



## Bluetooth Low-energy Integrated Module for SME's (BLIM4SME)

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## ***Executive Summary***

This document consists in the deliverable D4.1. “BLE Generic Module Preliminary Datasheet”. Its principle objectives are to define the basic requirements of the Generic Module. As a preliminary datasheet it contains mainly basic mechanical and electrical specifications for the module. There is also a brief description of the sensors that will be incorporated on the Generic Module.

# 1 Introduction

## 1.1 The BLIM4SME project

Emerging and future IOT applications call for radio links which have to fulfil stringent requirements, such as: standardized connectivity for plug-and-play interconnection with other devices; ultra-portability with tiny modules for maximal comfort for the wearer; ultra-low-power consumption for long autonomy; and flexibility for being easily embedded with a heterogeneous set of other components like sensors, signal processors, energy harvesters.

The BLIM4SME project addresses these challenges by developing an ultra-low-power Bluetooth Low Energy (BLE or Bluetooth Smart) module focusing on healthcare and wellness application as stand-alone module. But when it is connected to the generic sensor board with various sensors, extra memory, and maybe separate application Processor, it will serve well also in Industrial Applications.

The power requirements often limit the autonomy of the nodes – this is usually addressed with the use of external power supply – could be significantly reduced with the use of a low energy module. PRISMA intends to expand the capabilities of the wireless sensor nodes, introducing a new series of the device where the BLE module will replace the Xbee module. This will provide to the end users the ability for in-situ machinery inspection with the use of their own mobile device (smartphone or tablet). Of course this product will not replace the existing one but they will co-exist enhancing the capabilities of PRISMA in the market of remote monitoring and predictive maintenance.

## 2 Generic module

### 2.1 General considerations

The BLE Generic Module should be as small as possible but within the limits of an industrially practical implementation. For the purposes of this project the Generic Module will be realized in a way that provides full compatibility with the mechanical and electrical characteristics of the wireless PCB that is already in use in Prisma products. This approach will greatly accelerate the integration of the system and will show the commercial capabilities of the project's outcome.

### 2.2 Mechanical details

In the following diagram the mechanical dimensions of the existing wireless module are shown. The Generic module that will be developed by the consortium must be identical with the description below:

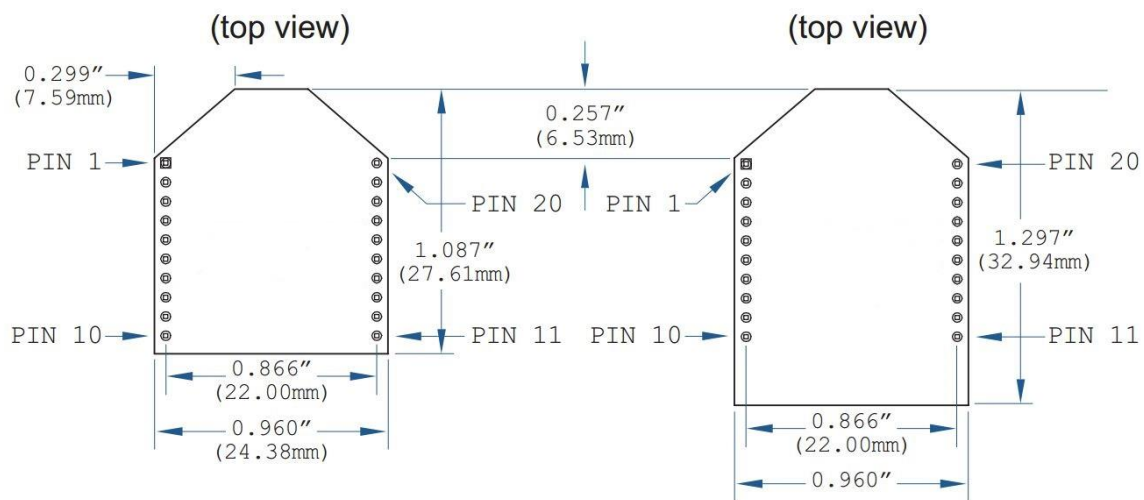


Figure 1: Top view of the module

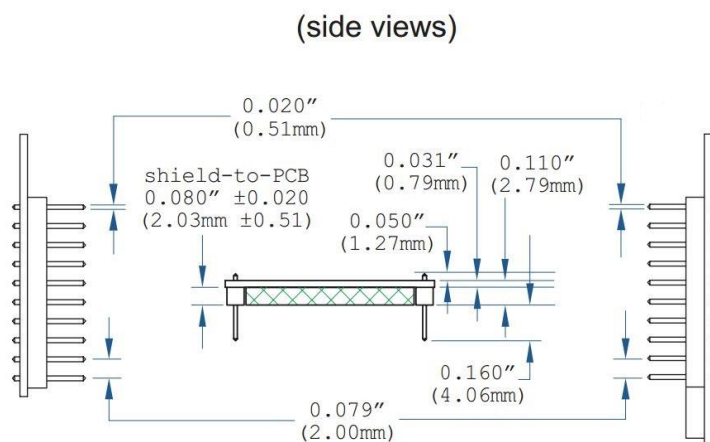
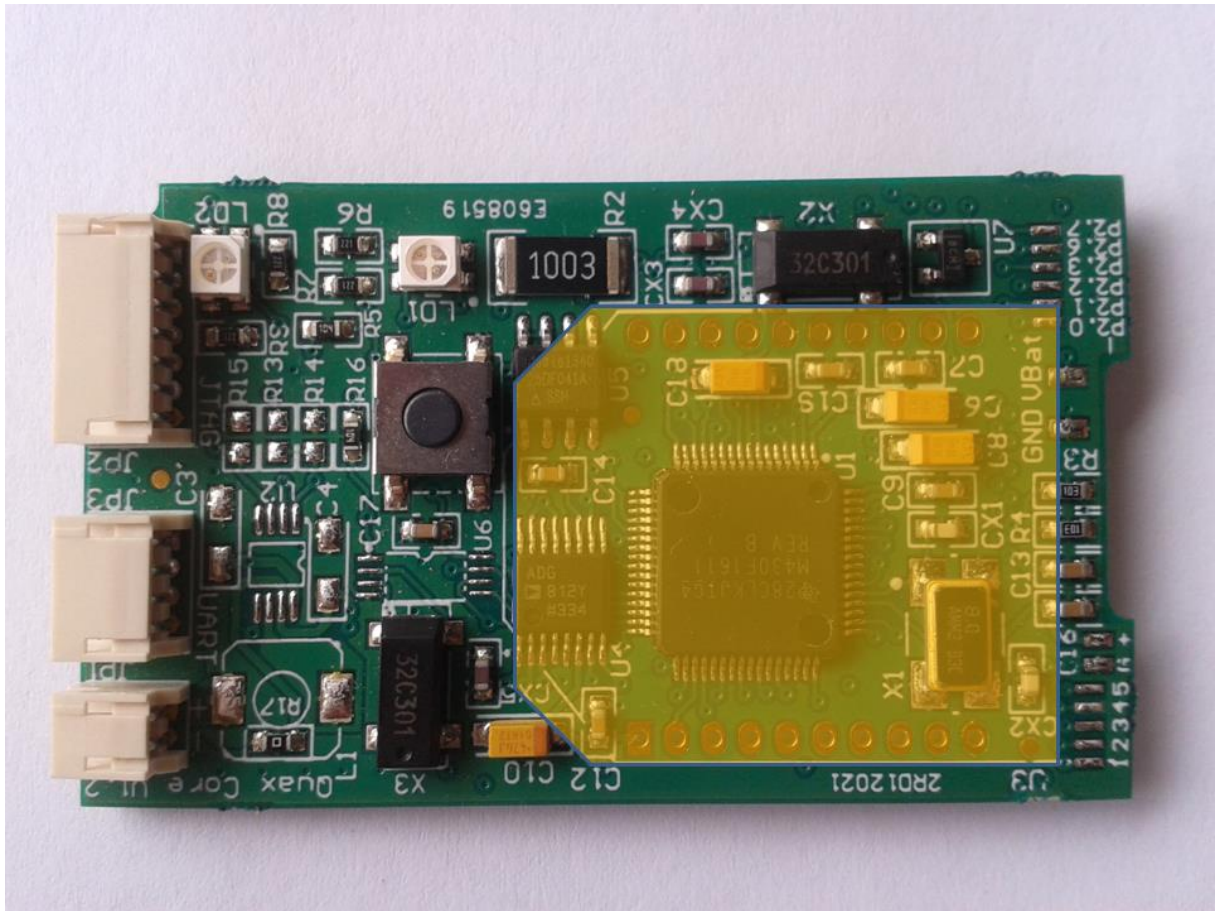


Figure 2: Side view of the module



**Figure 3: Placement of the module**

In the above picture the Core PCB is presented. This PCB is the main part of the wireless sensor nodes that are currently in use. The highlighted area marks the place where the Zigbee module is mounted. The Generic module is going to be placed in the yellow area. The generic module must be pin to pin compatible with the existing “slot”.

