FluoMini Pro Optical O_2 | T Sensor

User manual

System information

FluoMini Pro type: 300

Firmware: version 200501

Software: version 2.21

Baudrate: 19200

www.sendot.nl

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1. General

1.1. Product

Product	FluoMini Pro Optical O_2|T Sensor
Version	1
Software	2.21
Firmware	200501

1.1.1. Scope of delivery

- FluoMini Pro Optical O_2|T Sensor (handheld, analog or digital)
- Optical Fiber with O_2|T Probe (1.0 m)
- USB cable (1.0 m)
- Analog cable (2.0 m; for analog sensor only)
- TTL cable (2.0 m, for digital sensor only)
- Substrate Pre-drill
- Probe support

1.1.2. Technical specifications

Specifications	**Values**
Measuring range O_2 in gas	0 to 45 %Vol (@STP)
Measuring range dissolved O_2	0 to 18 mg/L (@STP)
Measuring range O_2 saturation in water	0 to 200 % (@STP)
Temperature range	+ 5 to + 45 °C
Accuracy O_2 at > 0% O_2 < 1% O_2	± 0.1 %
Accuracy O_2 at > 1% O_2 < 25% O_2	± 0.2 %
Accuracy O_2 at > 25% O_2	± 1 % of measured value
Accuracy temperature	± 1 °C
Accuracy pressure	± 5 mBar
Accuracy dissolved O_2 at 0 to 1 mg/L	± 0.05 mg/L
Accuracy dissolved O_2 at 1 to 10 mg/L	± 0.1 mg/L

Accuracy dissolved O_2 at >10 mg/L	± 1 % of measured value
Accuracy O_2 saturation in water at 0 to 10 %	± 0.5 %
Accuracy O_2 saturation in water at > 10 %	± 1 % of measured value
Resolution O_2	0.01 %
Resolution O_2 saturation in water	0.01 % (0-10 %) 0,1 % (10-100 %)
Resolution temperature	0.1 °C
Resolution pressure	1 mBar
Response time gas (T_{90})	≤ 5 sec
Response time water (T_{90})	≤ 60 sec (depending on flow rate)
Temperature compensation	Yes
Drift / Stability O_2 at < 1 %O_2	≤ 0.1 % per month (operating frequency 0.1Hz)
Drift / Stability O_2 at > 1 %O_2 < 25 %O_2	≤ 0.2 % per month (operating frequency 0.1Hz)
Drift / Stability O_2 at > 25 %O_2	≤ 2 % per month (operating frequency 0.1Hz)
Drift / Stability dissolved O_2	≤ 0.2 mg/L per month
Sample time	> 2 sec (freq. > 1.25 Hz)
Calibration	1 or 2 point for O_2 1 point for temperature
Coating lifetime	6 months year or 50000 measurements (excluding effects of chemical incompatibility)
Connectivity	Handheld: USB serial interface Digital: USB serial interface digital output / TTL serial port Analog: USB serial interface 4 – 20 mA output (4 wires) 12 – 24 V AC/DC
Dimensions (l x w x h in mm)	169 x 62 x 25
Weight (g)	235
Housing material	Aluminium, with ABS covers
Electrical connections	Handheld: 1 x M5 4 pole male Digital: 2 x M5 4 pole male Analog: 1 x M5 4 pole male 1 x M5 4 pole female
Probe material	Stainless steel (6mm OD, l = 100) with optical fiber
Protection level	IP53

Power supply	Handheld/digital: USB port (5V, < 200 mA) Analog:12-24 V
Battery lifetime (handheld/digital)	48 h at 5 sec intervals 2 weeks at 60 sec intervals

1.2. Important user instructions

CAUTION!
Always use the included substrate pre-drill & probe support for measurements in substrate to protect the coating from any damage and guarantee an adequate measurement.

This sensor is suitable for measurements in water/fluids and air/gas. The sensor is not suitable for measurements in strongly oxidizing, strongly acidic (pH < 1) and strongly caustic (pH > 12) media. In general, it is advised to test the sensor for the required application. Some strong (fluorescing) dyes might disturb the measurement; for those applications, the sensor should be tested first. We are constantly improving our sensors. Please keep following our website (www.sendot.nl) to check for new developments.

