BM11

Movement & Breathing Sensor

OEM Installation Instructions

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About the BM11 Movement & Breathing Sensor

The BM11 sensor is a complete non-contact breathing detector on a small circuit board. The sensor uses Radio Frequency, centred on 10.525 GHz, which is a license-free operating band. The BM11 is designed to be easily incorporated into Original Equipment Manufacturers' own products, where the breathing rate and rhythm of a subject is required.

The key features are:

- Small antenna horn: easy to incorporate the circuit board into another product.
- Slender and enclosed circuitry: gives maximum flexibility in enclosure design.
- Very low emitted power, less than home broadband router or mobile phone BlueTooth.
- Non-contact: ease of use and comfort for the customer.
- Very short range: the sensor is selective.

The sensor has 2 channels, I and Q, providing movement and breathing data. The sensor data is provided as an analogue signal.

BM11 Technology Overview

The sensor module is designed to emit very low power RF waves that are reflected by a human subject within the field of the sensor. The reflected waves received by the sensor contain information about the motion of the human subject based on the Doppler Effect. The system detects movement of the subject due to breathing and also due to change in position.

The sensor module translates the movement of the human subject into electrical signals. To maximise the information obtained from the sensor, the signals are converted into two voltage signals. These signals are referred to as the 'I' and 'Q' channels. The sensor module outputs these two analogue voltage signals and they are presented to the OEM host device for digitising.

There is a companion software library available, that extracts breathing, movement and sleeping information from the sensor data. This software library can reside within the OEM application and provide the information under the application's control. See BiancaMed product specification BM012_DES01 for details.

Module Specifications

The BiancaMed BM11 Sensor is a 10.525GHz motion detector. It comprises a motherboard PCBA, an integral RF PCBA, die cast RF metalwork and a custom plastic anti-tamper enclosure.

Physical Specifications

Parameter	Value	Remarks
Circuit board dimensions	44.5mm by 77.5mm by 6 mm	See diagram below
Complete assembly (including anti-tamper enclosure) dimensions	63.75mm (x) by 79.3mm (y) by 10mm (z) main body of enclosure,	13.8 mm (z) at enclosure hump 22.5mm (z) max by horn, see Figure 2 below
Complete assembly weight	<100 gm	

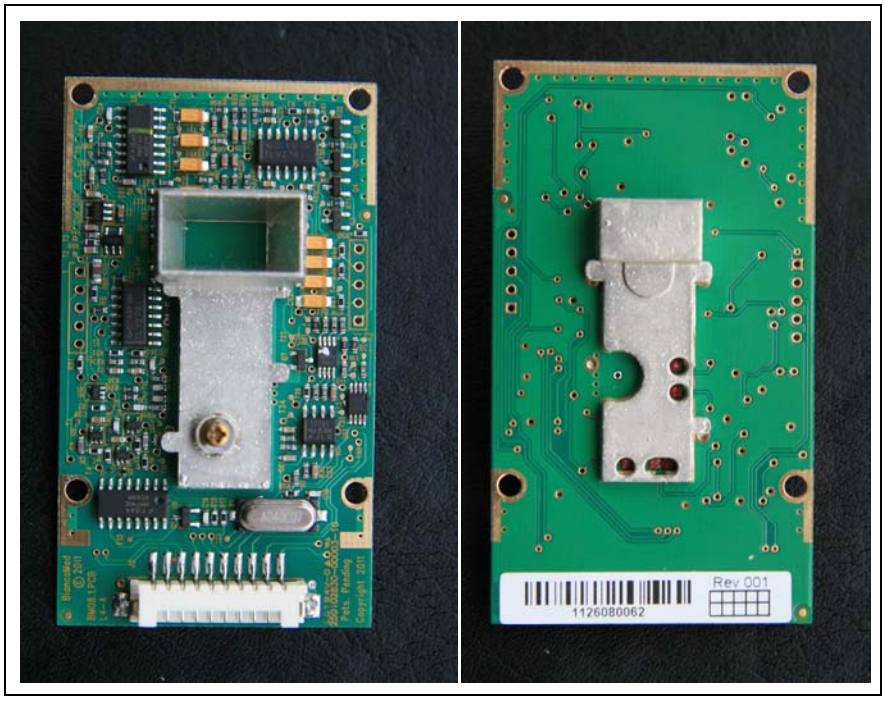

Figure 1: PCB Layout, showing the Antenna Horn on the top side and the connector at the bottom

