D-Opto Logger
Dissolved Oxygen Logger

Operation Manual

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1 Introduction

The D-Opto Logger is a fully self contained dissolved oxygen logger, incorporating a DO sensor, battery, and low power data logger in a rugged compact underwater housing.

The D-Opto Logger uses a field-proven solid-state optical sensing system to measure dissolved oxygen that is highly stable over long periods of time, even in harsh conditions. The data is stored onboard in non-volatile memory. The D-Opto Logger is setup, and data offloaded using simple Windows based software, supplied with the instrument.

1.1 Optical Sensor Technology

Unlike conventional dissolved oxygen sensors, the D-Opto Logger sensing element utilises fluorescence to measure dissolved oxygen. The basic principle involves subjecting a fluorescing compound (ruthenium) to a fixed wavelength of light. When the light source is removed, the compound emits a fluorescence, the intensity of which is dependent on the oxygen levels present in the surrounding water. An extremely stable electronic circuit has been designed to firstly excite the ruthenium, and then measure the intensity of the resulting fluorescence. Therefore using this circuitry, the D-Opto Logger should provide accurate dissolved oxygen measurements over long periods of time (many months) without re-calibration.

Unlike conventional polarographic dissolved oxygen sensors, the optical method does not consume oxygen. Consequently the measurement of dissolved oxygen by the D-Opto Logger is unaffected by water movement. Similarly the D-Opto Logger does not utilise a membrane or any other consumables, thus minimising servicing requirements.

2 Software

The D-Opto Logger is supplied with the custom designed Windows based communication software program “D-OptoLog”. This software:

- Enables the user to communicate with the D-Opto Logger via a computer;
- Is used to setup the D-Opto Logger prior to deployment;
- Is used to download data from the D-Opto Logger to the PC after retrieval.

2.1 Installation

The D-Opto Logger is supplied with a software CD that contains the file “Install D-OptoLogX.exe” (X = version number). Double clicking the file from Windows Explorer will initiate installation onto the PC. There are no restrictions or limitations on the distribution and installation of the D-OptoLog software.

During installation, the user can select the working path and directory, however it is recommended that the default is used (“c:\Program Files\D-OptoLog”).

2.2 Operation

The D-Opto Logger is supplied with a communication cable. This cable has a 9 pin serial plug on one end, and a 3.5mm jack plug on the other end.

The 9 pin plug is plugged into the serial plug on the PC. If the PC does not have a serial port, a USB to serial adaptor can be used. This adaptor plugs into the USB port on the PC, and has a serial port that the communication cable 9 pin plug can be plugged into.

The jack plug on the communication cable is plugged into the communication socket, located inside the D-Opto Logger housing. This is accessed by removing the D-Opto Logger end cap.

When D-OptoLog is started and the current port is unavailable, a port selection window opens (Figure 1).

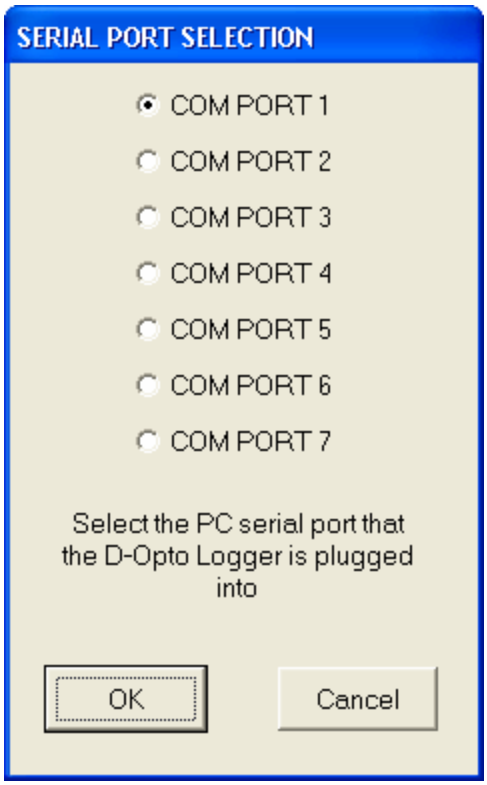


Figure 1: D-OptoLog serial port selection window.