1.3. Warranty

This product has a warranty of two years on the mechanics and electronics (excl. battery). The sensitive coating can be used for a period depending on the measurement frequency and environment where the sensor must operate in, like temperature, pressure and average oxygen partial pressure.

1.4. Transport, storage and disposal

This product is subject to the “GENERAL RESEARCH, ADVICE, SALES, DELIVERY AND PAYMENT CONDITIONS OF SENDOT RESEARCH BV (deposited with no. 62488295 bij KvK Haaglanden)”. It can be downloaded from www.sendot.nl.

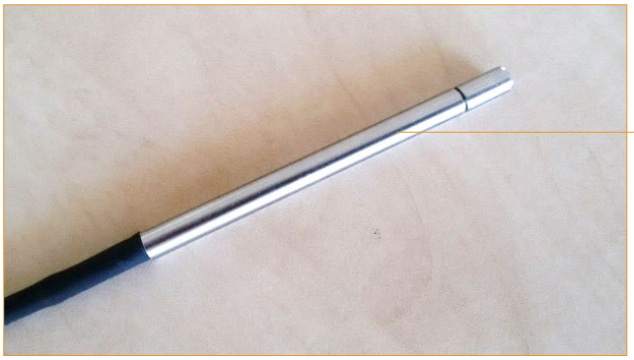
2. Installation

2.1. Unpacking and setup

The sensor will be delivered with the separate probe. It has been calibrated, ready to be used. Before first use, the sensor might need to be charged using the included USB cable. The display is protected with a plastic film that can be removed. The protection cap must be removed from the fiber and the fiber needs to be screwed on the SMA port on the top of the sensor.

For the installation of a digital or analog sensor, please read the corresponding manual.

2.2. Type probe



The FluoMini Pro Optical O_2|T Sensor is provided with a stainless-steel probe with an outer diameter of 6 mm.

2.3. Connections

2.3.1. Handheld sensor

The sensor can be connected to a Windows or Android system by means of a USB cable. Charging is possible via the USB port. A battery is included, so the sensor does not necessarily need to be attached to a power source for use.

2.3.2. Digital sensor

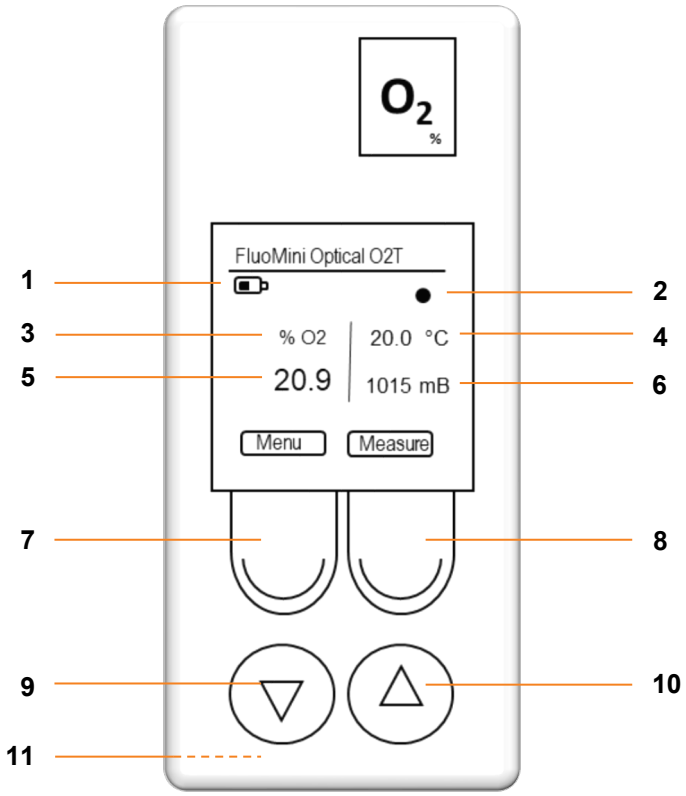
The sensor can be connected to a Windows or Android system by means of a USB cable. Charging is possible via the USB port. A battery is included, so the sensor does not necessarily need to be attached to a power source for use. Additionally, a digital input/output can be used to attach the sensor to an external control device, e.g. a wireless transmitter.