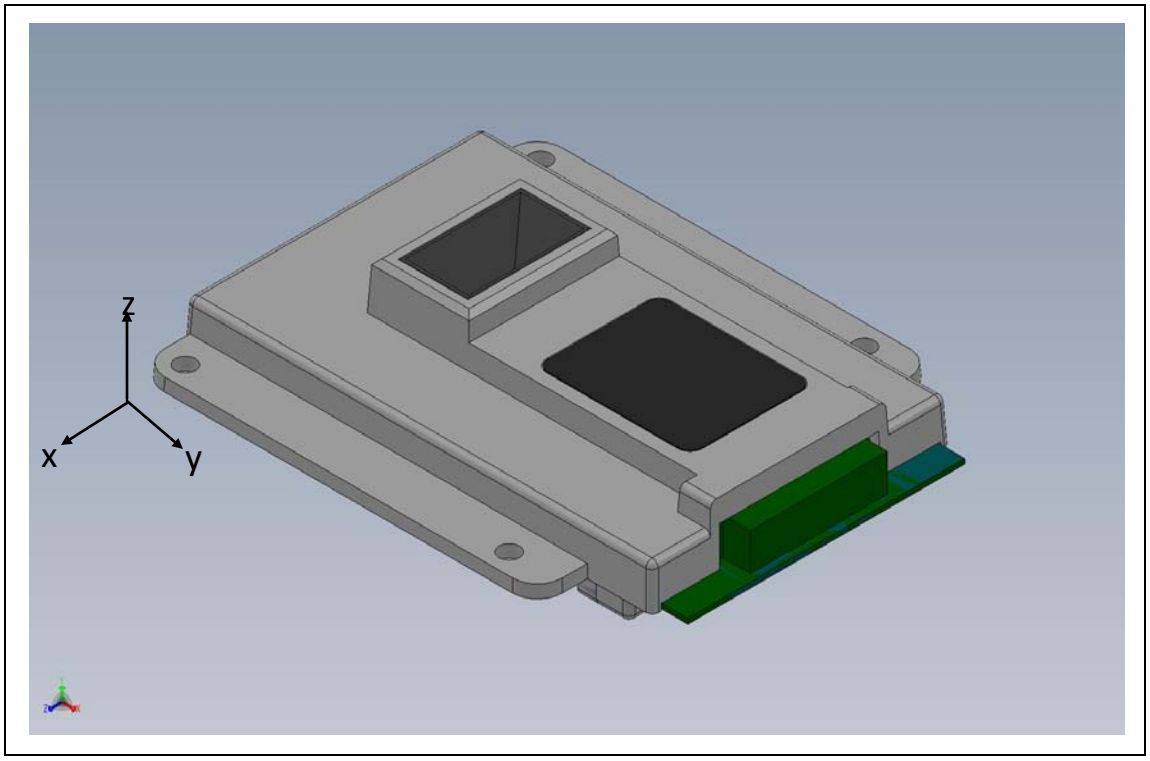

Figure 2: 3-D Model of PCB Enclosed in Anti-Tamper Enclosure

NB: A Solidworks 3D model is available from BiancaMed upon request.

Radio Frequency Sensor Specifications

Parameter	Value	Remarks
Centre frequency f_c	10.525 GHz	+/- 10 MHz
Peak RF power (conducted at antenna)	2 dBm nominal power	(Rated power +/- 50%)
Spurious Conducted Power	<-26dBm	
OBW (99%)	OBW will lie within f_c±15 MHz and OBW will be ≤18 MHz	
RF t/x Pulse	1000nS	
PRF	500 KHz	
RF Duty Cycle	50%	
Antenna Type	Broadside pyramidal HORN reflector antenna with planar monopole feed.	
Antenna Gain	6 dBi @ f_o	f_o = fundamental frequency
Antenna Beam width Azimuth*	60-70 degrees (3dB)	see sample beam pattern below at Figure 3a

Parameter	Value	Remarks
Antenna Beam width Elevation*	50-60 degree (3dB)	see sample beam pattern below at Figure 3b
Typical breathing detection range	Can detect bio-motion signals inside 1.5M. Cannot be measured outside 1.8M.	Target aspect is not important, ie the target can be sitting, lying down, face up face down, on side etc.
Comply with following Regulatory Approval Specifications:	ARIB-std T73v1.1 Electrical safety: IEC60065:2005 EMC & ESD: IEC60601-1, 1-2 (2nd) FCC part 15.245	

- *The antenna characterization applies to the unhoused sensor module – antenna characteristics may vary when inserted into an OEM housing – it is the responsibility of the system integrator to ensure that the final antenna characteristics are fit for purpose.

