Proto Sensor 2.0
Technical Guide

libelium

waspmote

INDEX

1. General

1.1. General and safety information

- In this section, the term "Waspmote" encompasses both the Waspmote device itself and its modules and sensor boards.
- Read through the document "General Conditions of Libelium Sale and Use".
- Do not allow contact of metallic objects with the electronic part to avoid injuries and burns.
- NEVER submerge the device in any liquid.
- Keep the device in a dry place and away from any liquid which may spill.
- Waspmote consists of highly sensitive electronics which is accessible to the exterior, handle with great care and avoid bangs or hard brushing against surfaces.
- Check the product specifications section for the maximum allowed power voltage and amperage range and consequently always use a current transformer and a battery which works within that range. Libelium is only responsible for the correct operation of the device with the batteries, power supplies and chargers which it supplies.
- Keep the device within the specified range of temperatures in the specifications section.
- Do not connect or power the device with damaged cables or batteries.
- Place the device in a place only accessible to maintenance personnel (a restricted area).
- Keep children away from the device in all circumstances.
- If there is an electrical failure, disconnect the main switch immediately and disconnect that battery or any other power supply that is being used.
- If using a car lighter as a power supply, be sure to respect the voltage and current data specified in the "Power Supplies" section.
- If using a battery in combination or not with a solar panel as a power supply, be sure to use the voltage and current data specified in the "Power supplies" section.
- If a software or hardware failure occurs, consult the Libelium Web **Development section**.
- Check that the frequency and power of the communication radio modules together with the integrated antennas are allowed in the area where you want to use the device.
- Waspmote is a device to be integrated in a casing so that it is protected from environmental conditions such as light, dust, humidity or sudden changes in temperature. The board supplied "as is" is not recommended for a final installation as the electronic components are open to the air and may be damaged.

1.2. Conditions of use

- Read the "General and Safety Information" section carefully and keep the manual for future consultation.
- Use Waspmote in accordance with the electrical specifications and the environment described in the "Electrical Data" section of this manual.
- Waspmote and its components and modules are supplied as electronic boards to be integrated within a final product. This product must contain an enclosure to protect it from dust, humidity and other environmental interactions. In the event of outside use, this enclosure must be rated at least IP-65.
- Do not place Waspmote in contact with metallic surfaces; they could cause short-circuits which will permanently damage it.

Further information you may need can be found at **http://www.libelium.com/development/waspmote**
The "General Conditions of Libelium Sale and Use" document can be found at:
http://www.libelium.com/development/waspmote/technical_service

2. Hardware

2.1. General Description

The Waspmote Prototyping Board 2.0 has been designed to make it as easy as possible for the user to integrate any type of sensor. With this aim in mind, the board has been endowed with a 16 bit analog-digital converter (ADC) which provides up to a 68uV resolution in a 0 to 4.5V range for a differential input; an area of independent pads where pins, cables, passives or DIP encapsulated integrated circuits can be welded; and an area for SMD encapsulated integrated circuits upon which various circuits or sockets with different sizes can be mounted.

2.2. Specifications

Weight:	20gr
Dimensions:	73.5 x 51 x 1.3 mm
Temperature Range:	[-20ºC, 65ºC]

