

BM-SP10/SP11

BLUETOOTH LOW ENERGY SENSOR POD

Datasheet

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Preliminary Version

General Description

The BM-SP10/SP11 Sensor Pod is an ultra-low-power, high-performance and fully integrated Bluetooth low energy device with an integrated high-resolution and low-noise MEMS acceleration and temperature sensor. A 32-bit MCU can be exploited to implement advanced algorithms based on sensor data.

The small and robust pod comes in a simple, space optimized housing. Utilizing the available operating modes typically results in years of battery life. The unit has been optimized for low-cost and is disposable.

The BM-SP10/SP11 could be either shipped with a pre-programmed bootloader allowing to wirelessly program and update an application or with a pre-programmed application still allowing application updates later on. It can be delivered in any quantity with guaranteed unique ID. A unique QR code containing the ID is printed on the pod for optical scanning.

The BM-SP10/SP11 is compatible with major beacon formats including iBeacon™ and also Eddystone™. The pod is fully customizable over the air or in manufacturing.

The BM-SP10/SP11 is Bluetooth 5.2, FCC, IC, and CE certified, RoHS and REACH compliant.



Features

- Standard version already supporting iBeacon™ and Eddystone™ with rich set of configurable parameters
- Long battery lifetime
 - Fully optimized ultra-low-power design
 - State-of-the-art processing unit, sensor and radio
 - Highly efficient algorithms for motion detection
- Small and robust:
 - 30mm diameter, 9mm height for CR2032
 - 34mm diameter, 11mm height for CR2450
- Low-cost and disposable
- Accelerometer can be used to activate pod on motion or gesture
- Secure wireless update with major mobile platforms
- Up to 300m line-of-sight transmission range
- Temperature range from -20°C to +60°C
- Push button, green and red LED

TABLE OF CONTENTS

1.	GENERAL DESCRIPTION	3
1.1	HARDWARE	3
1.2	FIRMWARE	3
2.	ENVIRONMENTAL AND STORAGE CONDITIONS	3
3.	PRODUCT DIMENSIONS	4
4.	ELECTRICAL	4
4.1	ABSOLUTE MAXIMUM RATINGS	4
4.2	GENERAL OPERATING CONDITIONS	4
4.3	ELECTRICAL CHARACTERISTICS	5
4.4	REGULATORY	7
5.	MARKING	7
5.1	SERIAL NUMBER	7
6.	OUTGOING QUALITY CONTROL	7
7.	ENVIRONMENTAL RESPONSIBILITY	7
7.1	RESTRICTION OF HAZARDOUS SUBSTANCES (ROHS)	7
7.2	"HALOGEN FREE" - IEC 61249-2-21:2003	7
7.3	REACH AND SVHC LIST	7
7.4	PRODUCT HARDWARE RECYCLING (WEEE)	8
8.	REFERENCE DOCUMENTS	8

1. GENERAL DESCRIPTION

1.1 HARDWARE

The BM-SP10/SP11 is a very thin sensor pod containing a Bluetooth V5.2 SoC, a sensor unit for high-precision 3 axis acceleration and temperature measurement and memory for data storage as shown in Figure 1. The pod is able to calculate parameters out of sensor data and transmit them real-time to a mobile device or gateway or to store data locally, which then can be downloaded later. The device firmware can also be updated over-the-air. The sensor pod works with all major mobile device platforms.

The device is suitable for all weather conditions. It contains a changeable CR2032 or CR2450 battery and depending on the operating requirements it is able to achieve a battery life of several years. RF connections can be maintained at up to 300m away.

On demand pushing the top of the casing will trigger a tactile switch. For optical feedback a green and a red LED are available, but would require a customized (semi)transparent casing.

