



1240 - Wireless Drop Bubble Counter

Revision: 0 | DS181

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Introduction

Thank you for purchasing the Smart Wireless Drop Bubble Counter. 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 Bubble Counter can be used to count either drops of fluid falling from a dropping device e.g. during a titration, or bubbles rising through fluid in a column.

The Counter has an infrared emitter and a receiver separated by a 83 mm air gap. When the light beam from the emitter is interrupted (e.g. by a drop or bubble) it creates a digital signal that is counted by the internal counter module.

The red LED is an indicator, which will blink as a drop or bubble passes through the infrared beam. There is a small button close to the indicator that can be pressed to reset a count to zero.



Overview

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

The Drop / Bubble Counter is equipped with a microcontroller that contains the calibration for each of its ranges. They are:

- The Drop/Bubble Count range. Counts the absolute number of drops or bubbles detected as they pass through the infrared beam. Data is displayed as the total number of drops or bubbles rather than volume.
- The pre-set calibrated volume ranges, are: 23 drops cm^3 ; 24 drops cm^3 ; 25 drops cm^3 ; 26 drops cm^3 ; 27 drops cm^3 ; 28 drops cm^3 and 29 drops cm^3 . When any of these ranges are selected the drops counted are automatically converted and displayed as volume in cm^3 .

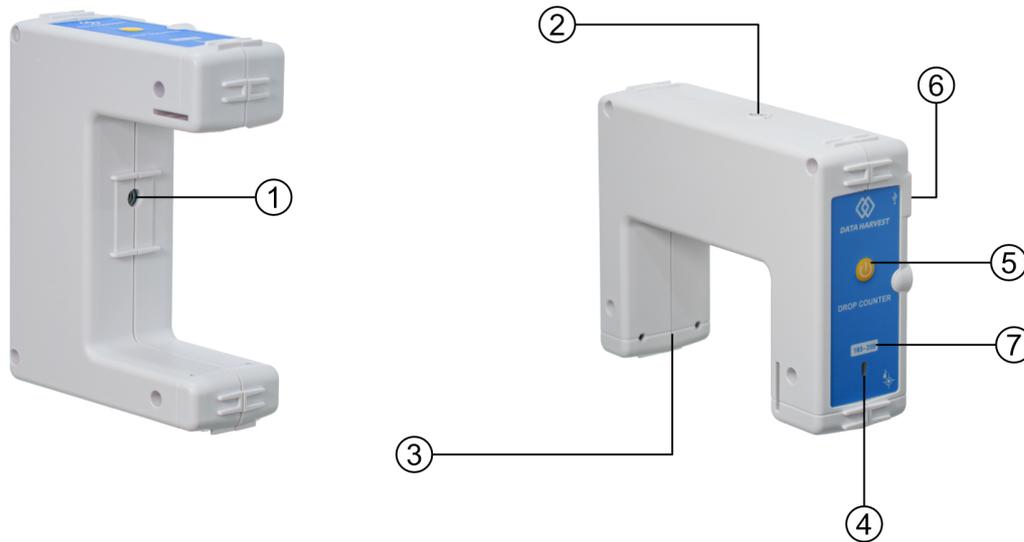
Pack Contents

This product is supplied with the following items:

- 1 x Smart Wireless Drop Bubble Counter
 - 1 x USB Connecting Lead
 - A steel support rod (80 mm long x 10 mm diameter with M6 thread). This can be screwed into the mounting threads, which are found at the base and sides of the sensor. The rod can be used for clamping into a suitable holding device.
 - A plastic reagent reservoir (syringe body)
 - Two 3-way stopcock fittings and two plastic tips (all with twist fittings).
 - An alignment adapter with securing screw, used to align drops from the reagent reservoir into the sensor's light beam.
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Operational Overview

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



1. Alignment mount adaptor
2. Support rod threaded mounting insert
3. Infrared emitter and receiver
4. Status indicators
5. On/Off switch & Reset
6. USB port
7. Unique ID number

Alignment mount adaptor (1)

This adaptor is used to align drops from the reagent reservoir into the sensor's light beam.

Support rod threaded mounting insert (2)

This support rod can be screwed into the mounting threads, which are found at the base and sides of the Sensor. The rod can be used for clamping into a suitable holding device.

