USER MANUAL

DAQ-PAC-F4X
With OXY-4 mini

1. List of parts

- **DAQ-4 instrument**
  - AutoResp™ 4
  - Power Cord
  - USB cable
  - 4-fold power strips for pumps, qty. 2
  - User manual

- **OXY-4 mini instrument**
  - Power Cord
  - RS232 cable
  - User manual
  - PC operating software for Windows 98/00/ME/NT/XP

- **OXY-REG instrument**
  - Galvanic O_2 probe
  - Maintenance kit for O_2 probe
  - Power Cord
  - Data cable
  - Solenoid valve w/push-in fittings
  - PU tubing
  - Air stone
  - User manual

- **TMP-REG instrument**
  - Pt100 probe
  - Power Cord
  - Data cable
  - Submersible Eheim pump
  - Soft PVC tubing
  - Stainless steel cooling coil
  - Adapter cable for pump
  - User manual

2. Contents

3. Installation procedure for DAQ-PAC-F4X

3.1 General

- AutoResp™ 4 is a piece of PC software designed to perform automated intermittent flow respirometry together with the DAQ-4 instrument.
- AutoResp™ 4 requires Windows XP running on a PC with an Intel Pentium IV processor of minimum 2.66 GHz or equivalent. The PC must have at least 256 MB memory and at least 1GB of free hard disk space. A minimum resolution of 1024x768 pixels is required.
- AutoResp™ 4 communicates with the DAQ-4 instrument via the accompanying USB cable which must be connected.
- AutoResp™ 4 can handle two different types of oxygen inputs. Either 0-5 VDC analog input (OXY-CH1-4) or serial inputs when using OXY-4 mini instrument manufactured by PreSens.
- If chamber oxygen is measured using the OXY-4 mini instrument one RS232 male DB9 connector must be available on the PC. If not available use an USB 232 adapter, e.g. USB Serial Adapter manufactured by VSCOM.
- If using the OXY-4 mini instrument turn this on before starting AutoResp™ 4.

Input labels, see Table 1.

Table 1

DAQ-4 instrument label	AutoResp™ 4 signal name
OXY-CH1	Chamber oxygen 1
OXY-CH2	Chamber oxygen 2
OXY-CH3	Chamber oxygen 3
OXY-CH4	Chamber oxygen 4
OXY-AM	Ambient oxygen
TEMP	Temperature

Output labels, see Table 2.

Table 2

DAQ-4 instrument label	AutoResp™ 4 indicator name
FLUSH	Flush
RECIRC	Recirc.
D2/N2	Ambient O_2 (kPa)
TEMP	Temperature (°C)

3.2 DAQ-4 instrument

3.2.1. Front side

OXY-CH1: Analog oxygen input for chamber 1. The input range is 0-5 VDC.

OXY-CH2: Analog oxygen input for chamber 2. The input range is 0-5 VDC.

OXY-CH3: Analog oxygen input for chamber 3. The input range is 0-5 VDC.

OXY-CH4: Analog oxygen input for chamber 4. The input range is 0-5 VDC.

Connect analog oxygen inputs, e.g. from an OXY-REG, via pin 1 (+) and pin 4 (GND) in the input connector.

OXY-AM: Analog oxygen input for ambient water. The input range is 0-5 VDC.

Connect analog oxygen input to the OXY-REG instrument via the accompanying data cable.

TEMP: Analog temperature input for ambient water. The input range is 0-5 VDC.

Connect analog temperature input to the TMP-REG instrument via the accompanying data cable.

PC: USB port for PC communication. Use the USB cable to connect the DAQ-4 instrument to the PC.

LEDS: Relay status LEDs.

IMPORTANT: DO NOT connect DAQ-4 instrument to PC before installation of driver from Measurement & Automation software from National Instruments is completed. The software will be installed together with the installation of AutoResp™ 4, see AutoResp™ 4 software for Windows page 6.

3.2.2. Back side

FLUSH: Relay socket for 110/230VAC (max 3A) flush pumps.

Connect one or more pumps by using one of the 4-fold power strips.

RECIRC: Relay socket for 110/230VAC (max 3A) recirculation pump.

Connect one or more pumps by using one of the 4-fold power strips.

O2/N2: Relay socket for 110/230VAC (max 3A) for solenoid valve. Use oxygen or nitrogen for hyperoxic or hypoxic control.

Connect the solenoid valve by using the push-in fittings.

TEMP: Relay socket for 110/230VAC (max 3A) heating/cooling pump.

Connect the heating/cooling pump by using the adapter cable.

100-240VAC 50-60 Hz: Power input for the DAQ-4 instrument.

Connect the instrument to a grounded 110/230VAC power supply using a standard pc-type cable with a grounded wall plug.

Power button: Turns the instrument on and off.

IMPORTANT: DO NOT connect any of the relay sockets to >3 amps equipment! USE grounded outlets only!

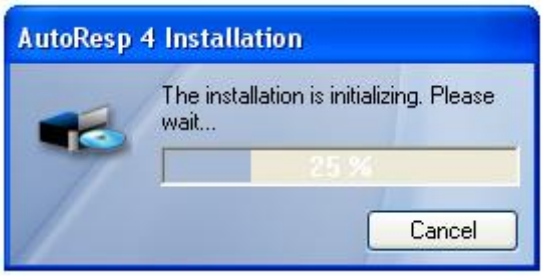
For further information about the DAQ-4 instrument see 8.3 DAQ-4 Instruction manual, page 52.

3.3 AutoResp™ 4 software for Windows

The following steps will explain how to install AutoResp™ 4 and drivers on your computer.

1. Insert the CD labelled AutoResp™ 4 and wait until you see Screen 1. If you do NOT se the screen, browse to the root of your CD and double click on the icon labelled AR4.exe.

Screen 1

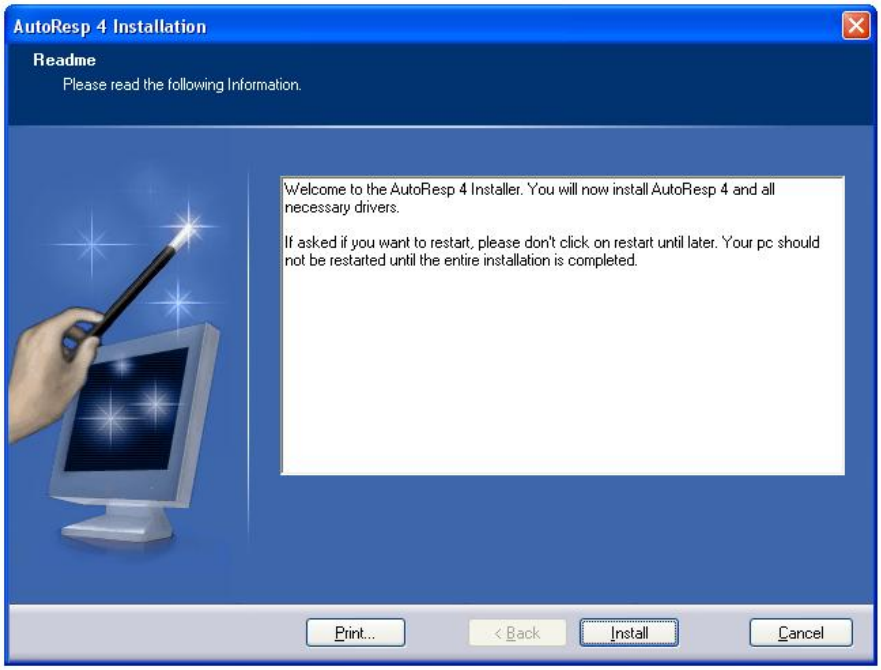


2. After the installation is initialized, click Setup to start the installation.

Screen 2

3. Click Install to start the installation of AutoResp™ 4 and all necessary drivers.

Screen 3



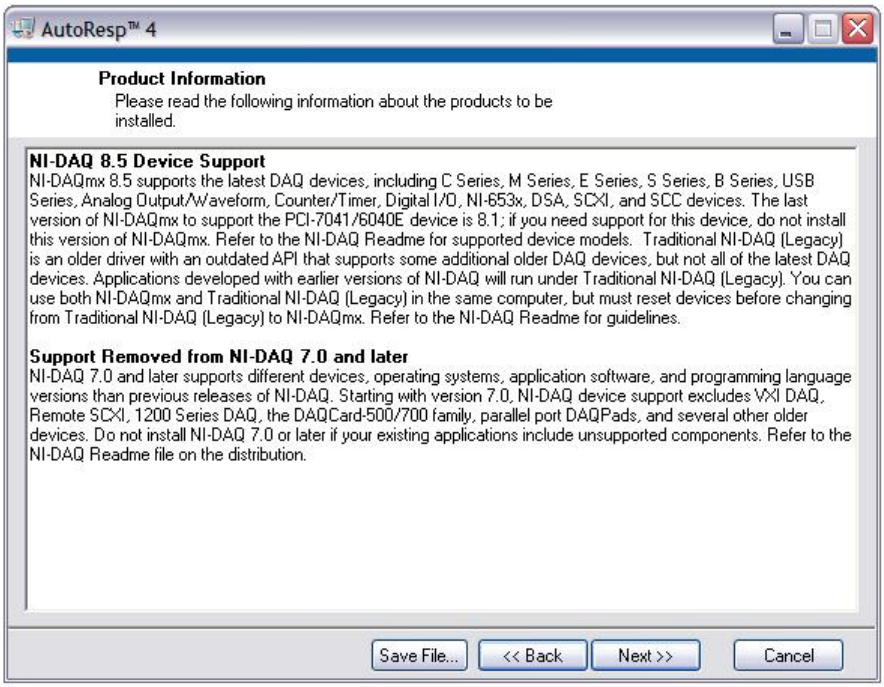
4. Click Next to start installation of AutoResp™ 4.

Screen 4

5. Click Next.

On Screen 5 the product information of the products to be installed are shown.

