Oxygen Sensor DT222A

The Oxygen sensor can be connected to the NOVA5000, NOVA LINK or MultiLogPRO data loggers. It is a galvanic oxygen electrode, capable of measuring % O_2 in air and O_2 concentration in aqueous solutions in mg/L.

The Oxygen sensor can be used to perform a wide variety of experiments to determine changes in % O_2 in air and dissolved oxygen levels, especially in aquariums, photosynthesis and respiration of plants and monitoring human respiration.

The sensor consists of a galvanic oxygen sensitive electrode with a processing unit (oxygen adapter, equipped with a calibration knob).

The range can be selected directly from the data logger or via the MultiLab software. The Oxygen sensor has to be calibrated before every measurement.

The electrode is warranted for 12-months to be free from manufacturing defects and to meet specifications. Improper storage without the shorting cap voids the warranty. These electrodes have been known to last for years with proper storage and use of the shorting cap.

Typical Experiments

- Monitoring human respiration
- Monitoring changes in oxygen during photosynthesis and respiration of plants
- Monitoring dissolved oxygen concentration resulting from photosynthesis and respiration in an aquarium containing plants and/or fish
- Demonstrating how oxygen is removed from the air by re-breathing the sample of air in a paper bag using different patterns of breathing

- Monitoring the pattern between light and dissolved oxygen levels, in an aquarium with pondweed
- Onsite testing in streams and ponds - lake survey to evaluate the capability of the water to support different types of plant and animal life
- Measuring respiration of animals, insects, geminating seeds
- Measuring consumption of oxygen by yeast during respiration of sugars
- Measuring the effect of temperature change on the solubility of oxygen
- Measuring fermentation of yoghurt
- Measuring oxidation of metals
- Discovering the change in oxygen level during combustion – using a candle burning in a bell jar

How it Works

The galvanic dissolved oxygen electrode consists of polarized platinum and lead electrodes, with the electrolyte separated from the sample by a Teflon/silicone gas permeable membrane. The external portion of the electrode is constructed of delrin. The internal portion of the electrode is constructed of 316 L stainless steel. A thin Teflon/silicon membrane provides for efficient sealing of cathode/anode and electrolyte within the cylinder. The membrane is permeable to oxygen but impermeable to water and electrolytes.

Oxygen diffuses across the electrode membrane and is reduced to hydroxyl ions at the platinum cathode according to the reaction:

(1) $O_2+2H_2O + 4e^- = 4OH^-$

The electrons necessary for this process are produced by a reaction at the lead anode. Because the electrolyte contains hydroxide ions, this reaction occurs as:

(2) $2Pb + 4OH^- = 2Pb(OH)2 + 4e^-$

At any given temperature, the current flow between cathode and anode is directly proportional to the level of oxygen.

Sensor Specification

Range:	0 – 12.5 mg/L DO_2 0 – 25 % O_2
Accuracy:	±7 % over entire range
Resolution (12-bit):	0 – 12.5 mg/L 0.003 mg/L 0 – 25 % 0.007 %
Temperature Compensation:	No
Response Time:	90% response in less than 30 seconds
Default Sample Rate:	10 samples per second
Membrane:	Teflon
Cathode:	Platinum
Anode:	Tubular lead
Electrolyte:	Sodium Hydroxide solution
Stability/Drift:	In water under constant pressure at constant temperature and amounts less than 2% per week
Features:	Equipped with an offset calibration knob
Sensor Storage:	Store with protective vinyl cap

Contents

Adaptor & Oxygen electrode set	DT222A
Adaptor only	DT222
Oxygen electrode	DT118
5 x 1 ml thick membrane	
30 ml Galvanic O_2 fill solution	
Syringe	
Nitrogen powder	

Equipment Setup

1. Connect the electrode to the adaptor.
2. Connect the adaptor to the data logger's input.

Technical Notes

- The sample water temperature has to be 25 °C since the Oxygen sensor can only be calibrated at 25 °C.
- If other electrochemical type sensors (pH and Conductivity) are placed in the same solution at the same time and connected to the same data logger, they can interfere with each other's signals. Keep the sensors as far apart as possible - the distance required will depend on the conductivity of the solution. If there is still a problem, try connecting the sensors to different data loggers or take readings using one sensor at a time.
- It is important during measurement to stir the solution as oxygen consumption by the probe can momentarily reduce the oxygen concentration at the probe surface.
- Do not allow any air bubbles to be trapped on the membrane surface, as it will read an air bubble as an oxygen–saturated sample.
- If the probe, when in air–saturated water, generates no potential (zero output), check that:
  - All cable connections are correct.
  - The probe is filled with electrolyte.
- If the calibration knob is on maximum but the signal does not reach the maximum level, change the membrane and the electrolyte.