2.3.3. Analog sensor

The sensor can be connected to a Windows or Android system by means of a USB cable. A battery is not included, so the sensor must be attached to a power source via the USB port for use. Additionally, an analog output can be used to attach the sensor to an external control device (e.g. a climate computer). The sensor will also be powered through this port.

2.4. Display and buttons

In the picture below the basic sensor screen is shown, as well as the buttons with their names as being used in this manual.



1	**Battery**
2	**Measurement indicator**
3	**Measurement unit for O_2**
4	**Measured temperature**
5	**Measured O_2**
6	**Pressure**

7	**Menu/Exit button** With this button the main menu can be entered, and every menu can be quit. The feature of this button is always visible on the display (bottom left).
8	**Measure/Enter button** This button is used to end the standby mode. This and additional features of this button are always visible on the display (bottom right). This button has several features, but for simplicity, it is named Measure/Enter button throughout this manual.
9	**Down button**
10	**Up button**
11	**Reset button** This button is located on the back of the sensor and resets the sensor to factory settings. It is protected by a white plastic screw which needs to be unscrewed to reach the reset button with a thin device.

3. Measuring with the FluoMini Pro Optical O_2 | T Sensor

3.1. Measurement principle

The FluoMini Optical O_2|T Sensor has two active components embedded in a polymer host. One component measures the temperature of the coating necessary for the compensation of the oxygen measurement. The other component measures the oxygen partial pressure.

The total pressure of a gas is the sum of the so-called partial pressures of the components in the gas. A standard atmosphere is composed of oxygen, nitrogen, CO_2, water and trace gasses. (formula 1)

$$P_{total} = p_{O2} + p_{N2} + p_{CO2} + p_{H2O} + \ldots$$

The O2|T sensitive coating can be considered as a small gas compartment, in gas as well as in water. Basically, it makes no difference for the coating to measure in gas or in water. Though, in water the partial pressure of water is well defined because the humidity is always 100 %. The response time of the sensor depends on the speed with which the gas compartment in the coating will come into equilibrium with its surroundings. The gas diffusion being 10000 times faster in gas than in water causes a different response time for the two applications.

Measuring in air is relatively simple. A percentage O_2 is directly given. The measurement is pressure dependent, so the pressure is measured and can be optionally corrected for. Customers can also choose to correct for it later, if necessary. A second unknown factor, if one measures in air, is the humidity. The higher the temperature the more water can be contained by the air and the larger the influence.

If the sensor is used to measure in water, saturation% as well as mg/L measurement units are available.

3.2. Ending the standby mode

3.2.1. Handheld sensor

To save energy the sensor display automatically turns off after 30 seconds. During battery operation, the sensor will automatically go into standby mode after 1 min. The sensor will wake up again when the Measure/Enter button is pressed. When the sensor is attached to a computer or external power source, it will not turn into standby mode, only the display will turn off. If the sensor is in logging mode, the sensor turns off after each measurement.

3.2.2. Digital sensor

When the sensor is connected to an external control device (e.g. a computer) through the USB port, it will wake up when the Measure/Enter button is pressed. From that moment on, it will respond like a regular handheld sensor. When the sensor is connected through the serial digital port it will operate in a special mode. For more information about running the sensor through the digital port please contact Sendot Research *via* phone (+31 (0)30-636-8477) or e-mail (info@sendot.nl).

3.2.3. Analog sensor

This sensor has no battery, why it always must be attached to a power source to operate. The sensor display automatically turns off after 30 seconds. When the sensor is connected to an external control device (e.g. a computer) through the USB port, it will operate as a regular handheld sensor. When it is connected *via* the analog port it will also never turn into standby mode. As soon as the sensor is coupled to an external control device it will start measuring with the interval specified in the sensor and output the analog value through the port.

3.3. Measurements

Apply the probe to the medium to be measured. For measurements in substrates, always use the probe support and substrate pre-drill to avoid damages on the coating. Therefore, first apply the probe support at the desired position, make a hole using the substrate pre-drill and carefully stick in the probe until the bottom of the hole. In liquid media, air bubbles caught up on the coating can result in false measurements, why they must be avoided.