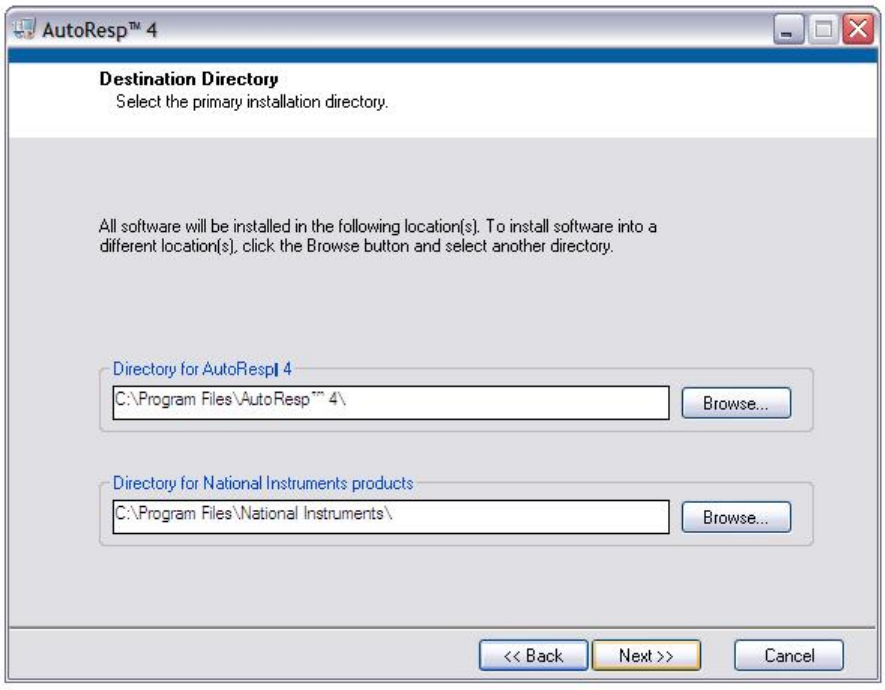
Screen 5



6. Click Next.

7. Select destination directory for AutoResp™ 4 and for the National Instruments driver.

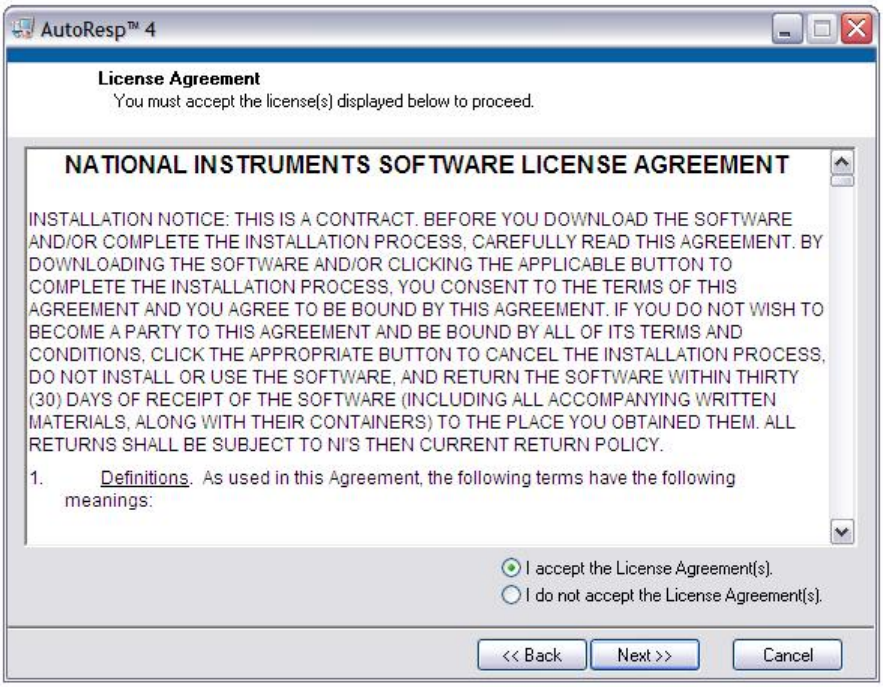
Screen 6



8. Click Next.

9. If you accept the License Agreement, please select "I accept the License Agreement(s).

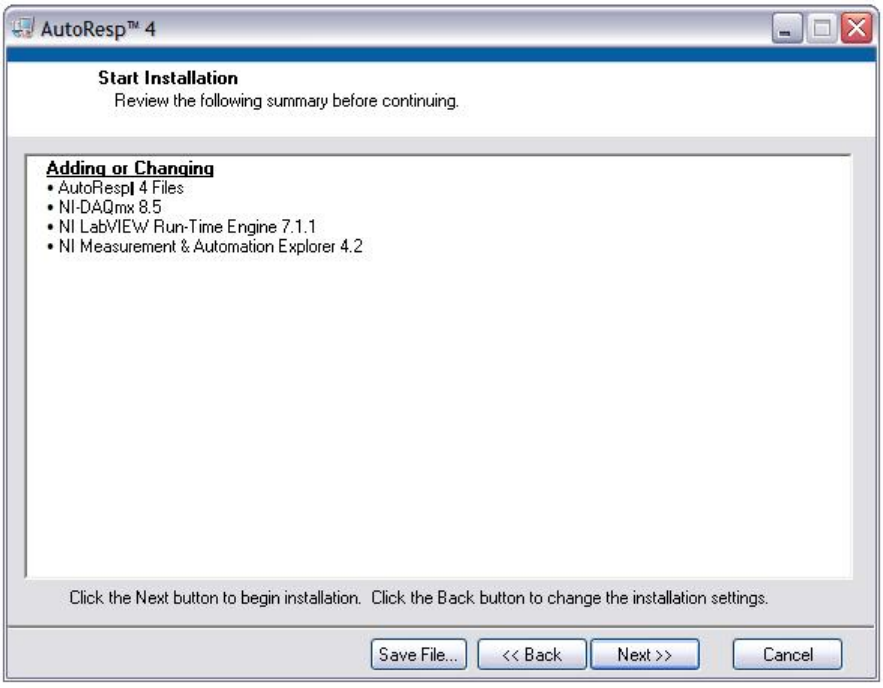
Screen 7



10. Then click Next.

On Screen 8 a summary is given of the products to be installed.

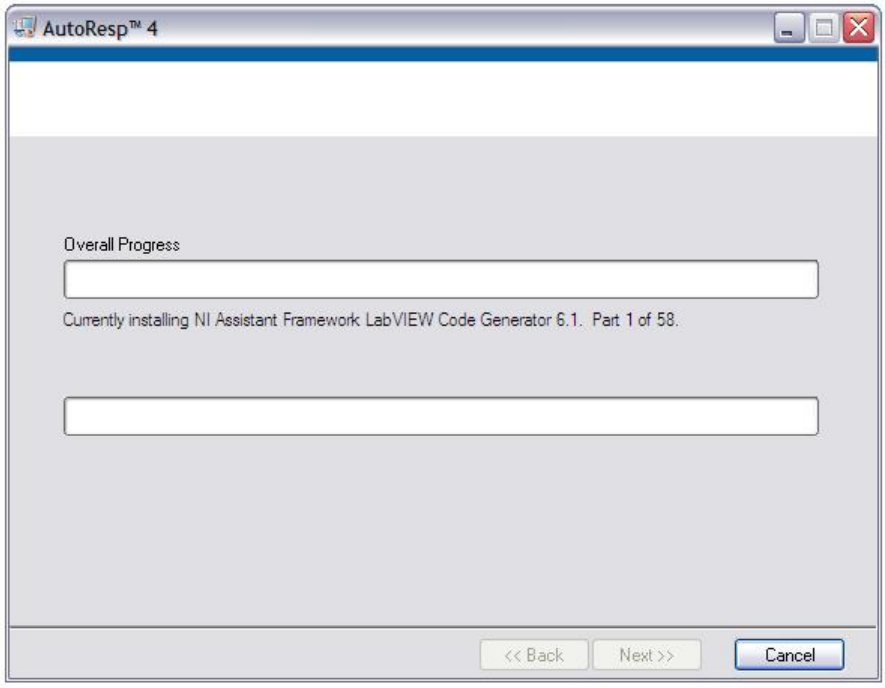
Screen 8



11. Click Next.

On Screen 9 the status of the installation is shown.

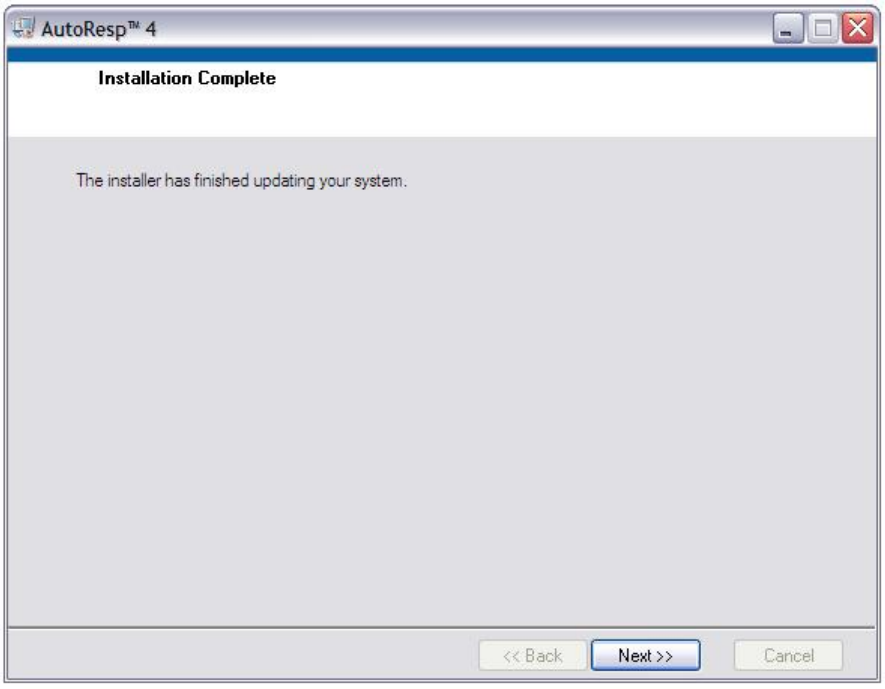
Screen 9



The installation may take a while.

When installation is complete Screen 10 becomes present.

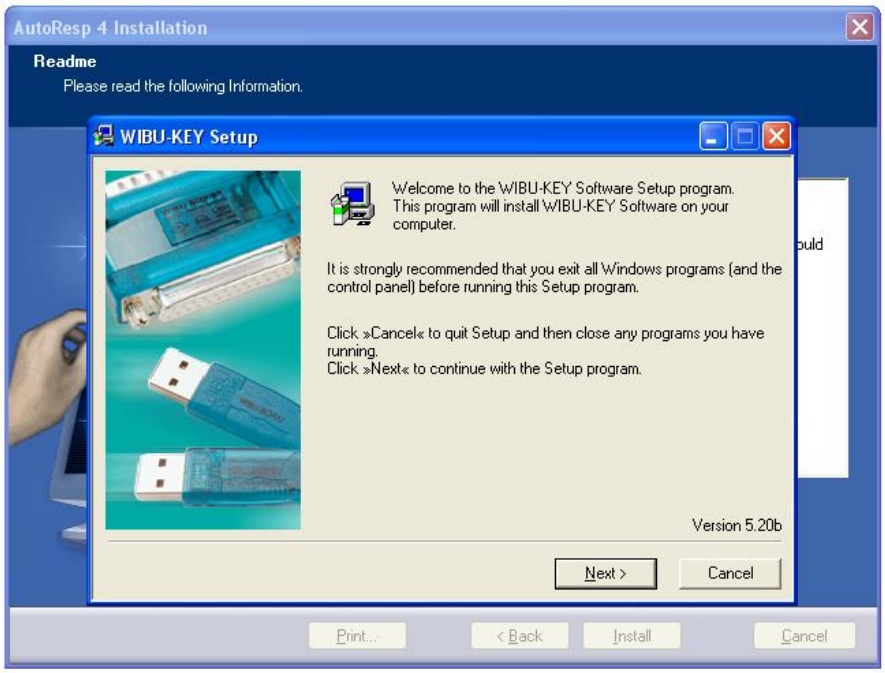
Screen 10



12. Click Next to end installation of AutoResp™ 4.

13. Now the WiBu drivers will be installed. When Screen 11 appears, click Next.

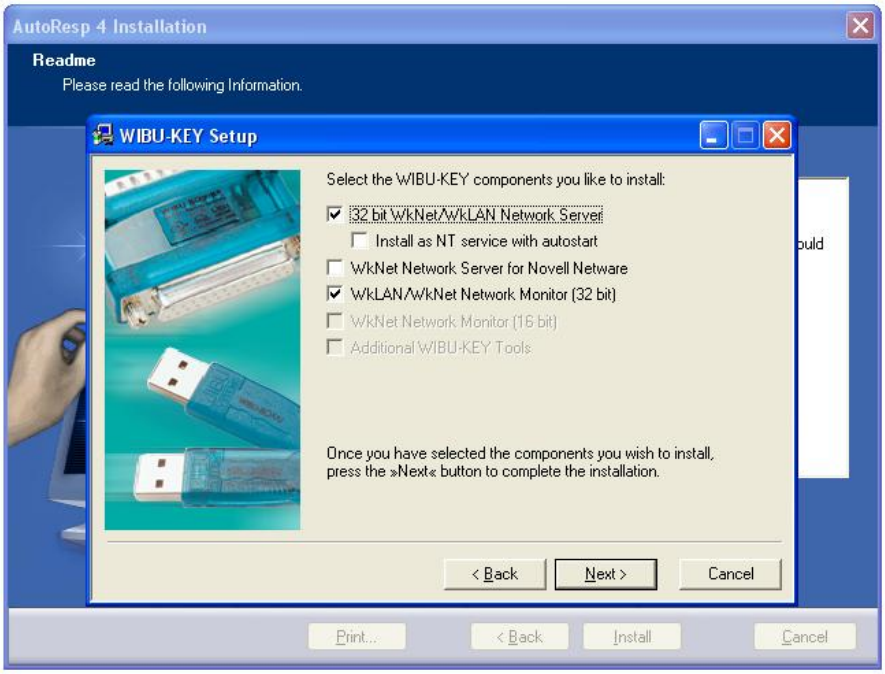
Screen 11



14. Select supported language, and click Next.

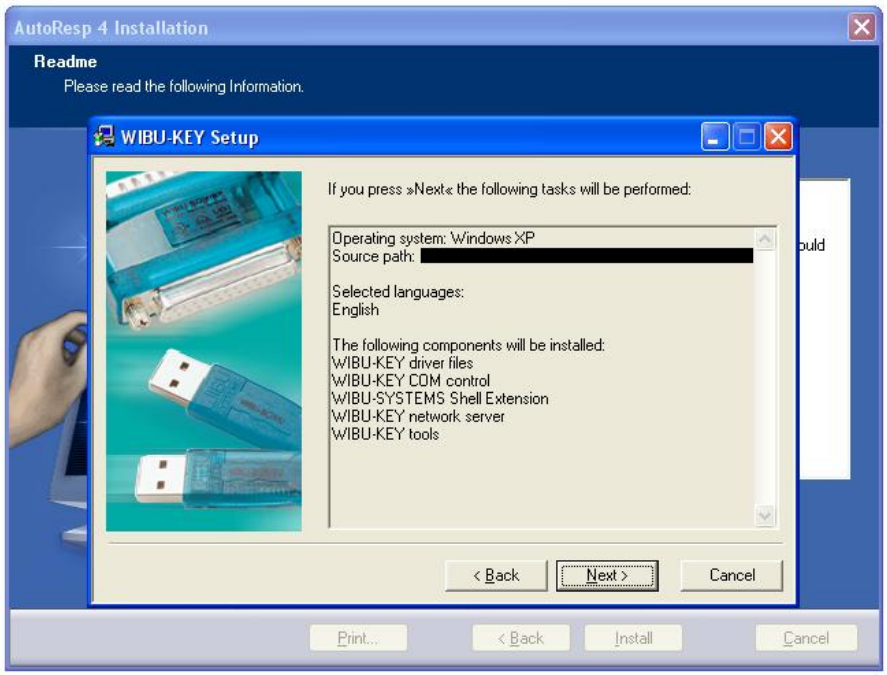
15. Select the options seen on Screen 12, and click Next.

