



Field Datalogger Mini Manual



FIELD DATALOGGER MINI MANUAL
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1 WARRANTY AND LIABILITY

This product is for research use only. Not for use in human diagnostic or therapeutic procedures.

1.1 Warning

Microsensors have very pointed tips and must be handled with care, to avoid personal injury, and only by trained personnel.

Unisense A/S recommends users to attend instruction courses to ensure proper use of the products.

1.2 Warranty and liability

The Field DataLogger Mini is covered by a one-year limited warranty.

The warranty does not include repair or replacement necessitated by accident, neglect, misuse, unauthorized repair, or modification of the product. In no event will Unisense A/S be liable for any direct, indirect, consequential or incidental damages, including lost profits, or for any claim by any third party, arising out of the use, the results of use, or the inability to use this product.

1.3 Repair or adjustment

Equipment that is not covered by the warranty will, if possible, be repaired by Unisense A/S with appropriate charges paid by the customer. In case of return of equipment please contact us for return authorization.

For further information please see the documents General Terms of Sale and Delivery of Unisense A/S, and Warranty and Shipping Information as well as the manuals for the respective products.

1.4 SensorTrace Suite Software

Unisense SensorTrace Suite software is checked and validated for the Windows platform as given in the specification. The Customer must ensure PC is fully updated and no conflicting third-party software is installed. Unisense do not warrant compliance with any other operating systems, language settings or third-party software.

For instrumentation and sensors, please refer to our warranty conditions as given in the document "General Terms of Sale and Delivery of Unisense A/S" found on www.unisense.com

1.5 License agreement

The following terms shall apply to the software provided by Unisense A/S ("Unisense") relating to the simultaneous sale to you ("Customer") of a Unisense SensorTrace Suite Software.

All rights, title and interest in the software belong to Unisense. Unisense grants to the Customer a royalty-free, non-exclusive and non-transferable license to use the software solely relating to the Unisense Product purchased from Unisense simultaneously with the purchase of the software. The Customer undertakes not to copy, modify, reverse engineer, disassemble or de-compile all or any part of the software or rent, lease, distribute or sell the software. The Customer shall, however, be entitled to make one copy of the software for

backup and recovery purposes for use solely relating to the Unisense Products supplied by Unisense together with the software.

Nothing in this License Agreement or any other agreement between Unisense and the Customer shall be construed as an obligation for Unisense to provide to the Customer updates of the software. This License Agreement shall automatically terminate if the Customer violates the terms of the license. In case of termination of the license the Customer shall immediately destroy the software and any copy thereof.

2 CONGRATULATIONS WITH YOUR NEW PRODUCT

2.1 Support, ordering, and contact information

The Field DataLogger Mini uses Unisense microsensors which are miniaturized Clark-type sensors that facilitate reliable and fast measurements with a high spatial resolution designed for research applications.

If you wish to order additional products or if you encounter any problems and need scientific/technical assistance, please do not hesitate to contact our sales and support team. We will respond to your inquiry within one working day.

E-mail: sales@unisense.com

Unisense A/S Tueager 1
DK-8200 Aarhus N, Denmark
Tel: +45 8944 9500
Fax: +45 8944 9549

Further documentation and support is available at our website www.unisense.com

Note: If you find errors in this manual or have suggestions to improvements, do not hesitate to contact us at sales@unisense.com

3 OVERVIEW

The Field DataLogger Mini (FDL Mini) is a digital microsensor amplifier with datalogger capability. It can operate as an autonomous unit that measures and logs data as specified by the user before deployment. After deployment data may be downloaded to a Windows PC using the SensorTrace Logger software. Alternatively, it can be operated from a Windows PC using the SensorTrace Logger software displaying and logging data in real time.

The FDL Mini comes with 2 or 4 sensor channels. The sensors (O₂, STOX, N₂O, H₂, H₂S, NO, pH, redox) are connected to the instrument via an In Situ UniAmp amplifier with a 2 m cable. Each amplifier is specific for one sensor type, except STOX amplifier which can also be used with a standard oxygen sensor.

The FDL Mini may be used with STOX sensors with a detection limit of < 10 nM O₂. The data collected includes both the oxygen signal and the front guard polarization signal. For easy extraction of data.

The FDL Mini may be integrated with other platforms. It may be powered from a CTD or ADV or other source using a 6 – 28 V power supply, and store and synchronize the measured data on a third-party device via the 0 – 5 V analog or RS-232 output from the FDL Mini.

3.1 *Operating and setup conditions*

The Field DataLogger Mini is built for 6000 m water depth.

Important: The bulkhead connectors on the FDL Mini must never be open when the unit is submerged. Each connector on the unit must either be mounted with the appropriate cable or must be covered with the appropriate dummy plug (see Figure 1).

Temperature: -10°C - 60°C

Internal battery: 13 Ah @ 7.4 V, deployment time up to 3 months @ 25°C

External battery: 2 x 13 Ah @ 7.4 V, deployment time: up to 6 months @ 25°C (to be purchased separately)

3.2 Field DataLogger Mini external features

The FDL Mini has connectors for the In Situ UniAmp at one end and for charging (Figure 1), communication and the Off-dongle at the other end (Figure 2).



Figure 1: Four channel FDL Mini seen from the sensor connector end. An In Situ UniAmp amplifier is plugged into channel 1 and channels 2-4 are closed with dummy plugs.



Figure 2: FDL Mini with Off-dongle and dummy at the non-sensor end.

4 SYSTEM FEATURES

The Field DataLogger Mini is an excellent tool for long-term studies with continuous and automated measurements at depths up to 6000 m. The support for the very sensitive O₂ sensors – STOX sensors – also makes it ideal for working in oxygen minimum zones.

The FDL Mini comes with 2 or 4 channels for O₂, STOX, N₂O, H₂, H₂S, NO, pH, and redox sensors

4.1 *Equipment to use with the Field DataLogger Mini*

Included with the Field DataLogger Mini:

- External charger with cable (MDL-CHG001)
- PC communication cable (MDL-COM001)
- Off-dongle (MDL-POWER DOWN001)
- SensorTrace Logger software for check, setup, calibration, and data retrieval
- Built-in battery (13 Ah @ 7.4 V. Deployment up to 3 months @ 25 °C)

Not included (to be ordered separately)

- Unisense in-situ microsensors
- External battery (2 x 13 Ah @ 7.4 V. Deployment up to 6 months @ 25 °C)

5 SOFTWARE FOR THE FIELD DATALOGGER MINI

The FDL Mini comes with the SensorTrace Logger software and the latest version can be downloaded from the Unisense support page: <http://www.unisense.com/support/>

Using the SensorTrace Logger it is possible to run the FDL Mini online with live data, to setup the FDL Mini for autonomous logging and to download data acquired by the FDL Mini in autonomous mode after deployment. Furthermore, it allows calibration of sensors and it is possible to calibrate already collected raw data using a new or any already saved calibration.

