

BHV160

Small, low-power Vital Sensor Hub with integrated Inertial Measurement Unit

Bosch Sensortec



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General Description

The BHV160 is a small, low-power Sensor Hub with integrated MEMS sensors specifically designed to enable heart rate and motion evaluation in fitness and wellbeing applications with enhanced user experience. The device integrates our best-in-class 6-axis IMU (BMI160) with the new Bosch Sensortec Fuser Core. The device fuses photo-plethysmography (PPG) signals with the onboard inertial MEMS sensor signals for robust, motion compensated heart rate measurement. The Fuser Core powers Firstbeat's field-proven vital analytics algorithms, translating the fused heartbeat data into rich, user-friendly personal insights. The BHV160 is specifically designed for sensor based always-on applications in wearable devices such as smartwatches, fitness wristbands, earphones, smart shoes and textiles.

BHV160 target applications

- ▶ Heart rate sensing and Vital Analytics
- ▶ Activity recognition, including pedestrian dead-reckoning and step-counting
- ▶ Full Android compliant sensor fusion, including gesture detection for motion based user interfaces

BHV160 target devices

- ▶ Smartwatches and smart glasses
- ▶ Wearable devices such as fitness wristbands, earphones, smart shoes and textiles

Sensor features

The BHV160 provides an ideal all-in-one-solution for sensor based always-on sensor applications such as fitness level and training effect analysis, sleep quality and body stress, tracking of physical activity and calorie consumption based on Firstbeat's powerful vital analytics algorithms.

Additionally, with the integration of the powerful Bosch Sensortec BSX Sensor Fusion library, the BHV160 enables always on sensor features like activity and gesture recognition. By significantly offloading the main application processor from these tasks the BHV160 maximizes system operational battery time.

Technical data	BHV160 (preliminary)
Package dimensions	3.0 × 3.0 × 0.95 mm ³
Temperature range	-40...+85 °C
Supply voltage V _{DD}	1.71...3.6 V
Supply voltage V _{DDIO}	1.6...3.3 V
Typ. current consumption	
▶ Full 9DoF Fusion @100 Hz ODR ¹	1,59 mA
▶ Hub+IMU @100 Hz ODR	1,15 mA
▶ Hub+Gyro @100 Hz ODR	1 mA
▶ Hub+Acc @100 Hz ODR	310 µA
▶ Hub+PPG @1 Hz ODR ²	788 µA
▶ Step counter ³	70 / 239 µA
▶ Suspend mode	11 µA
Sensor Fusion Performance	
▶ Static accuracy ¹ (Head., Pitch, Roll)	2, 2, 2 degrees
▶ Dynamic accuracy (Head., Pitch, Roll)	7, 2, 2 degrees
▶ Heart Rate ⁴	<2 bpm
▶ Calorie consumption	<7%
▶ Step counting error	<5% ⁵
▶ Activity recognition accuracy	Precision: 85...97% ⁶ Recall: 83...95% ⁶
Implemented Sensor Types ⁷ (with integrated IMU only)	Accelerometer, Gravity, Linear accel, Gyroscope, Gyroscope uncalibrated, Game rotation vector, Step counter, Step detector, Significant motion, Tilt detector, Pickup gesture, Wake up gesture, Glance gesture (Activity recognition)
(with attached PPG frontend)	Heart Rate Heart Rate Variability Calorie consumption

¹ With additional magnetometer

² Motion compensation active; 8mA LED on current

³ Still / in motion

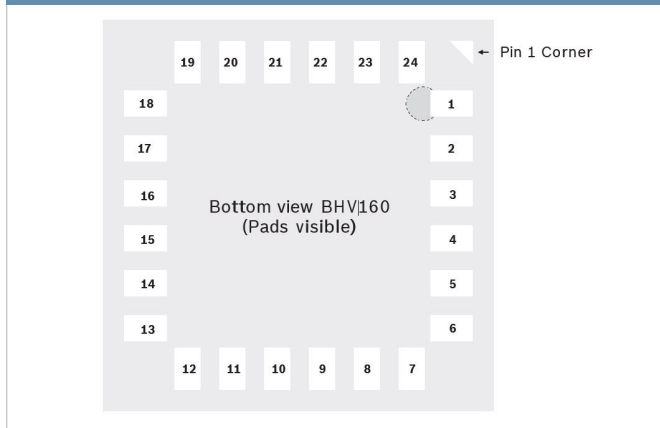
⁴ Measured at rest

⁵ False positives <9 counts within 5 min while driving

⁶ Dependent on activity magnetometer

⁷ Full Android Lollipop stack is supported by connecting additional sensors to the BHV160

Pin configuration (bottom view)



In conjunction with the available interrupt lines and the high speed I²C interface, which can transfer up to 3.4 MBit/s, the BHV160 optimizes data transmission to the host CPU making further positive contribution for an optimized system power consumption.

The integrated Fuser Core is a 32-bit floating-point microcontroller that is optimized to execute sensor fusion and activity recognition algorithms with ultralow power consumption. It uses significantly less power than standard microcontrollers. The BHV160 implements the full Android Lollipop sensor stack and can be updated with new software features to support future requirements. The internal RAM memory can be used for feature extension and/or data buffering in a very flexible way, giving a high degree of flexibility to the system designer.

The BHV160 is available in a 3.0 x 3.0 x 0.95 mm³ LGA package, simplifying the integration of the sensor hub into miniaturized PCBs, reducing the bill of materials, and saving valuable PCB space compared to solutions based on standard microcontrollers.

The device is compatible with a wide range of available PPG chipsets, giving customers the flexibility to support different configurations, opening a wide space for architectural decisions.

Pin	Name	Description
1	NC	Not connected
2	RESV1	Do not connect pin (reserved)
3	GPIO1	Application specific I/O pin
4	RESV2	Do not connect pin (reserved)
5	RESV3	Do not connect pin (reserved)
6	NC	Not connected
7	ASCK	I ² C Master serial clock, for connection of external sensors
8	VDDIO	Digital I/O power supply voltage (1.6 ... 3.3 V)
9	SA_GPIO7	Select I ² C address (I ² C Slave Address LSB) / Application specific I/O pin
10	VREG	Select I ² C address (I ² C Slave Address LSB) / Application specific I/O pin
11	GPIO2	Regulator filter capacitor connection
12	INT	Host interrupt
13	VDD	Analog power supply voltage (1.71 V ... 3.6 V)
14	NC	Not connected
15	NC	Not connected
16	NC	Not connected
17	NC	Not connected
18	GND	Analog power supply ground
19	NC	Not connected
20	GNDIO	Digital I/O power supply ground
21	ASDA	I ² C master serial data, for connection of external sensors
22	RESV4	Reserved
23	SCK	I ² C serial clock (Host interface)
24	SDA	I ² C serial data (Host interface)

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