3.3.1. Single measurement

1. Press the Measure/Enter button to activate the sensor.
2. Press the Measure/Enter button again to start a single measurement.

> **Tip:** The sensor will store single measurements not automatically. This can be changed. For further information see chapter 4.2.3.

3.3.2. Continuous measurements

In continuous measurement mode the sensor will perform a measurement every 2 seconds. To activate this mode:

1. Press the Measure/Enter button to activate the sensor.
2. Press the Measure/Enter button for 2 seconds to start continuous measurements.
3. Press the Measure/Enter button for 2 seconds to stop continuous measurements.

Tip: The sensor will store measurements not automatically. This can be changed. For further information see chapter 4.2.3 and 4.3.

3.4. Logger and transmitter function

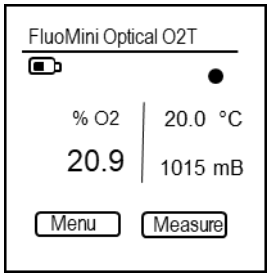
With this sensor it is possible to measure continuously. In case of a handheld and digital sensor, the data is stored on the internal memory (for further information on this logger function see chapter 4.3). In case of an analog sensor, the data is sent to an external device, e.g. a computer (for further information on this logger function see chapter 4.3).

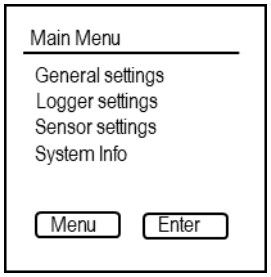
4. Settings

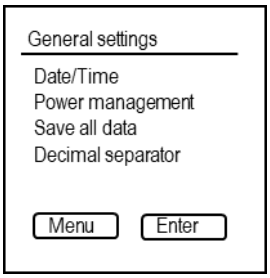
4.1. Main menu

The main menu can be entered by pressing the Menu/Exit button. The screen with the different setting options will be opened.

The main menu consists of four submenus: <General settings>, <Logger settings>, <Sensor settings>, and <System info>. To navigate towards any menu, use the Up and Down buttons and enter a submenu with the Measure/Enter button.





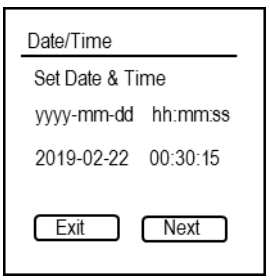


4.2. General settings

The menu <General settings> contains submenus to set date and time, control power management, save data and change the decimal separator. Use the Up and Down buttons to navigate to the desired submenu. To enter a submenu, press the Measure/Enter button.

4.2.1. Date/Time

In this menu, date and time can be set manually. Alternatively, date and time can be synchronized with the current date and time on the computer using the FluoMini Sensor Software Suite (for further information see manual for FluoMini Sensor Software Suite). Default, date and time are set to 0:00:00, 01/01/1999 and must be set after a restart due to an empty battery or a hard reset (pressing Menu/Exit button and Measure/Enter button parallel for 30 sec).

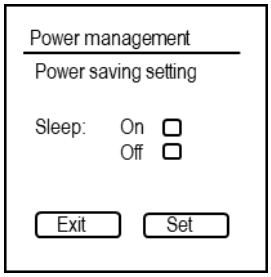


1. Open the menu <General settings>.
2. Open the menu <Date/Time>.
3. Use the Up and Down buttons to set date and time.
4. Use the Measure/Enter button (Next) to navigate to the next position in date and time.
5. Confirm settings and close menu with the Measure/Enter button.

4.2.2. Power management

In this menu, the standby mode can be turned on and off. Default, this function is turned on, so the sensor will turn into standby mode after 30 sec.

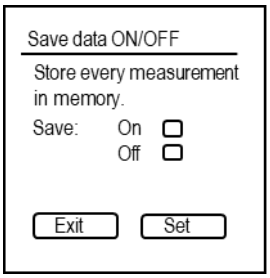
1. Open the menu <General settings>.
2. Open the menu <Power management>.
3. Use the Up and Down buttons to choose the desired setting.
4. Confirm setting and close menu with the Measure/Enter button (Set).



4.2.3. Save data

In this menu, automatic storage of every measurement can be turned on and off. Default, this function is turned off.