Note: The output signal may not reach the maximum if the ambient air temperature is less than 15 °C.

- The Oxygen electrode is supplied with a protecting cap that covers the membrane. Before using the electrode for the first time remove the protecting cap.

Temperature Compensation

The DO concentration in the water will vary with temperature. The data logger assumes that the temperature is 25 °C.

Salinity and Altitude Correction

The presence of dissolved salts and/or altitude parameters limits the amount of oxygen that can dissolve in water. The relationship between the concentration of oxygen and partial pressure varies with the salinity of each sample, so the data logger supplies the ability to manually correct for salinity and altitude in ionic concentration (see the section: **Calibration Procedure** below).

Electrode Preparation

The electrode is shipped filled with electrolytes and with the Teflon membrane in place. Upon receiving the electrode, remove the protective vinyl cap and inspect for damage.

Using the Oxygen Sensor with NOVA5000 and MultiLab Software

Selecting the range

By default MultiLab displays the range, in Auto ID mode, as **DO_2 (0 – 12.5mg/L).**

To set the NOVA5000 to the **O_2 (0 – 25%)** range:

1. Launch the MultiLab CE software.
2. Connect the Oxygen sensor to the NOVA5000's input (starting from I/O-1).
3. Click **Setup** on the main toolbar.
4. Uncheck the **Auto Detect Sensors** checkbox.
5. Choose from the drop-down menu next to the sensor input, **Oxygen O2 0-25%**.
6. Program the data logger's sample rate and number of samples.
7. Click **Run** on the main toolbar to start the measurement.

Calibration

Calibration in the air:

1. Connect the Oxygen sensor to the NOVA5000's input (starting from I/O-1).
2. Set the NOVA5000 to **O2 (0–25%)** range (see the section: **Selecting the range** above).
3. Choose **Table** display on the main tool bar.
4. Hold the probe in the air.

5. Click **Run** to start recording and turn the knob on the Oxygen adaptor until a value of **20.9%** is shown.
6. Wait 1 to 2 minutes for the reading to stabilize on **20.9%**.
7. Click **Stop** on the main tool bar.
8. Start using the Oxygen sensor.

This method is not recommended when air temperature changes (for example, when the air conditioner is turned on and off or if the calibration is being performed outside in windy conditions).

Calibration in water:

By default MultiLab displays the range, in Auto ID mode, as **DO_2 (0 – 12.5 mg/L).**

1. Obtain a water sample that has equilibrated to room temperature (25 °C).
2. Make sure that the water is saturated with oxygen:
   - A simple method is to slowly pour the water from one container to another many times.
   - Another method is to bubble air into the water, do not use a straw and blow into the straw. Your breath has more CO_2 in it than the air in the room.
   - Stir the water with a magnetic stirring bar for a while, making sure that the stirring rate is high and that you have a large vortex pulling air bubbles into the water.
3. Connect the Oxygen sensor to the NOVA5000's input (starting from I/O-1).
4. Choose **Table** display on the main tool bar.
5. Set up the correct atmospheric altitude and water salinity:
   a. Click **Logger** on the main tool bar.
   b. Select **DO2 Calibration Info** from the drop-down menu.
   c. From the **Salinity (ppt)** drop-down menu, select the salinity value of the solution (distilled water has 0 ppt salinity).
   d. From the **Altitude (ft)** drop-down menu select the altitude value.
   e. MultiLab CE will display the saturation level at 25 °C. Write down the saturation **Max. DO2 (mg/L)** level in your notebook.
   f. Click **Close**.
6. Hold the electrode in the water or suspend the probe into the water. Do not let the electrode rest on the bottom of the container.

7. Click **Run** to start recording and turn the knob on the Oxygen adaptor until the **Max. DO2 (mg/L)** value (the value which you have written in your notebook) is shown.
8. Wait 1 to 2 minutes for the reading to stabilize.
9. Click **Stop** on the main tool bar.
10. Start using the electrode.

Using this method the water has to be completely saturated with air. The best way to ensure the water saturation is to stir it using a stirrer for 2-3 minutes.

Zero point calibration is necessary before the measurement of low concentration.

