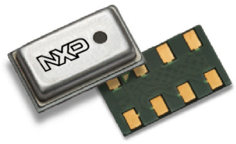


# FXPQ3115BV

## I$^2$C precision pressure sensor with altimetry

Rev. 1 — 9 October 2017 Short data sheet: technical data

## 1 General description

The FXPQ3115BV is a compact, piezoresistive, absolute pressure sensor with an I$^2$C digital interface. FXPQ3115BV has a wide operating range of 20 kPa to 110 kPa. This sensor is ideal for inhalers, continuous positive airway pressure (CPAP) masks or other medical devices coming in contact with a patient's airway. The MEMS and ASIC die are coated with a biomedically-approved gel. The gel is a nontoxic, nonallergenic elastomer which meets all United States Pharmacopeia (USP) biological testing class VI requirements. The gel properties allow uniform pressure transmission to the MEMS diaphragm.

A high resolution ADC provides fully compensated and digitized outputs for pressure in Pascals and temperature in °C. The compensated output is available as either barometric pressure in Pascals or as an altitude in meters. The internal processing in FXPQ3115BV removes compensation and unit conversion load from the system MCU, simplifying system design.

FXPQ3115BV's advanced ASIC has multiple user programmable modes such as power saving, interrupt and autonomous data acquisition modes, including programmed acquisition cycle timing, and poll-only modes. Typical active supply current is 40 µA per measurement-second.

## 2 Features and benefits

- Operating range: 20 kPa to 110 kPa absolute pressure
- Calibrated range: 50 kPa to 110 kPa absolute pressure
- Calibrated temperature output: −40 °C to 85 °C
- I$^2$C digital output interface
- Fully compensated internally
- Precision ADC resulting in 1.5 Pa of effective resolution
- Direct reading
  - Pressure: 20-bit measurement (Pascals)
    - 20 to 110 kPa
  - Temperature: 12-bit measurement (°C)
    - –40 °C to 85 °C
- Programmable interrupts
- Autonomous data acquisition
  - Embedded 32-sample FIFO
  - Data logging up to 12 days using the FIFO
  - One-second to nine-hour data acquisition rate
- 1.95 V to 3.6 V supply voltage, internally regulated
- 1.6 V to 3.6 V digital interface supply voltage
- Operating temperature from −40 °C to +85 °C

## 3 Applications

- Inhalers/nebulizers
- Medical tablets
- Health activity monitors
- Oxygen concentrators
- CPAP machine and mask
- Spyrometry

## 4 Ordering information

**Table 1. Ordering information**

| Device number | Shipping | Package | Number of ports | | | Pressure Type | | | Digital interface |
|---|---|---|---|---|---|---|---|---|---|
| | | | None | Single | Dual | Gauge | Differential | Absolute | |
| FXPQ3115BV | Tray | 98ASA002260D | • | — | — | — | — | • | • |
| FXPQ3115BVT1 | Tape and reel | 98ASA002260D | • | — | — | — | — | • | • |

