AN11737

Handling information for sensors in SOT453 and SOT477 packages

Rev. 1 — 30 November 2015 | Application note

Document information

Info	Content
Keywords	SOT453, SOT477, package, sensor, assembly
Abstract	This document describes the limitations to package handling and precautions for safe assembly of speed sensors in SOT453 and SOT477 packages.

Revision history

Rev	Date	Description
1	20151130	initial version

Contact information

For more information, please visit: http://www.nxp.com

For sales office addresses, please send an email to: salesaddresses@nxp.com

All information provided in this document is subject to legal disclaimers.
© NXP Semiconductors N.V. 2015. All rights reserved.

1. Introduction

1.1 General

NXP Semiconductors is not the owner of customer processes and cannot test them under all conditions. Therefore, the information below is a general guideline for product handling and package assembly.

It does not replace the process development and release by the customer.

1.2 Package information

The products have two (SOT453) or three (SOT477) leads. All products contain a magnet attached to the plastic body in different size, depending on the application.

Most products have a nickel finish plating, which is preferred for welding and crimping. Some have a tin finish plating to ensure good soldering performance. All products are recommended for thermoplastic overmolding. The leads can be bent according to customer requirements.

The products require gentle handling as especially the leads can bend unintentionally due to their small cross section and length.

The material of the attached ferrites is brittle, so collision with other hard materials should be avoided to prevent chipping.

The magnets attract ferromagnetic materials as well as other magnets with the risk of hard contacts. The magnets may collect tiny ferromagnetic or magnetic particles.

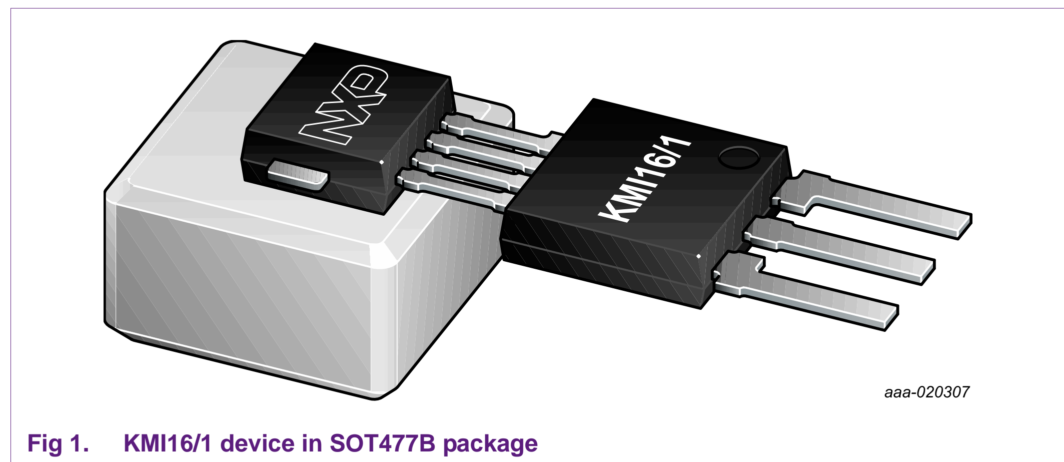


Fig 1. KMI16/1 device in SOT477B package

© NXP Semiconductors N.V. 2015. All rights reserved.

Fig 2. KMI17/4 device in SOT453E package

2. Storage

2.1 Store conditions

Secure and clean store areas must be provided to isolate and protect the products.

Conditions in the store areas shall be such that the quality of the products does not deteriorate due to, among others, harmful gasses or electrical fields.

Storage conditions:

- Temperature
  - Min. +8 °C
  - Max. +45 °C
- Humidity
  - Min. 25 %
  - Max. 75 %
  - No condensation is allowed under any condition
- Light intensity
  - No direct sunlight

2.2 Shelf life

The shelf life for packed products is 4 years after the date code.

3. Product handling

3.1 ESD protection

Apply the usual ESD protection measures.

3.2 Forces on body

Forces on the plastic body during general handling should not exceed 10 N. Apply forces via flat surfaces, parallel to the sensor surface. Avoid stress concentrations at smaller areas.