Screen 12



16. Click Next again after you have accepted the summary of the installation.

Screen 13

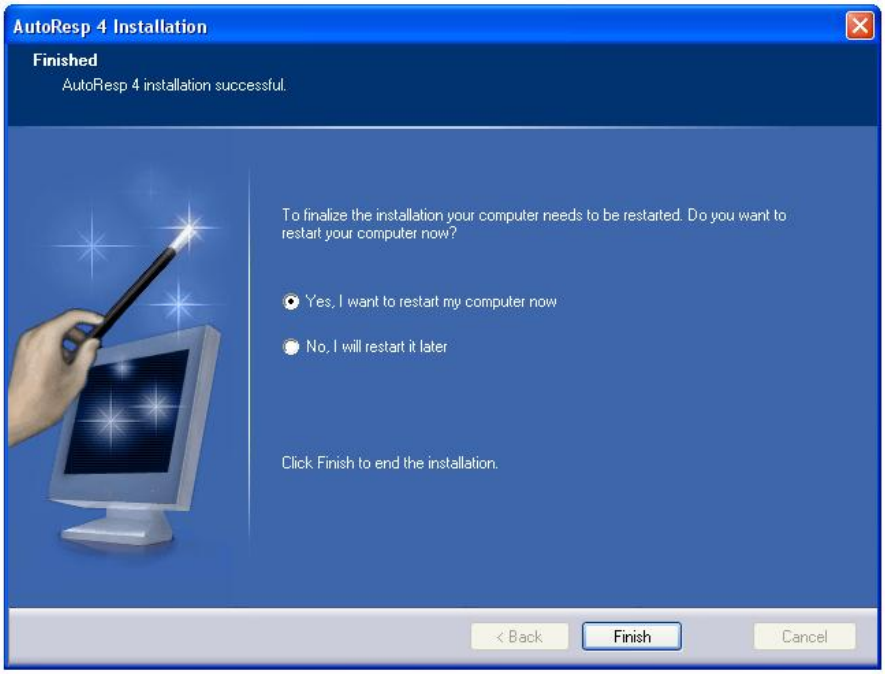


17. When installation is done, click Next again.

18. Click Finish to end installation of the WiBu drivers.

19. Close all open programs and choose "Yes, I want to restart my computer now", and click on Finish.

Screen 14



The following steps will explain how to finish the installation of the drivers together with your instruments.

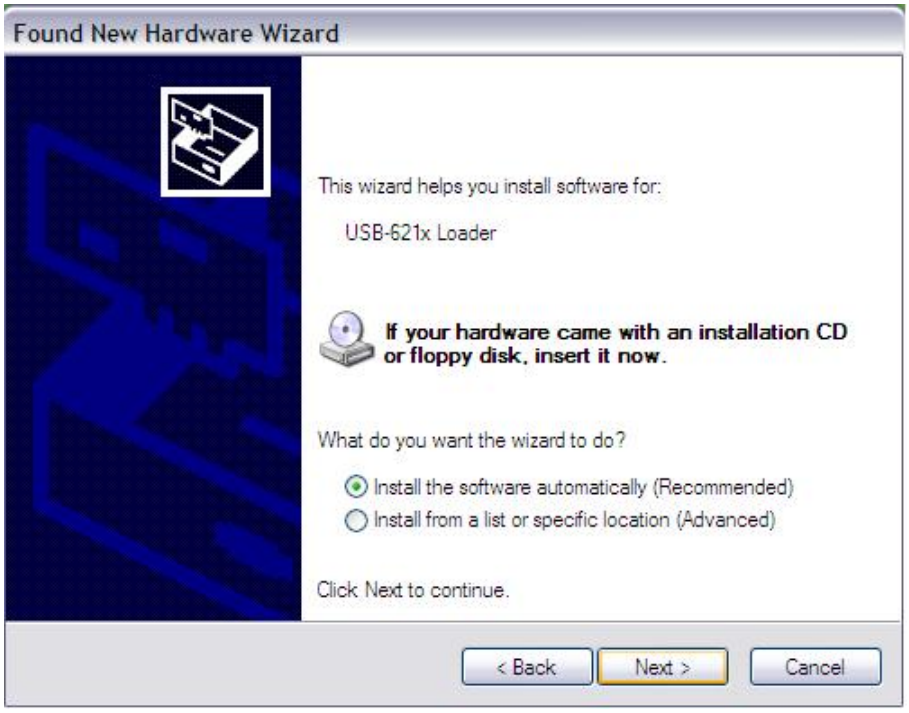
20. Connect the WiBu dongle to your computer via an USB port. The dongle will be detected automatically.

21. Connect the DAQ-4 instrument to the PC via the USB cable. After a few seconds Screen 15 becomes present.

Screen 15

22. Click on "No, not this time" and then on Next.

Screen 16



23. Click on "Install the software automatically (Recommended)" and then on Next.

Screen 17

24. Click Finish.

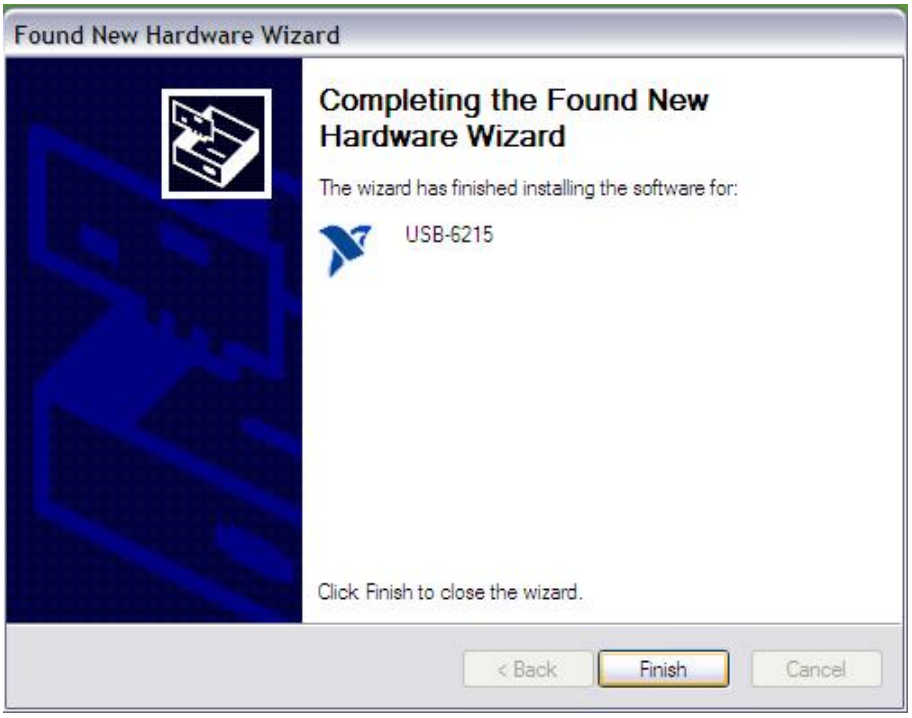
Screen 18

25. Click on "No, not this time" and then on Next.

Screen 19

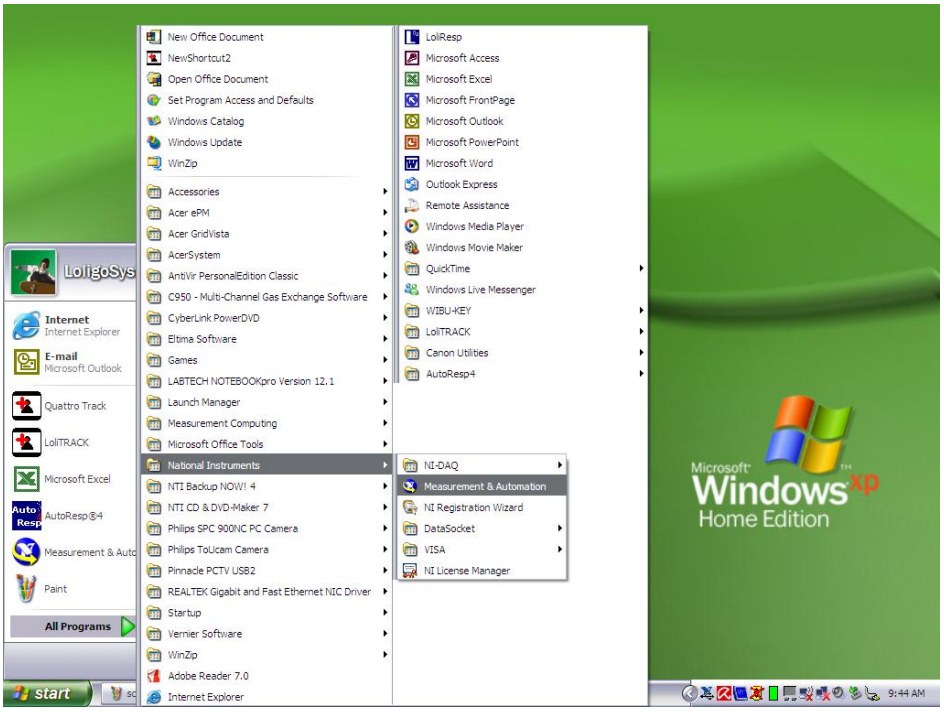
26. Click on "Install the software automatically (Recommended)" and then on Next.

Screen 20



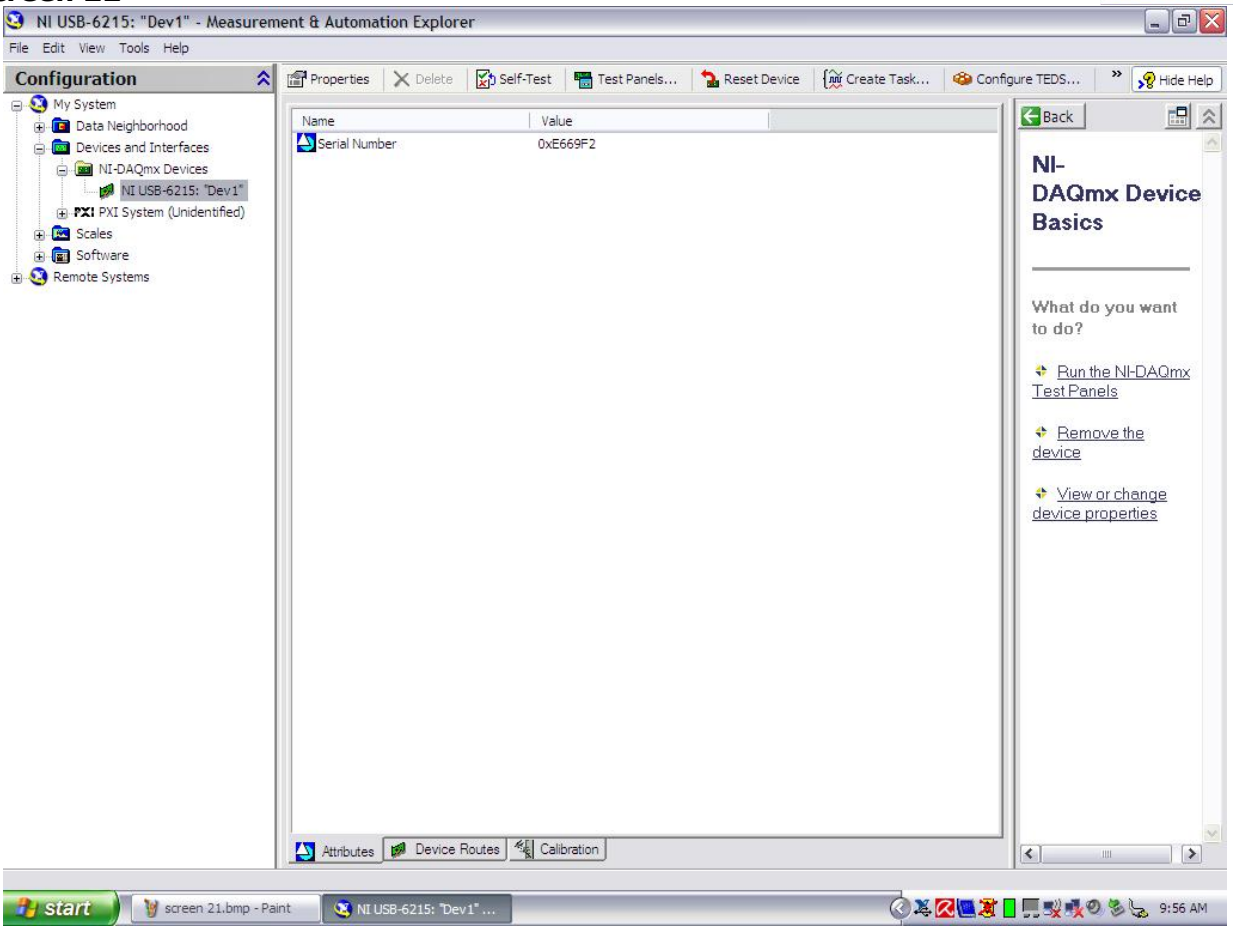
27. Click Finish.