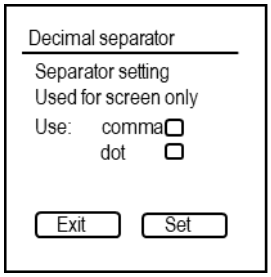
1. Open the menu <General settings>.
2. Open the menu <Save all data>.
3. Use the Up and Down buttons to choose the desired setting.
4. Close menu with the Measure/Enter button (Set).



4.2.4. Decimal separator

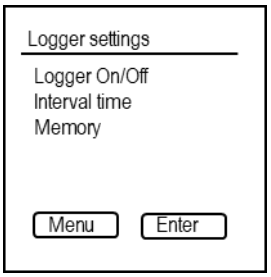
In this menu, the decimal separator for values shown on the screen can be changed.

1. Open the menu <General settings>.
2. Open the menu <Decimal separator>.
3. Use the Up and Down buttons to choose the desired setting.
4. Confirm setting and close menu with the Measure/Enter button (Set).

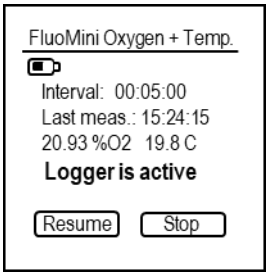


4.3. Logger settings (handheld/digital)

With the logger function continuous measurements are performed and stored internally. Within the menu <Logger settings> the logger function can be turned on and off, the interval time of the measurements can be set, or the stored data erased. Use the Up and Down buttons to navigate to the desired submenu. To enter a submenu, press the Measure/Enter button.



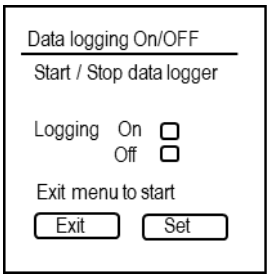
Remark: If the sensor is in logging mode, it is not possible to communicate with the sensor through an external device, e.g. a computer. Logging must be stopped first to communicate with the sensor. Nevertheless, by pressing the Measure/Enter button the last measured value will be visible on the display.



4.3.1. Logger On/Off

In this menu, the logger function can be turn on and off.

1. Open the menu <Logger settings>.
2. Open the menu <Logger On/Off>.
3. Use the Up and Down buttons to choose the desired setting.
4. Confirm the setting with the Measure/Enter button (Set).



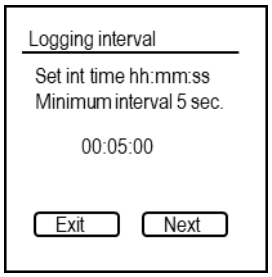
5. Exit menu with the Menu/Exit button. Logging will start automatically.

If date and time have not been set in advance, the sensor will show an error (Date & Time not set.). In this case, the logger function can still be started, if wanted. To start the logger function, press the Measure/Enter button (Ignore) or wait for 5 sec. The start date and time will be set to 00:00, 01/01/1999. Another option is to cancel the logger function by pressing the Menu/Exit button (Cancel). Now, date and time can be set before the logging function is started again (see chapter 4.2.1).

4.3.2. Interval time

In this menu, the time interval between the measurements during logging can be changed. For the most applications, an interval time of 5 min or higher is sufficient. The interval time should be set before the first use of the sensor.

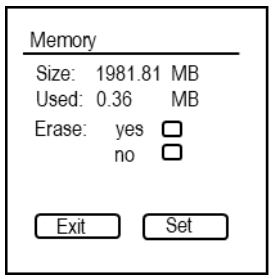
1. Open the menu <Logger settings>.
2. Open the menu <Interval time>.
3. Use the Up and Down buttons to change value.
4. Use the Measure/Enter button (Next) to navigate to the next position in time (hh:mm:ss).
5. Confirm the setting and close menu with the Measure/Enter button.



4.3.3. Memory

In this menu, the storage volume in total as well as used by stored data can be read. The stored data can be deleted.