SensorTrace Logger is freeware and can be downloaded at:

https://www.unisense.com/Software_download/

6 GENERAL FEATURES

6.1 *Operating principles*

6.1.1 *The Always on principle*

The FDL Mini is “Always on” meaning that whenever it has power (from external supply or internal battery) and the “Off-dongle” is not connected, it will log data using the settings last specified by the user.

6.1.2 *File creation*

The FDL Mini will keep logging data to a file until a new file is created. A new file is created when:

- The FDL Mini is switched off and turned on again (e.g. mounting the “Off-dongle” for 5 seconds and removing it again. Wait 30 seconds before connecting to a PC)
- The internal time setting of the FDL Mini is changed
- The FDL Mini sampling rate is changed
- STOX support is either enabled or disabled for one of the data channels

6.1.3 *Download of data*

The data can be downloaded at any time from the FDL Mini using the SensorTrace Logger software. Downloading data will not interrupt the data logging process. The FDL Mini will continue to store data in the same file and append it to the data that are already stored. Therefore, when data is downloaded at the end of a deployment the file will contain all data from that deployment. Downloading data during a deployment can be used as a sneak peek to see how things are going.

6.1.4 *Data calibration*

Sensors must be calibrated before deployment. The calibration data are stored in a SensorTrace Logger file on the PC. Data are recorded uncalibrated in the FDL Mini. These uncalibrated data are merged with the calibration file after download. It is recommended to calibrate sensors also after deployment to check for and potentially correct for any sensor drift.

6.2 *Sensors for the Field DataLogger Mini*

The FDL Mini can be equipped with sensors for O₂, H₂, H₂S, NO, N₂O, pH and redox. The sensors can in the shallow version be deployed down to 50 m and in the deep-sea version down to 6000 m. Only the N₂O sensor is not available in a deep-sea version.

Temperature is logged continuously from a sensor mounted inside the pressure housing.

NOTE: Deep sea sensors have a silver wire that must be removed before mounting in the in situ connector. This will enable pressure compensation (see 6.3 and the In Situ UniAmp Connector System manual)

6.3 In Situ UniAmp amplifiers and sensor connection

The sensors are connected to the FDL Mini via an In Situ UniAmp amplifier. The in situ amplifier has a 3 m cable between the SubConn connector at one end and the stainless steel electronics housing at the other. The sensor is connected to the electronics housing using an in situ connector. For underwater use, the in situ connector must always be filled with oil. See the In Situ UniAmp Connector System manual for how to use the in situ amplifiers.

An In Situ UniAmp amplifier is specific for one sensor type. For example, an amplifier for H₂ sensors will only work with H₂ sensors. The only exception is that an amplifier for STOX sensors will also work for normal O₂ sensors.

6.4 Support for STOX sensors

A STOX In Situ UniAmp amplifier is required in order to use STOX sensors for measuring extremely low O₂ concentrations. The timing and the polarization for the on/off cycles of the front guard can be set individually for each amplifier. The data file will contain both the signal for oxygen concentration and a signal indicating whether the front guard polarization is on or off.

6.5 Charging and battery

Battery lifetime is about 3 months at 25 °C.

Charging time is about 5 hours.

Battery state can be seen in the Unisense Logger software. See 7.3.4 *Checking battery level and storage capacity*.

6.6 Computer connection

The PC communication cable (MDL-COM001) connected to the communications bulkhead connector allows communication between the FDL Mini and a computer. Using the SensorTrace Logger software the settings of the FDL Mini may be changed, logged data may be downloaded, and the instrument may be used online.

6.7 Logging capabilities

The FDL Mini comes with 8 GB (micro SD) of data storage capacity. 24 hours logging of the signal from four sensors at 1 data point per second gives 2.3 MB corresponding to more than 3000 days of data storage capability with 8 GB memory.

The FDL Mini can log data at five different intervals: 1 sec. (Middle), 10 sec. (Low) or 60 sec. (Very low). All channels will log at the same frequency.

6.8 Connection with external units

The FDL Mini can send data in real time to external units such as CTD's or ADV's using RS-232 serial protocol or a ± 5 V analog output. Using the serial protocol the external unit can

poll the FDL Mini for getting the latest data point. Please contact Unisense if details on the serial communication protocol are needed.

6.9 Cables and connectors

The FDL Mini comes with a PC cable, an Off-dongle, a charger, dummy plugs for all bulkheads, and the number of In Situ UniAmp amplifiers that was ordered. Cables for connecting the FDL Mini with external units are ordered separately.

7 WORKING WITH THE FIELD DATA LOGGER MINI

7.1 Connecting the Field DataLogger Mini to a PC

Start up the FDL Mini by removing the Off-dongle first, then connect it to a USB port on a Windows PC using the supplied cable. The cable must be removed from the FDL Mini during start up. Once connected, start the Unisense Logger software which will automatically detect the instrument and show the available channels. Clicking the *Scan* button will force the Logger software to re-connect to the instrument.

7.1.1 Powering the FDL Mini on and off.

- Powering off: Connect the Off-dongle
- Powering on: Remove the Off-dongle (the communication cable must be removed)
- Restarting: Connect the Off-dongle for 5 seconds, then remove it again
- Connect to PC: Wait 30 seconds from powering up the FDL Mini before connecting it to a PC. The communication cable must be removed from the FDL Mini during start up

7.2 Charging and battery life

The battery is charged by connecting the external charger with the bulkhead connector on the non-sensor end of the FDL Mini. A full charge will take about 5 hours.

The instrument will run for about 10 - 20 days at 25°C on a full charge. Battery lifetime decreases with decreasing temperature and is about half at 4°C

7.3 Configuring the Field DataLogger Mini

Connect the In Situ UniAmp amplifiers to the FDL Mini.

Open the SensorTrace Logger software. The FDL Mini must be connected to the PC with the supplied USB cable and the Off-dongle must not be connected.

Logger will now display the available channels. Channel 1 will always be temperature (read from a sensor inside the pressure housing). If you have a 2-channel version channels 1 - 3 will be shown and if you have a 4-channel version channels 1 - 5 will be shown.