Figure 1: Upper side
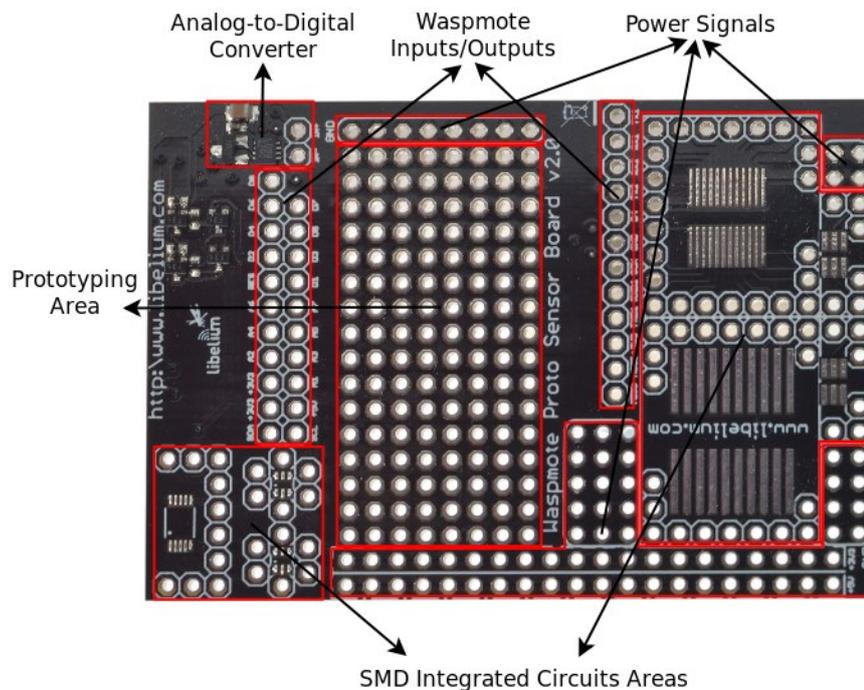
2.3. Electrical Characteristics

Operating ratings:

- Board supply voltages: 3.3V and 5V
- Analog-to-Digital converter supply voltage: 5V
- Maximum admitted current (continuous): 200mA
- Maximum admitted current (peak): 400mA

Absolute maximum ratings:

- Microprocessor pin voltage: -05.V to 3.8V
- Analog-to-Digital converter input voltage: -0.3V to 5.3V
- Microprocessor pin current: 40mA

3. Integration of Sensors

3.1. Prototyping area

The prototyping area included within the board is divided into two regions: the pads area and the integrated circuits area.

3.1.1. Pads Area

This is a matrix of 16x8 pads of 1mm diameter whose aim is to fit discrete components such as resistors, capacitors or DIP encapsulated integrated circuits. The metallised area of each pad is of a larger size to facilitate both welding the components to the pads and welding pads to each other.

On the upper part and the lower part of the matrix there are strips of pads that provide an output to all the mote's signals in the sensors' connectors. In figure 2 and its adjoining table we can see which microprocessor pin corresponds to each pad.
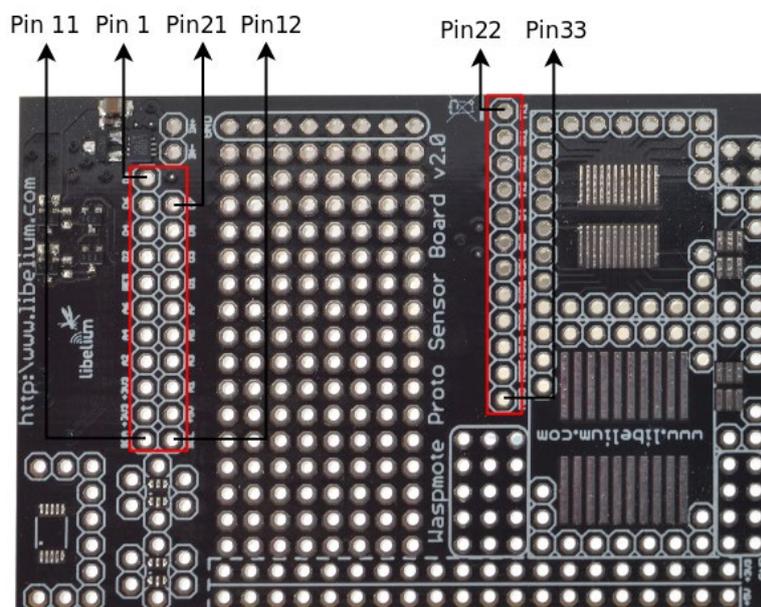

Figure 2: Image of the Waspmote inputs and outputs

Pin	Description
1	Digital input/output signal DIGITAL8
2	Digital input/output signal DIGITAL6
3	Digital input/output signal DIGITAL4
4	Digital input/output signal DIGITAL2
5	Reserved
6	Digital input/output signal and analog input ANALOG6
7	Digital input/output signal and analog input ANALOG4
8	Digital input/output and analog input signal ANALOG2
9	3.3V Power supply (SENS_PW_3V3)
10	3.3V Power supply (GPS_PW)
11	SDA (I2C bus signal)
12	SCL (I2C bus signal)