1. Obtain a water sample that has equilibrated to room temperature (25 °C).
2. Pour the nitrogen into the water (the powder in the small bottle).
3. Connect the Oxygen sensor to the NOVA5000's input (starting from I/O-1).
4. Click **Run** to start recording, and turn the knob on the Oxygen adaptor until the value reaches zero.
5. Wait 1 to 2 minutes for the reading to stabilize.
6. If the reading is not zero add more powder and turn the knob on the Oxygen adaptor to show zero.
7. Click **Stop** on the main tool bar.

Set a measurement

1. Select the measurement range (see section: **Selecting the range** above).
2. Calibrate the electrode using one of the methods described (see section: **Calibration** above).
3. Program the data logger's sample rate and number of samples.
4. Click **Run** on the main toolbar to start the measurement.

Using the Oxygen Sensor with the NOVA LINK or MultiLogPRO and MultiLab

Software

Selecting the range

By default MultiLab displays the range, in Auto ID mode, as **DO_2 (0 – 12.5mg/L)**.

To set the data logger to the **O_2 (0 – 25%)** range:

1. Set the NOVA LINK or MultiLogPRO to **8 inputs** mode.
2. Connect the Oxygen sensor to the NOVA LINK or MultiLogPRO's sensor input (starting from I/O-1).
3. Click **Setup** on the main toolbar.
4. Select from the drop-down menu near the sensor input, **Oxygen O_2 0 - 25%.**
5. Program the data logger's sample rate and number of samples.
6. Click **Run** on the main toolbar to start the measurement.

Calibration

Calibration In air:

1. Connect the Oxygen sensor to the data logger's input (starting from I/O-1).
2. Set the data logger to the **O_2 (0 – 25%)** range (see section: **Selecting the range** above).
3. Hold the probe in the air.
4. Click **Run** to start recording and turn the knob on the Oxygen adaptor until a value of **20.9%** is shown.
5. Wait 1 to 2 minutes for the reading to stabilize on **20.9%**.
6. Click **Stop** on the main toolbar.
7. Start using the Oxygen sensor.

This method is not recommended when air temperature changes (for example, when the air conditioner is turned on and off or if it is windy).

Calibration in water:

By default MultiLab displays the range, in Auto ID mode, as **DO_2 (0 – 12.5mg/L).**

1. Obtain a water sample that has equilibrated to room temperature (25 °C).
2. Make sure that the water is saturated with oxygen:
   - A simple method is to slowly pour the water from one container to another many times.
   - Another method is to bubble air into the water, do not use a straw and blow into the straw. Your breath has more CO_2 in it than room air.
   - Stir the water with a magnetic stirring bar for a while, making sure that the stirring rate is high and that you have a large vortex, pulling air bubbles into the water.
3. Connect the Oxygen sensor to the data logger's input (starting from I/O-1).

4. Set up the correct atmospheric altitude and water salinity. Use the **DO2 Calibration** command from the **System Configuration** menu on the MultiLogPRO:
   a. In the **MAIN MENU** screen, use the arrow buttons to navigate to the **System configuration** icon  , and then press **Enter**  to display the configuration screen.
   b. Press the **Enter** button  three times to select **DO2 Calibration**.
   c. Press the **Forward** arrow button  to enter the **DO2 Calibration** screen.
   d. Use the arrow buttons to select salinity between 0, 5, 10, 15, 20, 25, 30 and 35 ppt and press the **Enter** button to confirm. You will move to the **Calibrate Altitude** screen.
   e. Use the arrow buttons to select altitude between 0, 500, 1000, 1500, 2000, 2500, 3000 and 3500 ft and press the **Enter** button to confirm.
   f. MultiLogPRO will display the saturation level at 25 °C and will exit the **DO2 Calibration** screen. Write down the saturation level. The new calibration parameters will be saved until the next time you change them.
   g. Press the **Escape** button  twice to return to the main menu.
5. Hold the electrode in the water or suspend the probe into the water, do not let the electrode rest on the bottom of the container.
6. Click **Run** to start recording and turn the knob on the Oxygen adaptor until the **Saturation level** (the value which you have written in your notebook) is shown.
7. Wait 1 to 2 minutes for the reading to stabilize.
8. Click **Stop** on the main tool bar.
9. Start using the electrode.

Using this method the water has to be completely saturated with air. The best way to ensure the water saturation is to stir it with a stirrer for 2-3 minutes.

Zero point calibration is necessary before the measurement of low concentration.

1. Obtain a water sample that has equilibrated to room temperature (25 °C).
2. Pour the nitrogen into the water (the powder in the small bottle).

