Important:

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New version: Waspmote v15

This datasheet summarizes the benefits of the new Waspmote platform. This line was released on October 2016. It is an evolution from the previous Waspmote v12.

Waspmote v15 is not compatible with Waspmote v12, so it is NOT recommended to mix product generations. If you are using previous versions of our products, please use the corresponding guides, available on our Development website.

You can get more information about the generation change on the document "New generation of Libelium product lines". 
Waspmote

General data:

- Microcontroller: ATmega1281
- Frequency: 14.7456 MHz
- SRAM: 8 kB
- EEPROM: 4 kB
- FLASH: 128 kB
- SD card: 16 GB
- Weight: 20 g
- Dimensions: 73.5 x 51 x 13 mm
- Temperature range: [-30 ºC, +70 ºC]*
- Clock: RTC (32 kHz)
  *Temporary extreme temperatures are supported.
  Regular recommended usage: -20, +60 ºC.

Consumption:

- On: 17 mA
- Sleep: 30 μA
- Deep Sleep: 33 μA
- Hibernate: 7 μA
- Operation without recharging: 1 year*
  * Time obtained using the Hibernate mode as energy saving mode

Inputs/Outputs:

- 7 analog (I), 8 digital (I/O), 1 PWM,
- 2 UART, 1 I2C, 1 USB, 1 SPI

Electrical data:

- Battery voltage: 3.3 – 4.2 V
- USB charging: 5 V – 480 mA (max current input) —> 100 mA in batches since summer 2018
- Solar panel charging: 6 - 12 V – 300 mA (max current input)

Built-in sensors on the board:

- Accelerometer: ±2g/±4g/±8g
- Low power: 0.5/1/2/5/10 Hz
- Normal mode: 50/100/400/1000 Hz
802.15.4/ZigBee

<table>
<thead>
<tr>
<th>Radio version</th>
<th>Frequency</th>
<th>Transmission power</th>
<th>Sensitivity</th>
<th>Range*</th>
</tr>
</thead>
<tbody>
<tr>
<td>XBee-PRO 802.15.4 EU</td>
<td>2.4 GHz</td>
<td>10 dBm</td>
<td>-100 dBm</td>
<td>750 m</td>
</tr>
<tr>
<td>XBee-PRO 802.15.4</td>
<td>2.4 GHz</td>
<td>18 dBm</td>
<td>-100 dBm</td>
<td>1600 m</td>
</tr>
<tr>
<td>XBee-PRO DigiMesh</td>
<td>2.4 GHz</td>
<td>18 dBm</td>
<td>-100 dBm</td>
<td>1500 m</td>
</tr>
<tr>
<td>XBee-PRO ZigBee</td>
<td>2.4 GHz</td>
<td>17 dBm</td>
<td>-102 dBm</td>
<td>3200 m</td>
</tr>
<tr>
<td>XBe 868LP</td>
<td>863 - 870 MHz</td>
<td>14 dBm</td>
<td>-106 dBm</td>
<td>8.4 km</td>
</tr>
<tr>
<td>XBee-PRO 900HP US</td>
<td>902 - 928 MHz</td>
<td>24 dBm</td>
<td>-110 dBm</td>
<td>15.5 km</td>
</tr>
<tr>
<td>XBee-PRO 900HP BR</td>
<td>902 - 906.8 MHz / 915.6 - 928 MHz</td>
<td>24 dBm</td>
<td>-110 dBm</td>
<td>15.5 km</td>
</tr>
<tr>
<td>XBee-PRO 900HP AU</td>
<td>915.6 - 928 MHz</td>
<td>24 dBm</td>
<td>-110 dBm</td>
<td>15.5 km</td>
</tr>
</tbody>
</table>

* To determine your range, perform a range test under your operating conditions

Antennas: 2.4 GHz: 2 dBi / 5 dBi  
868/900 MHz: 4.5 dBi
Connector: RP-SMA
Encryption: AES 128 bits
Control Signal: RSSI
Standards: XBee-PRO 802.15.4: IEEE 802.15.4 compliant. XBee-PRO ZigBee: ZigBee-Pro v2007 compliant
Topologies: Star, tree, mesh

Figure: XBe module

Figure: Star network

Gateway (Meshium)  
Sensor Node (Waspmote)
Figure: Tree network

Figure: Mesh network
LoRaWAN modules

Protocol: LoRaWAN 1.0, Class A

LoRaWAN-ready

Frequency:
- LoRaWAN EU module: 868 MHz and 433 MHz ISM bands
- LoRaWAN US module: 902-928 MHz ISM band
- LoRaWAN AU module: 915-928 MHz ISM band
- LoRaWAN IN module: 865-867 MHz ISM band
- LoRaWAN ASIA-PAC / LATAM module: 923 MHz ISM band

TX power:
- LoRaWAN EU module: up to 14 dBm
- LoRaWAN US module: up to 18.5 dBm
- LoRaWAN AU module: up to 18.5 dBm
- LoRaWAN IN module: up to 18.5 dBm
- LoRaWAN ASIA-PAC / LATAM module: up to 18.5 dBm

Sensitivity: down to -136 dBm

Range: >15 km at suburban and >5 km at urban area. Typically, each base station covers some km. Check the LoRaWAN Network in your area.