With most computers the D-Opto Logger will be connected to com port number 1. However, if the D-Opto Logger is connected to the computer's USB port via a USB to serial converter, the port number will probably be either com port 4 or 5. The selected com port is maintained in an configuration file on the PC.

Once the correct port has been selected, and the 'OK' button pressed, the computer will start communicating with the D-Opto Logger. This may take up to 8 seconds, and when communication has begun the D-OptoLog main window will open (Figure 2).

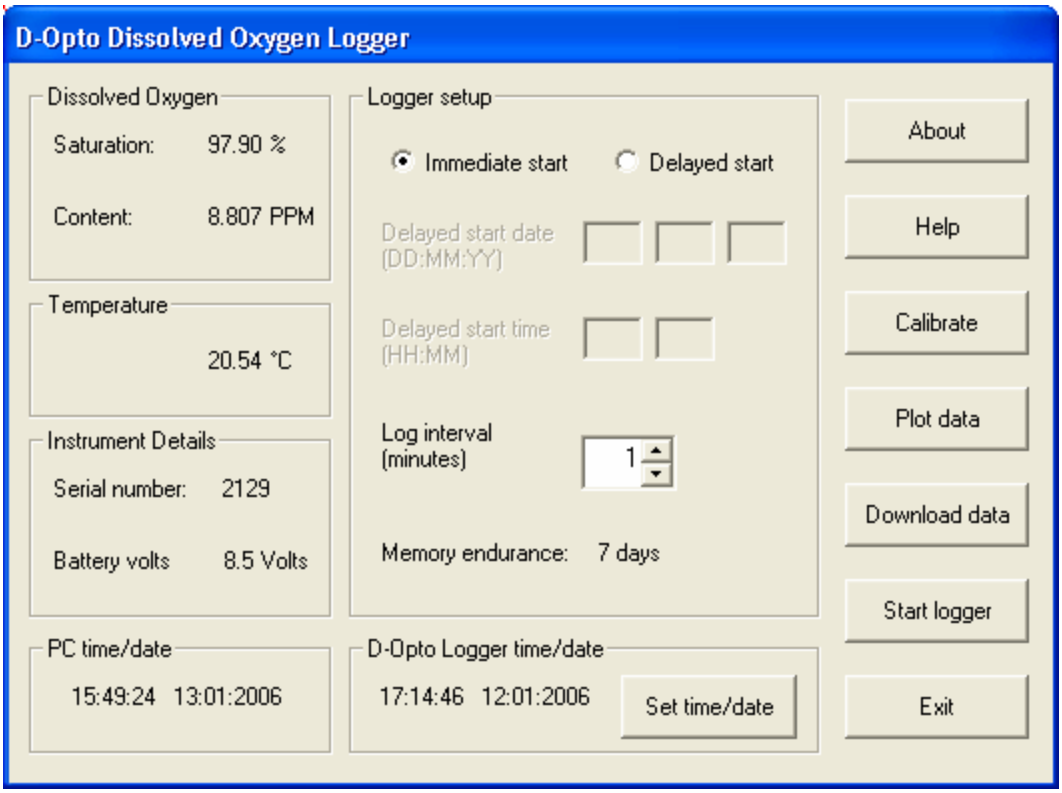


Figure 2: D-OptoLog main window

The main window displays current dissolved oxygen (% saturation and PPM) and temperature (°C) data, and is updated approximately once every second.

The serial number displayed is factory set and is unique to each D-Opto Logger. It corresponds to the number displayed on the outside of the D-Opto Logger housing.

The logger setup section enables the operator to set the desired logging parameters.

The “Plot” button enables a graphical plot of historic D-Opto Logger data to be displayed on the screen.