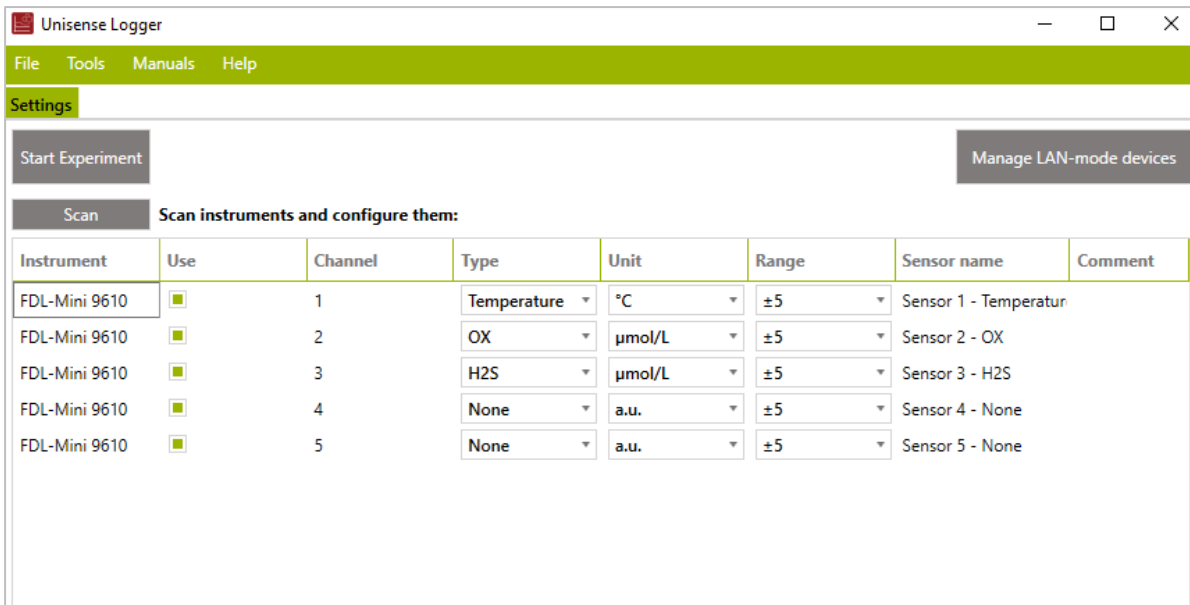


Figure 3: Channel setup window. The FDL Mini has been connected to a PC and Logger has been started. Sensor type, concentration unit etc. can be set. Clicking “Start Experiment” will create a file which will allow calibration of sensors, logging of data, setup of the FDL Mini etc. STOX-mode is not enabled

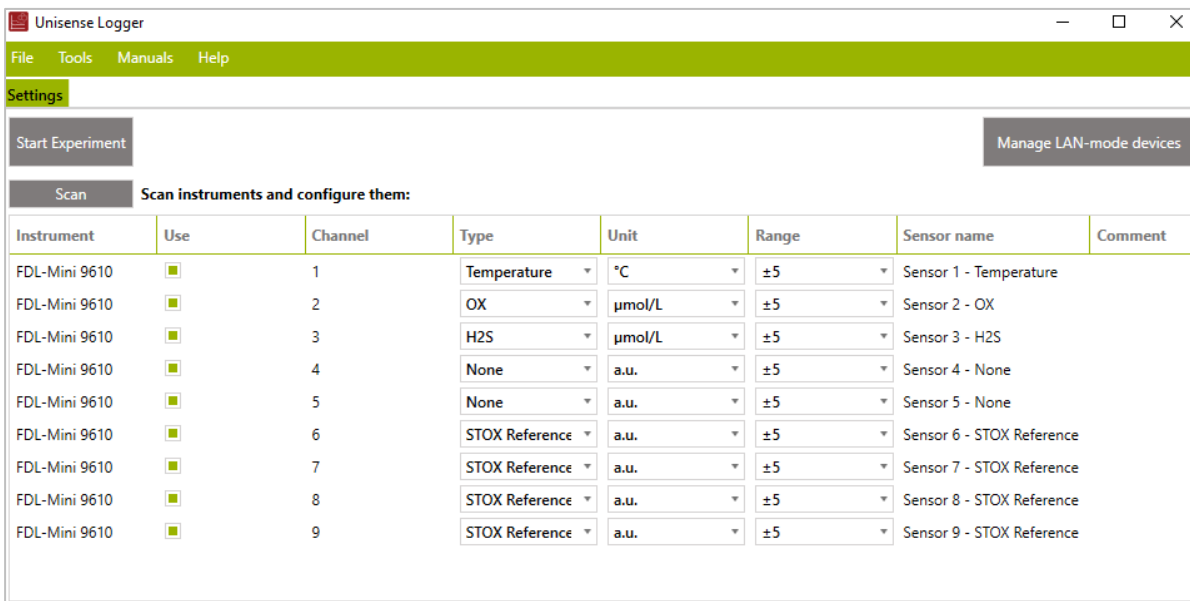


Figure 4: Same as Figure 3 but with STOX-mode enabled (see 7.3.1).

7.3.1 Enable STOX-mode

Right click the channel that you wish to change settings and this window will open:

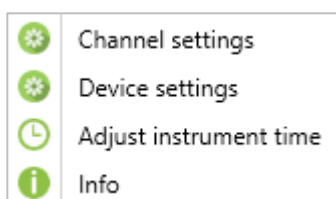


Figure 5: Right click on one of the channels in Figure 3 will open this window. Both channel specific and general settings can be modified.

Select *Channel settings* and in the window, that opens, you can *Enable STOX-mode*. If STOX-mode is enabled, the STOX-timing will be shown and can be changed (see the manual for the STOX sensor for selecting the correct on- and off-time and polarization).

The *Polarization (mV)* box will only have effect for FDL mini with sensors mounted directly on the FDL Mini. Polarization of sensors mounted on In Situ UniAmp amplifiers is physically set by the electronics and cannot be changed. However, changing the sign of the polarization voltage will change the sign of the sensor signal.

NOTE: If selecting or deselecting *Enable STOX-mode*, the grey *Scan* button in the upper left of the main Logger window must be clicked to apply the changes to the FDL Mini. This will create a new logging file in the FDL Mini (see 6.1.2).

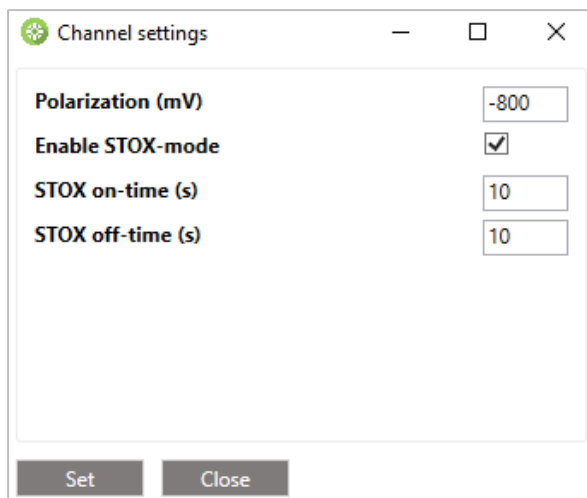


Figure 6: Channel specific settings. NOTE: Polarization will only have effect for FDL Mini with sensors mounted directly on the instrument. The polarization of sensors mounted via In Situ UniAmp amplifiers is physically set by the electronics and cannot be changed. Changing the sign of the Polarization will change the sign of the signal.