## 5 Block diagram

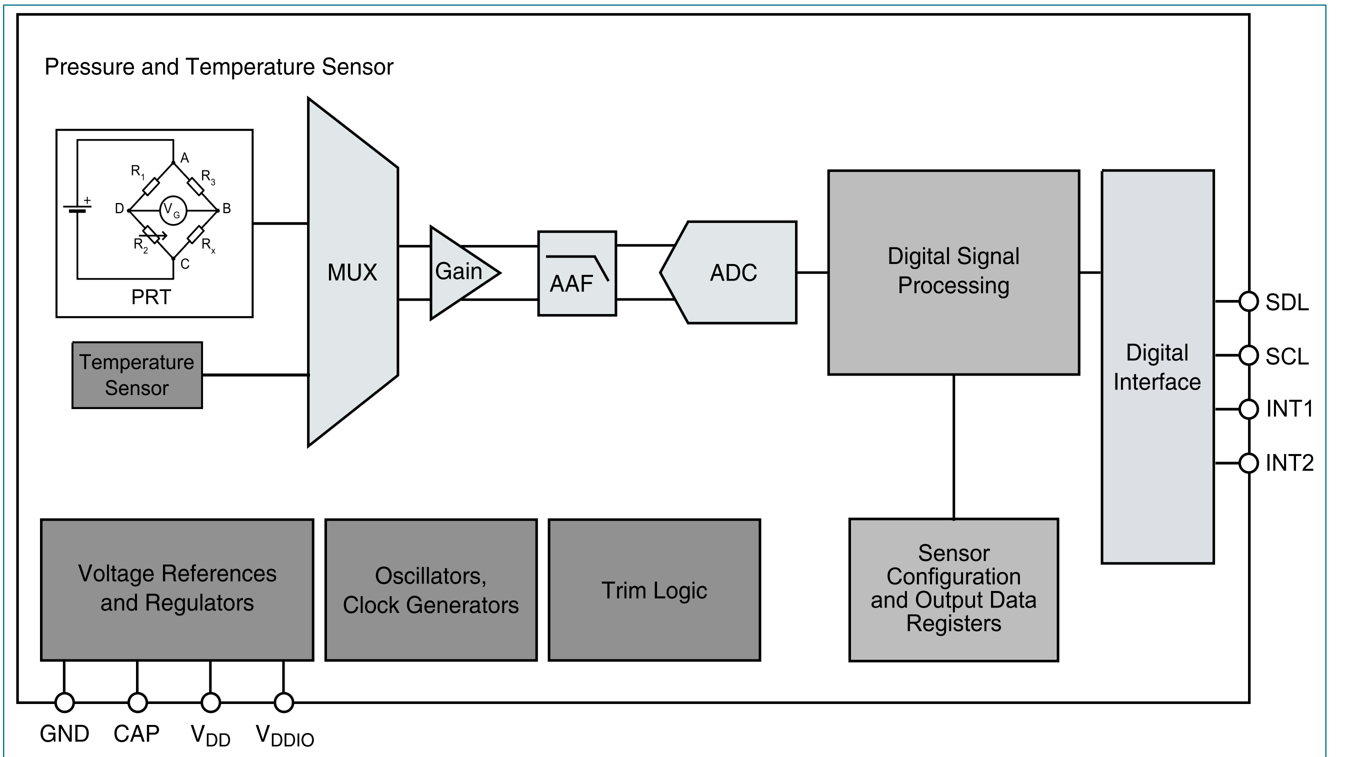



**Figure 1. Block diagram**

# 6 Pinning information

## 6.1 Pinning

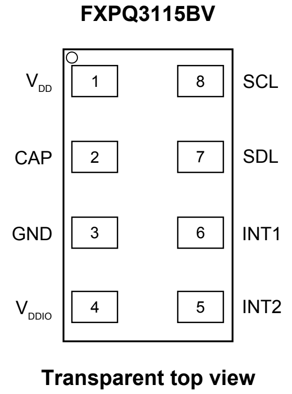



Figure 2. 8-pin LGA pinout

## 6.2 Pin description

Table 2. Pin description

| Symbol | Pin | Description |
|---|---|---|
| $V_{DD}$ | 1 | $V_{DD}$ power supply connection (1.95 to 3.6 V) |
| CAP | 2 | External capacitor |
| GND | 3 | Ground |
| $V_{DDIO}$ | 4 | Digital interface power supply (1.62 to 3.6 V) |
| INT2 | 5 | Pressure interrupt 2 |
| INT1 | 6 | Pressure interrupt 1 |
| SDL | 7 | $I^2C$ serial data |
| SCL | 8 | $I^2C$ serial clock |

# 7 Handling and board mount recommendations

The sensor die is sensitive to light exposure. Direct light exposure through the port hole can lead to varied accuracy of pressure measurement. Avoid such exposure to the port during normal operation.

## 7.1 Methods of handling

Components can be picked from the carrier tape using either the vacuum assist or the mechanical type pickup heads. A vacuum assist nozzle type is most common due to its lower cost of maintenance and ease of operation. The recommended vacuum nozzle configuration should be designed to make contact with the device directly on the metal cover and avoid vacuum port location directly over the vent hole in the metal cover of the device. Multiple vacuum ports within the nozzle may be required to effectively handle the device and prevent shifting during movement to placement position.