Chipset consumption:
- LoRaWAN EU module: 38.9 mA
- LoRaWAN US module: 124.4 mA
- LoRaWAN AU module: 124.4 mA
- LoRaWAN IN module: 124.4 mA
- LoRaWAN ASIA-PAC / LATAM module: 124.4 mA

Radio data rate:
- LoRaWAN EU module: from 250 to 5470 bps
- LoRaWAN US module: from 250 to 12500 bps
- LoRaWAN AU module: from 250 to 12500 bps
- LoRaWAN IN module: from 250 to 12500 bps
- LoRaWAN ASIA-PAC / LATAM module: from 250 to 12500 bps

Receiver: purchase your own base station or use networks from LoRaWAN operators

Compatibility with territories:
- LoRaWAN EU module: Europe (EU863-870 protocol)
- LoRaWAN US module: US, Canada, Mexico (US902-928 protocol)
- LoRaWAN AU module: Australia (AU915-928 protocol)
- LoRaWAN IN module: India (IN865-867 protocol)
- LoRaWAN ASIA-PAC / LATAM module: Australia, Bolivia, Brunei Darussalam, Cambodia, Chile, China, Costa Rica, Ecuador, Guatemala, Hong Kong, Indonesia, Laos, Malaysia, New Zealand, Pakistan, Panama, Paraguay, Peru, Salvador, Singapore, Taiwan, Thailand, Uganda, Uruguay and Venezuela (AS923 protocol)
Figure: LoRaWAN EU network
Sigfox modules

Frequency:
- Sigfox EU module: ISM 868 MHz
- Sigfox US module: ISM 900 MHz
- Sigfox AU / APAC / LATAM module: ISM 900 MHz

TX Power:
- Sigfox EU module: 16 dBm
- Sigfox US module: 24 dBm
- Sigfox AU / APAC / LATAM module: 24 dBm

ETSI limitation: 140 messages of 12 bytes, per module per day

Range: Typically, each base station covers some km. Check the Sigfox Network

Chipset consumption:
- Sigfox EU module: TX 51 mA @ 14 dBm
- Sigfox US module: TX 230 mA @ 24 dBm
- Sigfox AU / APAC / LATAM module: TX 230 mA @ 24 dBm

Radio data rate: 100 bps

Receive sensitivity: -126 dBm

Sigfox certificate: Class 0u (the highest level)

Sigfox service available in these territories:
- EU module: RC1 zone (Europe, Oman, Iran, South Africa, Tunisia, UAE)
- US module: RC2 zone (USA, Mexico, Brazil)
- AU / APAC / LATAM module: RC4 zone (Australia, New Zealand, Singapore, Taiwan, Hong Kong, Thailand, Malaysia, Colombia, Argentina, Chile, Costa Rica, Ecuador, Panama, El Salvador)
LoRa module

Protocol: Own, developed at Libelium. Not compatible with LoRaWAN.
Model: Semtech SX1272
Frequencies available: 860-1000 MHz, fits both 868 (Europe) and 900 MHz (USA) ISM bands
Max TX power: 14 dBm
Sensitivity: -137 dBm
Range:
- **Line of Sight**: 21+ km / 13.4+ miles (LoS and Fresnel zone clearance)
- **Non Line of Sight**: 2+ km / 1.2+ miles (nLoS going through buildings, urban environment)

Antenna: 868 / 915 MHz: 0 / 4.5 dBi
Connector: RPSMA
Encryption: AES 128/192/256 bits (performed by Waspmote API)
Control Signal: RSSI
Topology: Star
Receiver/Central node: Special Gateway LoRa (SPI) or another Waspmote unit
WiFi PRO module

TX power:
- 802.11b: 17 dBm
- 802.11g: 14 dBm
- 802.11n: 12 dBm

RX sensitivity:
- 802.11b @11Mbps PER<8%: -87 dBm
- 802.11b @1Mbps PER<8%: -94 dBm
- 802.11g @54Mbps PER<10%: -73 dBm
- 802.11g @6Mbps PER<10%: -86 dBm
- 802.11n MCS0 PER<10%: -86 dBm
- 802.11n MCS0 PER<10%: -70 dBm

Chipset consumption:
- TX mode: 350 mA
- RX mode: 130 mA

Internet protocols:
- ARP, ICMP, IP, UDP, TCP, DHCP, DNS, NTP, HTTP, HTTPS, FTP

Security protocols:
- SSL3/TLS1, HTTPS, RSA, AES-128/256, 3DES, RC-4, SHA-1, MD-5, WEP, WPA and WPA2 accelerated in hardware: AES, 3DEC and SHA

Wireless specifications:
- Standards:
  - IEEE 802.11b/g/n
- Frequency:
  - Europe: 2.412 – 2.472 GHz
  - USA: 2.412 – 2.462 GHz
  - Japan: 2.412 – 2.484 GHz
- Channels:
  - Europe: 13
  - USA: 11
  - Japan: 14

Antenna:
- Plug and Sense!: internal U.FL-to-SMA connector
- Wasmote OEM: on-chip antenna
GSM/GPRS

Model: SIM900 (SIMCom)
Quadband: 850/900/1800/1900 MHz
TX Power: 2 W (Class 4) 850/900 MHz, 1 W (Class 1) 1800/1900 MHz
Sensitivity: -109 dBm
Antenna connector: U.FL
External antenna: 0 dBi
Consumption in sleep mode: 1 mA
Consumption in power off mode: 0 mA

