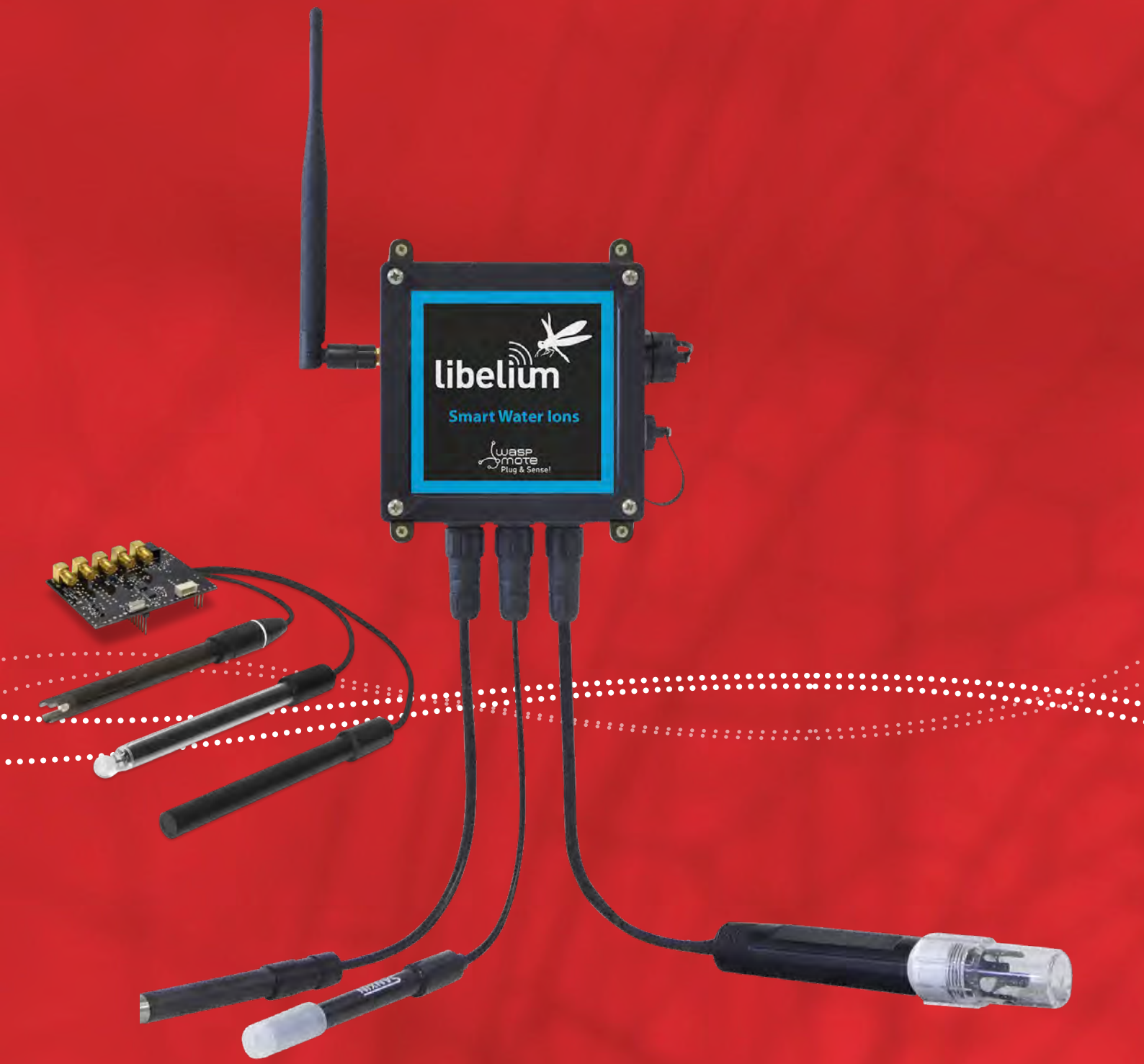
Smart Water Ions

Technical Guide



libelium

wasp mote

Document version: v7.4 - 12/2018

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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. New version: Smart Water Ions v3.0

This guide explains the new Smart Water Ions Board v3.0. This board was designed for our new product lines Waspmote v15 and Plug & Sense! v15, released on October 2016.

The previous version of this board (v1.0) was designed for Waspmote v12 and Plug & Sense! v12, and 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".

Differences of Smart Water Ions v3.0 with the previous version:

- Internal changes have been made on the board circuitry
- Clearer silkscreen for easier connection
- Internal changes in the library

3. Waspmote Plug & Sense!

The Waspmote Plug & Sense! line allows you to easily deploy Internet of Things 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.

Note: *For a complete reference guide download the "Waspmote Plug & Sense! Technical Guide" in the Development section of the Libelium website.*

3.1. Features

- Robust waterproof IP65 enclosure
- Add or change a sensor probe in seconds
- Solar powered external panel option
- Radios available: 802.15.4, 868 MHz, 900 MHz, WiFi, 4G, Sigfox and LoRaWAN
- Over the air programming (OTAP) of multiple nodes at once (via WiFi or 4G radios)
- Special holders and brackets ready for installation in street lights and building fronts
- Graphical and intuitive interface Programming Cloud Service
- Built-in, 3-axes accelerometer
- External, contactless reset with magnet
- Optional industrial protocols: RS-232, RS-485, Modbus, CAN Bus
- Optional GPS receiver
- Optional External Battery Module
- External SIM connector for the 4G models
- Fully certified: CE (Europe), FCC (USA), IC (Canada), ANATEL (Brazil), RCM (Australia), PTCRB (USA, cellular connectivity), AT&T (USA, cellular connectivity)

Figure: Waspmote Plug & Sense!

3.2. General view

This section shows main parts of Waspmote Plug & Sense! and a brief description of each one. In later sections all parts will be described deeply.

3.2.1. Specifications

- **Material:** polycarbonate
- **Sealing:** polyurethane
- **Cover screws:** stainless steel
- **Ingress protection:** IP65
- **Impact resistance:** IK08
- **Rated insulation voltage AC:** 690 V
- **Rated insulation voltage DC:** 1000 V
- **Heavy metals-free:** Yes
- **Weatherproof:** true - nach UL 746 C
- **Ambient temperature (min.):** -30 °C*
- **Ambient temperature (max.):** 70 °C*
- **Approximated weight:** 800 g

* *Temporary extreme temperatures are supported. Regular recommended usage: -20, +60 ºC.*

In the pictures included below it is shown a general view of Waspmote Plug & Sense! main parts. Some elements are dedicated to node control, others are designated to sensor connection and other parts are just identification elements. All of them will be described along this guide.

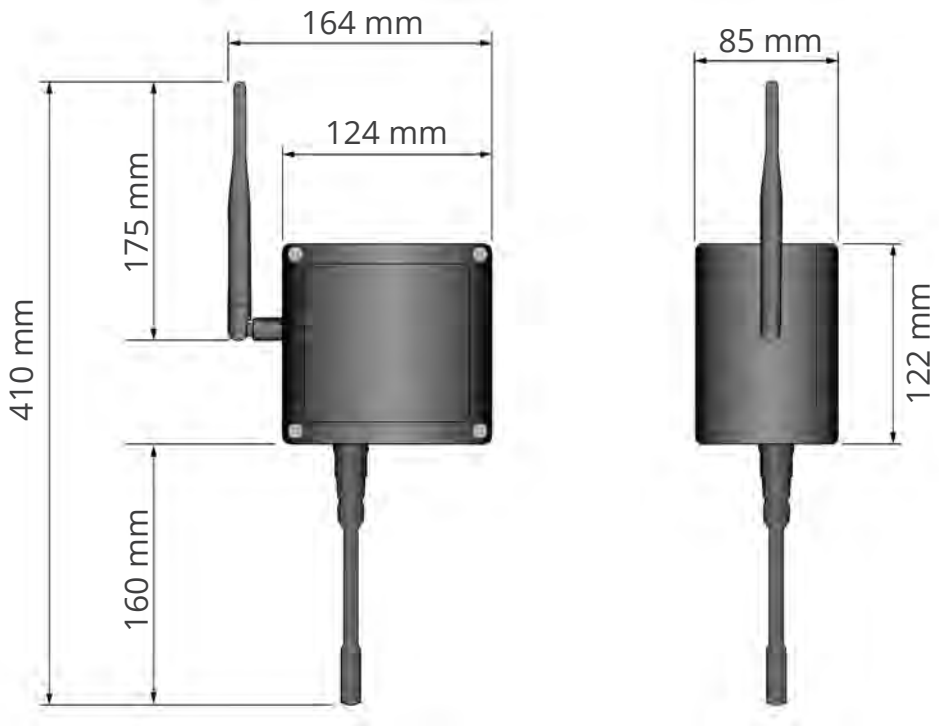


Figure: Main view of Waspmote Plug & Sense!

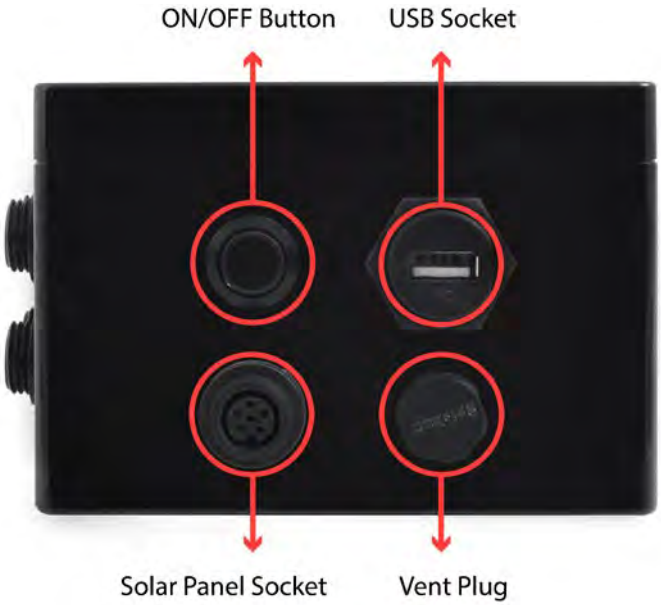
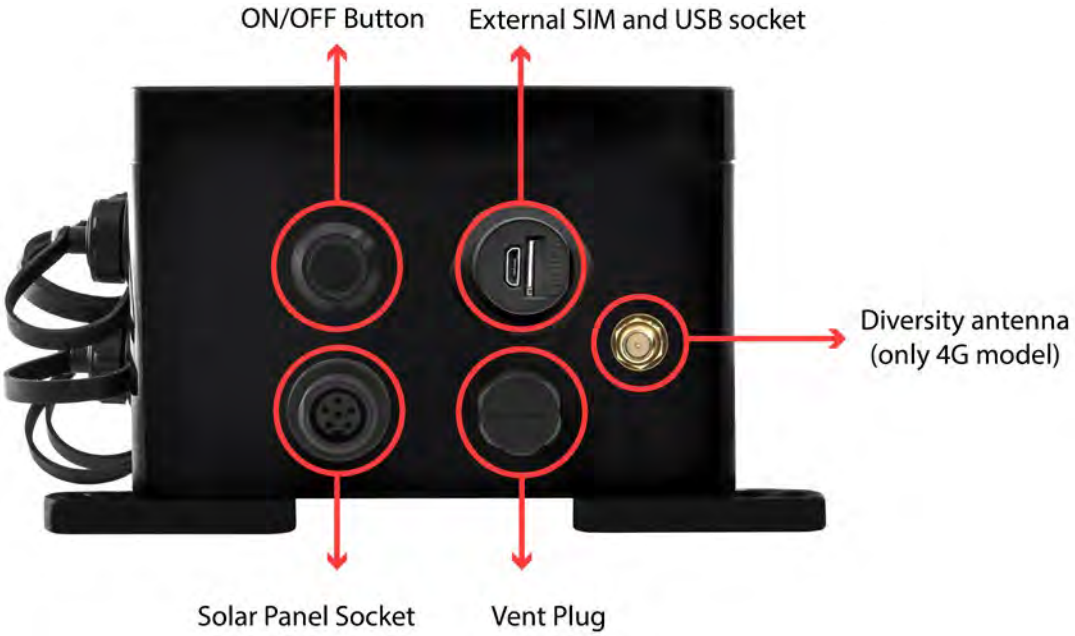


Figure: Control side of the enclosure



Control side of the enclosure for 4G model

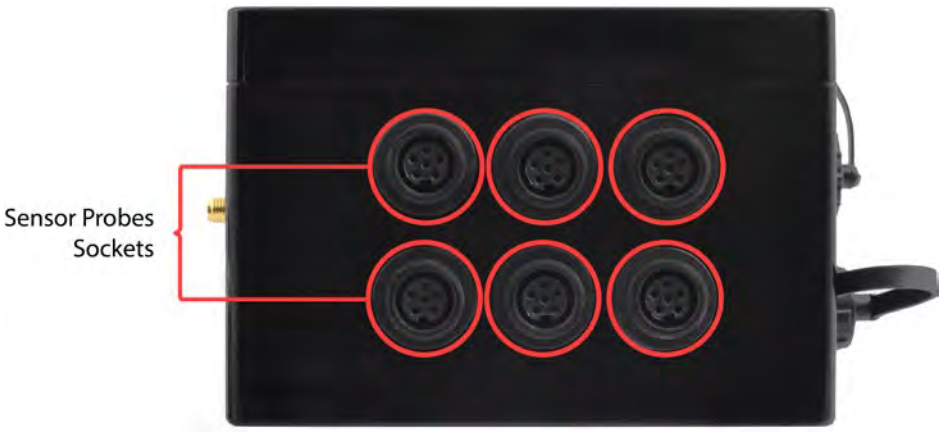


Figure: Sensor side of the enclosure

Figure: Antenna side of the enclosure

Figure: Front view of the enclosure

Figure: Back view of the enclosure

Figure: Warranty stickers of the enclosure

***Important note:** Do not handle black stickers seals of the enclosure (Warranty stickers). Their integrity is the proof that Waspmote Plug & Sense! has not been opened. If they have been handled, damaged or broken, the warranty is automatically void.*

3.2.2. Parts included

Next picture shows Waspmote Plug & Sense! and all of its elements. Some of them are optional accessories that may not be included.

Figure: Waspmote Plug & Sense! accessories: 1 enclosure, 2 sensor probes, 3 external solar panel, 4 USB cable, 5 antenna, 6 cable ties, 7 mounting feet (screwed to the enclosure), 8 extension cord, 9 solar panel cable, 10 wall plugs & screws

3.2.3. Identification

Each Waspmote model is identified by stickers. Next figure shows front sticker.

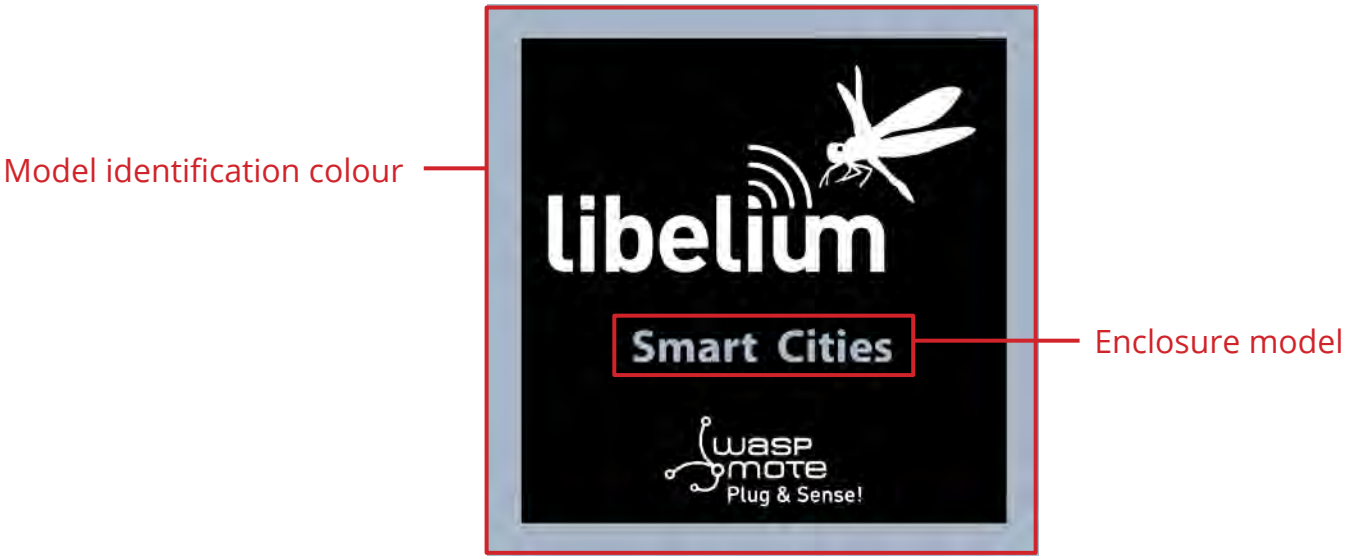


Figure: Front sticker of the enclosure

There are many configurations of Waspmote Plug & Sense! line, all of them identified by one unique sticker. Next image shows all possibilities.

Figure: Different front stickers

Moreover, Waspmote Plug & Sense! includes a back sticker where it is shown identification numbers, radio MAC addresses, etc. It is highly recommended to annotate this information and save it for future maintenance. Next figure shows it in detail.

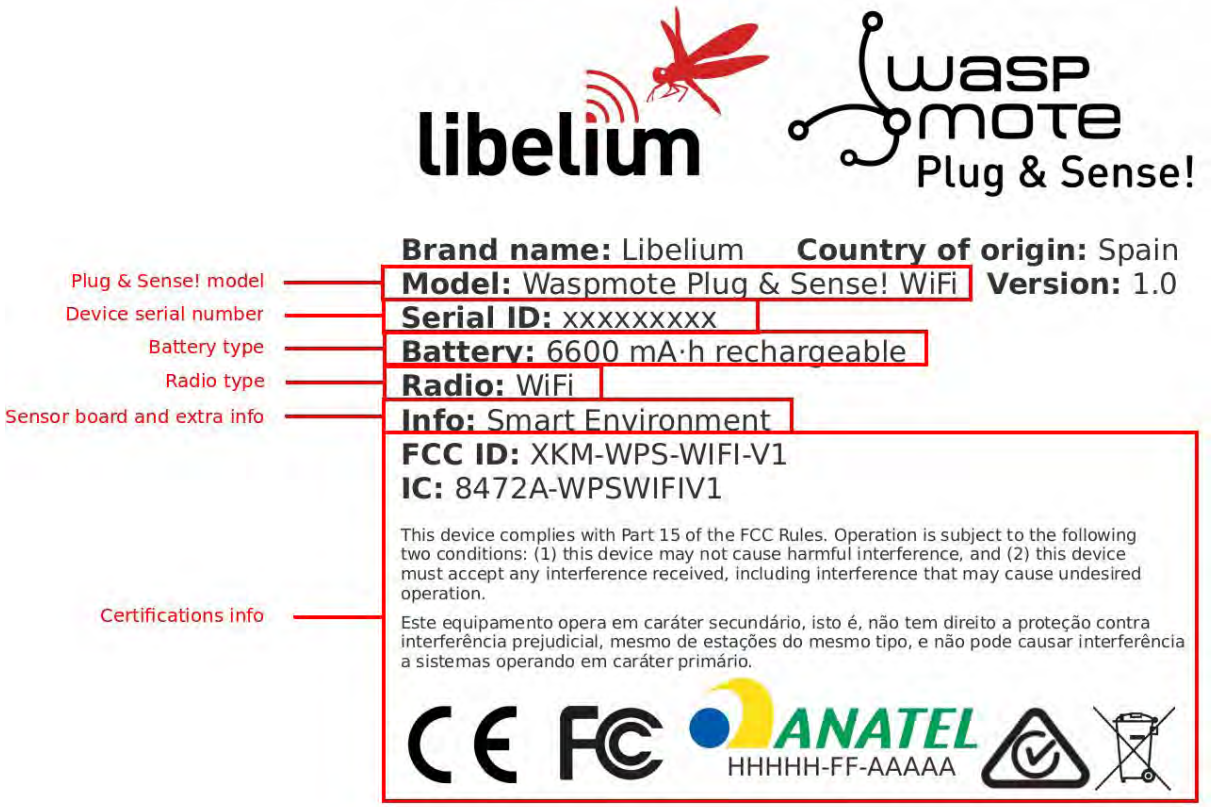


Figure: Back sticker

Sensor probes are identified too by a sticker showing the measured parameter and the sensor manufacturer reference.

Figure: Sensor probe identification sticker

3.3. Sensor probes

Sensor probes can be easily attached by just screwing them into the bottom sockets. This allows you to add new sensing capabilities to existing networks just in minutes. In the same way, sensor probes may be easily replaced in order to ensure the lowest maintenance cost of the sensor network.

Figure: Connecting a sensor probe to Waspmote Plug & Sense!

Go to the Plug & Sense! Sensor Guide to know more about our sensor probes.

3.4. Solar powered

The battery can be recharged using the waterproof USB cable but also the external solar panel option.

The external solar panel is mounted on a 45º holder which ensures the maximum performance of each outdoor installation.

Figure: Waspmote Plug & Sense! powered by an external solar panel

3.5. External Battery Module

The External Battery Module (EBM) is an accessory to extend the battery life of Plug & Sense!. The extension period may be from months to years depending on the sleep cycle and radio activity. The daily charging period is selectable among 5, 15 and 30 minutes with a selector switch and it can be combined with a solar panel to extend even more the node's battery lifetime.

Note: Nodes using solar panel can keep using it through the External Battery Module. The EBM is connected to the solar panel connector of Plug & Sense! and the solar panel unit is connected to the solar panel connector of the EBM.

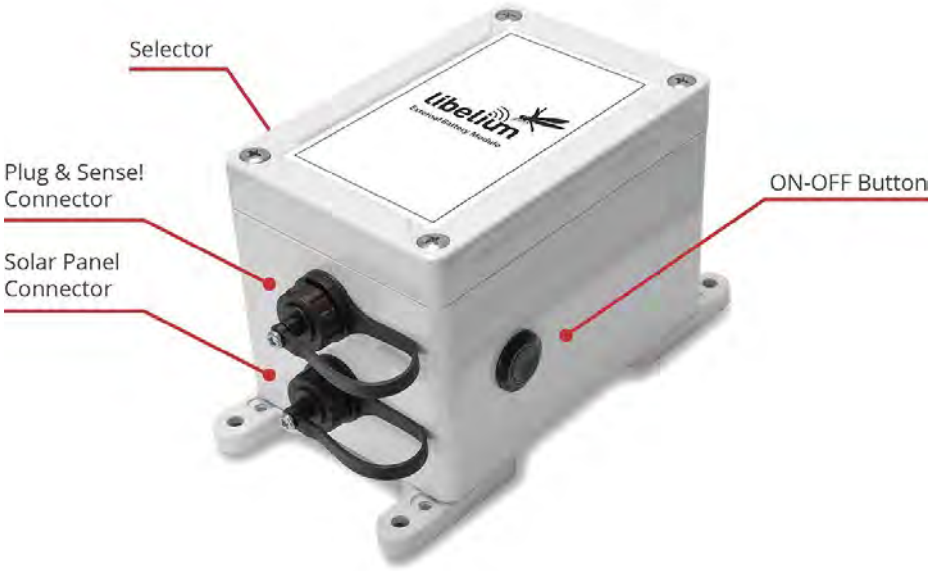


Figure: Plug & Sense! with External Battery Module

Figure: Plug & Sense! with External Battery Module and solar panel

3.6. Programming the Nodes

Waspmote Plug & Sense! can be reprogrammed in two ways:

The basic programming is done from the USB port. Just connect the USB to the specific external socket and then to the computer to upload the new firmware.

Figure: Programming a node

Over the Air Programming (OTAP) is also possible once the node has been installed (via WiFi or 4G radios). With this technique you can reprogram, wireless, one or more Waspmote sensor nodes at the same time by using a laptop and Meshlium.

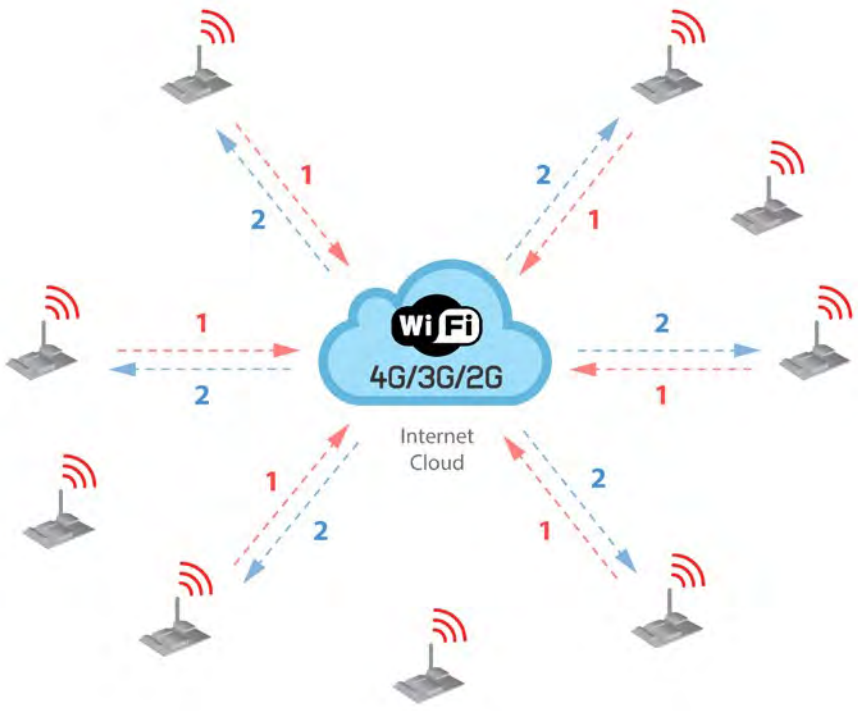


Figure: Typical OTAP process

3.7. Program in minutes

The Programming Cloud Service is an intuitive graphic interface which creates code automatically. The user just needs to to fill a web form to obtain binaries for Plug & Sense!. Advanced programming options are available, depending on the license selected.