Vacuum pressure required to adequately support the component should be approximately 25 in Hg (85kPa). This level is typical of in-house vacuum supply. Pickup nozzles are available in various sizes and configurations to suit a variety of component geometries. To select the nozzle best suited for the specific application, it is recommended that the customer consult their pick and place equipment supplier to determine the correct nozzle. In some cases it may be necessary to fabricate a special nozzle depending on the equipment and speed of operation.

Tweezers or other mechanical forms of handling that have a sharp point are not recommended since they can inadvertently be inserted into the vent hole of the device. This can lead to a puncture of the MEMS element that will render the device inoperable.

### 7.2 Board mount recommendations

Components can be mounted using solder paste stencil, screen printed or dispensed onto the PCB pads prior to placement of the component. The volume of solder paste applied to the PCB is normally sufficient to secure the component during transport to the subsequent reflow soldering process. Use of adhesives to secure the component is not recommended, but where necessary can be applied to the underside of the device.

Solder pastes are available in variety of metal compositions, particle size and flux types. The solder paste consists of metals and flux required for a reliable connection between the component lead and the PCB pad. Flux aids the removal of oxides that may be present on PCB pads and prevents further oxidation from occurring during the solder process.

The use of a No-Clean (NC) flux is recommended for exposed cavity components. Using pressure spray, wire brush, or other methods of cleaning is not recommended since it can puncture the MEMS device and render it unusable. If cleaning of the pcb is performed Water Soluble (WS) flux can be used. However, it is recommended the component cavity is protected by adhesive Kapton tape, vinyl cap or other means prior to the cleaning process. This covering will prevent damage to the MEMS device, contamination, and foreign materials from being introduced into device cavity as result of cleaning processes.

Ultrasonic cleaning is not recommended as the frequencies can damage wire bond interconnections and the MEMS device.

## 8 Mechanical and electrical specifications

### 8.1 Absolute maximum ratings

Absolute maximum ratings are the limits the device can be exposed to without permanently damaging it. Absolute maximum ratings are stress ratings only, functional operation at these ratings is not guaranteed. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

This device contains circuitry to protect against damage due to high static voltage or electrical fields. It is advised, however, that normal precautions be taken to avoid application of any voltages higher than maximum-rated voltages to this high-impedance circuit.

**Table 3. Maximum ratings**

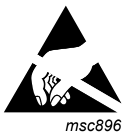
| Symbol | Characteristic | Value | Unit |
|---|---|---|---|
| $P_{max}$ | Maximum applied pressure | 500 | kPa |
| $V_{DD}$ | Supply voltage | −0.3 to 3.6 | V |
| $V_{DDIO}$ | Interface supply voltage | −0.3 to 3.6 | V |
| $V_{IN}$ | Input voltage on any control pin (SCL, SDA) | −0.3 to $V_{DDIO}$ + 0.3 | V |
| $T_{OP}$ | Operating temperature range | −40 to +85 | °C |
| $T_{STG}$ | Storage temperature range | −40 to +125 | °C |

**Table 4. ESD and latchup protection characteristics**

| Symbol | Rating | Value | Unit |
|---|---|---|---|
| HBM | Human body model | ±2000 | V |
| CDM | Charge device model | ±500 | V |
| — | Latchup current at T = 85 °C | ±100 | mA |

**Caution**

This device is sensitive to mechanical shock. Improper handling can cause permanent damage to the part or cause the part to otherwise fail.




**Caution**

This is an ESD sensitive device. Improper handling can cause permanent damage to the part.