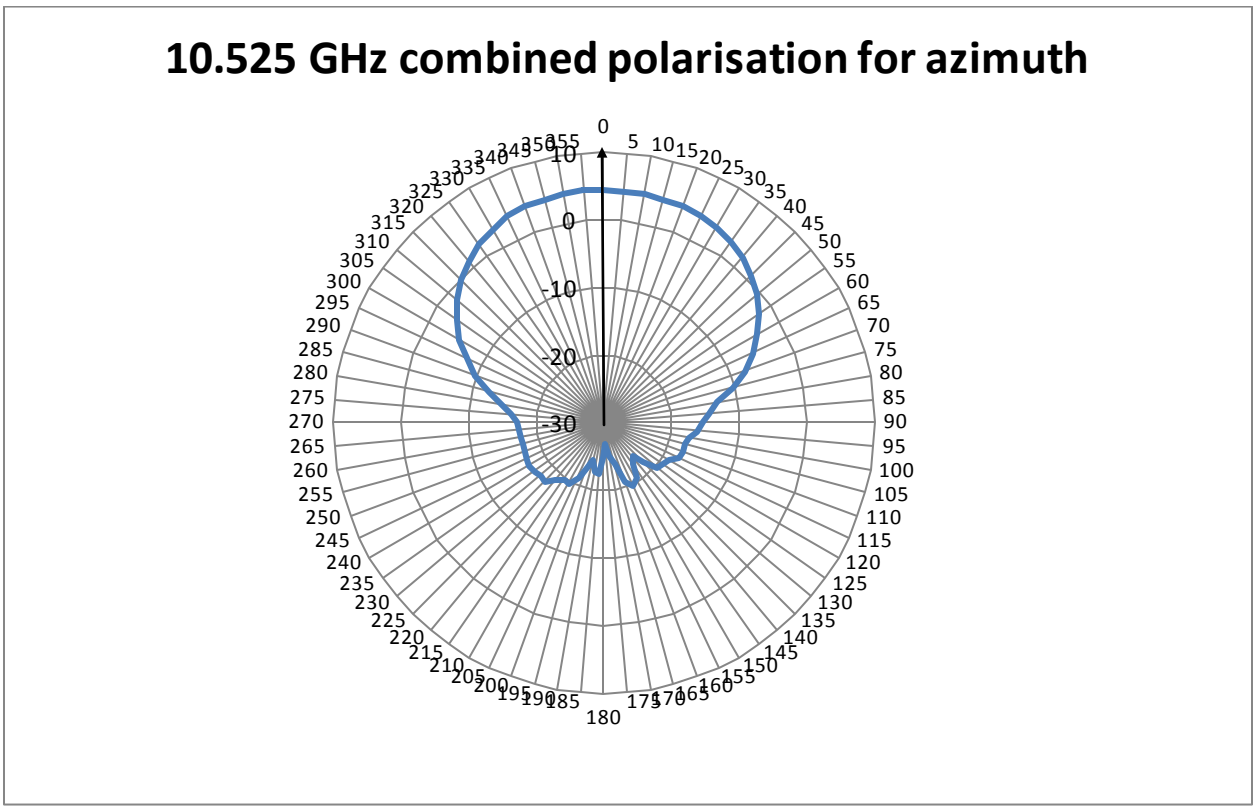

Figure 3a: Azimuth Beam Pattern (arrow depicts line of sight of the sensor)

