



## **APPLICATION NOTE**

Guidelines for positioning and fixation of Melexis Hall sensors in PCB-less assembly

Revision 1.0 – January 2022

Advanced Customer Solutions

# Guidelines for positioning and fixation in PCB-less assembly

## 1. Scope

## 2. XY (lateral) positioning options

2.1 Leadframe features to housing (DMP/SMP)

2.2 Mold body outline to housing (SIP)

## 3. Z (vertical) fixation

3.1 Hot riveting (DMP/SMP/SIP)

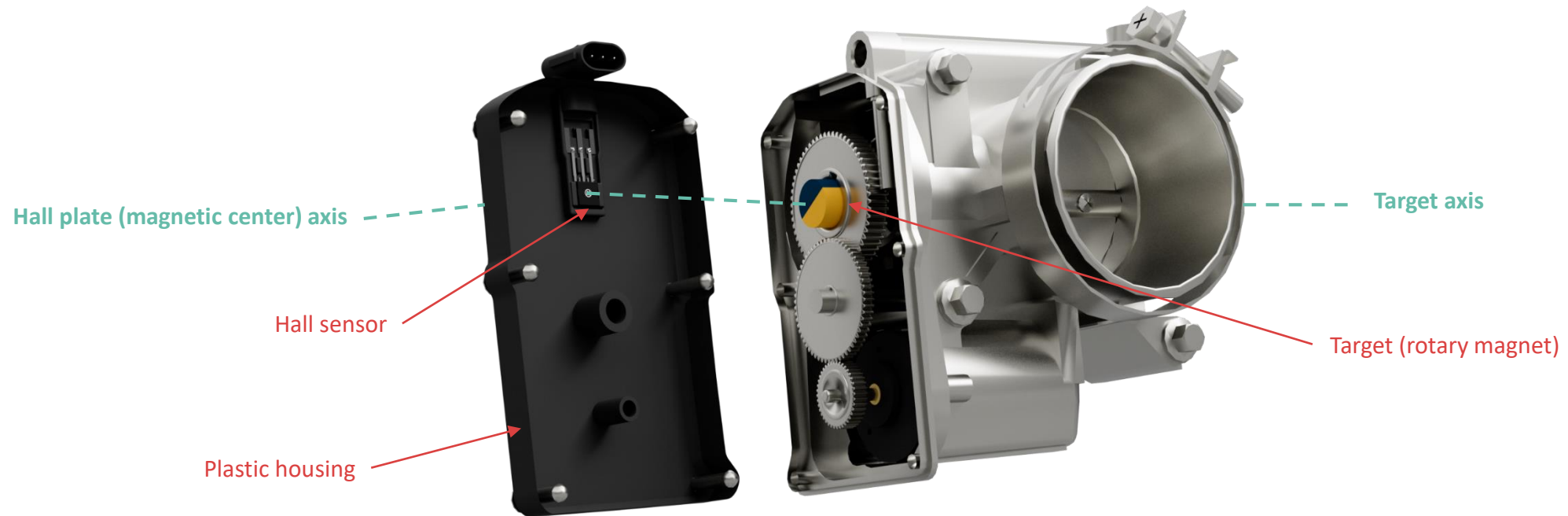
3.2 Gluing with UV pre-flash (DMP/SMP/SIP)

3.3 Sliding ears into plastic slots (DMP/SMP)

# 1. Scope

## Positioning and fixation for PCB-less assembly

Positioning and fixation is a step in the PCB-less assembly of ICs (Integrated Circuits) into a plastic housing or plastic carrier. This is especially important for magnetic sensors where a target (a magnet) has to be aligned with the Hall plate (magnetic center) within the IC.

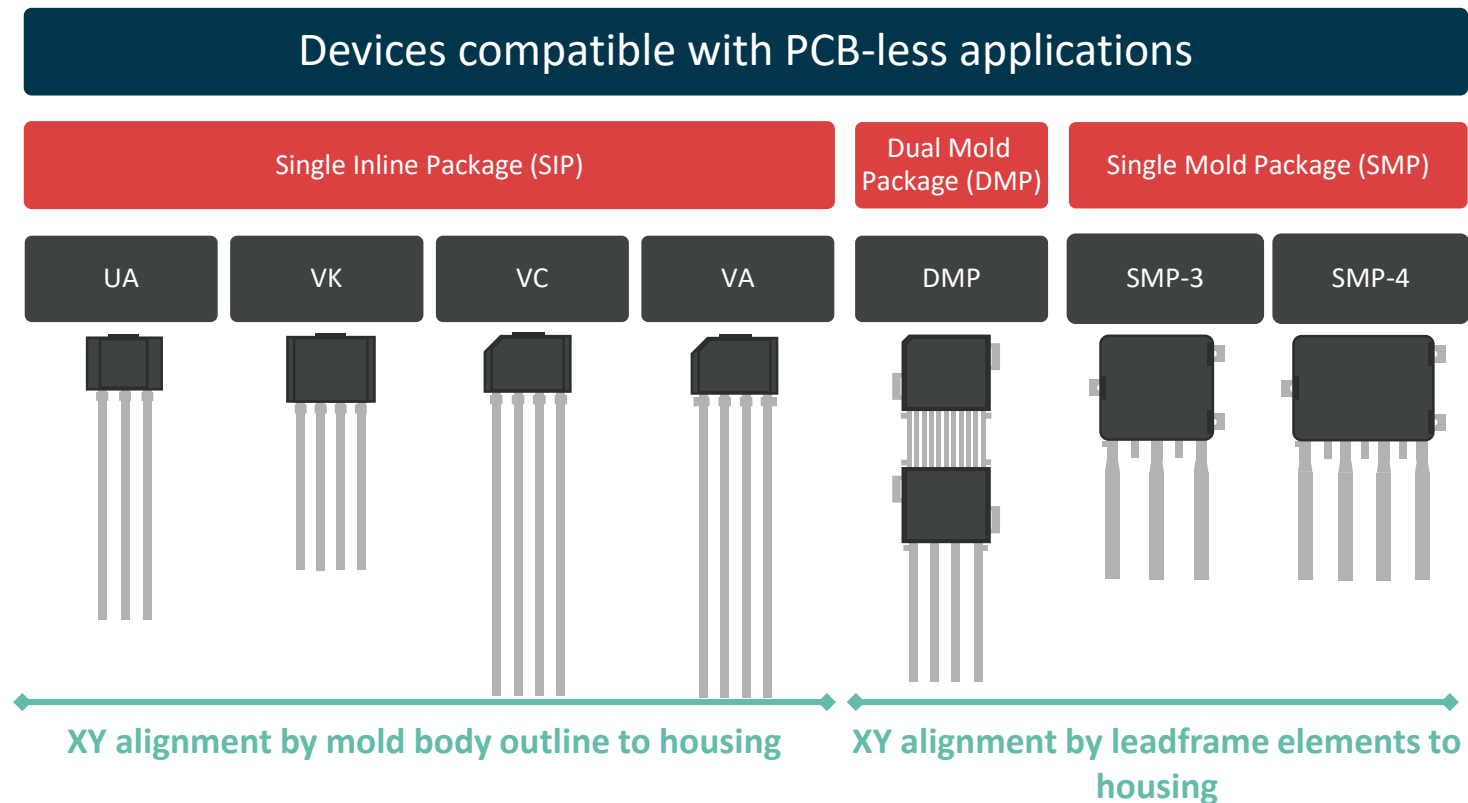


**Example of a Hall sensor in a plastic cover of an ETC (Electronic Throttle Body) assembly**  
Hall plate axis and target axis must be aligned to optimize the magnetic measurement error

# 1. Scope

## Melexis sensor packages for PCB-less applications

There are two main methodologies for XY positioning on a plastic housing, depending on the package type: using the mold body outline or using leadframe elements.

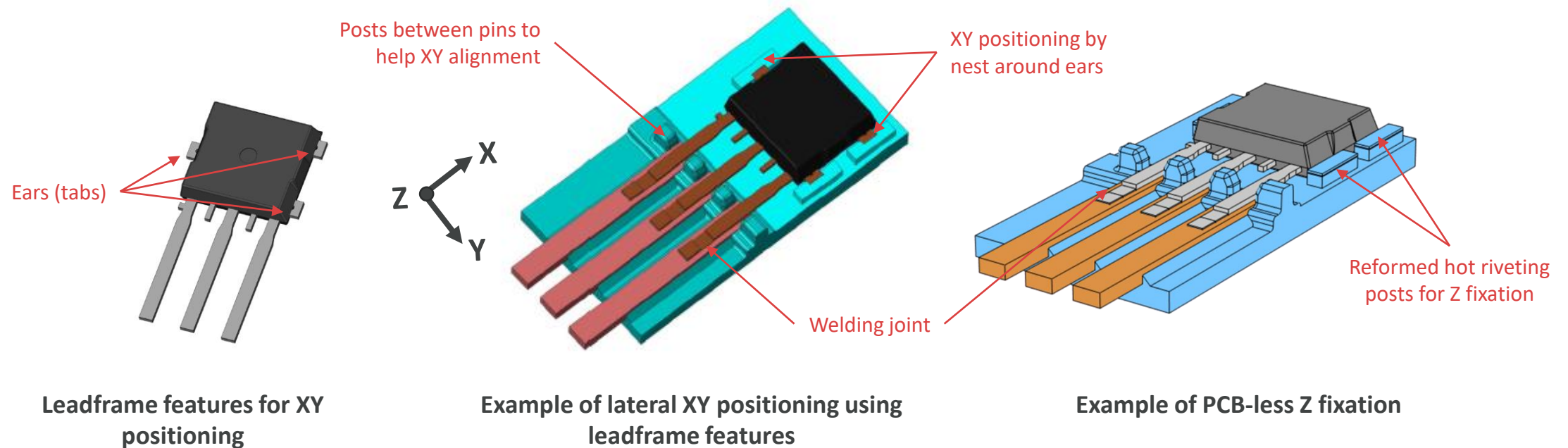


# 1. Scope

## XY positioning by leadframe features to housing

Packages like DMP and SMP are designed with exposed package leadframe features, called “ears” or “tabs” as a physical reference. Using ears (tabs) for lateral XY positioning improves positioning accuracy, since the silicon die is centered to the leadframe.