## 8.2 Mechanical characteristics

**Table 5. Mechanical characteristics**

*$V_{DD}$ = 2.5 V, T = 25 °C, over 50 kPa to 110 kPa, unless otherwise noted.*

| Symbol | Parameter | Test conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Pressure sensor** | | | | | | |
| $P_{FS}$ | Measurement range | Calibrated range | 50 | — | 110 | kPa |
| | | Operational range | 20 | — | 110 | kPa |
| | Pressure reading noise [1] | 1x oversample | — | 19 | — | Pa RMS |
| | | 128x oversample | — | 1.5 | — | Pa RMS |
| | Pressure absolute accuracy | 50 to 110 kPa over 0 °C to 50 °C | –0.75 | — | 0.75 | kPa |
| | | 50 to 110 kPa over −10 °C to 70 °C | — | ±0.75 | — | kPa |
| | Pressure relative accuracy | Relative accuracy during pressure change between 70 to 110 kPa at any constant temperature between −10 °C to 50 °C | — | ±0.05 | — | kPa |
| | | Relative accuracy during changing temperature between −10 °C to 50 °C at any constant pressure between 50 kPa to 110 kPa | — | ±0.1 | — | kPa |
| | Pressure/altitude resolution [2][3][4] | Barometer mode | 0.25 | 1.5 | — | Pa |
| | | Altimeter mode | 0.0625 | 0.3 | — | m |
| | Output data rate | One-shot mode | — | 100 | — | Hz |
| | | FIFO mode | — | — | 1 | Hz |
| | Board mount drift | After solder reflow | –0.45 | ±0.15 | 0.45 | kPa |
| | Long term drift | After a period of 1 year | –0.3 | ±0.1 | 0.3 | kPa |
| **Temperature sensor** | | | | | | |
| $T_{FS}$ | Measurement range | — | –40 | — | +85 | °C |
| | Temperature accuracy | @25 °C | — | ±1 | — | °C |
| | | Over temperature range | — | ±3 | — | °C |
| $T_{OP}$ | Operating temperature range | — | –40 | — | +85 | °C |

[1] Oversample (OSR) modes internally combine and average samples to reduce noise.
[2] Smallest bit change in register represents minimum value change in Pascals or meters. Typical resolution to signify change in altitude is 0.3 m.
[3] Reference pressure = 101.325 kPa (sea level).
[4] At 128x oversample ratio.