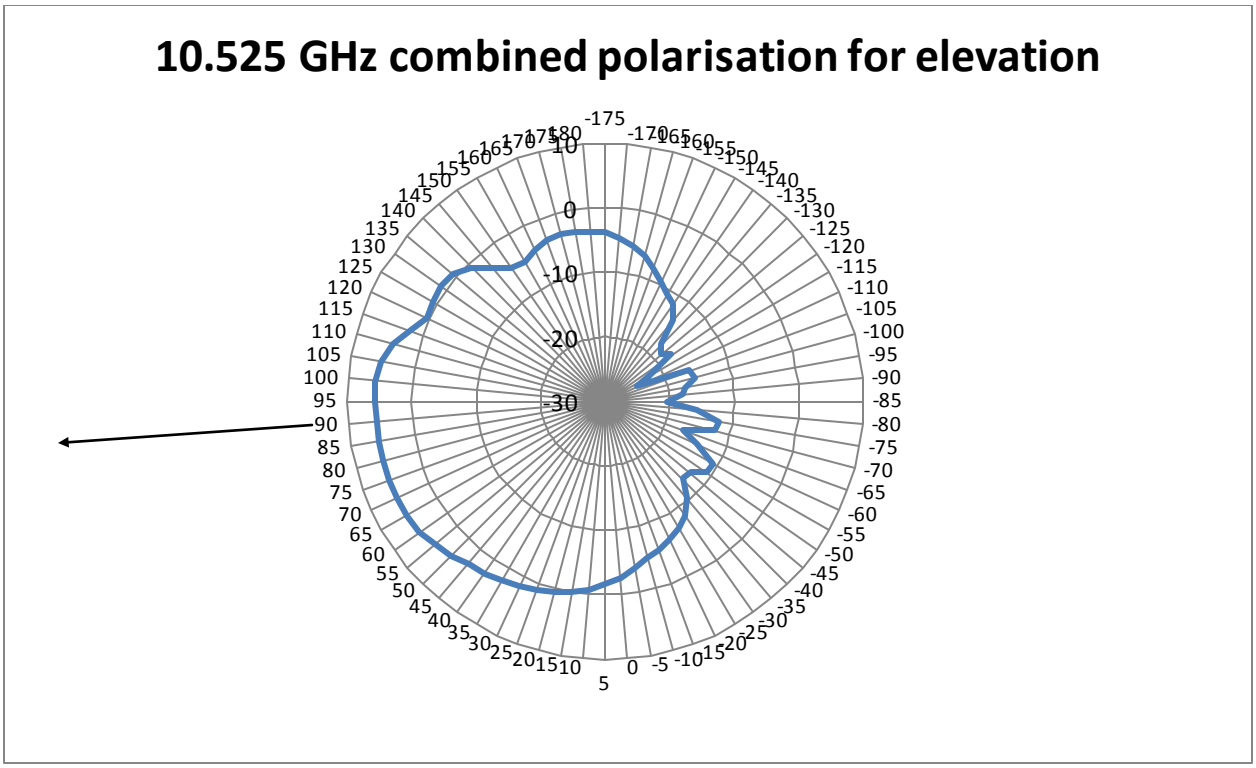

Figure 3b: Elevation Beam Pattern (arrow depicts the line of sight of the antenna, 5 deg below horizontal in standard mounting)

Electrical Specifications

Parameter	Value	Remarks
Input voltage	+4.5 to 12 VDC	Prefer 5 to 6 Vdc to reduce power dissipation on the sensor board. See notes 1 & 2 below.
Maximum current draw	25 mA	
nominal current draw	22mA	
Maximum voltage ripple allowed	40 μV_{rms} /($\sqrt{}$ (Hz)) over 10 Hz to 100 KHz bandwidth	Avoid any noise peak around 5 kHz (close to IF in the sensor)
Maximum supply voltage allowed	12 Vdc	
Minimum tolerable supply voltage	+4.5 Vdc	
Reference Voltage	1.25 Vdc	Provided back to motherboard from the sensor as analogue zero for ADC conversion
Reference Voltage line output	1 kOhm	

Parameter	Value	Remarks
impedance		
Sensor start time before data is available	n/a	Largely dependent upon software analysis algorithms. Sensor itself requires <5s before supplying a stable data stream.
Connector	Hirose 10-Way 2mm Pitch Header Connector	

