1112 - Wireless Conductivity Pack

Revision: 0 | DS177

Table of contents

Introduction

Thank you for purchasing the Smart Wireless Conductivity Pack. We pride ourselves on producing high quality products that meet with the demands of the busy classroom environment. If you have any problems using this sensor, please read this documentation in full before contacting the Data Harvest support team.

The Conductivity sensor enables a Conductivity electrode to be connected to the EasySense software.

The Conductivity sensor is used to measure the conductivity of a solution. The Conductivity electrode is a simple epoxy-bodied carbon (graphite plate) type selected for its durability in field use. It is ideal for measuring salinity and changes in conductivity of a water sample. It can be used by chemists for investigating the difference between ionic and molecular compounds in an aqueous solution. Although it will not identify the specific ions that are present, it can be used to determine the total concentration of ions in a sample.

If used for salinity measurements the plates will become contaminated with Na^+ and Cl^- ions. For salinity measurements we recommend the dedicated salinity sensor with platinum plates is used.

The SI unit of conductance is Siemens per cm (S cm- ^{1}). This was formerly known as a mhos (equal to S cm^{-1}) or CF units (mS cm^{-1} x 10). The Siemen is a large unit, so the value for aqueous samples is commonly expressed in microsiemens (µS).

Overview

The Smart Wireless Conductivity Pack is USB and Bluetooth compatible. Using Bluetooth, a sensor can connect to mobile devices, tablets, laptops and desktops.

The sensor has several ranges which do not always overlap (the K is subject to a 20% variance).

The range required is set in the Devices icon of the EasySense software

Electrical conductivity is an inherent property of most materials. Electrons carry electric current in metal; in water electrical current is carried by charged ions. The conductivity of a solution is determined by the ability of a solution to conduct an electric current between two electrodes. This will depend on the number of charge carriers, how fast they move, and how much charge each one carries.

For most water solutions, the higher the concentration of dissolved salts, and therefore more ions, the higher the conductivity.

Low conductivity will indicate an absence of ions and therefore purity of water.

Conductivity is measured by putting a voltage across two electrodes, which have a fixed area and are a fixed distance apart. The electric current that flows between the two electrodes varies as the conductivity of the solution changes.

Each Conductivity electrode has its own physical characteristics. This is defined as the cell constant (K) and is dependent on the distance (d) between the two electrodes, and the area of the electrode surface (A).

$K = d/A$

The Conductivity electrode supplied has a nominal cell constant (K) of 1.0 cm^{-1}.

Alternating Current is used to prevent complete ion migration to the two electrodes. With each A.C. cycle the polarity of the electrodes are reversed which in turn reverses the direction of ion flow. This will prevent electrolysis and polarisation from occurring.

Although the presence of ions due to dissolved salts will increase the conductivity of water, it is not specific and can only be used to determine solution concentration if a single known salt is present.

Some species ionise more completely in water than others do, and their solutions are more conductive as a result. Each acid, base or salt has its own characteristic curve for concentration vs. conductivity. The relationship persists until very large ion concentrations are reached.

Temperature compensation

Temperature has a large effect on conductivity. The Conductivity electrode incorporates an in-built temperature sensor that is used to compensate for changes in the conductivity of solutions with temperature.
The temperature compensation is to counteract real changes in the conductivity of solution with temperature, not variations in the electrode with temperature.

For example: a 0.01 mol dm^{-3} KCl solution has a conductivity of 1413 µS at 25ºC. Its conductivity changes from 1020 µS at 10ºC to 1552 µS at 30ºC. The Conductivity Sensor will read a value of approximately 1413 µS at any temperature in the 10 to 35ºC range.

This allows the conductivity of sample solutions to be compared without bringing them all to the same temperature.

Pack Contents

This product is supplied with the following items:

- 1 x Smart Wireless Conductivity Adaptor
- 1 x Conductivity Electrode
- 1 x USB Connecting Lead

Operational Overview

The diagram below shows the specific parts of the sensor. Read further to explore the functionality of each part of the sensor.