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

3.3 Forces along leads

Maximum pull force along outer leads is limited to 10 N per lead. Forces in other directions should be prevented as the leads tend to bend easily. Maximum pull force at inner leads is 20 N for all 4 leads combined.

Pushing of leads can cause bulging. As long as bulging is prevented, same push as pull forces are acceptable.

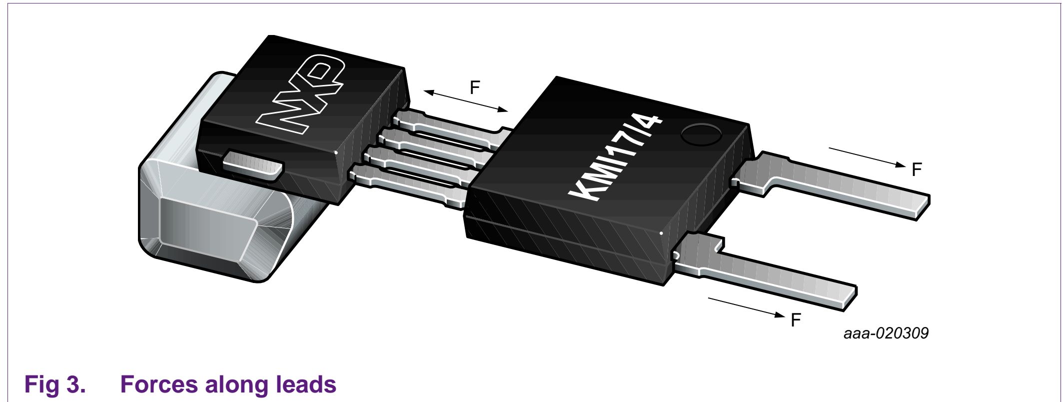


Fig 3. Forces along leads

3.4 External magnetic fields

3.4.1 Magnet-to-magnet clearance

During production and transport the (partly) assembled sensors may come close to each other. To prevent magnetization changes of the neighbor products, a minimum clearance is required in any direction. Their magnets should not touch each other. The recommended minimum distance of devices for safe handling is not related to the overmolding material. The magnet-to-magnet clearance depends on the temperature due to the physical parameters of the ferrite material.

- Temperatures above 10 °C (typical temperatures at assembly sites)
  - No special requirement
- Temperatures −40 °C to +10 °C
  - Minimum clearance of 2 mm in case the magnetization of the neighboring devices are perpendicular within ±30° to each other; see Figure 4
  - Minimum clearance of 2 mm in case of antiparallel magnetization of the neighboring devices for magnetized encoders; see Figure 5
  - Minimum clearance of 1.5 mm for all other directions (already achieved by typical overmold layers); see Figure 6