Screen 21



28. Open Measurement & Automation by following the folder hierarchy shown on Screen 21.

Screen 22



Make sure the NI USB-6215 is installed as device name ”Dev1”. If so the DAQ-4 instrument is now properly correct installed and ready for use with AutoResp™ 4.

29. Remove CD labelled AutoResp™ 4.

30. You have now installed AutoResp™ 4 and all necessary drivers. AutoResp™ 4 is now ready for use, see Using AutoResp™ 4, page 25 for help starting AutoResp™ 4.

3.4 OXY-4 mini instrument

3.4.1. Front side

CH1: Fiber optic oxygen input for chamber 1.

CH2: Fiber optic oxygen input for chamber 2.

CH3: Fiber optic oxygen input for chamber 3.

CH4: Fiber optic oxygen input for chamber 4.

Connect an oxygen sensor, e.g. oxygen needle type probe, to an input.

LINE: Indicates instruments ON/OFF

3.4.2. Back side

Power connector: Power input for the OXY-4 mini instruments.

Connect the instrument to a grounded 230 VDC power supply using a standard pc-type cable with a grounded wall plug.

Power button: Turns instrument on and off.

DATA: RS-232 interface (male).

Connect the OXY-4 mini instrument to the PC via a RS-232 cable.

For further information about the OXY-4 mini instrument see 8.6 OXY-4 Instruction manual, page 55

3.5 TMP-REG instrument

The TMP-REG instrument is designed for monitoring and regulating water temperature in fish tanks, respirometers etc.

3.5.1. Front side

IN: Pt100 temperature input.

Connect the Pt100 temperature sensor to this input.

3.5.2. Back side

ANALOG OUT: Analog temperature output. The output range is 0-5 VDC.

For using the TMP-REG instrument in general the signal is available via pin 1 (+) and pin 4 (GND) in the input connector.

RE1: Relay socket for 110/230VAC (max 3A) pump, cooling or heating coil.

RE2: Relay socket for 110/230VAC (max 3A) pump, cooling or heating coil.

POWER 24…230V UC: Power input for the TMP-REG instrument.

Connect the instrument to a grounded 24/230 VDC power supply using a standard pc-type cable with a grounded wall plug.

For further information about the TMP-REG instrument see 8.4 TMP-REG manual, page 55.

3.6 OXY-REG instrument

The OXY-REG instrument is designed for monitoring and regulating dissolved oxygen content of sea or fresh water in fish tanks, respirometers, aquaria etc.

3.6.1. Front side

IN: Analog oxygen input. The input range is 0-50 mVDC.

Connect the galvanic oxygen probe to this input.

0-cal button Button for use for calibration of oxygen signal.

3.6.2. Back side

ANALOG OUT: Analog oxygen output. The output range is 0-5 VDC.

For using the OXY-REG instrument in general the signal is available via pin 1 (+) and pin 4 (GND) in the input connector.

RE1: Relay socket for 110/230VAC (max 3A) solenoid valve.

RE2: Relay socket for 110/230VAC (max 3A) solenoid valve.

POWER 24…230V UC: Power input for the OXY-REG instrument. Connect the instrument to a grounded 24/230 VDC power supply using a standard pc-type cable with a grounded wall plug.

For further information about the OXY-REG instrument see 8.5 OXY-REG manual, page 55.

4. Introduction to intermittent flow respirometry

Three different methods are commonly used for measuring oxygen consumption in water breathers, e.g. fish:

- Closed respirometry
- Flow-through respirometry
- Intermittent flow respirometry

4.1 Closed respirometry (or constant volume respirometry)

Measurements are in a sealed chamber of known volume (a closed *respirometer*). The oxygen content of the water is measured initially (t_0), then the respirometer is closed and at the end of the experiment (t_1) the oxygen content is measured again.
Knowing the body weight of the animal, the respirometer volume and the oxygen content of the water at time t_0 and t_1 the mass specific oxygen consumption rate can be calculated as follows:

$VO_2 = ([O_2]t_0 - [O_2]t_1) \cdot V/t \cdot BW^{-1}$

VO_2 = oxygen consumption rate (mg O_2/kg/hour)
$[O_2]t_0$ = oxygen concentration at time t_0 (mg O_2/liter)
$[O_2]t_1$ = oxygen concentration at time t_1 (mg O_2/liter)
V = respirometer volume minus volume of experimental animal (liter)
t = $t_1 - t_0$ (hour)
BW = body weight of experimental animal (kg)

An advantage of this method is its simplicity. A disadvantage is that the measurements are never made at a constant oxygen level, due to the continuous use of oxygen by the animal inside the respirometer. This might cause problems when interpreting data, since animal respiration often changes with ambient oxygen partial pressure.
Furthermore, metabolites from the experimental animal, *i.e.* CO_2, accumulate in the water, thus limiting the duration of measurements. This limited time for measurements prevents the experimental animal to recover from initial handling stress that often increase fish respiration significantly and for several hours, thus overestimating oxygen consumption rates.

4.2 Flow-through respirometry (or open respirometry)

This is a more sophisticated method for oxygen consumption measurements. Experimental animals are placed in a flow-through chamber, with known flow rate. Oxygen is measured in the inflow and outflow and oxygen consumption rate can be calculated as:

$VO_2 = F \cdot ([O_2]_{in} - [O_2]_{out}) / BW$

VO_2 = oxygen consumption rate (mg O_2/kg/hour)
F = water flow rate (l/hour)
$[O_2]_{in}$ = oxygen content in water inflow (mg O_2/liter)
$[O_2]_{out}$ = oxygen content in water outflow (mg O_2/liter)
BW = body weight of experimental animal (kg)

The advantages of this method are several:

1) the duration of the experiment is in principle unlimited
2) no accumulation of CO_2 and other metabolites
3) its possible to measure at a constant oxygen level
4) by controlling the quality of the inflowing water it's possible to measure metabolism at different desired levels of oxygen, salinity etc.

However, this method bring along one significant disadvantage: in order to determine oxygen consumption by *open respirometry* it is crucial that the system is in steady state. This means that the oxygen content of the in flowing and out flowing water, AND the oxygen consumption of the animal have to be constant.
If the oxygen consumption of the animal for some reason changes during the experiment, steady state will not exist for a while. Not until the system is in steady state again will the above formula give the correct oxygen consumption rate. The duration of the time lag depends on the relationship between chamber volume and flow rate. Thus, *open respirometry* measurements have poor time resolution and are not suitable for determination of oxygen consumption on organisms with a highly variable respiration like fish.

4.3 Intermittent flow respirometry (or open-closed respirometry)

Our systems for automatic respirometry works by *intermittent flow respirometry* aiming at combining the best of both 1) c*losed* and 2) *flow-through* respirometry.

Reference: Steffensen, J.F. (1989). Some errors in respirometry of aquatic breathers: how to avoid and correct for them. *J. Fish. Physiol. Biochem.* **6**; 49-59.

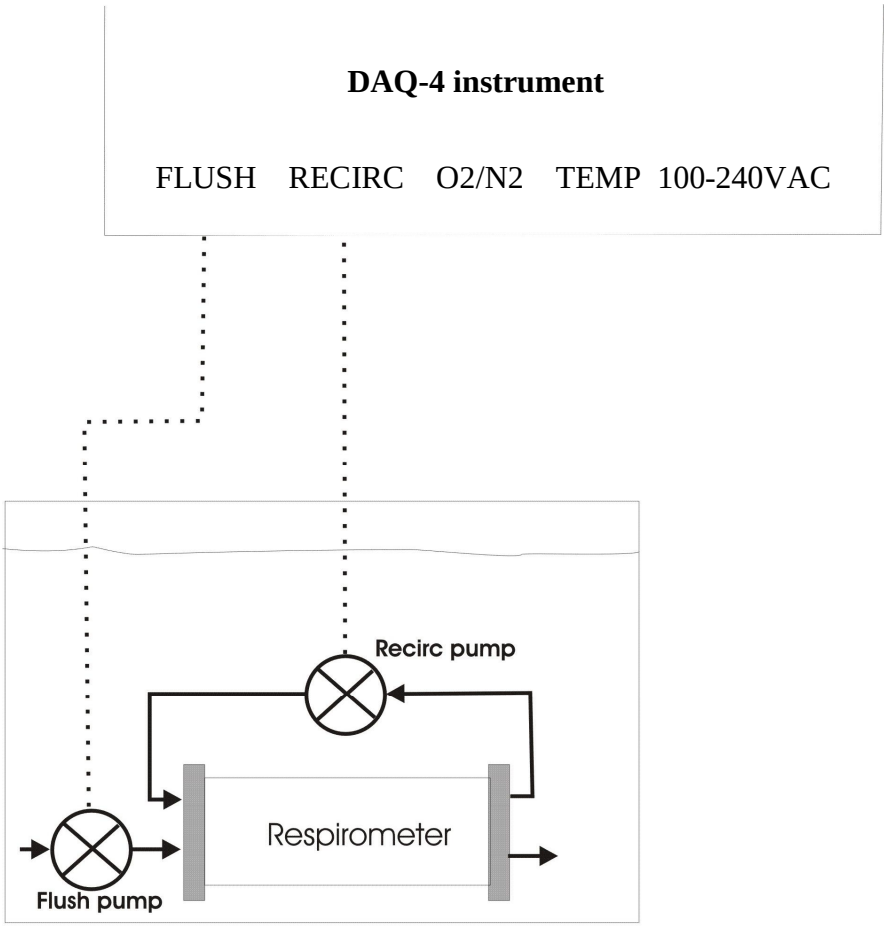
The experimental animal is placed in a closed chamber (respirometer) immersed in an ambient tank.
A recirculation pump ensures proper mixing of the water inside the respirometer and adequate flow past the oxygen probe. A second pump can change the water inside the respirometer with ambient water.
During measurements of oxygen consumption, this *flush pump* is turned off and the systems operates like 1) *closed respirometry*. Then the pc controlled flush pump turns on pumping ambient water into the respirometer and bringing the oxygen content back to pre measurement values.

In this way, problems with accumulating metabolites and severe changes in oxygen level due to animal respiration are avoided.

As with open respirometry, the duration of the experiment is in principle unlimited.

However, the most important advantage is the great time resolution of this method. Oxygen consumption rates of animals can be determined for every 10^{th} minutes over periods of hours or days, making the system extremely suited for uncovering short term variations (minutes) in metabolism. In summary, our systems for respirometry are developed for prolonged and automatic measurements of oxygen consumption rate in a controlled laboratory environment.

Screen 23



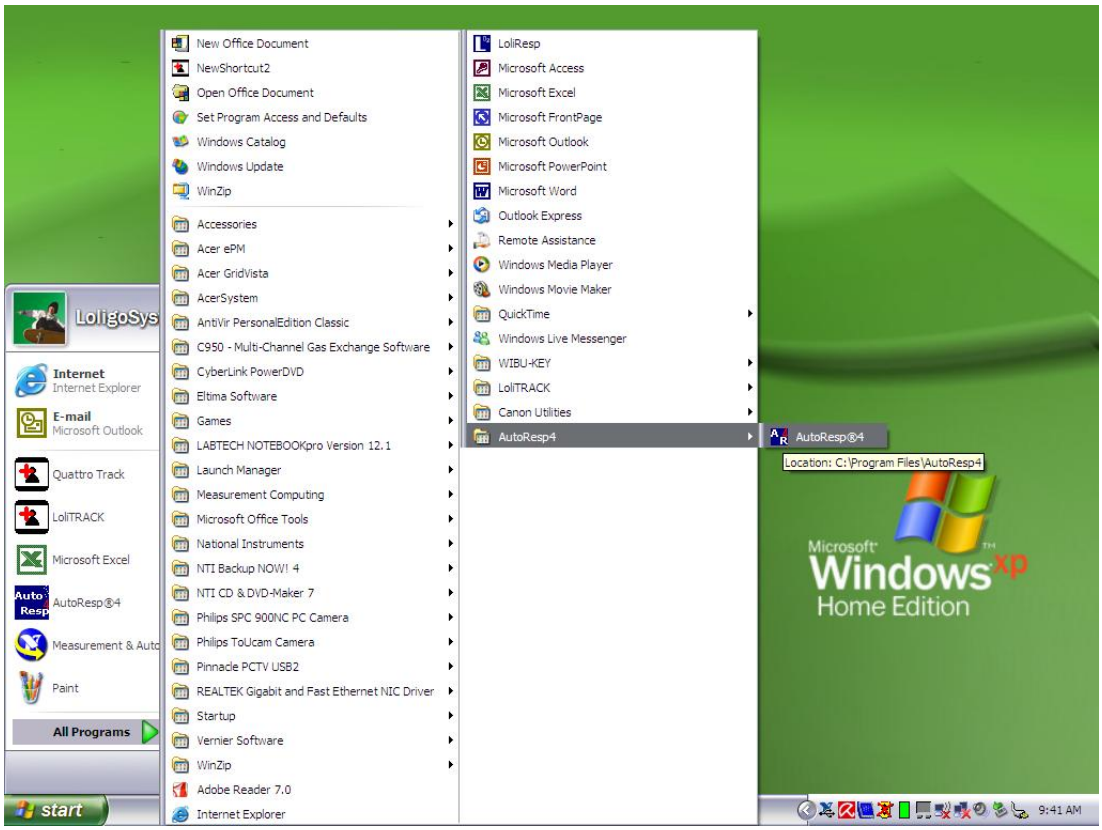
Screen 23 shows how to connect the flush and the recirc pump to the respirometer by tubes. The connection to the DAQ-4 instrument (dotted lines) is described above.