The conductivity electrode

The conductivity electrode has two carbon plates of known size facing each other across a cell of a known width. The relationship between the electrode size and the separation is used to create the K value. For the supplied electrode, the K value = 1. If you used a different electrode with a different K value, the output values would not be correct.

1 = The temperature sensor used for temperature compensation.
2 = The cell
3 = The carbon electrodes

Measurement procedure

- If possible, soak the tip of the Conductivity electrode in deionised water for about 30 minutes to make sure the electrodes are clean. If not, rinse the tip thoroughly with deionised water before use.
- Wipe the outer part of the electrode body with a clean paper towel. Shake vigorously to remove any droplets from the cell chamber. If possible, wash the tip in a sample of the solution to be tested.
- Place the Conductivity electrode in the sample to be tested. The sample must be at least 3 cm deep to ensure the cell chamber is fully submerged.
- Stir the solution gently to get rid of any air bubbles that could be trapped in the cell chamber. Wait for 10 seconds to allow the readings to stabilize.

  Note: If you are taking readings in a solution that has a temperature below 10ºC or above 35ºC, allow more time for the readings to stabilize.

- If the value is above, below, or near to the maximum or minimum value in the current range, alter the selected range of the Sensor.
- Clean thoroughly when testing is complete to avoid any contamination when the electrode is next used.

User calibration

The sensor is calibrated to the design specification, which assumes a known separation of the carbon plates, a known area for the plates, and a known current across the cell. It is understood that manufacture and tolerances can change one or more of the expected parameters.

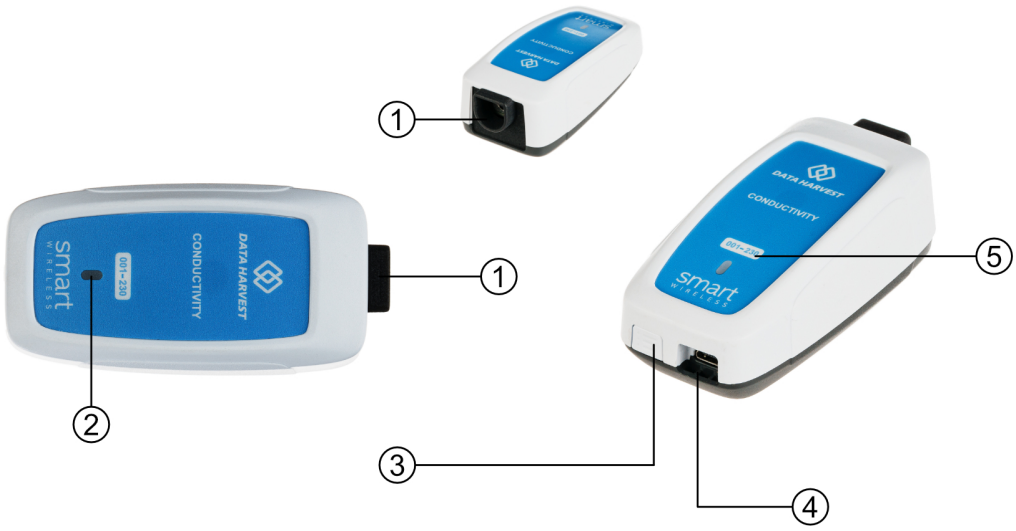
If the sensor gives a result that is far out (the conductivity readings are most accurate over the middle section of each range), it can be calibrated.

You will need two solutions of known conductivity (purchased or made to one of the many recipes available on the internet).

In devices, click on the calibrate button and place the electrode into the lower known solution, follow the on-screen directions. The calibration only applies to the range selected. It is best to use a known that is midway to the range being calibrated, for example use knowns of 50 -80 us on the 0 – 100us range.

Once you have selected OK the calibration will be stored as a user range. The calibration only holds for the electrode / sensor combination. If the sensors are separated from the electrodes, they will need re-calibrating.

As the electrode ages it will need calibrating more frequently due to contamination build up. To reduce the contamination build up clean the electrode in deionised water after each use.



1. Sensor End Cap
2. Status Indicator
3. On/Off Switch
4. USB Port
5. Unique ID Number

Sensor End Cap (1)

Most Smart Wireless Sensors feature an end cap that is specific to the requirements of the device's internal sensor. The sensor's end cap is the direct interface between the device’s internal sensor and your experiment.