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

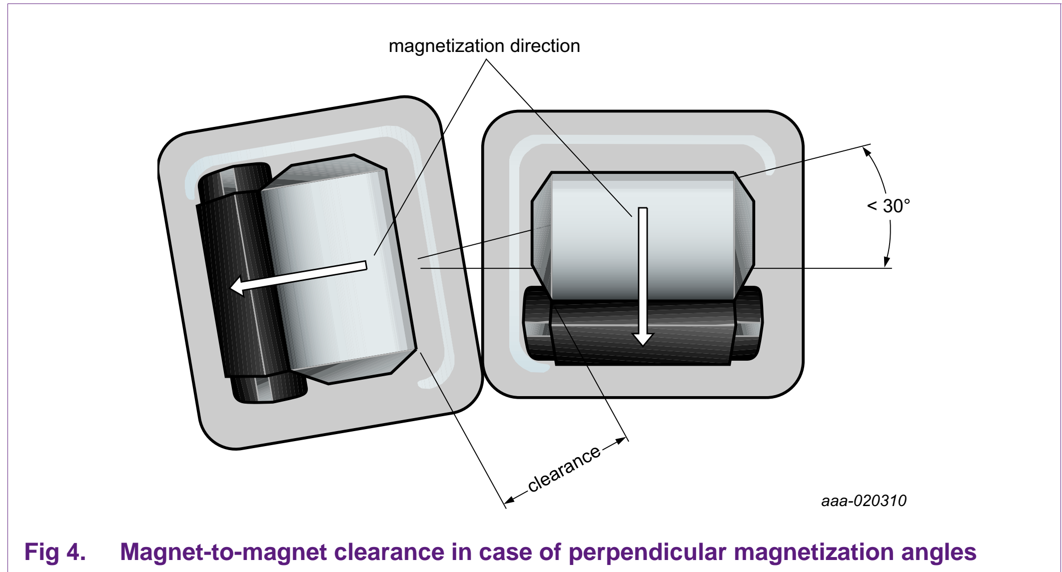


Fig 4. Magnet-to-magnet clearance in case of perpendicular magnetization angles

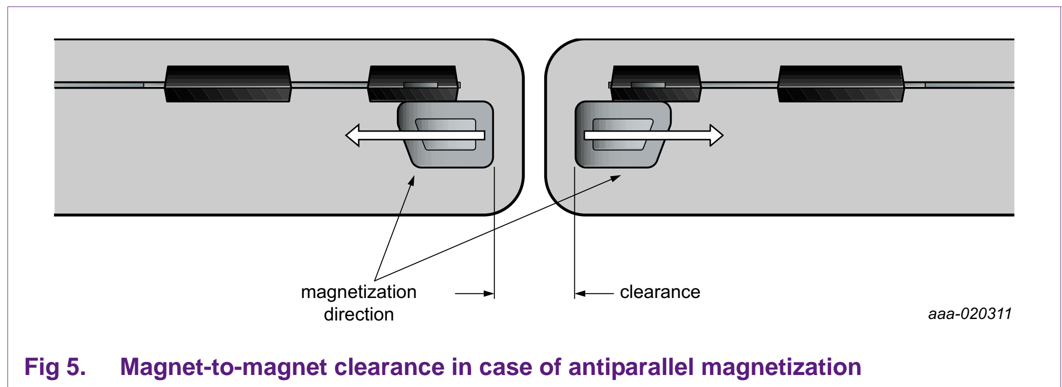


Fig 5. Magnet-to-magnet clearance in case of antiparallel magnetization

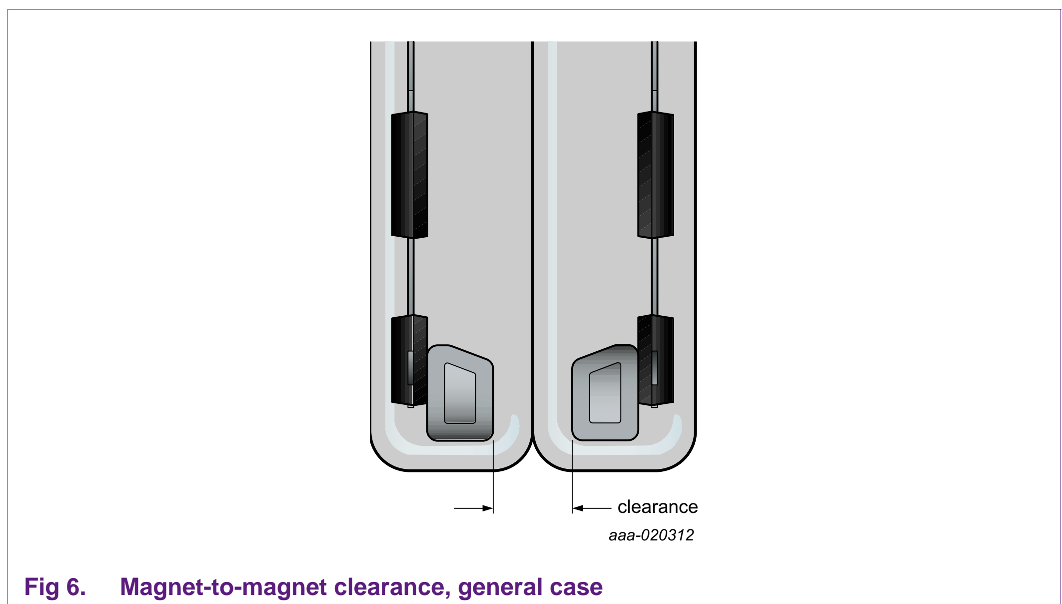


Fig 6. Magnet-to-magnet clearance, general case

© NXP Semiconductors N.V. 2015. All rights reserved.