Pin	Description
13	5V Power supply (SENS_PW_5V)
14	Digital input/output signal and analog input ANALOG1
15	Digital input/output signal and analog input ANALOG3
16	Digital input/output signal and analog input ANALOG5
17	Digital input/output signal and analog input ANALOG7
18	Digital input/output signal DIGITAL1
19	Digital input/output signal DIGITAL3
20	Digital input/output signal DIGITAL5
21	Digital input/output signal DIGITAL7
22	Transmission Output UART 1 SERIAL_1_TX
23	Reception Input UART 1 SERIAL_1_RX
24	Reception Input UART 2 SERIAL_2_RX
25	Transmission Output UART 2 SERIAL_2_TX
26	Battery Supply Voltage
27	Ground GND
28	SCK (SPI bus signal)
29	High interrupt input signal RXD1
30	Low interrupt input signal TXD1
31	3.3V Supply Voltage (SENS_PW_3V3)
32	MOSI (SPI bus signal)
33	MISO (SPI bus signal)

Finally a series of pads connected to the 3.3V supply, the 5V supply and to ground are included. They can be seen in figure 3.
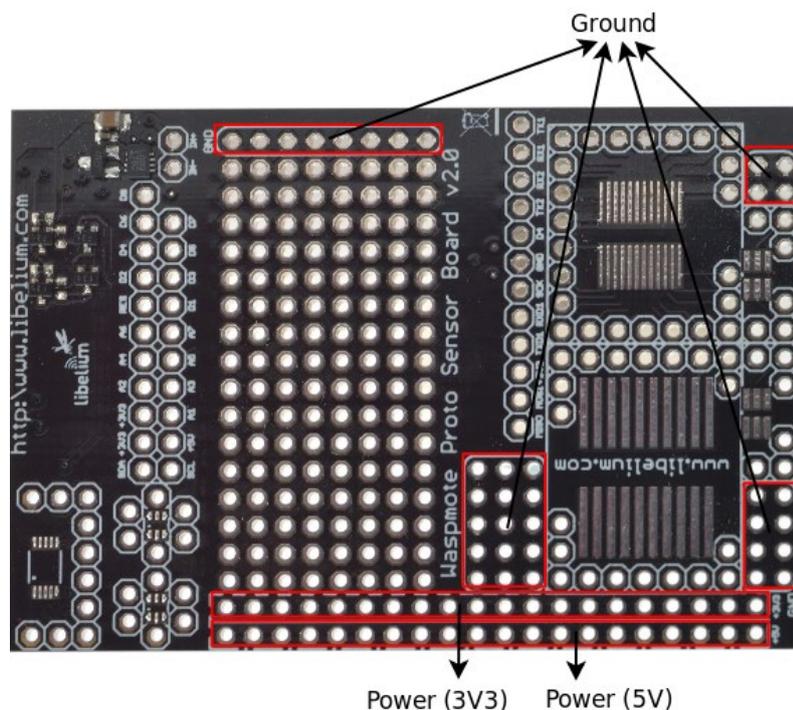

Figure 3: Image of the different power supply pads

3.1.2. Integrated Circuits Area

Seven footprints have been added for SMD integrated circuits of different sizes: One 20 port SO type, one 24 port TSSOP, one 10 port micro-SOIC, two 6 port SOT-23 and two 6 port SC-70. Output is given to each of the footprint ports through a 1mm diameter pad, from which it is possible to access the circuit.
In figures 4 and 5 all the integrated circuit footprints and the pads which correspond to their output ports can be seen.
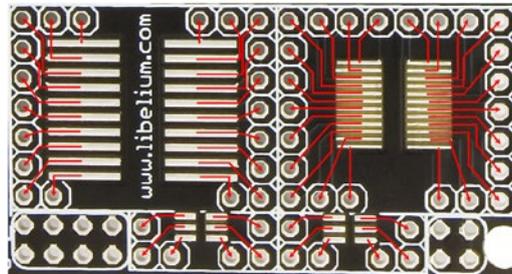