The Status Indicators (2)

The sensor features a single status indicator that changes colour and flashes. See the table below for further information.

Status Light		Indicates
No light		Sensor is Off. Short press the On/Off switch
Blue flashing		Sensor is On and Bluetooth advertising
White flashing		Charging via USB mains charger or USB port, Sensor is On and Bluetooth advertising
Red, Green, Blue Flashing		Charging via USB mains charger or USB port, Sensor is Off
Green flashing		Communication with the EasySense app (via USB or Bluetooth) has been established

Solid Green		Fully charged
Orange flashing		Recording data, a fast pulse indicates awaiting trigger in Remote Mode
Red flashing		Battery is low

On/Off Switch (3)

The sensor's on/off switch allows you to turn the sensor on, off or perform a hard reset.

To switch the sensor off

- Press and hold down the On/Off switch until the white light shows, then release.
- If not communicating with the EasySense app, the sensor will turn off after a period of one hour of inactivity.

Hard resetting the sensor

- If necessary, attach the sensor to power.
- Press and hold down the On/Off button for at least 8 seconds until the status LED gives a flash of blue light, then release.
- If the sensor fails to respond, contact Product Support at Data Harvest. Please provide details of:
    - The computer platform it is being used with and the EasySense app's version number.
    - A description of the problem being encountered.

USB Port (4)

Use to connect to a computer or a charging unit.

For specific USB or Bluetooth connectivity instructions, please see the 'Connectivity' section of this documentation.

For instructions on charging your device, see the section on 'Charging the Sensor'.

Unique ID Number (5)

All Smart Wireless Sensors are labelled with a unique ID number. This number is used in the EasySense app, so that you can identify each sensor when making a connection wirelessly.

The Sensor and EasySense

Please make sure that you use the latest release of the EasySense series of software. Both collection and analysis of data is available here, on a variety of operating systems.

Direct Data Logging
The sensor is designed to work directly with EasySense (as an installed application or PWA). A full compliment of experiments can be run by using the sensor through Bluetooth™ or USB. EasySense will support direct logging and data storage when connected as above.

Remote Data Logging
The ability to capture data independently (free of a capture station) is done through EasySense's Remote Mode.

This facility may be found in EasySense, under Setup. Once the conditions for data collection have been established, the sensor can be set to initiate collection for example, a rapid press of the power button. Initiation of the experimental data collection by the software is followed by remote detachment; collection is

then on the sensor.

Data gathering is realised by using Setup once again.

Details are given in the latest EasySense User Guide.

Connectivity

The sensor is both USB and Bluetooth compatible. Install the EasySense app, if it is not already on your device. For details of how to operate the EasySense app, please refer to the EasySense documentation.

USB Connectivity

Quick Steps

1. Connect the sensor to the computer's USB port using the USB cable supplied.
2. The computer will automatically detect a new device and depending on your operating system, will install any applicable device drivers.
3. Start EasySense app.
4. Within the EasySense app, the Devices icon will change to green to show that the sensor is connected, and the status light on the sensor will also turn green.
5. Begin your practical investigations.

Bluetooth Connectivity

Using Bluetooth, the sensor can wirelessly connect to mobile devices such tablets and mobile phones, as well as desktop or laptop computers, giving students the ability to run experiments independently without being tethered to a device.

See the EasySense app user manual system requirements for further details.

Quick Notes on Bluetooth Connectivity

Only use with the EasySense app, you do not need to pair the device. If paired, the sensor will not be available to the EasySense app.

Computers or devices will need to support Bluetooth Low Energy (BLE). For further information refer to the instructions provided for the EasySense app.

Quick Steps

1. Short press the on/off switch to turn the sensor on, blue LED will flash.
2. Open the EasySense app.
3. Select the Devices icon.
4. Select your sensor from the list of available sensors to connect to the device. Your sensor is identified by its unique ID in the list.
5. Click on connect at the side of your sensor in the list.
6. The Devices icon will change to green and the status light on the sensor will flash green to indicate a connection has been established.
7. Begin your practical investigations.