3.4.2 External magnetic field limits

External magnetic fields should not exceed 37.5 mT (30 kA/m) below 10 °C and 63 mT (50 kA/m) above 10 °C at the bias magnet. The limit is set to prevent magnetization change. It includes short pulses e.g. during welding of the sensor IC leads.

4. Product assembly

4.1 Product alignment

4.1.1 Package features for alignment

Blue areas are preferred for alignment in socket.

Red areas should not be used for alignment due to uncontrolled package outline caused by gate remains or potential mold compound flash.

Other areas can be used for alignment.

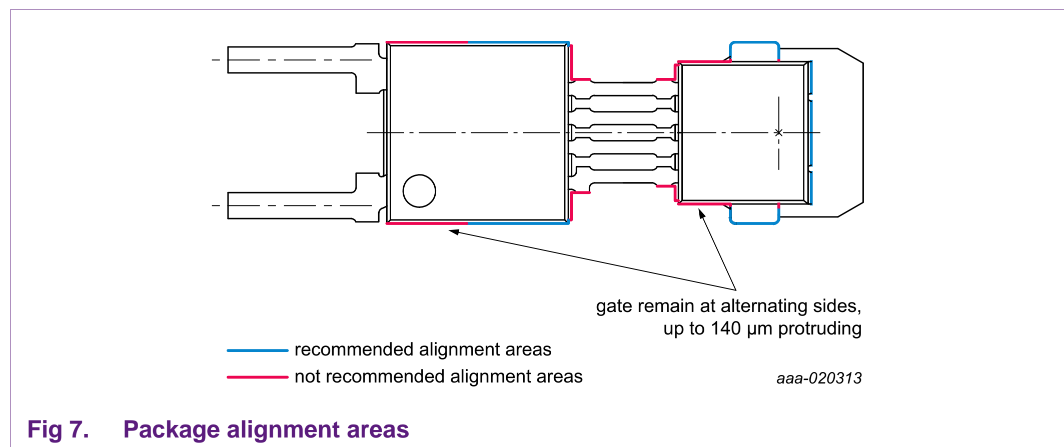


Fig 7. Package alignment areas

4.1.2 Reading point alignment

Best reference for the Reading Point (RP) is the Lead Frame (LF) as the die is attached to the LF.

- As the ears are part of the lead frame, they are the preferred alignment feature.
- The RP has a tolerance of ±0.1 mm regarding the ears.
- The lead frame formed the rim (mold compound flowed to the lead frame edge, forming the rim). Therefore, it has the same tolerance of ±0.1 mm.

All information provided in this document is subject to legal disclaimers. © NXP Semiconductors N.V. 2015. All rights reserved.

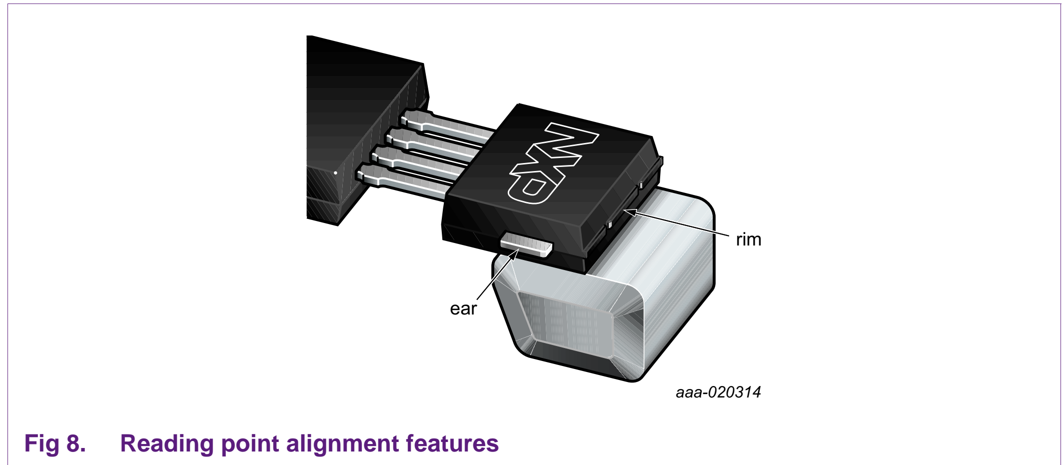


Fig 8. Reading point alignment features

4.1.3 Pin alignment

Just aligning the package at the sensor head may not be sufficient to ensure proper positioning of the pins to their external counterparts.