## 8.3 Electrical characteristics

**Table 6. Electrical characteristics**

*@ $V_{DD}$ = 2.5 V, T = 25 °C unless otherwise noted.*

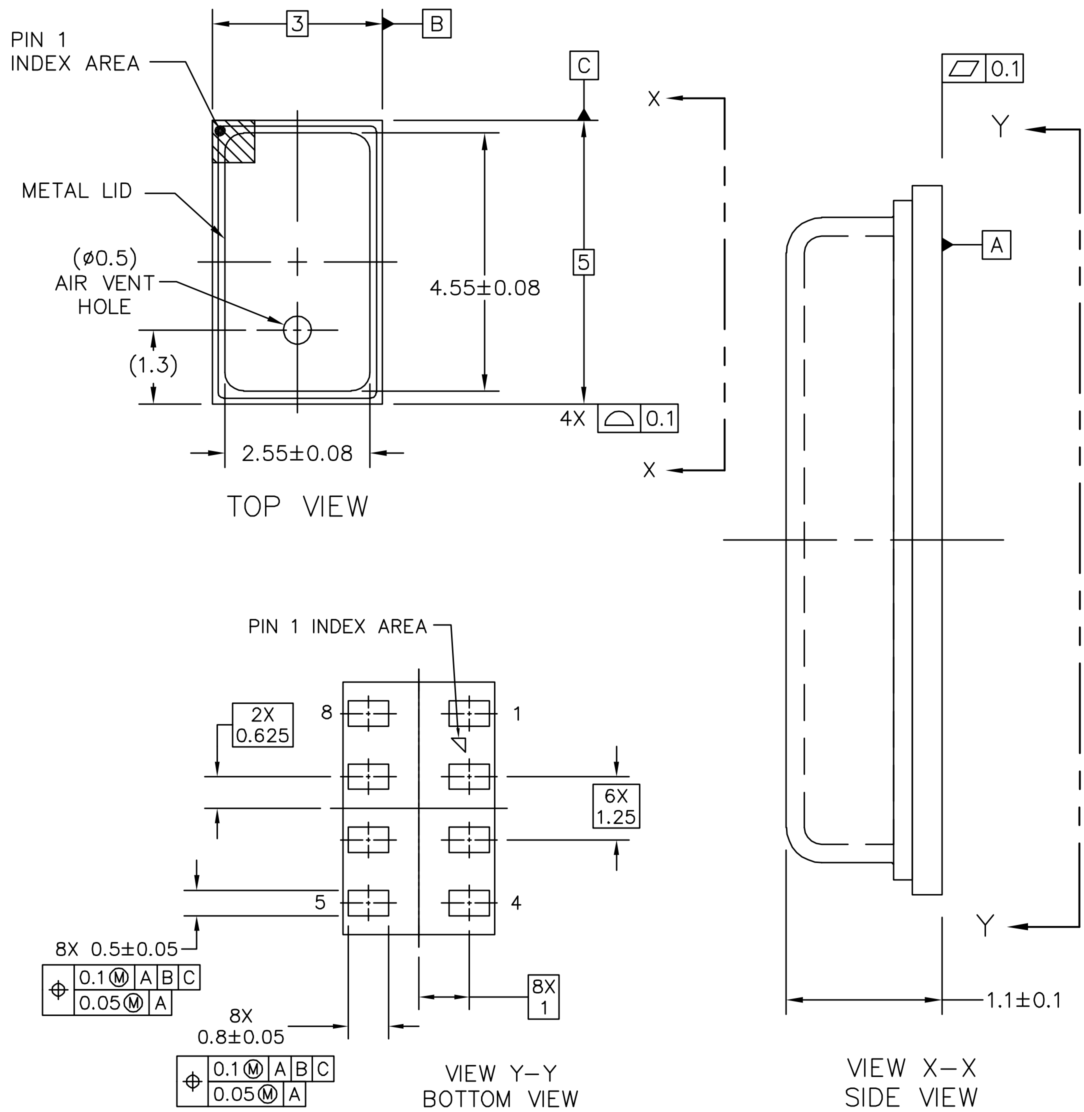
| Symbol | Parameter | Test conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{DDIO}$ | I/O supply voltage | — | 1.62 | 1.8 | 3.6 | V |
| $V_{DD}$ | Operating supply voltage | — | 1.95 | 2.5 | 3.6 | V |
| $I_{DD}$ | Integrated current 1 update per second | Highest speed mode oversample = 1 | — | 8.5 | — | µA |
| | | Standard mode oversample = 16 | — | 40 | — | µA |
| | | High resolution mode oversample = 128 | — | 265 | — | µA |
| $I_{DDMAX}$ | Max current during acquisition and conversion | During acquisition/ conversion | — | 2 | — | mA |
| $I_{DDSTBY}$ | Supply current drain in STANDBY mode | STANDBY mode selected SBYB = 0 | — | 2 | — | µA |
| VIH | Digital high level input voltage<br>SCL, SDA | — | 0.75 | — | — | $V_{DDIO}$ |
| VIL | Digital low level input voltage<br>SCL, SDA | — | — | — | 0.3 | $V_{DDIO}$ |
| VOH | High level output voltage<br>INT1, INT2 | $I_O$ = 500 µA | 0.9 | — | — | $V_{DDIO}$ |
| VOL | Low level output voltage<br>INT1, INT2 | $I_O$ = 500 µA | — | — | 0.1 | $V_{DDIO}$ |
| VOLS | Low level output voltage<br>SDA | $I_O$ = 500 µA | — | — | 0.1 | $V_{DDIO}$ |
| $T_{ON}$ | Turn-on time [1][2][3] | High speed mode | — | — | 60 | ms |
| | | High resolution mode | — | — | 1000 | ms |
| $T_{OP}$ | Operating temperature range | — | −40 | 25 | +85 | °C |
| **$I^2C$ addressing** | | | | | | |
| $I^2C$ Address | — | — | | 0x60 | | Hex |
| The device uses 7-bit addressing and does not acknowledge general call address 000 0000. Slave address has been set to 60h or 110 0000. 8-bit read is C1h, 8-bit write is C0h. | | | | | | |

[1] Time to obtain valid data from STANDBY mode to ACTIVE mode
[2] High speed mode is achieved by setting the oversample rate of 1x.
[3] High resolution mode is achieved by setting the oversample to 128x.