Charging the Sensor

The Smart Wireless sensors are fitted with a rechargeable lithium-ion battery and can be charged via the USB port. Use the supplied USB lead to connect the sensor either directly to a USB port on your computer, a powered USB hub or a USB mains charger that outputs 5 V at 500 mA or more.

A full charge can take up to four hours.

Additional Information

Whenever the sensor is connected to the USB port on the computer or to a USB mains charger (output 5 V at 500 mA or more), it will automatically recharge the battery (LED status flashing white).

When connected to a computer, the computer should be turned on and not in sleep or standby mode, as the battery may drain instead of charge.

The sensor will stay awake for five minutes when Bluetooth advertising (LED status flashing blue).

Lithium-ion batteries are ‘memory-free’ and prefer a partial rather than a full discharge. Constant partial discharges with frequent recharges will not cause any harm. Frequent full discharges should be avoided whenever possible. Ideally the sensor should be stored at about 40% or more charge.

The speed at which a lithium-ion battery will age is governed by both its storage temperature (preferably less than 40℃) and state-of-charge.

Firmware Updates

Occasionally Data Harvest may release updated firmware which will contain improvements or new features.

Updates will take place when you connect your sensor to the EasySense app. You will be given the option to decline an update.

Updates can be performed over USB or Bluetooth and will typically take less than one minute. Updating firmware over USB will be quicker than Bluetooth.

Do not disconnect the sensor, or power off during the update.

If you have a wireless connection to the EasySense app, the sensor will have to be reconnected after performing the update.

Usage Information

Some typical conductivity ranges of hydrous solutions are:

Sample	Conductivity/µS cm^{-1}
Ultra pure water	0.055
Distilled water	0.5 to 5
Rain water	20 to100
Drinking water	50 to 200
Tap water	100 to 1500
River water	250 to 800

Sample	Conductivity/µS cm^{-1}
Brackish water	1000 to 8000
KCl 0.01 M	1,410
$MgSO_4$	5,810
KCl 0.1M	12,900
Ocean water	53,000
H_2SO_4	82,600

- The Conductivity electrode needs to be kept clean and free of deposits and other types of build-up. This epoxy cell type of electrode has ‘easy to clean’ graphite plates which are corrosion safe and less easily contaminated.
- If used in solutions with a high ion concentration, it is possible for the graphite plates to become contaminated. Soak the electrode cell portion in water with a mild detergent for 15 minutes. Then soak in a dilute acid solution such as 0.1 mol dm^{-3} hydrochloric acid or 0.5 mol dm^{-3} acetic acid for another 15 minutes. Rinse well with distilled water.
- The most common reason for inaccurate measurements is cross contamination of samples. Take care not to transfer droplets of one sample to another. Wash the electrode with distilled water between test solutions and shake vigorously to remove droplets. Ideally air-dry and then wash the cell in a sample of the solution to be measured.
- Be sure that samples are capped to prevent evaporation. It is best to fill sample bottles to the brim to prevent a gas such as carbon dioxide dissolving in the water sample.
- Do not use in a situation that could result in damage to the graphite plates in the cell chamber. Do not attempt to blot or wipe the inside of the cell.
- The automatic temperature compensation for this electrode operates over the range 10ºC to 35ºC, but it can be placed in solutions within a temperature range of 0 to 80ºC.
- There may be a decrease in accuracy when used in solutions that have a conductance of above 20 mS (20,000 mS). Measurements above 50 mS will be approximate. If samples need to be diluted, use fresh deionised water (to reduce inaccuracy caused by variation in the conductivity of the deionised water).
- The Conductivity electrode not only measures conductivity between the graphite plates but also, to a lesser extent, in a field to the side of the electrode. In a narrow vessel, the walls may interfere with this field. If the electrode is held too close to the top of the liquid level or other objects (e.g. the bottom of a beaker) an incorrect reading may result.
- Interference may occur between electrochemical sensors (pH, Oxygen, and Conductivity) if they are placed in the same solution at the same time and connected to the software by a USB lead. This is because these sensors make an electrical connection to the solution; therefore an electrical path exists between the sensors through the solution. Maximise the distance between the sensors to minimise the effect; the distance required will depend on the conductivity of the solution.