Align the product at the lower body beside the gate position.

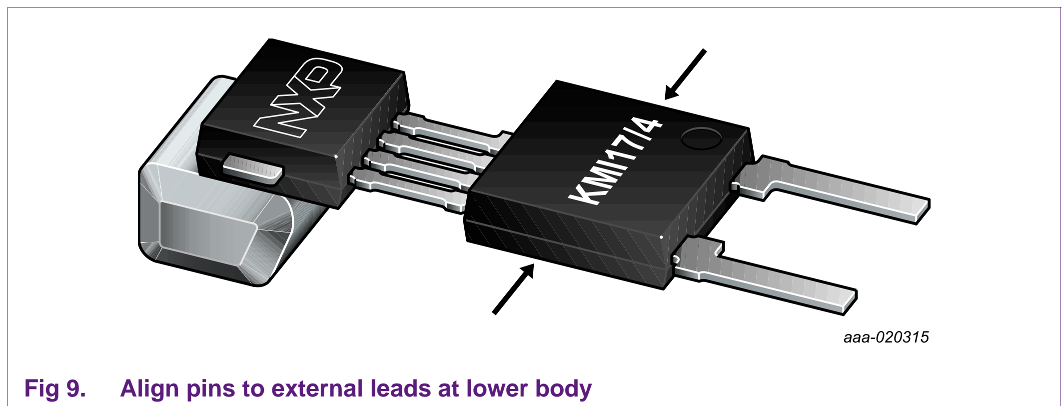


Fig 9. Align pins to external leads at lower body

4.2 Lead bending

4.2.1 General lead bending information

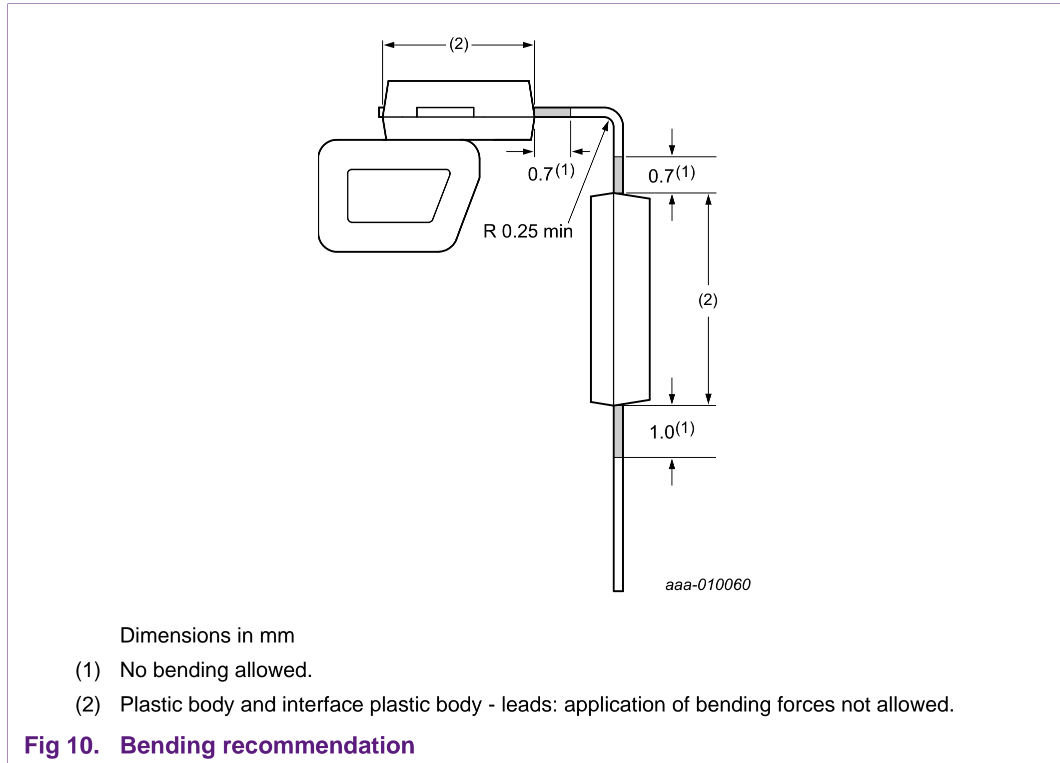
To adapt the packages to customer requirements, the leads can be bent as shown in Figure 10.