Check how easy it is to handle the Programming Cloud Service at:

https://cloud.libelium.com/

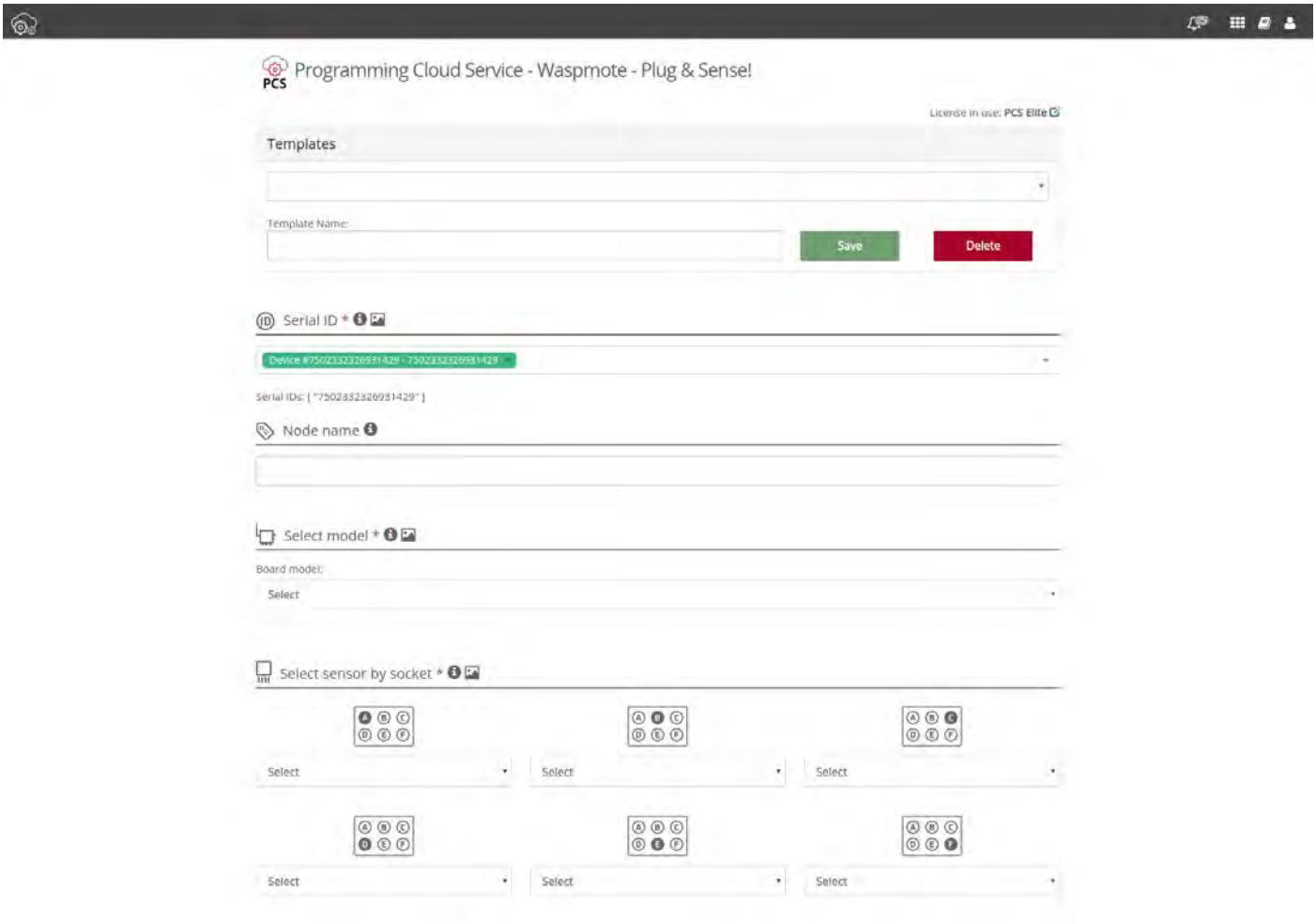


Figure: Programming Cloud Service

3.8. Radio interfaces

Radio	Protocol	Frequency bands	Transmission power	Sensitivity	Range*	Certification
XBee-PRO 802.15.4 EU	802.15.4	2.4 GHz	10 dBm	-100 dBm	750 m	CE
XBee-PRO 802.15.4	802.15.4	2.4 GHz	18 dBm	-100 dBm	1600 m	FCC, IC, ANATEL, RCM
XBee 868LP	RF	868 MHz	14 dBm	-106 dBm	8.4 km	CE
XBee 900HP US	RF	900 MHz	24 dBm	-110 dBm	15.5 km	FCC, IC
XBee 900HP BR	RF	900 MHz	24 dBm	-110 dBm	15.5 km	ANATEL
XBee 900HP AU	RF	900 MHz	24 dBm	-110 dBm	15.5 km	RCM
WiFi	WiFi (HTTP(S), FTP, TCP, UDP)	2.4 GHz	17 dBm	-94 dBm	500 m	CE, FCC, IC, ANATEL, RCM
4G EU/BR	4G/3G/2G (HTTP, FTP, TCP, UDP) GPS	800, 850, 900, 1800, 2100, 2600 MHz	4G: class 3 (0.2 W, 23 dBm)	4G: -102 dBm	- km - Typical base station range	CE, ANATEL
4G US	4G/3G/2G (HTTP, FTP, TCP, UDP) GPS	700, 850, 1700, 1900 MHz	4G: class 3 (0.2 W, 23 dBm)	4G: -103 dBm	- km - Typical base station range	FCC, IC, PTCRB, AT&T
4G AU	4G (HTTP, FTP, TCP, UDP)	700, 1800, 2600 MHz	4G: class 3 (0.2 W, 23 dBm)	4G: -102 dBm	- km - Typical base station range	RCM
Sigfox EU	Sigfox	868 MHz	16 dBm	-126 dBm	- km - Typical base station range	CE
Sigfox US	Sigfox	900 MHz	24 dBm	-127 dBm	- km - Typical base station range	FCC, IC
Sigfox AU / APAC / LATAM	Sigfox	900 MHz	24 dBm	-127 dBm	- km - Typical base station range	-
LoRaWAN EU	LoRaWAN	868 MHz	14 dBm	-136 dBm	> 15 km	CE
LoRaWAN US	LoRaWAN	902-928 MHz	18.5 dBm	-136 dBm	> 15 km	FCC, IC
LoRaWAN AU	LoRaWAN	915-928 MHz	18.5 dBm	-136 dBm	> 15 km	-
LoRaWAN IN	LoRaWAN	865-867 MHz	18.5 dBm	-136 dBm	> 15 km	-
LoRaWAN ASIA-PAC / LATAM	LoRaWAN	923 MHz	18.5 dBm	-136 dBm	> 15 km	-

** Line of sight and Fresnel zone clearance with 5dBi dipole antenna.*

3.9. Industrial Protocols

Besides the main radio of Waspmote Plug & Sense!, it is possible to have an Industrial Protocol module as a secondary communication option. This is offered as an accessory feature.

The available Industrial Protocols are RS-232, RS-485, Modbus (software layer over RS-232 or RS-485) and CAN Bus. This optional feature is accessible through an additional, dedicated socket on the antenna side of the enclosure.

Figure: Industrial Protocols available on Plug & Sense!

Finally, the user can choose between 2 probes to connect the desired Industrial Protocol: A standard DB9 connector and a waterproof terminal block junction box. These options make the connections on industrial environments or outdoor applications easier.

Figure: DB9 probe

Figure: Terminal box probe

3.10. GPS

Any Plug & Sense! node can incorporate a GPS receiver in order to implement real-time asset tracking applications. The user can also take advantage of this accessory to geolocate data on a map. An external, waterproof antenna is provided; its long cable enables better installation for maximum satellite visibility.

Figure: Plug & Sense! node with GPS receiver

Chipset: 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: 2 m
- Connector: SMA
- Gain: 26 dBi (active)

Available information: latitude, longitude, altitude, speed, direction, date&time and ephemeris management

3.11. Models

There are some defined configurations of Waspmote Plug & Sense! depending on which sensors are going to be used. Waspmote Plug & Sense! configurations allow to connect up to six sensor probes at the same time.

Each model takes a different conditioning circuit to enable the sensor integration. For this reason each model allows to connect just its specific sensors.

This section describes each model configuration in detail, showing the sensors which can be used in each case and how to connect them to Waspmote. In many cases, the sensor sockets accept the connection of more than one sensor probe. See the compatibility table for each model configuration to choose the best probe combination for the application.

It is very important to remark that each socket is designed only for one specific sensor, so **they are not interchangeable**. Always be sure you connected probes in the right socket, otherwise they can be damaged.

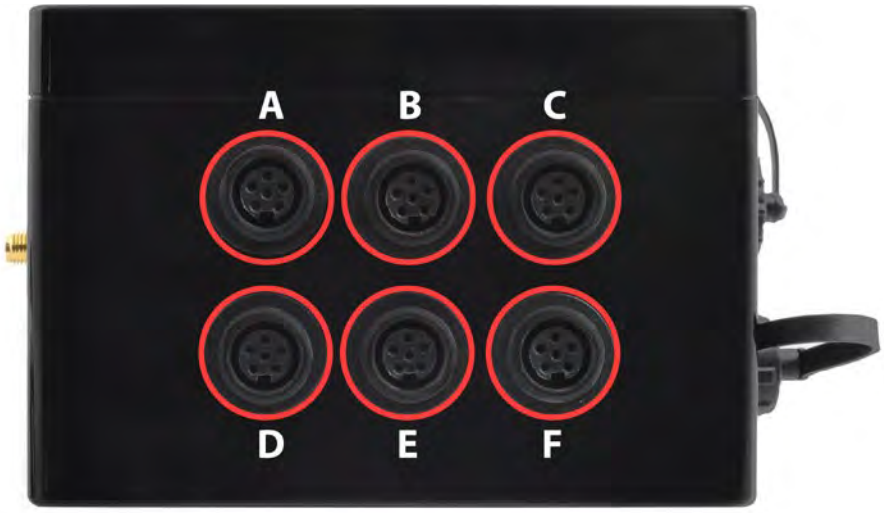


Figure: Identification of sensor sockets

3.12. Smart Water Ions

The Smart Water Ions models specialize in the measurement of ions concentration for drinking water quality control, agriculture water monitoring, swimming pools or waste water treatment.

The Smart Water line is complementary for these kinds of projects, enabling the control of parameters like turbidity, conductivity, oxidation-reduction potential and dissolved oxygen. Take a look to the Smart Water line in the previous section. Refer to Libelium website for more information.

There are 3 variants for Smart Water Ions: Single, Double and PRO. This is related to the type of ion sensor that each variant can integrate. Next section describes each configuration in detail.

Figure: Smart Water Ions Waspmote Plug & Sense! model

Single

This variant includes a Single Junction Reference Probe, so it can read all the single type ion sensors. Sensor sockets are configured as shown in the table below.

Sensor Socket	Sensor probes allowed for each sensor socket	
	Parameter	**Reference**
A, B, C and D	Calcium Ion (Ca^{2+})	9352
	Fluoride Ion (F^{-})	9353
	Fluoroborate Ion ($BF4^{-}$)	9354
	Nitrate Ion (NO_3^{-})	9355
	pH (for Smart Water Ions)	9363
E	Single Junction Reference	9350 (included by default)
F	Soil/Water Temperature	9255-P (included by default)

Figure: Sensor sockets configuration for Smart Water Ions model, single variant

Note: *For more technical information about each sensor probe go to the Development section on the Libelium website.*

Double

This variant includes a Double Junction Reference Probe, so it can read all the double type ion sensors. Sensor sockets are configured as shown in the table below.

Sensor Socket	Sensor probes allowed for each sensor socket	
	Parameter	**Reference**
A, B, C and D	Bromide Ion (Br^{-})	9356
	Chloride Ion (Cl^{-})	9357
	Cupric Ion (Cu^{2+})	9358
	Iodide Ion (I^{-})	9360
	Silver Ion (Ag^{+})	9362
	pH (for Smart Water Ions)	9363
E	Double Junction Reference	9351 (included by default)
F	Soil/Water Temperature	9255-P (included by default)

Figure: Sensor sockets configuration for Smart Water Ions model, double variant

Note: *For more technical information about each sensor probe go to the Development section on the Libelium website.*

Pro

This special variant integrates extreme quality sensors, with better performance than the Single or Double lines. In this case, there is only one type of reference probe and up to 16 different ion parameters can be analyzed in 4 sockets.

Sensor sockets are configured as shown in the table below.

Sensor Socket	Sensor probes allowed for each sensor socket	
	Parameter	**Reference**
A, B, C or D	Ammonium Ion (NH_4^+) [PRO]	9412
	Bromide Ion (Br^-) [PRO]	9413
	Calcium Ion (Ca^{2+}) [PRO]	9414
	Chloride Ion (Cl^-) [PRO]	9415
	Cupric Ion (Cu^{2+}) [PRO]	9416
	Fluoride Ion (F^-) [PRO]	9417
	Iodide Ion (I^-) [PRO]	9418
	Lithium Ion (Li^+) [PRO]	9419
	Magnesium Ion (Mg^{2+}) [PRO]	9420
	Nitrate Ion (NO_3^-) [PRO]	9421
	Nitrite Ion (NO_2^-) [PRO]	9422
	Perchlorate Ion (ClO_4^-) [PRO]	9423
	Potassium Ion (K^+) [PRO]	9424
	Silver Ion (Ag^+) [PRO]	9425
	Sodium Ion (Na^+) [PRO]	9426
	pH [PRO]	9411
E	Reference Sensor Probe [PRO]	9410 (included by default)
F	Soil/Water Temperature	9255-P (included by default)

Figure: Sensor sockets configuration for Smart Water Ions model, PRO variant

Note: *For more technical information about each sensor probe go to the Development section on the Libelium website.*

Differences between Ion Sensors and Ion Sensors PRO

Ions sensors are divided into two different groups: the normal ion sensor line and the PRO ion sensor line. The normal sensors are divided into Single and Double. It is important to know that it is not possible to combine the different groups of sensors (Single, Double and PRO). Each group has its own reference probe, and the reference probe can only be used with the corresponding sensors of that group:

Normal Ion Sensors	Single Junction Reference Probe
	Double Junction Reference Probe
PRO Ion Sensors	Smart Water Ions Reference Sensor Probe [PRO]

The main differences between the normal sensors and the PRO sensors are:

- Increased stability on time: PRO sensors are more stable and require less calibration and maintenance.
- Versatility: PRO sensors can be combined freely because all of them use the same reference probe.
- Modularity: The sensors of the PRO line are interchangeable, so you can measure different ion parameters just changing the header.
- Construction: PRO sensors are based on the technology of solid state carbon nanotubes.
- More parameters: The PRO line allows to measure parameters like Magnesium and Sodium; these ions are very important for hydroponics applications.

Note: The calibration and maintenance processes depend on the external conditions and the final usage of the sensor.

3.13. Smart Water

The Smart Water model has been conceived to facilitate the remote monitoring of the most relevant parameters related to water quality. With this platform you can measure more than 6 parameters, including the most relevant for water control such as dissolved oxygen, oxidation-reduction potential, pH, conductivity and temperature. An extremely accurate turbidity sensor has been integrated as well.

The Smart Water Ions line is complementary for these kinds of projects, enabling the control of concentration of ions like Ammonium (NH_4^+), Bromide (Br^-), Calcium (Ca^{2+}), Chloride (Cl^-), Cupric (Cu^{2+}), Fluoride (F^-), Iodide (I^-), Lithium (Li^+), Magnesium (Mg^{2+}), Nitrate (NO_3^-), Nitrite (NO_2^-), Perchlorate (ClO_4^-), Potassium (K^+), Silver (Ag^+), Sodium (Na^+) and pH. Take a look to the Smart Water Ions line in the next section.

Refer to Libelium website for more information.

Figure: Smart Water Plug&Sense! model

Sensor sockets are configured as shown in the figure below.

Sensor Socket	Sensor probes allowed for each sensor socket	
	Parameter	**Reference**
A	pH	9328
B	Dissolved Oxygen (DO)	9327
C	Conductivity	9326
E	Oxidation-Reduction Potential (ORP)	9329
F	Soil/Water Temperature	9255-P (included by default)
	Turbidity	9353-P

Figure: Sensor sockets configuration for Smart Water model

Note: *For more technical information about each sensor probe go to the* Development section *on the Libelium website.*

3.14. Smart Water Xtreme

Smart Water Xtreme was created as an evolution of Smart Water. This model integrates high-end sensors, calibrated in factory, with enhanced accuracy and performance. Their reduced recalibration requirements and robust design enlarge maintenance periods, making it more affordable to deploy remote Smart Water applications. This line includes a great combination of the most significant water parameters like dissolved oxygen, pH, oxidation-reduction potential, conductivity, salinity, turbidity, suspended solids, sludge blanket and temperature.

Refer to Libelium website for more information.

Figure: Smart Water Xtreme Waspmote Plug & Sense! model

Sensor sockets are configured as shown in the figure below.

Sensor	Sensor probes allowed for each sensor socket	
	Parameter	**Reference**
A, B, C, D and E	Optical dissolved oxygen and temperature OPTOD	9488-P
	Titanium optical dissolved oxygen and temperature OPTOD	9489-P
	pH, ORP and temperature PHEHT	9485-P
	Conductivity, salinity and temperature C4E	9486-P
	Inductive conductivity, salinity and temperature CTZN	9487-P
	Turbidity and temperature NTU	9353-P
	Suspended solids, turbidity, sludge blanket and temperature MES5	9490-P
A and D	Temperature, air humidity and pressure	9370-P
	Luxes	9325-P
	Ultrasound	9246-P
F	Manta+40	-
	Chlorophyll	-
	BGA	-
	Organic matter CDOM/FDOM	-
	Ammonium	-
	Nitrate	-
	Chloride	-
	Sodium	-
	Calcium	-

Figure: Sensor sockets configuration for Smart Water Xtreme model

Note: *For more technical information about each sensor probe go to the Development section on the Libelium website.*

3.14.1. Smart Security

The main applications for this Waspmote Plug & Sense! configuration are perimeter access control, liquid presence detection and doors and windows openings. Besides, a relay system allows this model to interact with external electrical machines.

Figure: Smart Security Waspmote Plug & Sense! model

Note: *The probes attached in this photo could not match the final location. See next table for the correct configuration.*

Sensor Socket	Sensor probes allowed for each sensor socket	
	Parameter	**Reference**
A, C, D or E	Temperature + Humidity + Pressure	9370-P
	Luminosity (Luxes accuracy)	9325-P
	Ultrasound (distance measurement)	9246-P
	Presence - PIR	9212-P
	Liquid Level (combustible, water)	9239-P, 9240-P
	Liquid Presence (Point, Line)	9243-P, 9295-P
	Hall Effect	9207-P
B	Liquid Flow (small, medium, large)	9296-P, 9297-P, 9298-P
F	Relay Input-Output	9270-P

Figure: Sensor sockets configuration for Smart Security model

As we see in the figure below, thanks to the directional probe, the presence sensor probe (PIR) may be placed in different positions. The sensor can be focused directly to the point we want.

Figure: Configurations of the Presence sensor probe (PIR)

Note: *For more technical information about each sensor probe go to the Development section on the Libelium website.*

4. Ions measurement

4.1. ISE sensors basic principles

An Ion Selective Electrode (ISE), also known as a specific ion electrode (SIE), is a transducer (or sensor) that converts the activity of a specific ion dissolved in a solution into an electrical potential, which can be measured by a voltmeter or pH meter. The probe includes at least two electrodes, a reference and a measurement electrode. The measurement electrode is equipped with a special membrane, capable of binding specific ions reversibly.

Depending on the activity of the measured ions in the liquid, a varying number of ions will bind to the measurement electrode – resulting in a varying potential difference between the measurement electrode and the reference electrode, which shows a constant potential in reference to the medium. The measured potential is put in relation to the activity of the measured ion by means of a calibration function.

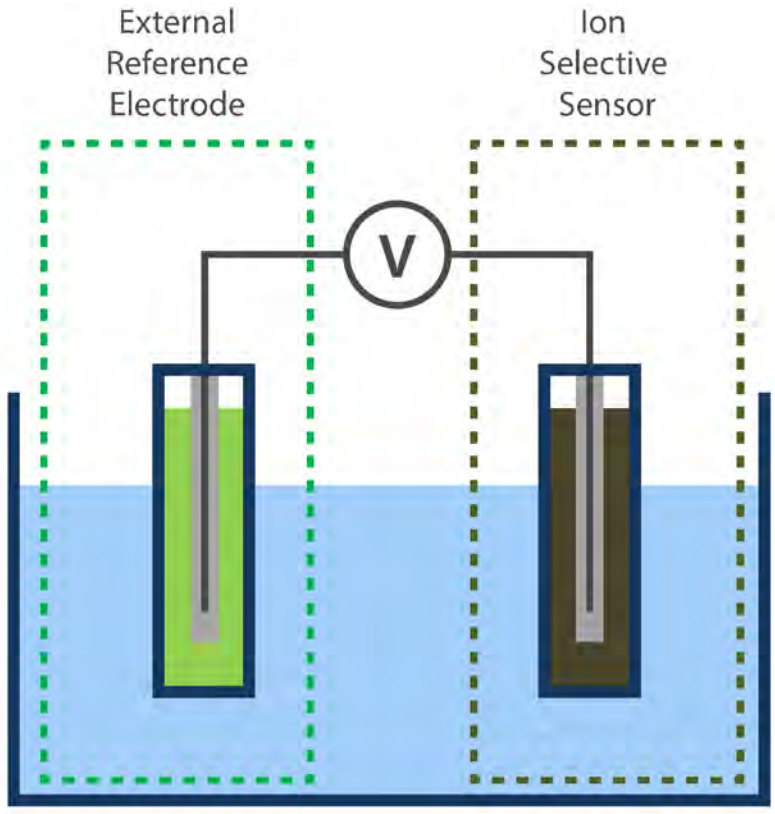


Figure: Measurement set-up of ion selective electrode (ISE)

The voltage is theoretically dependent on the logarithm of the ionic activity, according to the Nernst equation. The Nernst equation is frequently expressed in terms of base 10 logarithms rather than natural logarithms, in which case it is written, for a cell at 25 °C:

$$E = E^0 - \frac{RT}{nF} \ln(Q)$$

Figure: Nernst equation

The properties of an ion-selective electrode are characterized by parameters like:

Selectivity: The selectivity is one of the most important characteristics of an electrode, as it often determines whether a reliable measurement in the sample is possible or not. The experimental selectivity coefficients depend on the activity and a method of their determination. Different methods of the selectivity determination can be found in the literature. The IUPAC (International Union of Pure and Applied Chemistry) suggests two methods: separate solution method (SSM) and fixed interference method (FIM). The methods proposed by IUPAC with several precautions will give meaningful data.

Slope: of the linear part of the measured calibration curve of the electrode. The theoretical value according to the Nernst equation is: 59.16 (mV/log(a_x)) at 298 K for a single charged ion or 59.16/2 = 29.58 (mV per decade) for a double charged ion. However, in certain applications the value of the electrode slope is not critical and worse value does not exclude its usefulness.

Range of linear response: At high and very low target ion activities there are deviations from linearity. Typically, the electrode calibration curve exhibits linear response range between 10-1 M and 10-5 M.

Detection limit: According the IUPAC recommendation the detection limit is defined by the cross-section of the two extrapolated linear parts of the ion-selective calibration curve. In practice, detection limit on the order of 10^{-5}-10^{-6}M is measured for most of ion-selective electrodes.

Response time: In earlier IUPAC recommendations, it was defined as the time between the instant at which the Ion Selective Electrode and a reference electrode are dipped in the sample solution (or the time at which the ion concentration in a solution is changed on contact with ISE and a reference electrode) and the first instant at which the potential of the cell becomes equal to its steady-state value within 1 mV or has reached 90% of the final value (in certain cases also 63% or 95%).

4.2. Ions presence in Water

- **Ammonium (NH_4^+)**

Ammonium (NH_4^+), or its uncharged form ammonia (NH_3), is a form of nitrogen which aquatic plants can absorb and incorporate into proteins, amino acids, and other molecules. High concentrations of ammonium can enhance the growth of algae and aquatic plants. Bacteria can also convert high ammonium to nitrate (NO_3^-) in the process of nitrification, which lowers dissolved oxygen.

- **Bromide (Br^-)**

Bromide is commonly found in nature along with sodium chloride, owing to their similar physical and chemical properties, but in smaller quantities. Bromide concentrations in seawater are generally in the range of 65 mg/L to well over 80 mg/L in some confined sea area. Concentrations of bromide in fresh water typically range from trace amounts to about 0.5 mg/L. Concentrations of bromide in desalinated waters may approach 1 mg/L. Bromide ion has a low degree of toxicity; thus, bromide is not of toxicological concern in nutrition.

- **Calcium (Ca^{2+})**

Calcium is an important determinant of water harness, and it also functions as a pH stabilizer, because of its buffering qualities. Calcium is naturally present in water. It may dissolve from rocks such as limestone, marble, calcite, dolomite, gypsum, fluorite and apatite. Seawater contains approximately 400 ppm calcium. One of the main reasons for the abundance of calcium in water is its natural occurrence in the earth's crust. Calcium is also a constituent of coral. Rivers generally contain 1-2 ppm calcium, but in lime areas rivers may contains calcium concentrations as high as 100 ppm.

- **Chloride (Cl^-)**

Chloride increases the electrical conductivity of water and thus increases its corrosivity. Chloride concentrations in excess of about 250 mg/L can give rise to detectable taste in water, but the threshold depends upon the associated cations. Seawater can contains 20.000 ppm of this ion.

- **Cupric (Cu^{2+})**

Copper is a naturally occurring metal found in the earth's crust. Copper is also generally present in surface waters, with cupric ion (Cu^{2+}) as the primary form in natural surface waters. In freshwater systems, naturally occurring concentrations of copper range from 0.2 µg/L to 30 µg/L, at low concentrations, copper is an essential element to virtually all plants and animals, including humans.

- **Fluoride (F^-)**

Fluoride is the simplest anion of fluorine. Its salts and minerals are important chemical reagents and industrial chemicals, mainly used in the production of hydrogen fluoride for fluorocarbons. The MCLG for fluoride is 4.0 mg/L or 4.0 ppm. Exposure to excessive consumption of fluoride over a lifetime may lead to increased likelihood of bone fractures in adults, and may result in effects on bone leading to pain and tenderness.

- **Fluoroborate (BF_4^-)**

Fluoroborate (or Tetrafluoroborate) is used in industrial applications as thinner, catalysis and batteries. The presence of this element in water is not common, but if dangerous at high concentrations.

- **Iodide (I^-)**

Iodine is naturally present in water. Iodine ends up in surface waters naturally through rains and water evaporation. Eventually, it also ends up in groundwater. Other options include weathering of iodine-containing rocks, and volcanic activity (including under-water volcanoes). In nature iodine can be found in reasonably large amounts, but only in compounds. The average concentration in seawater is about 60 ppb, but varies from place to place. Rivers usually contain about 5 ppb of iodine, and in mineral sources some ppm can even be found.

- **Lithium (Li^+)**

Lithium (Li^+) is present in many minerals. Seawater contains approximately 0.17 ppm lithium. Rivers generally contain only 3 ppb, whereas mineral water contains 0.05-1 mg lithium per liter. Lithium is weakly harmful in water. Lithium is not a very big threat to flora and fauna, nor on the mainland, nor in aquatic environments. It is readily absorbed by plants, causing plants to be an indicator of soil lithium concentrations.

- **Magnesium (Mg^{2+})**

Magnesium is present in seawater in amounts of about 1300 ppm. After sodium, it is the most commonly found cation in oceans. Rivers contain approximately 4 ppm of magnesium, marine algae 6000-20,000 ppm, and oysters 1200 ppm. Dutch drinking water contains between 1 and 5 mg of magnesium per liter. Magnesium and other alkali earth metals are responsible for water hardness. Water containing large amounts of alkali earth ions is called hard water, and water containing low amounts of these ions is called soft water.

- **Nitrate (NO_3^-)**

Nitrate is one of the most frequent groundwater pollutants in rural areas. It needs to be regulated in drinking water basically because excess levels can cause methaemoglobinaemia, or "blue baby" disease. The standard for nitrate in drinking water is 10 mg/L nitrate-N, or 50 mg/L nitrate- NO_3, when the oxygen is measured as well as the nitrogen. Unless otherwise specified, nitrate levels usually refer only to the amount of nitrogen present, and the usual standard, therefore, is 10 mg/l.

- **Nitrite (NO_2^-)**

The nitrite ion is an ambidentate ligand, and is known to bond to metal centers in at least five different ways. Nitrite is also important in biochemistry as a source of the potent vasodilator nitric oxide. Nitrite levels above 0.75 ppm in water can cause stress in fish and greater than 5 ppm can be toxic.

- **Perchlorate (ClO_4^-)**

Perchlorate (ClO_4^-) salts are mainly used for propellants, exploiting properties as powerful oxidizing agents. Perchlorate contamination in the environment has been extensively studied as it has effects on human health. Perchlorate has been linked to its negative influence on the thyroid gland. Perchlorate is commonly used as an oxidizer in rocket propellants, munitions, fireworks, airbag initiators for vehicles, matches and signal flares. It is naturally occurring in some fertilizers.

- **Potassium (K^+)**

Potassium is non-water soluble, but it does react with water as was explained earlier. Potassium compounds may be water soluble. Seawater contains about 400 ppm. It tends to settle, and consequently ends up in sediment mostly. Rivers generally contain about 2-3 ppm potassium. This difference is mainly caused by a large potassium concentration in oceanic basalts.

- **Silver (Ag^+)**

Seawater contains approximately 2-100 ppt of silver, and the surface concentration may be even lower. River water generally contains approximately 0.3-1 ppb of silver. Under normal conditions silver is water insoluble. This also applies to a number of silver compounds, such as silver sulphide. Silver is not a dietary requirement for organisms. It may even be lethal to bacteria, and it inhibits fungi reproduction. This is mainly caused by Ag^+ ions.