3. Connect the Oxygen sensor to the NOVA5000's input (starting from I/O-1).
4. Click **Run** to start recording, and turn the knob on the Oxygen adaptor until the value reaches zero.
5. Wait 1 to 2 minutes for the reading to stabilize.
6. If the reading is not zero add more powder and turn the knob on the Oxygen adaptor to show zero.
7. Click **Stop** on the main tool bar.

Set a measurement

1. Select the measurement range (see section: **Selecting the range** above).
2. Calibrate the electrode using one of the methods described (see section: **Calibration** above).
3. Program the data logger's sample rate and number of samples.
4. Click **Run** on the main toolbar to start the measurement.

Maintenance and Storage

After the electrode has been used for a period of time the following cleaning method is recommended:

1. Carefully unscrew the cap from the body.
2. Rinse the inside of the membrane cartridge with DI water.
3. Soak the lead anode in 0.1N HCL (8.3 mL concentrated HCl in 1000 mL DI water) for 15 to 20 minutes. Rinse the lead anode with DI water, blot dry with tissue paper. Screw the lead anode back onto the body.
4. Dip the platinum cathode in aqua regia (a mixture of 3 parts HCl and 1 part HNO_3 five times, 30 seconds each. After each dip, clean the platinum surface with tissue paper.
5. Rinse the soaked portions thoroughly with DI water. Blot dry with tissue paper.
6. Fill the cap with electrolyte to a level just above the membrane cartridge using the syringe provided. Hold the electrode in an upright position and gently screw the cap back onto the body.
7. Inspect the membrane for tears or leakage. The membrane should be uniformly stretched across the inner body. Replace the membrane if any damage has occurred.

Membrane Replacement

The membrane should be examined routinely after each fermentation cycle and replaced if any deterioration is evident. See Figure 1 below.

1. Carefully unscrew the cap from the body.
2. Using the membrane tool provided, pop the membrane cartridge from the cap.
3. After the membrane cartridge is removed from the cap, inspect all of the O-rings. If the O-rings appear to be damaged, please replace them with the spare O-rings provided.
4. Inspect the platinum cathode. Gently wipe it with tissue paper and see if there are any cracks or damage.
5. Take a new membrane out of the plastic package and insert into the cap. Push it down inside until firmly seated inside the outer cap using the membrane tool provided.
6. Fill the cap with electrolyte to a level just above the membrane cartridge, using the syringe provided.
7. Hold the electrode in an upright position and gently screw the cap back onto the body. Inspect the membrane for tears or leakage. The membrane should be uniformly stretched across the inner body.

Troubleshooting

- If the probe in air saturated water generates no potential (zero output), check that all cable connections are correct and check that the probe is filled with electrolyte.
- If the calibration knob is on maximum but the signal doesn't reach 100%, change the membrane and the electrolyte.

Note: The output signal may not reach 100% if the ambient air temperature is less than 15 °C.