The bending operation should not cause gaps in between leads and plastic body at plastic body entrance.

Best bending results are achieved when bending is done at the straight part of the leads.

During bending process, pull force should not exceed 10 N per lead (external leads) or cumulative 20 N at internal leads.

All information provided in this document is subject to legal disclaimers.
© NXP Semiconductors N.V. 2015. All rights reserved.



Dimensions in mm

(1) No bending allowed.

(2) Plastic body and interface plastic body - leads: application of bending forces not allowed.

Fig 10. Bending recommendation

4.2.2 Unintended lead bending in lead frame plane

Unintended lead bending in lead frame plane should be prevented as it pre-stresses the product, especially the plastic body entrance of the lead. It could damage the lead to plastic body interface and could cause overstress problems in combination with other stress from the assembly steps.

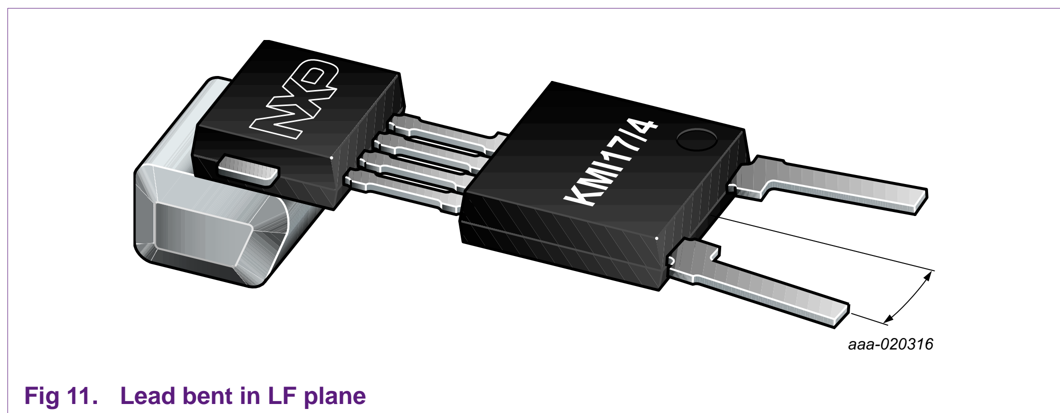


Fig 11. Lead bent in LF plane

All information provided in this document is subject to legal disclaimers.
© NXP Semiconductors N.V. 2015. All rights reserved.

4.2.3 Unintended lead twist

Unintended lead twist should be prevented as it pre-stresses the product, especially it could damage the lead to plastic body interface. It could cause overstress problems in combination with other stress from the assembly steps.

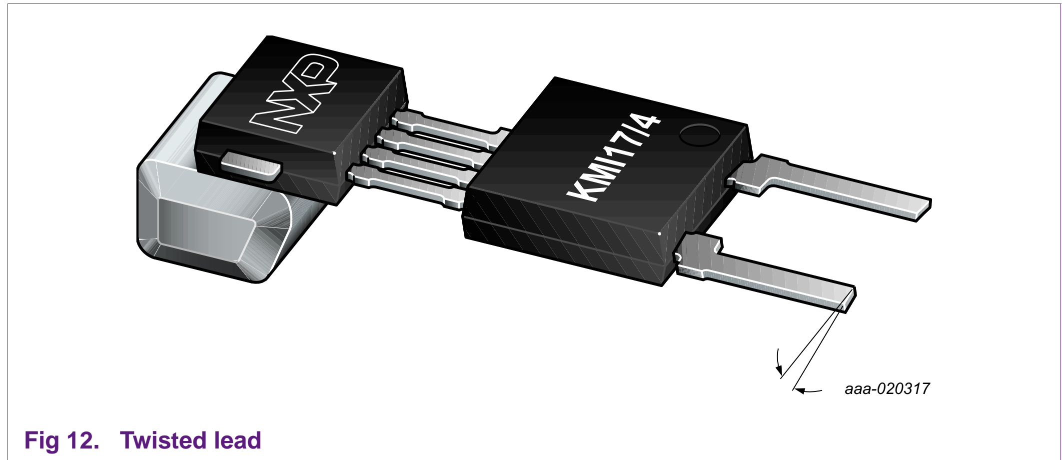


Fig 12. Twisted lead

4.2.4 Lead bend control

After intentional or unintentional lead bending or twisting, verify that the products are not mechanically damaged.