- **Sodium (Na^+)**

Sodium compounds serve many different industrial purposes, and may also end up in water from industries. They are applied in metallurgy, and as a cooling agent in nuclear reactors. Sodium nitrate is often applied as a synthetic fertilizer. Seawater contains approximately 11,000 ppm sodium. Rivers contain only about 9 ppm. Drinking water usually contains about 50 mg/L sodium.

5. Ion Selective Electrode (ISE) sensors frequent questions and answers

- **What is meant by Interference in ISE measurements?**

Unfortunately, most ion-selective membranes are not entirely specific for the designated ion but also allow the passage of some other ions to a greater or lesser extent. This increases the charge on the membrane above that which is due solely to the detected ion and causes a spuriously high measurement. This phenomenon is known as interference and the extent of this interference is expressed as the Selectivity Coefficient.

The Selectivity Coefficient can be determined experimentally to give some idea of the order of magnitude, but it is not a constant factor since it depends on several parameters including the concentration of both ions, the presence of other ions in solution, and the temperature. In the past this phenomenon has limited the use of ion-selective electrodes to only those applications where the interfering ion is known to be absent or only in a relatively small concentration compared to the detected ion. Ion-selective electrodes are not completely ion-specific.

A value of 0.1 of Selectivity Coefficient indicates that the electrode is ten times more sensitive to the primary ion than to the interfering ion. A value of 1 indicates equal sensitivity to both ions.

- **What can I do about a noisy electrode signal?**

If the signal is very erratic and jumps by tens or even hundreds of millivolts then this is probably due to minute bubbles in the reference electrode electrolyte. These can develop during transport or prolonged storage. This can normally be cured by holding the electrode firmly with the active tip pointing downwards and shaking down several times with a flick of the wrist.

- **What precision can I expect from an ISE sensor?**

Precision is the reproducibility of repeat measurements of the same sample. This is different from accuracy which is how near is the result to the true value. Ideally, results of any experimental measurement should give values that are accurate within the precision limit but this is not always true for ISE measurements.

Assuming that there are no variable systematic errors from interference or activity coefficient effects (which also affect the accuracy), the precision depends on the error in the measurement of the electrode potential (mV) and the slope of the calibration line (mV/decade of concentration).

These errors are unlikely to be better than about ± 1 mV and are equivalent to ~4% error in the concentration for monovalent ions (slope ~54) and ~8% error for divalent ions (slope~27), when working in the normal linear range of the electrodes. However, if there are added problems of interfering ions or high ionic strength or variable temperature or variable sample motion (as may be encountered in direct field measurements in natural samples) then the errors may be higher and a value of ±10 or 15% may be more realistic.

- **How should I store the electrodes between analytical sessions?**

In general, for overnight or longer storage, ISEs should always be rinsed with de-ionised water and gently dabbed dry with a low-lint tissue, and the black plastic cap should be replaced to protect the membrane from atmospheric oxidation/corrosion. Reference electrodes must be prevented from desiccation whenever they are not in use by replacing the protective cap containing a small quantity of the appropriate outer filling solution.

- **What is the shelf life and operating life of an ISE?**

The maximum usable life of Ion Selective electrodes depends very much on whether they are used for continuous monitoring or intermittent measurement of individual samples (in this case also on the frequency of use) and also on the nature of the samples. Prolonged exposure to solutions outside the optimum pH range for the electrode or to pure water or to solutions which do not contain any of the target ion will shorten the life.

6. Before calibrating sensors

- **What is ISAB and when is it used?**

Ionic Strength Adjustment Buffer is added equally to samples and standards to minimize any errors due to differences in ionic strength between samples and standards which will cause differences in activity coefficients which can cause the concentration to be under estimated by up to 50 or 60% in the worst cases. In some cases ISABs can also include ingredients which minimize interference effects, and ensure that the pH is optimum for the ISE measurement. Furthermore, for some ions, the addition of ISAB can help to reduce the time required to reach a stable reading after immersing the electrodes in a new solution.

ISAB is not normally necessary if the total ionic strength of the samples is less than 0.01 Molar for monovalent ions or 0.001 M for divalent ions (unless required for control of pH or interference or stabilization time) and may not be necessary at higher IS, depending on precision requirements.

However, it must be noted that most ISABs only increase the IS to about 0.1 Molar so will not be effective for samples which already approach this level. In this case there is no point adding more strength to the samples and it is necessary to bring the standards up to the same level by making them with a matrix similar to the samples but not containing the target ion or any that would interfere with it. Alternatively, high Ionic Strength samples can be analyzed by the Standard Addition or Sample Addition method.

Note: *Libelium does not provide ISA Buffers, but we recommend the use of them when more precision is required.*

- **What is the effect of temperature change on ISE measurements?**

Unfortunately this is a complicated relationship which cannot be simply quantified in terms of mV change per °C since the effect is different at different concentrations and actual value of the mV. Moreover, the electrode slope, the liquid junction potential, and solubility of the salts in the reference system all vary with temperature.

However, the magnitude of the effect of temperature change on the slope can be calculated from a modified form of the Nernst equation to be about 3.4 % per 10 °C, ie: if the slope is about 55 mV/dec then a 10 °C rise will increase this to about 57 mV/dec. Thus, in order to avoid any errors due to temperature change it is advisable to recalibrate with standards at the same temperature as the sample solutions if the sample temperature deviates by more than about 2 °C from the original calibration temperature.

- **How frequently should I re-calibrate the electrodes?**

This depends on the precision requirements for the results and the rate of drift of the electrode system. Apart from drift, any large temperature changes (greater than 2 °C) will cause a change in the calibration. Ideally, the temperature of the calibrating solution and any sample solutions should not differ by more than about ±1 °C. For the most precise results, it may even be beneficial to calibrate between every sample.

- **After immersing the electrodes, how long should I wait before taking a reading?**

Most electrode systems require about three or four minutes to reach a completely stable reading. Nevertheless, most electrode combinations get to within one or two millivolts of the final value in less than thirty seconds, so it depends on your precision requirements as to whether you wait for complete stabilization or not.

- **What is the concentration range and detection limit for an ISE measurement?**

The total measuring range for each ISE is given in the individual specification sheets where the lower figure is the detection limit - but note that these limits are necessarily only rough estimates of what is possible since the errors escalate dramatically in the non-linear range as the slope reduces and the detection limit is approached. The best precision can only be achieved in the linear range of the electrode.

The lower limit of linearity is also difficult to define precisely and will vary slightly depending on the individual ISE/Reference electrode combination and particular laboratory conditions. In some cases it can be an order of magnitude higher than the detection limit. If users wish to analyze samples near to this value then it is necessary to make measurements with their own set of electrodes to determine what is the lowest limit for acceptable results in their own particular application.

The upper concentration limit is often quoted as 1 Molar, but in practice it is difficult to obtain reliable results above about 0.1 Molar because of uncertainties in the effect of high ionic strength on the activity coefficient.

7. Hardware

7.1. General description

The Smart Water Ions Sensor Board has been designed to facilitate the measurement of the most important chemical parameters that allow the remote monitoring of water quality in different scenarios, which includes contamination surveillance in natural environments such as rivers and lakes, control of the appropriate conditions of water in pools or fish farms, agriculture, hydroponics and observation of industrial sewage from industries.

The Smart Water Ions Sensor Board have four available sockets to connect any of the Ions Probes, and one specific socket for the Reference Probe.

Every Smart Water Ions Sensor Board is provided with 5 BNC pigtail connectors and 1 Soil/Water Temperature Sensor (Pt-1000).

7.2. Specifications

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

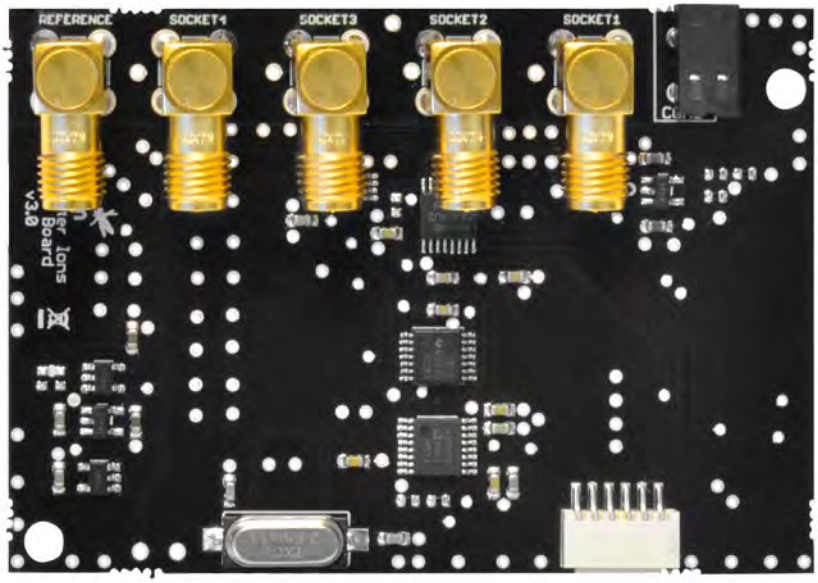


Figure: Upper side

7.3. Electrical characteristics

Board Power Voltages: 3.3 V and 5 V
Sensor Power Voltages: The ions sensors are very sensitive and never must be connected to a power supply
Max. admitted current (continuous): 200 mA
Max. admitted current (peak): 400 mA

8. Sensors

8.1. Soil/Water Temperature sensor (Pt-1000)

- **Measurement range:** 0 ~ 100 ºC
- **Accuracy:** DIN EN 60751
- **Resistance (0 ºC):** 1000 Ω
- **Diameter:** 6 mm
- **Length:** 40 mm
- **Cable lenght:** ~500 cm

Figure: Soil/Water Temperature (Pt-1000) Sensor

8.1.1. Measurement process

The Soil/Water Temperature (Pt-1000) Sensor is a resistive sensor whose conductivity varies in function of the temperature. The Smart Water Ions Sensor Board has been endowed with an instrumentation amplifier which allows to read the sensor placed in a voltage divider configuration along with one precision 1 kΩ resistor, which leads to an operation range between 0 ºC and 100 ºC approximately.

The whole reading process, from the voltage acquisition at the analog-to-digital converter to the conversion from the volts into Celsius degree, is performed by the `readTemperature()` function. The temperature sensor is directly powered from the 5 V supply, so is no necessary to switch the sensor ON, but it is advisable to not keep the Smart Water Ions Sensor Board powered for extended periods and switch it OFF once the measurement process has finished.

```
{
  float valuePT1000 = 0.0;
  SWIonsBoard.ON();
  // A few milliseconds for power supply stabilization
  delay(10);
  // Reading of the Temperature sensor
  float temperature = TemperatureSensor.read();
  // Print of the results
  USB.print(F("Temperature (celsius degrees): "));
  USB.println(temperature);
  // Delay to not heat the PT1000
  delay(1000);
}
```

You can find a complete example code for reading the temperature sensor in the following link:
http://www.libelium.com/development/waspmote/examples/swi-01-temperature-sensor-reading

8.1.2. Temperature sensor connection

To connect the Soil/Water Temperature (Pt-1000) Sensor to the Smart Water Ions Sensor Board a two ways PTSM connector has been placed, as indicated in the figure below. Both pins of the sensor can be connected to any of the two ways, since there is no polarity to be respected.

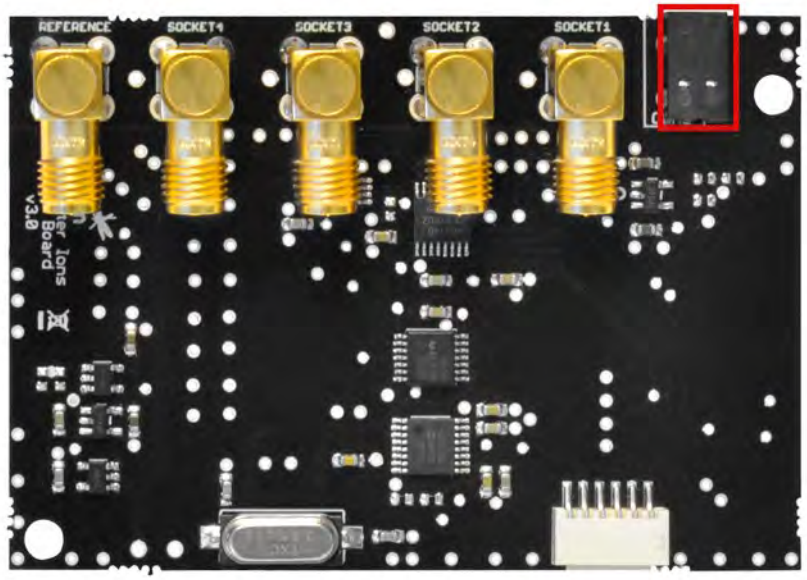


Figure: Image of the connector for the Soil/Water Temperature (Pt-1000) Sensor

8.2. Reference probes

A reference electrode is an electrode which has a stable and well-known electrode potential. Reference electrodes are critical to acquiring good electrochemical data. Drift in the reference electrode potential can cause quantitative and qualitative errors in data collection and analysis beyond simple inaccuracies in the measured potential.

The Smart Water Ions Sensor Board have 3 different Reference Probes, depending on the ion to be measured.

The next sensors must be used with the Single Junction Reference Probe:

- Calcium Ion (Ca^{2+}) Sensor Probe
- Fluoride Ion (F^{-}) Sensor Probe
- Fluoroborate Ion (BF_4^{-}) Sensor Probe
- Nitrate Ion (NO_3^{-}) Sensor Probe

Figure: Reference Probe

The next sensors must be used with the Double Junction Reference Probe:

- Bromide Ion (Br^{-}) Sensor Probe
- Chloride Ion (Cl^{-}) Sensor Probe
- Cupric Ion (Cu^{2+}) Sensor Probe
- Iodide Ion (I^{-}) Sensor Probe
- Silver Ions (Ag^{+}) Sensor Probe

The pH (for Smart Water Ions) Sensor must be always used with the Single **or** the Double Reference Probe.

All the PRO sensors must be used with the PRO Reference Probe (including the pH [PRO] sensor).

The Soil/Water Temperature Sensor is the only sensor in this board which does not need any Reference Probe.

Probes have a length of about 500 cm.

8.2.1. Reference probe connection

One Reference Probe (Single, Double or PRO) must **always** be connected in the corresponding socket marked as REFERENCE in the Smart Water Ions Sensor Board. **Only one** Reference Probe can be connected at the same time in the Smart Water Ions Sensor Board. One single-type sensor and one double-type sensor can **never be mixed** in the same system at the same time. The Reference Probe for PRO ion sensors can never be mixed with the Single or Double references.

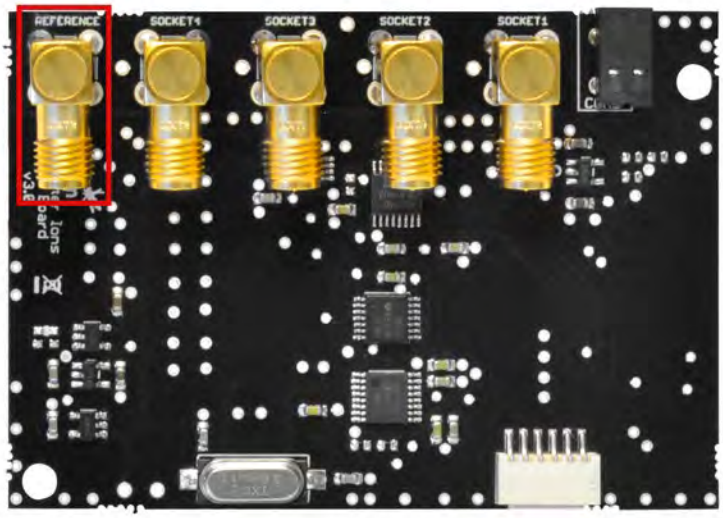


Figure: Reference Probe socket.

8.2.2. Maintenance solution

Reference probes should be cleaned with deionized water and stored with their plastic plug after every use. Sensors cannot be left in deionized/distiled water for more than 1 minute.

For a correct storage of the reference probes it's recommended to put a drop of the Reference Sensor Probe [PRO] Maintenance Solution (Lithium Acetate at 3 Mol.), inside their plastic plug.

8.3. Ion sensors

In this table we can see the main features of the ions sensors. The ion sensors are divided in two groups depending on the required reference (double, or single junction). In the Smart Water Ions Sensor Board, only one reference can be connected at the same time, so it is not possible to mix different sensor types.

Species	Construction	Concentration Range (mol/L)	pH Range	Temperature Range (ºC)	Dimensions (mm)	Required Reference
Bromide (Br^-)	Solid State Half-cell	10^{-1}-10^{-6}	2-11	5-60	Ø10x155	Double Junction
Chloride (Cl^-)	Solid State Half-cell	10^{-1}-$5x10^{-5}$	2-12	5-60	Ø10x155	Double Junction
Cupric (Cu^{2+})	Solid State Half-cell	10^{-1}-10^{-6}	2-12	5-60	Ø10x155	Double Junction
Iodide (I^-)	Solid State Half-cell	10^{-1}-$5x10^{-7}$	2-12	5-60	Ø10x155	Double Junction
Silver (Ag^+)*	Solid State Half-cell	10^{-1}-$3x10^{-7}$	2-8 (Ag^+)	5-60	Ø10x155	Double Junction
Calcium (Ca^{2+})	Plastic Membrane Half-cell	10^{-1}-10^{-5}	2.5-11	5-60	Ø10x155	Single Junction
Fluoride (F^-)	Plastic Membrane Half-cell	10^{-1}-10^{-6}	5-7	5-60	Ø10x155	Single Junction
Fluoroborate (BF_4^-)	Plastic Membrane Half-cell	10^{-1}-$3x10^{-6}$	2.5-11	5-60	Ø10x155	Single Junction
Nitrate (NO_3^-)	Plastic Membrane Half-cell	10^{-1}-10^{-5}	2.5-11	5-60	Ø10x155	Single Junction

* This sensor is also sensitive to Sulfide (S^{2-}) ions; take this into account in terms of cross-sensitivity if the monitored water could contain Sulfide. The user could even use this sensor to meter Sulfide ion if he is able to calibrate the sensor by his own means.

The ion sensors have a cable length of ~500 cm.

8.4. pH sensor (for Smart Water Ions)

The pH sensor integrated in the Smart Water Ions Sensor Board is specific to be used with this board and in combination with one of the Reference Probes. This pH sensor cannot be used with Smart Water Sensor Board, which integrates another pH sensor, different from the one exposed in this section.

- **pH Range:** 0-14
- **Temp. Range (ºC):** 5-60
- **Internal Reference Type:** Ag/AgCl
- **Dimensions (mm):** Ø12x160
- **Reader accuracy:** in function of calibration
- **Cable length:** ~500 cm

Figure: pH Sensor Probe for Smart Water Ions

8.5. PRO Ion Sensors

This is a special line of ion sensors. These sensors are solid state carbon nanotube-based selective electrodes. This feature reduces the maintenance of the sensors and increases their stability on time. Also, these sensors can be combined using a unique reference probe. In this table we can see the main features of the PRO ion sensors.

Ion	Sensitivity	Temp (ºC)	pH	Lineal Range	Interferences
Ammonium Ion (NH_4^+) Sensor Probe [PRO]	-54 ± 5	5 - 50	4 - 8,5	0,09 - 9000 mg/L	K (-0,8); Na (-2,7); Mg (-3,2); Ca (-4)
Bromide (Br^-) Sensor Probe [PRO]	-54 ± 5	5 - 50	1 - 12	0,4 - 8000 mg/L	Cl (-2,7); OH (-4,5)
Calcium Ion (Ca^{2+}) Sensor Probe [PRO]	24 ± 5	5 - 50	3,5 - 8	0,4 - 4000 mg/L	NH_4 (-3); K (-3,6); Na (-3,7)
Chloride Ion (Cl^-) Sensor Probe [PRO]	-54 ± 5	5 - 50	2 - 12	1,5 - 35000 mg/L	Error presence of Ag or S
Cupric Ion (Cu^{2+}) Sensor Probe [PRO]	24 ± 5	5 - 50	2 - 7	0,06 - 3200 mg/L	Error presence of Ag or Cl
Fluoride Ion (F^-) Sensor Probe [PRO]	-54 ± 5	5 - 50	4 - 8	0,1 - 1900 mg/L	OH (-1); Maintain pH < 8
Iodide Ion (I^-) Sensor Probe [PRO]	-54 ± 5	5 - 50	2 - 12	0,1 - 12000 mg/L	Error presence Ag or S; Br (-3,4); Cl (-6)
Lithium Ion (Li^+) Sensor Probe [PRO]	-54 ± 5	5 - 50	2 - 12	0,1 - 5000 mg/L	Na (-2,3); K (-2,4) H (-3)
Magnesium Ion (Mg^{2+}) Sensor Probe [PRO]	24 ± 5	5 - 50	3 - 8,5	2,4 - 2400 mg/L	Ca (-1); K (-3,6); Na (-3,9)
Nitrate Ion (NO_3^-) Sensor Probe [PRO]	-54 ± 5	5 - 50	2 - 11	0,6 - 31000 mg/L	Br (-1,2); NO2 (-1,7); OH (-1,8); AcO (-2,2)
Nitrite Ion (NO_2^-) Sensor Probe [PRO]	-54 ± 5	5 - 50	4 - 8	2,5 - 1000 mg/L	SCN (-0,2); I (-2,2); ClO4 (-2,4); Br (-3,3)
Perchlorate Ion (ClO4-) Sensor Probe [PRO]	-54 ± 5	5 - 50	1 - 11	1 - 10000 mg/L	SCN (-1,7); NO3 (-1,7); I (-1,7)
Potassium Ion (K+) Sensor Probe [PRO]	-54 ± 5	5 - 50	1 - 9	0,4 - 3900 mg/L	NH_4 (-2,1); Ca (-3,9), Li (-4,3); Na (-4,6)
Sodium Ion (Na+) Sensor Probe [PRO]	-27 ± 5	5 - 50	1 - 9	0,1 - 3200 mg/L	K (-2,5); Ca (-3), Li (-3,2)
Silver Ion (Ag+) Sensor Probe [PRO]	56 ± 5	5 - 50	1 - 9	0,1 - 10000 mg/L	Error presence S o Hg
pH Sensor Probe [PRO]	-54 ± 5	5 - 50	0 - 14	0 - 14	-
Smart Water Ions Reference Sensor Probe [PRO]	-	5 - 50	-	-	-

The PRO Ion Sensor Probes are composed of two independent parts: the head (the ion membrane) and the holder. We just need to change the header when it is not working properly due to the maximum lifetime was reached.

Figure: Ion sensor holder

Figure: Ion sensor header

The image below shows how the sensor head must be connected in the holder.

Figure: Connecting the sensor head to the sensor holder

8.5.1. Sensor connection in SOCKET1

Connect the sensor in the socket marked as SOCKET1 in the Smart Water Ions Sensor Board, and connect the corresponding Reference Probe. In this case we are going to use the Calcium Ion (Ca^{2+}) Sensor Probe so is necessary the use of the Single Junction Reference Probe. The probes must be connected using the pigtail adapter.

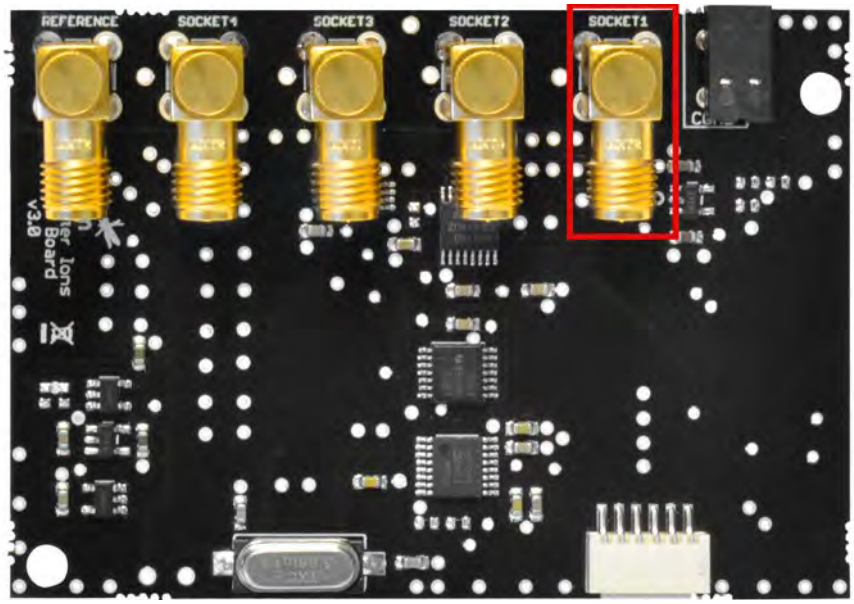


Figure: Ion Sensor and Reference connected to the SOCKET1

Example:

```
{
  // Declare the socket where the sensor will be connected
  socket1Class calciumSensor;
  // Turn ON the Smart Water Ions Sensor Board
  SWIonsBoard.ON();
  // Reading of the Calcium sensor
  float calciumVoltage = calciumSensor.read();
}
```

You can find a complete example code for reading from the socket1 in the following link:
http://www.libelium.com/development/waspmote/examples/swi-03-socket1-sensor-reading/

8.5.2. Sensor connection in SOCKET2

Connect the sensor in the socket marked as SOCKET2 in the Smart Water Ions Sensor Board, and connect the corresponding Reference Probe. In this case we are going to use the Nitrate Ion (NO_3^-) Sensor Probe so is necessary the use of the Single Junction Reference Probe. The probes must be connected using the pigtail adapter.

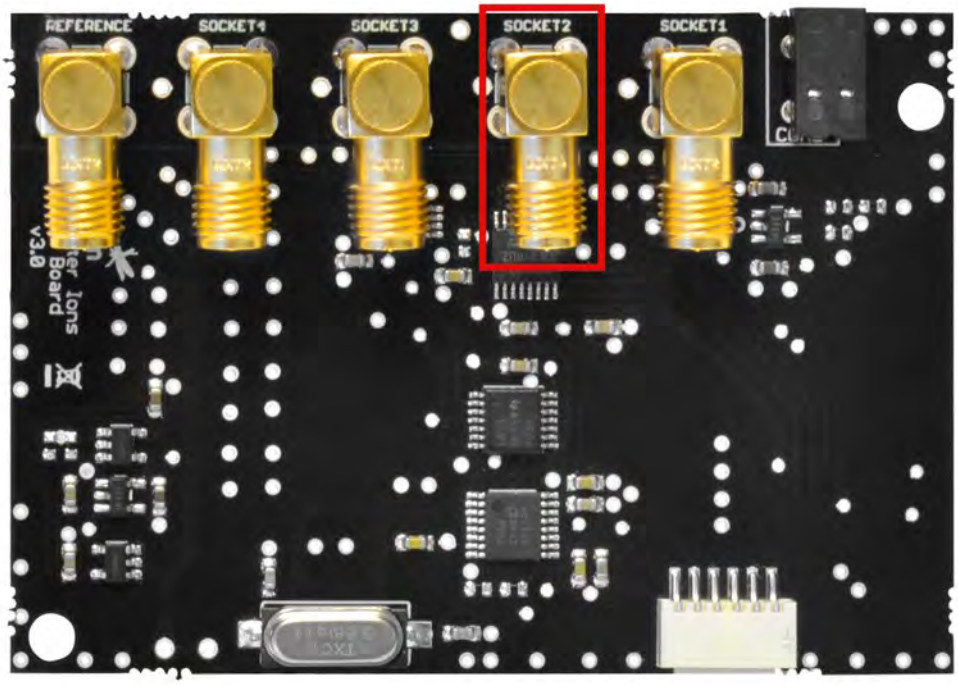


Figure: Sensor connected to the SOCKET2

Example:

```
{
  // Declare the socket where the sensor will be connected
  socket2Class NO3Sensor;
  // Turn ON the Smart Water Ions Sensor Board
  SWIonsBoard.ON();
  // Reading of the NO3 sensor
  float calciumVoltage = NO3Sensor.read();
}
```

You can find a complete example code for reading from the socket2 in the following link:
http://www.libelium.com/development/waspmote/examples/swi-04-socket2-sensor-reading/

8.5.3. Sensor connection in SOCKET3

Connect the sensor in the socket marked as SOCKET3 in the Smart Water Ions Sensor Board, and connect the corresponding Reference Probe. In this case we are going to use the Fluoride Ion (F^-) Sensor Probe so is necessary the use of the Single Junction Reference Probe. The probes must be connected using the pigtail adapter.

