BMA5xy in Wafer Level Chip Scale Package

Handling, Soldering and Mounting Instructions

HSMI for BMA5xy Accelerometers in WLCSP

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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 datasheet apply.

Table of contents

List of figures

List of tables

1 Purpose of This Document

This document describes the recommended conditions and parameters to be applied when handling, soldering and mounting Bosch Sensortec's sensor product to a printed circuit board (PCB). This document applies to the mentioned Sales Part Number mentioned on the cover sheet. In case the Sales Part Number of your Bosch Sensortec device is not listed, contact your Bosch Sensortec representative.

Be aware of the following important points:

- To avoid any damages of the sensor and resultant loss of warranty, strictly follow the instructions described in this document.
- It is strongly recommended to study the sensor datasheet prior to handling the sensor device.
- In case you have any other questions, contact your Bosch Sensortec representative for further advice.

2 Moisture Sensitivity Level (MSL)

Refer to the latest version of the corresponding product datasheet.

3 Handling Instruction

In addition to this document, first refer to the general information in the latest version of the corresponding product datasheet.

3.1 Component Placement

The wafer-level chip scale package (WLCSP) of the BMA5xy is compact in size, but it is important to note that these devices are delicate and prone to breakage. Therefore, it is highly recommended to use automated placement machines to avoid component damage, with compression forces controlled and monitored. Additionally, an automated Z-axis-height control equipment should be used. On the other hand, the manual placement of components is not recommended due to the higher possibility of component damage. Figure 1 shows an example of component damage on the WLCSP due to improper handling.

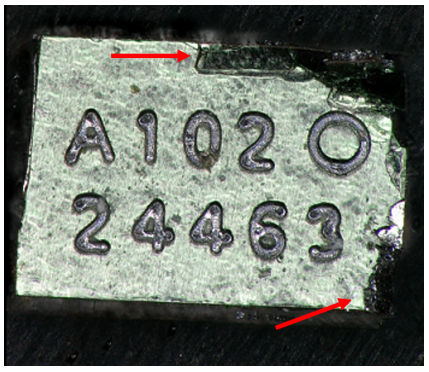

Figure 1: Component damage on WLCSP due to improper handling

When the automated placement machine picks up the BMA5xy from the pocket of the reel, it is important to avoid device misalignment, such as tilting caused by the tolerance of the pocket size. Therefore, it is recommended to hold the bottom side of the pocket by, for example, vacuum, as illustrated in the following Figure 2.

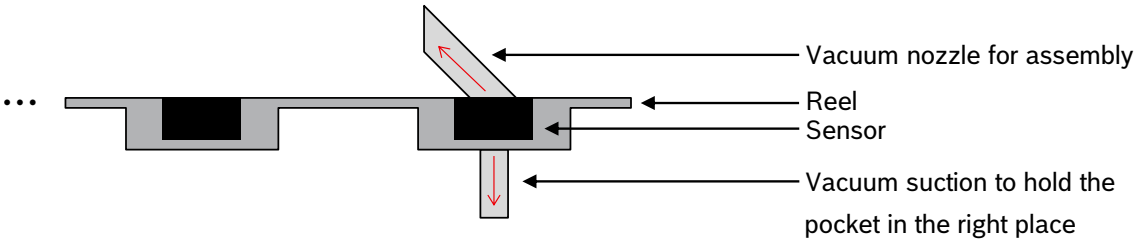

Figure 2: Recommendation to pick-up device from reel by automated placement machine

3.2 Contamination

Under certain circumstances, the WLCSP of the BMA5xy is sensitive to contamination, for example, organic contamination from a human origin. It is recommended to strictly follow industry standard automated processes and cleanliness requirements to prevent contamination from coming into contact with the sensor surfaces. The user must take care during the assembly process, component level qualification, etc. See the example in Figure 3.