## 2.3 Detailed pin-out

Since the Generic module will be mounted on the existing PCB designed which hosts the MSP430 microcontroller and provides the regulated operating voltage, it must be pin-to-pin compatible with the Zigbee module that is already in use. In the following table the pin functions are presented.

PIN	FUNCTION
1	VCC (+3.3V)
2	UART port, Tx reserved for communication with MSP430 MCU
3	UART port, Rx reserved for communication with MSP430 MCU
5	GPIO, can be used for any function
9	GPIO, can be used for any function
10	GND
12	GPIO, can be used for any function
13	GPIO, can be used for any function
15	GPIO, can be used for any function
16	GPIO, can be used for any function
4,6,7,8,11,14,17,18,19,20	NO CONNECT

**Table 1: Pin functions**

### 2.3.1 Notes on pins and their functions

- All pins are directly connected to the MSP430 MCU.
- The main board (Core) of Prisma's wireless platform can provide up to 150mA of continuous current. The power consumption of the MSP430 and external circuitry is no more than 50mA leaving a margin of 100mA as a current budget to supply the Generic module
- All digital logic is +3.3V level
- GPIOs can sink/source up to 6mA
- Pins indicated as "NO CONNECT" have no physical connection with the host board and therefore cannot be configured for any function



## 2.4 Digital I/O

The generic module will have to maintain the capability of integration within a system, like a data logger, a local measurement unit, or simply as part of a wireless sensor network comprised of interconnected nodes. This concept generates the need for on board implementation of at least one of the following standard communication protocols like:

- SPI
- I<sup>2</sup>C
- UART

There are 6 unused pins that can be configured to implement both a 2-wire I2C and 3 or 4 wire SPI protocol of communication between the Generic module and the host board.

### 2.4.1 Extra functionality

- For the purposes of an isolated measurement system, there should be the possibility to power on/off the Generic Module via a control pin.
- The Generic module should be able to inform the host processor for quality of signal reception/transmission.
- The acquisition of data from the various on-board sensors can result in a large amount of data, especially when the sampling rate is high. For this reason, the Generic module can host a micro SD card holder for data logging.

### 3 Embedded sensors

#### 3.1 General Considerations

Despite of its compact size, the Generic module is a flexible and modular platform that can host a variety of sensors. Prisma Electronics as the end user of the device, is looking forward the development of a BLE platform that will be able to be part of an industrial monitoring system, operating side by side with the existing products of the company.