7.3.2 Setting sampling rate

Right click one of the channels and select *Device settings*. In the window that opens you may select the datalogging frequency for the FDL Mini. Logging in the FDL Mini may occur at the following intervals (Figure 7):

- 1 sec. (Middle)
- 10 sec. (Low)
- 60 sec. (Very low)

Data from all channels are logged at the same frequency.

NOTE: The *Sampling rate* settings only affect the internal data logging on the FDL Mini. When the FDL Mini is connected to a PC the data transfer frequency is always 1 Hz but the internal logging in the FDL Mini still runs at the frequency specified in the *Sampling rate* window. To log data at a different interval on the PC, change the *Sampling interval* in the *Datalogger window* in SensorTrace Logger.

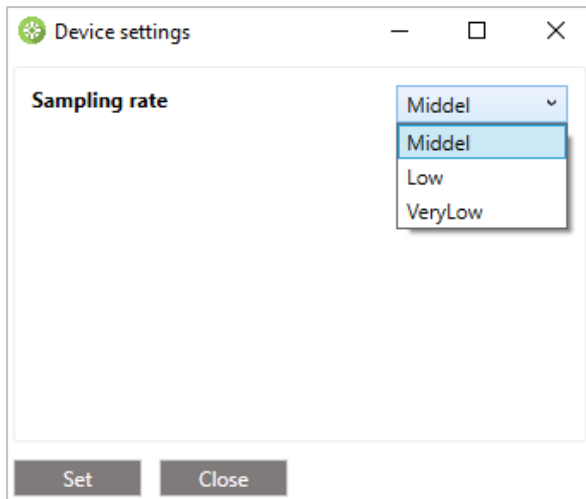


Figure 7: Setting data logging rate.

7.3.3 Changing the instrument time

Right click one of the channels and select *Adjust instrument time*. In the window that opens (Figure 8) the current FDL Mini date and time is displayed as *Instrument time*. The *New time* box shows the date and time of the PC. Clicking *New time* will update this.

- Click the *Set* button to set the instrument time to the date and time displayed in the *New time* box
- Click the *Synchronize* button to set the instrument time to the current date and time of the connected PC

NOTE: Setting the date and time of the FDL Mini will create a new logging file in the FDL Mini.

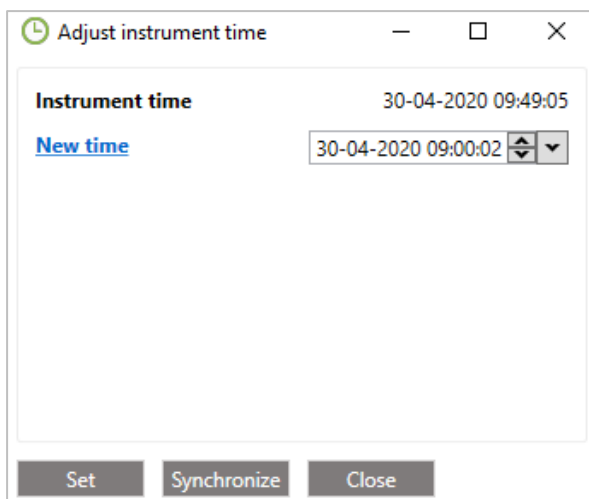


Figure 8: Display and adjustment of the internal clock in the FDL Mini.

7.3.4 Checking battery level and storage capacity

Right click one of the channels and select *Info*. Details about the instrument including the battery level and storage capacity are shown (Figure 9).

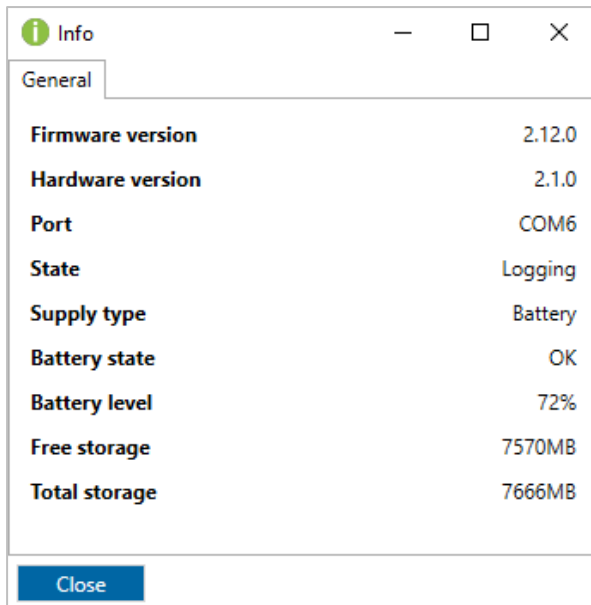


Figure 9: Status of the FDL Mini.

7.3.5 Setting individual channel information

There are a number of settings available for setting up information for each of the channels on the setup window (Figure 3 and Figure 4).

Use: Mark the checkboxes for the channels/sensors you want to view and record signals from.

Type: Choose sensor type from the drop-down menu.

Unit: Select an appropriate concentration unit for the sensor signal when calibrated.

Range (V): Select the voltage range for the amplifier. For standard sensors, the ± 5 V will be fine.

It is possible to adjust this to get the most out of the resolution of the amplifier matching the expected signal range of the sensors. It is recommended not to select an unnecessarily high range either, as this may cause loss of resolution. However, the range should not be chosen so small that the signal gets beyond the selected range as this will cause the amplifier to get out of range.

Name: Write a name describing your sensor (optional).

Comment: Write a comment about your sensor (optional).

7.4 Connecting the sensors

The sensor is connected to a Microsensor In Situ Amplifier which via cable is connected to the bulkhead connector on the pressure housing. The sensor needs to be mounted on an In Situ Connector which is then connected to the In Situ Amplifier. See separate manuals for this: <http://www.unisense.com/manuals/>

NOTE: Most microsensors require some time to stabilize after being connected. Consult the manual or each sensor type for more information. Therefore, it is recommended to connect the sensors at least a few hours, or the day before if possible, before calibration. To shorten the time needed after mounting the sensor on the FDL Mini, the sensors may be connected to a Unisense lab amplifier, for a few hours before being mounted on the FDL Mini. This requires a special cable.