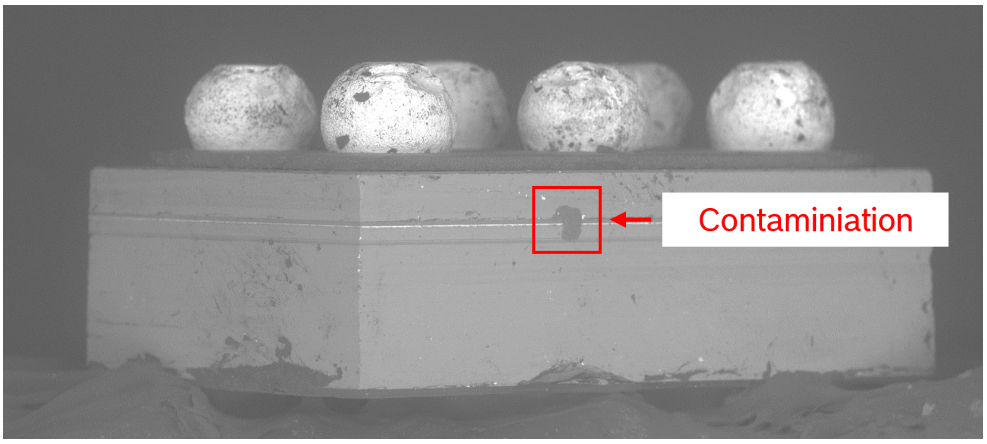

Figure 3: Example of contamination on the surface of the BMA5xy package

3.3 Assembly Process Flow

Considerations need to be taken during assembly to ensure a high PCB-level assembly yield. The suggested assembly process flow is as follows:

1. Solder paste printing
2. Optical inspection of the incoming package and reel
3. Component placement
4. Optical inspection of the package in pre-reflow state
5. Reflow soldering
6. Optical inspection of the package in post-reflow state

4 Reflow Soldering

In addition to this document, first refer to the general information in the latest version of the corresponding product datasheet.

4.1 Classification Reflow Profiles

The product fulfills the JEDEC and lead-free soldering requirements, i.e. reflow soldering (after MSL1 pre-treatment) with a peak temperature T_p up to 260 °C. For more detail, refer to Table 2, Table 5, and Figure 1 in IPC/JEDEC J-STD-020F "Joint Industry Standard: Moisture/Reflow Sensitivity Classification for Nonhermetic Surface Mount Devices".

4.2 Multiple Reflow Soldering Cycles

The product can withstand up to three reflow soldering cycles. This could be the situation where a PCB is mounted with devices from both sides, i.e., two reflow cycles are necessary, and in the next step an additional re-work cycles is required, i.e., one reflow cycle is necessary.

If five reflow soldering cycles are required, contact your local Bosch Sensortec representative for further support.

5 Mounting recommendations

Bosch Sensortec MEMS sensor devices are designed for precision, efficiency and mechanical robustness. To achieve the best possible results for the design, please consider the following recommendations when mounting the product on a PCB. The scenarios described below - given as example - may lead to a bending of the PCB, which, as a consequence, might influence the performance of the sensor mounted on the PCB.

Additionally, to evaluate and optimize the placement of the sensor on the PCB, it is recommended to use specialized tools during the design-in phase, e.g.:

- Use the infrared camera to evaluate the thermal stress.
- Perform the warpage measurement and Finite Element Method (FEM) simulation to evaluate the mechanical stress.

The scenarios described below – given as examples – may lead to undesirable stress, for example, through the bending of the underlying PCB or thermal expansion of the underfill material. Consequently, this might influence the performance of the sensor mounted on the PCB. For questions about mounting the sensor, or evaluating and optimizing the placement of the sensor on the target PCB, contact your Bosch Sensortec representative for further advice.

5.1 PCB thickness

It is generally recommended to minimize the PCB thickness (recommended: $\leq$ 0.8 mm) since a thin PCB shows less intrinsic stress while being bent.

5.2 Magnetic, Electric and Infrared (IR) Radiation Fields

Avoid mounting (and operation) of the sensor in the vicinity of the strong magnetic, electric, and infrared (IR) radiation fields.

5.3 Inline Calibration

5.3.1 General recommendation

If the mentioned recommendations in this chapter cannot be implemented, a specific in-line offset-calibration after placement of the device onto the target PCB can help to minimize potential stress effects.

5.3.2 Inline Calibration after Reflow Soldering

If the inline calibration is planned after the reflow soldering, it is recommended to wait until the relaxation of the stress effect on the PCB caused by the reflow soldering.

5.4 Electrostatic Charging

Avoid electrostatic charging of the sensor and device where the sensor is mounted.

5.5 Flexible PCB Substrates

Avoid mounting the sensor to flexible PCB substrates.

5.6 Shielding

Generally, shielding for electromagnetic thermal and mechanical protection is not necessary for BMA5xy's end application. However, if shielding is deemed necessary for the design, it is important to consider dimensions between the shielding, package, PCB, and surrounding components. Prevent collision on the WLCSP package since it can lead to component damage. Evaluate shielding dimensions statically when the end application is at rest and dynamically (for example, during a drop test).