Actions:
- Making/Receiving calls
- Making ‘x’ tone missed calls
- Sending/Receiving SMS
- Single connection and multiple connections TCP/IP and UDP/IP clients
- TCP/IP server
- HTTP service
- FTP service (downloading and uploading files)
3G module

**Model:** SIM5215 (SIMCom)

**Versions:** Europe and America/Australia

**Europe version:**
- Dual-Band: 900/2100MHz
- Tri-Band: 850/900/1800MHz

**America/Australia version:**
- Dual-Band: 850/1900 MHz
- Quad-Band: 850/900/1800/1900 MHz

**WCDMA (downlink):** up to 384 kbps

**WCDMA (uplink):** up to 384 kbps

**TX power:**
- UMTS 850/900/1900/2100: 0.25 W
- GSM 850/900: 2 W
- DCS 1800 / PCS 1900: 1 W

**Sensitivity:** -106 dBm

**Antenna connector:** UFL

**External antenna:** 0 dBi

**Consumption in sleep mode (RF circuits power off previously):** 1 mA

**Actions:**

- Videocall using 3G network available with Video Camera Sensor Board
- Record video (res. 320 x 240) and take pictures (res. 640 x 480) available with Video Camera Sensor Board
- Support microSD card up to 32 GB
- 64 MB of internal storage space
- Making/Receiving calls
- Making ‘x’ tone missed calls
- Sending/Receiving SMS
- Single connection and multiple connections TCP/IP and UDP/IP clients
- TCP/IP server
- HTTP and HTTPS service
- FTP and FTPS service (downloading and uploading files)
- Sending/receiving email (SMTP/POP3)
NB-IoT / Cat-M module

Model: BG96 (Quectel)

Frequency bands:
- LTE TDD: B39 (for Cat-M1 only)
- EGPRS: 850/900/1800/1900 MHz

Data:
- Cat-NB1: Max. 32 kbps (DL), Max. 70 kbps (UL)
- Cat-M1: Max. 375 kbps (DL), Max. 375 kbps (UL)
- EDGE: Max. 296 kbps (DL), Max. 236.8 kbps (UL)
- GPRS: Max. 107 kbps (DL), Max. 85.6 kbps (UL)

SMS:
- Point-to-point MO and MT
- SMS Cell Broadcast
- Text and PDU Mode

GNNS: Embedded GNSS. Supports GPS, GLONASS, BeiDou/Compass, Galileo and QZSS.

Antenna connectors:
- U.FL for main antenna (cellular)
- U.FL for GNSS antenna

External antenna: 5 dBi

Sensitivity:
- -113 dBm @Cat NB1, CE Level 0
- -107 dBm @Cat M1, 1.4 MHz Bandwidth, CE Mode A

SIM size: Nano-SIM (4FF standard) (not included)

Protocols: PPP/TCP/UDP/SSL/TLS/FTP(S)/HTTP(S)/NITZ/ PING/MQTT

Actions:
- Sending/receiving SMS
- TCP/IP and UDP/IP clients
- HTTP and HTTPS service (SSL/TLS for fully secured comms)

Certifications:
- GCF/Vodafone (Global)
- CE/Deutsche Telekom (Europe)
- FCC/PTCRB/AT&T/Verizon/T-Mobile*/Sprint* (North America)
- RCM/Telstra (Australia)
- IC/Telus/Bell* (Canada)
- Telefónica (Spain)
- JATE/TELEC/KDDI/SoftBank/DOCOMO* (Japan)
- KC/SKT/LGU++ (Korea)
- IFETEL (Mexico)
- IMDA (Singapore)
- NCC (Taiwan)
- CCC (China)

* Under development

**LTE B25 will be supported on BG96 with R1.2 hardware version

Figure: NB-IoT / Cat-M module
4G module

Model: LE910 (Telit)

Versions:
- Europe/Brazil
- America (new v2 in April 2019)

Europe/Brazil version:
- WCDMA: 850/900/2100 MHz
- LTE: 800/1800/2600 MHz

America version:
- 2G: 850/1900 MHz
- WCDMA: 850/1900 MHz
- LTE: 700/850/1700/1900 MHz

Australia version:
- 4G: 700/1800/2600 MHz

LTE (downlink):
- Europe/Brazil version up to 100 Mbps
- America version up to 100 Mbps

LTE (uplink): up to 50 Mbps

TX power:
- Europe/Brazil:
  - Class 4 (2 W, 33 dBm) @ GSM 900
  - Class 1 (1 W, 30 dBm) @ GSM 1800
  - Class E2 (0.5 W, 27 dBm) @ EDGE 900
  - Class E2 (0.4 W, 26 dBm) @ EDGE 1800
  - Class 3 (0.25 W, 24 dBm) @ UMTS
  - Class 3 (0.2 W, 23 dBm) @ LTE
- America:
  - Class E2 (0.5 W, 27 dBm) @ EDGE 900
  - Class E2 (0.4 W, 26 dBm) @ EDGE 1800
  - Class 3 (0.25 W, 24 dBm) @ UMTS
  - Class 3 (0.2 W, 23 dBm) @ LTE