# 9 Package information

## 9.1 Package dimensions

This drawing is located at http://nxp.com/files/shared/doc/package_info/98ASA00260D.pdf.




| | | |
|---|---|---|
| © NXP SEMICONDUCTORS N.V. ALL RIGHTS RESERVED | MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE |
| TITLE: LGA 8 I/O, 3 X 5 X 1.25 PITCH, SENSOR 1.2MAX MM PKG | | DOCUMENT NO: 98ASA00260D REV: A |
| | | STANDARD: NON–JEDEC |
| | | SOT1768–1 07 JAN 2016 |

NOTES:

1. ALL DIMENSIONS IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
3. STYLE:

| | |
|---|---|
| PIN 1: VDD | PIN 5: INT2 |
| PIN 2: CAP | PIN 6: INT1 |
| PIN 3: GND | PIN 7: SDA |
| PIN 4: VDDIO | PIN 8: SCL |

| © NXP SEMICONDUCTORS N.V. ALL RIGHTS RESERVED | MECHANICAL OUTLINE | PRINT VERSION NOT TO SCALE |
|---|---|---|
| TITLE: LGA 8 I/O, 3 X 5 X 1.25 PITCH, SENSOR 1.2MAX MM PKG | DOCUMENT NO: 98ASA00260D | REV: A |
| | STANDARD: NON-JEDEC | |
| | SOT1768-1 | 07 JAN 2016 |

**Figure 3. Case 98ASA00260D, LGA package**

## 10 Soldering/landing pad information

The LGA package is compliant with the RoHS standard.

***Note:*** *Pin 1 index area marker does not have any internal electrical connections. Handling and soldering recommendations for pressure sensors are available in application notes AN1984 and AN3150.*