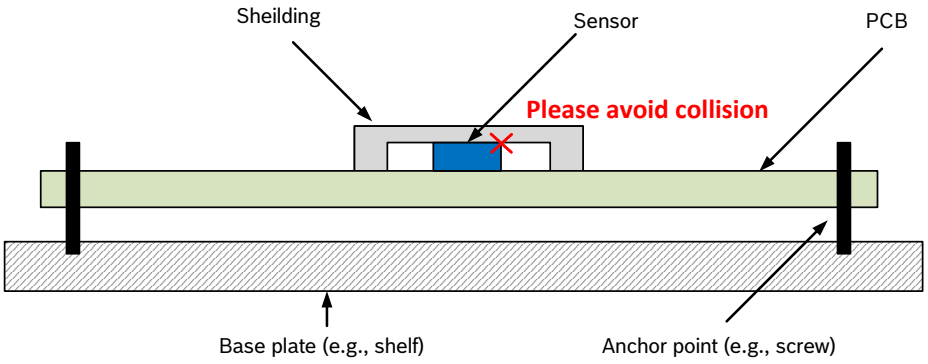

Figure 4: Push-button contacts

5.7 Placement of Surrounding Components

The placement of other surrounding components (e.g., multi-layer ceramic capacitors (MLCC) and inductors) in vicinity to the sensor on the target PCB needs to be carefully analyzed and optimized with the help of simulations (e.g., FEM) and tests (e.g., vibration analysis).

5.8 Push-Button Contacts

As shown in Figure 5, keep a reasonable distance from push-button contacts when placing the sensor device. The exact value for a "reasonable distance" depends on the individual design and, therefore, must be determined case by case. Do not position the sensor directly beneath a push-button contact.

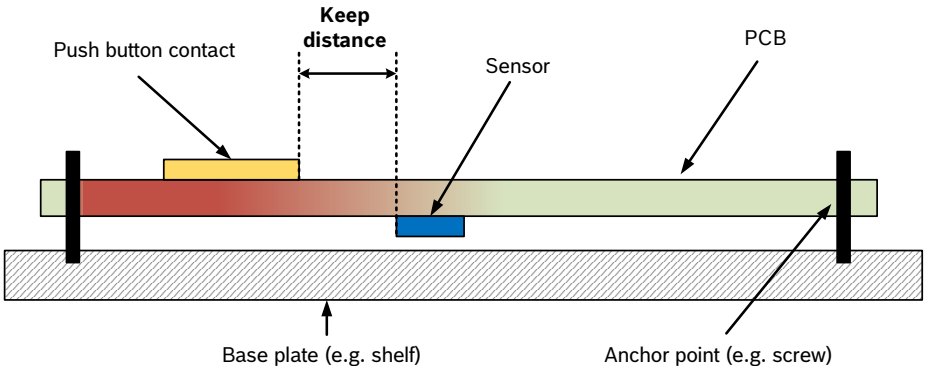

Figure 5: Push-button contacts

5.9 Distance to PCB Anchor Points

As shown in Figure 6, when placing the sensor device, please keep a reasonable distance from any anchor points, where the PCB is fixed at a base plate, e.g. a shelf. The exact value for a “reasonable distance” depends on many customer specific variables and must therefore be determined case by case.

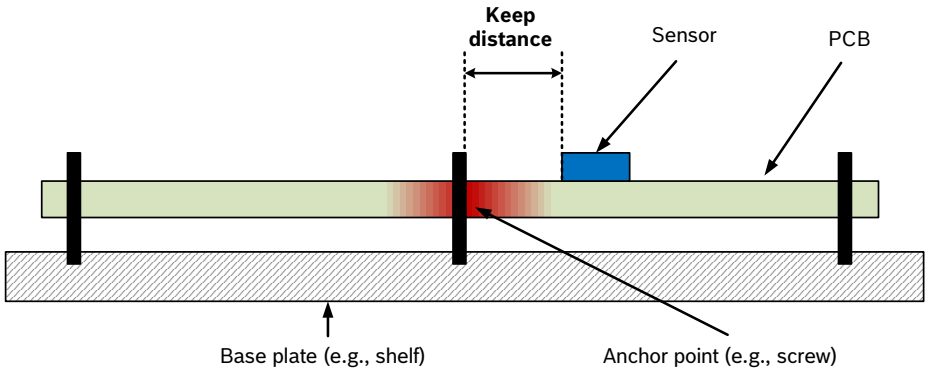

Figure 6: Distance to PCB anchor points

5.10 Thermal Hot-Spots on the PCB

As shown in Figure 7, when placing the sensor device, please keep a reasonable distance from any thermal hot spots, e.g., other integrated circuits with high power consumption, which can heat-up the sensor. The exact value for a “reasonable distance” depends on many customer-specific variables and, therefore, must be determined case by case.