7.5 Downloading data to PC

Connect the FDL Mini to a Windows PC and start the Unisense Logger software. The instrument with all its channels should now be displayed (as in Figure 3).

- Click *File - Import from instrument* and the dialog shown in Figure 10 opens
- Select the relevant file in the dialog box
- Click *Import selected*

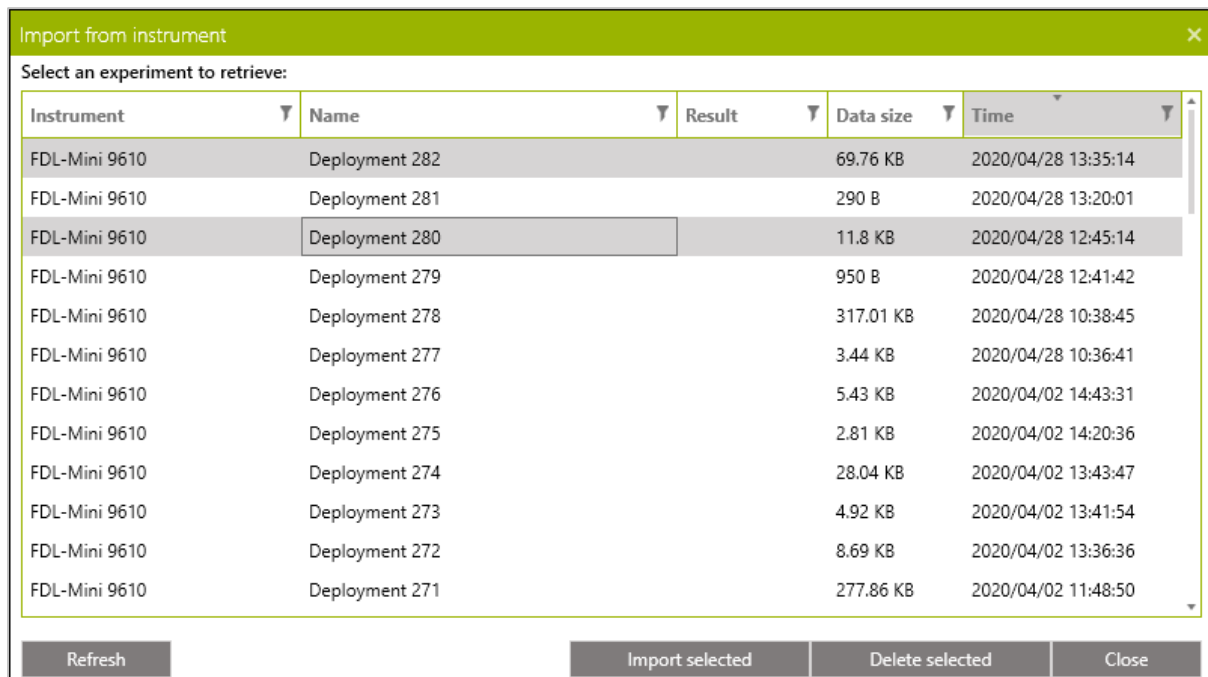


Figure 10: Import data from the FDL Mini. Click the file to be downloaded. To download multiple files, hold down the Ctrl. key and click the relevant files. Click "Import selected" to download the highlighted file/files. Here Deployment 280 and 282 are marked for download.

7.5.1 File size and download time

The time it takes to download data after a deployment depends on the data sampling frequency, the duration of the deployment, the number of channels and whether STOX mode has been active. The file size and download times are:

Expected file sizes:

- 4 sensor channels + one temperature channel, sampling rate 1 Hz, STOX mode not active: 2.3 MB/24 h
- 4 sensor channels + one temperature channel, sampling rate 1 Hz, STOX mode active: 3.7 MB/24 h

Expected download times:

- 2.5 min/MB = 0.4 MB/min

Number of data points

- Sampling at 1 Hz for 24 hours => 86,400 lines in the file

Note: Consider both sampling frequency and duration of a deployment to obtain data files that can be handled by your data processing software. As can be calculated from the above, the download of data from 24 hours of logging, at 1 Hz with four channels with STOX support, will last about 10 min.

7.6 Calibration

7.6.1 Calibration principle and storage on the FDL Mini

The calibration is only stored in a Logger file on the PC and not on the FDL Mini which will only store raw data as a mV signal. Therefore, after downloading of raw data from the instrument, a calibration must be applied to the data. This calibration must first be made in the Unisense Logger software and saved to the PC, preferably before deployment. This calibration may then be imported into the downloaded data file and the calibration may be applied.

The Logger file with the calibration may be made before or after the deployment. However, it is strongly recommended to calibrate the sensors before deployment to make sure the sensors are working as they should. Furthermore, if a sensor breaks during deployment, it is not possible to calibrate afterwards.

7.6.2 Calibration of the sensors

After setting the channel information as explained above (see 7.3), click *Start Experiment* and assign a name to the file. Select the *Calibration* tab (Figure 11). The individual sensor tabs to the left of the window show whether the sensors are calibrated or not. A red cross indicates that the sensor has not been calibrated and a green tag indicates that the sensor has been calibrated.

In the green column to the left, the sensor name, type, and calibration unit are shown for each sensor. The *Sensor signal (mV)* displays the measured raw sensor signal for the selected sensor. The sensor signal can also be followed continuously in the *Live Data* graph at the bottom of the screen.

Detailed information about the calibration procedure is found in the SensorTrace Suite Manual. For information on calibration of a specific sensor consult the individual sensor manuals. The manuals are found here: (<http://www.unisense.com/manuals/>). Below a very brief description of the calibration procedure is given.

To calibrate a sensor:

Unisense sensors generally can be calibrated with only two calibration solutions, zero and one known concentration.

- Select the sensor to be calibrated
- Expose the sensor the first calibration solution
- Enter the concentration in the *Known value* ($\mu\text{mol/L}$) box
- Let the sensor stabilize and click *Add point*
- Expose the sensor to second calibration solution
- Enter the concentration in the *Known value* ($\mu\text{mol/L}$) box
- Let the sensor stabilize and click *Add point*
- Click the *Save and use Calibration* button

The sensor is now calibrated, and the file is automatically saved. When all sensors have been calibrated, the file may be closed. After deployment and download of data from the FDL Mini, the calibration file may be imported into the data file and the calibration may be applied.