The role of vertical Z fixation is to keep the part in position during further assembly steps (welding) and application related vibration and mechanical stress.

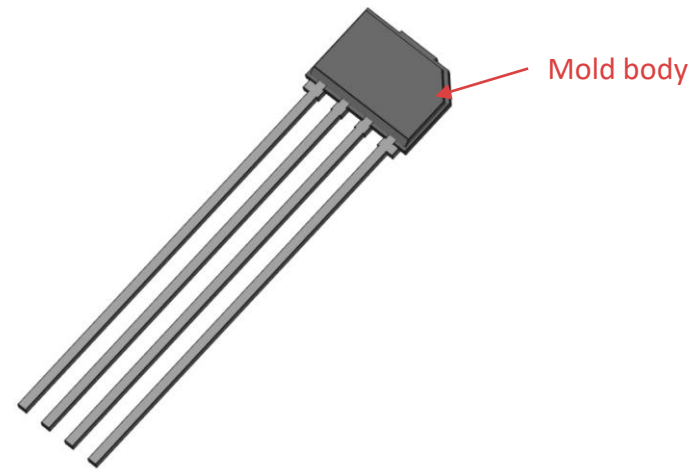


# 1. Scope

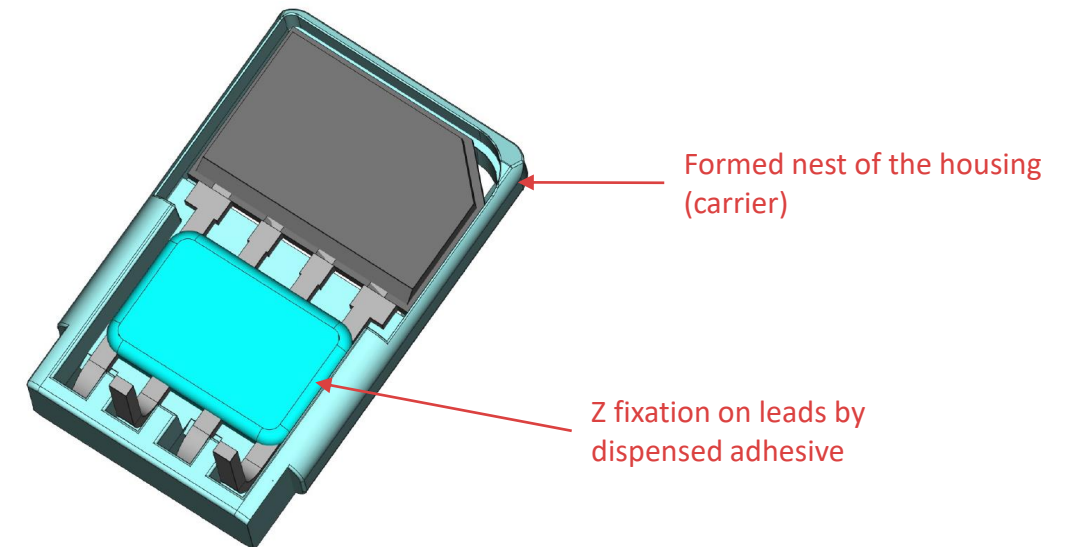
## XY positioning by mold body outline to housing

For Hall sensors in SIP package, lateral XY positioning can be done using the mold body outline of the IC, placed in a formed nest of the housing (carrier).

The role of vertical Z fixation is to keep the part in position during further assembly steps (welding) and application related vibration and mechanical stress.



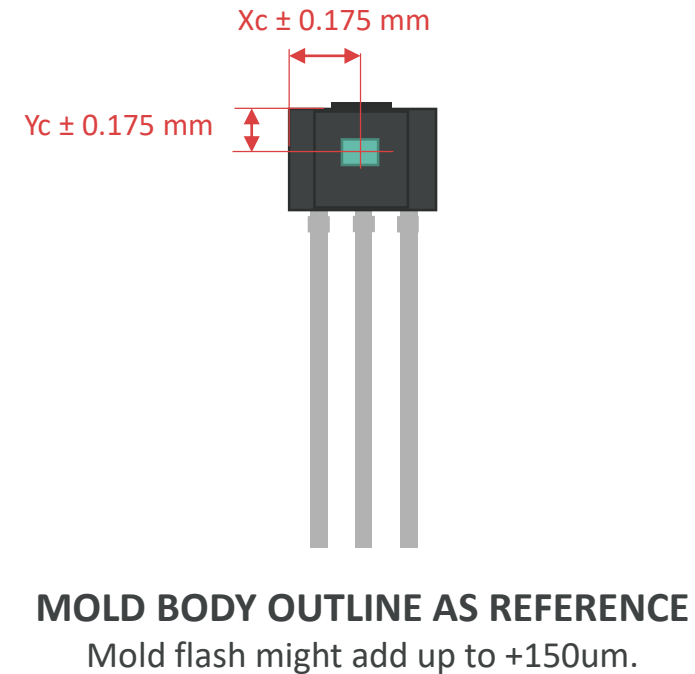
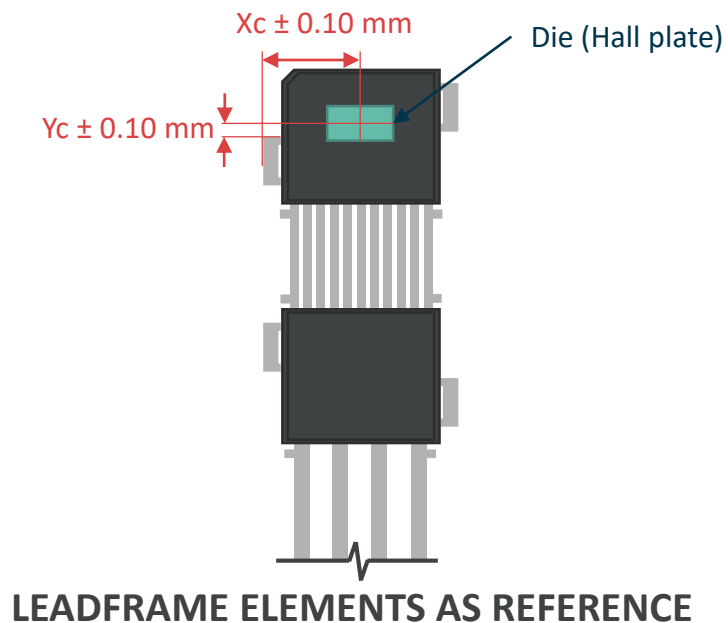
VA package



Example of lateral XY positioning using mold body outline

# 1. Scope

## Hall plate position tolerance inside PCB-less packages

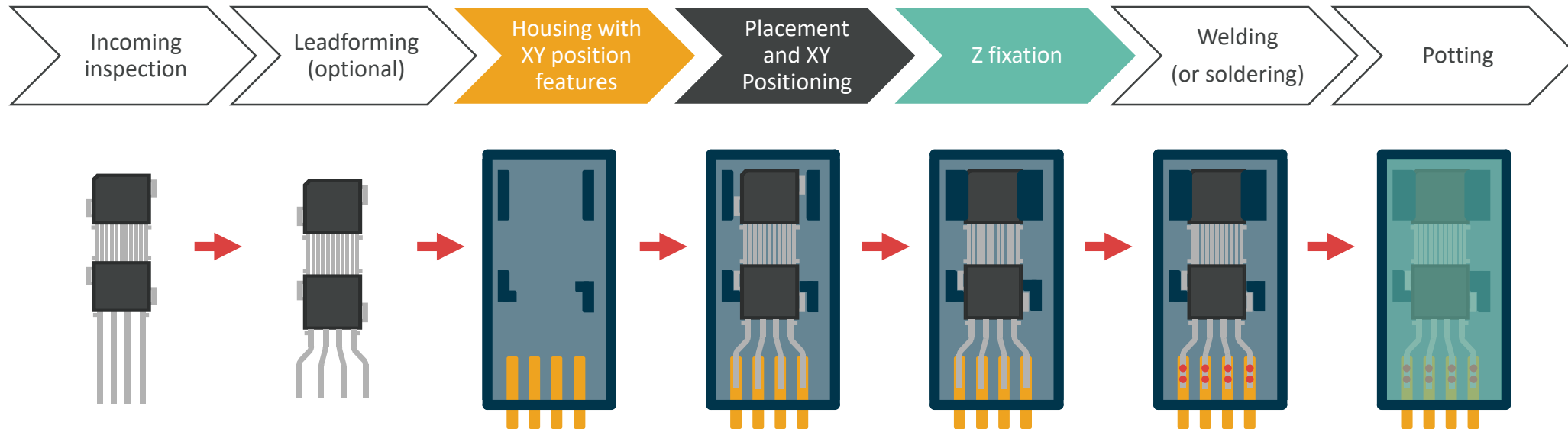


The tolerances are smaller when using the leadframe (ears) as a reference instead of the mold body as a reference. Ears are also easier to align/position to plastic housing stoppers

***Refer to the product datasheet for the actual  $X_c$  and  $Y_c$  dimensions.***

# 1. Scope

## Example of PCB-less assembly flow



Storage and handling of Melexis devices at customer side should follow guidelines in J-STD-033 *Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices*. Key parameters are printed on the label attached to the product packing. Refer to *Guidelines for storage and handling of plastic encapsulated ICs* on Melexis website for details.