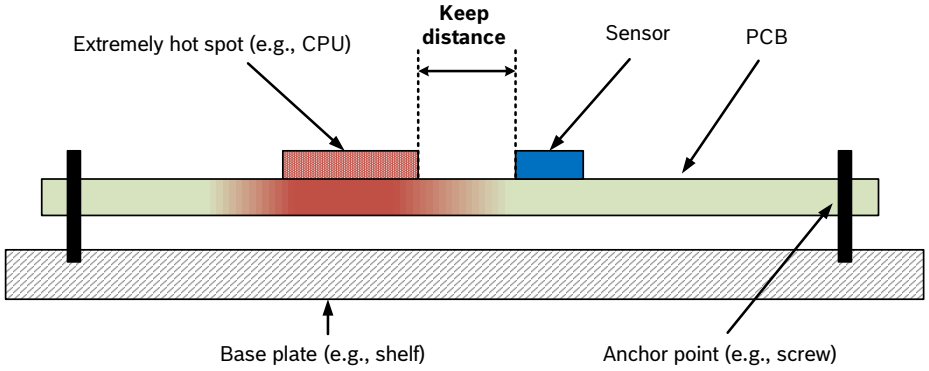

Figure 7: Thermal hot-spots on the PCB

5.11 Vibrating PCB

As shown in Figure 8, do not place the sensor next to components or in areas where resonant amplitudes (vibrations) of the PCB are likely to occur. External vibrations with high frequencies (> 20 kHz) can disturb the sensor output signals or permanently damage the sensor element.

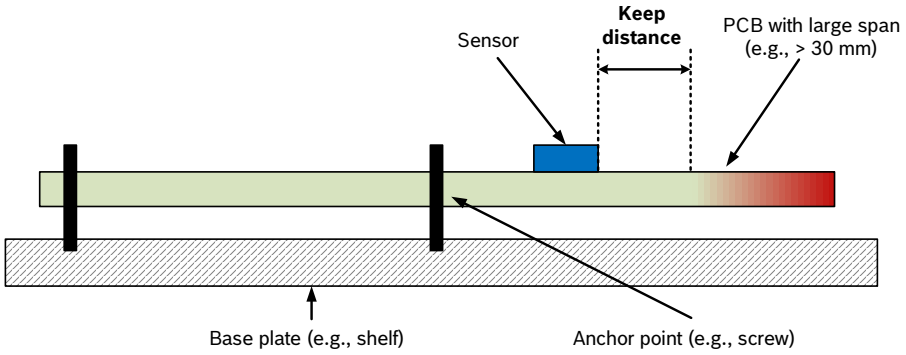

Figure 8: Vibrating PCB

5.12 Redundant PCB Anchor Points

It is recommended to unscrew or remove any redundant PCB anchor points. In theory, an ideal flat plane is exclusively determined by 3 anchor points. Any further anchor point over-determines the ideal flat plane criteria. If these redundant anchor points are in the out-of-plane position, which means they are not exactly in the in-plane position. Therefore, the ideal flat criteria is infringed, resulting in the mechanical stress. Figure 9 in below describes an expected stress maximum in the center of the diagonal crossover, assuming that the 4 anchor points are not 100% exactly in-plane, which over-determines the ideal flat plane criteria). Unscrewing or removing one of the redundant anchor points can reduce the mechanical stress in the sensor significantly.