If the Sensors are being used in a solution that has a fairly high conductance e.g. seawater, test in separate containers of the same solution.

Total dissolved solids (TDS)

Solids are found in mobile water (streams, rivers) and are present as suspended and dissolved.

Suspended solids are measured using a Turbidity sensor.

Dissolved solids which relate back to suspended solids can be measured by the changes in the conductivity they create. For a solid to dissolve in water it needs to be ionic; the ions in the water change the

conductivity; more ions, more conductivity.

The agreed standards for conductivity and TDS use a simple conversion factor

- Total solids (TDS) can be estimated in ppm (parts per million) i.e. mg L^{-1} by multiplying the reading in microSiemens by 0.67, i.e. 200 mS x 0.67 = 134 ppm.

The calculate function can be applied to produce the conversion. Use a calculate function that multiplies the channel by the constant (ax for example, where a = 0.67)

Take care to get the conductivity channel to the correct scale factor – micro Siemens.

Cleaning, storage, and maintenance of the electrode

Depending on the sample application, the electrode may require cleaning periodically to ensure accurate measurements.

- Water-soluble contamination can be removed by soaking in distilled water.
- Petroleum-based contamination can be removed by soaking in warm water and a mild detergent for 15 minutes.
- Ethanol may be used to clean the electrode, limit the wash time to a maximum of 5 minutes.
- Lime or hydroxide coating can be removed by soaking in a dilute acid solution such as 0.1 mol dm-3 hydrochloric acid or 0.5 mol dm^{-3} acetic acid for 15 minutes.
- Place the electrode in Deionised water and “measure the conductivity” this can force contamination out of the electrodes but may require many changes of water.

After cleaning, rinse well with distilled water, shake vigorously and leave to air-dry.

Store the electrode dry.

Practical Investigations

The Smart Wireless Conductivity Pack can be used to investigate a number of scientific experiments such as:

- Electrolytes and non-electrolytes
- Ionic non-ionic compounds in water
- Conductivity of saltwater
- Equivalence point
- Conducting solutions
- Water quality – using the 0 – 1000 µS range to test samples of water
- Milk quality
- Speed of diffusion
- Strength of weak acids & bases
- Finding the concentration of unknown samples
- Diffusion through membranes

Note: It is recommended that for salinity testing you use the salinity sensor and electrode

Online Videos

Learn how to use data logging in the classroom with our Secondary Science Academy demonstration videos, which will walk you through using the new EasySense app and show you how to get hands-on with the latest Bluetooth wireless sensors. The video experiments will show you how to get the best out of your science lessons.

New online content is being continuously uploaded onto our YouTube channel, including practical worksheets as well as videos.

See our website for further information and links.

Explore Bluetooth Sensors

Are you looking to make the jump to our smart wireless sensors? Or have you recently purchased them and want to know more about how they work?

View video playlist

Explore EasySense

The core of our science platform is our EasySense app. In these videos you will learn everything from the basics of our software to the most in-depth features.

View video playlist

Explore Science Practicals

See our Smart Wireless Sensors in action with a range of practical experiments. This is the best way to get started with the new Bluetooth sensors!

View video playlist

Sensor Specifications

Please read the following table for sensor specifications.

Feature	Detail
Measurement Ranges	Conductivity Ranges: 100,000 µS, resolution 0.1 µS 20,000 µS, resolution 0.01 µS 1000 µS, resolution 0.001 µS Temperature 0 to 85^{0}C, Resolution 0.1^{0}C
Accuracy	Built -in automatic temperature compensation Cell constant tolerance: ±20%
Connectivity	Wired via USB Wireless via Bluetooth
Bluetooth Specifications	Bluetooth 4.2 low energy radio, single mode compliant Transmit (TX) power: 0 dBm Receiver (RX) sensitivity: -90 dBm Usable transmission range: up to 10 m in open air Frequency Range: 2.402 to 2.480 GHz operation
Internal Battery	Rechargeable internal lithium-ion 3.7 V
Storage/Operating Temperature	0 to 40℃
Humidity	0 to 95% RH (non-condensing)
Physical Specifications	Weight: approx. 85 g External dimensions: approx. height 34 mm x width 50 mm x length 103 mm Electrode Diameter: 12 to 13 mm

Limited Warranty

For information about the terms of the product warranty, see the Data Harvest website at: https://data-harvest.co.uk/warranty

Product Repairs

When returning goods to Data Harvest, please download and complete the repair returnform to ensure you have sent us all the information we require, and send it to us alongside the item to be repaired. The second page of this form includes a return address label.