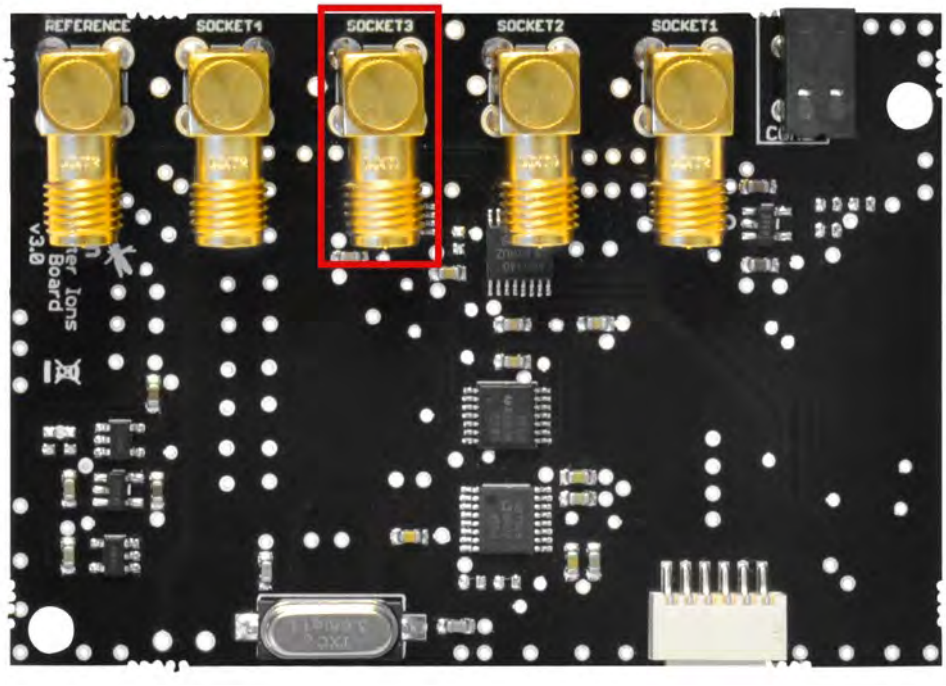


Figure: Sensor connected to the SOCKET3

Example:

```
{
  // Declare the socket where the sensor will be connected
  socket3Class FluorSensor;
  // Turn ON the Smart Water Ions Sensor Board
  SWIonsBoard.ON();
  // Reading of the Fluor sensor
  float fluorVoltage = FluorSensor.read();
}
```

You can find a complete example code for reading from the socket3 in the following link:
http://www.libelium.com/development/waspmote/examples/swi-05-socket3-sensor-reading/

8.5.4. Sensor connection in SOCKET4

Connect the sensor in the socket marked as SOCKET3 in the Smart Water Ions Sensor Board, and connect the corresponding Reference Probe. In this case we are going to use the Chloride Ion (Cl^-) Sensor Probe so is necessary the use of the Double Junction Reference Probe. The probes must be connected using the pigtail adapter.

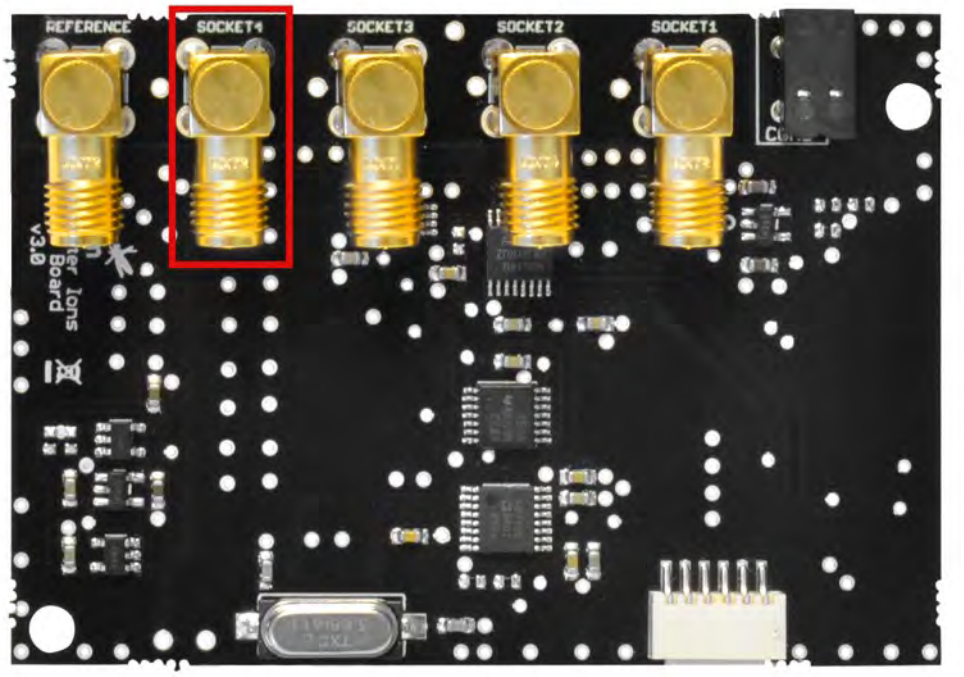


Figure: Sensor connected to the SOCKET4

Example:

```
{
  // Declare the socket where the sensor will be connected
  socket4Class ChlorideSensor;
  // Turn ON the Smart Water Ions Sensor Board
  SWIonsBoard.ON();
  // Reading of the Chloride sensor
  float chlorideVoltage = ChlorideSensor.read();
}
```

You can find a complete example code for reading from the socket4 in the following link:
http://www.libelium.com/development/waspmote/examples/swi-06-socket4-sensor-reading/

8.5.5. Connecting various sensors

The Smart Water Ions Sensor Board has been designed to connect four ions sensors simultaneously. As it mentioned in previous sections, there are two different Reference Probes, depending on the ions group to be measured.

Important: *for higher accuracies, we recommend the calibration of the entire system.*

Figure: Multi-ion measurement and calibration

8.6. Calibration solutions

Libelium provides several calibration solutions kits to calibrate the ion sensors. These kits are not mandatory, but **extremely recommended** to measure with good accuracy. The calibration process is described in section "Calibration Process" of this Technical Guide.

pH calibration Kit

Characteristics:

- 4.0 pH (red), 7.0 pH (yellow), 10.0 pH (blue) ±0.02 pH at 25 ºC
- 125 ml each

The calibration process of a pH sensor is described in section "Calibration Procedure" in the Smart Water Technical Guide, when handling them pay attention to the information provided in the MSDS.

Figure: Image of the pH calibration kit

Multi-ion calibration kit

The "Multi-ion" calibration solution allows to calibrate up to 7 different sensor probes. So we can use just three solutions to calibrate 7 Sensor Probes (with the old ones we would have needed 21 different solutions).

Characteristics:

- 250 ml each
- Concentrations:

Ion	Solution 1 (mg/L)	Solution 2 (mg/L)	Solution 3 (mg/L)
Ammonium Ion (NH_4^+)	4	20	40
Calcium Ion (Ca^{2+})	36	180	360
Chloride Ion (Cl^-)	75	375	750
Magnesium(Mg^{2+})	11	55	100
Nitrates(NO_3^-)	132	660	1320
Potassium(K^+)	39	195	390
Sodium(Na^+)	23	115	230

Figure: Image of the Multi-ion Calibration Kit

Bromide (Br^-) calibration Kit

Characteristics:

- 10 mg/L, 100 mg/L, 1000 mg/L at 25 ºC
- 100 ml each

Figure: Image of the Bromide (Br^-) calibration kit

Calcium (Ca2+) calibration Kit

Characteristics:

- 10 mg/L, 100 mg/L, 1000 mg/L at 25 ºC
- 100 ml each

Figure: Image of the Calcium (Ca^{2+}) calibration kit

Chloride (Cl^-) calibration Kit

Characteristics:

- 10 mg/L, 100 mg/L, 1000 mg/L at 25 ºC
- 100 ml each

Figure: Image of the Chloride (Cl^-) calibration kit

Cupric (Cu^{2+}) calibration Kit

Characteristics:

- 10 mg/L, 100 mg/L, 1000 mg/L at 25 ºC
- 100 ml each

Figure: Image of the Cupric (Cu^{2+}) calibration kit

Fluoride (F^-) calibration Kit

Characteristics:

- 10 mg/L, 100 mg/L, 1000 mg/L at 25 ºC
- 100 ml each

Figure: : Image of the Fluoride (F^-) calibration kit

Fluoroborate (BF_4^-) calibration Kit

Characteristics:

- 10 mg/L, 100 mg/L, 1000 mg/L at 25 ºC
- 100 ml each

Figure: Image of the Fluoroborate (BF_4^-) calibration kit

Iodide (I^-) calibration Kit

Characteristics:

- 10 mg/L, 100 mg/L, 1000 mg/L at 25 ºC
- 100 ml each

Figure: Image of the Iodide (I^-) calibration kit

Lithium (Li^+) calibration Kit

Characteristics:

- 1 mg/L, 10 mg/L, 100 mg/L at 25 ºC
- 100 ml each

Figure: Figure: Image of the Lithium (Li^+) calibration kit

Nitrate (NO_3^-) calibration Kit

Characteristics:

- 10 mg/L, 100 mg/L, 1000 mg/L at 25 ºC
- 100 ml each

Figure: Figure: Image of the Nitrate (NO_3^-) calibration kit

Nitrite (NO_2^-) calibration Kit

Characteristics:

- 10 mg/L, 100 mg/L, 1000 mg/L at 25 ºC
- 100 ml each

Figure: Figure: Image of the Nitrite (NO_2^-) calibration kit

Perchlorate (ClO_4^-) calibration Kit

Characteristics:

- 1 mg/L, 10 mg/L, 100 mg/L at 25 ºC
- 100 ml each

Figure: Figure: Image of the Perchlorate (ClO_4^-) calibration kit

Silver (Ag^+) calibration Kit

Characteristics:

- 10 mg/L, 100 mg/L, 1000 mg/L at 25 ºC
- 100 ml each

Important: This solution is very sensitive to the light and must used carefully. Please, read the corresponding safety guide.

Figure: Image of the Silver (Ag^+) calibration kit

Remember to read carefully the material safety data sheets you can find in the “Safety Guides” section of this guide, in order to take the corresponding precautions when manipulating these solutions and dispose them in the appropriate way.

8.7. Sensors maintenance

Smart Water Ions probes are delicate sensors and a proper maintenance is very important to enlarge the lifetime of the platform and to avoid any damage over them.

Ions sensors should be cleaned with **deionized water**, shaking the sensor part of the probe carefully in a glass with the deionized water. Also, a soft cloth can be used if there are solid residues.

For cleaning Smart Water Ions PRO sensors, the user should disassemble the cover of the header. Do not touch the membrane of the sensor directly.

Figure: Cleaning a sensor in deionized water

Figure: Cleaning a sensor in deionized water

Users must follow the next measures for a proper operation of the sensors:

- The sensor must be calibrated in increasing order of concentration.
- With the presence of solid residues in the water, the sensor should be washed with deionized water frequently, **recommended at least once per week**.
- Do not leave the sensor in deionized water for more than 1 minute.
- The storing conditions of the sensor are 25 ºC and protected from solar light.
- After long periods of storage, the sensor must be conditioned for at least 2 hours at a concentration of 0.1 M.
- Avoid direct contact with the membrane of the sensor.
- The membrane should be kept clean and free of solid residues.
- Never use in environments where the sensor may be damaged by water agitation or physical blows.

If a probe gets damaged because of a poor maintenance, it will not be covered by the warranty.

8.8. General considerations: probes performance and life expectancy

When developing a new application with the Smart Water Ions Sensor Board the conditions of the environment the sensors are going to operate in will deeply affect the durability and behavior of the probes. Thus, it is highly recommended to carry out an exhaustive study of the characteristics of the location of the device and perform all the laboratory tests required in order to assure the correct election of the sensors and of the way they will be deployed. Libelium provides standard sensors which have been largely tested and will work in most of the environments, but keep always in mind that if they are subjected to harmful chemicals present in certain specific scenarios they may be irreversibly damaged.

Sensors are not designed for salty water (sea) since seawater has many dissolved ions naturally. Besides, check your accuracy requirements, because sensors are conceived for measuring medium and high ions concentrations.

Below a few tips regarding the setup of the sensors are listed:

Sensor deployment

The main problems regarding the setup of the sensors concern both the way and the place they are deployed in. First of all, they must be installed in a way in which there is no interference between the sensor and near objects, making sure that the sensing parts (the bulb of the dissolved ions) are not in touch with the objects nearby. In the case of the conductivity sensor, as stated in the section about this sensor, take into account that it will have to be placed at certain distance from other objects in order to not interfere with the sensor magnetic field.

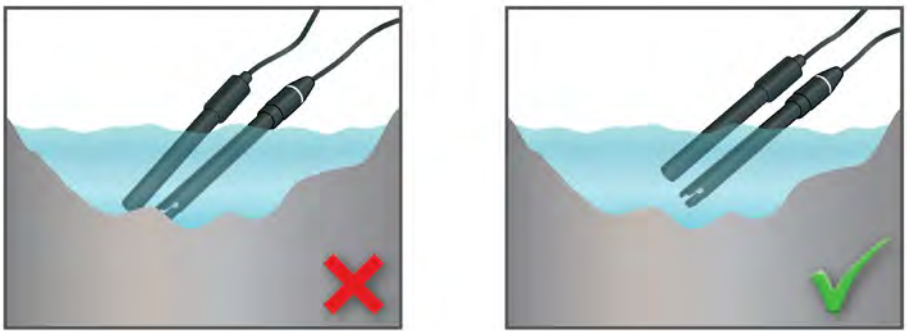


Figure: Image of two sensors wrongly and correctly placed

Secondly, it must be made sure that the sensors are completely submerged in the liquid all the time or the sensors may give an incorrect output. This problem may mainly appear in locations where the volume of water is variable owing to changes in the flow in rivers or canals or to the action of tides in seas. Another variant of this problem is given in locations where there is a continuous entry of air in the water, owing to the waves formed in the surface, jumps of the water flow, etc., which may generate bubbles that, in contact with the sensing part of the sensor, distort the output signal. The best method to avoid all these problems is to select a location where a minimum level of steady water is available all along. If the location where the sensor is going to be deployed does not meet these requirements and it is not possible to find a more proper place it will be necessary to build a protection system to ensure that the sensor is completely immersed and that there is not an airflow disturbing the measurement.

Figure: Image of several situations with the sensor incorrectly installed

Recalibration

A periodic recalibration of the sensors is highly advisable in order to maintain an accurate measurement along time in order to correct changes owed to a drift output, polarization or wear. Even though manufacturers generally recommend a calibration before every measurement, it is not feasible at all when sensors are deployed in a remote location. Nevertheless, it is not really necessary unless an extremely accurate value is required, for a general purpose application a much more spread set of recalibrations should be enough.

This way, the frequency of the recalibration process will be determined by both the accuracy required in the given application and the environment in which the sensors will be operating. The more accurate measurements required, the more often will be necessary to recalibrate the sensor. As well, an aggressive environment with harmful chemicals or with an important variation of the conditions of the parameter under measurement and its temperature will lead to a faster loose of precision, while more steady conditions will allow the user to spread the recalibrations along time.

This recalibration process, which will basically consist in the repetition of the calibration indicated for each sensor in its own section, will be different depending on the place where the conversion into useful units is performed. In case it is the mote itself which carries out this conversion, it will be necessary to provide the code with a calibration option allowing the visualization of the output values under calibration the introduction of the new coefficients in the conversion function. On the other hand, if the conversion is being performed in reception the software must be ready to interpret the calibration data and update its conversion algorithm with the new values arrived.

Life expectancy

If they are not subject to harassing environments Smart Water Ions Sensor Board sensors may keep on functioning for periods of several months, providing the required recalibrations are performed to maintain the accuracy demanded by the application. Tests carried out at Libelium facilities have shown that sensors working for at least six months have not suffered an important variance in their output and still provide an accurate output when calibrated.

We can summarize that both recalibration and lifetime of the sensor probes depend on three main factors:

- **1. Water environment:** corrosive chemicals, salt, dirt, extreme temperatures, strong flow currents decrease the lifetime
- **2. Usage:** the more the probes are used, the sooner they need to be changed due to the depletion of the substances used as reference and measurement electrodes
- **3. Time:** even in perfect conditions and low usage the chemical reactions that take place in the reference electrodes will stop working

Owing to all that, the sensor probes will probably have to be replaced between six months and one year after they have been deployed. The process of replacement is really easy as the probes may be easily unscrew using just the hand.

The PRO sensor boards have proven to be more robust and durable than the normal (Single or Double) sensor boards.

Figure: Images of the procedure to change the probes for the Smart Water Ions Plug & Sense!

Also beware that if as indicated before the sensors are placed in a chemically or physically aggressive media, with for example temperatures close to the extremes of the operating range, strong flow of water or with presence of corrosive chemicals, these wear and depletion processes may accelerate thus severely shortening the life of the sensors. In case of doubt please contact Libelium to get support about the sensors' durability.

How to detect that the probes are not working properly.

There are certain symptoms that will reveal that a sensor is not working properly:

- **A lack of a proper response during calibration process.** This is an obvious error which may appear in different ways and in different degree. A noisy output of several millivolts when submerging the probes in the calibration solutions, inconsistent values with the expected output given in section "Calibration Procedure" and never reaching a stable output will be indicatives of a defective of probe.
- **A steady continuous measurement for a long time.** It is very rare that these sensors show a continuous value in a real environment as they do in laboratory. Owing to liquid flow, temperature effects or biological action, a slow fluctuation is to be expected. If the measurement is stalled in a given value, the probe will probably be broken.
- **A sudden change in the output of the sensor.** The sensors' reaction is not instantaneous, if there is a leap between two consecutive measurements a problem with the sensor may have occurred (this kind of error may not be detected if a long time takes place between measurements).
- **Values out of range.** If the sensor drifts out of the normal operation range it will probably be caused by a failure. If there are doubts about the correct operation of the sensor it is recommended to carry out a new calibration in order to discard any possible malfunction.

Figure: Drying the sensor with care

If there are doubts about the correct operation of the sensor it is recommended to carry out a new calibration in order to discard any possible malfunction.

Important summary:

Due to the chemical nature of the sensors, the user **must recalibrate them periodically**. The frequency of this recalibration process depends on the accuracy desired and on the environment conditions; this time should be concluded after real tests. A standard recalibration period would be one month, but certain applications may force to recalibrate after a **few days**.

The lifetime of the sensors depends on many factors. The standard expectancy is about **one year** but harsh environment conditions could be decreased it to some months.

8.9. Specific recommendations for Smart Water Ions PRO

Storage and conservation

- Store below 25 ºC in a dry and dark place, avoiding direct sunlight.
- Store the electrode unplugged from Plug & Sense! or the Smart Water Ions sensor board. The electrode must NOT to be connected to when it is not in use.
- Electrodes should be cleaned with deionized water and stored dry with their plastic plug. Sensors cannot be left in deionized/distiled water for more than 1 minute.
- To store reference probes it's recommended to put a drop of the Reference Sensor Probe [PRO] Maintenance Solution (Lithium Acetate at 3 Mol), inside their plastic plug.
- When an electrode has been exposed to target liquids with high interferences or solid particles, after rinsing and before storing, it must be immersed in the conditioning solution for 20-30 minutes in order to regenerate its sensing area (the tip of the electrode).
- **Electrodes are NOT designed to be immersed all the time. If the user leaves them in a liquid for days or hours, they will deteriorate faster. For the best results, electrodes must be kept outside liquids and immerse them only when new measurements want to be taken.**

Before starting

- The gray circumference marks the maximum immersion level. Never immerse the electrode beyond this gray mark.
- Always use electrodes with the protective head, in order to avoid the tip of the electrode touches anything (for example, the bottom of the bottles or recipients).
- Do not touch or manipulate the electrode tip.

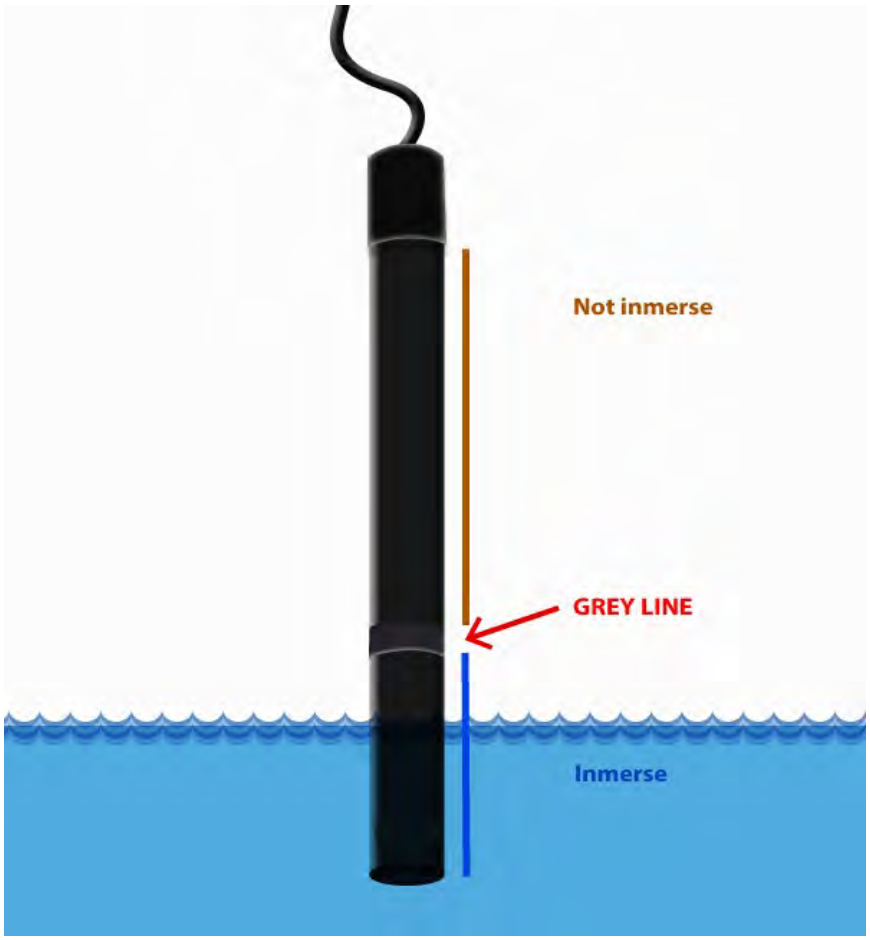


Figure: Do not immerse the electrodes beyond the mark

Electrode accommodation

Accommodation is a key step when preparing the electrode. Before the first time use (and after long time storage too) it must be accommodated for at least 2 hours and a maximum of 8 hours. Some electrodes need 12-24 hours.

The accommodation time for electrodes with a frequent use (daily or weekly) is 15 minutes. The accommodation process must be carried out with the probe unplugged from the meter. The accommodation process is done at 0.1 M of the target ion (or alternatively at 1000 mg/L) or highest calibration solution. Remove the rubber cap without damaging the sensing area and immerse the electrode in the accommodation solution for the recommended time.

After the accommodation process, rinse with deionized water, and the electrode will be ready to be calibrated.

Note: When changing from high concentration to low concentration, the response time could change. In some cases, the electrodes must be kept some minutes in the low-concentration solution before obtaining a stable reading in order to start the calibration process.

Figure: Accommodating an electrode

Calibration

- The ion electrode and the reference electrode need to be in the same solution at the same time.
- Calibration solutions should be used in ascendant order and all calibration solutions should be at the same temperature.
- When moving the electrode from one solution to another, it must be rinsed with deionized water and dried with a clean tissue paper. Do not hit the sensing area.
- Depending on the needed accuracy, you can calibrate with 2 or 3 points. If you need the best accuracy, you should calibrate with 3 points. If you need to choose 2 of the 3 calibration solutions, choose them so the expected concentration of the target liquid is between them.
- Check the concentration range of your electrode.

Process to calibrate:

Make sure that membranes and holders are clean. Use deionized/distiled water for cleaning.

Figure: Cleaning a sensor in deonized water

Use the Waspmote IDE examples to read the sensor; the first calibration point that you need to take is with the lower calibration solution. Introduce the ion electrode and the reference probe in the liquid and you will start getting the values.

The values of the sensor stabilize in few minutes (about 5 - 20 minutes). This stabilization time depends on the concentration of the calibration solution (it could take more time in the low calibration solutions). Note that, in low calibration solutions, values could get some noise. When the values show a variation of 0.02 V or less, you can consider the output is stabilized; you have the 1st calibration point, write it down. After a correct the stabilization process, the values could degrade if you are measuring for a long time: in the calibration process, the liquid and electrode start to degrade, so values could deteriorate on time.

It is important to use the same time to obtain each calibration point. If you waited 8 minutes for the 1st point, wait 8 minutes with the next calibration solution. You can leave the calibration more time and afterwards choose the best values, but always choose for each point the voltages corresponding to the same time.

Figure: Calibrating a sensor in a calibration solution

If you plot voltage in a graph, you can detect its stabilization better; you will see something like the next figure.

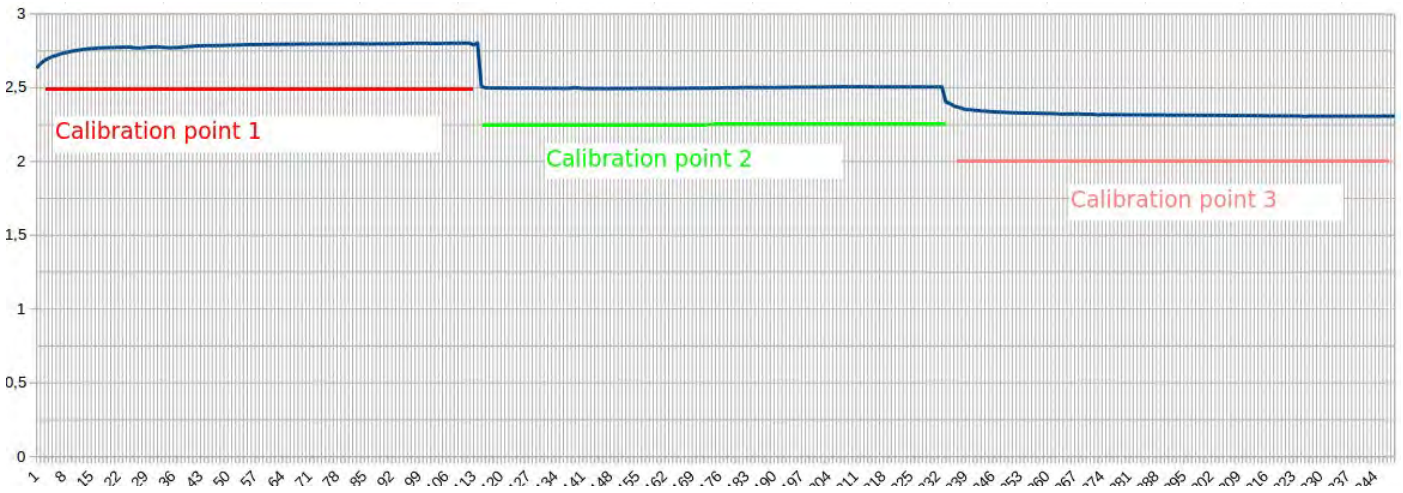


Figure: Stabilization of an electrode in a three-point calibration process

> Note: Calibration graphs could not be exactly like this.

In the calibration process, remember to clean the electrode when moving from a calibration solution to another one. Last, clean the electrode when you finish the whole calibration process (2 or 3 points).