5. Using AutoResp™ 4

5.1 Startup

- Click on the AutoResp™ 4 icon in the Start menu by following the folder hierarchy shown on Screen 24.

Screen 24

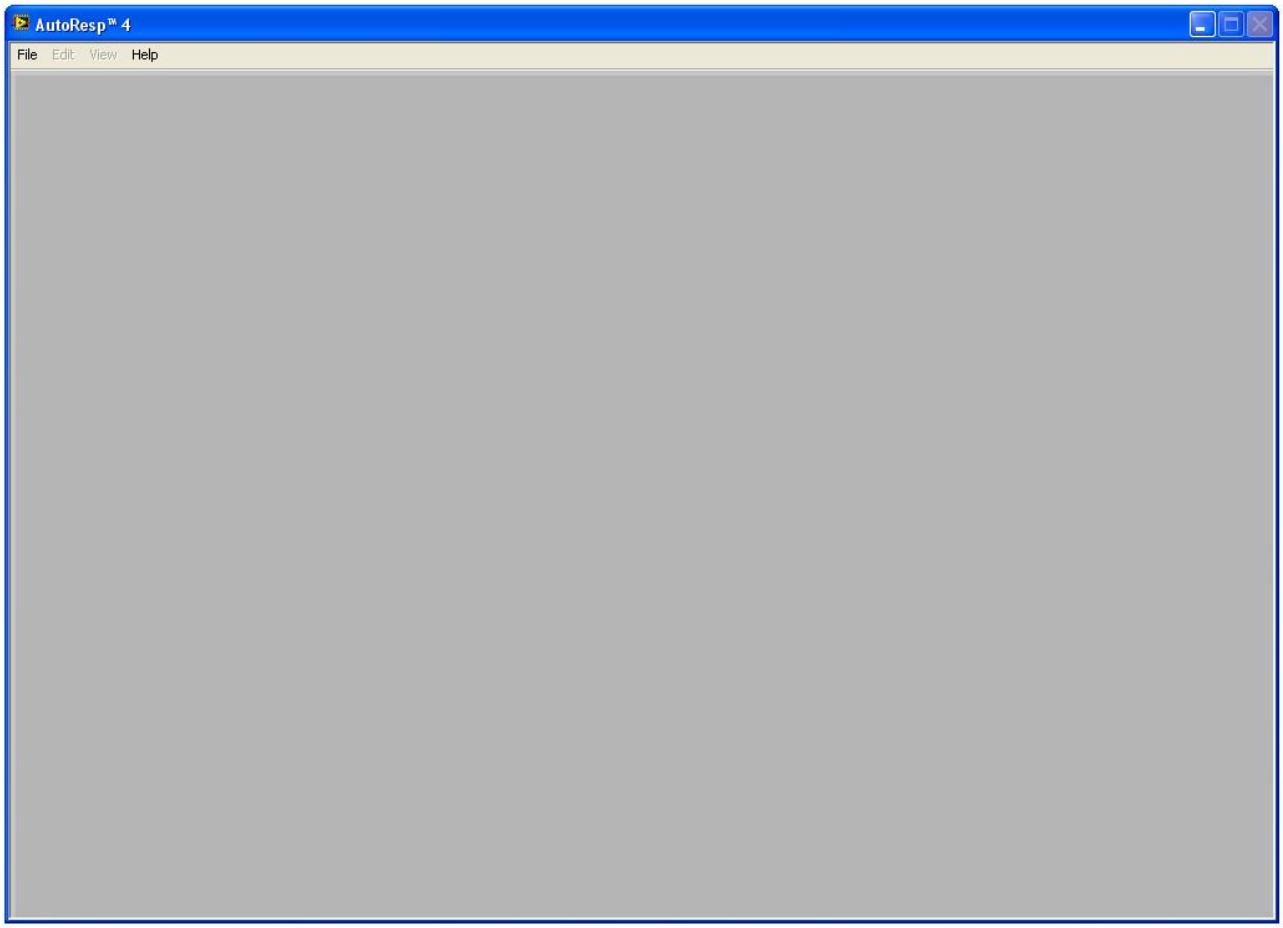


- If the USB hardware protection dongle is not connected to the PC, an error dialog box pops up, see Screen 25.

Screen 25

- Connect the USB hardware protection dongle to the PC via an USB port and click on Retry. Screen 26 now becomes present.

Screen 26



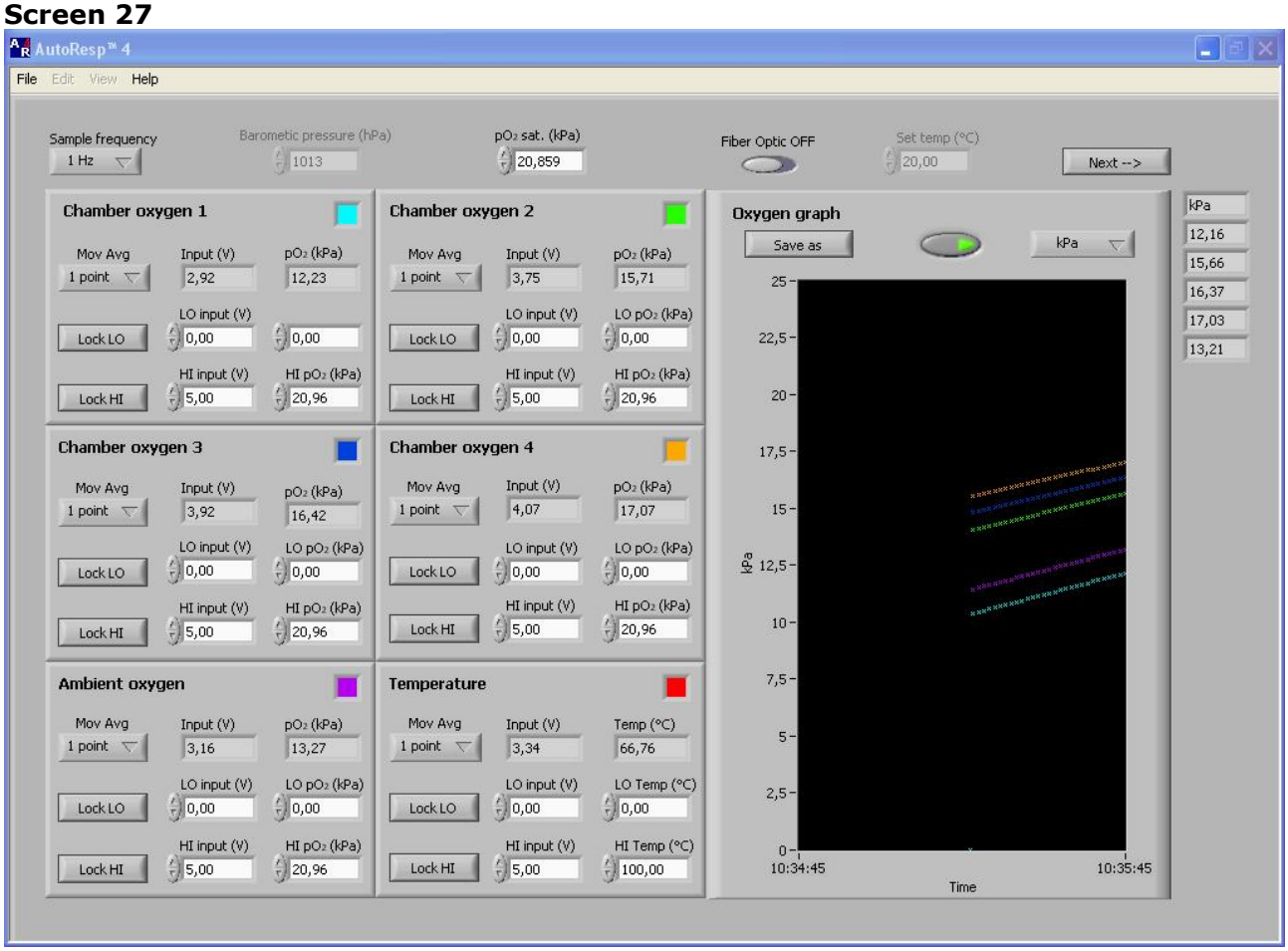
- When AutoResp™ 4 has started properly click on the File menu → New experiment. Screen 27 is now present.

5.2 Calibration and selection of oxygen input

5.2.1. General about Screen 27

Screen 27 is the calibration screen as it looks if chamber oxygen input is a 0-5 VDC analog signal, e.g. from an OXY-REG or some other O_2 instrument. On this screen a common sample frequency for all inputs can be chosen, and the inputs can be calibrated from voltages into oxygen partial pressures and temperature. This screen can also be used to do a quick oxygen or temperature measurement. **Please note:** The calibration values is not stored until an experiment has been started. That means the calibration values are NOT stored when the Next --> button is pressed.

Screen 27



5.2.2. Sample frequency button

Use this button to set a common sample frequency for all inputs. The frequency can be set from one sample to ten samples per second.
Please note: All inputs are always sampled at the same rate.

5.2.3. Barometic pressure (hPa)

Use this button to set the days actual barometic pressure in hPa. This field is used only in fiber optic measurements, and is disabled/enabled together with the fiber optic button status OFF/ON. The default value is 1013 = 1 atm =760 mmHg.

5.2.4. pO2 sat. (kPa)

Use this button to set the saturated partial pressure of oxygen in kPa, see 8.1 pO2 kPa table on page 50. This field is needed to convert the oxygen values in kPa to %air sat. and %oxygen sat. via the Unit button, see 5.2.11.2 Unit button on page 34. The default value is 20,859 which corresponds to 1013 kPa at 15 °C.

5.2.5. Fiber optic button

Use this button to select the type of oxygen input. When the button displays "Fiber optic off", chamber oxygen input should be 0-5 VDC, e.g. from OXY-REG instrument. When the button displays "Fiber optic on", the chamber oxygen input is acquired via the PreSens fiber optic instrument and the RS232 port of the PC. Pressing the button toggles Screen 27 and Screen 29 seen on page 35. Before proceeding to "Fiber Optic on" the user is prompted to choose the COM port the fiber optic instruments from PreSens is connected too.
Please note: When fiber optic is on, as seen on Screen 29 on page 35, the sample frequency cannot be altered as it is predetermined by the fiber optic instrument from PreSens. The frequency is approx. 1 Hz when reading 1 channel and 2 Hz when reading all 4 channels.

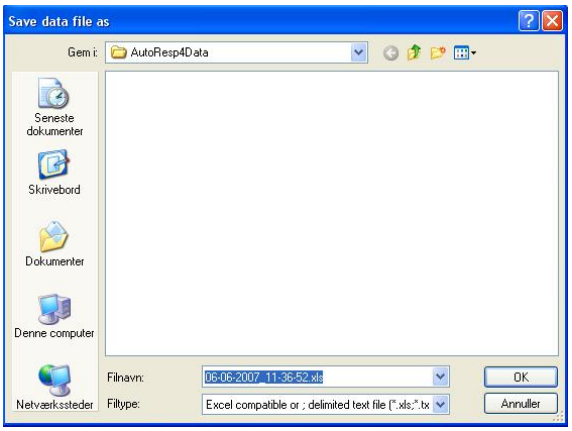
5.2.6. Set temp (°C)

Use this button to set the temperature of the ambient water in °C. This field is used only in fiber optic measurements, and is disabled/enabled together with the fiber optic button status OFF/ON. The default value is 20 °C.
If the temperature cannot be kept during measurements within the entered value with ±0,2 °C, choose to compensate the fiber optic oxygen signal with the measured temperature signal by enable the checkmark Analog Comp, see 5.2.14.1, page 37. If Analog Comp is enabled, the Set temp (°C) field gets disabled and will be updated with the measured temperature. The fiber optic oxygen value will now be real-time compensated for the temperature.

5.2.7. Next --> button

Use this button to accept the calibration settings and move on to setting up a resp. experiment see 5.2.14, page 37. Before proceeding to the setup the user is prompted to enter a data file name and path, see Screen 28. The path specifies the location of the main data file and a folder containing raw data files from the experiment. The path is by default the installation directory of AutoResp4\AutoResp4Data. The current time and date.xls is suggested as a filename in the prompt. Both the path and filename can be altered by choice. The system suggests two file extensions .xls and .txt. The .xls extension will create a tabulator separated text file which is readable by Microsoft ® Excel. The .txt extension will create a semicolon separated text file which is readable by any Microsoft ® Windows PC.
In addition to the data file the system will also generate a folder named as the data file. The dot (.) in the filename will however be replaced by an underscore (_) in the folder name. In this folder files containing raw data will be generated for each measurement loop. The raw data files contain data from the measure period on which the calculated values in the main data file are based.