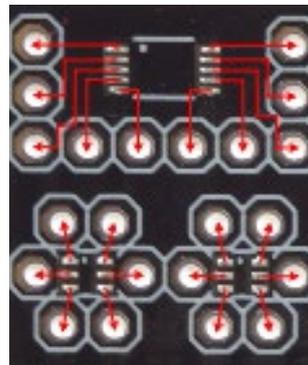*Figure 4: Image of the SO, TSSOP and SOT-23 circuit area*

Figure 5: Image of the micro-SOIC and SC-70 circuit area

3.2. Analog-to-Digital Converter

The Waspmote microprocessor incorporates a 10-bit analog-to-digital converter which can be accessed through any of the analog inputs within the main 2x11 pin connector. In the event of any application requiring a higher resolution, a 16-bit Sigma-Delta ($\Sigma\Delta$) analog-to-digital converter has been added to the prototyping board, with a maximum conversion time of 23ms (Linear model LTC2453). Communication with this device is carried out through the I2C, allowing a differential reading between its input IN+ and IN- (see section "API" about the board libraries for information on the necessary commands for communication). Each of the inputs allows a range of voltage between 0 and 4.5V, allowing therefore a differential measurement between -4.5V and 4.5V. To obtain a more precise reading, the reference voltage for the conversion is fixed by a voltage reference of 4.5V, model MAX6107. In figure 6 there is a diagram of the connections which follow the converter circuit, and in figure 7 the pads from which this is accessed can be seen.
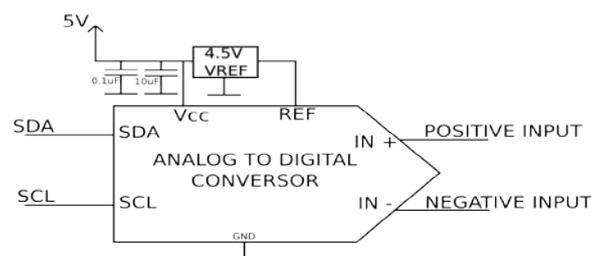

Figure 6: Diagram of the integration of the analog-to-digital converter

Basic reading code:

```
{
  float value;
  SensorProtov20.ON();
  delay(10);
  value = SensorProtov20.readADC();
}
```

You can find a complete example code for reading the analog-to-digital converter at:

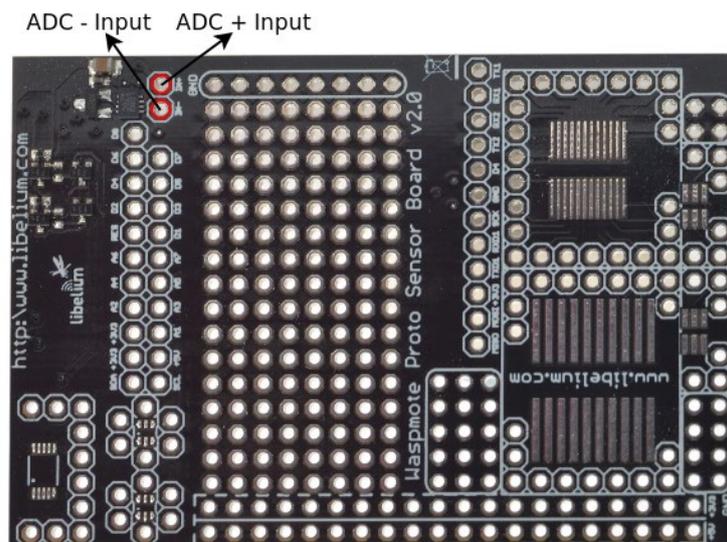**http://www.libelium.com/development/waspmote/examples/pr-1-reading-the-adc-at-prototyping-2-0-board**

Figure 7: Input pins to the analog-to-digital converter

4. Board configuration and programming

4.1. Hardware configuration

Following one of the main premises that guided the design of the Waspmote Prototyping Board 2.0, to offer the highest flexibility possible, only the pads' connections which give access to the mote's microprocessor input and output signals and to each one of the adaptation stages have been fixed, allowing to use any resources considered necessary in user's design. This way, to use any of the board's components or signals it will be necessary to weld a pin or cable to its access pad.