If the part requires leadforming by customer, refer to *Guidelines for lead forming of Hall sensors in SIP package*

Welding and potting are covered in different Application Notes, refer to *Guidelines for welding of PCB-less devices* and *Guidelines for potting of plastic encapsulated ICs*



# Guidelines for positioning and fixation in PCB-less assembly

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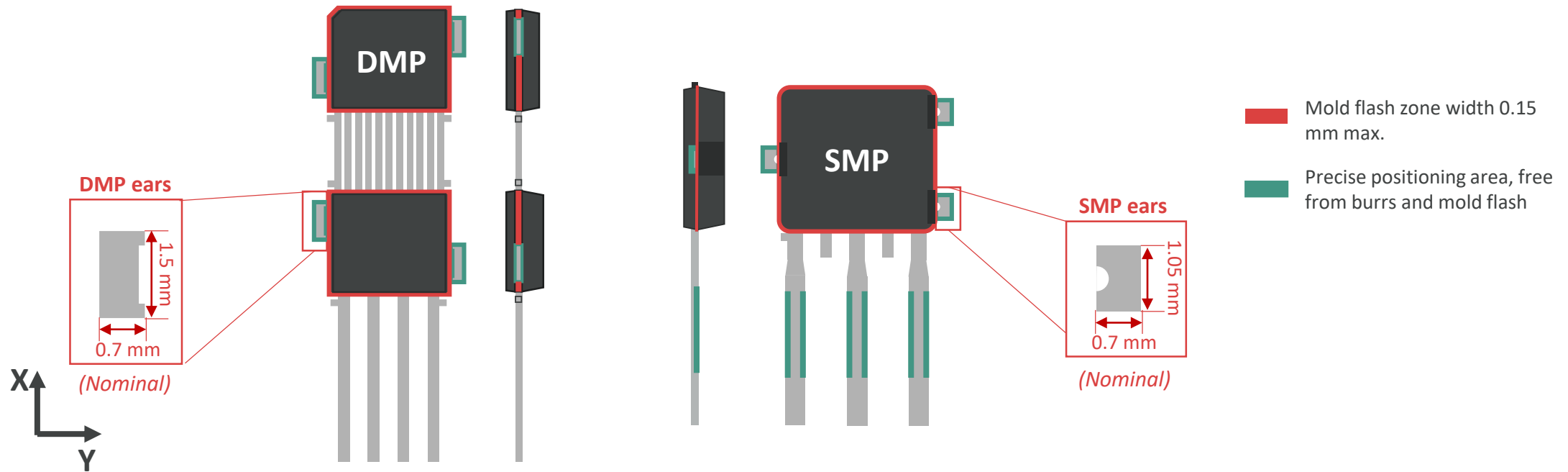
### 3.1 Hot riveting (DMP/SMP/SIP)

### 3.2 Gluing with UV pre-flash (DMP/SMP/SIP)

### 3.3 Sliding ears into plastic slots (DMP/SMP)

## 2.1 Leadframe features to housing (DMP/SMP)

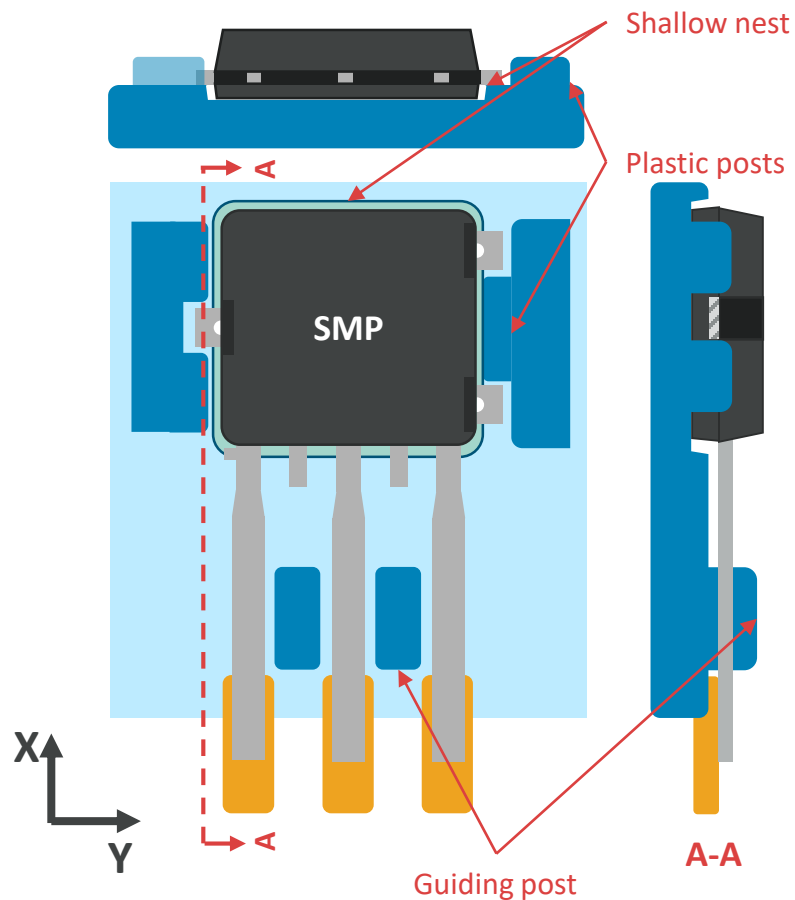
Leadframe positioning features for accurate XY positioning



Mold flash and mold gate burr are inherent results of the molding process. They are mostly removed during mechanical de-flash process, but a minor leftover might still exist because of the clearance between the de-flash punch and the mold package.

## 2.1 Leadframe features to housing (DMP/SMP)

### XY (lateral) positioning by ears



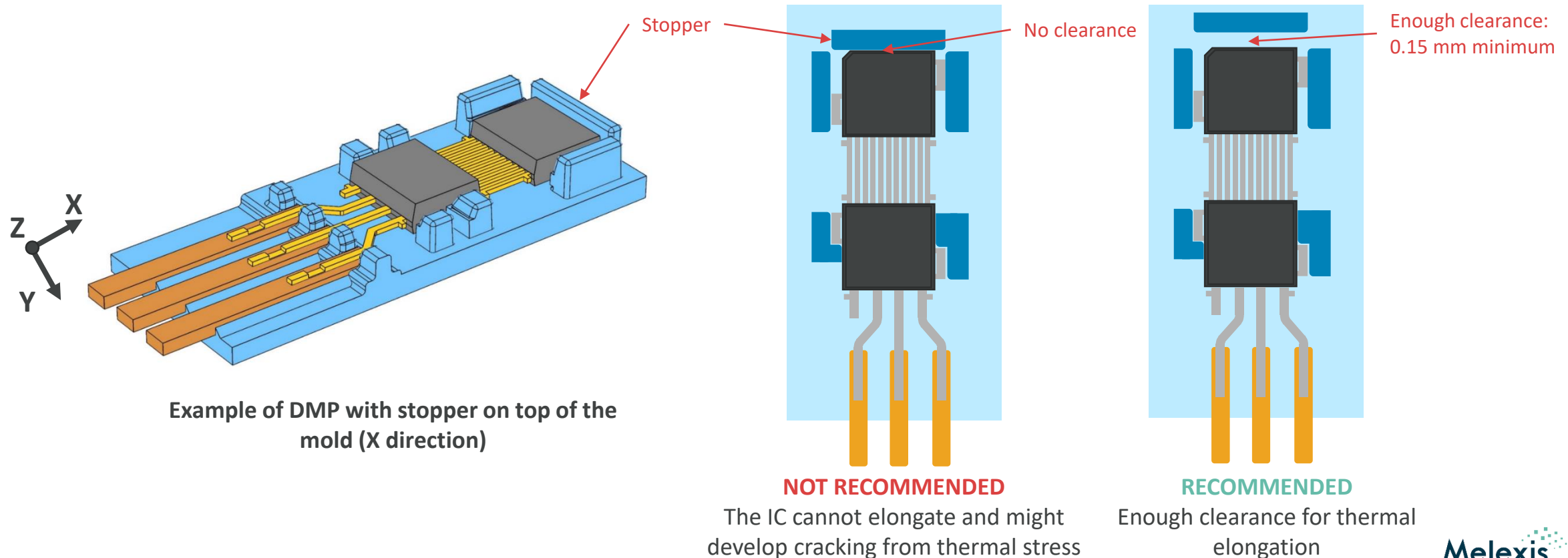
XY positioning can be achieved with plastic posts around the ears. It is also recommended to add guiding posts between the pins to help with the alignment to the plastic housing leadframe.

A shallow nest with a thickness less than bottom mold thickness (to avoid conflict with the mold flash on the parting line) can be present for self-alignment on the package draft angle.

## 2.1 Leadframe features to housing (DMP/SMP)

### Thermal elongation during thermal excursions

Stoppers on top of the mold (in X direction) are not recommended. If the design includes one, enough clearance needs to be foreseen for thermal elongation of the part at the temperature range of the application.



