contained in this data sheet. They are therefore not intended or fit for resale to third parties or for use in end products. Their sole purpose is internal client testing. The testing of an engineering sample may in no way replace the testing of a product series. Bosch Sensortec assumes no liability for the use of engineering samples. The Purchaser shall indemnify Bosch Sensortec from all claims arising from the use of engineering samples.

9.2 Product use

Bosch Sensortec products are developed for the consumer goods industry. They may only be used within the parameters of this product data sheet. They are not fit for use in life-sustaining or safety-critical systems. Safety-critical systems are those for which a malfunction is expected to lead to bodily harm, death or severe property damage. In addition, they shall not be used directly or indirectly for military purposes (including but not limited to nuclear, chemical or biological proliferation of weapons or development of missile technology), nuclear power, deep sea or space applications (including but not limited to satellite technology).

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The purchaser accepts the responsibility to monitor the market for the purchased products, particularly with regard to product safety, and to inform Bosch Sensortec without delay of all safety-critical incidents.

9.3 Application examples and hints

With respect to any examples or hints given herein, any typical values stated herein and/or any information regarding the application of the device, Bosch Sensortec hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights or copyrights of any third party. The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics. They are provided for illustrative purposes only and no evaluation regarding infringement of intellectual property rights or copyrights or regarding functionality, performance or error has been made.

10 Document history and modification

Rev. No	Chapter	Description of modification/changes	Date
1.0	all	Initial release	October 2020

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