Antenna connector:
- U.FL for main antenna
- U.FL for cellular diversity antenna
- U.FL for GPS antenna (only for the Europe/Brazil module)

External antenna: +5 dBi

GPS: GPS feature is supported only in the Europe/Brazil version

This module can carry out the following tasks:
- Sending/Receiving SMS
- Multisocket up to 6 TCP/IP and UDP/IP clients
- TCP/IP server
- TCP SSL
- HTTP service
• FTP service (downloading and uploading files)
• Sending/receiving email (SMTP/POP3)

Certifications:
• LE910-EUG (Europe / Brazil): CE, GCF, ANATEL
• LE910-NAG (US / Canada): FCC, IC, PTCRB, AT&T approved
• LE910-SKG (South Korea): KCC, SK Telecom approved
• LE910-JN V2 / LE910-JK V2 (Japan): NTT DoCoMo, KDDi
Bluetooth low energy module

**Protocol:** Bluetooth v.4.0 / Bluetooth Smart  
**Chipset:** BLE112  
**RX Sensitivity:** -103 dBm  
**TX Power:** [-23 dBm, +3 dBm]  
**Antenna:** 2 dBi/5 dBi antenna options  
**Security:** AES-128 bits  
**Range:** 100 m (at maximum TX power)

**Actions:**
- Send broadcast advertisements (iBeacons)
- Connect to other BLE devices as Master / Slave
- Connect with smartphones and tablets
- Set automatic cycles sleep / transmission
- Calculate distance using RSSI values
- Perfect for indoor location networks (RTLS)
- Scan devices with maximum inquiry time
- Scan devices with maximum number of nodes
- Scan devices looking for a certain user by MAC address

*Figure: Bluetooth Low Energy module*
Bluetooth module for device discovery

**Protocol:** Bluetooth 2.1 + EDR. Class 2  
**TX Power:** 3 dBm  
**Antenna:** 2 dBi  
**Max Scan:** Up to 250 unique devices in each inquiry  
**Power levels:** 7 [-27 dBm, +3 dBm]

**Application:**  
- Vehicular and pedestrian traffic monitoring

**Features:**  
- Received Strength Signal Indicator (RSSI) for each scanned device  
- Scan devices with maximum inquiry time  
- Scan devices with maximum number of nodes  
- Scan devices looking for a certain user by MAC address  
- Class of Device (CoD) for each scanned device

---

![Figure: Bluetooth module for device discovery](image-url)
RFID/NFC

Features:
- **Compatibility:** Reader/writer mode supporting ISO 14443A, MIFARE / FeliCaTM / NFCIP-1
- **Distance:** 5 cm
- **Max capacity:** 4 kB
- **Tags:** Cards, keyrings, stickers

Applications:
- Located based services (LBS)
- Logistics (assets tracking, supply chain)
- Access management
- Electronic prepaid metering (vending machines, public transport)
- Smartphone interaction (NFCIP-1 protocol)
Over the Air Programming (OTA)

Over the Air Programming (OTA) can be made with 4G, 3G, GPRS and WiFi modules via FTP.

Benefits:

- Enables the upgrade or change of firmware versions without physical access.
- Upgrades the new firmware by querying a FTP server which helps to keep battery life.
- Upload new firmware in few minutes.

Topologies:

- Protocols which support FTP transmissions are directly connected to the Network Access Point.

Figure: OTA with 4G/3G/GPRS/WiFi fundamentals
Encryption Libraries

The new Encryption Libraries are designed to add to the Waspmote sensor platform the capabilities necessary to protect the information gathered by the sensors. To do so, **two cryptography layers** are defined:

- **Link Layer**: In the first one all the nodes of the network share a common **preshared key** which is used to encrypt the information using **AES 128**. This process is carried out by specific hardware integrated in the same 802.15.4/ZigBee radio, allowing the maximum efficiency of the sensor nodes energy consumption. This first security layer ensures no third party devices will be able to even connect to the network (access control).

- **Secure Web Server Connection**: The third security technique is carried out in Meshlium -the Gateway- where **HTTPS** and **SSH** connections are used to send the information to the Cloud server located on the Internet.

A third optional encryption layer allows each node to encrypt the information using the Public key of the Cloud server. Thus, the information will be kept confidentially all the way from the sensor device to the web or data base server on the Internet.

Information is encrypted in the application layer via software with **AES 256** using the key shared **exclusively** between the **origin** and the **destination**. Then the packet is encrypted again in the link layer via hardware with **AES 128** so that only trusted packets be forwarded, ensuring access control and improving the usage of resources of the network.

---

Figure: Communication diagram
Industrial Protocols

RS-485, CAN Bus and Modbus are widely used standards in the industrial and automation market. Waspmote can be interfaced with standard devices and sensors thanks to the Industrial Protocols modules.