Infrared emitter and receiver (3)

This is where the infra-red beam goes from one side to the other.

The Status Indicators (4)

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 & Reset Switch (5)

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 eight 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.

Zero count volume

- A short press of the button will reset the count/volume to zero.

USB Port (6)

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 (7)

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 complement 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, using 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.
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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 C) 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

Setting the range

To alter the range in the EasySense software:

1. Select Devices
2. Select the Drop-down arrow on the sensor name
3. Select the range required from the selection available
4. Close the Devices box
5. Select Finish to exit the wizard

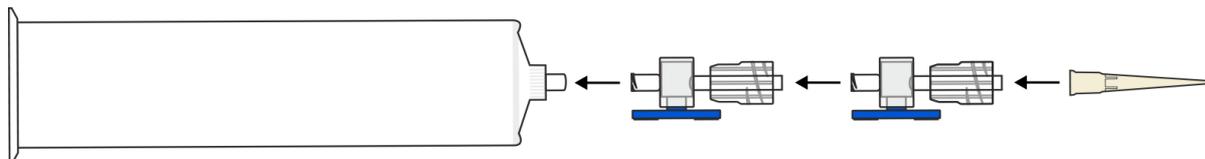
Using the Drop / Bubble Counter to count drops

Setting up the reagent reservoir and alignment adapter

The plastic reagent reservoir and tip supplied with the counter will provide drops within the preset calibration ranges. The reservoir has two stopcocks. One stopcock is used to set the rate of flow from the reservoir and therefore the drop rate. The other stopcock is used to turn the drops on and off.

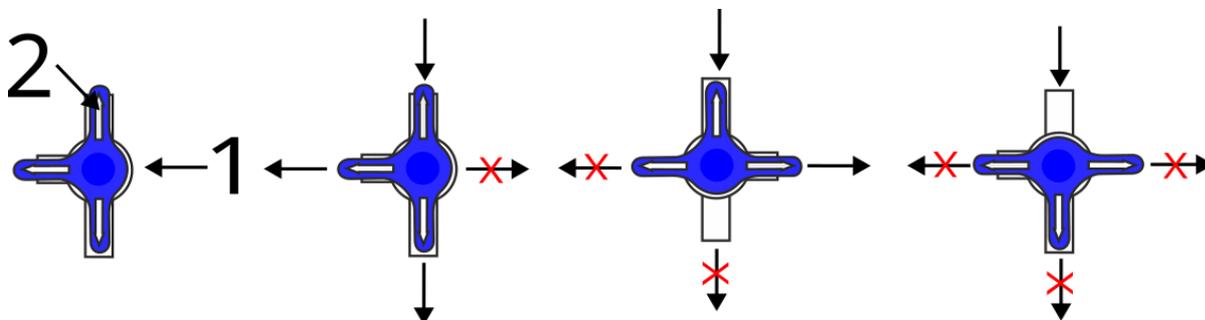
Assemble the plastic reagent reservoir

Screw a stopcock fitting onto the syringe body with a gentle half turn. Fit the second stopcock onto the first, then the tip. Turn both threaded collars to secure the fittings in place (twist back to release).



The combination of two three-way stopcocks is used to control the flow of fluid from the reservoir. The top stopcock is used as an adjustment valve to set the rate of flow and therefore the drop rate from the reservoir. The lower stopcock is used in either an open or closed position to turn the drops on and off.

The stopcock has three ports and a three-point valve. The part of the stopcock labelled (1) has no port; if any point of the valve is directed to this position, flow is not possible in the flow indicator (2) direction. Flow is shown by the flow indicator marker (2). The part of the blue valve that has no handle or flow indicator has no opening. By moving the valve, you can direct the flow. Some examples are shown in the diagram.