When the process is done, write the calibration values in the code. You can do it like that:

```
// Concentrations of the calibration solutions used in the process:
#define point1 10.0
#define point2 100.0
#define point3 1000.0

// Read calibration voltage values:
#define point1_volt_Ca 2.163
#define point2_volt_Ca 2.296
#define point3_volt_Ca 2.425
```

After that, you can upload the new code to Waspmote and start sensing the target liquid.

Measurement process:

For better performance, we recommend applying to the calibration process the same conditions that the target liquid has (for example, adjust the solution's temperature when calibrating).

Solid particles in the target liquid, its color or turbidity do not affect the performance of the electrodes.

If the target liquid contains solid particles, rinse the probe properly.

When the calibration process is completed and the new parameters are updated in the code, you can start sensing. In a continuous sensing process, the electrode membrane and liquid could degrade, so the accuracy would not be enough for your application. In this case, a minimal maintenance is necessary to get the best performance: the sensors will have to be cleaned and re-calibrated. The maintenance period can be defined for the output values and the needed accuracy. The maintenance has not a defined period: when the values degrade, you should apply maintenance. Depending on the accuracy that your application needs, the maintenance period will be shorter. Qualified personal is not necessary for the maintenance process.

Additional tips:

- If you change the sensor holder, you should recalibrate the sensor. Any variation of items or conditions could change the calibration values, so a new calibration process will be necessary.
- When using the pH sensor and the reference electrode, both electrodes need to be in the same solution at the same time.
- When you are finished with the sensors, please clean and store them. Remember that, if you want use it again, you need to accommodate and calibrate them.
- For the best accuracy, we recommend calibrating the sensors before each measurement process.

9. Calibration process

Before calibrating the sensor is important to read the chapters “ISE sensors frequent AQ” and “Before calibrating sensors” of this technical guide. The calibration process is very sensitive and it must be carried out carefully and following the recommendations of this technical guide. Calibrating is needed for both the normal (Single and Double) sensor probes and the PRO sensor probes; the process is just the same. The complete calibration process must be done by the final user, and Libelium is not responsible the final result of the process. Next steps describe a typical calibration process, but other methods can be followed.

Figure: Image of the material necessary for the ion sensors calibration process

Things that can affect to the calibration process

- **Ambient noise:** electromagnetic fields can affect directly to the voltage measurement. The voltage values generated by the ISE Sensors are low, and be easily affected by interferences.
- **Temperature changes:** the ISE Sensors are very sensitive to temperature changes. Deviations by more than about 2 °C from the original calibration temperature, cause deviations in the voltage value measurement.
- **Contamination of the calibration solutions:** During the calibration process, the calibration solutions can be contaminated. Before calibrating be sure that the sensor and the beaker is clean.
- **Clean the material with deionized water:** soaking the electrodes in de-ionized water for a few seconds before each measurement.
- **Use of ISA Buffers:** ISAB (Ionic Strength Adjustment Buffer) is added to all standards and samples to increase the ionic strength to the same high level, and hence generate a uniform difference between activity and concentration. In this case the potential reading can then be directly related to concentration. The choice of ISAB is critical and varies depending on the ion being analyzed and the reference electrode being used.

9.1. Calibration process for ISE Sensors

In this example we are going to calibrate the Calcium Ion (Ca^{2+}) Sensor Probe in the socket1 of the Smart Water Ions Sensor Board.

- 1. Turn on the Waspmote with the Smart Water Ions Sensor Board and the Calcium Ion (Ca^{2+}) Sensor Probe connected.
- 2. Upload the example "Socket1 reading for Smart Water Ions" to the Waspmote board and make sure of receiving the data in the serial monitor.
- 3. Pour one of the solutions (about 50 ml should be enough) in a clean beaker. In this case we are going to use 10 mg/L solution of Calcium.
- 4. Immerse the probe in pure de-ionized water for about 30 seconds to ensure that the membranes were always in the same state at the beginning of each measurement.
- 5. Introduce the Calcium Ion (Ca^{2+}) Sensor Probe in the solution and wait for a stable output. Make sure that the sensor is completely immersed in the solution and that it is not close to the beaker wall, which may affect the field between the electrodes and disturb the measurement. Once the output is steady, annotate the value in volts obtained.

Figure: Calcium Ion (Ca^{2+}) Sensor Probe in 10 mg/L solution

- 6. After getting the sensor from the first solution, carefully rinse it and repeat the process explained in step 3 with the next solution.

- 7. Introduce the values noted and the concentration of the calibration solutions in your code, as shown in the next images.

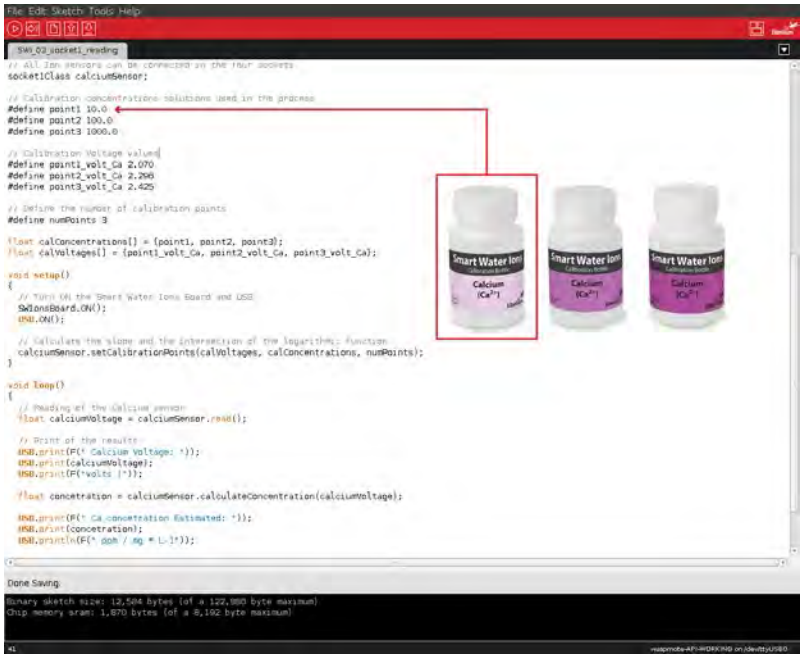


Figure: In this define, you should write the value of the calibration solution used

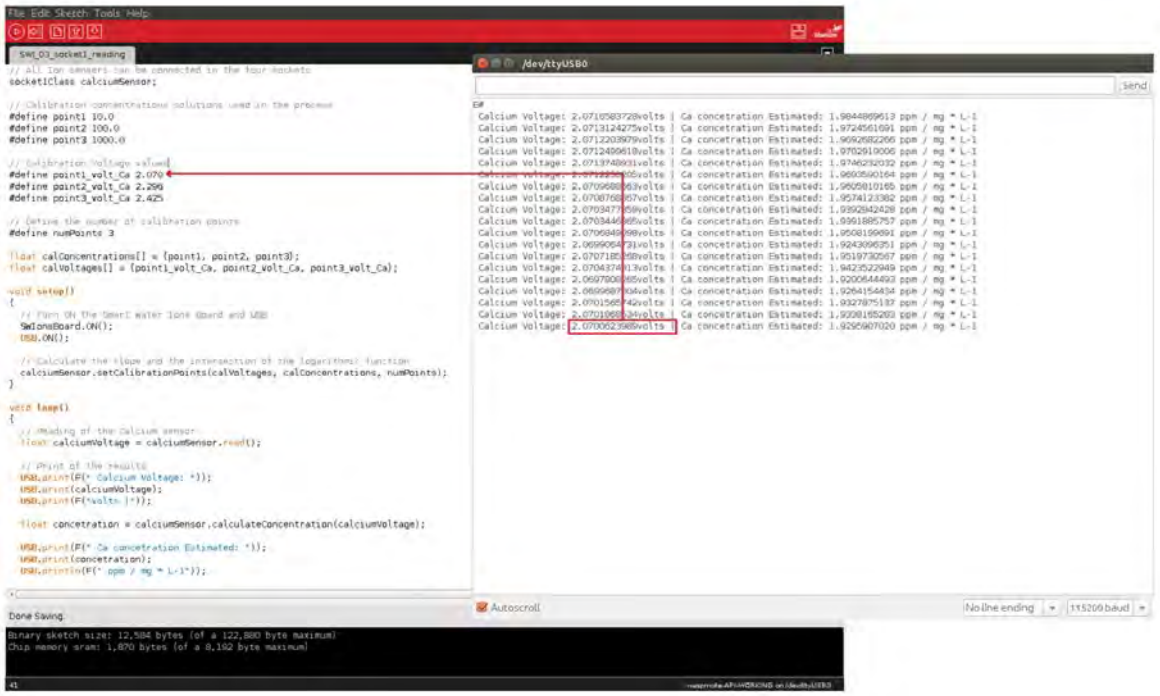


Figure: In this define, you should write the voltage value obtained

8. The function `setCalibrationPoints()` is used to configure the calibration parameters. The pH Sensor Probe (for Smart Water Ions), has its own calibration function called `setpHCalibrationPoints()`.

9. During the process, the temperature of the solution must be measured and annotated. The Soil/Water Temperature (Pt-1000) Sensor can be used in combination with the corresponding example, "Temperature Sensor Reading".

10. Upload the code again with the new calibration values obtained from the calibration process. At least, it is recommended the use of three points, but if the sensors is working in the linear range, good results can be obtained with only two points.

10. Board configuration and programming

10.1. Hardware configuration

The Smart Water Ions Sensor Board does not require any other manipulation than the sensor connection to its corresponding socket. There are two kinds of connectors on the Smart Water Ions Sensor Board:

First of all, the temperature sensor is connected through two ways PTSM connectors, which allow to easily assemble the wire by pressing it into the pin. To remove the wires press the slot above the input pin while pulling off the wire softly.

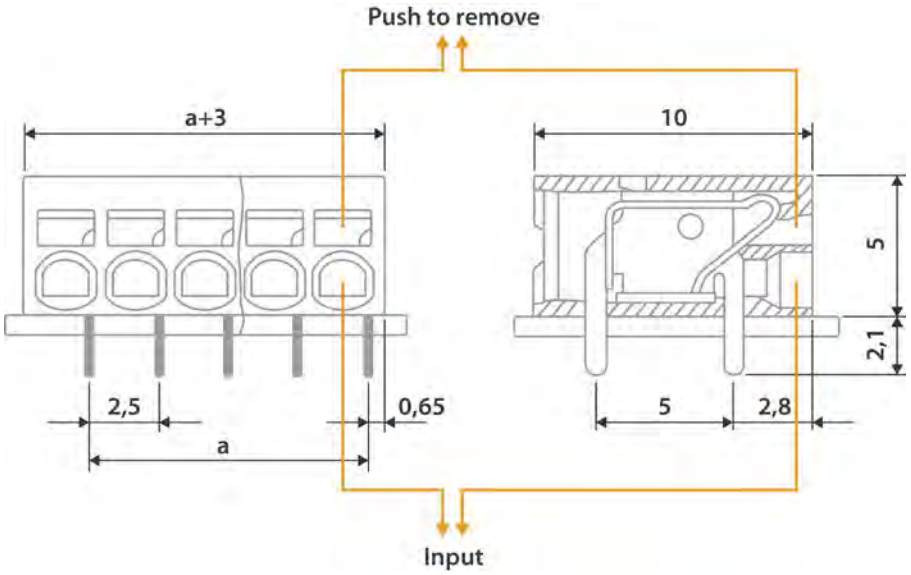


Figure: Diagram of the socket, extracted from the Phoenix Contact data sheet

Secondly, SMA-RP connectors have been used for the other four kinds of sensors. Since the sensors are supplied with a BNC connector, it is necessary to connect a pigtail in between.

Figure: Image of the pigtail to adapt the sensors with BNC connector

10.2. API

All the software functions necessary to operate the Smart Water Ions Sensor Board have been compiled in a library added to the Waspmote API, so the supply of the board and its components and the reading of the sensors can be easily managed.

When using the Smart Water Ions Sensor Board, remember it is mandatory to include the `smartWaterIons.h` library by introducing the next line at the beginning of the code:

```
#include <smartWaterIons.h>
```

The Smart Water Ions library includes different classes for managing the different sockets and sensors of the board:

`WaspSensorSWIons`	This class is used for power control functions
`ionSensorClass`	This is the general class witch derive the other classes
`pt1000Class`	This class is for managing the temperature sensor
`socket1Class`	This class derives from `ionSensorClass`, and is used for managing the socket1 of the Smart Water Ions Sensor Board
`socket2Class`	This class derives from `ionSensorClass`, and is used for managing the socket2 of the Smart Water Ions Sensor Board
`socket3Class`	This class derives from `ionSensorClass`, and is used for managing the socket3 of the Smart Water Ions Sensor Board
`socket4Class`	This class derives from `ionSensorClass`, and is used for managing the socket4 of the Smart Water Ions Sensor Board

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

Power control functions

The power control functions must be managed with the `SWIonsBoard` object.

`SWIonsBoard.ON()`	Turns on the sensor board by activating the 3.3 V and 5 V supply voltage lines
`SWIonsBoard.OFF()`	Turns off the sensor board by cutting the 3.3 V and 5 V supply voltage lines

Calibration configuration functions

This functions can be used by creating different objects

```
socket1Class calciumSensor;
socket2Class pHSensor;
```

`CalciumSensor.setCalibrationPoints(`
`const float calVoltages[],`
`const float calConcentrations[],`
`uint8_t numPoints)`
	Calculate the slope and the intersection of the approximated logarithmic function

`pHSensor.setpHCalibrationPoints(`
`float _calibration_point_10,`
`float _calibration_point_7,`
`float _calibration_point_4,`
`float _calibration_temperature)`
	Configures the calibration points of the pH sensor

Read sensor functions

```
socket1Class pHSensor;
socket2Class NO3Sensor;
pt1000Class temperatureSensor;
```

`temperatureSensor.read()`	Returns the temperature value from Soil/Water Temperature (Pt-1000) Sensor
`pHSensor.read()`	Returns the voltage value from the socket1
`NO3Sensor.read()`	Returns the voltage value from the socket2

Conversion functions

`NO3Sensor.calculateConcentration(float input)`	Calculates the concentration in ppm from the voltage value measured
`pHSensor.pHConversion(float input, float temp)`	Returns the pH value from a voltage input

10.3. Specific declaration for Plug & Sense!

For easy use with the Plug & Sense! platform, the library include specific declaration methods. In the example below, we can see how to associate an Ions Sensor Probe with the corresponding socket in Plug & Sense!.

Example:

```
{
  ionSensorClass calciumSensor(SOCKETA);
  ionSensorClass NO3Sensor(SOCKETB);
  ionSensorClass pHSensor(SOCKETC);
  ionSensorClass fluorideSensor(SOCKETD);
}
```

You can find a complete example code for Plug & Sense! reading from following link:
http://www.libelium.com/development/waspmote/examples/swi-07-plugsense-reading/

11. Consumption

11.1. Power control

The Smart Water Ions Sensor Board requires of both supply voltage lines from Waspmote (3.3 V and 5 V), which are activated and deactivated when calling the functions SWIonsBoard.ON() or SWIonsBoard.OFF() detailed in section “API”.

Important: Ion sensors must not be connected to a power supply line. The connection to a any kind of power supply will damage the sensor and cause his destruction, or losses of its features.

11.2. Consumption

The ISE sensors are potentiometer sensors that converts the activity of an ion into an electrical potential. This mean that these sensors do not need power supply and do not have electrical consumption. The only consumption in the Smart Water Ions Sensor Board comes from the electronic stage. This consumption is about **5 mA** when the Smart Water Ions Sensor Board is in normal operation.

- **Low consumption mode**

The Smart Water Ions Sensor Board has been designed to minimize the consumption of the mote during operation, allowing the activation of only the electronics that are really necessary to take the desired measurements.

- **Use the Waspmote low consumption modes**

Like in the other sensor boards for Waspmote, the library of the Smart Water Ions Sensor Board includes all the functions necessary to deactivate the sensors and the whole board so the mote can be put in low consumption mode to save battery when measurements are not being taken.

12. Safety Guides

12.1. pH 4.00 Calibration Solution

Section 1: Product and Company Identification

- **Product name:** pH 4.00 Calibration Solution
- **Synonyms/General Names:** pH 4.00 Buffer solution
- **Product Use:** For device calibration

#US/Canada/International:

24 Hour Emergency Information Telephone Numbers

CHEMTREC (USA): 800.424.9300

CANUTEC (Canada): 613.424.6666

International 703-527-3887

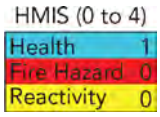
#Spain:

Centro Nacional de Toxicología

Teléfono: 91 5620420

http://institutodetoxicologia.justicia.es/

Section 2: Hazards Identification



Red liquid; no odor.

CAUTION! Body tissue irritant.

Target organs: None known.

This material is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200) if used properly.

Section 3: Composition / Information on Ingredients

- **Potassium Hydrogen Phthalate:** 10.21g, 1-2%
- **Hydrochloric Acid:** 1ml, <1%
- **Water:** (7732-18-5), 97-99%
- **Food coloring:** <1%

Section 4: First Aid Measures

Always seek professional medical attention after first aid measures are provided.

- **Eyes:** Immediately flush eyes with excess water for 15 minutes, lifting lower and upper eyelids occasionally.
- **Skin:** Immediately flush skin with excess water for 15 minutes while removing contaminated clothing.
- **Ingestion:** Call Poison Control immediately. Rinse mouth with cold water. Give victim 1-2 cups of water or milk to drink. Induce vomiting immediately.
- **Inhalation:** Remove to fresh air. If not breathing, give artificial respiration.

Section 5: Fire Fighting Measures

Non-combustible solution. When heated to decomposition, emits acrid fumes.

Protective equipment and precautions for firefighters: Use foam or dry chemical to extinguish fire.

Firefighters should wear full fire fighting turn-out gear and respiratory protection (SCBA). Cool container with water spray. Material is not sensitive to mechanical impact or static discharge.

Section 6: Accidental Release Measures

Use personal protection recommended in Section 8. Isolate the hazard area and deny entry to unnecessary and unprotected personnel. Contain spill with sand or absorbent material and place in sealed bag or container for disposal. Ventilate and wash spill area after pickup is complete. See Section 13 for disposal information.

Section 7: Handling and Storage

- **Handling:** Use with adequate ventilation and do not breathe dust or vapor. Avoid contact with skins, eyes, or clothing. Wash hands thoroughly after handling.
- **Storage:** Store in General Storage Area with other items with no specific storage hazards. Store in a cool, dry, well-ventilated, locked store room away from incompatible materials.

Section 8: Exposure Controls / Personal Protection

Use ventilation to keep airborne concentrations below exposure limits. Have approved eyewash facility, safety shower, and fire extinguishers readily available. Wear chemical splash goggles and chemical resistant clothing such as gloves and aprons. Wash hands thoroughly after handling material and before eating or drinking.

Exposure guidelines: Sodium Hydroxide: OSHA PEL: 2 mg/m^3, ACGIH: TLV: N/A, STEL: 2 mg/m^3 ceiling.

Section 9: Physical and Chemical Properties

Molecular formula:	N/A	**Appearance:**	Red liquid
Molecular weight:	N/A	**Odor:**	No odor
Specific Gravity:	1.00 g/mL @ 20°C	**Odor Threshold:**	N/A
Vapor Density (air=1):	0.7 (water)	**Solubility:**	Complete
Melting Point Freezes:	@ ~0 °C	**Evaporation rate:**	N/A (Butyl acetate = 1)
Boiling Point/Range:	~100°C	**Partition Coefficient:**	N/A (log POW)
Vapor Pressure (20°C):	N/A	**pH:**	4.0
Flash Point:	N/A	**LEL:**	N/A
Autoignition Temp:	N/A	**UEL:**	N/A

Section 10: Stability and Reactivity

- **Avoid heat and moisture.**
- **Stability:** Stable under normal conditions of use and storage.
- **Incompatibility:** Acids, alkalis.
- **Shelf life:** Indefinite if stored properly.

Section 11: Toxicology Information

- **Acute Symptoms/Signs of exposure:** Eyes: Redness, tearing, itching, burning, conjunctivitis. Skin: Redness, itching.
- **Ingestion:** Irritation and burning sensations of mouth and throat, nausea, vomiting and abdominal pain.
- **Inhalation:** Irritation of mucous membranes, coughing, wheezing, shortness of breath.
- **Chronic Effects:** No information found.
- **Sensitization:** none expected.

Sodium Hydroxide: LD50 [oral, rabbit]; N/A; LC50 [rat]; N/A; LD50 Dermal [rabbit]; N/A.

Material has not been found to be a carcinogen nor produce genetic, reproductive, or developmental effects.

Section 12: Ecological Information

- **Ecotoxicity (aquatic and terrestrial):** Not considered an environmental hazard.

Section 13: Disposal Considerations

Check with all applicable local, regional, and national laws and regulations. Local regulations may be more stringent than regional or national regulations. Small amounts of this material may be suitable for sanitary sewer or trash disposal.

Section 14: Transport Information

- **DOT Shipping Name:** Not regulated by DOT
- **DOT Hazard Class:**
- **Identification Number:**
- **Canada TDG:** Not regulated by TDG
- **Hazard Class:**
- **UN Number:**

Section 15: Regulatory Information

- **EINECS:** Not listed
- **TSCA:** All components are listed or are exempt
- **WHMIS Canada:** Not WHMIS Controlled
- **California Proposition 65:** Not listed

The product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

Section 16: Other Information

- **Current Issue Date:** January 2011

Disclaimer: Libelium believes that the information herein is factual but is not intended to be all inclusive. The information relates only to the specific material designated and does not relate to its use in combination with other materials or its use as to any particular process. Because safety standards and regulations are subject to change and because Libelium has no continuing control over the material, those handling, storing or using the material should satisfy themselves that they have current information regarding the particular way the material is handled, stored or used and that the same is done in accordance with federal, state and local law. Libelium makes no warranty, expressed or implied, including (without limitation) warranties with respect to the completeness or continuing accuracy of the information contained herein or with respect to fitness for any particular use.

12.2. pH 7.00 Calibration Solution

Section 1: Product and Company Identification

- **Product name:** pH 7.00 Calibration Solution
- **Synonyms/General Names:** pH 7.00 Buffer solution
- **Product Use:** For device calibration

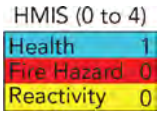
#US/Canada/International:

24 Hour Emergency Information Telephone Numbers
CHEMTREC (USA): 800.424.9300
CANUTEC (Canada): 613.424.6666
International 703-527-3887

#Spain:

Centro Nacional de Toxicología
Teléfono: 91 5620420
http://institutodetoxicologia.justicia.es/

Section 2: Hazards Identification



Yellow liquid; no odor.
CAUTION! Body tissue irritant.
Target organs: None known.
This material is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200) if used properly.

Section 3: Composition / Information on Ingredients

- **Potassium Dihydrogen Phosphate:** 6.81g, <1%
- **Sodium Hydroxide:** 291mL, <1%
- **Water:** (7732-18-5), >99%
- **Food coloring:** <1%

Section 4: First Aid Measures

Always seek professional medical attention after first aid measures are provided.

- **Eyes:** Immediately flush eyes with excess water for 15 minutes, lifting lower and upper eyelids occasionally.
- **Skin:** Immediately flush skin with excess water for 15 minutes while removing contaminated clothing.
- **Ingestion:** Call Poison Control immediately. Rinse mouth with cold water. Give victim 1-2 cups of water or milk to drink. Induce vomiting immediately.
- **Inhalation:** Remove to fresh air. If not breathing, give artificial respiration.

Section 5: Fire Fighting Measures

Noncombustible solution. When heated to decomposition, emits acrid fumes.

Protective equipment and precautions for firefighters: Use foam or dry chemical to extinguish fire.

Firefighters should wear full fire fighting turn-out gear and respiratory protection (SCBA). Cool container with water spray. Material is not sensitive to mechanical impact or static discharge.

Section 6: Accidental Release Measures

Use personal protection recommended in Section 8. Isolate the hazard area and deny entry to unnecessary and unprotected personnel. Contain spill with sand or absorbent material and place in sealed bag or container for disposal. Ventilate and wash spill area after pickup is complete. See Section 13 for disposal information.

Section 7: Handling and Storage

- **Handling:** Use with adequate ventilation and do not breathe dust or vapor. Avoid contact with skins, eyes, or clothing. Wash hands thoroughly after handling.
- **Storage:** Store in General Storage Area with other items with no specific storage hazards. Store in a cool, dry, well-ventilated, locked store room away from incompatible materials.

Section 8: Exposure Controls / Personal Protection

Use ventilation to keep airborne concentrations below exposure limits. Have approved eyewash facility, safety shower, and fire extinguishers readily available. Wear chemical splash goggles and chemical resistant clothing such as gloves and aprons. Wash hands thoroughly after handling material and before eating or drinking.

Exposure guidelines: Sodium Hydroxide: OSHA PEL: 2 mg/m^3, ACGIH: TLV: N/A, STEL: 2 mg/m^3 ceiling.

- **Acute Symptoms/Signs of exposure:** Eyes: Redness, tearing, itching, burning, conjunctivitis. Skin: Redness, itching.
- **Ingestion:** Irritation and burning sensations of mouth and throat, nausea, vomiting and abdominal pain.
- **Inhalation:** Irritation of mucous membranes, coughing, wheezing, shortness of breath.
- **Chronic Effects:** No information found.
- **Sensitization:** none expected.

Sodium Hydroxide: LD50 [oral, rabbit]; N/A; LC50 [rat]; N/A; LD50 Dermal [rabbit]; N/A.

Material has not been found to be a carcinogen nor produce genetic, reproductive, or developmental effects.

Section 9: Physical and Chemical Properties

Molecular formula:	N/A	**Appearance:**	Yellow liquid
Molecular weight:	N/A	**Odor:**	No odor
Specific Gravity:	1.00 g/mL @ 20°C	**Odor Threshold:**	N/A
Vapor Density (air=1):	0.7 (water)	**Solubility:**	Complete
Melting Point Freezes:	@ ~0 °C	**Evaporation rate:**	N/A (Butyl acetate = 1)
Boiling Point/Range:	~100°C	**Partition Coefficient:**	N/A (log POW)
Vapor Pressure (20°C):	N/A	**pH:**	7.0
Flash Point:	N/A	**LEL:**	N/A
Autoignition Temp:	N/A	**UEL:**	N/A

Section 10: Stability and Reactivity

- **Avoid heat and moisture.**
- **Stability:** Stable under normal conditions of use and storage.
- **Incompatibility:** Acids, alkalis.
- **Shelf life:** Indefinite if stored properly.

Section 11: Toxicology Information

Section 12: Ecological Information

- **Ecotoxicity (aquatic and terrestrial):** Not considered an environmental hazard.

Section 13: Disposal Considerations

Check with all applicable local, regional, and national laws and regulations. Local regulations may be more stringent than regional or national regulations. Small amounts of this material may be suitable for sanitary sewer or trash disposal.

Section 14: Transport Information

- **DOT Shipping Name:** Not regulated by DOT
- **DOT Hazard Class:**
- **Identification Number:**
- **Canada TDG:** Not regulated by TDG
- **Hazard Class:**
- **UN Number:**

Section 15: Regulatory Information

- **EINECS:** Not listed.
- **TSCA:** All components are listed or are exempt.
- **WHMIS Canada:** Not WHMIS Controlled.
- **California Proposition 65:** Not listed.

The product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

Section 16: Other Information

- **Current Issue Date:** January 2011

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12.3. pH 10.00 Calibration Solution

Section 1: Product and Company Identification

- **Product name:** pH 10.00 Calibration Solution
- **Synonyms/General Names:** pH 10.00 Buffer solution
- **Product Use:** For device calibration

#US/Canada/International:
24 Hour Emergency Information Telephone Numbers
CHEMTREC (USA): 800.424.9300
CANUTEC (Canada): 613.424.6666
International 703-527-3887

#Spain:
Centro Nacional de Toxicología
Teléfono: 91 5620420
http://institutodetoxicologia.justicia.es/

Section 2: Hazards Identification

HMIS (0 to 4)

Health	1
Fire Hazard	0
Reactivity	0

Blue liquid; no odor.
CAUTION! Body tissue irritant.
Target organs: None known.
This material is not considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200) if used properly.