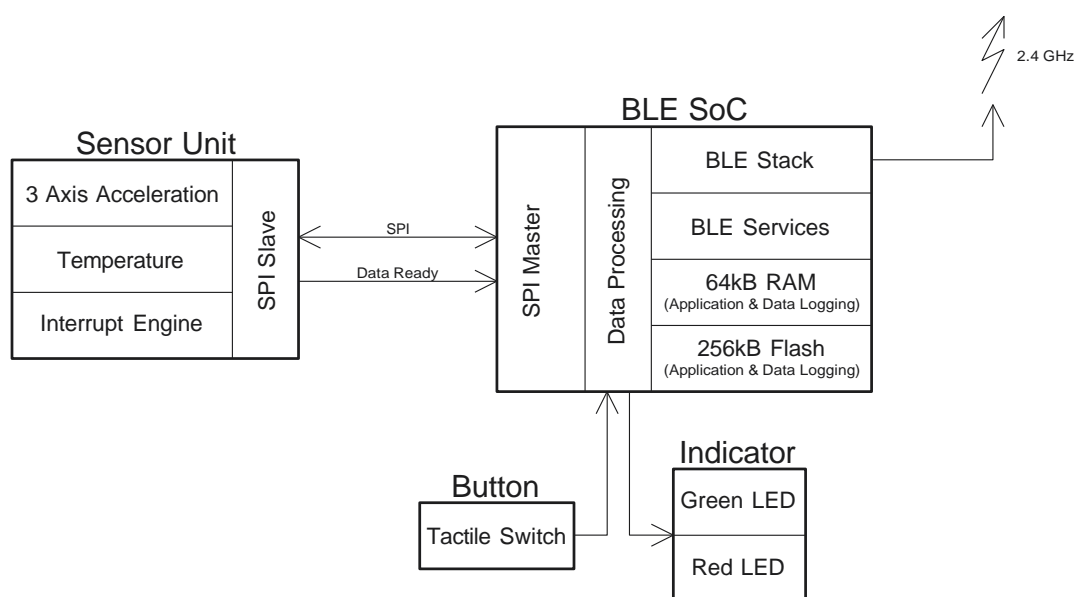


Figure 1: Block Diagram

1.2 FIRMWARE

The SoC allows to run both the application and the BLE stack in parallel in a very efficient and flexible way due to its 32-bit MCU. Implementing highly efficient sensor data processing algorithms is possible due to the available processing power.

An advanced power management system implemented on the SoC supports several active, standby and sleep modes of operation so that all not required parts of the device can be switched off on demand.

The 2.4GHz RF system on chip supports Bluetooth V5.2 low energy applications and a sensitivity of -97dBm @ 1Mbps and -104dBm @ 125kbps.

2. ENVIRONMENTAL AND STORAGE CONDITIONS

The environmental and storage conditions are listed in Table 1.

Table 1: Environmental and Storage Conditions	
Sensor Pod operating temperature and humidity range	-20°C to 60°C and 0 to 90% RH
Sensor Pod storage temperature and humidity range	Pods must be stored at Temp=25°C±10°C / RH≤70%.

3. PRODUCT DIMENSIONS

The BM-SP10/SP11 sensor pod outline dimensions are shown in Figure 3 below.