The “Calibration” button opens the D-Opto Logger Calibration window (Figure 4). All calibration values are calculated and stored internally by the D-Opto Logger. The “Restore Defaults” button causes the D-Opto Logger to resort back to the original factory calibrations. A full description of the calibration procedure is outlined in the operation section.

The “Altitude Correction” button opens up the Pressure Correction Calculator which provides a tool for pressure correcting the dissolved oxygen saturation

content of fully aerated water (Figure 5). It will accept either altitude (m) or barometric pressure (mBar).

By pressing the “Restore defaults” button, the original factory calibration values are reinstated by the D-Opto Logger.

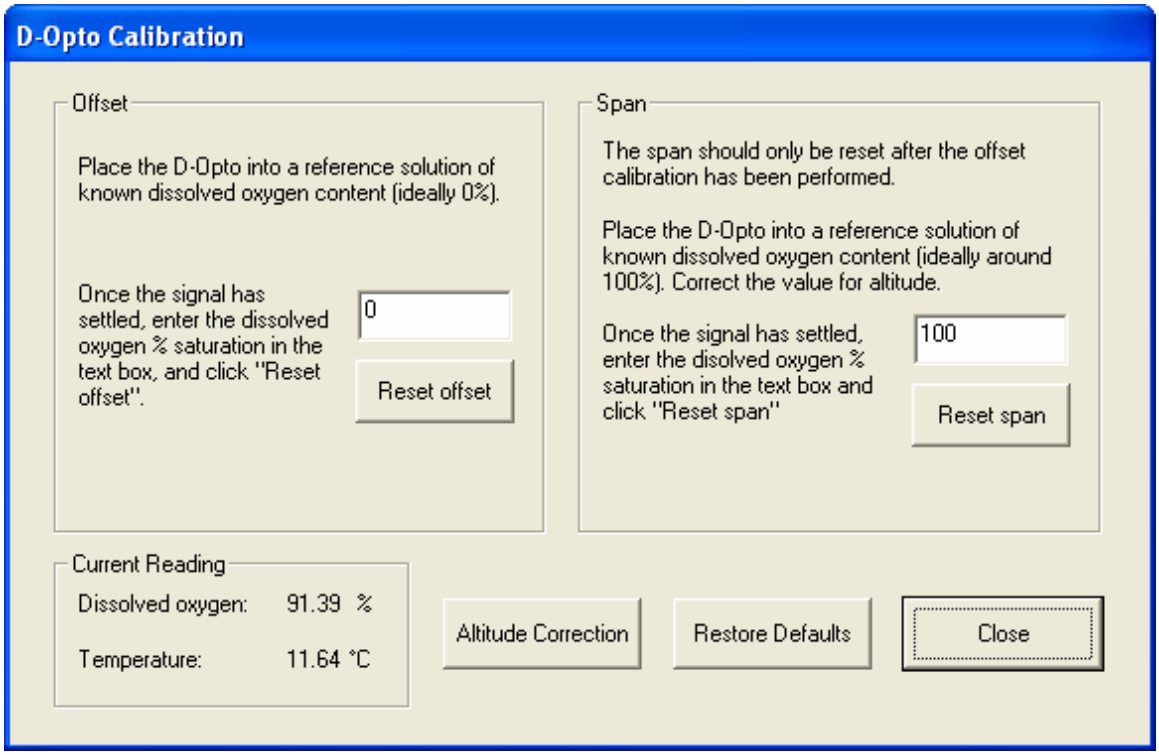


Figure 4: D-OptoLogger Calibration window.