Screen 28



5.2.8. Chamber oxygen field 1-4

5.2.8.1. Mov Avg button

Use this button to select if the chamber oxygen input signal should be averaged or not. The default value is 1 point which means no averaging of the input. If any other value is chosen the chamber oxygen input will be averaged and the averaged values will be used for all subsequent computations, screen and file outputs. Use moving average if you wish to "smoothen" the chamber oxygen signal.
Please note: No calibrated values will be displayed either on screen or in the data file before sufficient samples have been collected to compute the moving average. *E.g. if the moving average is set to 30 points and the sample rate is set to 10 Hz there will be no chamber oxygen values the first 30 samples equivalent to the first three seconds of samples.*

5.2.8.2. Input (V) indicator

This field displays the actual voltage input.

5.2.8.3. pO_2 (kPa) indicator

This field displays the actual calculated oxygen partial pressure from the voltage input.

5.2.8.4. Lock LO button

This button can be used to copy the actual value from the Input (V) indicator to the LO input (V) field instead of manually reading and retyping the value.

5.2.8.5. LO input (V)

Use this field to enter the low input voltage from the Input (V) indicator during the chamber oxygen calibration.
Please note: The field is limited to values between 0V to 5V

5.2.8.6. LO pO_2 (kPa)

Use this field to enter the oxygen pressure during the low level oxygen calibration of the chamber oxygen input.
Please note: The field is limited to values between 0.00 kPa to 60.00 kPa

5.2.8.7. Lock HI button

This button can be used to copy the actual value from the Input (V) indicator to the HI input (V) field instead of manually reading and retyping the value.

5.2.8.8. HI input (V)

Use this field to enter the high input voltage from the Input (V) indicator during the chamber oxygen calibration.
Please note: The field is limited to values between 0V to 5V

5.2.8.9. HI pO_2 (kPa)

Use this field to enter the oxygen pressure during the high level oxygen calibration of the chamber oxygen input.
Please note: The field is limited to values between 0.00 kPa to 60.00 kPa

5.2.9. Ambient oxygen field

5.2.9.1. Mov Avg button

Use this button to select if the ambient oxygen input signal should be averaged or not. The default value is 1 point which means no averaging of the input. If any other value is chosen the ambient oxygen input will be averaged and the averaged values will be used for all subsequent computations, screen and file outputs. Use moving average if you wish to "smoothen" the ambient oxygen signal.
Please note: No calibrated values will be displayed either on screen or in the data file before sufficient samples have been collected to compute the moving average. *E.g. if the moving average is set to 30 points and the sample rate is set to 10 Hz there will be no ambient oxygen values the first 30 samples equivalent to the first three seconds of samples.*

5.2.9.2. Input (V) indicator

This field displays the actual voltage input.

5.2.9.3. pO_2 (kPa) indicator

This field displays the actual calculated oxygen partial pressure from the voltage input.

5.2.9.4. Lock LO button

This button can be used to copy the actual value from the Input (V) indicator to the LO input (V) field instead of manually reading and retyping the value.

5.2.9.5. LO input (V)

Use this field to enter the low input voltage from the Input (V) indicator during the ambient oxygen calibration.
Please note: The field is limited to values between 0V to 5V

5.2.9.6. LO pO_2 (kPa)

Use this field to enter the oxygen pressure during the low level oxygen calibration of the ambient oxygen input.
Please note: The field is limited to values between 0.00 kPa to 60.00 kPa

5.2.9.7. Lock HI button

This button can be used to copy the actual value from the Input (V) indicator to the HI input (V) field instead of manually reading and retyping the value.

5.2.9.8. HI input (V)

Use this field to enter the high input voltage from the Input (V) indicator during the ambient oxygen calibration. The lower Lock button can be used to copy the actual value from the Input (V) indicator to the HI input (V) field instead of manually reading and retyping the value.
Please note: The field is limited to values between 0V to 5V

5.2.9.9. HI pO_2 (kPa)

Use this field to enter the oxygen pressure during the high level oxygen calibration of the ambient oxygen input.
Please note: The field is limited to values between 0.00 kPa to 60.00 kPa

5.2.10. Temperature field

5.2.10.1. Mov Avg button

Use this button to select if the temperature input signal should be averaged or not. The default value is 1 point which means no averaging of the input. If any other value is chosen the temperature input will be averaged and the averaged values will be used for all subsequent computations, screen and file outputs. Use moving average if you wish to "smoothen" the temperature signal.
Please note: No calibrated values will be displayed either on screen or in the data file before sufficient samples have been collected to compute the moving average. *E.g. if the moving average is set to 30 points and the sample rate is set to 10 Hz there will be* temperature *values the first 30 samples equivalent to the first three seconds of samples.*

5.2.10.2. Input (V) indicator

This field displays the actual voltage input.

5.2.10.3. Temp (°C) indicator

This field displays the actual calculated temperature from the voltage input.

5.2.10.4. Lock LO button

This button can be used to copy the actual value from the Input (V) indicator to the LO input (V) field instead of manually reading and retyping the value.

5.2.10.5. LO input (V)

Use this field to enter the low input voltage from the Input (V) indicator during the low temperature calibration.
Please note: The field is limited to values between 0V to 5V.

5.2.10.6. LO Temp (°C)

Use this field to enter the temperature during the low temperature calibration.
Please note: The field is limited to values between 0 °C to 100 °C.

5.2.10.7. Lock HI button

This button can be used to copy the actual value from the Input (V) indicator to the HI input (V) field instead of manually reading and retyping the value.

5.2.10.8. HI input (V)

Use this field to enter the high input voltage from the Input (V) indicator during the high temperature calibration.
Please note: The field is limited to values between 0V to 5V.

5.2.10.9. HI Temp (°C)

Use this field to enter the temperature during the high temperature calibration.
Please note: The field is limited to values between 0 °C to 100 °C.

5.2.11. Chamber Oxygen graph field

This graph shows the oxygen pressure vs. time measured for the 4 chambers going back 1 min. By right clicking the graph it is possible to show/hide the output data from a chamber. It is also possible to show/hide the ambient oxygen. This is only possible if the Play button is ON. When OFF and right clicking it is possible to copy data and export a simplified image of the graph. Right to the graph there are six fields, where current data are shown. The first field shows the chosen units, which can be altered by the unit button.

It is possible to change the color for every signal by clicking on the color field for every signal.

5.2.11.1. Save button

Use this button to save the data displayed in the Oxygen graph. Furthermore the temperature will be saved. When pressed the user is prompted to enter a file name and path, see Screen 28. The path is by default the installation directory of AutoResp4\AutoResp4Data. The current time and date.xls is suggested as a filename in the prompt. Both the path and filename can be altered by choice. The system suggests two file extensions .xls and .txt. The .xls extension will create a tabulator separated text file which is readable by Microsoft ® Excel. The .txt extension will create a semicolon separated text file which is readable by any Microsoft ® Windows PC.

5.2.11.2. Unit button

Use this button to convert the displayed oxygen partial pressure values on the chamber oxygen graph into Torr, %oxygen saturation or %air saturation.

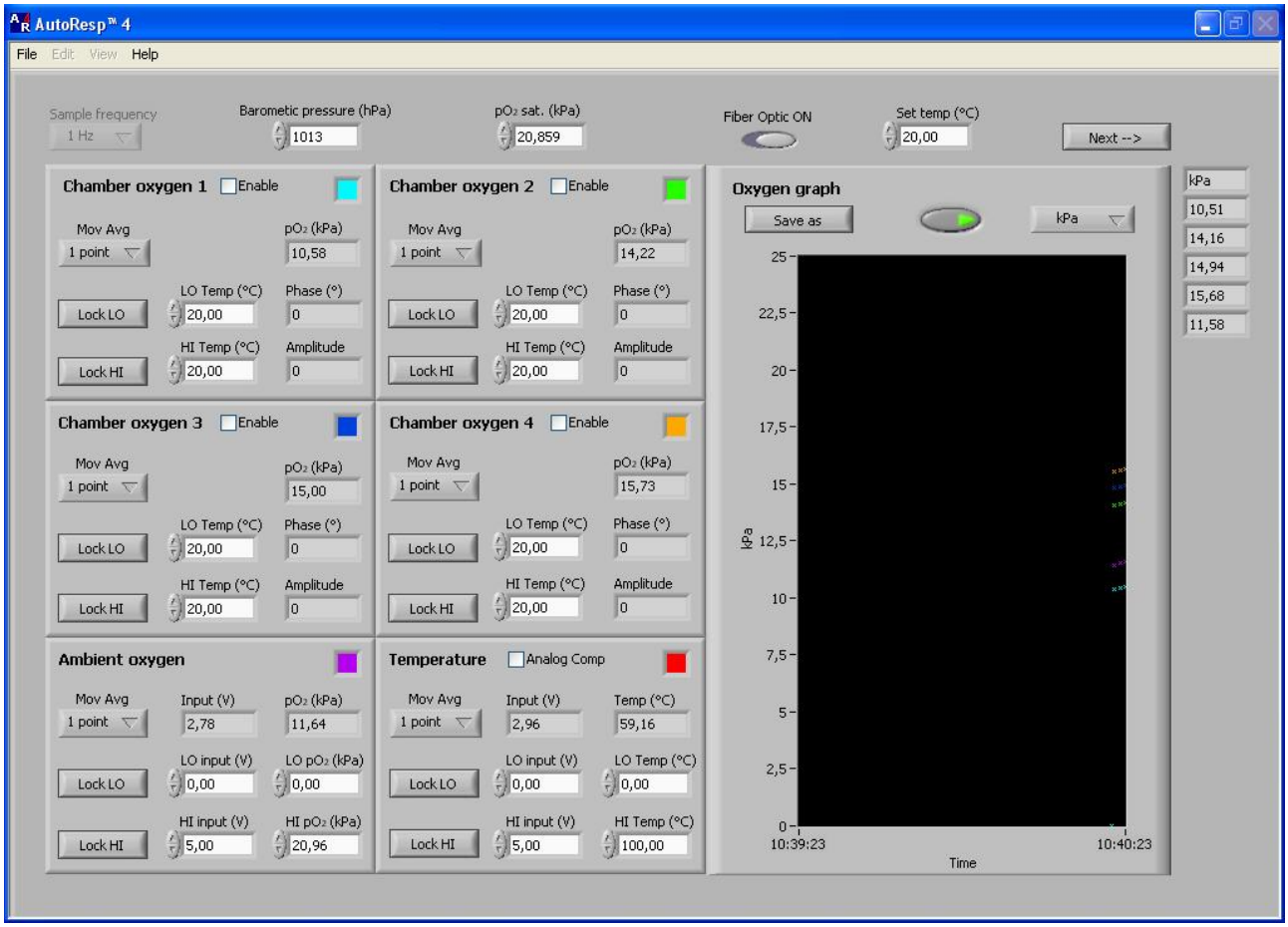
5.2.11.3. Play button

Use this button to start/stop data from being graphed. When the play button is ON, new data will be shown on the oxygen graph and the Unit button is enabled. When the play button is OFF, the Unit button is disabled. Furthermore a scroll bar is shown for the chamber oxygen graph. The state of the Play button also changes the menu of the Chamber oxygen graph, see 5.2.11, page 34.

5.2.12. General about Screen 29

Screen 29 is the calibration screen as it looks if the chamber oxygen signal is acquired from the OXY-4 OXY-4 mini instrument and the RS232 port of the PC.
Please note: When fiber optic is on, as seen on Screen 29, the sample frequency cannot be altered as it is predetermined to approx. 1-2 Hz by the OXY-4 mini instrument.
Please note: The look and functionality of the Ambient Oxygen field and the Oxygen graph field are similar to those of Screen 27.

Screen 29



5.2.13. Chamber oxygen field 1-4

5.2.13.1. Mov Avg button

Use this button to select if the chamber oxygen input signal should be averaged or not. The default value is 1 point which means no averaging of the input. If any other value is chosen the chamber oxygen input will be averaged and the averaged values will be used for all subsequent computations, screen and file outputs. Use moving average if you wish to "smoothen" the chamber oxygen signal.
Please note: No calibrated values will be displayed either on screen or in the data file before sufficient samples have been collected to compute the moving average. *E.g. if the moving average is set to 10 points and all four channels are enabled there will be no chamber oxygen values the first ten samples equivalent to the first twenty seconds of samples.*

5.2.13.2. Enable channel

By clicking on this field, the channel gets enabled, and oxygen data will be received.
Please note: It is only possible to enable a channel, when a sensor is connected to the OXY-4 mini instrument.
Please note: If a sensor is not used, then disable the channel. This will increase the lifetime of the sensor.

5.2.13.3. pO_2 (kPa) indicator

This field displays the chamber oxygen pressure from the OXY-4 fiber optic instrument from PreSens relative the calibration.

5.2.13.4. Lock LO button

Press this button to calibrate the OXY-4 mini instrument in a 0% air saturation O_2 sample.
Please note: It is important not to push the Lock LO button before the Phase (°) and Amplitude indicators has stabilized.
Please note: A full calibration must consist of a 0% calibration and a 100% calibration before the oxygen readouts are reliable.
Please note: The calibration will be written down on an EEPROM in the OXY-4 mini instrument. If you want to use the OXY-4 mini instrument with the software from PreSens a new calibration may be done using this software.