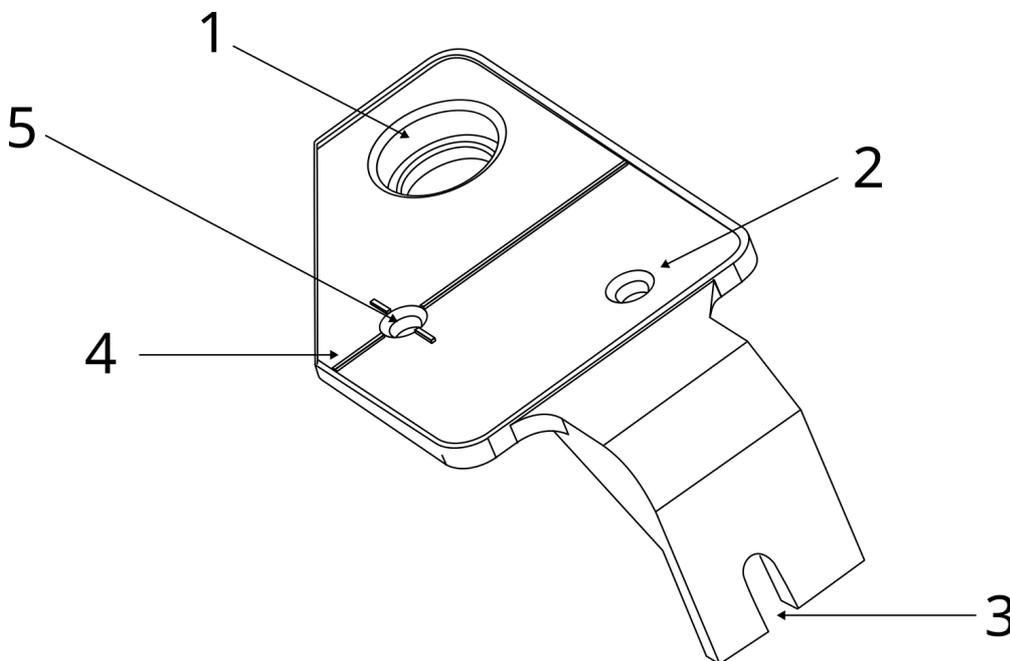
Note: Leave the white sealing blank fitted to the side port of the stopcock.

Turn both stopcocks into the closed position. Clamp the reagent reservoir into place using the alignment adapter.

Using the alignment adapter

The alignment adapter has been provided to give an easy way of aligning drops through the infrared beam of the counter. The adapter has three holes in its flat plate.

Note: the adapter supplied with the wired Wireless Drop Counter will not align correctly if used with this apparatus.



1. Large hole for an electrode (e.g. pH, conductivity).
2. Small hole for a temperature probe.
3. Slot for mounting to body of drop counter.
4. Alignment guide describes the light path from transmitter to receiver.
5. Location for the reservoir drop point. Positions the drops to fall through the light path.

Attach the alignment adapter to the Counter:

- Part screw the Pozi-drive pan-head screw supplied into the mounting thread between the two ridges in the centre of the Counter.
- Slide the mounting arm of the adapter behind the screw head.
- Gently tighten the screw, do not over tighten.

Calculating which Volume range to use

The Drop / Bubble Counter can be used record data directly as a volume (in cm³) measurement by selecting one of the preset calibrated ranges: 23 drops cm⁻³; 24 drops cm⁻³; 25 drops cm⁻³; 26 drops cm⁻³; 27 drops cm⁻³; 28 drops cm⁻³ and 29 drops cm⁻³.

If accuracy is not critical, and you are using the reagent reservoir and tip supplied with a low viscosity liquid (like water), and the flow rate is set to:

- Fast e.g. 10 plus drops per second, use the 24 drops cm⁻³ range.
- Medium e.g. between 5 – 10 drops per second, use the 25 drops cm⁻³ range.
- Slow e.g. between 1.5 – 5 drops per second, use the 26 drops cm⁻³ range.
- Very Slow e.g. less than 1.5 drops per second, use the 27 drops cm⁻³ range

Note: When used with a pH or Conductivity Sensor, the flow rate needs to be very slow (less than 1.5 drops per second) to allow the Sensor time to settle to a new reading after addition of the titrant.