<table>
<thead>
<tr>
<th>MODULE</th>
<th>MAIN APPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS-485 / Modbus module</td>
<td>• Industrial Equipment</td>
</tr>
<tr>
<td></td>
<td>• Industrial Control Systems, including the most common versions of Modbus and Profibus</td>
</tr>
<tr>
<td></td>
<td>• Programmable Logic Controllers</td>
</tr>
<tr>
<td></td>
<td>• RS-485 is also used in building automation</td>
</tr>
<tr>
<td></td>
<td>• Interconnect security control panels and devices</td>
</tr>
<tr>
<td>CAN Bus module</td>
<td>• Automotive applications</td>
</tr>
<tr>
<td></td>
<td>• Home automation</td>
</tr>
<tr>
<td></td>
<td>• Industrial Networking</td>
</tr>
<tr>
<td></td>
<td>• Factory automation</td>
</tr>
<tr>
<td></td>
<td>• Marine electronics</td>
</tr>
<tr>
<td></td>
<td>• Medical equipment</td>
</tr>
<tr>
<td></td>
<td>• Military uses</td>
</tr>
<tr>
<td>Modbus software layer</td>
<td>• Modbus is a software layer which can be run over the RS-485 module</td>
</tr>
<tr>
<td></td>
<td>• Multiple master-slave applications</td>
</tr>
<tr>
<td></td>
<td>• Sensors and instruments</td>
</tr>
<tr>
<td></td>
<td>• Industrial Networking</td>
</tr>
<tr>
<td></td>
<td>• Building and infrastructure</td>
</tr>
<tr>
<td></td>
<td>• Transportation and energy applications</td>
</tr>
</tbody>
</table>

Figure: RS-485 module
Figure: Can Bus module
Figure: RS-485 module
Expansion Radio Board

The Expansion Board allows to connect two communication modules at the same time in the Waspmote sensor platform. This means a lot of different combinations are possible using any of the wireless radios available for Waspmote: 802.15.4, ZigBee, DigiMesh, 868 MHz, 900 MHz, LoRa, WiFi, GPRS, 3G, NB-IoT / Cat-M, 4G, Sigfox, LoRaWAN, Bluetooth Pro, Bluetooth Low Energy and RFID/NFC. Besides, the following Industrial Protocols modules are available: RS-485/Modbus and CAN Bus.

Some of the possible combinations are:

- LoRaWAN - GPRS
- 802.15.4 - Sigfox
- 868 MHz - RS-485
- NB-IoT / Cat-M - WiFi
- DigiMesh - 4G
- NB-IoT / Cat-M - RFID/NFC
- WiFi - 3G
- CAN Bus - Bluetooth
- etc.

Remark: GPRS, 3G, NB-IoT / Cat-M and 4G modules do not need the Expansion Board to be connected to Waspmote. They can be plugged directly in the socket.

Applications:

- Multifrequency Sensor Networks: (2.4 GHz - 868/900 MHz)
- Bluetooth - ZigBee hybrid networks
- NFC (RFID) applications with 3G/GPRS
- ZigBee - WiFi hybrid networks

GPS module

Model: JN3 (Telit)

Sensitivity:

- Acquisition: -147 dBm
- Navigation: -160 dBm
- Tracking: -163 dBm

Hot start time: <1 s

Cold start time: <35 s

Positional accuracy error: < 2.5 m

Speed accuracy: < 0.01 m/s

EGNOS, WAAS, GAGAN and MSAS capability

Antenna:

- Cable length: 9cm
- Connector: UFL
- Gain: 24 dBi (active)

Available information: latitude, longitude, altitude, speed, direction, date/time and ephemeris management
Programmable interruptions

- **Asynchronous**
  - Sensors (programmable threshold)
  - Accelerometer: Free-fall, impact (programmable threshold)
- **Synchronous**:
  - Watchdog: programmable alarms: from 32 ms to 8 s
  - RTC: programmable alarms: from 1 s to days

**Watchdog reset**

An RTC Watchdog has been implemented for reseting Waspmote if it gets stuck. That periodical reset avoids erratic behaviour.
## Sensor Boards

### GASES PRO v3*

<table>
<thead>
<tr>
<th>APPLICATIONS</th>
<th>SENSORS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>City pollution</strong></td>
<td>• Carbon Monoxide – CO</td>
</tr>
<tr>
<td>CO, NO, NO₂, O₃, SO₂, Particle Matter - Dust</td>
<td>• Carbon Dioxide – CO₂</td>
</tr>
<tr>
<td><strong>Air Quality Index calculation</strong></td>
<td>• Molecular Oxygen – O₂</td>
</tr>
<tr>
<td>SO₂, NO₂, Particle Matter - Dust, CO, O₃, NH₃</td>
<td>• Ozone – O₃</td>
</tr>
<tr>
<td><strong>Emissions from farms and hatcheries</strong></td>
<td>• Nitrile Oxide – NO</td>
</tr>
<tr>
<td>CH₄, H₂S, NH₃</td>
<td>• Nitrile Dioxide – NO₂</td>
</tr>
<tr>
<td><strong>Greenhouse management</strong></td>
<td>• Sulfur Dioxide – SO₂</td>
</tr>
<tr>
<td>CO₂, CH₄, Humidity</td>
<td>• Ammonia – NH₃</td>
</tr>
<tr>
<td><strong>Control of chemical and industrial processes</strong></td>
<td>• Methane – CH₄ and other combustible gases</td>
</tr>
<tr>
<td>H₂, HCl, CH₄, SO₂, CO₂</td>
<td>• Molecular Hydrogen – H₂</td>
</tr>
<tr>
<td><strong>Indoor air quality</strong></td>
<td>• Hydrogen Sulfide – H₂S</td>
</tr>
<tr>
<td>CO₂, CO, Particle Matter - Dust, O₃</td>
<td>• Hydrogen Chloride – HCl</td>
</tr>
<tr>
<td><strong>Forest fires</strong></td>
<td>• Hydrogen Cyanide - HCN</td>
</tr>
<tr>
<td>CO, CO₂</td>
<td>• Phosphine – PH₃</td>
</tr>
<tr>
<td>(*) Calibrated gas sensors are manufactured once the order has been placed to ensure maximum durability of the calibration feature. Manufacturing process and delivery may take from 4 to 6 weeks. Lifetime of calibrated gas sensors is 6 months working at its maximum accuracy. We strongly encourage our customers to buy extra gas sensor probes to replace the originals after that time to ensure maximum accuracy and performance.</td>
<td></td>
</tr>
</tbody>
</table>