4.2.4.1 Bending zone

Smooth bending without buckling in bending zone, inner radius > 250 μm.

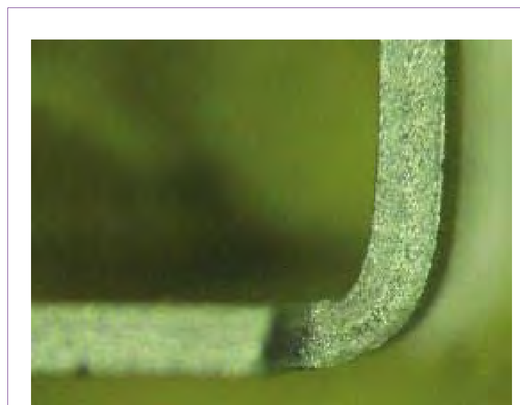


Fig 13. Smooth bending with inner radius > 250 μm, pass

Fig 14. Kink in bending zone, reject

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

4.2.4.2 Dambar zone

No lead deformation allowed at dambar zone in between bending zone and plastic body.

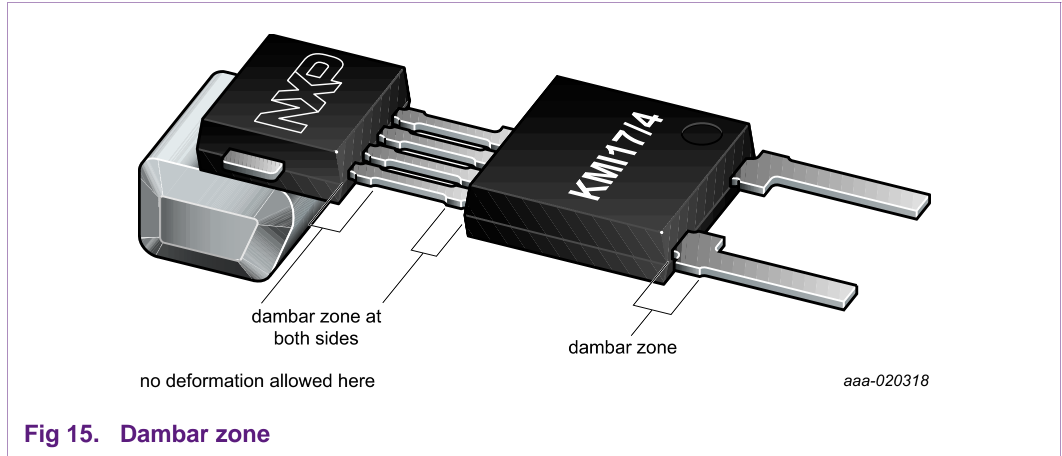


Fig 15. Dambar zone

4.2.4.3 Lead entrance

No gaps are allowed in between leads and plastic body all around internal and external leads.

