

BMI160

Small, low-power Inertial Measurement Unit

Bosch Sensortec



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Invented for life

General Description

The BMI160 is a small, low-power, low-noise 16 bit Inertial Measurement Unit designed for use in mobile applications such as augmented reality or indoor navigation which require highly accurate, real-time sensor data. In full operation mode, with both the accelerometer and gyroscope enabled, the current consumption is typically 925 μ A, enabling always-on applications in battery driven devices. It is available in a compact 14-pin $2.5 \times 3.0 \times 0.8 \text{ mm}^3$ LGA package.

BMI160 target applications

- ▶ Augmented reality and immersive gaming
- ▶ 3D-scanning and indoor mapping
- ▶ Indoor navigation, pedestrian dead-reckoning and step-counting
- ▶ 6- and 9-axis sensor fusion, air mouse applications
- ▶ Optical image stabilization

BMI160 target devices

- ▶ Mobile phones and tablets
- ▶ Wearable devices such as smart watches, head mounted displays, sports and fitness devices
- ▶ Game controllers and smart remote controls
- ▶ Toys, e.g. quadcopters

Sensor features

Due to the built-in hardware synchronization of the inertial sensor data and its ability to synchronize data from external devices such as geomagnetic sensors, the BMI160 is ideally suited for augmented reality, immersive gaming and navigation applications which require highly accurate, low power and low latency 9-axis sensor data fusion. The BMI160 provides high precision sensor data together with a 39 μ s resolution time stamp generated by a real-time clock.

The BMI160 features a configurable on-chip interrupt engine which provides context awareness as always-on background functions. Examples of interrupts that can be issued in a power efficient manner without using soft-

Technical data	BMI160 (preliminary)
Package dimensions	$2.5 \times 3.0 \times 0.8 \text{ mm}^3$
Temperature range	-40...+85 °C
Supply voltage V_{DDIO}	1.2 ... 3.6 V
Supply voltage V_{DD}	1.71 ... 3.6 V
Typ. current consumption	
▶ Gyro @max. ODR	850 μ A
▶ Gyro+acc @max. ODR	925 μ A
▶ Gyro @fast start-up	500 μ A
▶ Acc. @full operation	180 μ A
▶ Suspend mode	3 μ A
▶ Significant motion	20 μ A
▶ Step detector	20 μ A
Sensitivity (typ.)	(A): $\pm 2\text{g}$: 16384LSB/g $\pm 4\text{g}$: 8192LSB/g $\pm 8\text{g}$: 4096LSB/g $\pm 16\text{g}$: 2048LSB/g
	(G): $\pm 125^\circ/\text{s}$: 262.4 LSB/ $^\circ/\text{s}$ $\pm 250^\circ/\text{s}$: 131.2 LSB/ $^\circ/\text{s}$ $\pm 500^\circ/\text{s}$: 65.6 LSB/ $^\circ/\text{s}$ $\pm 1000^\circ/\text{s}$: 32.8 LSB/ $^\circ/\text{s}$ $\pm 2000^\circ/\text{s}$: 16.4 LSB/ $^\circ/\text{s}$
TCS (typ.)	(A): $\pm 0.03 \text{ \%}/\text{K}$, (G): ± 0.02
Nonlinearity (typ.)	(A): 0.5 %FS, (G): 0.1%FS
Offset (typ.)	(A): $\pm 25 \text{ mg}$, (G): $\pm 3^\circ/\text{s}$
TCO (typ.)	(A): 1.0mg/K, (G): 0.05 $^\circ/\text{s}/\text{K}$
Noise density (typ.)	(A): 180 $\mu\text{g}/\sqrt{\text{Hz}}$ (G): 0.007 $^\circ/\text{s}/\sqrt{\text{Hz}}$
FIFO size	1024 byte
OS support/compatibility	Android \leq 4.4, Windows \leq 8.1

ware algorithms include: any- or no-motion detection, tap / double tap sensing, orientation detection, free-fall or shock events.

The smart built-in power management unit (PMU) can be configured, for example, to further lower the power consumption by automatically sending the gyroscope into fast start-up mode and waking it again based on the any-motion interrupt of the accelerometer. By allowing the host to sleep longer, the PMU significantly contributes to power saving on system level.