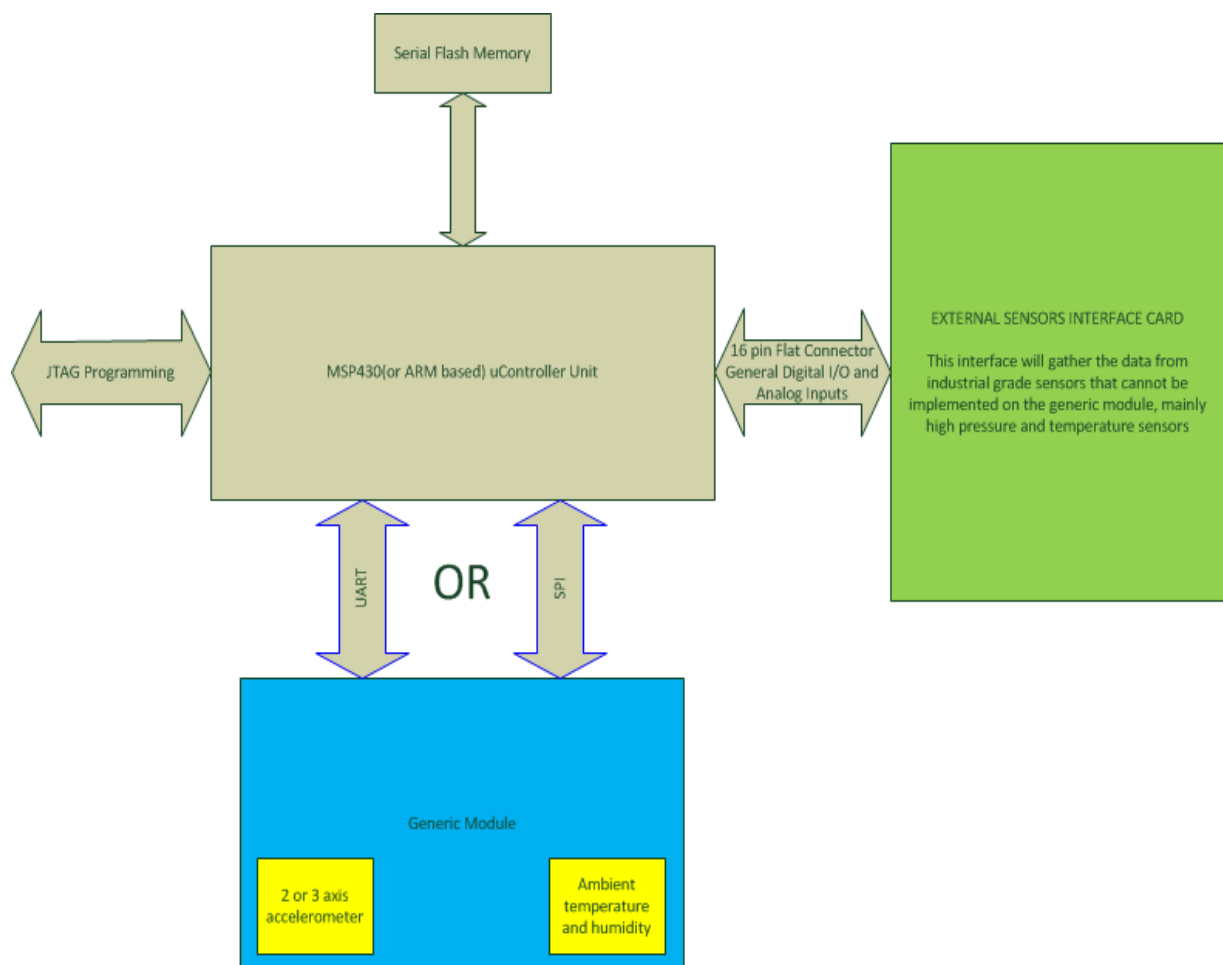


Figure 4: Top level architecture of a wireless node

## 3.2 Proposed sensors

### 3.2.1 Accelerometers

One of the key components in a remote monitoring system is the analysis of the vibrations that occur during the operation of the various machines. Prisma Electronics has developed an extensive signal analysis software library both for the embedded wireless nodes and the backend software that runs on the user's PC. This library when fed with the appropriate raw data can produce conclusions about the status of a machine. The choice of the appropriate accelerometer is a complicated matter since it depends a lot on the specific machinery that will be under monitoring. The frequency of operation and the desired accuracy determine the characteristics of these ICs. In general, a 3 axis accelerometer that is able to detect a linear acceleration up to 7-8g is a good starting point for machine vibration analysis.

- Analog Devices ADXL363BCCZ-RL7
- STMicroelectronics LSM303CTR

### 3.2.2 Temperature/Humidity

In the case of environmental or industrial monitoring temperature and humidity play a significant role. Accurate measurements of these two factors are essential for a wireless monitoring system.

- Sensirion SHT21

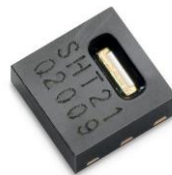


Figure 5: Temperature/humidity sensor

### 3.2.3 Barometer

Suitable parts for this purpose are:

- MPL115A2T1 from Freescale Semiconductors
- LPS25HTR from ST Microelectronics

### 3.2.4 Ultrasonic Microphone

- The SPU0410LR5H-QB can undertake the ultrasonic signal acquisition in cases where the mechanical equipment that is under inspection produces high frequency acoustic noise.

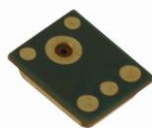


Figure 6: Ultrasonic microphone

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