Figure 11: The Calibration window in SensorTrace Logger. The live data from all sensors can be seen in the “Live Data” frame at the bottom of the window. Most Unisense sensors require a 2-point calibration, zero and one known concentration. To record a calibration point, expose the sensor to a known concentration, enter this in the “Known value ($\mu\text{mol/L}$)” box, let the sensor stabilize, and click “Add point”. Repeat this for the second calibration point. Click “Save and use Calibration” to save the calibration.

7.6.3 Calibration of recorded data

The FDL Mini only stores raw data. The calibration data are stored in a Logger file on a PC and are applied to the FDL Mini datafile after logging is completed.

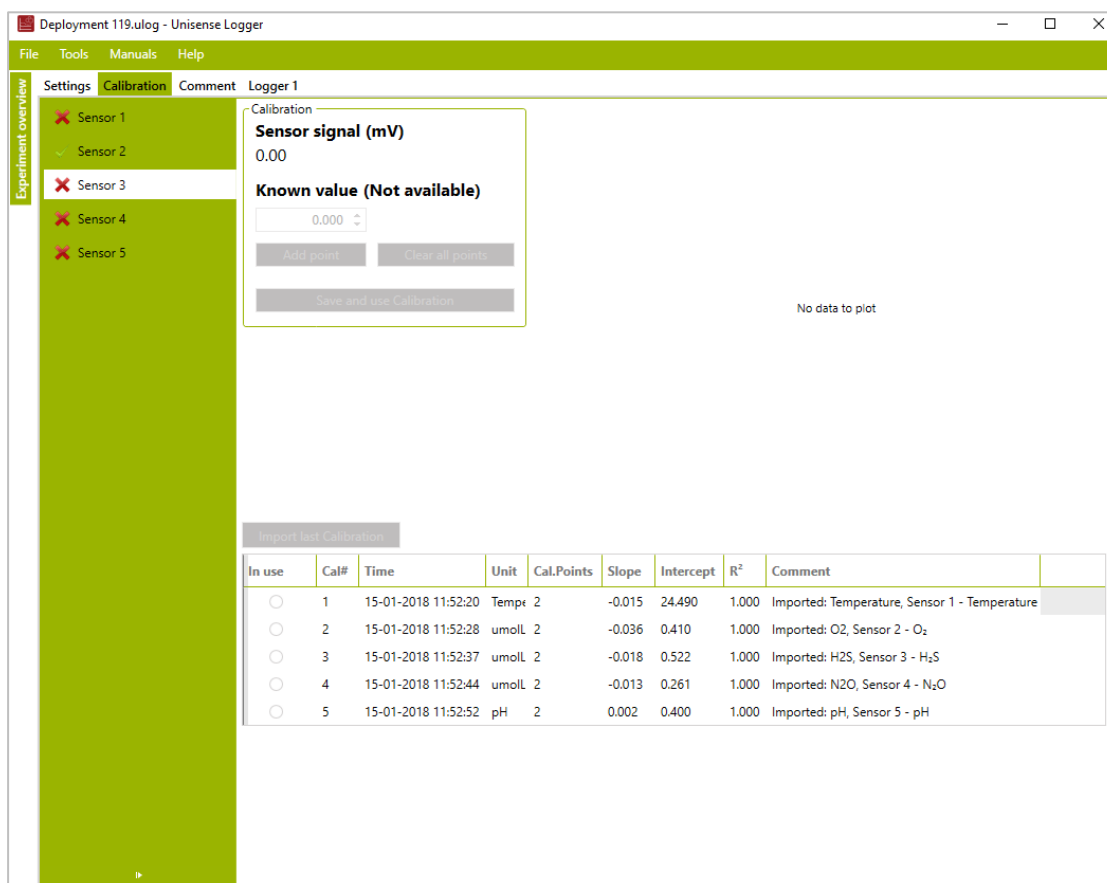
Open the data file in Logger using the *File - Open* dialog. Make the dataset active by double-clicking the appropriate experiment name in the *Experiment overview* column. The uncalibrated data will now be shown in a new tab.

Import the calibration from the saved Logger file with the relevant calibration data, using the *File - Import calibration* dialog. The imported calibrations are now available in the file and shown in the calibration table (Figure 12)

Select a sensor in the green column to the left and click the radio button in the *In use* column to select the appropriate calibration. Click OK in the pop-up box to apply the selected calibration to all data measured with the selected sensor. Repeat this for each sensor in the green column to the left.

The unit of the calibrated data will be that saved for each sensor in the data file. In Figure 12 the unit the calibrated data for Sensor 3 will be *Not available*. However, the calibration was done in $\mu\text{mol/l}$ so the correct unit is $\mu\text{mol/l}$.

NOTE: Calibration of large datasets may take some time: Ca. 1.5 min for 100,000 data points



The screenshot shows the 'Deployment 119.ulong - Unisense Logger' application window. The 'Calibration' tab is active, displaying a calibration configuration panel for 'Sensor 3'. The panel shows 'Sensor signal (mV)' as 0.00 and 'Known value (Not available)' with a dropdown set to 0.000. There are buttons for 'Add point', 'Clear all points', and 'Save and use Calibration'. Below this, an 'Import test Calibration' button is visible above a table of imported calibrations.

In use	Cal#	Time	Unit	Cal.Points	Slope	Intercept	R ²	Comment
<input type="radio"/>	1	15-01-2018 11:52:20	Tempe	2	-0.015	24.490	1.000	Imported: Temperature, Sensor 1 - Temperature
<input type="radio"/>	2	15-01-2018 11:52:28	umolL	2	-0.036	0.410	1.000	Imported: O2, Sensor 2 - O ₂
<input type="radio"/>	3	15-01-2018 11:52:37	umolL	2	-0.018	0.522	1.000	Imported: H2S, Sensor 3 - H ₂ S
<input type="radio"/>	4	15-01-2018 11:52:44	umolL	2	-0.013	0.261	1.000	Imported: N2O, Sensor 4 - N ₂ O
<input type="radio"/>	5	15-01-2018 11:52:52	pH	2	0.002	0.400	1.000	Imported: pH, Sensor 5 - pH

Figure 12: Deployment file after import of calibration data from a saved Logger file. The calibration table shows the 5 calibrations that have been imported. By clicking a button in the "In use" column, this calibration will be applied to all data measured with the selected sensor (in the example above, this is sensor 3).

7.7 Data export and processing

After download of data from the FDL Mini and applying a calibration using stored calibration data, data can now be exported in Excel or CSV format.