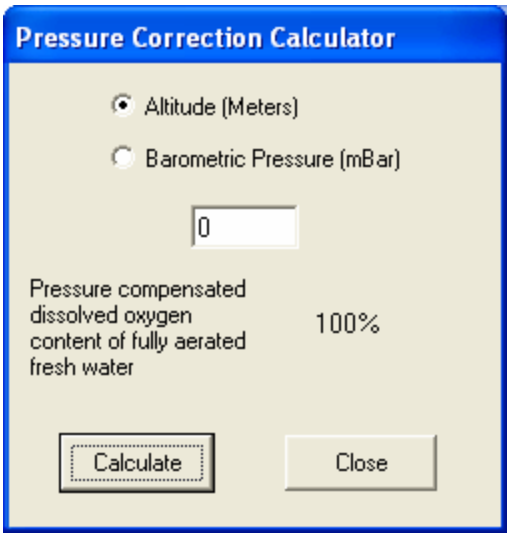


Figure 5: Pressure Correction Calculator

3 Operation

3.1 Installation

A new battery should always be used when starting a deployment. Good quality alkaline batteries such as, Duracell or Energizer, should always be used.

The D-Opto Logger can be mounted in any orientation. The body can be clamped in position; however avoid using excessive force. A safety wire can be attached to the eyelet swivel on the top cap of the logger. It is not recommended that the D-Opto Logger is suspended solely from the eyelet swivel.

3.2 Sealing the D-Opto Logger

The D-Opto Logger end cap features a dual “O” ring sealing system. It is essential that these “O” rings are properly serviced and maintained; otherwise moisture may penetrate the housing.

The “O” rings must be cleaned and lubricated each time the end cap is replaced, prior underwater deployment.

1) Using the “O” ring pick supplied, remove the “O” rings from the inside of the end cap and the body of the D-Opto Logger
2) Using a lint free tissue, clean the “O” ring seats, the corresponding “O” ring surfaces, and both “O” rings
3) Lightly grease both “O” rings with the grease supplied with the D-Opto Logger.
4) Replace the “O” rings, ensuring no hairs or particles become trapped under them.
5) Screw the end cap onto the D-Opto Logger body. **Do not over tighten**.

3.3 Logging Endurance

The D-Opto Logger can log 10,080 data records into non-volatile memory. Each data record consists of the time and date, battery voltage, dissolved oxygen percent saturation, PPM and temperature (See appendix 1).

Data is retained in the non-volatile memory until a new logging session is started, at which point the memory is cleared of the previous data.

Memory logging endurance for different logging intervals are shown in table1. In reality battery power may limit the deployment duration, not memory capacity.

The D-Opto Logger will operate correctly until the battery voltage drops below around 7.0 volts. If this occurs whilst the D-Opto Logger is in logging mode, the last set of data values in the data file will be set to zero, and the D-Opto Logger enters a low power sleep mode, with no further data values being logged.

Logging Interval (minutes)	Memory Endurance (Days) Standard D-Opto Logger
1	7
5	35
10	70
15	105
30	210
60	420

Table 1. Memory endurance

3.4 Routine Maintenance

As with all instruments, it is good operating practice to make regular checks on the quality of data being generated by the D-Opto Logger. This can be carried out on site, using one of the following two methods:

1. Place a recently calibrated transportable dissolved oxygen sensor next to the D-Opto Logger and compare the measurements. It is important to allow a sufficient period of time for temperature equilibration to occur.

2. Place the D-Opto Logger in a solution of known dissolved oxygen content. A solution of 0% dissolved oxygen saturation can be created by adding a few teaspoons of sodium sulfite to 1 litre of distilled or fresh tap water.

The D-Opto Logger can tolerate some biofouling, however where possible steps should be taken to minimise this; for example covering the D-Opto Logger can reduce the amount of bio-growth by restricting available light. . The copper biofouling control ring should reduce bio-growth in the area around the optical window; this ring is sacrificial and may require replacement on an occasional basis. Always use the nylon bolts supplied with the replacement ring to attach the ring to the D-Opto Logger, and avoid over tightening.

Periodically it may be necessary to clean the D-Opto optical window, to remove bio-growth or other accumulated deposits. **DO NOT** use a brush or any object that may scratch or damage the optical window. Only use the cleaning pads supplied with the D-Opto.

3.5 Calibration

Under normal operating conditions, the D-Opto Logger should only require infrequent calibration.

Calibration of the D-Opto Logger is a simple operation that can be carried out in the field. Due to the measurement principle of the D-Opto Logger, performing air calibrations are not advisable. The Zebra-Tech Do-Cal Kit greatly simplifies the field calibration of the D-Opto Logger.