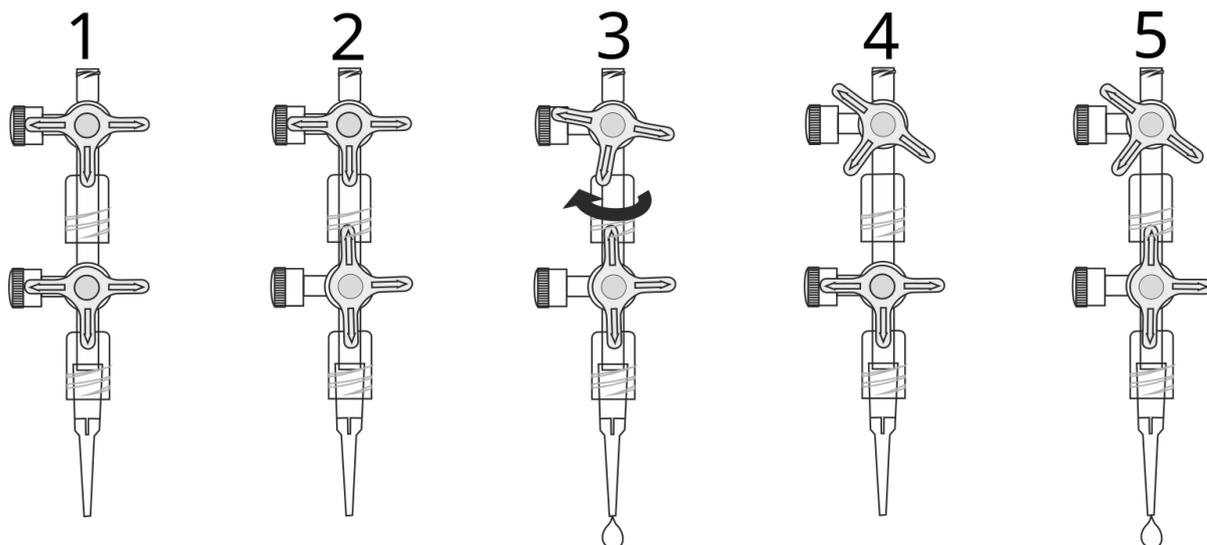
To calculate the number of drops in a cm^3

The volume of a drop of fluid (and therefore the number of drops per cm^3) depends on a number of factors.

These include the:

- Size and shape of the dropper end
- Type of solution (its density, viscosity, and surface tension)
- Flow rate of the liquid through the dropper end (the slower the dropping the smaller the drop)

1. Set up the reagent reservoir in the alignment adapter of the Counter. Close both stopcocks (a) and fill the reservoir with the solution being used.



2. The first step is to adjust the flow rate. Place a beaker under the stopcock to catch the drops. Fully close the lower stopcock and upper stopcock (1).
3. Fully open the lower stopcock, leave the upper stopcock closed (2).
4. Slowly turn the top stopcock until it begins to produce drops and then finely adjust the drop rate (3).
5. When the correct flow rate of drops is achieved close the lower stopcock to stop the flow (4).
6. Now the 'flow rate' is set, do not adjust the top stopcock – leave in this position. Use the lower stopcock to turn the drops on and off (5).

Note: Do not set the flow rate too fast or the drops may form a stream and will not be counted as individual drops.

7. Top up the reservoir. Place the accurate measuring container e.g. volumetric flask (10 cm^3 or less) under the dropping tip.
8. Set the range of the Counter to Drop/Bubble (Count). Press the zero reset button.
9. Open the lower stopcock fully and count the number of drops required to fill up to the volume mark on the measuring container. Use the lower stopcock to turn the drops off.

Notes:

Make sure the lower stopcock is fully open or the rate of flow (and therefore the number of drops per cm^3) will be affected.

Divide the number of drops by the volume (in cm^3) to get the drops per cm^3 value e.g. 272 drops fill a capacity of $10 \text{ cm}^3 = 27.2 \text{ drops cm}^{-3}$. Top up the reservoir and repeat three times to get an average value.

Using the drop bubble counter for an accurate titration

The drop counter counts individual drops as they pass through the light path of the counter. The sensor uses infra-red to count the drops. The drops to be counted must absorb some infra-red to change the light path intensity. Water or aqueous solutions work well.