5.2.13.5. LO Temp (°C)

Use this field to specify the temperature during calibration of the OXY-4 fiber optic instrument with the 0% air saturation O_2 solution.

5.2.13.6. Lock HI button

Press this button to calibrate the OXY-4 mini instrument in a 100% air saturation O_2 sample.
Please note: It is important not to push the Lock HI button before the Phase (°) and Amplitude indicators has stabilized.
Please note: A full calibration must consist of a 0% calibration and a 100% calibration before the oxygen readouts are reliable.
Please note: The calibration will be written down on an EEPROM in the OXY-4 mini instrument. If you want to use the OXY-4 mini instrument with the software from PreSens a new calibration may be done using this software.

5.2.13.7. HI Temp (°C)

Use this field to specify the temperature during calibration of the OXY-4 fiber optic instrument with the 100% air saturation O_2 solution.

5.2.13.8. Phase (°) indicator

This field indicates the phase angle of the optical signal that the OXY-4 mini instrument uses for computations of the chamber oxygen pressure. For further information about the OXY-4 mini instrument see 8.6 OXY-4 Instruction manual, page 55

5.2.13.9. Amplitude indicator

This field indicates the amplitude of the optical signal that the OXY-4 mini instrument measures. The signal strength is an indicator for the sensor condition. See the manual of the OXY-4 fiber optic instrument from PreSens for further explanation.

5.2.14. Temperature field

When the fiber optic button is ON, the Temperature field gets changed from Screen 27 page 27, to Screen 29 page 35. A checkmark appears named Analog Comp.

5.2.14.1. Analog Comp

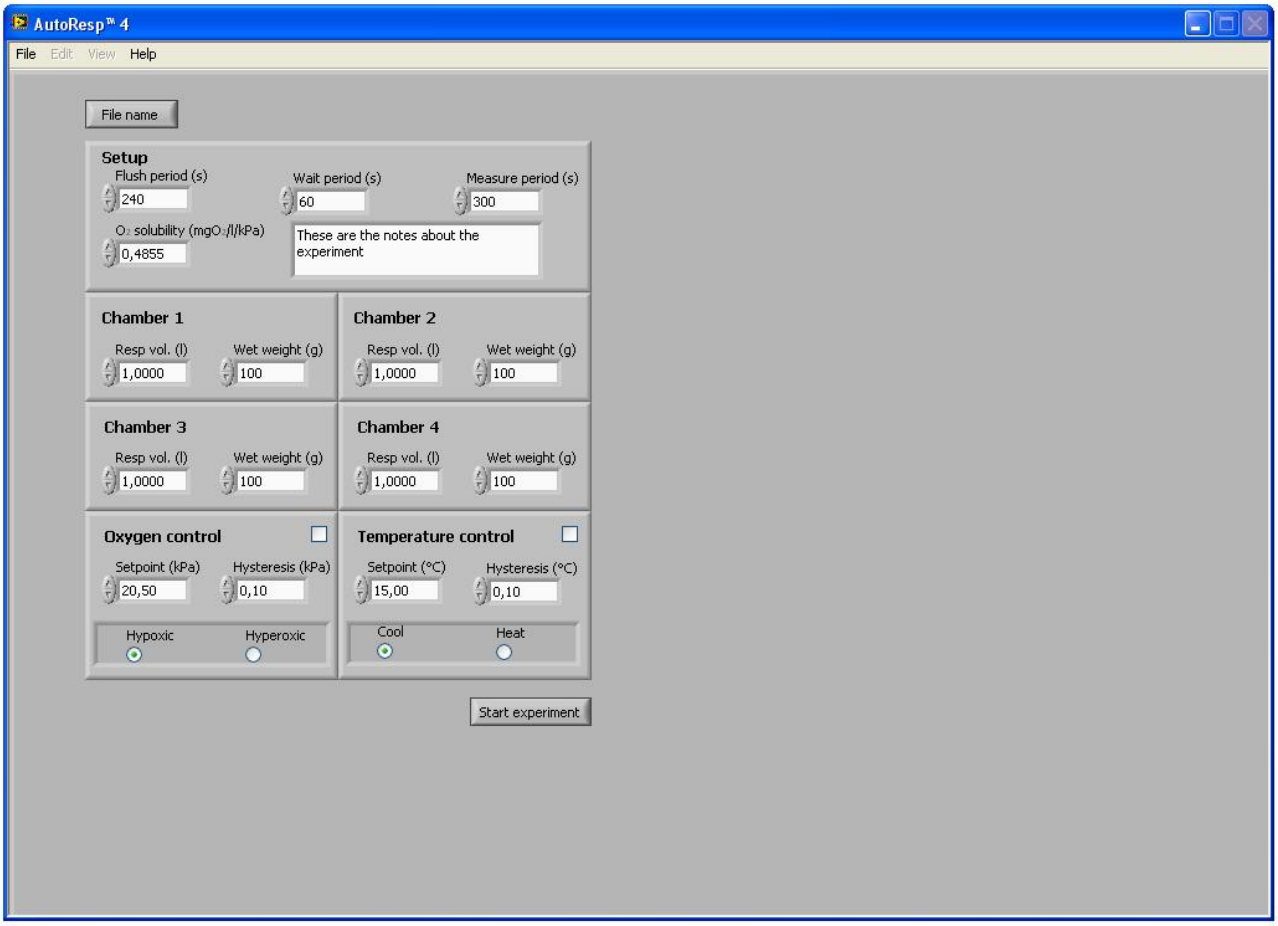
Use this checkmark to enable/disable the real-time compensation of the fiber optic oxygen signal with the analog measured temperature. If the temperature changes with 0,2 °C, the new temperature will be send to the fiber optic instrument.

5.3 Setup experiment

5.3.1. General about Screen 30

On Screen 30 the intermittent respirometry experiment is configured.

Screen 30



5.3.2. File name button

Use this button to change the path and filename of the data file and raw data folder. The path specifies the location of the main data file and the folder containing raw data from the experiment. The path is by default the installation directory of AutoResp4\AutoResp4Data. The current time and date.xls is suggested as a filename in the prompt. Both the path and filename can be altered by choice. The system suggests two file extensions .xls and .txt. The .xls extension will create a tabulator separated text file which is readable by Microsoft ® Excel. The .txt extension will create a semicolon separated text file which is readable by any Microsoft ® Windows PC.
In addition to the data file the system will also generate a folder named as the data file. The dot (.) in the filename will however be replaced by an underscore (_) in the folder name. In this folder files containing raw data will be generated for each measurement loop. The raw data files contain data from the measure period on which the calculated values in the main data file are based.
Please note: The start experiment button will be disabled until a valid path/filename is selected.

5.3.3. Setup field

5.3.3.1. Flush period (s)

Use this field to specify the duration of flush periods in seconds during the intermittent flow respirometry experiment.
Please note: The field is limited to values between 0 s to 35 weeks.

5.3.3.2. Wait period (s)

Use this field to specify the duration of the wait periods in seconds during the intermittent flow respirometry experiment.
Please note: The field is limited to values between 1 s to 35 weeks.

5.3.3.3. Measure period (s)

Use this field to specify the duration of the measure periods during the intermittent flow respirometry experiment.
Please note: The field is limited to values between 1 s to 35 weeks.

5.3.3.4. O_2 solubility (mg O2/l/kPa)

Use this field to specify the oxygen solubility of sample water.
Please note: This field is limited to values between 0 to 0,75 mg/L/kPa. The default value is 0,4855 corresponding to a 15°C fresh water. For further information see the appendix, page 50 and 51

5.3.3.5. Note field

In this field the user can write a note about the experiment. The note is saved to the data file.

5.3.4. Chamber field 1-4

5.3.4.1. Resp vol. (l)

Use this field to specify the volume of water used for the calculation of the MO_2 value.

Resp vol. = chamber volume + tube volume - volume of organism(s)

To specify the Resp vol., fill the chamber and the tubes with water and measure the weight on a scale. Now empty the chamber and the tubes for water and measure the weight again. The difference between the two measurements will be the weight of the chamber volume and the tube volume. Multiply the calculated weight with the mass specific volume of water for finding the volume for the chamber and the tubes.
To find the volume of the organism measure the weight of the organism and multiply with the mass specific volume of the organism.
Please note: This field is limited to values between 0 to 2500 l.

5.3.4.2. Wet weight (g)

Use this field to specify the weight of the experimental organism(s).
Please note: This field is limited to values between 0,001g to 100 kg

5.3.5. Oxygen control field

5.3.5.1. Checkbox

Use the checkbox to enable or disable the O_2/N_2 relay on the DAQ-4 instrument. If the checkbox is checked AutoResp™ 4 can control the O_2 pressure in the ambient water as specified in the oxygen control field.

5.3.5.2. Setpoint (kPa)

Use this field to set an oxygen level in the ambient water that the system should maintain during an experiment.
Please note: The field is limited to values between 0 kPa to 60 kPa.

5.3.5.3. Hysteresis (kPa)

Use this field to change the oxygen hysteresis value. Use a hysteresis value > 0 kPa to ensure that the O_2/N_2 valve does not flicker on the sharp edge of the setpoint. If the hysteresis pressure is 0 kPa the O_2/N_2 valve is very susceptible to electronic noise on the ambient oxygen channel.
Please note: The field is limited to values between 0 kPa to 30 kPa.

5.3.5.4. Hypoxic/Hyperoxic

Use these buttons to select if the system must maintain the setpoint as a maximum (Hypoxic) or a minimum (Hyperoxic) oxygen pressure.

5.3.6. Temperature control field

5.3.6.1. Checkbox

Use the checkbox to enable or disable the TEMP relay on the DAQ-4 instrument. If the checkbox is checked AutoResp™ 4 can control the temperature in the ambient water as specified in the temperature control field.

5.3.6.2. Setpoint (°C)

Use this field to set a temperature level in the ambient water that the system should maintain during an experiment.
Please note: The field is limited to values between -2 °C to 100 °C.

5.3.6.3. Hysteresis (°C)

Use this field to change the temperature hysteresis value. Use a hysteresis value > 0 °C to ensure that the cooler/heater pump does not flicker on the sharp edge of the setpoint.
If the hysteresis temperature = 0 °C the cooler/heater pump is very susceptible to electronic noise on the temperature channel.
Please note: The field is limited to values between 0 °C to 49,99 °C.

5.3.6.4. Cool/Heat

Use these buttons to select if the system must maintain the setpoint as a maximum (Cool) or a minimum (Heat) temperature.

5.3.7. Start experiment button

Use this button to accept the setup settings as they are displayed on Screen 30 and proceed to Screen 31.

5.3.8. Menus in Screen 27, Screen 29 and Screen 30

5.3.8.1. File → Exit

Exits AutoResp™ 4 without saving changes to the calibration screens.

5.3.8.2. File → Continue experiment

Continues the last experiment, if stopped by user. Data on the graphs will only be in memory, when AutoResp™ 4 has not been shut down.
Please note: This option is only available if a calibration has been made and the user has stopped a running experiment.

5.3.8.3. Help → About

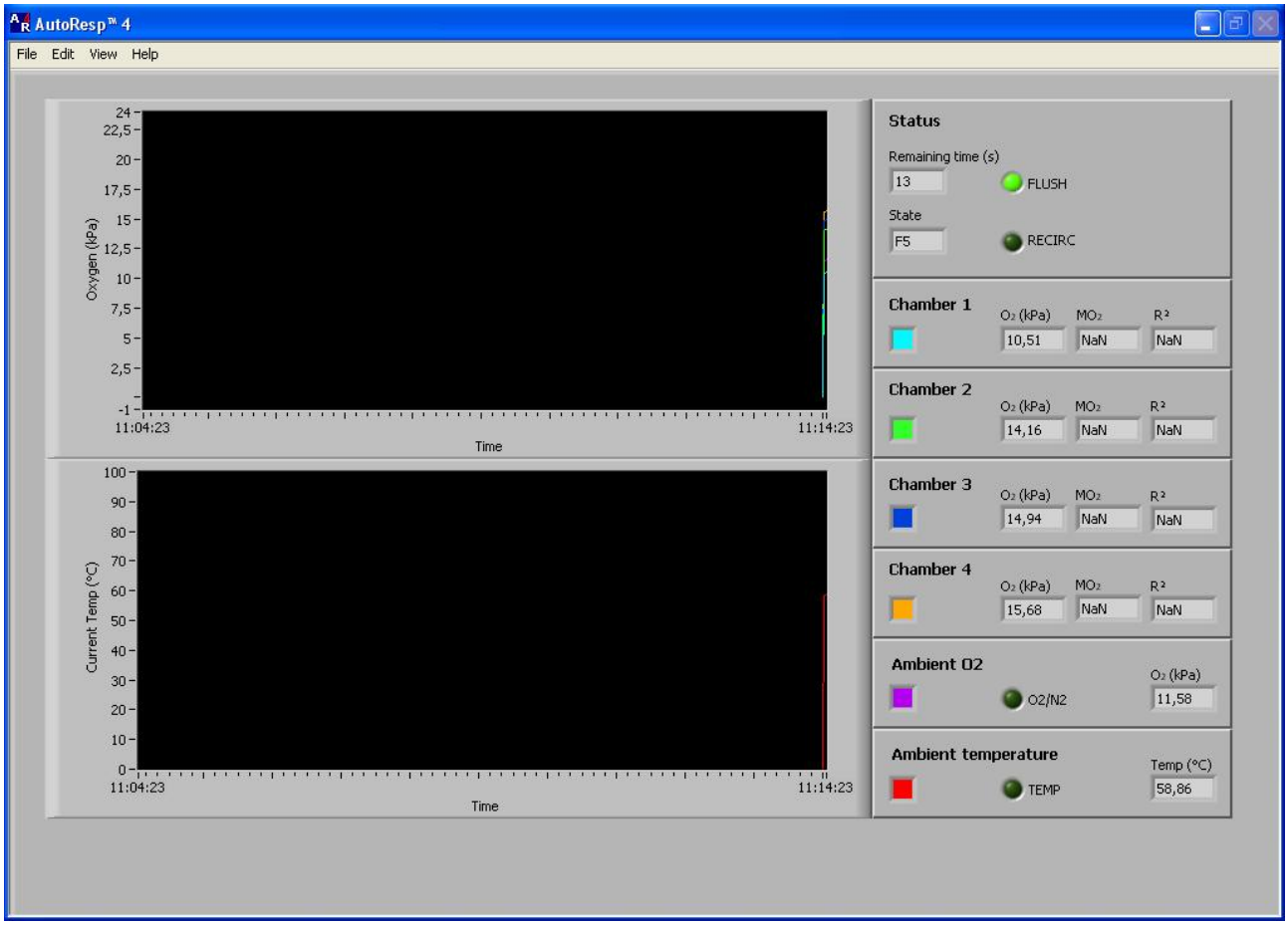
Displays contact information about Loligo Systems.