- Open the data file in Logger
- Double click the relevant experiment in the *Experiment overview* window to the left
- Select the relevant data tab in the Menu bar (Logger 1 in Figure 13)
- Click the *Export* button to the right
- Choose the file format (Excel or CSV) and click OK
- Give the exported file a name and click Save

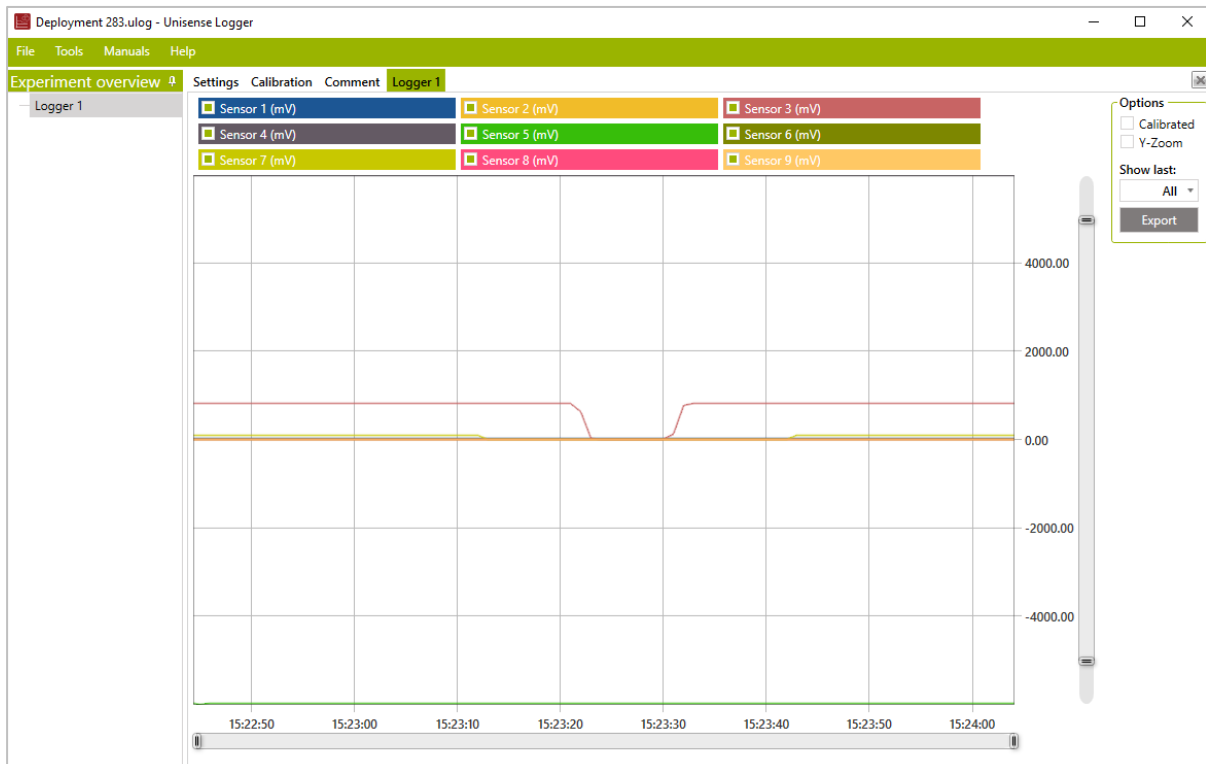


Figure 13: View of data from the Experiment named "Logger 1". The tab "Logger 1" is active.

7.8 Using STOX sensors

STOX sensors a STOX In Situ UniAmp amplifier. To use STOX sensors, the STOX-mode must be activated (see 7.3.1, Figure 6).

The use of STOX sensors and handling of STOX data is different from all other sensor types and it is strongly recommended to consult the *STOX Sensor Manual - for UniAmp* which can be found at: <https://www.unisense.com/manuals/>. This manual describes the principles, data handling and calibration for STOX sensors.

As the STOX sensors have a built-in zeroing it is only necessary to do a one-point calibration with one known oxygen concentration above zero, but it may be reassuring also to do a zero calibration in an ascorbate solution.

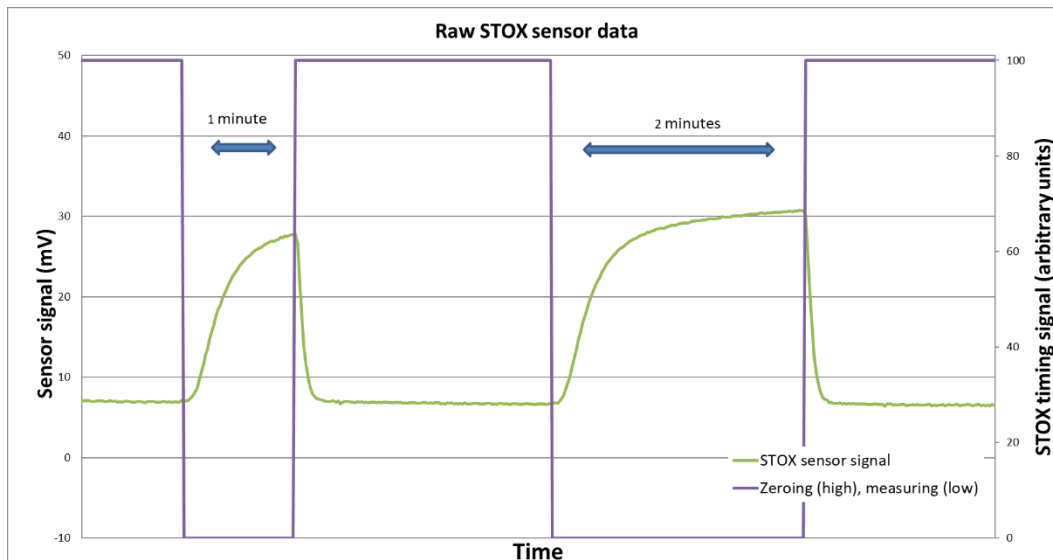


Figure 14: Example of STOX data. Both the STOX sensor signal and the zeroing signal is shown. In this example, when the Zeroing signal is 100, the front guard is polarized and the STOX sensor signal is low. With the Zeroing signal at 0, the front guard is not polarized and the STOX sensor signal is high. The oxygen concentration is proportional to the difference between the high and the low STOX sensor signal.

The signal for oxygen concentration is the difference between the STOX sensor signal with the front guard polarized and unpolarized - the Δ -signal (Figure 14). Calibration of the STOX sensor should not be performed using the calibration function in Logger, instead it is recommended to record uncalibrated data and to do the calibration in a spreadsheet. Consult the *STOX Sensor Manual - for UniAmp* for details.

If you are measuring low O_2 concentrations with the STOX sensor it is best to calibrate in that range and not at atmospheric saturation as you would normally do with O_2 sensors. This may be done by injecting a known small volume of air saturated water into a larger known volume of water with low O_2 concentration while recording the STOX sensor signal.