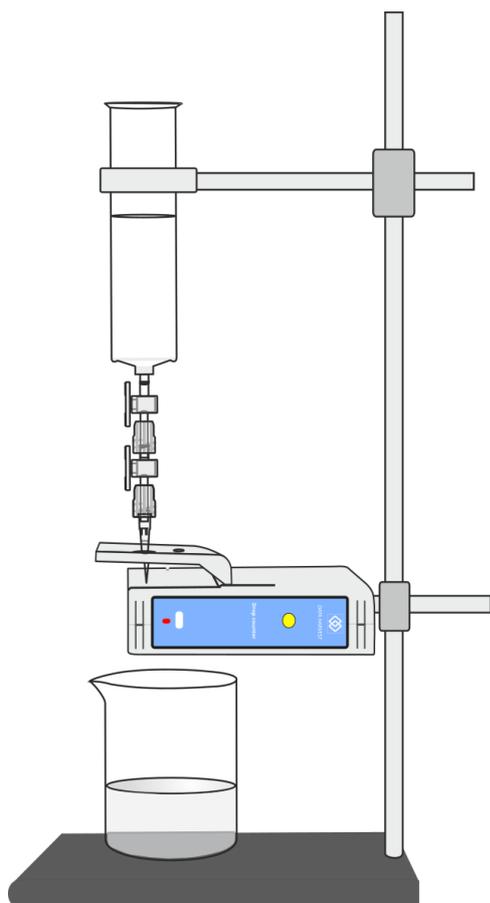
With a drop rate of 1 drop per second and the supplied tip used to form the drops, the default range of 27drops per cm^3 should be used.

Use the stopcock closest to the reservoir as a rate valve and the lower stopcock as the on/off valve.

For even more precise counting, the drops per cm^3 will need to be found using a small volumetric flask and use the drops range to find how many drops to fill the volume.

It is advisable to check that the drops are being counted before tightening the apparatus. The alignment shield will take much of the guesswork out of the set up, but if the reservoir is not true vertical, the drops formed can potentially miss the infra-red light beam.

A burette can replace the reservoir and stopcock setup. However, the single stopcock of the burette may make it more difficult to create an even flow of drops. A burette will probably need calibration as not every burette point is the same.



For simplicity, the example apparatus does not show the pH sensor in position. The alignment plate has a large hole to accept a pH electrode. If required, the light path of the sensor can travel through the glass of the beaker with the proviso that the glass does not absorb infra-red or is not so thick it blocks the light.