# Guidelines for positioning and fixation in PCB-less assembly

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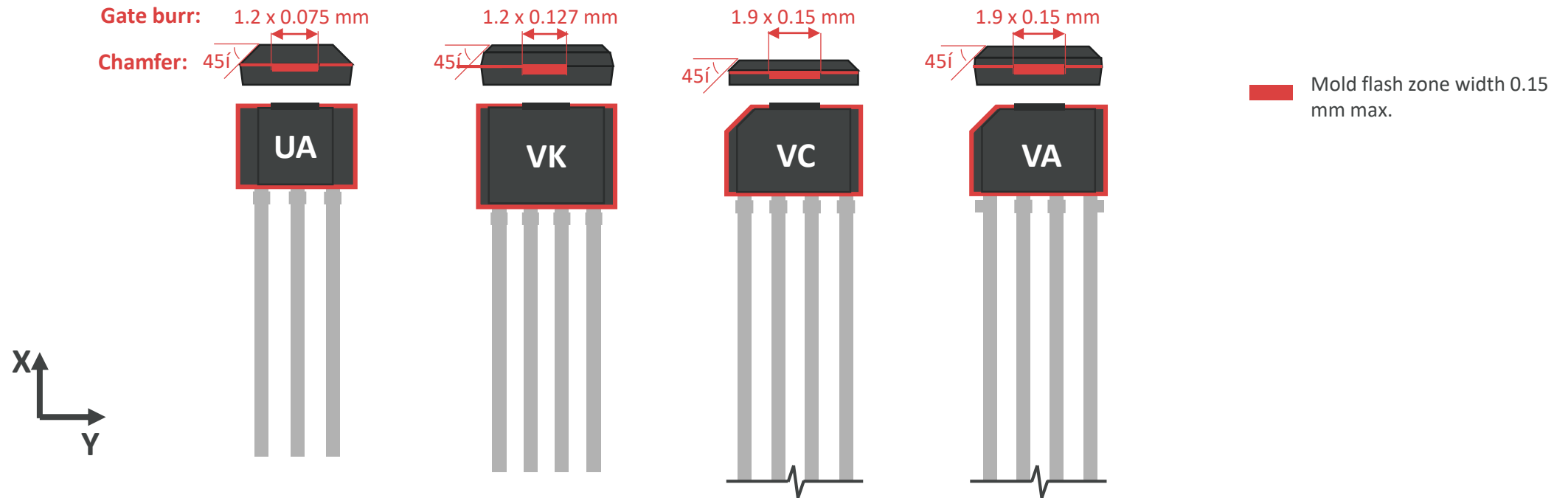
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## 2.2 Mold body outline to housing (SIP)

### Mold positioning features for rough XY positioning



The 45° chamfer is a designed feature for self-alignment with the plastic housing after placement face down.

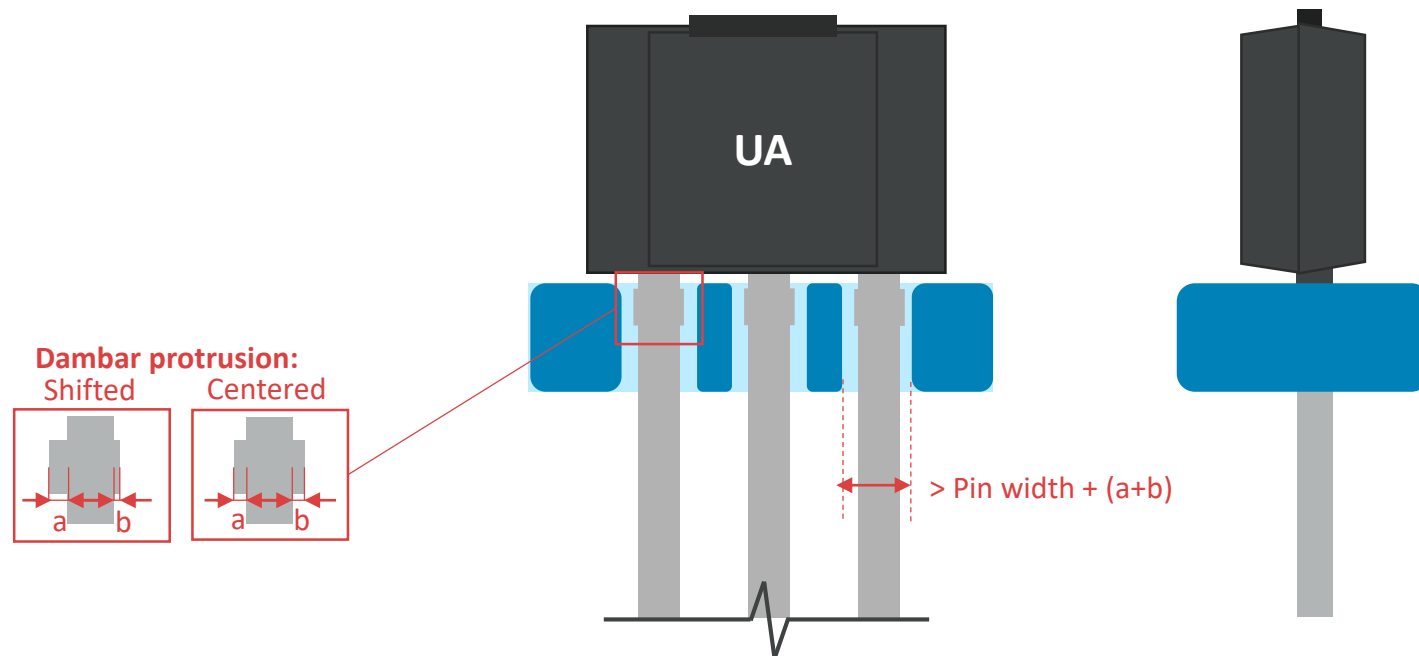
Mold flash and mold gate burr are inherent results of the molding process. They are mostly removed during mechanical de-flash process, but a minor leftover might still exist because of the clearance between the de-flash punch and the mold package.

## 2.2 Mold body outline to housing (SIP)

### Clearances to dambar protrusion

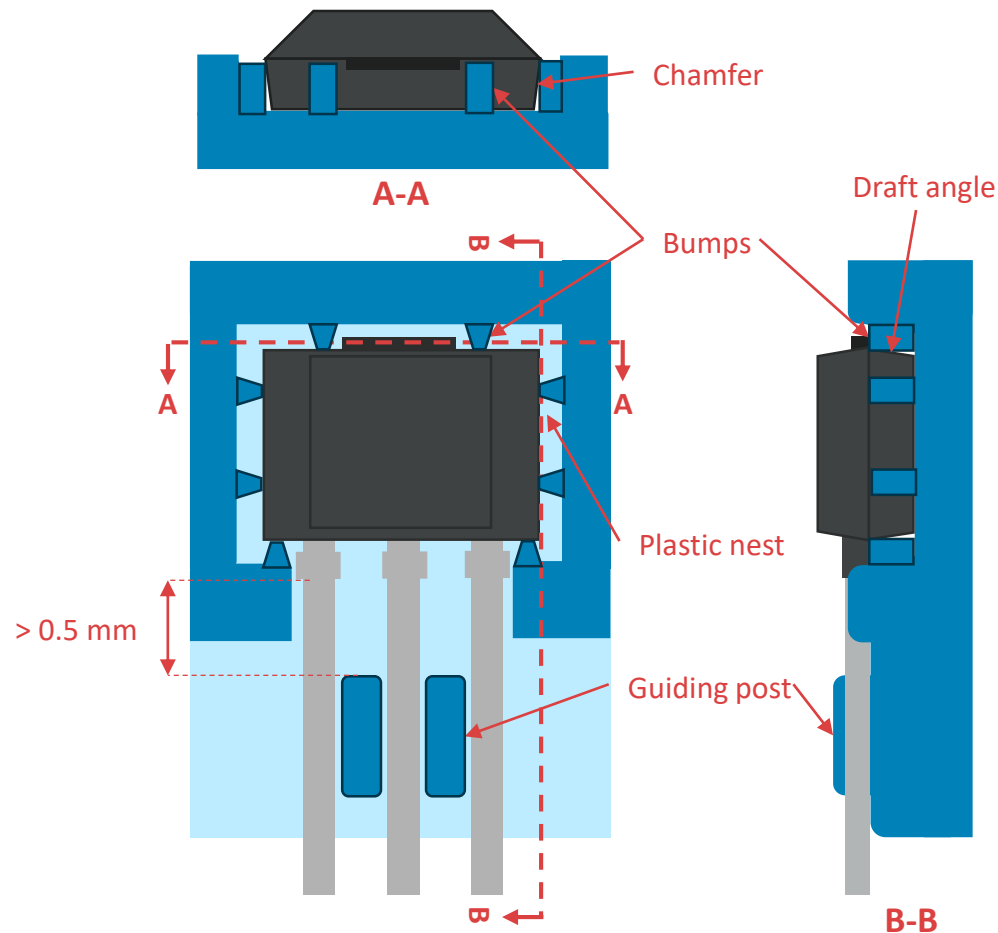
The dambar protrusion is a remnant from tie bar cutting: it can be centered on the pin or shifted to one side, but total maximum dimension (a+b) is the same in both cases. Refer to the POD (package outline drawing) in the datasheet for the dimensions.

If openings or channels are designed in the housing for the pins, they should incorporate the dambar protrusion maximum size (a+b).



## 2.2 Mold body outline to housing (SIP)

### XY positioning by plastic nest with bumps

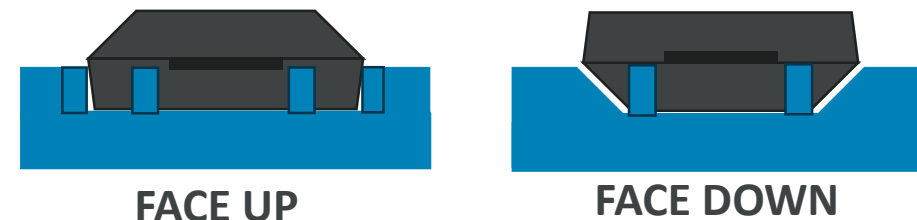


A shallow nest with a thickness less than bottom mold thickness (to avoid conflict with the mold flash on the parting line) can be present for self-alignment on the package draft angle.

Bumps can be added pressing on the draft angles of the mold body to hold the IC by friction (destroying the tip). This helps achieve temporary Z fixation prior to welding. However, it might be not strong enough to survive under vibration and hence potting is highly recommended for permanent Z fixation.