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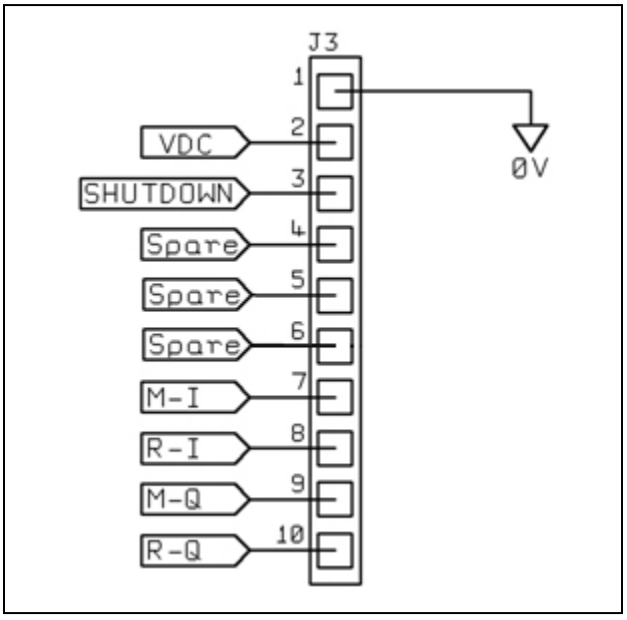
Note 1: If the OEM motherboard has a regulator that is dedicated to the sensor alone, then a low loss linear regulator would be suitable as the dedicated supply. The output voltage to the sensor should be in the region 5 to 6VDC to limit the power dissipation on the sensor PCB. An example suitable regulator is LM78L05.

Note 2: If supplying a number of sub-assemblies (eg sensor and clock), then a switched-mode power supply can be used, but the individual sub-assemblies should be wired in "star" formation so that noise generated on the power line by one sub-assembly does not affect the sensor sub-assembly. If that is a possible design solution, then BiancaMed could provide some advice on suitable SMPS and attendant circuitry. Though, the inherent stability and isolation that a dedicated power supply provides is much preferred.

Analogue Sensor Data



Where:

Input:

VDC = +4.5 to +12 VDC

Shutdown = active low, connect to pin 2 to enable sensor

Output:

M-I= Movement I channel data

R-I= Respiration I channel data

M-Q= Movement Q channel data

R-Q= Respiration Q channel data

Figure 4: Pin out of Connector

Note: Changes to pins 4, 5 & 6: no longer used, to be left floating

Parameter	Value	Remarks
Movement I & Q Channel		See ADC below
Signal bandwidth	50 mHz – 8 Hz	
DC offset voltage	1.25 Vdc	Reference voltage provided within the sensor to centre the analogue signal around 1.25Vdc
Voltage range	0 – 2.5 Vdc	
Noise	<8 mV_{rms}	
R I & Q Channels	Not used in this implementation	It is recommended that pins 4, 5, 6, 8 & 10, which are not used in this implementation, are left unconnected. If, for production reasons, a full 10-way ribbon cable is used, then pins 4, 5, 6, 8 & 10 should be terminated at the host motherboard and left floating, not tied to ground.
Buffering	The sensor module output pins 5, 7 & 9 must be followed by additional levels of buffering and isolation >30dB before interfacing with a user's A/D circuitry	See figure 5 below for examples
Analogue to Digital conversion (ADC) requirement	The analogue signal is to be digitised by the OEM motherboard at a rate of 64 samples per second (sps), with 10 to 12 bit precision. Post ADC, the sample rate is to be down sampled to 16 sps by averaging.	The 64 sps is to avoid Nyquist aliasing on the source signal (8Hz bandwidth). Down sampling then reduces the memory overhead for data buffering by the OEM motherboard. Example down sampling routine is available from BiancaMed

