

NEULOG CO₂ LOGGER SENSOR GUIDE



NeuLog CO₂ logger sensor NUL-220 Part# NL-2200

The CO₂ Sensor can be used for any science experiment where CO₂ levels are required. Some fields of study include Chemistry, Physiology, Exercise Science, Biochemistry, Biology, Earth Science, Environmental Science, etc.

The sensor comes pre-calibrated so you can start experimentation right out of the box using this guide.

This sensor is practical for testing CO₂ levels both in laboratories and in the field. An electromechanical cell in the sensor reacts with carbon dioxide to produce a voltage which is directly interpreted to give a CO₂ concentration reading.

Among hundreds of possible experiments that can be performed with the NUL-202 sensor are: Monitoring ecological systems, combustion reactions, CO₂ consumption rates, studying photosynthesis, testing chemical solutions, hydrogen peroxide decomposition, and many more.

The NeuLog CO₂ sensor's measurement unit is:
Parts per million (ppm): The total number of carbon dioxide molecules per million molecules sampled.

Sensor offset:

Prior to each use, the CO₂ sensor needs to warm up for roughly half an hour. For best results, plug the CO₂ sensor into a USB or battery module and allow it to sit for half an hour before to collecting data.

Open air mode:

Although the NeuLog CO₂ sensor does not need to be calibrated, it is recommended to offset its probe.

The sensor offsets to the standard atmospheric CO₂ concentration of 380 ppm in open air (assuming stable levels in the Earth's atmosphere at sea level).

Materials Needed:

- NUL-220 CO₂ sensor
- One of the following (depending on experiment type):
 - USB-200 Module (For On-line experiments)
 - BAT-200 Battery Module (For Off-line experiments)
 - VIEW-101 Graphic Display Module and BAT-200 Battery Module (Optional, for use with NeuLog Viewer)

Procedure:

1. It is recommended to offset the sensor outside (you can get it out through a window if it is connected to a USB module).
2. The CO₂ sensor needs a power supply to properly offset. Connect the CO₂ sensor to:
 - USB-200 module for On-line experiments
 - BAT-200 battery module for Off-line experiments
 - VIEW-101 graphic display module and BAT-200 battery module for use with the NeuLog Viewer.

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3. After the sensor has been connected to a power supply for at least 30 minutes, check that the values are relatively stable.
4. The sensor now needs to be offset - hold the probe vertically with the opening facing the ground.
5. Press and hold the blue "Start/Stop" button on the faceplate of the sensor for 3 seconds.
6. The CO₂ Sensor is now offset for use.

Included with the sensor:

- NeuLog General Guide
- NeuLog CO₂ sensor probe attached to the sensor's body by a durable rubber-coated wire
- Glass bottle

Sensor specifications:

Range and operation modes	350-10,000 ppm
ADC resolution	14 bit
Resolution	1 ppm
Max sample rate (S/sec)	100

Experiment Duration: 1 seconds to 31 days.

Sensor's features:

- Fully digital data
- Rugged plastic ergonomic case
- Push button switch for Start/Stop experiments in off line mode
- LED indicator of experiment status (blinks while collecting data)
- Attached probe cased in durable plastic

Note: NeuLog products are intended for educational use.

Videos and experiment examples:

- Videos, literature and other probes can be found at www.NeuLog.com.
- In order to access the CO₂ sensor's page, choose "Products" on the main menu and then "CO₂ logger sensor".
- In order to access the CO₂ sensor's experiments, choose "Example Labs":
 - Photosynthesis (B-10)
 - Respiration of Germinating Seeds (B-11)

Technical background:

The philosophy behind NeuLog's plug and play technology is based on each sensor's ability to store its own data due to an internal flash memory chip and micro-controller in each plastic NeuLog body. This technology allows the sensor to collect and then store the digital data in the correct scientific units (°C, °F, Lux, %, ppm, for example).

The sensor is pre-calibrated at the factory. The built-in software in the logger can be upgraded for free at any time using the provided firmware update.

In spite of that, the probe needs to be offset prior to its initial use. Please review the "Sensor offset" guide at the beginning of this document for detailed instructions.

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The CO₂ sensing element consists of a cation (Na⁺) solid electrolyte formed between two electrodes together with a printed heater (RuO₂) substrate.

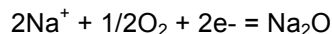
The cathode (sensing element) consists of lithium carbonate and gold, while the anode (counter electrode) is made of gold.

When the sensor is exposed to CO₂ gas, the following electrochemical reaction occurs:

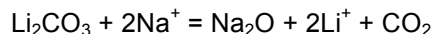
Cathodic reaction:



Anodic reaction:



Overall chemical reaction:



As a result of the electrochemical reaction, an electro-motive force (EMF) is generated according to Nernst's equation:

$$\text{EMF} = E_c - (R \times T) / (2F) \ln (P(\text{CO}_2))$$

where

P(CO₂) : Partial pressure of CO₂,

E_c : Constant value R : Gas constant

T : Temperature (K) F : Faraday constant

By monitoring the electromotive force (EMF) generated between the two electrodes, it is possible to measure CO₂.

Maintenance and storage:

- Never submerge the NeuLog sensor's plastic body and probe in any liquid.
- Do not allow liquid into the NeuLog sensor's plastic body and probe.
- After use, wipe off all excess material, liquid or residue from the CO₂ probe's body.
- Store in a box at room temperature out of direct sunlight.

Warranty:

We promise to deliver our sensor free of defects in materials and workmanship. The warranty is for a period of 3 years from the date of purchase and does not cover damage of the product caused by improper use, abuse, or incorrect storage. Sensors with a shelf life such as ion selective probes have a warranty of 1 year. Should you need to act upon the warranty, please contact your distributor. Your sensor will be repaired or replaced.

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