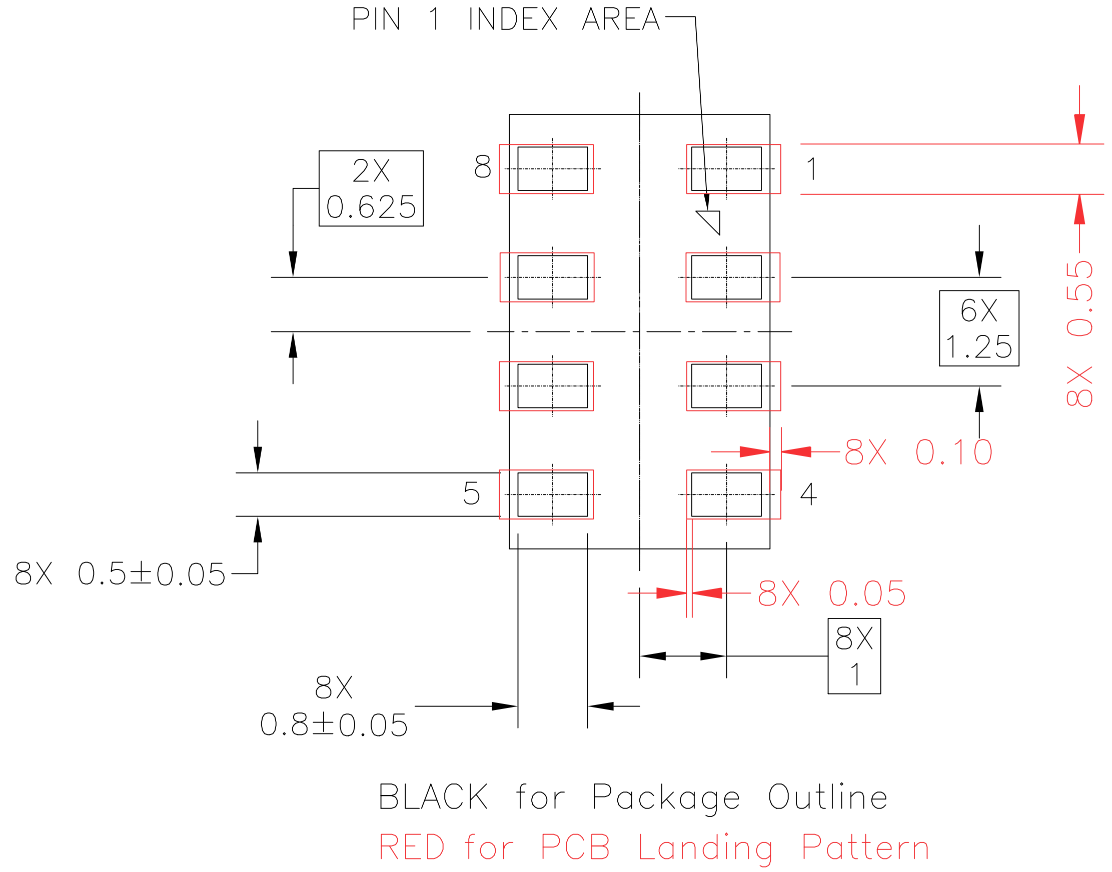
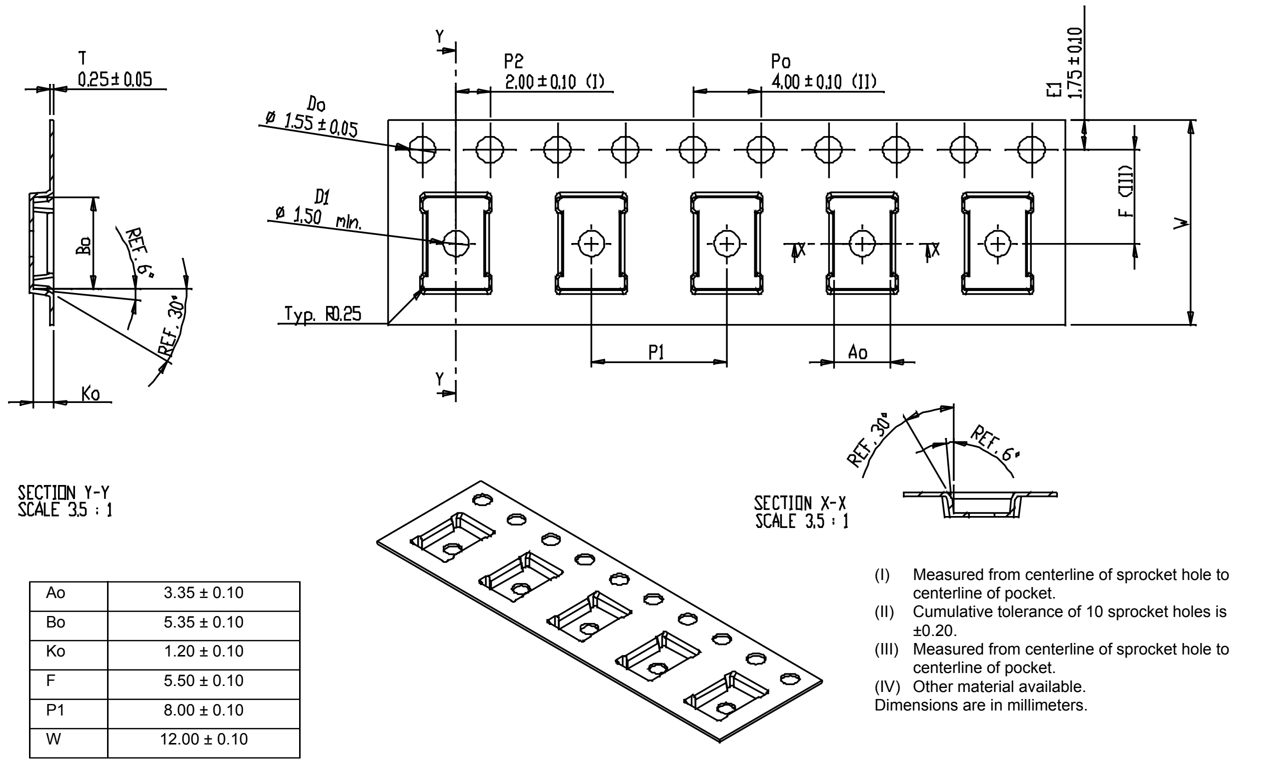



Figure 4. Recommended PCB landing pattern

# 11 Tape and reel specifications




| | |
|---|---|
| Ao | 3.35 ± 0.10 |
| Bo | 5.35 ± 0.10 |
| Ko | 1.20 ± 0.10 |
| F | 5.50 ± 0.10 |
| P1 | 8.00 ± 0.10 |
| W | 12.00 ± 0.10 |

(I) Measured from centerline of sprocket hole to centerline of pocket.
(II) Cumulative tolerance of 10 sprocket holes is ±0.20.
(III) Measured from centerline of sprocket hole to centerline of pocket.
(IV) Other material available.
Dimensions are in millimeters.