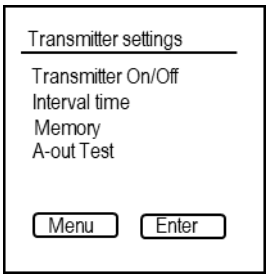
1. Open the menu <Logger settings>.
2. Open the menu <Memory>.
3. Use the Up and Down buttons to choose the desired setting.
4. Confirm the setting and close menu with the Measure/Enter button (Set).



It is advisable to use the FluoMini Sensor Software Suite to store the data on a computer before the data is deleted from the sensor's memory.

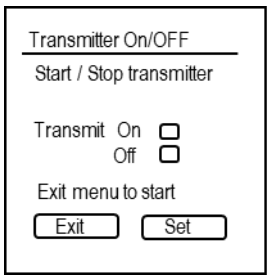
4.4. Transmitter settings (analog)

With the transmitter function continuous measurements are performed and send to an external device, e.g. computer. Within the menu <Transmitter settings> the transmitter function can be turned on and off, the interval time of the measurements can be set, stored data erased and the analog output being tested. Use the Up and Down buttons to navigate to the desired submenu. To enter a submenu, press the Measure/Enter button.



4.4.1. Transmitter On/Off

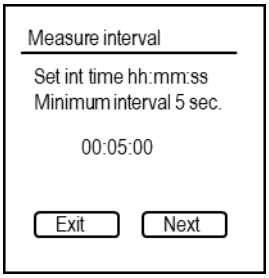
In this menu, the transmitter function can be turn on and off.



1. Open the menu <Transmitter settings>.
2. Open the menu <Transmitter On/Off>.
3. Use the Up and Down buttons to choose the desired setting.
4. Confirm the setting with the Measure/Enter button (Set).
5. Exit menu with the Menu/Exit button. Transmitting will start automatically.

4.4.2. Interval time

In this menu, the time interval between the measurements transmitted can be changed. For the most applications, an interval time of 5 min or higher is sufficient. The interval time should be set before the first use of the sensor.

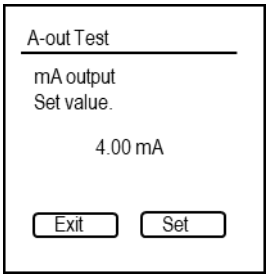


1. Open the menu <Transmitter settings>.
2. Open the menu <Interval settings>.
3. Open the menu <Interval time>.
4. Use the Up and Down buttons to change value.

5. Use the Measure/Enter button (Next) to navigate to the next position in time (hh:mm:ss).
6. Confirm the setting and close menu with the Measure/Enter button.

4.4.3. A-out Test

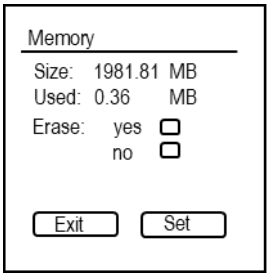
This function only applicable for analog sensors and is to test the analog output signal send to an external device, e.g. computer.



1. Open the menu <Transmitter settings>.
2. Open the menu <A-out Test>.
3. Use the Up and Down buttons to set a value.
4. Confirm the value with the Measure/Enter button (Set). A signal will be sent to the external device, which is translating it into % O_2.
5. Compare this value with the O_2 and temperature on the external device. For O_2, 4 – 20 mA can be translated to 0 - 30 % O_2 for air saturation, 0 - 200 % O_2 for saturation or 0 - 20 mg/L for dissolved oxygen, depending on the settings. Therefore, a change of 1 mA relates to a change of 0.53 %, 0.08 % or 0.8 mg/L, respectively. For the temperature, 4 – 20 mA can be translated to -10 – 100 °C. Therefore, a change of 1 mA relates to a change of 6.875 °C.

4.4.4. Memory

In this menu, the storage volume in total as well as used by stored data can be read. The stored data can be deleted as followed:

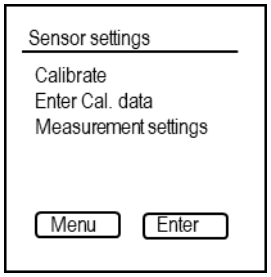


1. Open the menu <Transmitter settings>.
2. Open the menu <Memory>.
3. Use the Up and Down buttons to choose the desired setting.
4. Confirm setting and close menu with the Measure/Enter button (Set).