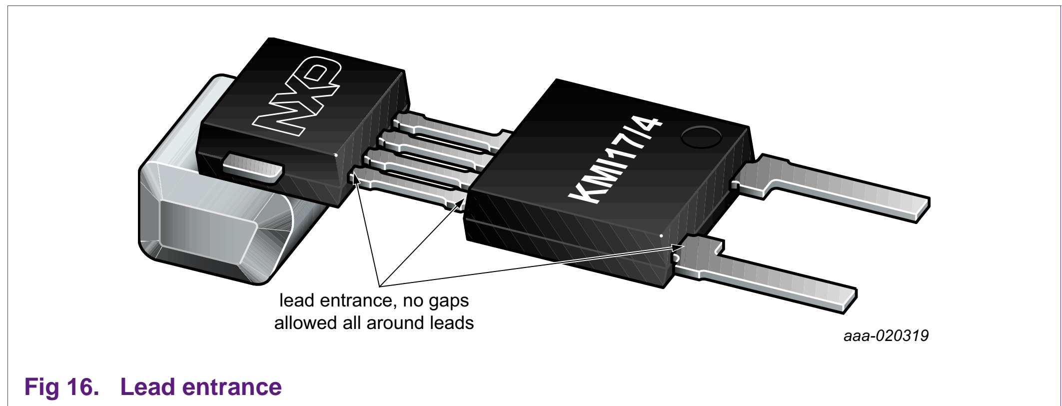


Fig 16. Lead entrance

4.2.4.4 Plating

No exposed copper allowed caused by bending process.

4.3 Molding

Both packages SOT453 and SOT477 are designed for PolyAmide (PA) overmolding. The challenge is the high temperature in combination with high pressure as well as the shear force at the magnet adhesive.

Limiting values are:

- Isostatic pressure to the package
  - 48 MPa
- Sensor IC temperature
  - 250 °C

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

5. Legal information

5.1 Definitions

Draft — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

5.2 Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the *Terms and conditions of commercial sale* of NXP Semiconductors.

Right to make changes — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use in automotive applications — This NXP Semiconductors product has been qualified for use in automotive applications. Unless otherwise agreed in writing, the product is not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors and its suppliers accept no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

Translations — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

5.3 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

© NXP Semiconductors N.V. 2015. All rights reserved.

6. Figures

Fig 1. KMI16/1 device in SOT477B package 3
Fig 2. KMI17/4 device in SOT453E package 4
Fig 3. Forces along leads 5
Fig 4. Magnet-to-magnet clearance in case of perpendicular magnetization angles 6
Fig 5. Magnet-to-magnet clearance in case of antiparallel magnetization 6
Fig 6. Magnet-to-magnet clearance, general case 6
Fig 7. Package alignment areas 7
Fig 8. Reading point alignment features 8
Fig 9. Align pins to external leads at lower body 8
Fig 10. Bending recommendation 9
Fig 11. Lead bent in LF plane 9
Fig 12. Twisted lead. 10
Fig 13. Smooth bending with inner radius > 250 μm, pass 10
Fig 14. Kink in bending zone, reject. 10
Fig 15. Dambar zone 11
Fig 16. Lead entrance 11

All information provided in this document is subject to legal disclaimers.
© NXP Semiconductors N.V. 2015. All rights reserved.

7. Contents

1 Introduction . . . 3
1.1 General . . . 3
1.2 Package information . . . 3
2 Storage . . . 4
2.1 Store conditions . . . 4
2.2 Shelf life . . . 4
3 Product handling . . . 4
3.1 ESD protection . . . 4
3.2 Forces on body . . . 4
3.3 Forces along leads . . . 5
3.4 External magnetic fields . . . 5
3.4.1 Magnet-to-magnet clearance . . . 5
3.4.2 External magnetic field limits . . . 7
4 Product assembly . . . 7
4.1 Product alignment . . . 7
4.1.1 Package features for alignment . . . 7
4.1.2 Reading point alignment . . . 7
4.1.3 Pin alignment . . . 8
4.2 Lead bending . . . 8
4.2.1 General lead bending information . . . 8
4.2.2 Unintended lead bending in lead frame plane . 9
4.2.3 Unintended lead twist . . . 10
4.2.4 Lead bend control . . . 10
4.2.4.1 Bending zone . . . 10
4.2.4.2 Dambar zone . . . 11
4.2.4.3 Lead entrance . . . 11
4.2.4.4 Plating . . . 11
4.3 Molding . . . 11
5 Legal information . . . 12
5.1 Definitions . . . 12
5.2 Disclaimers . . . 12
5.3 Trademarks . . . 12
6 Figures . . . 13
7 Contents . . . 14

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section ‘Legal information’.

© NXP Semiconductors N.V. 2015. All rights reserved.

For more information, please visit: http://www.nxp.com
For sales office addresses, please send an email to: salesaddresses@nxp.com
Date of release: 30 November 2015
Document identifier: AN11737