The STOX sensor is sensitive to temperature and calibration should be done at the same temperature as the measurements. If temperature varies during the deployment the calibration should be done at both the highest and lowest encountered temperature. It may then be assumed that sensitivity varies linearly between the two temperatures.

The O_2 concentration in air saturated water at a given temperature and salinity may be calculated with the O_2 -calculator tool in the Logger software toolbar: *Tools - O_2 calculator*.

Example (see Figure 15)

- 1 litre of N_2 bubbled water is transferred to a conical flask. The STOX sensor is placed in the water and at least two full front guard polarization - depolarization cycles are recorded
- 5.0 ml air saturated water is added to the conical flask and gently mixed. At least two full polarization - depolarization cycles are recorded.
- The amendment of air saturated water may be repeated to obtain several estimates of the sensitivity

This procedure may at best be performed before deployment and with the FDL Mini online with the Logger software to see the response of the Δ -signal to the O_2 concentrations. Make sure to log the data as this procedure is performed. The raw data will be saved in the Logger file and may be exported for doing manual calibration of measurements.

Calculation of calibration concentrations:

- Air saturated water at 22°C and a salinity of 0 = 273 μM
- 5.0 ml air saturated water added to 1 litre water gives an increase in concentration of: $273 \mu\text{M} \times (5/1000) = 1.37 \mu\text{M}$

Note that it is not necessary to know the O_2 concentration of the N_2 bubbled water. The Δ -signal for zero O_2 is per definition zero and the Δ -signal increases linearly with O_2 concentration. Therefore, it is only necessary to estimate the slope of the calibration curve ($\text{mV}/\mu\text{M}$) i.e., the increase in Δ -signal for a given increase in O_2 concentration.

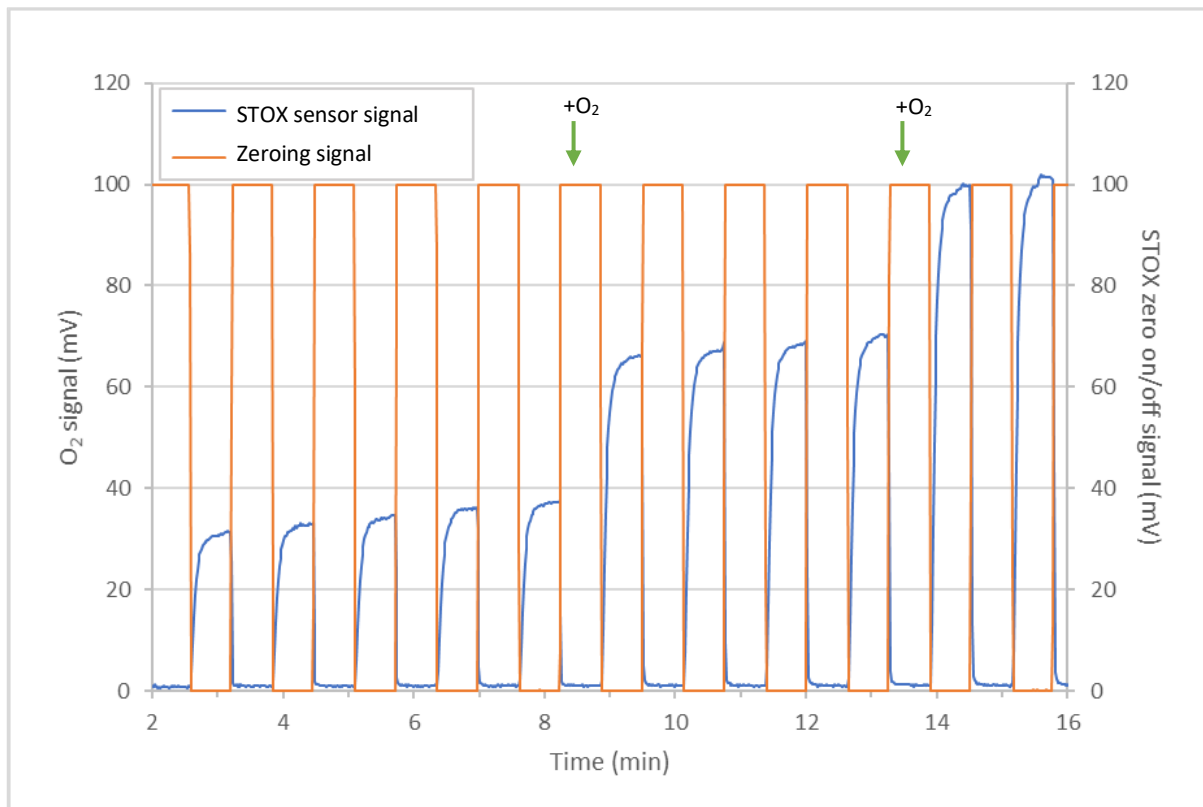


Figure 15: Example of raw STOX data with both the STOX sensor signal and the Zeroing signal plotted. The STOX zero on-time and off-time was 36 seconds each. A STOX on/off signal of 100 mV indicates that the front guard is on, 0 mV indicates that it is off. The green arrows indicate amendment of 1.37 μM of oxygen (5 ml air saturated water (273 μM) in 1 litre).

7.9 Making a deployment

To make a deployment with the FDL Mini the following is needed:

- Remove the *Off-dongle*. Wait 30 seconds and connect the instrument to a PC and start SensorTrace Logger. The communication cable must be disconnected from the FDL Mini during start up
- Make sure the FDL Mini has power and storage capacity
 - See 7.3.4 *Checking battery level and storage capacity*
- Set the Sampling rate
 - See 7.3.2 *Setting sampling rate*
- Connect the sensors
 - See 7.4 *Connecting the sensors*
- Set the appropriate sensor type and unit for each channel
 - See 7.3.5 *Setting individual channel information*
- Let the sensors stabilize
 - See 7.4 *Connecting the sensors* for advice regarding minimizing this period
- Calibrate each sensor
 - See 7.6.2 *Calibration of the sensors*
- Remove the PC to FDL Mini cable and place a dummy on the bulkhead connector
- Make sure all bulkhead connectors on both ends of the pressure housing are either connected or capped with a dummy.
- The FDL Mini is now ready for deployment

7.10 Using the Field DataLogger Mini online with a PC

The FDL Mini may be used online with a PC running the Unisense Logger software. Consult the Logger part of the SensorTrace Suite manual (<http://www.unisense.com/manuals/>) for details on how to log data directly on a PC. Note that the delivery of data from the FDL Mini to the PC will always occur with a frequency of 1 Hz no matter which sampling rates that are selected in the Logger software and on the FDL Mini.



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