Section 3: Composition / Information on Ingredients

- **Sodium Tetraborate:** 4.77g, 0.32-0.51%
- **Sodium Hydroxide:** 183mL, <1%
- **Water:** (7732-18-5), 99.1%

Section 4: First Aid Measures

Always seek professional medical attention after first aid measures are provided.

- **Eyes:** Immediately flush eyes with excess water for 15 minutes, lifting lower and upper eyelids occasionally.
- **Skin:** Immediately flush skin with excess water for 15 minutes while removing contaminated clothing.
- **Ingestion:** Call Poison Control immediately. Rinse mouth with cold water. Give victim 1-2 cups of water or milk to drink. Induce vomiting immediately.
- **Inhalation:** Remove to fresh air. If not breathing, give artificial respiration.

Section 5: Fire Fighting Measures

Noncombustible solution. When heated to decomposition, emits acrid fumes.

Protective equipment and precautions for firefighters: Use foam or dry chemical to extinguish fire.

Firefighters should wear full fire fighting turn-out gear and respiratory protection (SCBA). Cool container with water spray. Material is not sensitive to mechanical impact or static discharge.

Section 6: Accidental Release Measures

Use personal protection recommended in Section 8. Isolate the hazard area and deny entry to unnecessary and unprotected personnel. Contain spill with sand or absorbent material and place in sealed bag or container for disposal. Ventilate and wash spill area after pickup is complete. See Section 13 for disposal information.

Section 7: Handling and Storage

- **Handling:** Use with adequate ventilation and do not breathe dust or vapor. Avoid contact with skins, eyes, or clothing. Wash hands thoroughly after handling.
- **Storage:** Store in General Storage Area with other items with no specific storage hazards. Store in a cool, dry, well-ventilated, locked store room away from incompatible materials.

Section 8: Exposure Controls / Personal Protection

Use ventilation to keep airborne concentrations below exposure limits. Have approved eyewash facility, safety shower, and fire extinguishers readily available. Wear chemical splash goggles and chemical resistant clothing such as gloves and aprons. Wash hands thoroughly after handling material and before eating or drinking. Use NIOSH-approved respirator with an dust cartridge.

Exposure guidelines: Sodium hydroxide: OSHA PEL: Not Available, ACGIH: TLV: Not Available, STEL: Not Available.

Section 9: Physical and Chemical Properties

Molecular formula:	N/A	**Appearance:**	Blue liquid
Molecular weight:	N/A	**Odor:**	No odor
Specific Gravity:	1.00 g/mL @ 20°C	**Odor Threshold:**	N/A
Vapor Density (air=1):	0.7 (water)	**Solubility:**	Complete
Melting Point Freezes:	@ ~0 °C	**Evaporation rate:**	N/A (Butyl acetate = 1)
Boiling Point/Range:	~100°C	**Partition Coefficient:**	N/A (log POW)
Vapor Pressure (20°C):	N/A	**pH:**	10.0
Flash Point:	N/A	**LEL:**	N/A
Autoignition Temp:	N/A	**UEL:**	N/A

Section 10: Stability and Reactivity

- **Avoid heat and moisture.**
- **Stability:** Stable under normal conditions of use and storage.
- **Incompatibility:** Acids, alkalis.
- **Shelf life:** Indefinite if stored properly.

Section 11: Toxicology Information

- **Acute Symptoms/Signs of exposure:** Eyes: Redness, tearing, itching, burning, conjunctivitis. Skin: Redness, itching.
- **Ingestion:** Irritation and burning sensations of mouth and throat, nausea, vomiting and abdominal pain.
- **Inhalation:** Irritation of mucous membranes, coughing, wheezing, shortness of breath.
- **Chronic Effects:** No information found.
- **Sensitization:** none expected.

Sodium Hydroxide: LD50 [oral, rabbit]; N/A; LC50 [rat]; N/A; LD50 Dermal [rabbit]; N/A.

Material has not been found to be a carcinogen nor produce genetic, reproductive, or developmental effects.

Section 12: Ecological Information

- **Ecotoxicity (aquatic and terrestrial):** Not considered an environmental hazard.

Section 13: Disposal Considerations

Check with all applicable local, regional, and national laws and regulations. Local regulations may be more stringent than regional or national regulations. Small amounts of this material may be suitable for sanitary sewer or trash disposal.

Section 14: Transport Information

- **DOT Shipping Name:** Not regulated by DOT
- **DOT Hazard Class:**
- **Identification Number:**
- **Canada TDG:** Not regulated by TDG
- **Hazard Class:**
- **UN Number:**

Section 15: Regulatory Information

- **EINECS:** Not listed.
- **TSCA:** All components are listed or are exempt.
- **WHMIS Canada:** Not WHMIS Controlled.
- **California Proposition 65:** Not listed.

The product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

Section 16: Other Information

- **Current Issue Date:** January 2011

Disclaimer: Libelium believes that the information herein is factual but is not intended to be all inclusive. The information relates only to the specific material designated and does not relate to its use in combination with other materials or its use as to any particular process. Because safety standards and regulations are subject to change and because Libelium has no continuing control over the material, those handling, storing or using the material should satisfy themselves that they have current information regarding the particular way the material is handled, stored or used and that the same is done in accordance with federal, state and local law. Libelium makes no warranty, expressed or implied, including (without limitation) warranties with respect to the completeness or continuing accuracy of the information contained herein or with respect to fitness for any particular use.

12.4. Multi-ion Calibration Solution

- Safety Data Sheet
- According to Regulation (EC) No. 1907/2006
- Version 1.0
- Revision Date: 27.02.2013

1. Identification Of The Substance/Mixture

- Product Name: Multi-ion calibration solution
- Relevant identified uses: Ion-Selective Standard Solutions
- #US/Canada/International:
- 24 Hour Emergency Information Telephone Numbers
- CHEMTREC (USA): 800.424.9300
- CANUTEC (Canada): 613.424.6666
- International 703-527-3887
- #Spain:
- Centro Nacional de Toxicología
- Teléfono: 91 5620420
- http://institutodetoxicologia.justicia.es/
- INTCF - Instituto Nacional de toxicología y Ciencias Forenses - 91 562 04 2

2. Hazards identification

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture according to Regulation (EC) No. 1272/2008.

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.2 Label elements

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.3 Other hazards

This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

3. Composition/information on ingredients

Aqueous solution of ions.

4. First aid measures

4.1 Description of first aid measures

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration.

In case of skin contact

Wash off with soap and plenty of water.

In case of eye contact

Flush eyes with water as a precaution.

If swallowed

Never give anything by mouth to an unconscious person. Rinse mouth with water.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labeling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

5. Firefighting measures

Extinguishing media

Suitable extinguishing media

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

No data available

5.3 Advice for firefighters

Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information

no data

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Avoid dust formation. Avoid breathing vapours, mist or gas.

For personal protection see section 8.

6.2 Environmental precautions

No special environmental precautions required.

6.3 Methods and materials for containment and cleaning up

Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections

For disposal see section 13.

7. Handling and storage

7.1 Precautions for safe handling

Provide appropriate exhaust ventilation at places where dust is formed.

For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Store in cool place. Keep container tightly closed in a dry and well-ventilated place.

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated.

8. Exposure controls/personal protection

8.1 Control parameters

Components with workplace control parameters

8.2 Exposure controls

Appropriate engineering controls

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection

Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.

Wash and dry hands.

The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

Body Protection

The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection

Respiratory protection is not required

Control of environmental exposure

No special environmental precautions required

9. Physical and chemical properties

9.1 Information on basic physical and chemical properties

a) Appearance Form: liquid

Colour: Colourless

b) Odour no data available

c) Odour Threshold no data available

d) pH no data available

e) Melting point/freezing point

Melting point/range

f) Initial boiling point and boiling range

no data available

g) Flash point not applicable

h) Evapouration rate no data available

i) Flammability (solid, gas) no data available

j) Upper/lower flammability or explosive limits

no data available

k) Vapour pressure no data available

l) Vapour density no data available

m) Relative density 1,000 g/cm3

n) Water solubility no data available

o) Partition coefficient: noctanol/water

no data available

p) Auto-ignition temperature

no data available

q) Decomposition temperature

no data available

r) Viscosity no data available

s) Explosive properties no data available

t) Oxidizing properties no data available

10. Stability and reactivity

10.1 Reactivity

no data available

10.2 Chemical stability

Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions

no data available

10.4 Conditions to avoid

no data available

10.5 Incompatible materials

Strong oxidizing agents

10.6 Hazardous decomposition products

Other decomposition products - no data available

In the event of fire: see section 5

11. Toxicological information

Information on toxicological effects

Acute toxicity

no data available

Skin corrosion/irritation

no data available

Serious eye damage/eye irritation

no data available

Respiratory or skin sensitisation

no data available

Germ cell mutagenicity

no data available

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

Reproductive toxicity

no data available

Specific target organ toxicity - single exposure

no data available

Specific target organ toxicity - repeated exposure

no data available

Aspiration hazard

no data available

Additional Information

RTECS: Not available

12. Ecological information

12.1 Toxicity

no data available

12.2 Persistence and degradability

no data available

12.3 Bioaccumulative potential

no data available

12.4 Mobility in soil

no data available

12.5 Results of PBT and vPvB assessment

PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects

no data available

13. Disposal considerations

Waste treatment methods

Product

Offer surplus and non-recyclable solutions to a licensed disposal company.

Contaminated packaging

Dispose of as unused product.

14. Transport information

14.1 UN number

ADR/RID: - IMDG: - IATA: -

14.2 UN proper shipping name

ADR/RID: Not dangerous goods

IMDG: Not dangerous goods

IATA: Not dangerous goods

14.3 Transport hazard class(es)

ADR/RID: - IMDG: - IATA: -

14.4 Packaging group

ADR/RID: - IMDG: - IATA: -

14.5 Environmental hazards

ADR/RID: no IMDG Marine pollutant: no IATA: no

14.6 Special precautions for user

no data available

15. Regulatory information

This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

no data available

15.2 Chemical Safety Assessment

For this product a chemical safety assessment was not carried out

16. Other information

Ion-Selective Standard Solutions

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product.

12.5. Calcium calibration solution

- Safety Data Sheet
- According to Regulation (EC) No. 1907/2006
- Version 1.0
- Revision Date: 27.02.2013

1. Identification Of The Substance/Mixture

- Product Name : Standard Solution Calcium Ions
- Relevant identified uses : Ion-Selective Standard Solutions
- #US/Canada/International:
- 24 Hour Emergency Information Telephone Numbers
- CHEMTREC (USA): 800.424.9300
- CANUTEC (Canada): 613.424.6666
- International 703-527-3887
- #Spain:
- Centro Nacional de Toxicología
- Teléfono: 91 5620420
- http://institutodetoxicologia.justicia.es/
- INTCF - Instituto Nacional de toxicología y Ciencias Forenses - 91 562 04 20

2. Hazards identification

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture according to Regulation (EC) No. 1272/2008.

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.2 Label elements

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.3 Other hazards

This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

3. Composition/information on ingredients

Aqueous solution of Calcium Chloride (CaCl2)

CAS Number: 10043-52-4

4. First aid measures

4.1 Description of first aid measures

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration.

In case of skin contact

Wash off with soap and plenty of water.

In case of eye contact

Flush eyes with water as a precaution.

If swallowed

Never give anything by mouth to an unconscious person. Rinse mouth with water.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labeling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

5. Firefighting measures

Extinguishing media

Suitable extinguishing media

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

No data available

5.3 Advice for firefighters

Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information

no data

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Avoid dust formation. Avoid breathing vapours, mist or gas.

For personal protection see section 8.

6.2 Environmental precautions

No special environmental precautions required.

6.3 Methods and materials for containment and cleaning up

Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections

For disposal see section 13.

7. Handling and storage

7.1 Precautions for safe handling

Provide appropriate exhaust ventilation at places where dust is formed.

For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Store in cool place. Keep container tightly closed in a dry and well-ventilated place.

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. Exposure controls/personal protection

8.1 Control parameters

Components with workplace control parameters

8.2 Exposure controls

Appropriate engineering controls

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection

Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.

Wash and dry hands.

The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

Body Protection

The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection

Respiratory protection is not required

Control of environmental exposure

No special environmental precautions required

9. Physical and chemical properties

9.1 Information on basic physical and chemical properties
a) Appearance Form: liquid
Colour: Colourless
b) Odour no data available
c) Odour Threshold no data available
d) pH no data available
e) Melting point/freezing point
Melting point/range: 384 °C
f) Initial boiling point and boiling range
no data available
g) Flash point not applicable
h) Evapouration rate no data available
i) Flammability (solid, gas) no data available
j) Upper/lower flammability or explosive limits
no data available
k) Vapour pressure no data available
l) Vapour density no data available
m) Relative density 1,009 g/cm3
n) Water solubility no data available
o) Partition coefficient: noctanol/water
no data available
p) Auto-ignition temperature
no data available
q) Decomposition temperature
no data available
r) Viscosity no data available
s) Explosive properties no data available
t) Oxidizing properties no data available

10. Stability and reactivity

10.1 Reactivity
no data available
10.2 Chemical stability
Stable under recommended storage conditions.
10.3 Possibility of hazardous reactions
no data available
10.4 Conditions to avoid
no data available
10.5 Incompatible materials
Strong oxidizing agents
10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. Toxicological information

Information on toxicological effects
Acute toxicity
no data available
Skin corrosion/irritation
no data available
Serious eye damage/eye irritation
no data available
Respiratory or skin sensitisation
no data available
Germ cell mutagenicity
no data available
Carcinogenicity
IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
Reproductive toxicity
no data available
Specific target organ toxicity - single exposure
Inhalation - May cause respiratory irritation.
Specific target organ toxicity - repeated exposure
no data available
Aspiration hazard
no data available
Additional Information
RTECS: Not available

12. Ecological information

12.1 Toxicity
Toxicity to fish LC50 - Pimephales promelas (fathead minnow) - > 13 mg/l - 96 h
12.2 Persistence and degradability
no data available
12.3 Bioaccumulative potential
no data available
12.4 Mobility in soil
no data available
12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted
12.6 Other adverse effects
no data available

13. Disposal considerations

Waste treatment methods
Product
Offer surplus and non-recyclable solutions to a licensed disposal company.
Contaminated packaging
Dispose of as unused product.

14. Transport information

14.1 UN number
ADR/RID: - IMDG: - IATA: -
14.2 UN proper shipping name
ADR/RID: Not dangerous goods
IMDG: Not dangerous goods
IATA: Not dangerous goods
14.3 Transport hazard class(es)
ADR/RID: - IMDG: - IATA: -
14.4 Packaging group
ADR/RID: - IMDG: - IATA: -
14.5 Environmental hazards
ADR/RID: no IMDG Marine pollutant: no IATA: no
14.6 Special precautions for user
no data available

15. Regulatory information

This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.
15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture
no data available
15.2 Chemical Safety Assessment
For this product a chemical safety assessment was not carried out

16. Other information

Ion-Selective Standard Solutions

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the produc.

12.6. Fluoride Calibration Kit

- Safety Data Sheet
- According to Regulation (EC) No. 1907/2006
- Version 1.0
- Revision Date: 27.02.2013

1. Identification Of The Substance/Mixture

- Product Name : Standard Solution Fluoride Ions
- Relevant identified uses : Ion-Selective Standard Solutions
- #US/Canada/International:
- 24 Hour Emergency Information Telephone Numbers
- CHEMTREC (USA): 800.424.9300
- CANUTEC (Canada): 613.424.6666
- International 703-527-3887
- #Spain:
- Centro Nacional de Toxicología
- Teléfono: 91 5620420
- http://institutodetoxicologia.justicia.es/
- INTCF - Instituto Nacional de toxicología y Ciencias Forenses - 91 562 04 20

2. Hazards identification

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture according to Regulation (EC) No. 1272/2008.

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.2 Label elements

The product does not need to be labeled in accordance with EC directives or respective national laws.

2.3 Other hazards

This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

3. Composition/information on ingredients

Aqueous solution of Sodium Fluoride (NaF)

CAS: 7681-49-4

4. First aid measures

4.1 Description of first aid measures

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration.

In case of skin contact

Wash off with soap and plenty of water.

In case of eye contact

Flush eyes with water as a precaution.

If swallowed

Never give anything by mouth to an unconscious person. Rinse mouth with water.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labeling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

5. Firefighting measures

Extinguishing media

Suitable extinguishing media

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
5.2 Special hazards arising from the substance or mixture
No data available
5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.
5.4 Further information
no data

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures
Avoid dust formation. Avoid breathing vapours, mist or gas.
For personal protection see section 8.
6.2 Environmental precautions
No special environmental precautions required.
6.3 Methods and materials for containment and cleaning up
Sweep up and shovel. Keep in suitable, closed containers for disposal.
6.4 Reference to other sections
For disposal see section 13.

7. Handling and storage

7.1 Precautions for safe handling
Provide appropriate exhaust ventilation at places where dust is formed.
For precautions see section 2.2.
7.2 Conditions for safe storage, including any incompatibilities
Store in cool place. Keep container tightly closed in a dry and well-ventilated place.
7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. Exposure controls/personal protection

8.1 Control parameters
Components with workplace control parameters
8.2 Exposure controls
Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.
Personal protective equipment
Eye/face protection
Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).
Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.
Wash and dry hands.
The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.
Body Protection
The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.
Respiratory protection
Respiratory protection is not required
Control of environmental exposure
No special environmental precautions required

9. Physical and chemical properties

9.1 Information on basic physical and chemical properties
a) Appearance Form: liquid
Colour: Colourless
b) Odour no data available
c) Odour Threshold no data available
d) pH no data available
e) Melting point/freezing point
Melting point/range
f) Initial boiling point and boiling range 100 °C at 1.000 hPa
g) Flash point not applicable
h) Evapouration rate no data available
i) Flammability (solid, gas) no data available
j) Upper/lower flammability or explosive limits
no data available
k) Vapour pressure no data available
l) Vapour density no data available
m) Relative density 1,000 g/cm3
n) Water solubility no data available
o) Partition coefficient: noctanol/water
no data available
p) Auto-ignition
temperature
no data available
q) Decomposition
temperature
no data available
r) Viscosity no data available
s) Explosive properties no data available
t) Oxidizing properties no data available

10. Stability and reactivity

10.1 Reactivity
no data available
10.2 Chemical stability
Stable under recommended storage conditions.
10.3 Possibility of hazardous reactions
no data available
10.4 Conditions to avoid
no data available
10.5 Incompatible materials
Strong oxidizing agents
10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. Toxicological information

Information on toxicological effects
Acute toxicity
no data available
Skin corrosion/irritation
no data available
Serious eye damage/eye irritation
no data available
Respiratory or skin sensitisation
no data available
Germ cell mutagenicity
no data available
Carcinogenicity
IARC: 3 - Group 3: Not classifiable as to its carcinogenicity to humans (Sodium fluoride)
3 - Group 3: Not classifiable as to its carcinogenicity to humans

(Sodium fluoride)
Reproductive toxicity
no data available
Specific target organ toxicity - single exposure
Inhalation - May cause respiratory irritation.
Specific target organ toxicity - repeated exposure
no data available
Aspiration hazard
no data available
Additional Information
RTECS: Not available

12. Ecological information

12.1 Toxicity
Toxicity to fish LC50 - Pimephales promelas (fathead minnow) 13 mg/l - 96 h
12.2 Persistence and degradability
no data available
12.3 Bioaccumulative potential
no data available
12.4 Mobility in soil
no data available
12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted
12.6 Other adverse effects
no data available

13. Disposal considerations

Waste treatment methods
Product
Offer surplus and non-recyclable solutions to a licensed disposal company.
Contaminated packaging
Dispose of as unused product.

14. Transport information

14.1 UN number
ADR/RID: - IMDG: - IATA: -
14.2 UN proper shipping name
ADR/RID: Not dangerous goods
IMDG: Not dangerous goods
IATA: Not dangerous goods
14.3 Transport hazard class(es)
ADR/RID: - IMDG: - IATA: -
14.4 Packaging group
ADR/RID: - IMDG: - IATA: -
14.5 Environmental hazards
ADR/RID: no IMDG Marine pollutant: no IATA: no
14.6 Special precautions for user
no data available

15. Regulatory information

This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.
15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture no data available
15.2 Chemical Safety Assessment
For this product a chemical safety assessment was not carried out

16. Other information

Ion-Selective Standard Solutions

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product.

12.7. Fluoroborate Calibration Kit

- Safety Data Sheet
- According to Regulation (EC) No. 1907/2006
- Version 1.0
- Revision Date: 27.02.2013

1. Identification Of The Substance/Mixture

- Product Name : Standard Solution tetrafluoroborate Ions
- Relevant identified uses : Ion-Selective Standard Solutions
- #US/Canada/International:
- 24 Hour Emergency Information Telephone Numbers
- CHEMTREC (USA): 800.424.9300
- CANUTEC (Canada): 613.424.6666
- International 703-527-3887
- #Spain:
- Centro Nacional de Toxicología
- Teléfono: 91 5620420
- http://institutodetoxicologia.justicia.es/
- INTCF - Instituto Nacional de toxicología y Ciencias Forenses - 91 562 04 20

2. Hazards identification

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture according to Regulation (EC) No. 1272/2008.

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.2 Label elements

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.3 Other hazards

This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

3. Composition/information on ingredients

Aqueous solution of Sodium tetrafluoroborate (NaBF4)

CAS Number: 13755-29-8

4. First aid measures

4.1 Description of first aid measures

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration.

In case of skin contact

Wash off with soap and plenty of water.

In case of eye contact

Flush eyes with water as a precaution.

If swallowed

Never give anything by mouth to an unconscious person. Rinse mouth with water.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labeling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

5. Firefighting measures

Extinguishing media

Suitable extinguishing media

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

No data available

5.3 Advice for firefighters

Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information

no data

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Avoid dust formation. Avoid breathing vapours, mist or gas.

For personal protection see section 8.

6.2 Environmental precautions

No special environmental precautions required.

6.3 Methods and materials for containment and cleaning up

Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections

For disposal see section 13.

7. Handling and storage

7.1 Precautions for safe handling

Provide appropriate exhaust ventilation at places where dust is formed.

For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Store in cool place. Keep container tightly closed in a dry and well-ventilated place.

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. Exposure controls/personal protection

8.1 Control parameters

Components with workplace control parameters

8.2 Exposure controls

Appropriate engineering controls

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection

Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.

Wash and dry hands.

The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

Body Protection

The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection

Respiratory protection is not required

Control of environmental exposure

No special environmental precautions required

9. Physical and chemical properties

9.1 Information on basic physical and chemical properties
a) Appearance Form: liquid
Colour: Colourless
b) Odour no data available
c) Odour Threshold no data available
d) pH no data available
e) Melting point/freezing point
Melting point/range: 384 °C
f) Initial boiling point and
boiling range
no data available
g) Flash point not applicable
h) Evapouration rate no data available
i) Flammability (solid, gas) no data available
j) Upper/lower
flammability or
explosive limits
no data available
k) Vapour pressure no data available
l) Vapour density no data available
m) Relative density 2,47 g/mL at 25 °C
n) Water solubility no data available
o) Partition coefficient: noctanol/water
no data available
p) Auto-ignition
temperature
no data available
q) Decomposition
temperature
no data available
r) Viscosity no data available
s) Explosive properties no data available
t) Oxidizing properties no data available

10. Stability and reactivity

10.1 Reactivity
no data available
10.2 Chemical stability
Stable under recommended storage conditions.
10.3 Possibility of hazardous reactions
no data available
10.4 Conditions to avoid
no data available
10.5 Incompatible materials
acids, Strong oxidizing agents
10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. Toxicological information

Information on toxicological effects
Acute toxicity
no data available
Skin corrosion/irritation
no data available
Serious eye damage/eye irritation
no data available
Respiratory or skin sensitisation
no data available
Germ cell mutagenicity
no data available
Carcinogenicity
IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
Reproductive toxicity
no data available
Specific target organ toxicity - single exposure
Inhalation - May cause respiratory irritation.
Specific target organ toxicity - repeated exposure
no data available
Aspiration hazard
no data available
Additional Information
RTECS: Not available

12. Ecological information

12.1 Toxicity
Toxicity to fish LC50 - Pimephales promelas (fathead minnow) - > 13 mg/l - 96 h
12.2 Persistence and degradability
no data available
12.3 Bioaccumulative potential
no data available
12.4 Mobility in soil
no data available
12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted
12.6 Other adverse effects
no data available

13. Disposal considerations

Waste treatment methods
Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.
Contaminated packaging
Dispose of as unused product.

14. Transport information

14.1 UN number
ADR/RID: - IMDG: - IATA: -
14.2 UN proper shipping name
ADR/RID: Not dangerous goods
IMDG: Not dangerous goods
IATA: Not dangerous goods
14.3 Transport hazard class(es)
ADR/RID: - IMDG: - IATA: -
14.4 Packaging group
ADR/RID: - IMDG: - IATA: -
14.5 Environmental hazards
ADR/RID: no IMDG Marine pollutant: no IATA: no
14.6 Special precautions for user
no data available

15. Regulatory information

This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.
15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture
no data available
15.2 Chemical Safety Assessment
For this product a chemical safety assessment was not carried out

16. Other information

Ion-Selective Standard Solutions

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product.

12.8. Lithium Calibration Kit

- Safety Data Sheet
- According to Regulation (EC) No. 1907/2006
- Version 1.0
- Revision Date: 27.02.2013

1. Identification Of The Substance/Mixture

- Product Name : Standard Solution Lithium Ions
- REACH nº: A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.
- Relevant identified uses : Ion Standard Solutions for Ion Selective Electrodes
- #US/Canada/International:
- 24 Hour Emergency Information Telephone Numbers
- CHEMTREC (USA): 800.424.9300
- CANUTEC (Canada): 613.424.6666
- International 703-527-3887
- #Spain:
- Centro Nacional de Toxicología
- Teléfono: 91 5620420
- http://www.mju.es/toxicologia
- INTCF - Instituto Nacional de toxicología y Ciencias Forenses - 91 562 04 20

2. Hazards identification

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture according to Regulation (EC) No. 1272/2008.

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.2 Label elements

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.3 Other hazards

This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

3. Composition/information on ingredients

Aqueous solution of Lithium Chloride (LiCl)

CAS-No. 7447-41-8

EC-No. 231-212-3

Classification:

Acute Tox. 4; Skin Irrit. 2; Eye; Irrit. 2; STOT SE 3; H302,H315, H319, H335

Xn, R22 - R36/37/38

Concentration < 1%

For the full text of the H-Statements and R-Phrases mentioned in this Section, see Section 16

4. First aid measures

4.1 Description of first aid measures

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration.

In case of skin contact

Wash off with soap and plenty of water.

In case of eye contact

Flush eyes with water as a precaution.

If swallowed

Never give anything by mouth to an unconscious person. Rinse mouth with water.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

5. Firefighting measures

Extinguishing media

Suitable extinguishing media

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

No data available

5.3 Advice for firefighters

Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information

no data

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Avoid dust formation. Avoid breathing vapours, mist or gas.

For personal protection see section 8.

6.2 Environmental precautions

No special environmental precautions required.

6.3 Methods and materials for containment and cleaning up

Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections

For disposal see section 13.

7. Handling and storage

7.1 Precautions for safe handling

No data available

7.2 Conditions for safe storage, including any incompatibilities

Store in cool place. Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

Recommended storage temperature: 2 - 8 °C

7.3 Specific end use(s)

no data available

8. Exposure controls/personal protection

8.1 Control parameters

Components with workplace control parameters

8.2 Exposure controls

Appropriate engineering controls

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection

Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.

Wash and dry hands.