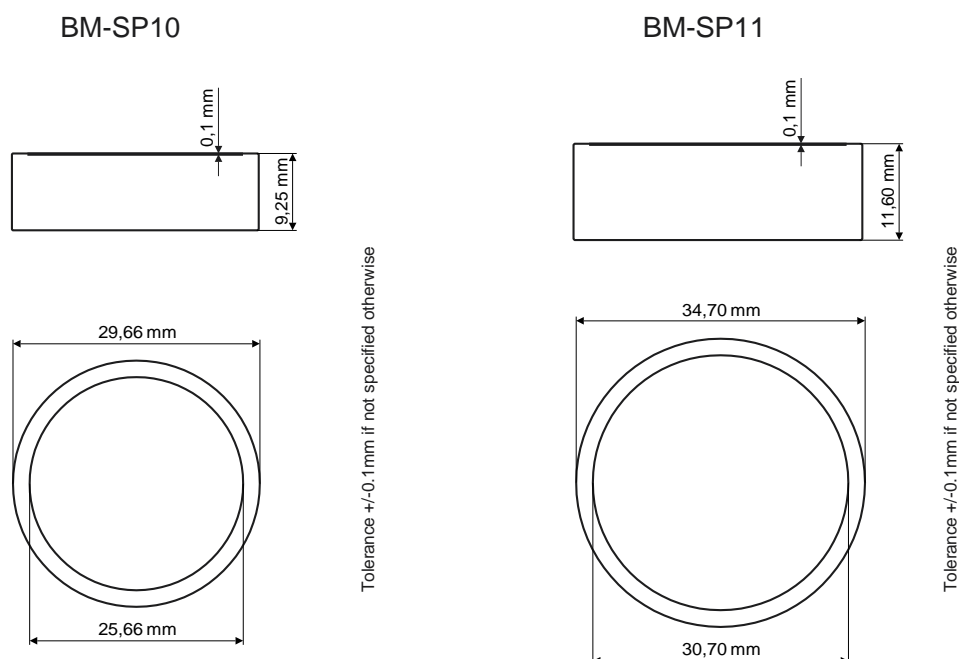


Figure 3: Finished product dimensions

4. ELECTRICAL

Typical values are stated at room temperature ($T=25^{\circ}\text{C}$) with a supply voltage of $V_{CC}=3.0\text{V}$.

4.1 ABSOLUTE MAXIMUM RATINGS

The absolute maximum ratings of BM-SP10/SP11 are listed in Table 2.

Table 2: Absolute Maximum Ratings			
Parameter	Min	Max	Unit
Supply Voltage $V_{CC} - V_{SS}$	-0.3	3.6	V

Stresses above these listed maximum ratings may cause permanent damage to the device. Exposure beyond specified operating conditions may affect device reliability or cause malfunction.

The Sensor Pod is compliant with EN 61000-4-2 (Electrostatic Discharge) level 2: 4kV contact discharge and 4kV air discharge.

4.2 GENERAL OPERATING CONDITIONS

The general operating conditions of the BM-SP10/SP11 are listed in Table 3.

Table 3: General Operating Conditions				
Parameter	Min	Typ	Max	Unit
Supply Voltage (Battery operating supply range)	1.8	3.0	3.3	V
Temperature range	-20	25	+60	$^{\circ}\text{C}$

The BM-SP10/SP11 Sensor Pod includes a battery compliant with these conditions.

4.3 ELECTRICAL CHARACTERISTICS

The radio parameters of BM-SP10/SP11 are given in Table 4.

Table 4: Radio Parameters			
Parameter	Specification	Typ	Unit
Radio protocol	Bluetooth V5.2		
Output Power		0	dBm
Sensitivity	@ 1Mbps	-97	dBm
Sensitivity	@ 125kbps	-104	dBm
Range	Line-of-sight	300	m

The battery capacity of BM-SP10/SP11 is given in Table 6.

Table 5: Battery Capacity, T = 25°C			
Parameter	Specification	Typ	Unit
Usable battery capacity	CR2032 version @ 0dBm	220	mAh
	CR2450 version @ 0dBm	540	mAh

The current consumption in different operating modes of BM-SP10/SP11 are given in 6. The current consumption of the listed operating modes could be summed up to get an estimation of the overall system current consumption if as an example sensors are active while connected or while advertising.

Table 6: Average Current Consumption, T = 25°C			
Operating Mode	Specification	0dBm Typ	Unit
Sleep Mode	Motion detection, 1.6Hz sampling rate	2.1	µA
Advertising, interval 1s	iBeacon data format, no sensor active	14.5	µA
Advertising, interval 10s	iBeacon data format, no sensor active	2.6	µA
Advertising, interval 1min	iBeacon data format, no sensor active	1.8	µA
Advertising, interval 10min	iBeacon data format, no sensor active	1.6	µA
Connected, interval 1s	No sensor active	7.5	µA
Data acquisition	No radio, 1.6Hz sampling rate	2.2	µA
Data acquisition	No radio, 12.5Hz sampling rate	3.4	µA
Data acquisition	No radio, 25Hz sampling rate	4.9	µA
Data acquisition	No radio, 50Hz sampling rate	7.8	µA
Data acquisition	No radio, 100Hz sampling rate	13.1	µA
Data acquisition	No radio, 200Hz sampling rate	24.3	µA
Data acquisition	No radio, 400Hz sampling rate	99.7	µA
Memory download	10.0kB/s data rate, no sensor active	3.9	mA

The battery lifetime in different operating modes of BM-SP10/SP11 with CR2032 is given in Table 7.