Guiding posts between the pins can be added for Y positioning but they should not conflict with the dambar protrusion – **a clearance of 0.5 mm is recommended**

Both face-up and face-down configurations are possible:





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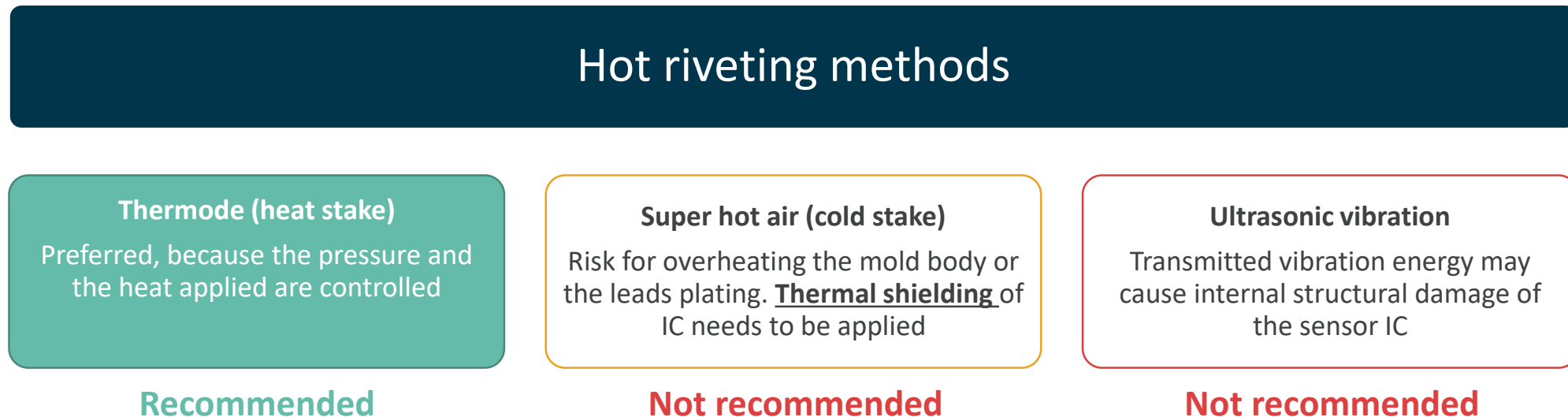
3.2 Gluing with UV pre-flash (DMP/SMP/SIP)

3.3 Sliding ears into plastic slots (DMP/SMP)

## 3.1 Hot riveting (DMP/SMP/SIP)

### Hot riveting

Z fixation can be done using hot riveting on plastic posts. Preferred method is to use a thermode (hot bar): for heat staking the thermode applies both heat and pressure. Alternative “super hot air/cold bar” and “Ultrasonic staking” riveting methods are not recommended – see below.

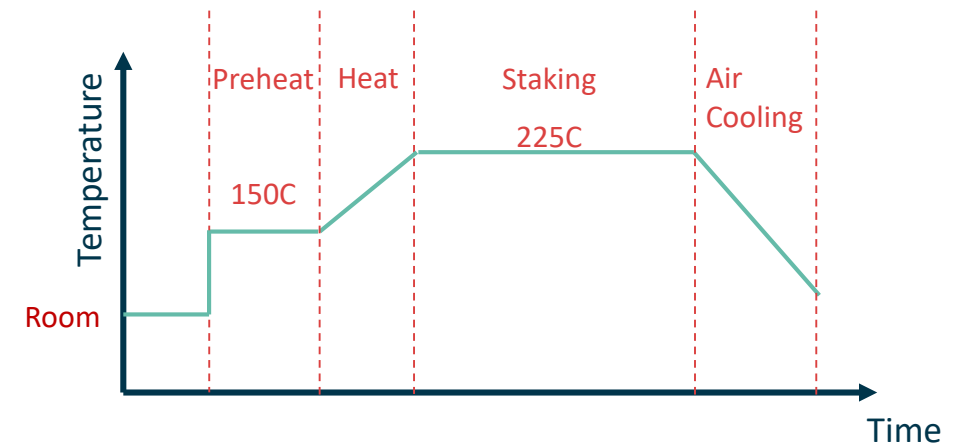
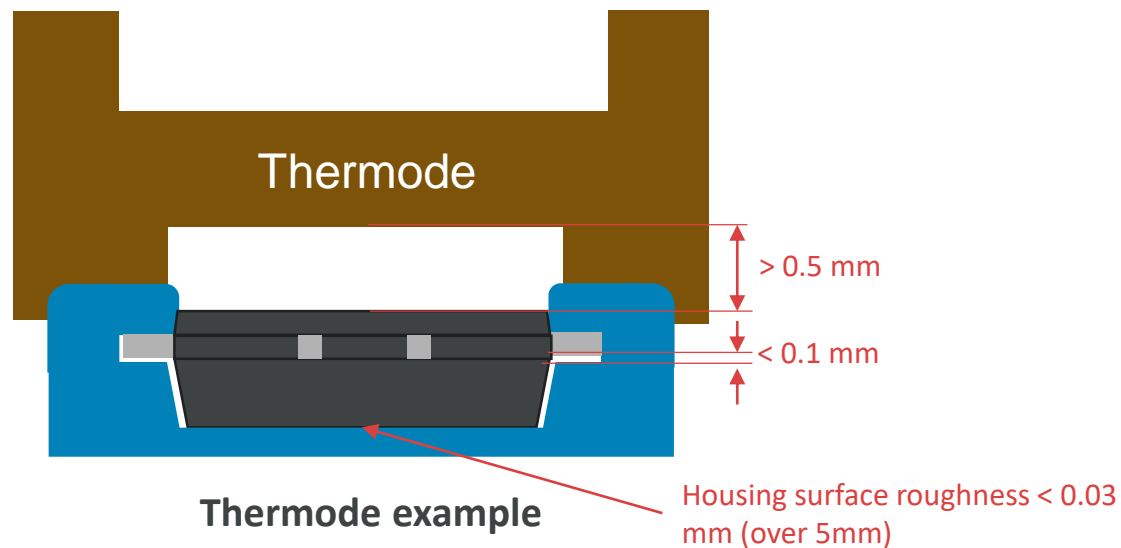


## 3.1 Hot riveting (DMP/SMP/SIP)

### Restrictions for heat staking

To avoid IC mold overheating, no direct contact between the thermode and the IC ears or mold body is allowed, and a gap of at least 0.5 mm has to be kept between the thermode hot surface and the mold body. The thermode shall always stake plastic posts on both sides of the mold body at the same time to prevent lateral misplacement of the IC. The thermode should be clean and polished to avoid sticking of the reformed plastic post to the thermode during the cold down phase.

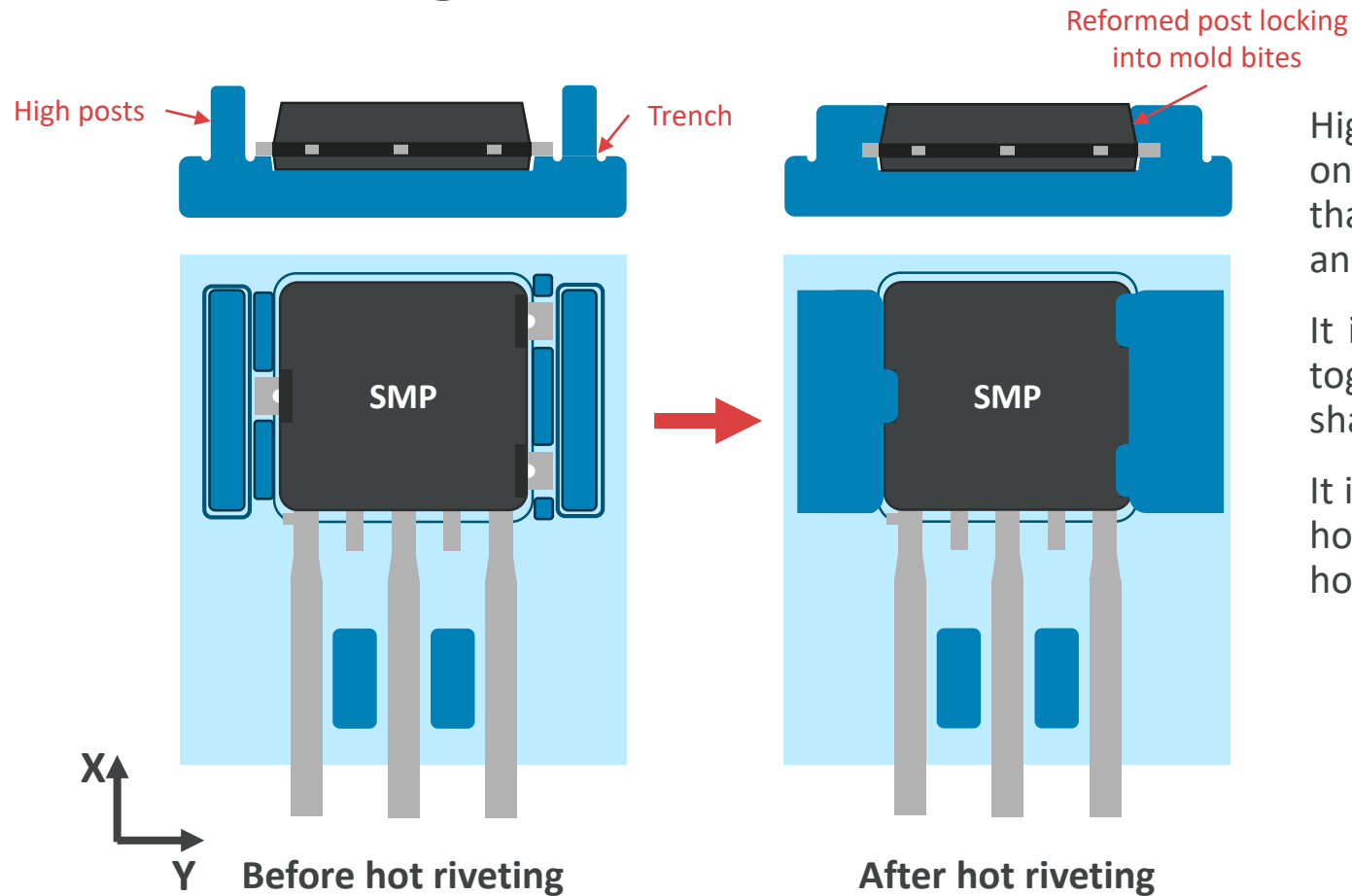
Under hot riveting pressure, it is allowed to have the ears bent down a maximum of 20deg. Therefore it is recommended to secure a clearance of maximum 0.1 under the ears. The mold body of the IC shall be placed on a flat plastic surface with maximum roughness of 0.03mm over 5mm distance.