4.2. API

To facilitate handling of the different stages which have been added to the Prototyping Board 2.0, a series of functions have been implemented in the WaspSensorPrototying_v20 library.
When using the Prototyping Board 2.0 on Waspmote PRO, remember it is mandatory to include the SensorProtov20 library by introducing the next line at the beginning of the code:

```
#include <WaspSensorPrototyping_v20.h>
```

Next the different functions that make up the library are described:

`SensorProtov20.ON()`
Turns on the sensor board by activating the 3.3V and 5V supply lines.

`SensorProtov20.OFF()`

Turns off the sensor board by cutting the 3.3V and 5V supply lines.

`SensorProtov20.setBoardMode(MODE)`

This function is used to manage the power applied to the board. Assigning the value `SENS_ON` to the variable `MODE` activates the board's switches which allow the passage of 3.3V and 5V voltage, while assigning the value `SENS_OFF` disconnects both switches cutting the power. This function is called inside `SensorProtov20.ON` and `SensorProtov20.OFF` functions.

`SensorProtov20.readADC()`

When a floating point (`float`) value is assigned to the function `readADC`, it reads the analog-to-digital converter record through the I2C bus and returns the voltage value stored. Given that the chosen converter carries out the voltage conversion in its input immediately after reading, on occasions in which the time between record readings is high, so that the change in the converter's value may be significant, it may be recommended to carry out the reading instruction two consecutive times, at least 20 milliseconds apart, discarding the first of the values obtained and accepting the second.

`SensorProtov20.readAnalogSensor(PIN)`

This function allows the capture of the voltage value of one of the analog input pins to the Waspmote, indicating the variable `PIN` (from `ANALOG1` to `ANALOG7`). Once a floating point (`float`) variable is assigned it returns a value between 0 and 3.3V, the maximum value which the Waspmote microprocessor can read at its input.

The files of the sensor board itself are: **WaspSensorPrototyping_v20.h, WaspSensorPrototyping_v20.cpp**

They can be downloaded from: **http://www.libelium.com/development/waspmote/sdk_and_applications**

5. Consumption

5.1. Power control

The supply voltage of the prototyping board may be managed through the `setBoardMode` function of the library, described in the previous section, which allows to activate or deactivate both supply lines to the board (3.3V and 5V).

5.2. Consumption table

In the following table the consumption of the board when it is active is shown, from minimum consumption (fixed by the components which are permanently active), together with an estimate of the average consumption of determined tasks and their duration.

	Consumption
Minimum (constant)	0μA
Analog-to-Digital Converter (Idle state)	200μA
Reading of Analog-to-Digital Converter (approximately 20ms)	900μA

6. API Changelog

Function / File	Changelog	Version
`WaspSensorPrototyping_v20::WaspSensorPrototyping_v20`	Internal change in function	v005 → v006
`WaspSensorPrototyping_v20::setBoardMode`	Internal change in function	v005 → v006
`WaspSensorPrototyping_v20::readADC`	Internal change in function	v004 → v005
`#include`	Remember to include the WaspSensorPrototyping_v20 library in the top of your pde	v0.31 → v001
`SensorProtov20.ON()`	New function to turn on the board	v0.31 → v001
`SensorProtov20.OFF()`	New function to turn off the board	v0.31 → v001

7. Documentation Changelog

From v4.1 to v4.2

- API changelog updated to v006

From v4.0 to v4.1

- API changelog updated to API v005
- Documentation changelog created

8. Maintenance

- In this section, the term "Waspmote" encompasses both the Waspmote device itself as well as its modules and sensor boards.
- Take care with the handling of Waspmote, do not drop it, bang it or move it sharply.
- Avoid putting the devices in areas of high temperatures since the electronic components may be damaged.
- The antennas are lightly threaded to the connector; do not force them as this could damage the connectors.
- Do not use any type of paint for the device, which may damage the functioning of the connections and closure mechanisms.

9. Disposal and Recycle

In this section, the term "Waspmote" encompasses both the Waspmote device itself as well as its modules and sensor boards.

- When Waspmote reaches the end of its useful life, it must be taken to a recycling point for electronic equipment.
- The equipment has to be disposed on a selective waste collection system, different to that of urban solid waste. Please, dispose it properly.
- Your distributor will inform you about the most appropriate and environmentally friendly waste process for the used product and its packaging.