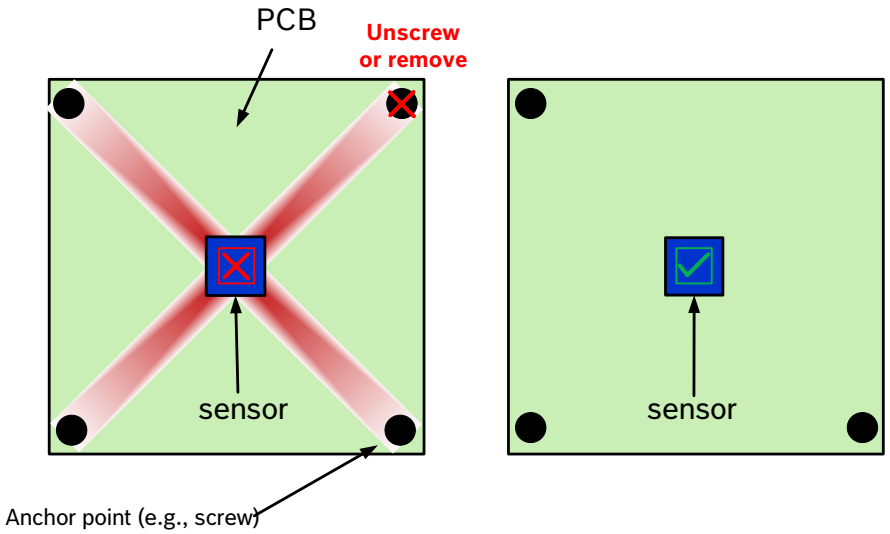

Figure 9: Redundant PCB anchor points

5.13 Mechanical Stress Maximum on the PCB

When placing the sensor device, it is recommended to keep a reasonable distance from any mechanical stress maximum. The mechanical stress can be induced for example by redundant anchor points, as described in section 5.12. The blow example in Figure 10 shows a stress maximum in the center of the diagonal crossover of the 4 anchor points. It is a good manufacturing practice 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. The best practice is to place the sensor on the PCB in locations where the stress value is less than 500 µstrain.

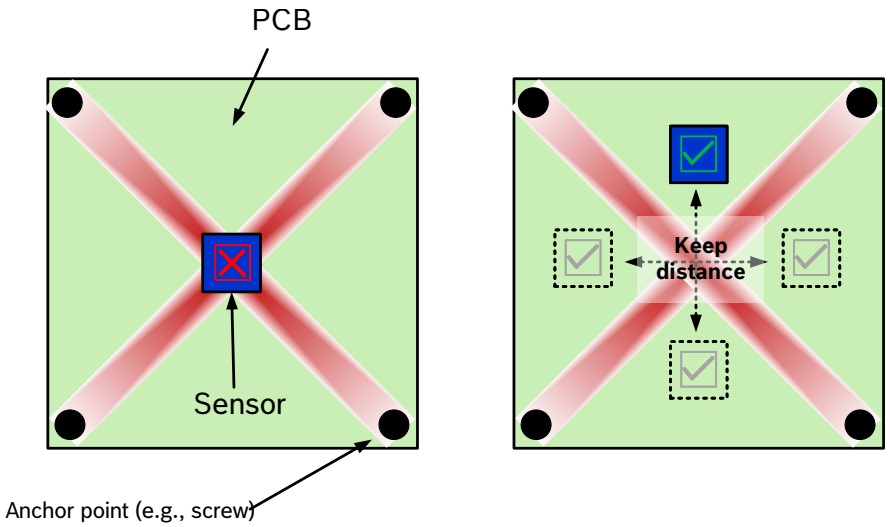

Figure 10: Mechanical Stress Maximum on the PCB

5.14 Encapsulation/Over-molding/Resin Coatings

As shown in Figure 11 and Figure 12, avoid the encapsulation/over-molding or even partial covering of the sensor with any protective materials such as the epoxy resin. This issue can lead to an asymmetric stress distribution over the sensor package.