Remark: It is advisable to use the FluoMini Sensor Software Suite to store the data on a computer before the data is deleted from the sensor's memory.

4.5. Sensor settings

Within this menu, the sensor can be calibrated automatically or manually. Additionally, the measurement units can be changed.



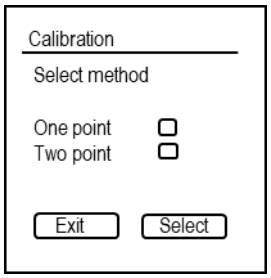
4.5.1. Calibrate

The FluoMini Pro O_2|T Sensor has been calibrated prior to delivery. Therefore, no calibration is necessary. Whenever the probe is exchanged, the sensor must be recalibrated for this new probe.

Remark: When you have more than one FluoMini Pro O_2|T Sensor, you cannot exchange the probes with each other without a new calibration. Ensure to always use the same probe for a FluoMini Pro O_2|T Sensor to guarantee reproducible measurements.

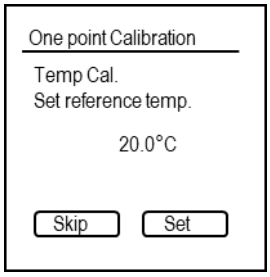
In this menu, the sensor can be calibrated automatically for a new probe. Calibration can be performed either as a 1-point calibration (at 20.95 % O_2) or a 2-point calibration (at 0 % and 20.95 % O_2). To choose the desired calibration mode:

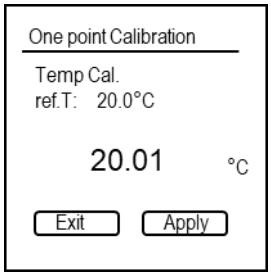
1. Open the menu <Sensor settings>.
2. Open the menu <Calibrate>.
3. Use the Up and Down buttons to navigate to the desired calibration mode.
4. Confirm the mode with the Measure/Enter button (Select).

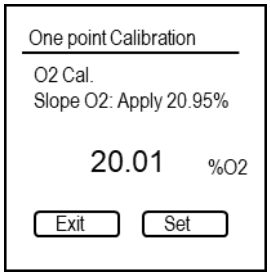


The temperature is always the first parameter to be calibrated. A temperature calibration is advisable for accurate measurements but can be skipped by pressing the Menu/Exit button (Skip), if wanted. If so, the sensor will automatically ask for the next parameter to be calibrated.

For a 1-point calibration (incl. temperature calibration):

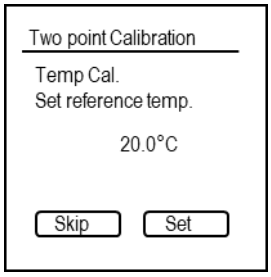


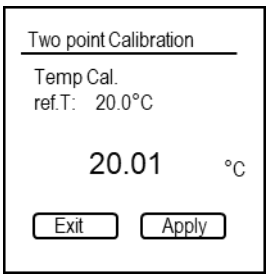


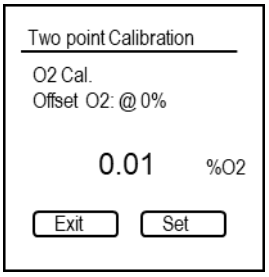


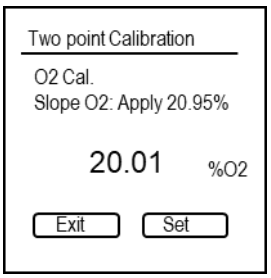
1. Expose the probe to 20.95 % O_2 environment.
2. Use the Up and Down buttons to set the actual temperature.
3. Confirm the setting with the Measure/Enter button (Set).
4. Wait until the measured temperature on the display has stabilized and press the Measure/Enter button (Apply).
5. Wait until the measured O_2 value on the display has stabilized and press the Measure/Enter button (Set).