**Thermode Position**  
(Example for PBT GF30, total Duration 6-8 sec.)

## 3.1 Hot riveting (DMP/SMP/SIP)

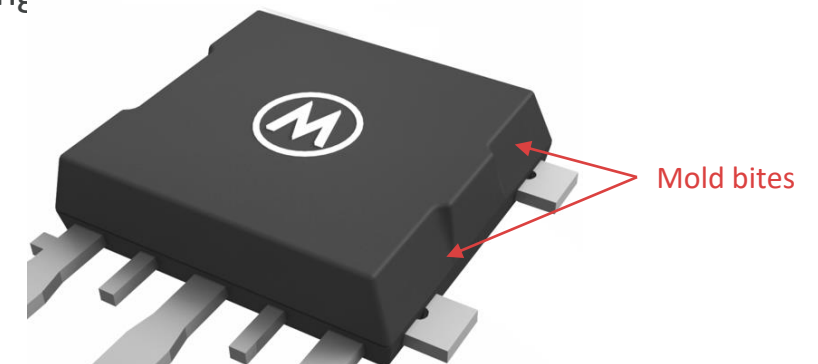
### Hot riveting on ears



High posts can be used for Z-fixation by hot riveting on each ear. Post height should be dimensioned so that after hot riveting the plastic fully covers the ear and locks into the mold bite above ear.

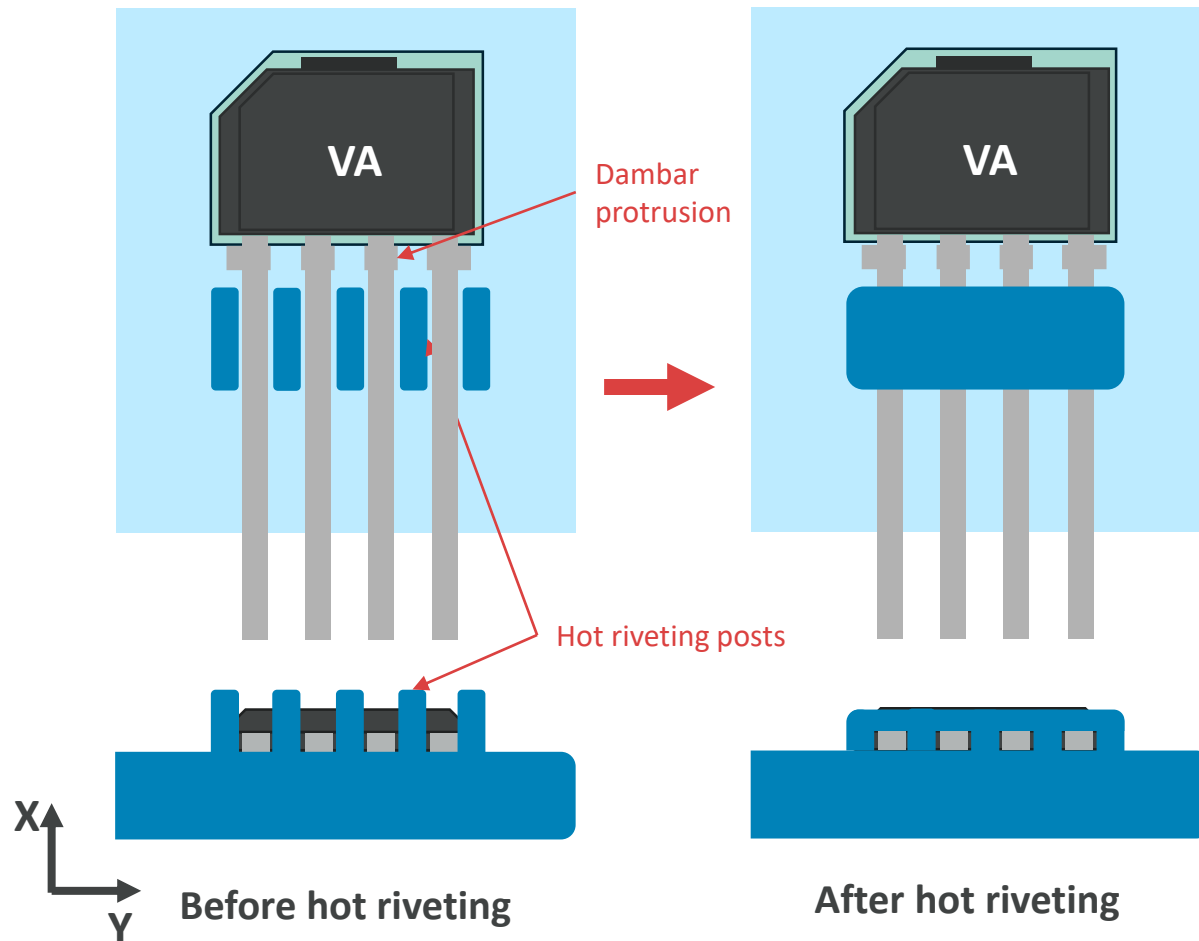
It is recommended to reform the two plastic posts together at the same time with one hot bar tool, shaped accordingly.

It is recommended to add a narrow trench around the hot riveting post to avoid the plastic cracking during hot riveting.



## 3.1 Hot riveting (DMP/SMP/SIP)

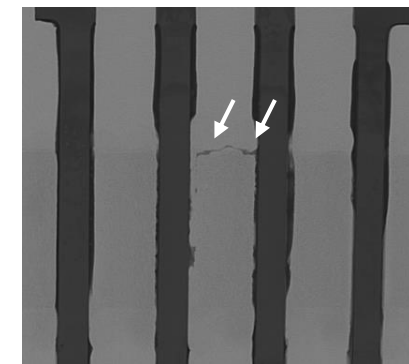
### Hot riveting on leads



Hot riveting on the leads can be done close to the body and below the dambar protrusion.

The housing surface should be flat and without clearance under the pins in order to avoid pin bending during hot riveting, which might create a residual stress in the mold-lead interface.

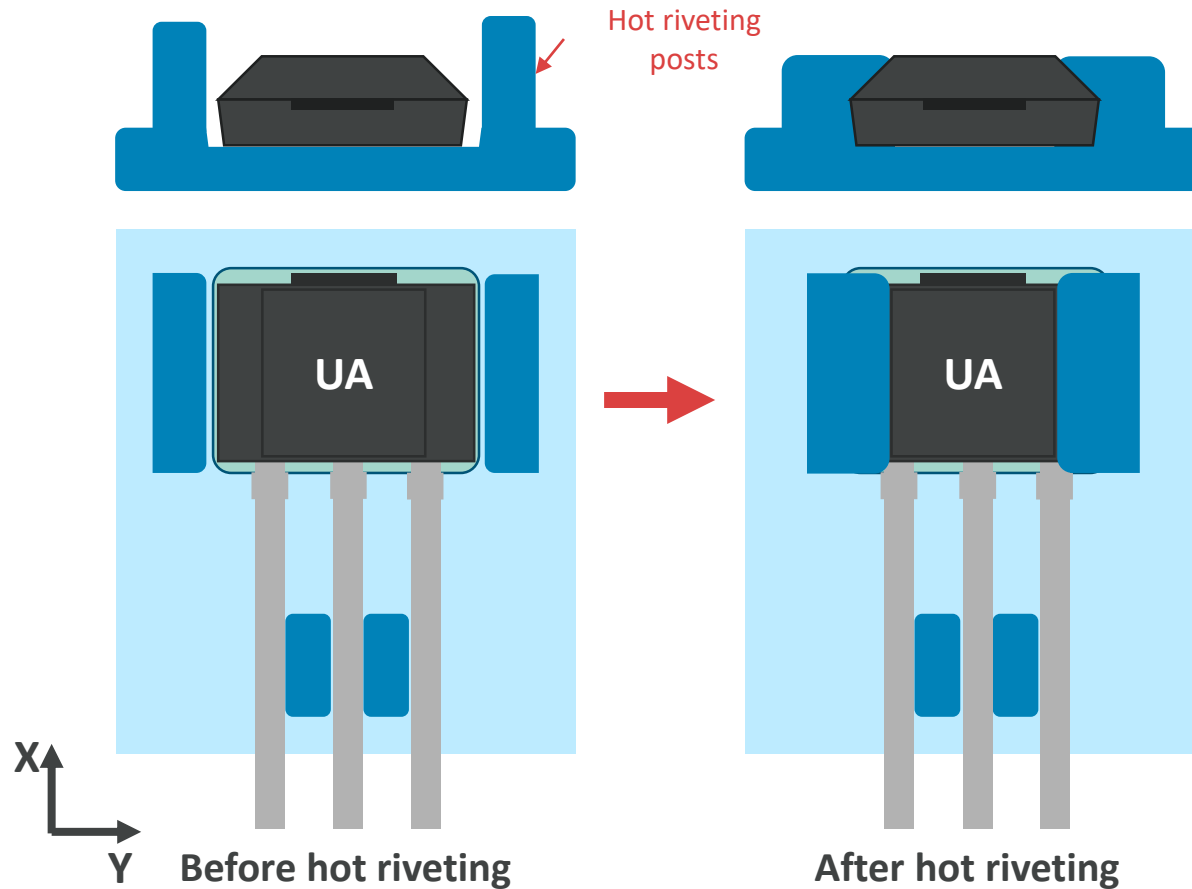
The tin plating has a melting temperature of 232 degC, so care should be taken that this temperature is not reached to avoid melting it during hot riveting, which might lead to electrical shorts



Tin melting after hot riveting

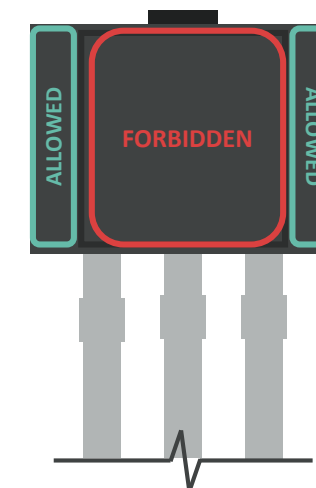
## 3.1 Hot riveting (DMP/SMP/SIP)