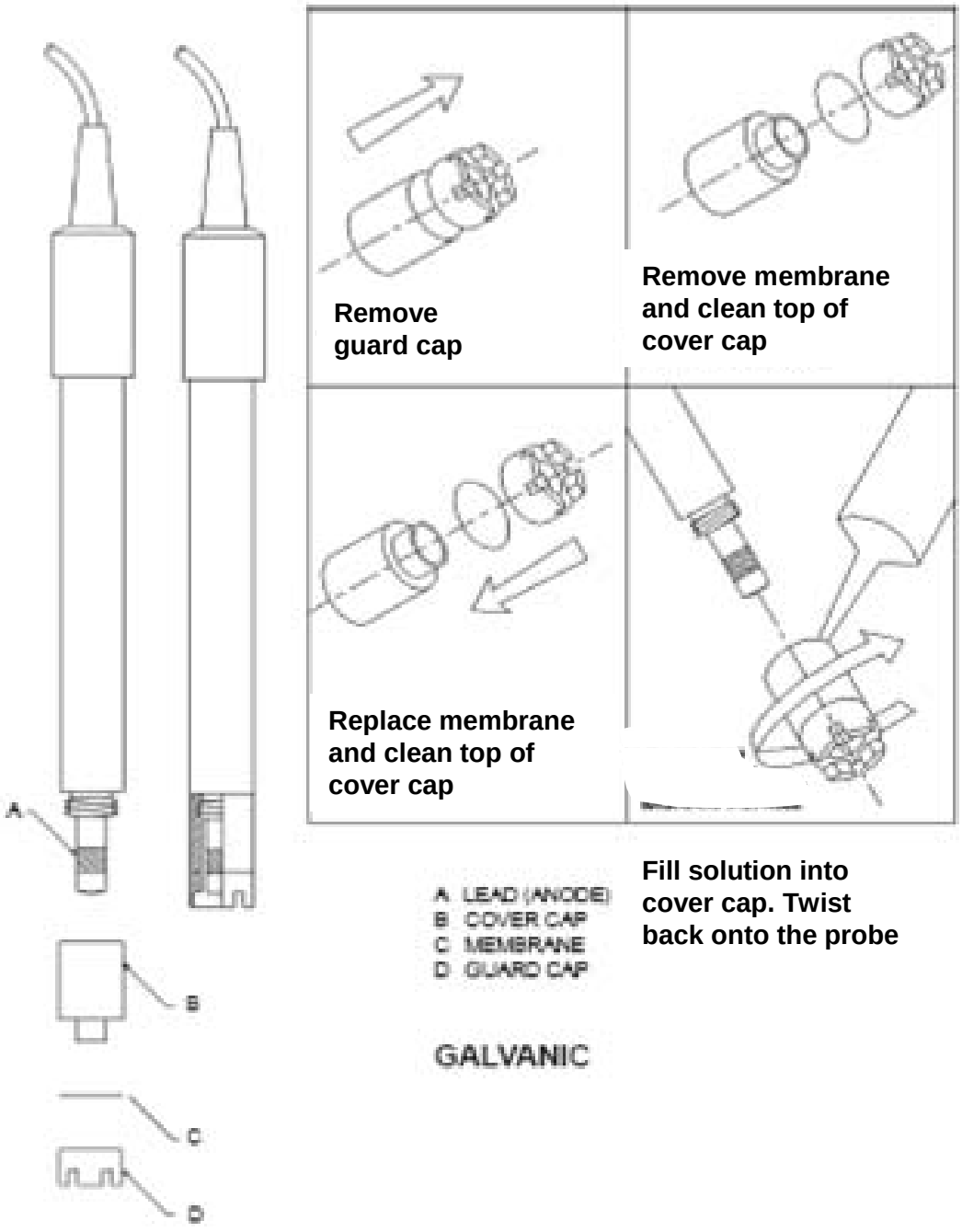

Figure 1: Membrane replacement

An Example of using the Oxygen Sensor

Catalytic Decomposition of H_2O_2 by the Enzyme, Catalase: Effect of Enzyme Concentration

In this experiment we follow changes in Oxygen in Air vs. Time (as a result of release of oxygen) at different concentrations of catalase. Under saturating substrate concentrations, the rate of enzyme catalysis is directly proportional to the concentration of the enzyme. Figure 2 below displays the change in Oxygen in Air vs. Time (as a result of release of oxygen) at different catalase concentrations.

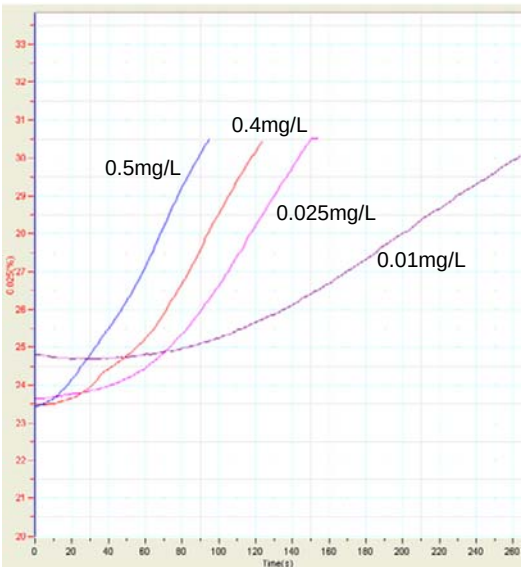

Figure 2: Oxygen in Air *vs.* Time

Technical Support

Please contact the Fourier technical support team as follows:

Web: http://fourieredu.com/support/
Email: support@fourieredu.com

Copyright and Warranty

All standard Fourier Systems sensors carry a one (1) year warranty, which states that for a period of twelve months after the date of delivery to you, it will be substantially free from significant defects in materials and workmanship.

This Warranty does not cover breakage of the product caused by misuse or abuse.

This Warranty does not cover Fourier Systems consumables such as electrodes, batteries, EKG stickers, cuvettes and storage solutions or buffers.