### EVENTS v3

<table>
<thead>
<tr>
<th>APPLICATIONS</th>
<th>SENSORS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Security</strong></td>
<td>• Pressure/Weight</td>
</tr>
<tr>
<td>Hall effect (doors and windows), person detection PIR</td>
<td>• Hall Effect</td>
</tr>
<tr>
<td><strong>Emergencies</strong></td>
<td>• Temperature, Humidity and Pressure</td>
</tr>
<tr>
<td>Presence detection and water level sensors, temperature</td>
<td>• Liquid Presence</td>
</tr>
<tr>
<td><strong>Control of goods in logistics</strong></td>
<td>• Liquid Level</td>
</tr>
<tr>
<td></td>
<td>• Liquid flow</td>
</tr>
<tr>
<td></td>
<td>• Luminosity (Luxes)</td>
</tr>
<tr>
<td></td>
<td>• Presence (PIR)</td>
</tr>
<tr>
<td></td>
<td>• Ultrasound (distance measurement)</td>
</tr>
</tbody>
</table>

(*) Particle Matter (PM1 / PM2.5 / PM10) – Dust Sensor [only for Plug & Sense]

- Temperature, Humidity and Pressure

---

*Figure: Gases PRO Board*

*Figure: Events Board*
### SMART WATER v3

**APPLICATIONS**
- Potable water monitoring
  - pH, ORP, Dissolved Oxygen (DO), Nitrates, Phosphates
- Chemical leakage detection in rivers
  - Extreme pH values signal chemical spills, Dissolved Oxygen (DO)
- Swimming pool remote measurement
  - pH, Oxidation-Reduction Potential (ORP)
- Pollution levels in the sea
  - Temperature, Conductivity (Salinity), pH, Dissolved Oxygen (DO) and Nitrates

**SENSORS**
- pH
- Oxidation-Reduction Potential (ORP)
- Dissolved Oxygen (DO)
- Conductivity
- Temperature
- Turbidity

*Figure: Smart Water Board*

### SMART WATER XTREME

**APPLICATIONS**
- Industrial and public sewage treatment plants
- Wastewater management (nitrification and de-nitrification)
- Surface water monitoring
- Fish farming, aquaculture
- Drinking water monitoring
- Process engineering plants

**SENSORS**
- Optical dissolved oxygen and temperature OPTOD
- Titanium optical dissolved oxygen and temperature OPTOD
- pH, ORP and temperature PHEHT
- Conductivity, salinity and temperature C4E
- Inductive conductivity, salinity and temperature CTZN
- Turbidity and temperature NTU
- Suspended solid, turbidity, sludge blanket and temperature MESS
- Manta+ 40 sensor
- Chlorophyll sensor for Manta probe
- BGA sensor for Manta probe
- Organic matter sensor CDOM/FDOM for Manta probe
- Ammonium sensor for Manta probe
- Nitrate sensor for Manta probe
- Chloride sensor for Manta probe
- Sodium sensor for Manta probe
- Calcium sensor for Manta probe

*Figure: Plug & Sense! Smart Water Xtreme*

This sensor board is only available for Plug & Sense!
### SMART WATER IONS

**Applications**

- Drinking water quality control
  - Calcium (Ca\(^{2+}\)), Iodide (I\(^-\)), Chloride (Cl\(^-\)), Nitrate (NO\(_3^-\)), Magnesium (Mg\(^{2+}\)), Sodium (Na\(^+\)), pH

- Agriculture water monitoring
  - Calcium (Ca\(^{2+}\)), Nitrate (NO\(_3^-\)), Magnesium (Mg\(^{2+}\)), Sodium (Na\(^+\)), Potassium (K\(^+\)), Ammonium (NH\(_4^+\)), pH

- Swimming pools
  - Bromide (Br\(^-\)), Chloride (Cl\(^-\)), Fluoride (F\(^-\)), pH

- Waste water treatment
  - Cupric (Cu\(^{2+}\)), Silver (Ag\(^+\)), Fluoroborate (BF\(_4^-\)), Lithium (Li\(^+\)), Nitrite (NO\(_2^-\)), Perchlorate (ClO\(_4^-\)), pH

---

### SMART CITIES PRO*

**Applications**

- Noise maps
  - Monitor in real time the acoustic levels in the streets of a city

- Air quality
  - Detect the level of gases and particulates in the air

- Waste management
  - Measure the garbage levels in bins to optimize the trash collection routes