The offset and gain of the D-Opto Logger are calibrated individually. Normally only the offset will need to be calibrated as the gain is even more stable than the offset over time. The gain should only be calibrated AFTER the offset has been calibrated.

When calibrating the D-Opto Logger, take care not to allow water to enter into the instrument.

- Offset Calibration
  A reference solution of 0% dissolved oxygen is required for the offset calibration. This can be created by mixing a couple of teaspoons of sodium sulfite into 1 litre of distilled or fresh tap water.

  Procedure:
  1) Place the D-Opto Logger in the reference solution and allow equilibrating for at least 30 minutes.
  2) Power up the D-Opto Logger, and start D-OptoLog. Once the measurements have stabilised, press the “Calibrate” button in the main window.
  3) Enter 0 (zero) in the offset calibration edit box and press the “Reset offset” button.
  4) The D-Opto Logger performs a calibration routine followed by a self check; this can take up to 30 seconds. Do not remove the D-Opto Logger from the reference solution during this period. The operator will be notified when the process is complete.

- Gain Calibration
  A solution of known dissolved oxygen content, other than 0%, should be used for the gain calibration. The most practical method is to create a fully aerated solution. This can be done by bubbling air through a container of distilled or fresh tap water, stirring frequently. After around 30 minutes, the water can be assumed to be fully saturated.

  The actual dissolved oxygen saturation can be calculated by correcting for altitude, or preferably, the local barometric pressure if that is known. The “Correction Calculator” can be used to calculate the corrected dissolved oxygen content of the fully aerated reference solution. As an example, if

the D-Opto Logger is installed at a field site at 435 meters above sea level, and a fully aerated reference solution is prepared on site, the actual dissolved oxygen percent saturation is calculated at 95%.

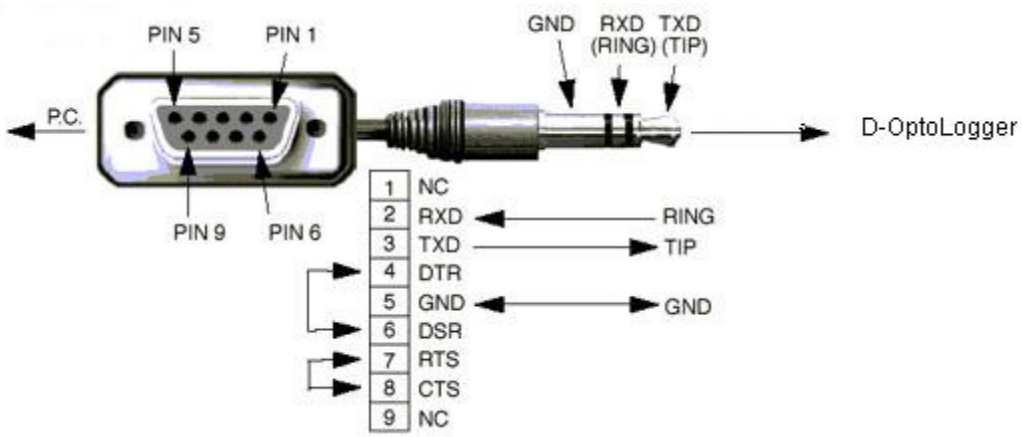
Procedure:

1) Place the D-Opto Logger is placed in the reference solution, and allow it to equilibrate for at least 30 minutes.
2) Power up the D-Opto Logger and start D-OptoLog. Once the measurements have stabilised, press the “Calibrate” button in the main window to open the Calibration window.
3) Enter the pressure corrected dissolved oxygen percent saturation of the reference solution in the gain calibration edit box and press the “Reset gain” button.
4) The D-Opto performs a calibration routine followed by a self check; this can take up to 30 seconds. Do not remove the D-Opto Logger from the reference solution during this period. The operator will be notified when the process is complete.