The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

Body Protection

The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection

Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator

with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure

No special environmental precautions required

9. Physical and chemical properties

9.1 Information on basic physical and chemical properties

a) Appearance Form: liquid

b) Odour no data available

c) Odour Threshold no data available

d) pH no data available

e) Melting point/freezing point

Melting point/range

f) Initial boiling point and boiling range

no data available

g) Flash point not applicable

h) Evapouration rate no data available

i) Flammability (solid, gas) no data available

j) Upper/lower flammability or explosive limits

no data available

k) Vapour pressure no data available

l) Vapour density no data available

m) Relative density no data available

n) Water solubility no data available

o) Partition coefficient: noctanol/water

no data available

p) Auto-ignition temperature

no data available

q) Decomposition temperature

no data available

r) Viscosity no data available

s) Explosive properties no data available

t) Oxidizing properties no data available

10. Stability and reactivity

10.1 Reactivity

no data available

10.2 Chemical stability

Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions

no data available

10.4 Conditions to avoid

no data available

10.5 Incompatible materials

Strong oxidizing agents

10.6 Hazardous decomposition products

Other decomposition products - no data available

In the event of fire: see section 5

11. Toxicological information

Information on toxicological effects

Acute toxicity

no data available

Skin corrosion/irritation
no data available
Serious eye damage/eye irritation
no data available
Respiratory or skin sensitisation
no data available
Germ cell mutagenicity
no data available
Carcinogenicity
IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
Reproductive toxicity
no data available
Specific target organ toxicity - single exposure
No data available
Specific target organ toxicity - repeated exposure
no data available
Aspiration hazard
no data available
Potential health effects
Inhalation May be harmful if inhaled. May cause respiratory tract irritation.
Ingestion May be harmful if swallowed.
Skin May be harmful if absorbed through skin. May cause skin irritation.
Eyes May cause eye irritation.
Signs and Symptoms of Exposure
To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.
Additional Information
RTECS: Not available

12. Ecological information
12.1 Toxicity
No data available
12.2 Persistence and degradability
no data available
12.3 Bioaccumulative potential
no data available
12.4 Mobility in soil
no data available
12.5 Results of PBT and vPvB assessment
This substance/mixture contains no components considered to be either persistent, bioaccumulative toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.
12.6 Other adverse effects
Harmful to aquatic life

13. Disposal considerations
Waste treatment methods
Product
Offer surplus and non-recyclable solutions to a licensed disposal company.
Contaminated packaging
Dispose of as unused product.

14. Transport information
14.1 UN number
ADR/RID: - IMDG: - IATA: -
14.2 UN proper shipping name
ADR/RID: Not dangerous goods
IMDG: Not dangerous goods
IATA: Not dangerous goods
14.3 Transport hazard class(es)
ADR/RID: - IMDG: - IATA: -
14.4 Packaging group
ADR/RID: - IMDG: - IATA: -
14.5 Environmental hazards
ADR/RID: no IMDG Marine pollutant: no IATA: no
14.6 Special precautions for user
no data available

15. Regulatory information
This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.
15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture
no data available
15.2 Chemical Safety Assessment
No data available

16. Other information
Ion-Selective Standard Solutions
Text of H-code(s) and R-phrase(s) mentioned in Section 3
Acute Tox. Acute toxicity
Eye Irrit. Eye irritation
H302 Harmful if swallowed.
H315 Causes skin irritation.
H319 Causes serious eye irritation.
H335 May cause respiratory irritation.
Skin Irrit. Skin irritation
STOT SE Specific target organ toxicity - single exposure
Xn Harmful
R22 Harmful if swallowed.
R36/37/38 Irritating to eyes, respiratory system and skin.

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product.

12.9. Nitrate Calibration Kit

- Safety Data Sheet
- According to Regulation (EC) No. 1907/2006
- Version 1.0
- Revision Date: 27.02.2013

1. Identification Of The Substance/Mixture

- Product Name : Standard Solution Nitrate Ions
- Relevant identified uses : Ion-Selective Standard Solutions
- #US/Canada/International:
- 24 Hour Emergency Information Telephone Numbers
- CHEMTREC (USA): 800.424.9300
- CANUTEC (Canada): 613.424.6666
- International 703-527-3887
- #Spain:
- Centro Nacional de Toxicología
- Teléfono: 91 5620420
- http://institutodetoxicologia.justicia.es/
- INTCF - Instituto Nacional de toxicología y Ciencias Forenses - 91 562 04 20

2. Hazards identification

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture according to Regulation (EC) No. 1272/2008.

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.2 Label elements

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.3 Other hazards

This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

3. Composition/information on ingredients

Aqueous solution of Potassium Nitrate (KNO_3)

Natural product

4. First aid measures

4.1 Description of first aid measures

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration.

In case of skin contact

Wash off with soap and plenty of water.

In case of eye contact

Flush eyes with water as a precaution.

If swallowed

Never give anything by mouth to an unconscious person. Rinse mouth with water.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labeling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

5. Firefighting measures

Extinguishing media

Suitable extinguishing media

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

No data available

5.3 Advice for firefighters

Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information

no data

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Avoid dust formation. Avoid breathing vapours, mist or gas.

For personal protection see section 8.

6.2 Environmental precautions

No special environmental precautions required.

6.3 Methods and materials for containment and cleaning up

Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections

For disposal see section 13.

7. Handling and storage

7.1 Precautions for safe handling

Provide appropriate exhaust ventilation at places where dust is formed.

For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Store in cool place. Keep container tightly closed in a dry and well-ventilated place.

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. Exposure controls/personal protection

8.1 Control parameters

Components with workplace control parameters

8.2 Exposure controls

Appropriate engineering controls

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection

Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.

Wash and dry hands.

The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

Body Protection

The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection

Respiratory protection is not required

Control of environmental exposure

No special environmental precautions required

9. Physical and chemical properties

9.1 Information on basic physical and chemical properties
a) Appearance Form: liquid
Colour: Colourless
b) Odour no data available
c) Odour Threshold no data available
d) pH no data available
e) Melting point/freezing
point
Melting point/range
f) Initial boiling point and
boiling range
no data available
g) Flash point not applicable
h) Evapouration rate no data available
i) Flammability (solid, gas) no data available
j) Upper/lower
flammability or
explosive limits
no data available
k) Vapour pressure no data available
l) Vapour density no data available
m) Relative density 1,000 g/cm3
n) Water solubility no data available
o) Partition coefficient: noctanol/water
no data available
p) Auto-ignition
temperature
no data available
q) Decomposition
temperature
no data available
r) Viscosity no data available
s) Explosive properties no data available
t) Oxidizing properties no data available

10. Stability and reactivity

10.1 Reactivity
no data available
10.2 Chemical stability
Stable under recommended storage conditions.
10.3 Possibility of hazardous reactions
no data available
10.4 Conditions to avoid
no data available
10.5 Incompatible materials
Strong oxidizing agents
10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. Toxicological information

Information on toxicological effects
Acute toxicity
no data available
Skin corrosion/irritation
no data available
Serious eye damage/eye irritation
no data available
Respiratory or skin sensitisation
no data available
Germ cell mutagenicity
no data available
Carcinogenicity
IARC: 2A - Group 2A: Probably carcinogenic to humans (Potassium nitrate)
Reproductive toxicity
no data available
Specific target organ toxicity - single exposure
Inhalation - May cause respiratory irritation.
Specific target organ toxicity - repeated exposure
no data available
Aspiration hazard
no data available
Additional Information
RTECS: Not available

12. Ecological information

12.1 Toxicity
Toxicity to fish LC50 - Pimephales promelas (fathead minnow) → 13 mg/l - 96 h
12.2 Persistence and degradability
no data available
12.3 Bioaccumulative potential
no data available
12.4 Mobility in soil
no data available
12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted
12.6 Other adverse effects
no data available

13. Disposal considerations

Waste treatment methods
Product
Offer surplus and non-recyclable solutions to a licensed disposal company.
Contaminated packaging
Dispose of as unused product.

14. Transport information

14.1 UN number
ADR/RID: - IMDG: - IATA: -
14.2 UN proper shipping name
ADR/RID: Not dangerous goods
IMDG: Not dangerous goods
IATA: Not dangerous goods
14.3 Transport hazard class(es)
ADR/RID: - IMDG: - IATA: -
14.4 Packaging group
ADR/RID: - IMDG: - IATA: -
14.5 Environmental hazards
ADR/RID: no IMDG Marine pollutant: no IATA: no
14.6 Special precautions for user
no data available

15. Regulatory information

This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.
15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture
no data available
15.2 Chemical Safety Assessment
For this product a chemical safety assessment was not carried out

16. Other information

Ion-Selective Standard Solutions

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product.

12.10. Nitrite Calibration Kit

- Safety Data Sheet
- According to Regulation (EC) No. 1907/2006
- Version 1.0
- Revision Date: 27.02.2013

1. Identification Of The Substance/Mixture

- Product Name : Standard Solution Nitrite Ions
- REACH nº: A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.
- Relevant identified uses : Ion Standard Solutions for Ion Selective Electrodes
- #US/Canada/International:
- 24 Hour Emergency Information Telephone Numbers
- CHEMTREC (USA): 800.424.9300
- CANUTEC (Canada): 613.424.6666
- International 703-527-3887
- #Spain:
- Centro Nacional de Toxicología
- Teléfono: 91 5620420
- http://institutodetoxicologia.justicia.es/
- INTCF - Instituto Nacional de toxicología y Ciencias Forenses - 91 562 04 20

2. Hazards identification

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture according to Regulation (EC) No. 1272/2008.

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.2 Label elements

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.3 Other hazards

This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

3. Composition/information on ingredients

Aqueous solution of Sodium Nitrite ($NaNO_2$)

4. First aid measures

4.1 Description of first aid measures

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration.

In case of skin contact

Wash off with soap and plenty of water.

In case of eye contact

Flush eyes with water as a precaution.

If swallowed

Never give anything by mouth to an unconscious person. Rinse mouth with water.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

5. Firefighting measures

Extinguishing media

Suitable extinguishing media

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

No data available

5.3 Advice for firefighters

Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information

no data

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Avoid dust formation. Avoid breathing vapours, mist or gas.

For personal protection see section 8.

6.2 Environmental precautions

No special environmental precautions required.

6.3 Methods and materials for containment and cleaning up

Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections

For disposal see section 13.

7. Handling and storage

7.1 Precautions for safe handling

Provide appropriate exhaust ventilation at places where dust is formed.

For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Store in cool place. Keep container tightly closed in a dry and well-ventilated place.

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. Exposure controls/personal protection

8.1 Control parameters

Components with workplace control parameters

8.2 Exposure controls

Appropriate engineering controls

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection

Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.

Wash and dry hands.

The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

Body Protection

The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection

Respiratory protection is not required

Control of environmental exposure

No special environmental precautions required

9. Physical and chemical properties

9.1 Information on basic physical and chemical properties

a) Appearance Form: liquid

Colour: Colourless

b) Odour no data available

c) Odour Threshold no data available

d) pH no data available

e) Melting point/freezing point

Melting point/range

f) Initial boiling point and boiling range

no data available

g) Flash point not applicable

h) Evapouration rate no data available

i) Flammability (solid, gas) no data available

j) Upper/lower flammability or explosive limits

no data available

k) Vapour pressure no data available

l) Vapour density no data available

m) Relative density 1,000 g/cm3

n) Water solubility no data available

o) Partition coefficient: noctanol/water

no data available

p) Auto-ignition temperature

no data available

q) Decomposition temperature

no data available

r) Viscosity no data available

s) Explosive properties no data available

t) Oxidizing properties no data available

10. Stability and reactivity

10.1 Reactivity

no data available

10.2 Chemical stability

Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions

no data available

10.4 Conditions to avoid

no data available

10.5 Incompatible materials

Strong oxidizing agents

10.6 Hazardous decomposition products

Other decomposition products - no data available

In the event of fire: see section 5

11. Toxicological information

Information on toxicological effects

Acute toxicity

no data available

Skin corrosion/irritation

no data available

Serious eye damage/eye irritation

no data available

Respiratory or skin sensitisation

no data available

Germ cell mutagenicity

no data available

Carcinogenicity

IARC: 2A - Group 2A: Probably carcinogenic to humans (Sodium nitrite)

Reproductive toxicity

no data available

Specific target organ toxicity - single exposure

No data available
Specific target organ toxicity - repeated exposure
no data available
Aspiration hazard
no data available
Additional Information
RTECS: Not available
Liver - Irregularities - Based on Human Evidence (Sodium nitrite)

12. Ecological information
12.1 Toxicity
No data available
12.2 Persistence and degradability
no data available
12.3 Bioaccumulative potential
no data available
12.4 Mobility in soil
no data available
12.5 Results of PBT and vPvB assessment
This substance/mixture contains no components considered to be either persistent, bioaccumulative toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.
12.6 Other adverse effects
Harmful to aquatic life

13. Disposal considerations
Waste treatment methods
Product
Offer surplus and non-recyclable solutions to a licensed disposal company.
Contaminated packaging
Dispose of as unused product.

14. Transport information
14.1 UN number
ADR/RID: - IMDG: - IATA: -
14.2 UN proper shipping name
ADR/RID: Not dangerous goods
IMDG: Not dangerous goods
IATA: Not dangerous goods
14.3 Transport hazard class(es)
ADR/RID: - IMDG: - IATA: -
14.4 Packaging group
ADR/RID: - IMDG: - IATA: -
14.5 Environmental hazards
ADR/RID: no IMDG Marine pollutant: no IATA: no
14.6 Special precautions for user
no data available

15. Regulatory information
This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.
15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture
no data available
15.2 Chemical Safety Assessment
For this product a chemical safety assessment was not carried out

16. Other information
Ion-Selective Standard Solutions
The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product.

12.11. Perchlorate Calibration Kit

- Safety Data Sheet
- According to Regulation (EC) No. 1907/2006
- Version 1.0
- Revision Date: 27.02.2013

1. Identification Of The Substance/Mixture

- Product Name : Standard Solution Perchlorate Ions
- REACH nº: A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.
- Relevant identified uses : Ion Standard Solutions for Ion Selective Electrodes
- #US/Canada/International:
- 24 Hour Emergency Information Telephone Numbers
- CHEMTREC (USA): 800.424.9300
- CANUTEC (Canada): 613.424.6666
- International 703-527-3887
- #Spain:
- Centro Nacional de Toxicología
- Teléfono: 91 5620420
- http://institutodetoxicologia.justicia.es/
- INTCF - Instituto Nacional de toxicología y Ciencias Forenses - 91 562 04 20

2. Hazards identification

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture according to Regulation (EC) No. 1272/2008.

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.2 Label elements

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.3 Other hazards

none

3. Composition/information on ingredients

Aqueous solution of Perchlorate ions (ClO4-)

3.2 Mixtures

No components need to be disclosed according to the applicable regulations.

4. First aid measures

4.1 Description of first aid measures

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration.

In case of skin contact

Wash off with soap and plenty of water.

In case of eye contact

Flush eyes with water as a precaution.

If swallowed

Never give anything by mouth to an unconscious person. Rinse mouth with water.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

5. Firefighting measures

Extinguishing media

Suitable extinguishing media

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

No data available

5.3 Advice for firefighters

Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information

no data

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Avoid dust formation. Avoid breathing vapours, mist or gas.

For personal protection see section 8.

6.2 Environmental precautions

No special environmental precautions required.

6.3 Methods and materials for containment and cleaning up

Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections

For disposal see section 13.

7. Handling and storage

7.1 Precautions for safe handling

No data available

7.2 Conditions for safe storage, including any incompatibilities

Store in cool place. Keep container tightly closed in a dry and well-ventilated place.

7.3 Specific end use(s)

no data available

8. Exposure controls/personal protection

8.1 Control parameters

Components with workplace control parameters

8.2 Exposure controls

Appropriate engineering controls

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection

Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.

Wash and dry hands.

The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

Body Protection

The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection

Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-

face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).
Control of environmental exposure
No special environmental precautions required

9. Physical and chemical properties
9.1 Information on basic physical and chemical properties
a) Appearance Form: liquid
b) Odour no data available
c) Odour Threshold no data available
d) pH no data available
e) Melting point/freezing point
Melting point/range
f) Initial boiling point and boiling range
no data available
g) Flash point not applicable
h) Evapouration rate no data available
i) Flammability (solid, gas) no data available
j) Upper/lower flammability or explosive limits
no data available
k) Vapour pressure no data available
l) Vapour density no data available
m) Relative density no data available
n) Water solubility no data available
o) Partition coefficient: noctanol/ water
no data available
p) Auto-ignition temperature
no data available
q) Decomposition temperature
no data available
r) Viscosity no data available
s) Explosive properties no data available
t) Oxidizing properties no data available

10. Stability and reactivity
10.1 Reactivity
no data available
10.2 Chemical stability
Stable under recommended storage conditions.
10.3 Possibility of hazardous reactions
no data available
10.4 Conditions to avoid
no data available
10.5 Incompatible materials
Strong bases, Strong acids, Amines, Phosphorus halides, Alcohols, Organic materials, Powdered metals, Strong reducing agents
10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. Toxicological information
Information on toxicological effects
Acute toxicity
no data available
Skin corrosion/irritation
no data available
Serious eye damage/eye irritation
no data available
Respiratory or skin sensitisation
no data available
Germ cell mutagenicity
no data available
Carcinogenicity
IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
Reproductive toxicity
no data available
Specific target organ toxicity - single exposure
No data available
Specific target organ toxicity - repeated exposure
no data available
Aspiration hazard
no data available
Additional Information
RTECS: Not available

12. Ecological information
12.1 Toxicity
No data available
12.2 Persistence and degradability
no data available
12.3 Bioaccumulative potential
no data available
12.4 Mobility in soil
no data available
12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted
12.6 Other adverse effects
No data available

13. Disposal considerations
Waste treatment methods
Product
Offer surplus and non-recyclable solutions to a licensed disposal company.
Contaminated packaging
Dispose of as unused product.

14. Transport information
14.1 UN number
ADR/RID: - IMDG: - IATA: -
14.2 UN proper shipping name
ADR/RID: Not dangerous goods
IMDG: Not dangerous goods
IATA: Not dangerous goods
14.3 Transport hazard class(es)
ADR/RID: - IMDG: - IATA: -
14.4 Packaging group
ADR/RID: - IMDG: - IATA: -
14.5 Environmental hazards
ADR/RID: no IMDG Marine pollutant: no IATA: no
14.6 Special precautions for user
no data available

15. Regulatory information
This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.
15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture
no data available
15.2 Chemical Safety Assessment
No data available

16. Other information

Ion-Selective Standard Solutions

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knozledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product.

12.12. Bromide Calibration Kit

- Safety Data Sheet
- According to Regulation (EC) No. 1907/2006
- Version 1.0
- Revision Date: 27.02.2013

1. Identification Of The Substance/Mixture

- Product Name : Standard Solution Bromide Ions
- Product Number : Br-SCxxxP
- Relevant identified uses : Ion-Selective Standard Solutions
- #US/Canada/International:
- 24 Hour Emergency Information Telephone Numbers
- CHEMTREC (USA): 800.424.9300
- CANUTEC (Canada): 613.424.6666
- International 703-527-3887
- #Spain:
- Centro Nacional de Toxicología
- Teléfono: 91 5620420
- http://institutodetoxicologia.justicia.es/
- INTCF - Instituto Nacional de toxicología y Ciencias Forenses - 91 562 04 20

2. Hazards identification

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture according to Regulation (EC) No. 1272/2008.

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.2 Label elements

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.3 Other hazards

This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

3. Composition/information on ingredients

Aqueous solution of Potassium Bromide (KBr)
CAS nº 7758-02-3
Hazardous ingredients according to Regulation (EC) No 1272/2008
Potassium Bromide
Skin Irrit. 2; Eye Irrit. 2; STOT
SE 3; H315, H319, H335
Concentration <10%
Hazardous ingredients according to Directive 1999/45/EC
Potassium Bromide
Xi, R36/37/38
Concentration <10%

4. First aid measures

4.1 Description of first aid measures
If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration.
In case of skin contact
Wash off with soap and plenty of water.
In case of eye contact
Flush eyes with water as a precaution.
If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water.
4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in

the labelling (see section 2.2) and/or in section 11
4.3 Indication of any immediate medical attention and special treatment needed
No data available

5. Firefighting measures

Extinguishing media
Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
5.2 Special hazards arising from the substance or mixture
No data available
5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.
5.4 Further information
no data

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures
Avoid dust formation. Avoid breathing vapours, mist or gas.
For personal protection see section 8.
6.2 Environmental precautions
No special environmental precautions required.
6.3 Methods and materials for containment and cleaning up
Sweep up and shovel. Keep in suitable, closed containers for disposal.
6.4 Reference to other sections
For disposal see section 13.

7. Handling and storage

7.1 Precautions for safe handling
Provide appropriate exhaust ventilation at places where dust is formed.
For precautions see section 2.2.
7.2 Conditions for safe storage, including any incompatibilities
Store in cool place. Keep container tightly closed in a dry and well-ventilated place.
7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. Exposure controls/personal protection

8.1 Control parameters
Components with workplace control parameters
8.2 Exposure controls
Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.
Personal protective equipment
Eye/face protection
Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166 (EU).
Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.
Wash and dry hands.
The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.
Body Protection
The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.
Respiratory protection
Respiratory protection is not required
Control of environmental exposure
No special environmental precautions required

9. Physical and chemical properties

9.1 Information on basic physical and chemical properties
a) Appearance Form: liquid
Colour: Colourless
b) Odour no data available
c) Odour Threshold no data available
d) pH no data available
e) Melting point/freezing point
Melting point/range
f) Initial boiling point and boiling range
no data available
g) Flash point not applicable
h) Evapouration rate no data available
i) Flammability (solid, gas) no data available
j) Upper/lower flammability or explosive limits
no data available
k) Vapour pressure no data available
l) Vapour density no data available
m) Relative density 1,000 g/cm3
n) Water solubility no data available
o) Partition coefficient: noctanol/water
no data available
p) Auto-ignition temperature
no data available
q) Decomposition temperature
no data available
r) Viscosity no data available
s) Explosive properties no data available
t) Oxidizing properties no data available

10. Stability and reactivity

10.1 Reactivity
no data available
10.2 Chemical stability
Stable under recommended storage conditions.
10.3 Possibility of hazardous reactions
no data available
10.4 Conditions to avoid
no data available
10.5 Incompatible materials
no data available
10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. Toxicological information

Information on toxicological effects
Acute toxicity
no data available
Skin corrosion/irritation
no data available
Serious eye damage/eye irritation
no data available
Respiratory or skin sensitisation
no data available
Germ cell mutagenicity
no data available
Carcinogenicity
IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
Reproductive toxicity

no data available
Specific target organ toxicity - single exposure
no data available
Specific target organ toxicity - repeated exposure
no data available
Aspiration hazard
no data available
Potential health effects
Inhalation May be harmful if inhaled. May cause respiratory tract irritation.
Ingestion May be harmful if swallowed.
Skin May be harmful if absorbed through skin. May cause skin irritation.
Eyes May cause eye irritation.
Additional Information
RTECS: Not available

12. Ecological information

12.1 Toxicity
no data available
12.2 Persistence and degradability
no data available
12.3 Bioaccumulative potential
no data available
12.4 Mobility in soil
no data available
12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted
12.6 Other adverse effects
no data available

13. Disposal considerations

Waste treatment methods
Product
Offer surplus and non-recyclable solutions to a licensed disposal company.
Contaminated packaging
Dispose of as unused product.

14. Transport information

14.1 UN number
ADR/RID: - IMDG: - IATA: -
14.2 UN proper shipping name
ADR/RID: Not dangerous goods
IMDG: Not dangerous goods
IATA: Not dangerous goods
14.3 Transport hazard class(es)
ADR/RID: - IMDG: - IATA: -
14.4 Packaging group
ADR/RID: - IMDG: - IATA: -
14.5 Environmental hazards
ADR/RID: no IMDG Marine pollutant: no IATA: no
14.6 Special precautions for user
no data available

15. Regulatory information

This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.
15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture
no data available
15.2 Chemical Safety Assessment
For this product a chemical safety assessment was not carried out

16. Other information

Ion-Selective Standard Solutions

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product.

12.13. Chloride Calibration Kit

- Safety Data Sheet
- According to Regulation (EC) No. 1907/2006
- Version 1.0
- Revision Date: 27.02.2013

1. Identification Of The Substance/Mixture

- Product Name : Standard Solution Chloride Ions
- Product Number : CL-SCxxxP
- Relevant identified uses : Ion-Selective Standard Solutions
- #US/Canada/International:
- 24 Hour Emergency Information Telephone Numbers
- CHEMTREC (USA): 800.424.9300
- CANUTEC (Canada): 613.424.6666
- International 703-527-3887
- #Spain:
- Centro Nacional de Toxicología
- Teléfono: 91 5620420
- http://institutodetoxicologia.justicia.es/
- INTCF - Instituto Nacional de toxicología y Ciencias Forenses - 91 562 04 20

2. Hazards identification

2.1 Classification of the substance or mixture

Not a hazardous substance or mixture according to Regulation (EC) No. 1272/2008.

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.2 Label elements

Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.3 Other hazards

This substance/mixture contains no components considered to be either persistent, bioaccumulative and

toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

3. Composition/information on ingredients

Aqueous solution of Potassium Chloride (KCl)

CAS nº 7447-40-7

4. First aid measures

4.1 Description of first aid measures

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration.

In case of skin contact

Wash off with soap and plenty of water.

In case of eye contact

Flush eyes with water as a precaution.

If swallowed

Never give anything by mouth to an unconscious person. Rinse mouth with water.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

5. Firefighting measures

Extinguishing media

Suitable extinguishing media

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

No data available

5.3 Advice for firefighters

Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information

no data

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Avoid dust formation. Avoid breathing vapours, mist or gas.

For personal protection see section 8.

6.2 Environmental precautions

No special environmental precautions required.

6.3 Methods and materials for containment and cleaning up

Sweep up and shovel. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections

For disposal see section 13.

7. Handling and storage

7.1 Precautions for safe handling

Provide appropriate exhaust ventilation at places where dust is formed.

For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Store in cool place. Keep container tightly closed in a dry and well-ventilated place.

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. Exposure controls/personal protection

8.1 Control parameters

Components with workplace control parameters

8.2 Exposure controls

Appropriate engineering controls

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection

Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.

Wash and dry hands.

The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

Body Protection

The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection

Respiratory protection is not required

Control of environmental exposure

No special environmental precautions required
9. Physical and chemical properties
9.1 Information on basic physical and chemical properties
a) Appearance Form: liquid
Colour: Colourless
b) Odour no data available
c) Odour Threshold no data available
d) pH no data available
e) Melting point/freezing point
Melting point/range
f) Initial boiling point and boiling range
no data available
g) Flash point not applicable
h) Evapouration rate no data available
i) Flammability (solid, gas) no data available
j) Upper/lower flammability or explosive limits
no data available
k) Vapour pressure no data available
l) Vapour density no data available
m) Relative density 1,000 g/cm3
n) Water solubility no data available
o) Partition coefficient: noctanol/water
no data available
p) Auto-ignition temperature
no data available
q) Decomposition temperature
no data available
r) Viscosity no data available
s) Explosive properties no data available
t) Oxidizing properties no data available

10. Stability and reactivity

10.1 Reactivity
no data available
10.2 Chemical stability
Stable under recommended storage conditions.
10.3 Possibility of hazardous reactions
no data available
10.4 Conditions to avoid
no data available
10.5 Incompatible materials
Strong oxidizing agents
10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. Toxicological information

Information on toxicological effects
Acute toxicity
no data available
Skin corrosion/irritation
no data available
Serious eye damage/eye irritation
no data available
Respiratory or skin sensitisation
no data available
Germ cell mutagenicity
no data available
Carcinogenicity
IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
Reproductive toxicity
no data available
Specific target organ toxicity - single exposure
no data available
Specific target organ toxicity - repeated exposure
no data available
Aspiration hazard
no data available
Additional Information
RTECS: Not available

12. Ecological information

12.1 Toxicity
no data available
12.2 Persistence and degradability
no data available
12.3 Bioaccumulative potential
no data available
12.4 Mobility in soil
no data available
12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted
12.6 Other adverse effects
no data available

13. Disposal considerations

Waste treatment methods
Product
Offer surplus and non-recyclable solutions to a licensed disposal company.
Contaminated packaging
Dispose of as unused product.