If you have purchased a Data Harvest manufactured product via a different company, please also supply proof of purchase.

Postage Charges

- In the event of a fault developing, the product must be returned in suitable packaging to Data Harvest for repair or replacement at no expense to the user other than postal charges.
- There will be no postal charge for the return of repaired goods to any mainland UK address (for other areas, additional shipping charges may apply).

Out of Warranty Repairs

Please visit https://data-harvest.co.uk/repairs for the most up to date charges for out of warranty repairs.

Warranty on Repaired Items

Once an item has been serviced and repaired, the product will have 1 year warranty against further failure of the component repaired.

International Returns

Please contact the authorised Data Harvest representative in your country for assistance in returning equipment for repair.

Compliance

This product complies to the following standards:

Waste Electrical and Electronic Equipment Legislation

Data Harvest Group Ltd is fully compliant with WEEE legislation and is pleased to provide a disposal service for any of our products when their life expires. Simply return them to us clearly identified as 'life expired' and we will dispose of them for you.

FCC Details

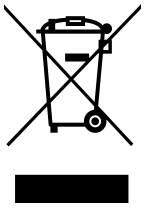
This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

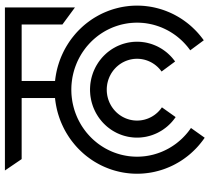
CE

This product conforms to the CE specification. It has been assessed and deemed to meet EU safety, health and environmental protection requirements as required for products manufactured anywhere in the world that are then marketed within the EU.

UKCA

This product conforms to the UKCA specifications.





Troubleshooting

If you experience any problems with your product, please try the following troubleshooting tips before contacting the Data Harvest support team.

Feature	Detail
Loss of Bluetooth Connectivity	**If the sensor loses Bluetooth connection and will not reconnect try:** Closing and reopening the EasySense app. Switching the sensor Off and then On again. If you are using a Bluetooth Smart USB Adaptor on your computer, unplug the adaptor, plug back in again and try to reconnect. Hard reset the sensor and then try to reconnect.

Notices

Please read the following notices with regards to using your sensor

1. The sensor is much smarter than traditional Bluetooth sensors and you are not required to pair the device. If paired, the sensor will not be available to the EasySense 2 app.
2. When the sensor is connected to a computer, the computer should be turned on and not in sleep or standby mode or the battery may drain instead of charge.
3. Data Harvest products are designed for educational use and are not intended for use in industrial, medical or commercial applications.
4. The sensor is not waterproof.
5. Plastic parts may fade or discolour over time if exposed to UV light. This is normal and will not affect the operation of the sensor.

Contact Information

To contact Data Harvest directly, please use any of the following channels:

Traditional Communications

Data Harvest Group Ltd.
1 Eden Court, Eden Way,
Leighton Buzzard,
Bedfordshire,
LU7 4FY
United Kingdom

Tel: +44 (0) 1525 373666
Fax: +44 (0) 1525 851638
Sales email: sales@data-harvest.co.uk
Support email: support@data-harvest.co.uk

Online Communications

We have active social media support channels using the following platforms

- Facebook
- X
- YouTube

Office Opening Hours

Monday to Thursday - 08:30 to 16:45
Friday - 08:30 to 13:30
Saturday & Sunday & UK Bank Holidays - Closed

PDF Translations

The PDF formatted download of this manual is by default provided in the English (United Kingdom) language. If an alternative translation is available, it will be listed here.

We have for your convenience included a webpage translation feature to the online documentation which will allow you to translate and print individual pages of this documentation.