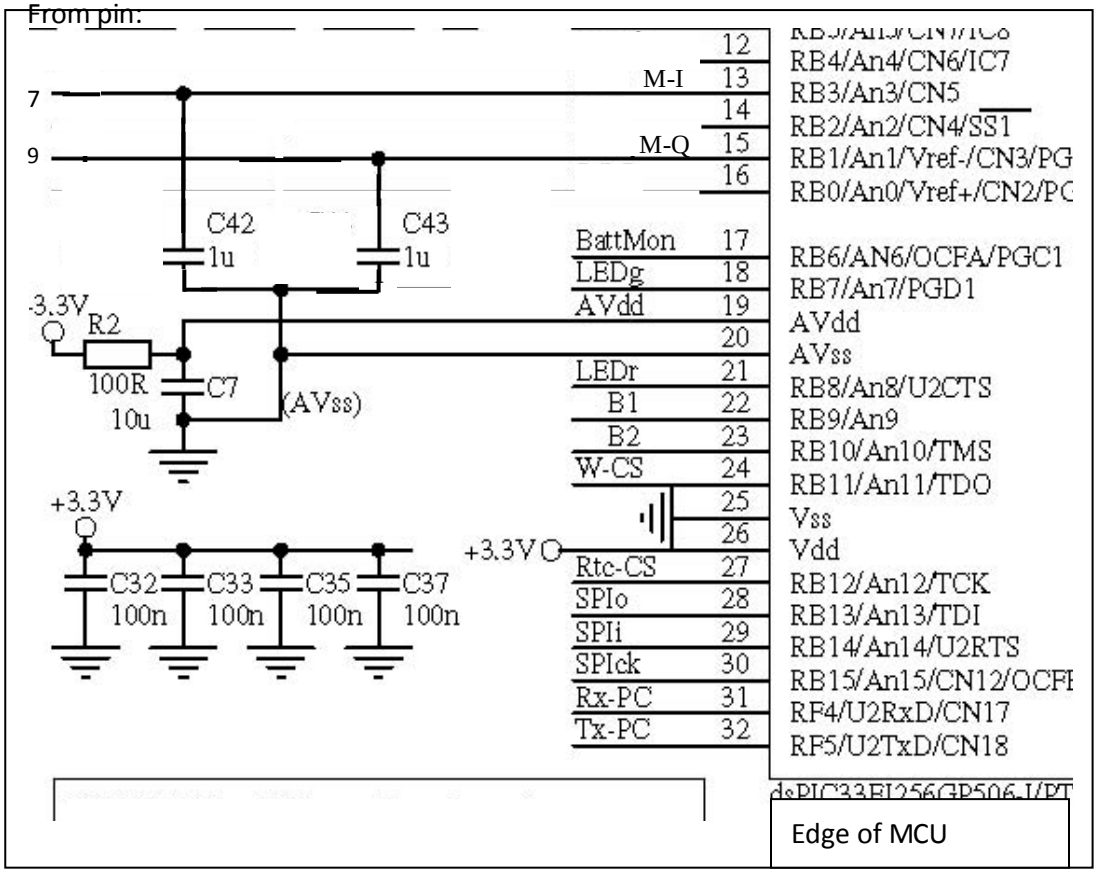


Figure 5: Example of Buffering of Sensor Pins

Environmental Specifications

Parameter	Value	Remarks
Operating Temperature Range	+15 to +35 deg C	To conform to IEC60065
Operating Humidity Range	30 to 75% RH (non condensing)	To conform to IEC60065
Storage Temperature range	-20 to +60C	
Storage Humidity Range	20 to 95 RH (non-condensing)	
IP value	Not Applicable	IP value provided by OEM enclosure

Parts & Materials

Test Parameter	Standard no/name	Remarks
Chemicals used in manufacture	RoHS	Only Lead-free solder used in PCBA

Test Parameter	Standard no/name	Remarks
Chemicals/materials incorporated into product	RoHS, WEEE directive	

Testing Standards/Conformance to Collateral/ International Standards

Test Parameter	Standard no/name	Remarks
Environmental test of packaged item	IEC60065	BM11 tested in a representative enclosure, but the OEM is responsible for confirming the compliance in the OEM enclosure
Electrical safety test	IEC60065	BM11 tested in a representative enclosure, but the OEM is responsible for confirming the compliance in the OEM enclosure
Electro Static Discharge	IEC60601-1-2; EN61000-4-2	BM11 tested in a representative enclosure, but the OEM is responsible for confirming the compliance in the OEM enclosure
EMC – Radiation emitted by the BM11	IEC60601-1-2, ETSI EN 300 440-1, FCC part 15.245	
EMC - Susceptibility to external radiation	IEC60601-1-2	BM11 tested in a representative enclosure, but the OEM is responsible for confirming the compliance in the OEM enclosure
Device life	5 years by component analysis	
Radio Standards	R&TTE Directive 1999/5/EC, FCC part 15.245, ARIB-std T73v1.1	
Audio & video equipment safety requirements	IEC60065	The sensor's conformance to the relevant parts of IEC60065 is satisfied by the IEC60601 tests, a table of compliance is available from BiancaMed

