# BMA400
## Ultra-low power, triaxial accelerometer

## GENERAL DESCRIPTION

The BMA400 is the first real ultra-low power acceleration sensor without compromising on performance. Featuring 12-bit digital resolution, continuous measurement and a defined selectable bandwidth combined with ultra-low power the BMA400 allows low-noise measurement of accelerations in three perpendicular axes. The BMA400 thus senses tilt, orientation, tab/double tab, and enables plug 'n' play step counting with activity recognition especially suited for wearable devices, which need a long-lasting battery lifetime. Thanks to the continuous measurement principle and always-defined bandwidth, the BMA400 is the ideal solution for smart home applications such as smart indoor climate systems and smart home security systems. In the latter, the BMA400 can distinguish between real alarm situations like broken glass and false signals coming from random vibrations. Thereby, the new acceleration sensor avoids false alarms.

### BMA400 TARGET APPLICATIONS

▶ IoT and smart home applications (e.g. indoor climate systems, security systems)

▶ Activity tracking and step counting in wearable devices (e.g. fitness bands, smart and regular watches, hearables)

▶ Industrial applications (e.g. predictive maintenance, package tracking)

▶ Power management of consumer end-devices based on motion
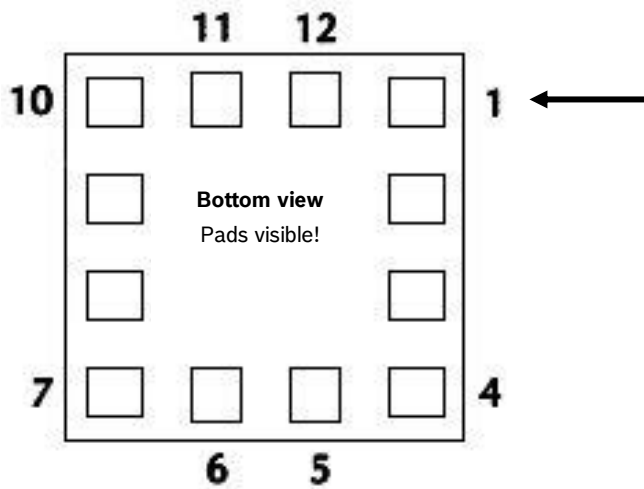
## SENSOR FEATURES

With its embedded features the BMA400 is unique in the class of ultra-low current accelerometers for wearable devices, smart home- and Internet of Things applications. The embedded step counter and activity recognition enables low current step-counting and activity tracking at only 4 µA overall current consumption. The plug'n' play step counter is optimized for wrist band usage and can also be used in other wearable devices. On top, the BMA400 integrates a multitude of other features (e.g. activity change, orientation, tab/double tab etc.) that facilitate its use especially in wearable devices and increase battery life significantly. Featuring continuous measurement and low pass filters in all power/noise configurations down to 3.2 µA, the BMA400 is robust to vibrations and aliasing. In an additional ultra-low power mode the current consumption can be reduced

even further, down to 800 nA. This mode offers an auto wake-up function to switch the sensor into any normal mode configuration when precise measurement is required. In addition, an auto ultra-low power feature is available to switch the sensor into its lowest current consumption configuration, when simple motion monitoring is needed. The BMA400 is highly configurable in terms of current consumption and noise performance in order to give the designer full flexibility when integrating the sensor into an always-on low power system. The integrated features enable the sensor to be used as main part of a power management unit.

| BMA400 Technical data | |
|---|---|
| **Measurement range** | ±2 g, ±4 g, ±8 g, ±16 g |
| **Digital resolution** | 12 bit |
| **Output Data Rate (ODR)** | 12.5 Hz to 800 Hz |
| **Low path filter bandwidth** | Selectable 0.48xODR or 0.24xODR |
| **Current consumption** (independent from ODR due to continuous measurement) | Max. performance: 14 µA<br>Typical use case: < 8 µA<br>Low power use case: < 4 µA |
| **Noise density** | Max. performance: < 220 µg/√Hz<br>Typical use case: < 320 µg/√Hz<br>Low power: < 600 µg/√Hz |
| **Ultra low power / Auto-wake-up mode** | 800 nA @ 25 Hz ODR |
| **Embedded features** | - Step counter (< 4 µA overall)<br>- Activity recognition (walking, running, standing still)<br>- Activity change<br>- Orientation<br>- Tab/Double tab (< 8 µA overall)<br>- General interrupt 1 and 2 (programmable via thresholds, timer, logical AND/OR operations)<br>- 1 kB FIFO |
| **Offset** | ±80 mg |
| **TCO** | ±1 mg/K |
| **Interface** | SPI & I²C & 2 Interrupt pins |
| **Supply voltage** | 1.71 V up to 3.6 V |
| **Package** | 12 pin LGA 2x2x0.95 m³ |

## TECHNICAL SPECIFICATIONS



Bottom view
Pads visible!

| Pin configuration | | |
|---|---|---|
| Pin | Name | Description |
| 1 | SDO | Serial data output in SPI<br>Address select in I²C mode |
| 2 | SDX | SDA serial data I/O in I²C<br>SDI serial data input in SPI 4W<br>SDA serial data I/O in SPI 3W |
| 3 | VDDIO | Digital I/O supply voltage<br>(1.2 V … 3.6 V) |
| 4 | NC | Do not connect |
| 5 | INT1 | Interrupt output 1 (default) |
| 6 | INT2 | Interrupt output 2 (default) |
| 7 | VDD | Power supply for analog & digital<br>domain (1.62 V … 3.6 V) |
| 8 | GNDIO | Ground for I/O |
| 9 | GND | Ground for digital & analog |
| 10 | CSB | Chip select for SPI mode |
| 11 | NC | Do not connect |
| 12 | SCX | SCK for SPI serial clock<br>SCL for I²C serial clock |

## SENSOR OPERATION

1) Standard data polling mode: Acceleration data is directly read-out via the sensor's digital interface and computed by a system µController or an application processor. Down to 3.2 µA the acceleration data on the interface is always continuously measured and has a defined selectable bandwidth. An integrated FIFO with 1 kB of size as well as auto wake-up and auto ultra-low power can be used optionally to reduce the overall system current consumption.

2) Plug 'n' play embedded functionality: Acceleration data is computed already within the BMA400. The embedded features of the sensor can trigger an interrupt at certain selectable events which can be mapped to the selectable interrupt pins. In addition to the electrical interrupt, the status of the events and the counted steps are stored in the register map and can be read out easily.

Embedded features:

▶ Step detector / Step counter
▶ Activity recognition: standing still, walking running
▶ Activity change (detects change of unspecific periodic activities)
▶ Orientation
▶ Tab/double tap
▶ General interrupt 1 und 2: programmable by threshold, timing, axes and logical AND/OR functionality.

Feature parameters can be configured by the designer and thus perfectly support the adoption to the required use case and system design.

## SYSTEM COMPATIBILITY

The BMA400 has been designed for best possible fit into modern wearable and IoT devices which are either non-chargeable or chargeable devices that require a long battery lifetime. Besides the lowest current consumption and superior performance, the BMA400 has very wide ranges for $V_{DD}$ and $V_{DDIO}$ supply voltages. The performance and the current consumption are stable over the whole voltage supply range. The BMA400 features I²C and SPI (3-wire/4-wire) digital, serial interfaces. The availability of data timestamping enables the synchronization of the acceleration data with other sensors connected to the same µController or application processor. This reduces the complexity of sensor data fusion and additionally improves its precision. BMA400 is designed for plug 'n' play functionality and ease-of-use in various system designs which require ultra-low current consumption on both sensor and system level.