14. Transport information

14.1 UN number
ADR/RID: - IMDG: - IATA: -
14.2 UN proper shipping name
ADR/RID: Not dangerous goods
IMDG: Not dangerous goods
IATA: Not dangerous goods
14.3 Transport hazard class(es)
ADR/RID: - IMDG: - IATA: -
14.4 Packaging group
ADR/RID: - IMDG: - IATA: -
14.5 Environmental hazards
ADR/RID: no IMDG Marine pollutant: no IATA: no
14.6 Special precautions for user
no data available

15. Regulatory information

This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.
15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture
no data available
15.2 Chemical Safety Assessment
For this product a chemical safety assessment was not carried out

16. Other information

Ion-Selective Standard Solutions

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product.

12.14. Cupric Calibration Kit

- Safety Data Sheet
- According to Regulation (EC) No. 1907/2006
- Version 1.0
- Revision Date: 27.02.2013

1. Identification Of The Substance/Mixture

- Product Name : Standard Solution Copper Ions
- Relevant identified uses : Ion-Selective Standard Solutions
- #US/Canada/International:
- 24 Hour Emergency Information Telephone Numbers
- CHEMTREC (USA): 800.424.9300
- CANUTEC (Canada): 613.424.6666
- International 703-527-3887
- #Spain:
- Centro Nacional de Toxicología
- Teléfono: 91 5620420
- http://institutodetoxicologia.justicia.es/
- INTCF - Instituto Nacional de toxicología y Ciencias Forenses - 91 562 04 20

2. Hazards identification

2.1 Classification of the substance or mixture
Acute aquatic toxicity (Category 1), H400
Chronic aquatic toxicity (Category 1), H410
2.2 Label elements
Signal word Warning
Hazard statement(s)
H410 Very toxic to aquatic life with long lasting effects.
Precautionary statement(s)
P273 Avoid release to the environment
P501 Dispose of contents/ container to an approved waste disposal plant.
2.3 Other hazards
none

3. Composition/information on ingredients

Aqueous solution of Copper Sulfate (CuSO4)
CAS Number: 7758-99-8

4. First aid measures

4.1 Description of first aid measures
If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration.
In case of skin contact
Wash off with soap and plenty of water.
In case of eye contact
Flush eyes with water as a precaution.
If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water.
4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labeling (see section 2.2) and/or in section 11
4.3 Indication of any immediate medical attention and special treatment needed
No data available

5. Firefighting measures

Extinguishing media
Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
5.2 Special hazards arising from the substance or mixture
No data available
5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.
5.4 Further information
no data

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures
Avoid dust formation. Avoid breathing vapours, mist or gas.
For personal protection see section 8.
6.2 Environmental precautions
No special environmental precautions required.
6.3 Methods and materials for containment and cleaning up
Sweep up and shovel. Keep in suitable, closed containers for disposal.
6.4 Reference to other sections
For disposal see section 13.

7. Handling and storage

7.1 Precautions for safe handling
Provide appropriate exhaust ventilation at places where dust is formed.
For precautions see section 2.2.
7.2 Conditions for safe storage, including any incompatibilities
Store in cool place. Keep container tightly closed in a dry and well-ventilated place.
7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. Exposure controls/personal protection

8.1 Control parameters
Components with workplace control parameters
8.2 Exposure controls
Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.
Personal protective equipment
Eye/face protection
Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).
Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique
(without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.
Wash and dry hands.
The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.
Body Protection
The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.
Respiratory protection
Respiratory protection is not required
Control of environmental exposure
No special environmental precautions required

9. Physical and chemical properties

9.1 Information on basic physical and chemical properties
a) Appearance Form: liquid
Colour: Blue
b) Odour no data available
c) Odour Threshold no data available
d) pH : 3,7 - 4,5
e) Melting point/freezing point
Melting point/range: 384 °C
f) Initial boiling point and boiling range
no data available
g) Flash point not applicable
h) Evapouration rate no data available
i) Flammability (solid, gas) no data available
j) Upper/lower flammability or explosive limits
no data available
k) Vapour pressure 9,7 hPa at 25 °C
l) Vapour density no data available
m) Relative density no data available
n) Water solubility no data available

o) Partition coefficient: noctanol/water
no data available
p) Auto-ignition temperature
no data available
q) Decomposition temperature
no data available
r) Viscosity no data available
s) Explosive properties no data available
t) Oxidizing properties no data available

10. Stability and reactivity

10.1 Reactivity
no data available
10.2 Chemical stability
Stable under recommended storage conditions.
10.3 Possibility of hazardous reactions
no data available
10.4 Conditions to avoid
no data available
10.5 Incompatible materials
Powdered metals, Anhydrous copper(II) sulfate, reacts violently with:, hydroxylamine, Magnesium
10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. Toxicological information

Information on toxicological effects
Acute toxicity
no data available
Skin corrosion/irritation
no data available
Serious eye damage/eye irritation
no data available
Respiratory or skin sensitisation
no data available
Germ cell mutagenicity
no data available
Carcinogenicity
IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
Reproductive toxicity
no data available
Specific target organ toxicity - single exposure
Inhalation - May cause respiratory irritation.
Specific target organ toxicity - repeated exposure
no data available
Aspiration hazard
no data available
Additional Information
RTECS: Not available
Symptoms of systemic copper poisoning may include: capillary damage, headache, cold sweat, weak pulse, and kidney and liver damage, central nervous system excitation followed by depression, jaundice, convulsions, paralysis, and coma. Death may occur from shock or renal failure. Chronic copper poisoning is typified by hepatic cirrhosis, brain damage and demyelination, kidney defects, and copper deposition in the cornea as exemplified by humans with Wilson's disease. It has also been reported that copper poisoning has lead to hemolytic anemia and accelerates arteriosclerosis.

12. Ecological information

12.1 Toxicity
Toxicity to fish LC50 - Pimephales promelas (fathead minnow) - > 13 mg/l - 96 h
12.2 Persistence and degradability
no data available
12.3 Bioaccumulative potential
no data available
12.4 Mobility in soil
no data available
12.5 Results of PBT and vPvB assessment

PBT/vPvB assessment not available as chemical safety assessment not required/not conducted
12.6 Other adverse effects
no data available

13. Disposal considerations

Waste treatment methods
Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.
Contaminated packaging
Dispose of as unused product.

14. Transport information

14.1 UN number
ADR/RID: 3082 IMDG: 3082 IATA: 3082
14.2 UN proper shipping name
ADR/RID: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (Copper sulphate)
IMDG: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (Copper sulphate)
IATA: Environmentally hazardous substance, liquid, n.o.s. (Copper sulphate)
14.3 Transport hazard class(es)
ADR/RID: 9 IMDG: 9 IATA: *
14.4 Packaging group
ADR/RID: III IMDG: III IATA: III
14.5 Environmental hazards
ADR/RID: yes IMDG Marine pollutant: yes IATA: yes
14.6 Special precautions for user
no data available

15. Regulatory information

This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.
15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture
no data available
15.2 Chemical Safety Assessment
For this product a chemical safety assessment was not carried out

16. Other information

Ion-Selective Standard Solutions

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product.

12.15. Iodide Calibration Kit

- Safety Data Sheet
- According to Regulation (EC) No. 1907/2006
- Version 1.0
- Revision Date: 27.02.2013

1. Identification Of The Substance/Mixture

- Product Name : Standard Solution Iodide Ions
- Product Number : I-SCxxxP
- Relevant identified uses : Ion-Selective Standard Solutions
- #US/Canada/International:
- 24 Hour Emergency Information Telephone Numbers
- CHEMTREC (USA): 800.424.9300
- CANUTEC (Canada): 613.424.6666
- International 703-527-3887
- #Spain:
- Centro Nacional de Toxicología
- Teléfono: 91 5620420
- http://institutodetoxicologia.justicia.es/
- INTCF - Instituto Nacional de toxicología y Ciencias Forenses - 91 562 04 20

2. Hazards identification

2.1 Classification of the substance or mixture
Not a hazardous substance or mixture according to Regulation (EC) No. 1272/2008.
Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.
2.2 Label elements
Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.
2.3 Other hazards
This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

3. Composition/information on ingredients

Aqueous solution of Potassium Iodide (KI)
CAS nº 7681-11-0
No components need to be disclosed according to the applicable regulations.

4. First aid measures

4.1 Description of first aid measures
If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration.
In case of skin contact
Wash off with soap and plenty of water.
In case of eye contact
Flush eyes with water as a precaution.
If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water.
4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11
4.3 Indication of any immediate medical attention and special treatment needed
No data available

5. Firefighting measures

Extinguishing media
Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
5.2 Special hazards arising from the substance or mixture
No data available
5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information
no data

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures
Avoid dust formation. Avoid breathing vapours, mist or gas.
For personal protection see section 8.
6.2 Environmental precautions
No special environmental precautions required.
6.3 Methods and materials for containment and cleaning up
Sweep up and shovel. Keep in suitable, closed containers for disposal.
6.4 Reference to other sections
For disposal see section 13.

7. Handling and storage

7.1 Precautions for safe handling
Provide appropriate exhaust ventilation at places where dust is formed.
For precautions see section 2.2.
7.2 Conditions for safe storage, including any incompatibilities
Store in cool place. Keep container tightly closed in a dry and well-ventilated place.
7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. Exposure controls/personal protection

8.1 Control parameters
Components with workplace control parameters
8.2 Exposure controls
Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.
Personal protective equipment
Eye/face protection
Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).
Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.
Wash and dry hands.
The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.
Body Protection
The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.
Respiratory protection
Respiratory protection is not required
Control of environmental exposure
No special environmental precautions required

9. Physical and chemical properties

9.1 Information on basic physical and chemical properties
a) Appearance Form: liquid
Colour: Colourlessb) Odour no data available
c) Odour Threshold no data available
d) pH no data available
e) Melting point/freezing point
Melting point/range
f) Initial boiling point and boiling range
no data available
g) Flash point not applicable
h) Evapouration rate no data available
i) Flammability (solid, gas) no data available
j) Upper/lower flammability or explosive limits
no data available
k) Vapour pressure no data available
l) Vapour density no data available
m) Relative density 1,000 g/cm3

n) Water solubility no data available
o) Partition coefficient: noctanol/water
no data available
p) Auto-ignition temperature
no data available
q) Decomposition temperature
no data available
r) Viscosity no data available
s) Explosive properties no data available
t) Oxidizing properties no data available

10. Stability and reactivity

10.1 Reactivity
no data available
10.2 Chemical stability
Stable under recommended storage conditions.
10.3 Possibility of hazardous reactions
no data available
10.4 Conditions to avoid
no data available
10.5 Incompatible materials
Strong reducing agents, Nickel, Strong acids, and its alloys, Steel (all types and surface treatments), Aluminum, Alkali metals, Brass, Magnesium, Zinc, cadmium, Copper
10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. Toxicological information

Information on toxicological effects
Acute toxicity
no data available
Skin corrosion/irritation
no data available
Serious eye damage/eye irritation
no data available
Respiratory or skin sensitisation
no data available
Germ cell mutagenicity
no data available
Carcinogenicity
IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
Reproductive toxicity
no data available
Specific target organ toxicity - single exposure
no data available
Specific target organ toxicity - repeated exposure
no data available
Aspiration hazard
no data available
Potential health effects
Inhalation May be harmful if inhaled. May cause respiratory tract irritation.
Ingestion May be harmful if swallowed.
Skin May be harmful if absorbed through skin. May cause skin irritation.
Eyes May cause eye irritation.
Additional Information
RTECS: Not available

12. Ecological information

12.1 Toxicity
no data available
12.2 Persistence and degradability
no data available
12.3 Bioaccumulative potential

no data available
12.4 Mobility in soil
no data available
12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted
12.6 Other adverse effects
no data available

13. Disposal considerations

Waste treatment methods
Product
Offer surplus and non-recyclable solutions to a licensed disposal company.
Contaminated packaging
Dispose of as unused product.

14. Transport information

14.1 UN number
ADR/RID: - IMDG: - IATA: -
14.2 UN proper shipping name
ADR/RID: Not dangerous goods
IMDG: Not dangerous goods
IATA: Not dangerous goods
14.3 Transport hazard class(es)
ADR/RID: - IMDG: - IATA: -
14.4 Packaging group
ADR/RID: - IMDG: - IATA: -
14.5 Environmental hazards
ADR/RID: no IMDG Marine pollutant: no IATA: no
14.6 Special precautions for user
no data available

15. Regulatory information

This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.
15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture
no data available
15.2 Chemical Safety Assessment
For this product a chemical safety assessment was not carried out

16. Other information

Ion-Selective Standard Solutions

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product.

12.16. Silver Calibration Kit

- Safety Data Sheet
- According to Regulation (EC) No. 1907/2006
- Version 1.0
- Revision Date: 27.02.2013

1. Identification Of The Substance/Mixture

- Product Name : Standard Solution Silver Nitrate
- Relevant identified uses : Ion-Selective Standard Solutions
- #US/Canada/International:
- 24 Hour Emergency Information Telephone Numbers
- CHEMTREC (USA): 800.424.9300
- CANUTEC (Canada): 613.424.6666
- International 703-527-3887
- #Spain:
- Centro Nacional de Toxicología
- Teléfono: 91 5620420
- http://institutodetoxicologia.justicia.es/
- INTCF - Instituto Nacional de toxicología y Ciencias Forenses - 91 562 04 20

2. Hazards identification

2.1 Classification of the substance or mixture
Classification according to Regulation (EC) No 1272/2008
Skin corrosion (Category 2), H315
Eye irritation (Category 2ª), -H319
Chronic aquatic toxicity (Category 1), H410
For the full text of the H-Statements mentioned in this Section, see Section 16.
Classification according to EU Directives 67/548/EEC or 1999/45/EC
C Corrosive R34
N Dangerous for the environment
R50/53
O Oxidising R 8, R22
For the full text of the R-phrases mentioned in this Section, see Section 16.
2.2Label elements
Labeling according Regulation (EC) No 1272/2008

Pictogram
Signal word Danger
Hazard statement(s).
H314/319 Causes severe skin burns and eye damage.
H410 Very toxic to aquatic life with long lasting effects.
Precautionary statement(s)
P273 Avoid release to the environment.
P302+352 Wear protective gloves/ protective clothing/ eye protection/ face protection.
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
Supplemental Hazard
Statements

3. Composition/information on ingredients

Aqueous solution of $AgNO_3$
Formula : $AgNO_3$
CAS-No. : 7761-88-8

4. First aid measures

4.1 Description of first aid measures
General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.
If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.
In case of skin contact
Wash off with soap and plenty of water. Consult a physician.
In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.
If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.
4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labeling (see section 2.2) and/or in section 11
4.3 Indication of any immediate medical attention and special treatment needed
no data available

5. Firefighting measures

Extinguishing media
Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
5.2 Special hazards arising from the substance or mixture
Nitrogen oxides (NOx), Silver/silver oxides
Container explosion may occur under fire conditions.
5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.
5.4 Further information
Use water spray to cool unopened containers.

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures
Use personal protective equipment. Avoid dust formation. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas. Avoid breathing dust.
For personal protection see section 8.
6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.
6.3 Methods and materials for containment and cleaning up
Sweep up and shovel. Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13). Keep in suitable, closed containers for disposal.
6.4 Reference to other sections
For disposal see section 13.

7. Handling and storage

7.1 Precautions for safe handling
Avoid contact with skin and eyes. Avoid formation of dust and aerosols.
Provide appropriate exhaust ventilation at places where dust is formed.Keep away from sources of ignition
- No smoking. Keep away from heat and sources of ignition.
For precautions see section 2.2
7.2 Conditions for safe storage, including any incompatibilities
Store in cool place. Keep container tightly closed in a dry and well-ventilated place.
7.3 Specific end use(s)
Apart from the uses mentioned in section 1 no other specific uses are stipulated

8. Exposure controls/personal protection

8.1 Control parameters
Components with workplace control parameters
8.2 Exposure controls
Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.
Personal protective equipment

Eye/face protection

Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices.

Wash and dry hands.

The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

Body Protection

impervious clothing, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection

For nuisance exposures use type P95 (US) or type P1 (EU EN 143) particle respirator.For higher level protection use type OV/AG/P99 (US) or type ABEK-P2 (EU EN 143) respirator cartridges.

Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure

Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

9. Physical and chemical properties

9.1 Information on basic physical and chemical properties
a) Appearance Form: liquid
Colour:
b) Odour no data available
c) Odour Threshold no data available
d) pH no data available
e) Melting point/freezing
point
Melting point/range: 212 °C - dec.
f) Initial boiling point and
boiling range
440 °C - Decomposes on heating.
g) Flash point not applicable
h) Evapouration rate no data available
i) Flammability (solid, gas) no data available
j) Upper/lower
flammability or
explosive limits
no data available
k) Vapour pressure no data available
l) Vapour density no data available
m) Relative density 4.350 g/cm3 at 25 °C
n) Water solubility no data available
o) Partition coefficient: noctanol/water
log Pow: 5
p) Auto-ignition
temperature
no data available
q) Decomposition temperature
no data available
r) Viscosity no data available
s) Explosive properties no data available
t) Oxidizing properties The substance or mixture is classified as oxidizing with the category 2

10. Stability and reactivity

10.1 Reactivity
no data available
10.2 Chemical stability
Decomposes on exposure to light.
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
no data available
10.4 Conditions to avoid
Light
10.5 Incompatible materials
Strong reducing agents, Alcohols, Ammonia, Magnesium, Strong bases
10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. Toxicological information

Information on toxicological effects
Acute toxicity
LD50 Oral - Rat - 1.173 mg/kg
Remarks: Behavioral:Tetany. Cyanosis Diarrhoea
Skin corrosion/irritation
No data available
Serious eye damage/eye irritation
Eyes - Rabbit
Result: Severe eye irritation
Respiratory or skin sensitisation
No data available
Germ cell mutagenicity
No data available
Carcinogenicity
IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
Reproductive toxicity
No data available
Specific target organ toxicity - single exposure
No data available
Specific target organ toxicity - repeated exposure
No data available
Aspiration hazard
No data available
Additional Information
RTECS: VW4725000

12. Ecological information

12.1 Toxicity
Toxicity to fish mortality NOEC - Oncorhynchus mykiss (rainbow trout) - 0,108 mg/l - 96,0 h
mortality LOEC - Oncorhynchus mykiss (rainbow trout) - > 0,007 mg/l - 7,0 d
LC50 - Leuciscus idus (Golden orfe) - 0,029 mg/l - 96,0 h
LC50 - Oncorhynchus mykiss (rainbow trout) - 0,006 mg/l - 96,0 h
Toxicity to daphnia and other aquatic invertebrates
12.2 Persistence and degradability
no data available
12.3 Bioaccumulative potential
Bioaccumulation Lepomis macrochirus - 60 d
- 70 µg/l
Bioconcentration factor (BCF): 120
12.4 Mobility in soil
no data available
12.5 Results of PBT and vPvB assessment
This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.
12.6 Other adverse effects
Harmful to aquatic life.

13. Disposal considerations

Waste treatment methods

Product

Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company.

Contaminated packaging

Dispose of as unused product.

14. Transport information

14.1 UN number

ADR/RID: 1493 IMDG: 1493 IATA: 1493

14.2 UN proper shipping name

ADR/RID: SILVER NITRATE

IMDG: SILVER NITRATE

IATA: Silver nitrate

14.3 Transport hazard class(es)

ADR/RID: 5.1 IMDG: 5.1 IATA: 5.1

14.4 Packaging group

ADR/RID: II IMDG: II IATA: II

14.5 Environmental hazards

ADR/RID: yes IMDG Marine pollutant: yes IATA: no

14.6 Special precautions for user

no data available

15. Regulatory information

This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.
15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture
no data available
15.2 Chemical Safety Assessment
For this product a chemical safety assessment was not carried out

16. Other information

Full text of H-Statements referred to under sections 2 and 3.
Acute Tox. Acute toxicity
Aquatic Acute Acute aquatic toxicity
Aquatic Chronic Chronic aquatic toxicity
H272 May intensify fire; oxidiser.
H302 Harmful if swallowed.
H314 Causes severe skin burns and eye damage.
H400 Very toxic to aquatic life.
H410 Very toxic to aquatic life with long lasting effects.
Ox. Sol. Oxidizing solids
Skin Corr. Skin corrosion
Full text of R-phrases referred to under sections 2 and 3
C Corrosive
N Dangerous for the environment
O Oxidising
R 8 Contact with combustible material may cause fire.
R22 Harmful if swallowed.
R34 Causes burns.
R50/53 Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
Designed use Ion-Selective Standard Solutions
The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product.

12.17. Reference Sensor Probe [PRO] Maintenance Solution

Section 1: Product and company identification

Product name: Lithium Acetate Solution

Product use: Solution to storage and/or conditioning Reference Electrodes (PRO version)

NFPA ratings: Health: 0 Flammability: 0 Reactivity: 0

#US/Canada/International:

24 Hour Emergency Information Telephone Numbers

CHEMTREC (USA): 800.424.9300

CANUTEC (Canada): 613.424.6666

International 703-527-3887

#Spain:

Centro Nacional de Toxicología

Teléfono: 91 5620420

http://www.mju.es/toxicologia

Section 2: Composition/ information on ingredients

Aqueous solution of Lithium Acetate 3M (3 mol)

CAS-No. 546-89-4

EC-No. 208-914-3

No components need to be disclosed according to the applicable regulations.

Section 3: Hazards identification

Classification of the substance or mixture:

- Not a hazardous substance or mixture according to Regulation (EC) No. 1272/2008.
- Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

Label elements:

- Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

Other hazards:

- This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

Section 4: First aid measures

Description of first aid measures:

- If inhaled: If breathed in, move person into fresh air. If not breathing, give artificial respiration.
- In case of skin contact: Wash off with soap and plenty of water.
- In case of eye contact: Flush eyes with water as a precaution.
- If swallowed: Never give anything by mouth to an unconscious person. Rinse mouth with water.

Most important symptoms and effects, both acute and delayed:

- The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11.

Indication of any immediate medical attention and special treatment needed:

- No data available.

Section 5: Fire fighting measures

Suitable extinguishing media: Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

- Special hazards arising from the substance or mixture: No data available.
- Advice for firefighters: Wear self contained breathing apparatus for fire fighting if necessary.
- Further information: no data.

Section 6: Accidental release measures

Personal precautions, protective equipment and emergency procedures: Avoid dust formation. Avoid breathing vapours, mist or gas. For personal protection see section 8.

Environmental precautions: No special environmental precautions required.

Methods and materials for containment and cleaning up: Sweep up and shovel. Keep in suitable, closed containers for disposal.

Reference to other sections: For disposal see section 13.

Section 7: Handling and storage

Precautions for safe handling: Provide appropriate exhaust ventilation at places where dust is formed.Normal measures for preventive fire protection.

Conditions for safe storage, including any incompatibilities: Store in cool place. Keep container tightly closed in a dry and well-ventilated place. Storage class (TRGS 510): Non Combustible Solids.

Specific end use(s): Apart from the uses mentioned in section 1.2 no other specific uses are stipulated.

Section 8: Exposure controls/ personal protection

Control parameters:

- Components with workplace control parameters

Exposure controls:

- Appropriate engineering controls: Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.
- Personal protective equipment:
  - Eye/face protection: Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).
  - Skin protection: Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands. The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.
  - Body Protection: The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.
  - Respiratory protection: Where risk assessment shows air-purifying respirators are appropriate use a full-

face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

- Control of environmental exposure: No special environmental precautions required.

Section 9: Physical and chemical properties

Appearance Form: liquid

Odour: no data available

Odour Threshold: no data available

pH: no data available

Melting point/freezing point

Initial boiling point and boiling range: no data available

Flash point: not applicable

Evapouration rate no: data available

Flammability (solid, gas): no data available

Upper/lower flammability or explosive limits: no data available

Vapour pressure: no data available

Vapour density: no data available

Relative density: no data available

Water solubility: no data available

Partition coefficient: noctanol/water: no data available

Auto-ignition temperature: no data available

Decomposition temperature: no data available

Viscosity: no data available

Explosive properties: no data available

Oxidizing properties: no data available

Section 10: Stability and reactivity

Reactivity: no data available

Chemical stability: Stable under recommended storage conditions.

Possibility of hazardous reactions: no data available

Conditions to avoid: no data available

Incompatible materials: Strong oxidizing agents

Hazardous decomposition products: Other decomposition products - no data available. In the event of fire: see section 5

Section 11: Toxicological information

Information on toxicological effects:

- Acute toxicity: no data available
- Skin corrosion/irritation: no data available
- Serious eye damage/eye irritation: no data available
- Respiratory or skin sensitisation: no data available
- Germ cell mutagenicity: Mouse Cytogenetic analysis. Mouse Sister chromatid exchange
- Carcinogenicity: IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
- Reproductive toxicity: Possible risk of congenital malformation in the fetus
- Specific target organ toxicity - single exposure: No data available
- Specific target organ toxicity - repeated exposure: no data available
- Aspiration hazard: no data available

Potential health effects:

- Inhalation: May be harmful if inhaled. May cause respiratory tract irritation.
- Ingestion: May be harmful if swallowed.
- Skin: May be harmful if absorbed through skin. May cause skin irritation.
- Eyes: May cause eye irritation.
- Signs and Symptoms of Exposure: To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Additional Information:

- RTECS: AI5450000 - Large doses of lithium ion have caused dizziness and prostration, and can Dehydration, weight loss, dermatological effects, and thyroid disturbance include slurred speech, blurred vision, sensory loss, ataxia, and convuls effects such as tremor, clonus, and hyperactive reflexes may occur as a r, To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Section 12: Ecological information

Toxicity: No data available

Persistence and degradability: no data available

Bioaccumulative potential: no data available

Mobility in soil: no data available

Results of PBT and vPvB assessment: This substance/mixture contains no components considered to be either persistent, bioaccumulative toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

Other adverse effects: Harmful to aquatic life

Section 13: Disposal considerations

Waste treatment methods:

- Product: Offer surplus and non-recyclable solutions to a licensed disposal company.
- Contaminated packaging: Dispose of as unused product.

Section 14: Transport information

UN number:

- ADR/RID: - IMDG: - IATA: -

UN proper shipping name:

- ADR/RID: Not dangerous goods
- IMDG: Not dangerous goods
- IATA: Not dangerous goods

Transport hazard class(es):

- ADR/RID: - IMDG: - IATA: -

Packaging group:

- ADR/RID: - IMDG: - IATA: -

Environmental hazards:

- ADR/RID: no IMDG Marine pollutant: no IATA: no

Special precautions for user: no data available

Section 15: Regulatory information

This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.

Safety, health and environmental regulations/legislation specific for the substance or mixture: no data available

Chemical Safety Assessment: no data available

Section 16: Other information

Ion-Selective ElectrodeSolutions

Text of H-code(s) and R-phrase(s) mentioned in Section 3

Acute Tox. Acute toxicity

Eye Irrit. Eye irritation

H302 Harmful if swallowed.

H315 Causes skin irritation.

H319 Causes serious eye irritation.

H335 May cause respiratory irritation.

Skin Irrit. Skin irritation

STOT SE Specific target organ toxicity - single exposure

Xn Harmful

R22 Harmful if swallowed.

R36/37/38 Irritating to eyes, respiratory system and skin.

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product.

13. Documentation changelog

From v7.3 to v7.4

- Added more details about the maintenance solutions
- Added references to the new Smart Water Xtreme line
- Added references to the new LoRaWAN ASIA-PAC / LATAM module

From v7.2 to v7.3

- Added recommendations about sensors lifetime, preservation, accommodation and calibration
- Added references to new Sigfox AU / APAC / LATAM module
- Added references to new LoRaWAN AU and IN modules

From v7.1 to v7.2

- Added recommendations for sensors maintenance
- The length of the Pt-1000 sensor cable was updated

From v7.0 to v7.1

- The lengths of the cables of the sensors were updated
- Added references for the new Industrial Protocols and GPS accessories for Plug & Sense!

14. 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
- **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

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

www.libelium.com/products/meshlium

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

You can find all the certification documents at:

www.libelium.com/certifications

15. 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.

16. Disposal and recycling

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.