### Hot riveting on mold body



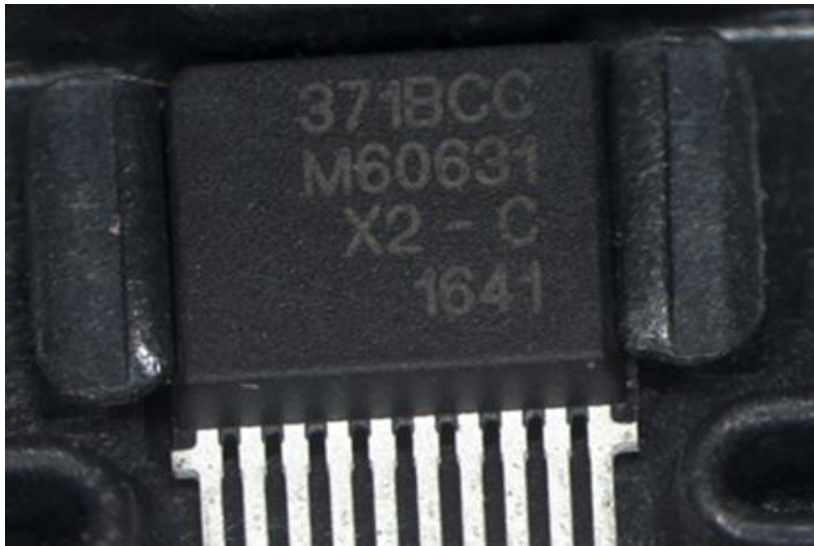
It is possible to use the chamfer of SIP packages (specially UA) for hot riveting if the part is faced up. After riveting, the active sensor surface shall remain clean from riveting plastic since a permanent stress might remain affecting the sensitivity of the Hall plate within the die.

The hot bar should not touch the active sensor surface

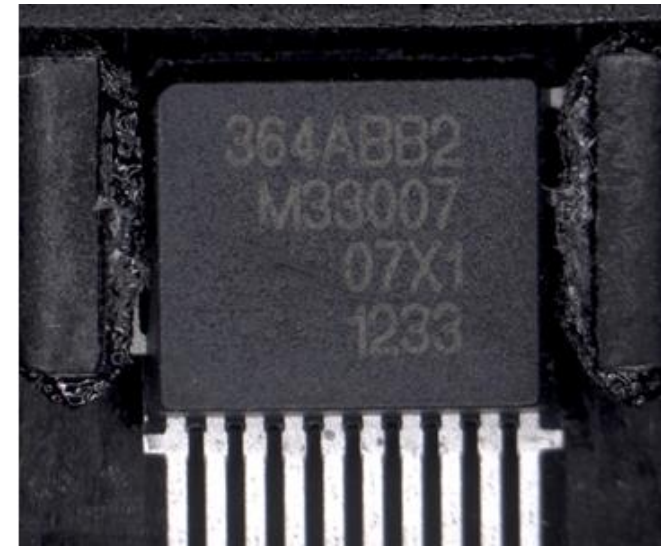


## 3.1 Hot riveting (DMP/SMP/SIP)

### Hot riveting quality visual check



OK



NOK

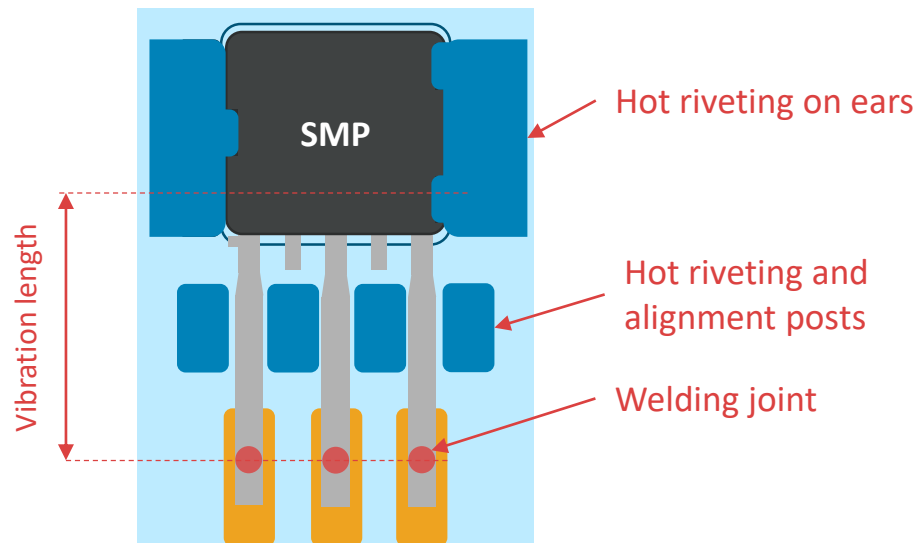
Some common problems that might affect the quality of hot riveting are:

- If the thermode temperature is too high, there might be molten plastic material on the edge of the reformed post
- If the height of the hot riveting post is not enough, the reformed will not fully cover the ears after bending.

## 3.1 Hot riveting (DMP/SMP/SIP)

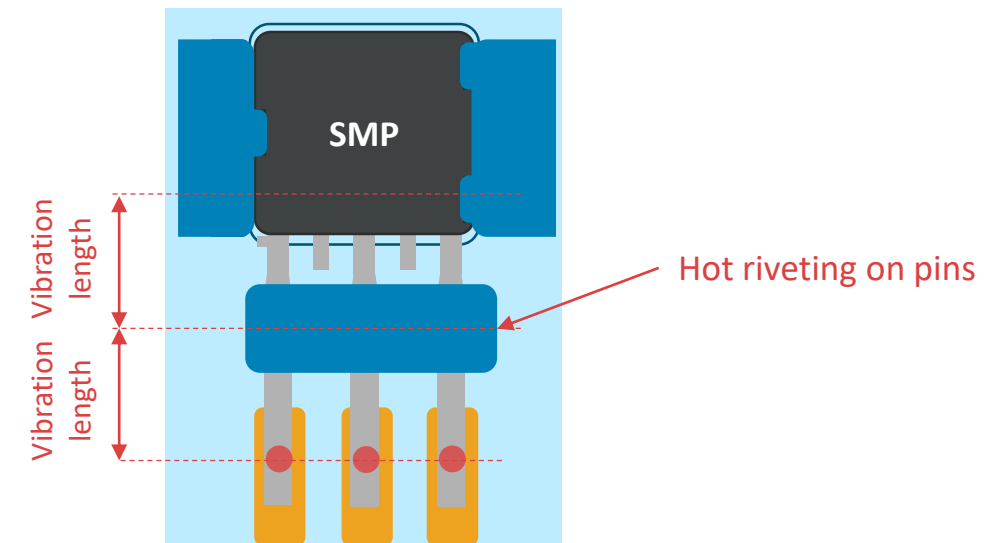
### Natural frequency of vibration and Z fixation

Usually a minimum of two points suffice for proper Z fixation of an IC to the plastic housing: the pins at the welding joint and the mold body. However, since PCB-less packages have long pins, the natural frequency of vibration might fall within the frequency range of a vibration test profile as per ISO 16750-3 or OEM specific. Adding a third Z fixation point in between (for example hot riveting on pins middle point) will be increasing the natural frequency of vibration of the IC, decreasing the risk of resonance. An alternative option to achieve vibration resistance is applying polymer potting. Refer to *Guidelines for potting of plastic encapsulated ICs*



**2 Z fixation points**

*(longer length between fixation points and decreased natural frequency of vibration)*



**3 Z fixation points**

*(shorter length between fixation points and increased natural frequency of vibration)*



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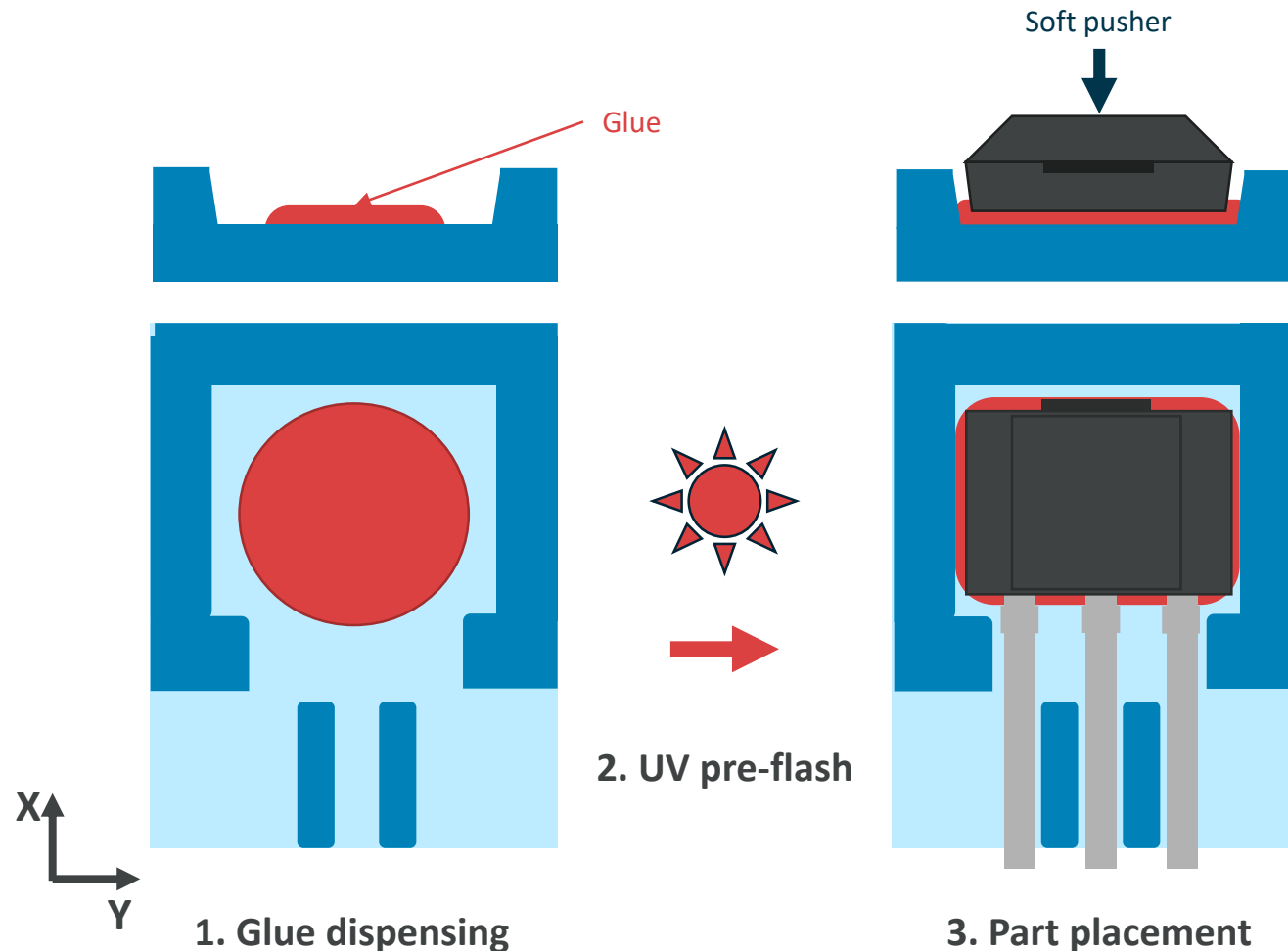
3.1 Hot riveting (DMP/SMP/SIP)