---

(*) Calibrated gas sensors are manufactured once the order has been placed to ensure maximum durability of the calibration feature. Manufacturing process and delivery may take from 4 to 6 weeks. Lifetime of calibrated gas sensors is 6 months working at its maximum accuracy. We strongly encourage our customers to buy extra gas sensor probes to replace the originals after that time to ensure maximum accuracy and performance.
<table>
<thead>
<tr>
<th>SMART PARKING</th>
<th>APPLICATIONS</th>
<th>SENSORS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Car detection for available parking information</td>
<td>• Magnetic field</td>
</tr>
<tr>
<td></td>
<td>• Detection of free parking lots outdoors</td>
<td>• Temperature</td>
</tr>
<tr>
<td></td>
<td>• Parallel and perpendicular parking lots control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Sigfox and LoRaWAN connectivity (EU, US, APAC / LATAM / AU / AU915, IN and APAC / LATAM / AU / AS923)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Extreme battery life</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Surface-mount enclosure, fast installation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Easy configuration, remote management from the cloud</td>
<td></td>
</tr>
</tbody>
</table>

**Figure:** Plug & Sense! Smart Parking node

<table>
<thead>
<tr>
<th>AGRICULTURE v30</th>
<th>APPLICATIONS</th>
<th>SENSORS</th>
</tr>
</thead>
</table>
|                 | • **Precision Agriculture**  
Leaf temperature, fruit diameter | • Air Temperature, Humidity and Pressure |
|                 | • **Irrigation systems**  
Soil moisture, leaf wetness | • Soil Temperature / Moisture |
|                 | • **Greenhouses**  
Solar radiation, humidity, temperature | • Leaf Wetness |
|                 | • **Weather stations**  
Anemometer, wind vane, pluviometer | • Atmospheric Pressure |
|                 |                           | • Solar Radiation - PAR |
|                 |                           | • Ultraviolet Radiation - UV |
|                 |                           | • Trunk Diameter |
|                 |                           | • Stem Diameter |
|                 |                           | • Fruit Diameter |
|                 |                           | • Anemometer |
|                 |                           | • Wind Vane |

**Figure:** Smart Cities PRO Board
<table>
<thead>
<tr>
<th>AGRICULTURE XTREME</th>
<th>APPLICATIONS</th>
<th>SENSORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Precision Agriculture</td>
<td></td>
<td></td>
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<tr>
<td>• Irrigation systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Greenhouses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Weather monitoring</td>
<td></td>
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<tr>
<td>• Soil management</td>
<td></td>
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<tr>
<td>• Accurate fruit observation</td>
<td></td>
<td></td>
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<tr>
<td>• Non-contact surface temperature measurement SI-411</td>
<td></td>
<td></td>
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<tr>
<td>• Leaf and flower bud temperature SF-421</td>
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<td></td>
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<tr>
<td>• Soil oxygen level O-411</td>
<td></td>
<td></td>
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<tr>
<td>• Shortwave radiation SP-510</td>
<td></td>
<td></td>
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<tr>
<td>• Solar radiation (PAR) SQ-110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Ultraviolet radiation (UV) SU-100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Air temperature, humidity and pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Conductivity, water content and soil temperature GS3</td>
<td></td>
<td></td>
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<tr>
<td>• Conductivity, water content and soil temperature STE</td>
<td></td>
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<tr>
<td>• Soil temperature and volumetric water content STM</td>
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<tr>
<td>• Soil water potential MPS-6</td>
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<tr>
<td>• Vapor pressure, humidity, temperature, and atmospheric pressure in soil and air VP-4</td>
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<tr>
<td>• Leaf wetness Phytos 31</td>
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<tr>
<td>• Trunk Diameter DC2</td>
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<td></td>
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<tr>
<td>• Stem Diameter DD-S</td>
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<td></td>
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<tr>
<td>• Fruit Diameter DF</td>
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<td></td>
</tr>
<tr>
<td>• Weather station GMX-100 (PO)</td>
<td></td>
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<tr>
<td>• Weather station GMX-101 (R)</td>
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<td>• Weather station GMX-200 (W)</td>
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<tr>
<td>• Weather station GMX-240 (W-PO)</td>
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<tr>
<td>• Weather station GMX-300 (T-H-AP)</td>
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<tr>
<td>• Weather station GMX-301 (T-H-AP-R)</td>
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<tr>
<td>• Weather station GMX-400 (PO-T-H-AP)</td>
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<tr>
<td>• Weather station GMX-500 (W-T-H-AP)</td>
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<tr>
<td>• Weather station GMX-501 (W-T-H-AP-R)</td>
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<tr>
<td>• Weather station GMX-531 (W-PT-T-H-AP-R)</td>
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<tr>
<td>• Weather station GMX-541 (W-PO-T-H-AP-R)</td>
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<tr>
<td>• Weather station GMX-550 (W-x-T-H-AP)</td>
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<tr>
<td>• Weather station GMX-551 (W-x-T-H-AP-R)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Weather station GMX-600 (W-PO-T-H-AP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Solar radiation and temperature Datasol MET</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Luminosity (Luxes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Ultrasound (distance measurement)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 4-20 mA type (generic input)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• RS-232 type (generic input)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 4-20 mA CURRENT LOOP

**APPLICATIONS**
- Sensors and instruments
- Remote transducers
- Monitoring processes
- Data transmission in industrial ambients