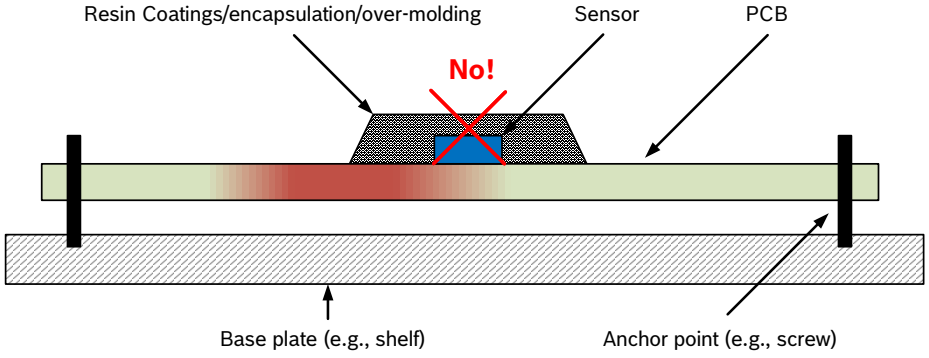

Figure 11: Encapsulation/over-molding/resin coatings fully covers the sensor

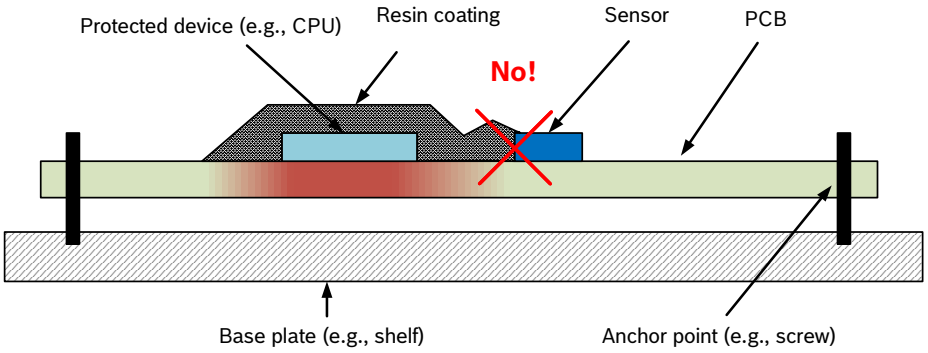

Figure 12: Resin coatings partially covers the sensor

5.15 Underfill

Underfill materials underneath the package are not allowed, as shown in Figure 13.

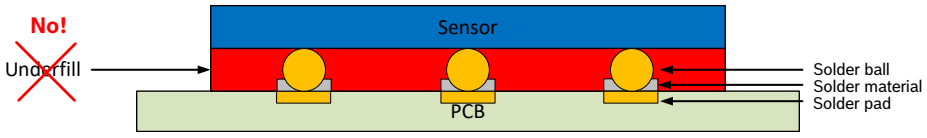

Figure 13: Underfill is not allowed

5.16 Landing Pad Pattern

PCB designers can choose from the following two types of land pad patterns:

- Non-solder mask defined (NSMD): The opening of the solder mask is larger than the metal pad on the PCB. Therefore, the metal pad size and shape determines the final landing dimensions.
- Solder mask defined (SMD): The solder mask opening is smaller than than the metal pad on the PCB. In this case, the solder mask opening determines the final landing dimensions.

Figure 14 illustrates the difference of these two landing pad patterns.

For the BMA5xy, it is recommended to use Non-solder Mask Defined (NSMD) pads. It improves the solder joint reliability and provides a wider space for signal trace routing, which are important factors due to the compact size of BMA5xy. However, it is highly recommended that the designer perform own experiment and reliability test to determine the most suitable landing pad pattern.

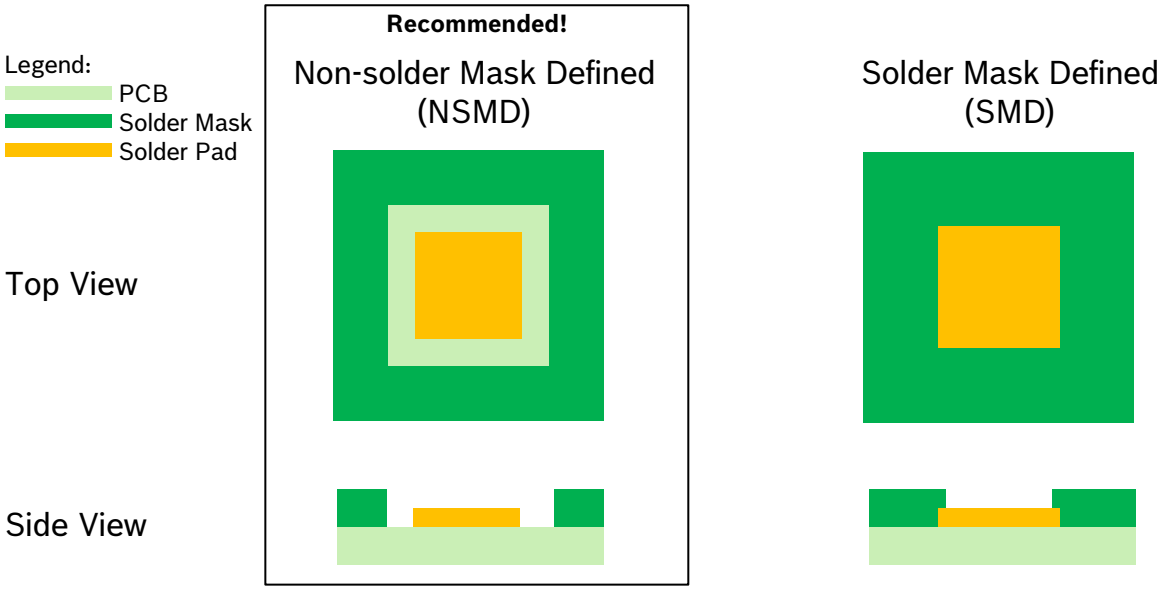

Figure 14: Non-solder Mask Defined (NSMD) and older Mask Defined (SMD) pads

6 RoHS Compliance/Halogen Content

Refer to the latest version of the corresponding product datasheet.