Module Mounting & Product Integration Considerations

- The sensor module consists of a broadside pyramidal horn reflector antenna with a planar monopole feed. The module is encased in a "hard to access" plastic housing.
- Ideally, the BM11 sensor module would be positioned with no other components within 5 cm, to prevent the influence of other components on the RF tuning.
- It is recommended that OEMs liaise with BiancaMed during the preliminary design of the product enclosure to ensure the best positioning of the components within the product. The following design guidelines should be considered:
    - The antenna should not have any metallic object in its line of sight (the full cone angle as specified above).
    - There should be 5 to 10mm air gap between the mouth of the antenna and the enclosure skin.
    - The order of preference for the enclosure skin in the way of the antenna is:
        - Nothing or a totally RF transparent material, eg speaker cloth.
        - A planar surface of plastic.
        - A curved surface of plastic, with no reinforcing ribs.

      OEMs should provide BiancaMed with an example of the intended product enclosure at the preliminary design stage. BiancaMed can then test the effects of the enclosure design on the sensor for shift in centre frequency or beam modification.
- No moving parts with an oscillating frequency below 10 Hz should exist within the product's housing. Any internal movement may be detected by the BM11 sensor and thus lead to measurement inaccuracies.

Interference from Internal Wireless Devices

Other RF devices within the enclosure have the potential to interfere with the BM11 sensor; such effects will depend upon operating frequency, radiated power and antenna position. BiancaMed should be consulted if it is intended to incorporate other RF devices within, or in close proximity to the product.

Information for OEM User Leaflet & Labeling

The following items are provided for OEMs to include in the user leaflets of products that incorporate the BiancaMed BM11 Sensor.

The items are categorised as Mandatory and Information.

- Mandatory items are required by regulatory authorities to be included in device documentation.
- The Information items are for guidance and can be altered in tone and language to suit the house style.

It is recommended that the draft device labels and user information leaflet are reviewed by BiancaMed to ensure their accuracy and regulatory compliance.

Mandatory

Device Label:

(For US Market)

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.

The final end product must be labeled in a visible area with the following:

“Contains TX FCC ID: YAKBM11” or “Contains FCC ID: YAKBM11”.FCC ID: YAKBM11

User Leaflet:

(For US Market)

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 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.

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.
FCC Caution: Any changes or modifications not expressly approved by "OEM name" could void the user's authority to operate this equipment.

Note for OEM:
This transmitter module is authorized to be used in other devices only by OEM further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).
The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user manual of the end product.

Information

Device Information

The non-contact sensor is a very low power Radio Frequency (RF) emitter. The RF power levels are much less than the BlueTooth on your mobile/cell phone and a WLAN router. The sensor has a maximum range of 1.5m and is designed to measure the breathing and body movement of an adult within range. If there are 2 persons in the bed, the sensor is will measure the parameters of the nearer person.

Device Placement

The product should be placed on a bedside table on the same side of the bed as the user. The height of the bedside table should ensure that there is a clear line of sight between the sensor and your upper chest when you are lying on the bed. This is typically a table top height of level with the mattress to around 6" (15cm) above the mattress. Do not place the product so that it has to "look" through the mattress at you: the springs in the mattress are likely to disrupt the RF beam. The product should be placed on the bedside table such that it is within easy arm's reach of your normal sleeping position.

Tips for initial setup:

- Place the product on your bedside table as outlined above.
- Angle the product so that the screen is at an easy reading angle when you are lying down, and that the sensor (or front of the product) is aimed approximately at the top of your chest when in your normal sleeping position.
- Run the application with the live breathing display active.

- Lie on the bed in your normal sleeping position. After approximately 30 seconds, a breathing rate should be displayed. Continue to breath in a normal and steady rate, the displayed breathing rate should stabilise after approximately 1 minute.
- If you move, the breathing rate display should be suspended whilst you are moving and then return approximately 15 seconds after you cease moving. Small movements are ignored.
- If you get any periods of "absent" indicated during your test, the sensor is having difficulty locking on to you. If this happens, re-position the product so that there is a clear line of sight to your upper chest area, and if necessary, bring the product a bit closer.

Device Specifications

Parameter	Value	Remarks
Centre frequency	10.525 GHz	+/- 10MHz
Antenna Beam width	50 to 60 deg	ie 25 to 30 deg either side of direct line of sight
Typical breathing detection range	1.5m	Target aspect not important, ie can be sitting, lying down on back/side/front