**Figure 5. LGA 3 mm × 5 mm embossed carrier tape dimensions**

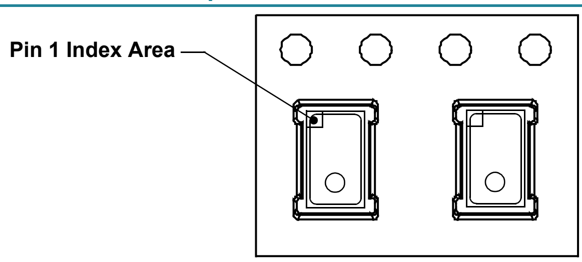



**Figure 6. Device orientation in chip carrier**

# 12 Revision history

**Table 7. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supercedes |
|---|---|---|---|---|
| FXPQ3115BVSDS v.1 | 20171009 | Technical data | n.a. | n.a. |

# 13 Legal information

## 13.1 Data sheet status

| Document status[1][2] | Product status[3] | Definition |
|---|---|---|
| [short] Data sheet: product preview | Development | This document contains certain information on a product under development. NXP reserves the right to change or discontinue this product without notice. |
| [short] Data sheet: advance information | Qualification | This document contains information on a new product. Specifications and information herein are subject to change without notice. |
| [short] Data sheet: technical data | Production | This document contains the product specification. NXP Semiconductors reserves the right to change the detail specifications as may be required to permit improvements in the design of its products. |

[1] Please consult the most recently issued document before initiating or completing a design.
[2] The term 'short data sheet' is explained in section "Definitions".
[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

## 13.2 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.

**Short data sheet** — A short data sheet is an extract from a full data sheet with the same product type number(s) and title. A short data sheet is intended for quick reference only and should not be relied upon to contain detailed and full information. For detailed and full information see the relevant full data sheet, which is available on request via the local NXP Semiconductors sales office. In case of any inconsistency or conflict with the short data sheet, the full data sheet shall prevail.

**Product specification** — The information and data provided in a technical data data sheet shall define the specification of the product as agreed between NXP Semiconductors and its customer, unless NXP Semiconductors and customer have explicitly agreed otherwise in writing. In no event however, shall an agreement be valid in which the NXP Semiconductors product is deemed to offer functions and qualities beyond those described in the technical data data sheet.

## 13.3 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** — NXP Semiconductors products are 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.

**Limiting values** — Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and (proper) operation of the device at these or any other conditions above those given in the Recommended operating conditions section (if present) or the Characteristics sections of this document is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

**Terms and conditions of commercial sale** — NXP Semiconductors products are sold subject to the general terms and conditions of commercial sale, as published at http://www.nxp.com/profile/terms, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NXP Semiconductors hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NXP Semiconductors products by customer.

**No offer to sell or license** — Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

**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.

**Non-automotive qualified products** — Unless this data sheet expressly states that this specific NXP Semiconductors product is automotive qualified, the product is not suitable for automotive use. It is neither qualified nor tested in accordance with automotive testing or application requirements. NXP Semiconductors accepts no liability for inclusion and/or use of non-automotive qualified products in automotive equipment or applications. In the event that customer uses the product for design-in and use in automotive applications to automotive specifications and standards, customer (a) shall use the product without NXP Semiconductors' warranty of the product for such automotive applications, use and specifications, and (b) whenever customer uses the product for automotive applications beyond NXP Semiconductors' specifications such use shall be solely at customer's own risk, and (c) customer fully indemnifies NXP Semiconductors for any liability, damages or failed product claims resulting from customer design and use of the product for automotive applications beyond NXP Semiconductors' standard warranty and NXP Semiconductors' product specifications.

**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.

## 13.4 Trademarks

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

**NXP** — is a trademark of NXP B.V.

## Contents





**Date of release: 9 October 2017**
**Document identifier: FXPQ3115BVSDS**