7 Customer Return

The BMA5xy can be returned to Bosch Sensortec for failure analysis (FA) purposes. Please follow the guidance in below to return customer samples.

7.1 Traceability Data Request

In case of customer return, provide the following traceability data if available:

- Bosch label on the product wheel. Figure 15 provides an example.
- Laser marking on the package. Figure 16 provides an example.

Figure 15: Example of Bosch label on the wheel

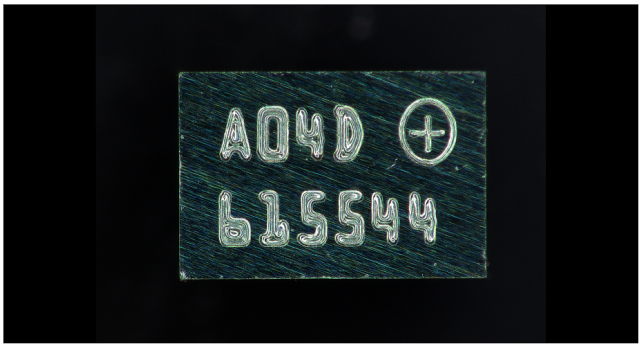

Figure 16: Example of laser marking on the package

7.2 Optical Inspection Request

The optical inspection of the customer return samples, which are still in a soldered state on the original PCB of the end application, is necessary. Provide images of four sides, top side with laser marking and from additional angles to include any physical damages on the package such as scratches, chipping and cracks. See the examples in Figure 17.

Figure 17: Example of optical inspection of customer return sample

7.3 Customer Return with PCB

It is preferred that the whole PCB with assembled sensor will be provided. If this is not possible, check the option to carefully cut a larger area around the part while avoiding the warpage of the assembly. For the shipment of sensor embedded on PCBs, use packaging materials that protect against the electrostatic discharge (ESD) and mechanical damage. It is recommended to place the part in an ESD bag, place the bag in foam/bubble material and ship it in a stable package. An example is shown in Figure 18. These procedures are required to ensure that the failure analysis (FA) can be conducted at Bosch Sensortec successfully.

Figure 18: Example of ESD bag for customer return

7.4 Desoldered Customer Return

the recommendations above for reusing the PCB are not possible, desolder the sensor following the recommendations in Chapter 8. Please use this method only if it is absolute necessary, and please avoid the additional manual handling. Choose one the following shipment methods to return the desoldered BMA5xy.

7.4.1 Shipment in Gel-Pak® box

It is recommended to carefully place the desoldered BMA5xy in a Gel-Pak® box with solder the balls facing upwards, as shown in Figure 19. This can help to avoid the additional mechanical stress on the solder balls inside the Gel-Pak®. Then, wrap the Gel-Pak® in foam materials and ship it in a stable package.

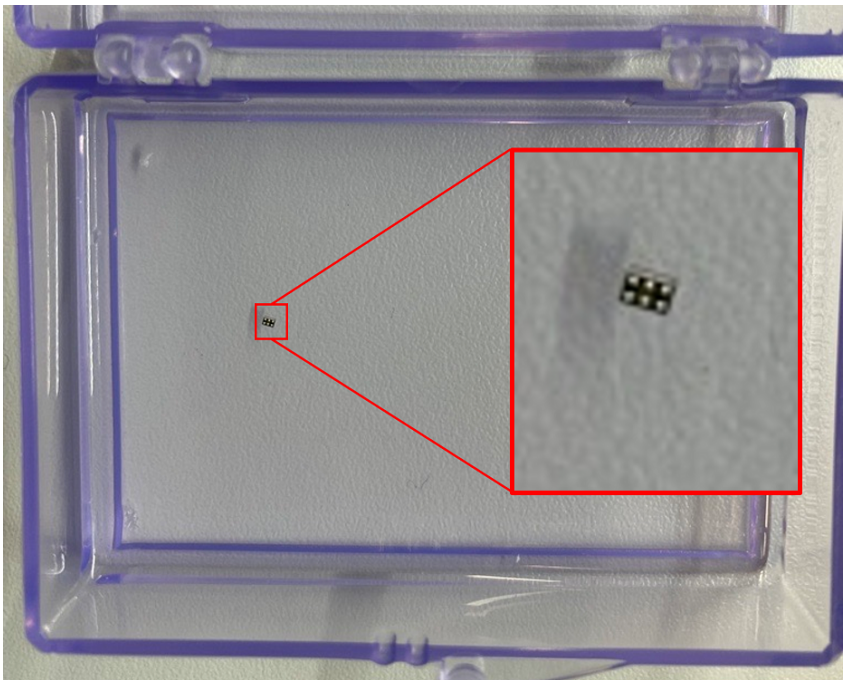

Figure 19: Customer return sample placed in Gel-Pak®

7.4.2 Shipment in ESD bag and foam material

Please place the part carefully in an ESD bag and seal the ESD bag. The ESD bag must be packed then in foam/bubble material and a stable package. An example is shown in 18.