Table 7: Average Battery Lifetime for CR2032 Version, T = 25°C			
Operating Mode	Specification	0dBm Typ	Unit
Sleep Mode	Motion detection, 1.6Hz sampling rate	143	months
Advertising, interval 1s	iBeacon data format, no sensor active	20	months
Advertising, interval 10s	iBeacon data format, no sensor active	115	months
Advertising, interval 1min	iBeacon data format, no sensor active	166	months
Advertising, interval 10min	iBeacon data format, no sensor active	187	months

The battery lifetime in different operating modes of BM-SP10/SP11 with CR2450 is given in Table 8.

Operating Mode	Specification	0dBm Typ	Unit
Sleep Mode	Motion detection, 1.6Hz sampling rate	340	months
Advertising, interval 1s	iBeacon data format, no sensor active	50	months
Advertising, interval 10s	iBeacon data format, no sensor active	273	months
Advertising, interval 1min	iBeacon data format, no sensor active	379	months
Advertising, interval 10min	iBeacon data format, no sensor active	431	months

Mechanical characteristics of the acceleration sensor used in BM-SP10/SP11 are given in Table 9.

Parameter	Test conditions	Typ.	Unit
Measurement range		±2	g
		±4	
		±8	
		±16	
Sensitivity	@ Range ±2g	0.244	mg/digit
	@ Range ±4g	0.488	
	@ Range ±8g	0.976	
	@ Range ±16g	1.952	
RMS noise in low-power mode	@ Range ±2g	2.4	mg(RMS)
Zero-g level offset accuracy		±20	mg
Zero-g offset change vs. temperature		±0.2	mg/°C
Sensitivity change vs. temperature		0.01	%/°C

Temperature sensor characteristics of the sensor used in BM-SP10/SP11 are given in Table 10.

Parameter	Typ	Unit
Temperature accuracy (0°C to 40°C)	±0.5	°C
Temperature accuracy (-20°C to 60°C)	±1.0	°C
Temperature refresh rate in high-performance mode	50	Hz
Temperature refresh rate in low-power mode for ODR ≥ 50Hz	50	Hz
Temperature refresh rate in low-power mode for ODR ≤ 25Hz	ODR	Hz

Operating mode parameters of the acceleration sensor used in BM-SP10/SP11 are given in Table 11.

Parameter	High-Performance Mode	Low-Power Mode
Resolution [bit]	14-bit	14-bit
Output datarate ODR [Hz]	12.5 – 1600	1.6 - 200
Bandwith BW [Hz]	ODR/2 (N/A for 1600 Hz), ODR/4, ODR/10, ODR/20	720 ODR/4, ODR/10, ODR/20
Typ. noise density [$\mu\text{g}/\sqrt{\text{Hz}}$] @ Range = ±2g, ODR = 200Hz	120	350
Typ. current consumption [μA]	ODR = 1.6Hz	-
	ODR = 12.5Hz	90
	ODR = 25Hz	90
	ODR = 50Hz	90
	ODR = 100Hz	90
	ODR = 200Hz	90
	ODR = 400, 800, 1600Hz	90

4.4 REGULATORY

BM-SP10/SP11 complies with the following regulatory requirements:

USA-FCC:

Part 15 – General emissions

Part 15.247:2011 – Operation within the band 2.4-2.4835GHz

Parts 15.205 and 15.209 – Spurious emissions

Canada-IC:

ICES-003 – General emissions

Europe-CE:

BM innovations GmbH, as the responsible party for regulatory compliance, declares under our sole responsibility that as delivered the described product is in conformity with the RED Radio Equipment Directive 2014/53/EU, following the provisions of ERP Directive 2009/125/EC, EU RoHS Directive 2011/65/EU and carries the CE-marking.