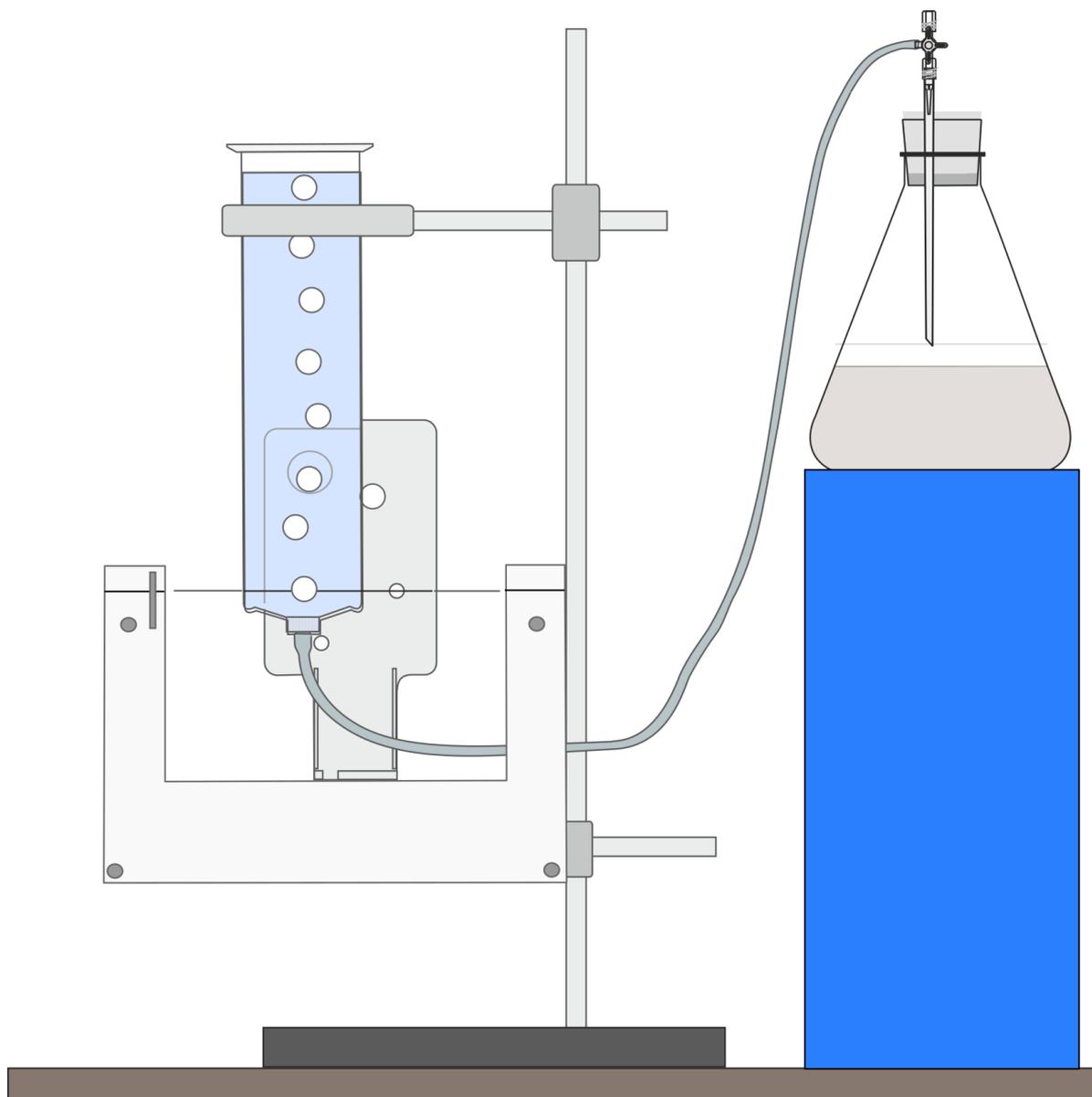
Using the Drop / Bubble Counter to count bubbles

The Drop / Bubble Counter can be used to detect a bubble formed in a column of water. The column of water should be positioned between the Counter's receiver and emitter, so it blocks the infrared beam. When a bubble rises, the beam is momentarily changed, and a bubble is counted.

Bubbles cannot be calibrated for volume but can be used to show the change of gas production over time.

Test your set up before beginning the experiment. It is critical that the column of fluid is positioned so the bubbles will change the beams level as they rise. Bubble counting is not an exact science. Bubbles have an inconsistent format and can move through the fluid in an erratic manner; they need to rise separately from the same origin to be counted.

Note: Small, fine bubbles such as those produced by oxygenating pond weed are unlikely to be detected.



- Set the range of the counter to Drop/Bubble Count.
- Set up the column of fluid for the bubbles to rise through.

The reagent reservoir can be used as a vessel for counting bubbles. Connect a length of PVC tubing (3 mm inside diameter) from the reservoir to a stopcock attached to the delivery tube on the apparatus.

Turn the stopcock to a closed position.

- Clamp the Counter vertically.
- Clamp the reservoir and position in the gap between the receiver and emitter so that the reservoir is touching the emitter's moulding.

Adjust the Counter or reservoir vertically so the moulding ring at the bottom of the reservoir barrel is level with the lower edge of the emitter moulding.

Adjust the reservoir laterally so the reservoir is just touching the moulding of the large hole in the alignment plate. In this position bubbles rising should pass through the light path between the receiver and emitter.

Note: You may need to make fine lateral adjustments of the reservoir.

Check the reservoir is vertical and parallel to the Counter.

Note: Try to keep the experimental apparatus higher than the water level in the reagent reservoir to prevent backflow of water into the experimental apparatus.

- Pour approximately 10 cm³ of water into the reservoir.
- Test to make sure the bubbles cause the red LED indicator on the Counter to blink as they rise through the water.
- Press the zero reset button on the Counter. Run the experiment (remember to turn the stopcock to an open position).