7.4.3 Additional notes

In addition, contact with your local Bosch Sensortec representative for further information, support and delivery of the desoldered parts.

Note: If any underfill/encapsulation/over-molding was used (not recommended, see Chapter 5) and the part needs to be returned to Bosch Sensortec for FA, provide details on the type of materials used for the underfill/encapsulation/over-molding (silicone based etc.) to facilitate the chemical removal at Bosch Sensortec for FA. Also, in this situation, the FA might take longer time and the reliability of the FA results can not be guaranteed.

8 Desoldering Recommendations

To desolder the BMA5xy, the heat must be applied to melt the solder balls so that the component can be lifted from the board. A guiding principle to desolder the BMA5xy is to duplicate the original re-flow profile recommended in the HSMI. For reference, a maximum reflow temperature of 340 °C is applied to the part during this procedure.

It is recommended to use a system that has the thermal profile capability with localized convection heating, bottom side heating and a pick-and-place device. In addition, it is recommended to use a microscope or magnifier.

For manual desoldering, it is recommended to use a large-area bottom-side PCB heater in combination with the hot air heater (e.g., a hand-held one) applied to the top of the component. Please see Figure 20 as an example. Here are the detailed suggestions:

1. Using the bottom-side PCB heater:
   a. Raise the temperature on the PCB slowly (within 1-2 minutes) towards 300 °C.
   b. Once the temperature has been reached, proceed to apply the hot air.
2. Using the hot air heater, where the size of the nozzle should be selected to match the component footprint.
   a. Set the hot air to 340 °C and 10% airflow to avoid blowing away the desoldered sensor.
   b. Heat the sensor for max. 1 minute from a 1-2 cm distance.
   c. After heating has melted the solder, lift the component from the board. Do not push the component to the side while lifting it up to avoid creating connections between the solder balls. Also, carefully place the sensor with the pins facing upwards to avoid smudging the solder joints.

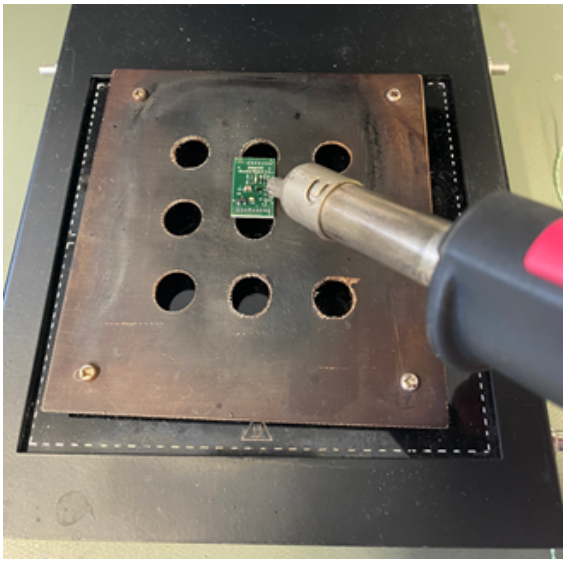

Figure 20: Setup for manual de-soldering

To produce the least damage during the desoldering process, use vacuum tweezers as the best practice recommendation. An example of the vacuum tweezer is shown in Figure 21. If using vacuum tweezers is not possible, plastic tweezers are also allowed, e.g., in Figure 22. However, they have a higher possibility to damage the product package.

Figure 21: Example of a vacuum tweezer

Figure 22: Example of a plastic tweezer

9 Package outline

Refer to the latest version of the corresponding product datasheet.

10 Landing pattern

Refer to the latest version of the corresponding product datasheet.

11 Device marking

Refer to the latest version of the corresponding product datasheet.

12 Tape on reel

Refer to the latest version of the corresponding product datasheet.

13 Document History and Modifications

Table 1: Change log

Rev No	Chapter	Description of modification/changes	Date
1.0	all	Initial Release	August 22nd 2023
1.1	3, 7, 8	Provide additional handling instructions	June 2024

Bosch Sensortec GmbH
Gerhard-Kindler-Strasse 9
72770 Reutlingen / Germany

contact@bosch-sensortec.com
www.bosch-sensortec.com

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