Appendix 1: Data File Format

Data Field Number	Description
1	Year
2	Month
3	Day
4	Hour
5	Minute
6	Second
7	Battery voltage
8	Temperature (Degrees C)
9	Dissolved Oxygen (%)
10	Dissolved Oxygen (ppm)

Appendix 2: Communication Cable Wiring Scheme



Appendix 3: LED flash sequence codes

Inside the D-OptoLogger housing, next to the battery and communication socket, there is an LED. The LED flashes according to the current status of the D-OptoLogger. The interval between the flashing sequence may be up to 8 seconds.

1 Flash = Operational
2 Flash = Delayed start
3 Flash = Not operational, waiting for PC communications
4 Flash = Memory full
5 Flash = Low battery shut down

Appendix 4: Trouble shooting

The PC starts to communicate with the D-Opto Logger, but then looses communication.

- Replace the D-Opto Logger battery

The D-Opto Logger is not communicating with the PC

- Check the battery voltage.
- Check the communications cable is plugged into the correct serial port on the PC

Dissolved oxygen readings are highly erratic, but temperature readings are stable.

The D-Opto Logger incorporates a high gain amplification circuit to measure the fluorescence of the optical window. The instrument has been carefully designed to prevent electrical interference impacting on the operation. Under extreme conditions however, noise may become a problem.

- Track down the source of noise; this could be a nearby pump or other motor.
- If the D-Opto Logger is being bench tested in a small container of water, noise can be caused by a lack of suitable earthing. Place a grounding wire from the water to the D-Opto Logger power ground.
- The D-Opto Logger is supplied with built in noise rejection specific for the country of supply. If the D-Opto Logger is being used in a country other than the country it was supplied to, contact your supplier.

The last data record in the data file consists of zero values.

- The D-Opto Logger battery ran critically flat.

Appendix 5: Specifications

Physical Dimensions
200mm long x 50mm diameter

Accuracy
Temperature: +/- 0.1 deg C
DO: 1% of reading or 0.02 PPM, which ever is greater

Resolution
Temperature: 00.01 Deg C
DO saturation: 000.01%
PPM: 00.001 ppm

Sensor Drift
< 1% per year (provided measurement interval ≥10 minutes)

Power supply
1 x PP9 - 9 volt alkaline battery. Duracell or Energizer recommended

Power consumption
12 mA during measurement, 0.07 mA between measurements

Memeory Capacity
128 KB
10080 data records

Depth rating
Maximum 30 m water depth

"O" Rings
2 of #128 (1 ½" x 3/32")

Appendix 6: Pressure correction chart

Dissolved oxygen % saturation values of air saturated fresh water, corrected for atmospheric pressure.

Altitude (m)	Altitude (feet)	Barometric pressure (mBar)	% Saturation
0	0	1013	100
85	278	1003	99
170	558	993	98
256	841	983	97
343	1126	973	96
431	1413	963	95
519	1703	952	94
608	1995	942	93
698	2290	932	92
789	2587	922	91
880	2887	912	90
972	3190	902	89
1066	3496	899	88
1160	3804	882	87
1254	4115	871	86
1350	4430	861	85
1447	4747	851	84
1544	5067	841	83
1643	5391	831	82
1743	5717	821	81
1843	6047	811	80
1945	6381	800	79
2047	6717	790	78
2151	7058	780	77
2256	7401	770	76
2362	7749	760	75
2469	8100	750	74
2577	8455	740	73
2687	8815	730	72
2797	9178	719	71
2909	9545	709	70
3023	9917	699	69
3137	10293	689	68

Appendix 7: Useful Conversions

Convert from	To	Calculation
kPA	mBar	Multiply by 10
inHg	mBar	Multiply by 33.85
Feet	Meters	Multiply by 0.3048
° Centigrade	Fahrenheit	(9/5 °C)+32

Zebra-Tech Ltd

Contact Details

PO Box 1668
Nelson
New Zealand

Tel: (0064)03 5471590
Fax: (0064)03 5471598

Email: enquiry@zebra-tech.co.nz