For 2-point calibration (incl. temperature calibration):







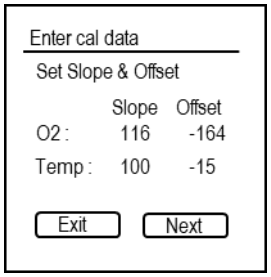


1. Expose the probe to 20.95 % O_2 environment.
2. Use the Up and Down buttons to set the actual temperature.
3. Confirm the setting with the Measure/Enter button (Set).
4. Wait until the measured temperature on the display has stabilized and press the Measure/Enter button (Apply).
5. Expose the probe to 0 % O_2.
6. Wait until the measured O_2 value on the display has stabilized and press the Measure/Enter button (Set).
7. Expose the probe to 20.95 % O_2.

8. Wait until the measured O_2 value on the display has stabilized and press the Measure/Enter button (Set).

4.5.2. Enter Cal. data

In this menu, you can manually add an offset and slope to the measured amount of O_2 and the temperature. These values will be set by the system automatically during the calibration (see chapter 4.5.1).



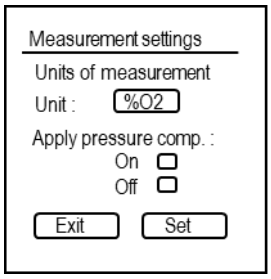
1. Open the menu <Sensor settings>.
2. Open the menu <Enter Cal. data>.
3. Use the Up and Down buttons to adjust slope and offset.
4. Use the Measure/Enter button to navigate to the next position.
5. Confirm settings and close the menu with the Measure/Enter button.

4.5.3. Measurement settings

The sensor offers several measurement units to display the results:

- mg/L (water)
- $\%O_2$ (gas)
- %saturation (water)

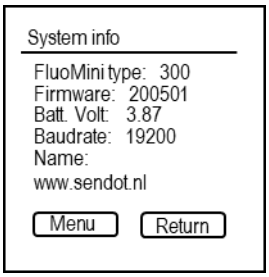
Within this menu, units can be changed. Additionally, the pressure compensation can here be activated or deactivated.



1. Open menu <Sensor setting>.
2. Open menu <Measurement settings>.
3. Use the Up and Down buttons to choose the desired unit.
4. Confirm the setting with the Measure/Enter button (Set).
5. Use the Up and Down button to turn the pressure compensation on or off.
6. Confirm the setting and exit the menu with the Measure/Enter button.

4.6. System info

The menu System info contains information about the FluoMini type, the installed firmware, the battery voltage and the baud rate necessary to communicate with the sensor. Additionally, the sensor can be named using the FluoMini Software Suite (for further info see manual for FluoMini Software Suite). In this menu, the given name is visible.



5. Troubleshooting

The display stays black and the sensor is not reacting anymore.

1. Recharge the sensor using the included USB cable. The battery might be empty.
2. If the sensor is still not responding, reset the sensor by pressing the Up and Down button at the same time for 2 sec.
3. If the sensor still not reacts, the sensor can be reset to factory settings by pressing the Up and Down button at the same time for 30 sec.
4. If the sensor still not reacts, press the reset button on the back of the sensor. Therefore, screw of the white plastic screw on the back of the sensor. Use a thin plastic or metal device, e.g. an open paper clip, to carefully press the button. Close the hole with the screw again.
5. If there is still no response, please contact Sendot Research *via* phone (+31 (0)30-636-8477) or e-mail ((info@sendot.nl).

The following errors can be visible on the display:

Low signal

1. Check if the fiber is properly attached to the sensor and the coating is still intact.
2. If this message is still shown, the lifetime of the coating might have been reached. In this case the probe needs to be exchanged. Therefore, please contact Sendot Research *via* phone (+31 (0)30-636-8477) or e-mail (info@sendot.nl).

Error opening logfile

1. Check if the sensor is properly attached to the computer. Reattach the sensor and press refresh in the menu Sensors in the FluoMini Software Suite.
2. If date & time of the logging strongly changes, reading the logfile might not be possible. This can happen, if the time has been changed between two log sessions or if the sensor logged once without a set time & date, followed by logging with set time & date. It is advisable to set time & date before the first log. If the time changes (e.g. different time zone), the memory should be emptied in between.

No SD card

1. The communication between the sensor and the internal memory is interrupted. Please contact Sendot Research *via* phone (+31 (0)30-636-8477) or e-mail ((info@sendot.nl).

Red battery icon

This icon is showing that the battery is empty. In this case the sensor needs to be recharged with the included USB cable.