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3.3 Sliding ears into plastic slots (DMP/SMP)

## 3.2 Gluing with UV pre-flash (DMP/SMP/SIP)

### Z fixation with UV curable adhesive



Z fixation by UV pre-flash works in three steps:

1. Dispensing of glue
2. UV pre-flash curing
3. Placement of part

It is recommended to pre-flash the glue before placing the IC, since otherwise the IC will shadow the glue and curing will not be possible. That means a limited time (20-30sec) is available for sensor placement on glue after UV pre-flash to avoid glue hardening. Manual placement is not recommended due to the inaccurate timing control.

A soft pusher might be applied for a few seconds to make sure the IC does not lift before the glue is completely cured.

An alternative approach for Z fixation with glue is potting – refer to *Guidelines for potting of plastic encapsulated ICs*

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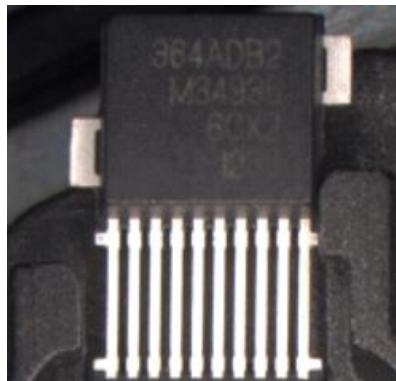
3.3 Sliding ears into plastic slots (DMP/SMP)

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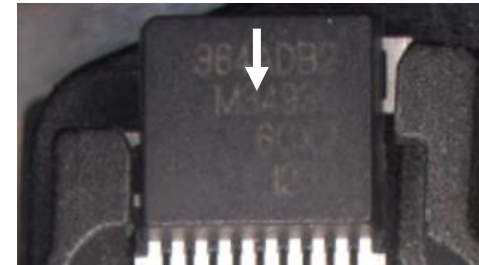
### Ears into plastic slots

The part is placed down and then slides to using the same nozzle (which needs to be able to handle vertical and horizontal movement).

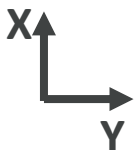
Z fixation is done by the slots where the ears reside after the sliding action.



1. Top-down placement

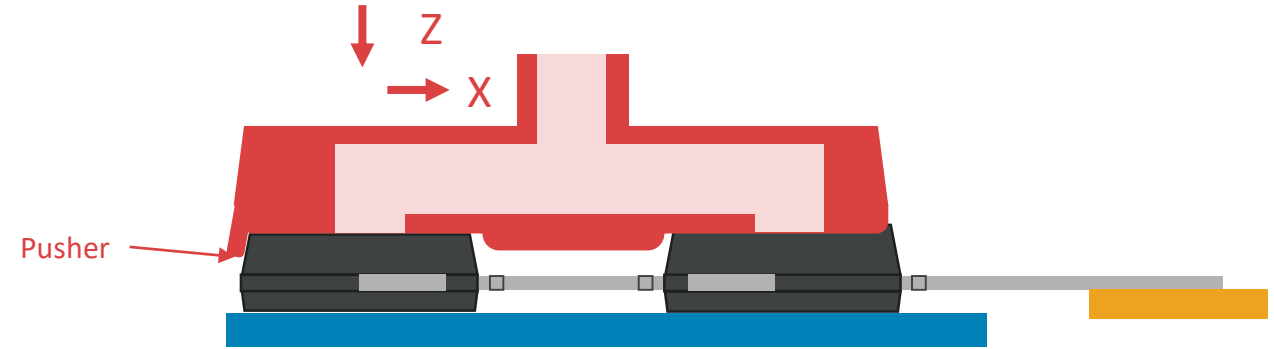
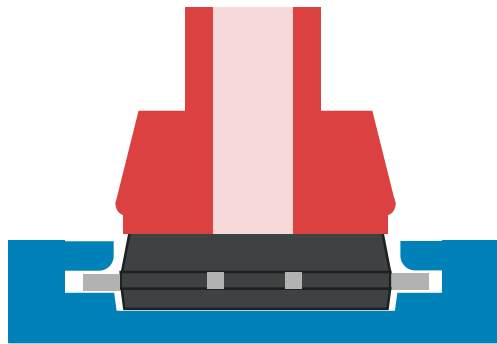


2. Sliding movement

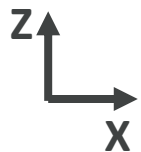
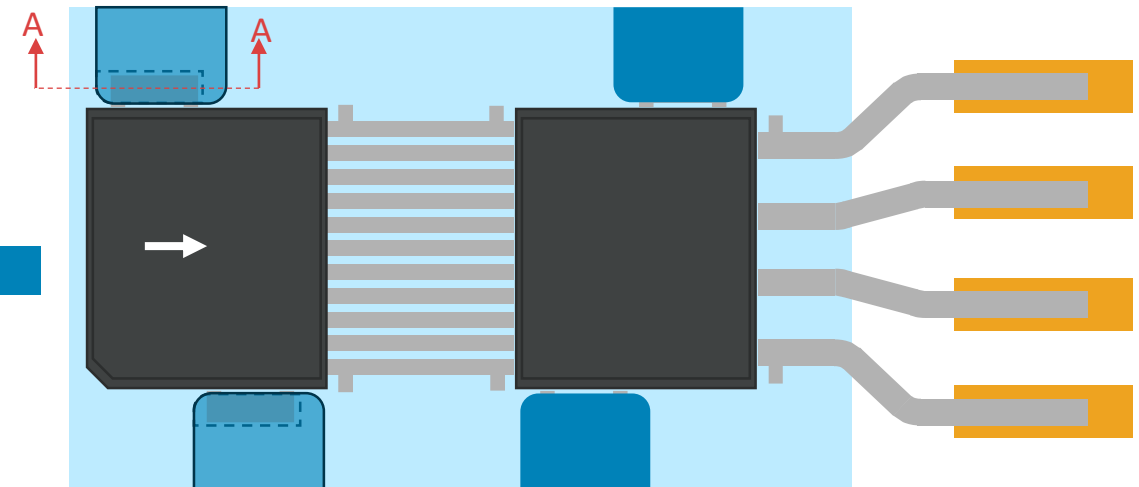
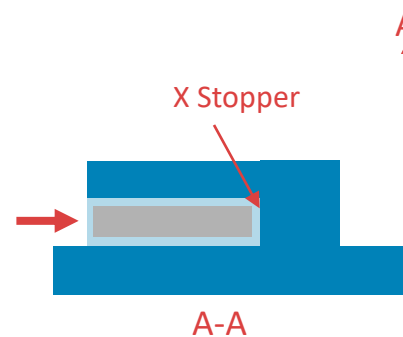


## 3.3 Sliding ears into plastic slots (DMP/SMP)

Nozzle for place-and-slide to stopper



X Positioning is achieved with stoppers on the sliding ears.



# Annex I: List of Abbreviations

**DMP:** Dual Mold Package

**ETC:** Electronic Throttle Body

**IC:** Integrated Circuit

**OD:** Outer Diameter

**PCB:** Printed Circuit Board

**PnP:** Pick And Place

**POD:** Package Outline Drawing

**PBT GF30:** Polybutylene terephthalate 30% Glass-fiber Reinforced

**SIP:** Single Inline Package

**SMP:** Single Mold Package

**TOR:** Tape On Reel

**UV:** Ultra Violet

# Annex II: List of Standards

**J-STD-033:** Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices

**IEC 60286-2:** Packaging of Components for Automatic Handling - Part 2: Packaging of Components with Unidirectional Leads on Continuous Tapes

**IEC 60286-3:** Packaging of Components for Automatic Handling - Part 3: Packaging of Surface Mount Components on Continuous Tapes

**ISO 16750-3:** Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 3: Mechanical loads

# Annex III: List of Related Application Notes

*For the latest revision of this document and related Application Notes, visit [www.melexis.com/ic-handling-and-assembly](http://www.melexis.com/ic-handling-and-assembly)*

*Guidelines for storage and handling of plastic encapsulated ICs*

*Guidelines for lead forming of Hall sensors in SIP package*

*Guidelines for welding of PCB-less devices*

*Guidelines for potting of plastic encapsulated ICs*





# Melexis

INSPIRED ENGINEERING

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