Practical information

- The fastest speed that data can be captured is 50 Hz (20 ms). If an inter-sample time of less than 20 ms is selected, then the values obtained will either default to the lowest reading or the set up will be rejected by the logger/software.
- A replacement parts pack for the Counter reservoir is available from Data Harvest, which contains 2 x 3-way stopcocks and 5 plastic tips - use Product No. 3271.
- The Drop / Bubble Counter works by recording interruptions of a beam of infrared energy. The receiver can be sensitive to high levels of ambient infrared light or heat. Shield the Counter from bright light e.g. sunlight, which can produce a false OFF result. Work in an area away from direct light or rotate through 180° so the external light source is directed towards the emitter.
- Any calculations for drops per cm³ will only be valid for the same dropper with the same type of solution and flow rate.
- If the flow rate is too fast the drops will merge to form a continuous stream. The flow rate should be set so that each drop passes through the Counter before the succeeding drop.
- With a titration use a very slow drop rate (e.g. with a maximum speed of 1.5 drops a second) so the drops can add to and mix thoroughly with the reactant, allowing the electrode time to respond.
- If you use a burette as a reservoir you will need to devise a method of stopping the flow from the burette without altering the drop rate. If the burette has a replaceable tip, use a length of plastic tubing to link the tip to the burette. A tube clamp can be used to crimp the plastic tubing and shut off the flow. A bung inserted into the top of a burette will also prevent flow and can be used as a 'flow stop'. During test we found a standard 50 ml burette produced 23 or 24 drops per cm³ (depending on flow rate).
- Volume measurements are calculated by using the 'drops per cm³' data so there is no need for the reagent reservoir to have a volume scale.

SI units: Volume is a measurement of the space occupied by a body. The SI unit of volume is the cubic metre (m³). The volume of a liquid is calculated from the space it takes up in its containing vessel. The internal volume of the containing vessel is called its capacity. The SI unit of capacity is the litre (L) - equal to 10⁻³ m³ (1 ml = 1 cm³).

Practical Investigations

The Smart Wireless Drop Bubble Counter can be used to investigate a number of scientific experiments such as:

- Acid-base titrations – used as a Drop Counter with the Smart Q pH sensor to record a pH vs. volume graph e.g. sodium hydroxide with hydrochloric or ethanoic acid, ammonia with hydrochloric or ethanoic acid, sodium carbonate with hydrochloric acid, etc.
- Conductometric titrations - used as a Drop Counter with the Smart Q Conductivity sensor to record conductivity vs. volume graph e.g. the equivalence point of barium hydroxide and sulphuric acid, sodium hydroxide with hydrochloric acid, ethanoic acid with sodium hydroxide, potassium chloride with silver nitrate, etc.
- Gas evolution investigations - used as a Bubble Counter in e.g. rate of reaction of marble chips and hydrochloric acid, catalytic decomposition of hydrogen peroxide, yeast fermentation of sucrose, etc.

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.

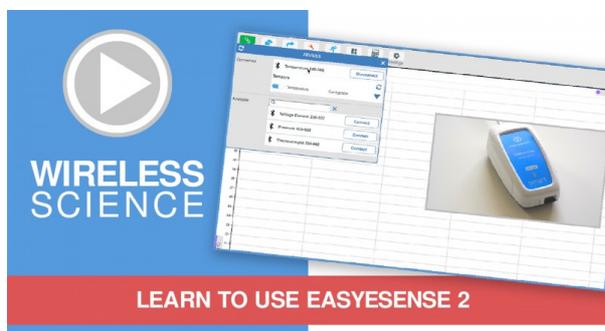
See our website for further information and links.



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	Count Range: 0 to 16 x 10 ⁶ Volume Ranges: 23 to 29 drops cm ⁻³
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 C
Humidity	0 to 95% RH (non-condensing)
Physical Specifications	Weight: approx. 144 g External dimensions: approx. height 130 mm x width 40 mm x length 100 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 return [form](#) 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	<p>If the sensor loses Bluetooth connection and will not reconnect try:</p> <p>Closing and reopening the EasySense app.</p> <p>Switching the sensor Off and then On again.</p> <p>If you are using a Bluetooth Smart USB Adaptor on your computer, unplug the adaptor, plug back in again and try to reconnect.</p> <p>Hard reset the sensor and then try to reconnect.</p>

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 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.
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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.