The integrated 1024 byte FIFO buffer supports low-power applications and prevents data loss in non-real-time systems. The intelligent FIFO architecture allows dynamic re-allocation of FIFO space for accelerometer, gyroscope and external sensors, respectively. For a 6-axis application at 25Hz ODR, this is sufficient for approximately three seconds of data capture. In a typical 9-axis application – including the geomagnetic sensor – this is sufficient for approximately two seconds.

System compatibility

With a footprint of $2.5 \times 3.0 \text{ mm}^2$ and a package height of only 0.8 mm, BMI160 can easily be designed into devices with miniaturized PCBs.

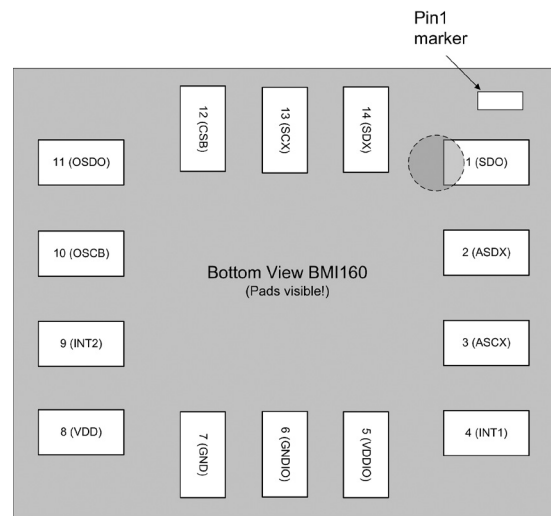
The accelerometer and the gyroscope of the BMI160 both have 16 bit digital resolution. The product offers a wide V_{DD} voltage range from 1.71V to 3.6V and a V_{DDIO} range from 1.2V to 3.6V, allowing the BMI160 to be powered at 1.8V for both V_{DD} and V_{DDIO} .

In mobile phone applications, the BMI160 fulfills the requirements of most standard operating systems. The device is Android 4.4 (Kitkat) and Windows 8.1 compliant. Significant motion and step detector interrupts have been implemented in a power-efficient manner and consume less than 20µA each.

Additional Bosch Sensortec sensors, e.g. geomagnetic (BMM series) or pressure sensors (BMP series) can be connected as slaves via a secondary I²C interface. In this configuration, the BMI160 controls the data acquisition of the external sensor and the data of all sensors is made available via the built-in FIFO.

In addition to the flexible primary interface (I²C@max. 1MHz or SPI@max. 10MHz) used to connect to the host, BMI160 provides an additional high speed interface. This secondary SPI interface supports OIS (optical image stabilization) and EIS (electronic image stabilization) applications in conjunction with camera modules or advanced gaming use cases.

Pin configuration (top view)



Pin	Name	Description
1	SDO	Serial data output in SPI Address select in I ² C mode
2	ASDx	Magnetometer interface
3	ASCx	Magnetometer interface
4	INT1	Interrupt pin 1
5	VDDIO	Digital I/O supply voltage (1.2 ... 3.6V)
6	GNDIO	Ground for I/O
7	GND	Ground for digital & analog
8	VDD	Power supply analog & digital domain (1.62V – 3.6V)
9	INT2	Interrupt pin 2
10	OCSB	Secondary SPI interface
11	OSDO	Secondary SPI interface
12	CSB	Chip select for SPI mode
13	SCx	SCK for SPI serial clock SCL for I ² C serial clock
14	SDx	SDA serial data I/O in I ² C SDI serial data input in SPI 4W SDA serial data I/O in SPI 3W

Headquarters Bosch Sensortec GmbH

Gerhard-Kindler-Strasse 9
72770 Reutlingen · Germany
Telephone +49 7121 3535 900
Fax +49 7121 3535 909
contact@bosch-sensortec.com
www.bosch-sensortec.com

AMEYA360

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➤ Address :

401 Building No.5, JiuGe Business Center, Lane 2301, Yishan Rd
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➤ Sales :

Direct +86 (21) 6401-6692
Email amall@ameya360.com
QQ 800077892
Skype ameyasales1 ameyasales2

➤ Customer Service :

Email service@ameya360.com

➤ Partnership :

Tel +86 (21) 64016692-8333
Email mkt@ameya360.com