**FEATURES**
- Type: Analog
- Media: Twisted Pair
- No. of devices: 4
- Distance: 900m
- Supply: 12 V

The user can choose among a wide variety of standard sensors

---

**Figure: 4-20 mA Current Loop Board**

### RADIATION

**APPLICATIONS**
- Monitor the radiation levels wirelessly without compromising the life of the security forces
- Create prevention and control radiation networks in the surroundings of a nuclear plant
- Measure the amount of Beta and Gamma radiation in specific areas autonomously

**SENSORS**
- Geiger tube $[\beta, \gamma]$ (Beta and Gamma)

---

**Figure: Radiation Board**

### PROTOTYPING SENSOR

**APPLICATIONS**
- Prepared for the integration of any kind of sensor.

---

**Figure: Prototyping Sensor Board**

It is possible to find more detailed information in the manual for each board at:

http://www.libelium.com/development/waspmote/documentation
Power supplies

- 6600 mAh Li-Ion rechargeable // 52000 mA·h **non-rechargeable**
- Solar Panel: rigid (7 V – 500 mA) and flexible (7.2 V – 100 mA)
- USB (220 V - USB, car lighter USB)

USB-PC interface

- Model: Waspmote Gateway
- Communication: 802.15.4/ZigBee/DigiMesh/868/900/LoRa/Bluetooth/BLE - USB PC
- Programmable buttons and LEDs

Compiler:

- IDE - Waspmote (open source)
- Language: C++
- Versions Windows, Linux and Mac-OS
Waspmote vs Waspmote Plug & Sense!

Waspmote is the original line in which developers have a total control over the hardware device. You can physically access to the board and connect new sensors or even embed it in your own products as an electronic sensor device.

The Waspmote Plug & Sense! line allows developers to forget about electronics and focus on services and applications. Now you can deploy wireless sensor networks in an easy and scalable way ensuring minimum maintenance costs. The platform consists of a robust waterproof enclosure with specific external sockets to connect the sensors, the solar panel, the antenna and even the USB cable in order to reprogram the node. It has been specially designed to be scalable, easy to deploy and maintain.

For more information about Waspmote Plug & Sense! go to:
http://www.libelium.com/plug-sense
Meshlium - The IoT Gateway

The sensor data gathered by the Waspmote Plug & Sense! nodes is sent to the Cloud by Meshlium, the IoT gateway router specially designed to connect Waspmote sensor networks to the Internet via Ethernet and 4G/3G/2G interfaces.

Meshlium can work as:
- an RF (XBee) to Ethernet router for Waspmote nodes
- an RF (XBee) to 4G/3G/GPRS/GSM router for Waspmote nodes
- a WiFi Access Point
- a WiFi to 4G/3G/GPRS/GSM router
- a GPS – 4G/3G/GPRS/GSM real-time tracker
- a smartphone scanner (detects iPhone and Android devices)

Meshlium storage options

- Local data base
- External data base
Meshlium connection options

- XBee / 4G / 3G / 2G / WiFi → Ethernet
- XBee / 4G / 3G / 2G / WiFi → 4G / 3G / 2G

All the networking options can be controlled from the Manager System, a web interface which comes with Meshlium. It allows to control all the interfaces and system options in a secure, easy and quick way.

Figure: Meshlium connection options

All information about Meshlium can be found in the Meshlium Technical Guide. All the Meshlium documentation is located in the Development section in the Libelium website.
Meshlium Visualizer

Meshlium Visualizer is a plugin which plots graphs and maps with the data stored in the database. It can also export data in common formats. Meshlium Visualizer is a special software feature only available in the Meshlium units included in the IoT Vertical Kits (Smart Cities IoT Vertical Kit, Smart Water IoT Vertical Kit, etc).

Figure: Meshlium visualizer
Cloud Connectors

Meshlium allows developers to connect easily with third party cloud servers such as Amazon, IBM, Microsoft, Alibaba, Telefónica, ESRI, ThingWorks, etc. Just select the desired plugin in the Manager System and add the account info to synchronize the internal data base of Meshlium with the desired platform.
The Bridge

The Bridge is a service on the cloud created by Libelium. It sends information from any IoT device to the main worldwide cloud platforms simultaneously and without having to implement each specific cloud protocol or authentication process.

For more info about Meshlium go to:
http://www.libelium.com/products/meshlium/
Certifications

Libelium offers 2 types of IoT sensor platforms, Waspmote OEM and Plug & Sense!:

- **Waspmote OEM** is intended to be used for research purposes or as part of a major product so it needs final certification on the client side. More info at: [www.libelium.com/products/waspmote](http://www.libelium.com/products/waspmote)
- **Plug & Sense!** is the line ready to be used out-of-the-box. It includes market certifications. See below the specific list of regulations passed. More info at: [www.libelium.com/products/plug-sense](http://www.libelium.com/products/plug-sense)

Besides, Meshlium, our multiprotocol router for the IoT, is also certified with the certifications below. Get more info at:

List of certifications for Plug & Sense! and Meshlium:

- CE (Europe)
- FCC (US)
- IC (Canada)
- ANATEL (Brazil)
- RCM (Australia)
- PTCRB (cellular certification for the US)
- AT&T (cellular certification for the US)

![Figure: Certifications of the Plug & Sense! product line](image-url)

You can find all the certification documents at:
[www.libelium.com/certifications](http://www.libelium.com/certifications)

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