SAFETY File:

Information on all plastics (flame rating and UL listing) model numbers

Battery: Specification, UL listing, and reports from vendor (Standards are UL 1642 and IEC/EN 62133)

PCB Board (same info as plastics)

5. MARKING

Each pod is uniquely laser marked with a serial number and 2D QR-code.

5.1 SERIAL NUMBER

The serial number is the same as the internal MAC address of the Bluetooth chip, with a format of xx:xx:xx:xx:xx:xx.

6. OUTGOING QUALITY CONTROL

OQC is performed according to General Inspection Level II, AQL=0.65%.

It includes a visual inspection and functional test (RF).

7. ENVIRONMENTAL RESPONSIBILITY

7.1 RESTRICTION OF HAZARDOUS SUBSTANCES (ROHS)

BMi Product (BM-SP10/SP11) is compliant with the EU RoHS Directive 2015/863/EU (European Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment).

7.2 "HALOGEN FREE" - IEC 61249-2-21:2003.

BMi Product (BM-SP9) is compliant with the international standard IEC 61249-2-21:2003.

7.3 REACH AND SVHC LIST

BMi Product (BM-SP10/SP11) is compliant with the EU Regulation 1907/2006 (REACH) and the SVHC list (Substances of Very High Concern).

7.4 PRODUCT HARDWARE RECYCLING (WEEE)

The Directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE) aims to reduce the waste arising from electrical and electronic equipment, and improve the environmental performance of everything involved in the life cycle of electrical and electronic equipment.

Instructions for Disposal of Waste Equipment by Users in Private Households
This symbol on the product or on its packaging indicates that this product must not be disposed of with your other household waste. Inappropriate disposal may be harmful. Instead, it is your responsibility to dispose of your waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste equipment for recycling, please contact your local city office, your household waste disposal service or the sales point where you purchased the product.



Responsibilities:
BMi is committed to meeting the requirements of the European Union's WEEE Directive. However, the end user has the responsibility of recycling of the BMi Product after its end of life. BMi Customer can send back the collected BMi Product to BMi at DAP conditions (Delivery at Place). If the Lithium batteries are included in the air freight shipment, IATA DGR (Dangerous Goods) rules are to be applied.

Specifics on battery:

The Directive 2012/19/EU does apply to batteries and requires their removal from the electronic equipment and their separate collection. Once removed from equipment, used batteries are governed by the Batteries Directive 2006/66/EC.

8. REFERENCE DOCUMENTS

Bluetooth Specification V5.2.

9. ORDER CODE

Sensor Pods being pre-programmed with a Bootloader are available as standard devices and do not need customization. Sensor Pods pre-programmed also with an Application Firmware are customized devices and will get a customer&app specific code (xxx):

Device	Order code
BM-SP10 with CR2032, only Bootloader pre-programmed	BM-SP10-BL
BM-SP11 with CR2450, only Bootloader pre-programmed	BM-SP11-BL
BM-SP10 with CR2032, Bootloader and App pre-programmed	BM-SP10-Cxxx
BM-SP11 with CR2450, Bootloader and App pre-programmed	BM-SP11-Cxxx

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- replacement of a battery with an incorrect type that can defeat a safeguard (for example, in the case of some lithium battery types);
- disposal of a battery into fire or a hot oven, or mechanically crushing or cutting of a battery, that can result in an explosion;
- leaving a battery in an extremely high temperature surrounding environment that can result in an explosion or the leakage of flammable liquid or gas; and
- a battery subjected to extremely low air pressure that may result in an explosion or the leakage of flammable liquid or gas.

FCC Compliance Statements

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Radiation Exposure statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

ISED Compliance Statements

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

- (1) This device may not cause interference.
- (2) This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes :

- (1) L'appareil ne doit pas produire de brouillage;
- (2) L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

ISED Radiation Exposure statement

This equipment complies with IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Cet équipement est conforme aux limites d'exposition aux radiations IC CNR-102 établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec une distance minimale de 20cm entre le radiateur et votre corps. Cet émetteur ne doit pas être colocalisé ou fonctionner en conjonction avec une autre antenne ou un autre émetteur.