5.4 Running experiment

5.4.1. General about Screen 30

On Screen 31 the intermittent respirometry experiment is running.

Screen 31



5.4.2. Oxygen graph field

This field shows the measured oxygen values vs. time. By right clicking the graph, the user can choose which chamber graph is to be shown. It is also possible to show the ambient oxygen as a graph and modify the time interval on the x scale (10, 30 and 90 min). Another option is to save the graph to a file and to show the experiment settings.

5.4.3. Graph field

This field shows some different graphs for the experiment. As default the current temperature vs. time graph is shown. The user can choose between the following graphs by clicking with the mouse on the view button in the menu.

- MO_2 vs. time
- MO_2 vs. avg. Chamber O_2
- Avg. temperature vs. time
- Current temperature vs. time
- R^2 vs. time
- Current R^2 vs. time

The MO_2, avg. temperature and the R^2 vs. time graph shows data from the whole experiment. The current temperature and the current R^2 vs. time graph shows data for the last 10, 30 or 90 min, depended on the x scale from the oxygen graph, see 5.4.2. By right clicking on the graph, the user can save the shown graph to a file.

5.4.4. Status field

5.4.4.1. Loop remaining (s)

This field shows the remaining seconds left of the current measurement loop. The loop is defined as the summed duration of flush, wait and measure periods.

5.4.4.2. Loop number (s)

This field shows the actual state of the loop and the number of loops. The letter F means flush, W means wait and M means measure. Behind the letter a number is shown, which shows the actual number of the loop.

5.4.4.3. Flush indicator

This diode indicates if the flush pump is activated or not. The flush pump is running only in a flush period.

5.4.4.4. Recirc indicator

This diode indicates if the recirculation pump is activated or not. The recirculation pump is running in a flush and a measure period.

5.4.5. Ambient measure field

5.4.5.1. Ambient O_2 (kPa)

This field shows the actual measured ambient water oxygen pressure.

5.4.5.2. Temperature (°C)

This field shows the actual measured temperature.

5.4.5.3. Oxygen regulation

This field shows if the oxygen regulator is working to maintain the oxygen level in the ambient tank as hypoxic or hyperoxic, see 5.3.5 Oxygen control field, page 40.

5.4.5.4. Temperature regulation

This field shows if the temperature regulator is working to maintain the temperature level in the ambient water, see 5.3.6 Temperature control field, page 41.

5.4.6. Chamber measure field 1-4

5.4.6.1. Chamber O_2 (kPa)

This field shows the actual measured oxygen pressure for the chamber.

5.4.6.2. MO_2 field

This field shows the calculated MO_2 value for the chamber as described in background, see 4 Introduction to intermittent flow respirometry, page 21. The MO_2 value is calculated as follows:

$$MO_2\left[\frac{mg\,O_2}{h\cdot kg}\right] = 3600\cdot O_2\,\text{solubility}\left[\frac{mgO_2}{l\cdot kPa}\right]\cdot slope\left[\frac{kPa}{s}\right]\cdot resp\,vol.[l]\cdot\frac{1000}{wet\,weight}\left[g^{-1}\right]$$

Where slope is calculated as follows:

$$slope\left[\frac{kPa}{s}\right] = \frac{O_{2n} - O_{2n-1}}{time_n - time_{n-1}}$$

Please note: MO_2 is only calculated in each measurement period, e.g. 29 MO_2 values after 30 seconds measure period at 1 Hz.

5.4.6.3. R^2 field

This field shows the calculated R^2 linear correlation coefficient value for the chamber when MO_2 is calculated. The R^2 value can be used to validate the linear fit of the O_2 curve.

5.4.7. Menus in Screen 31

5.4.7.1. File → Stop experiment

This option stops the current experiment.
Please note: To immediately turn on the flush pump use this option.

5.4.7.2. Edit → Oxygen

While the experiment is running the user can use this option to alter the oxygen regulation. This can be done by changing the setpoint, the hysteresis or the mode hypoxic/hyperoxic.

5.4.7.3. Edit → Temperature

While the experiment is running the user can use this option to alter the temperature regulation. This can be done by changing the setpoint, the hysteresis or the mode cool/heat.

5.4.7.4. View

By this option the user decides which graph is to be shown in the graph field, see 5.4.3 Graph field on page 43.

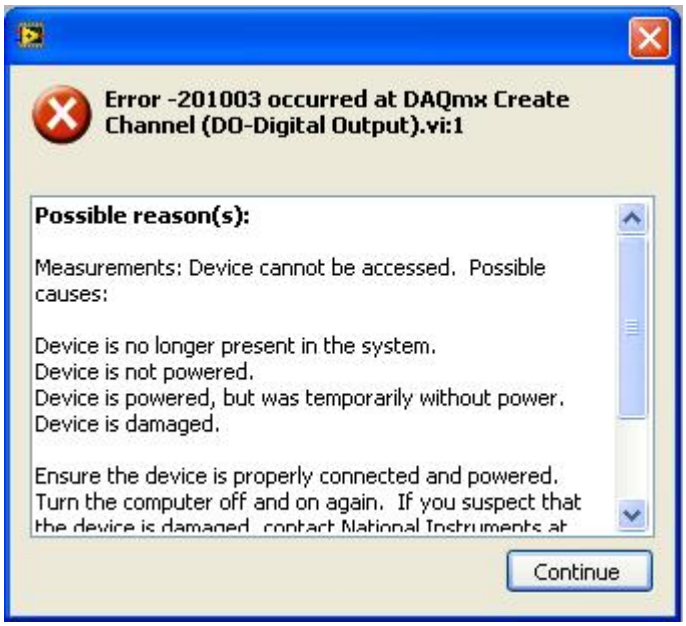
5.4.7.5. Help → About

Displays contact information about Loligo Systems

6. Troubleshooting

6.1 No connection to the DAQ-4 instrument

Screen 32

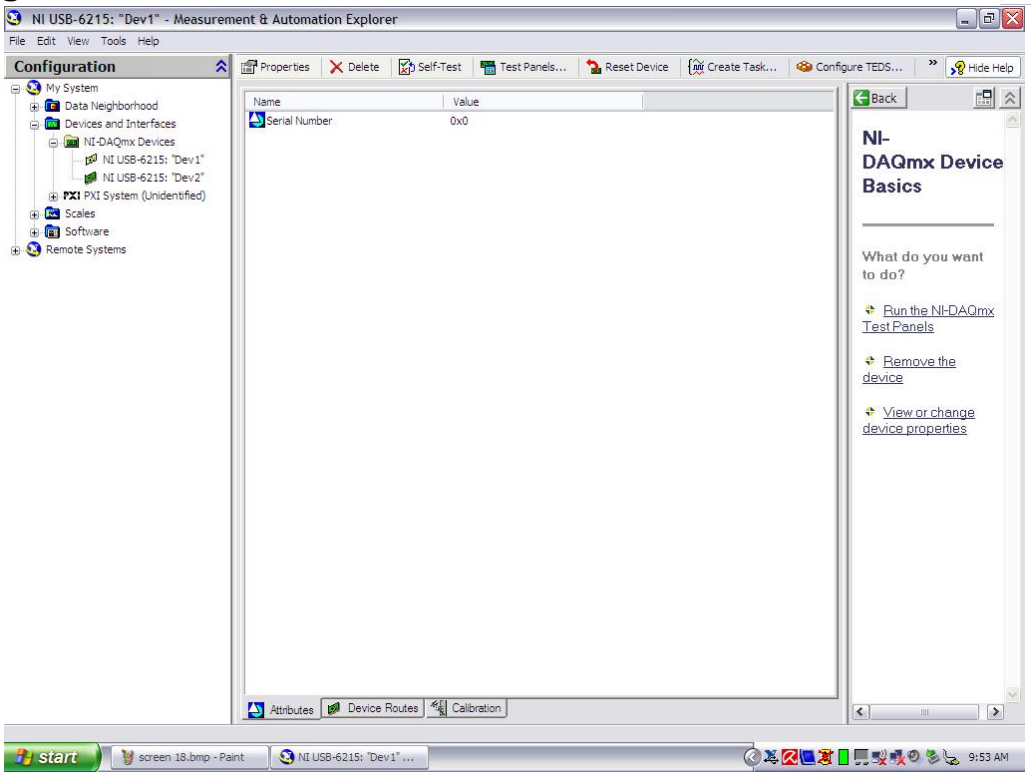


The error shown on Screen 32 occurs, when the NI-USB 6215 DAQ card has no properly connection to the PC. This error can occur in 2 ways.

6.1.1. Name is not "Dev1"

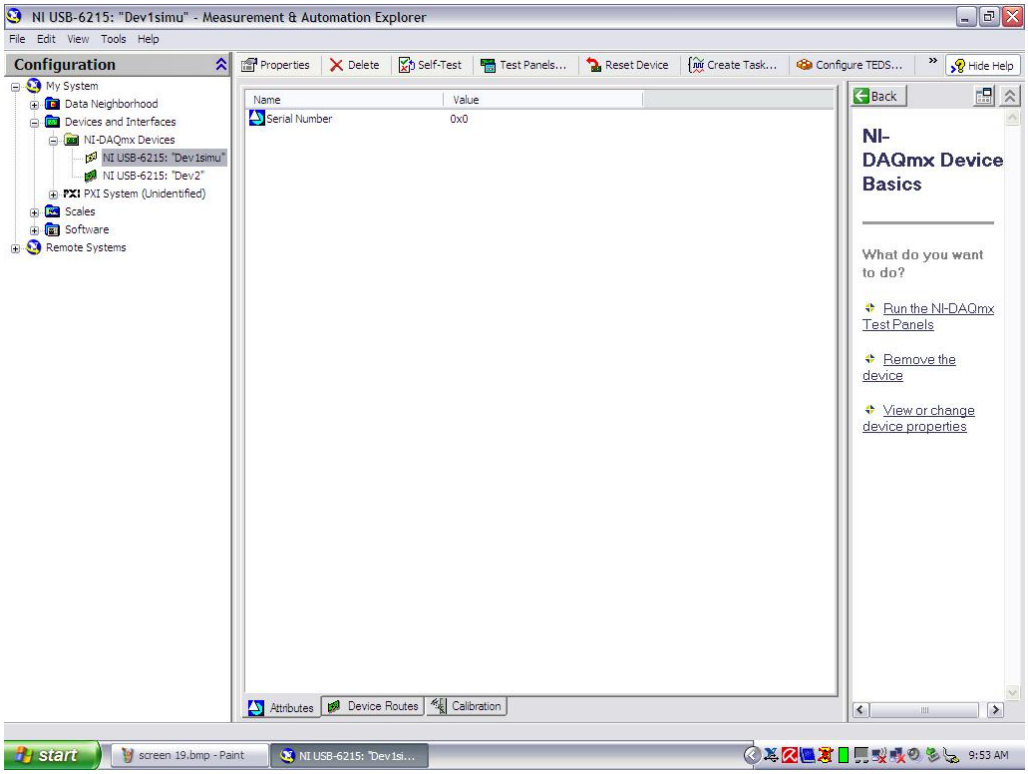
To change the device name, open Measurement & Automation by following the folder hierarchy shown on Screen 21, page 16. The following example shows on Screen 33 a simulated device named as "Dev1". The NI-USB 6215 DAQ card is registered as "Dev2"

Screen 33



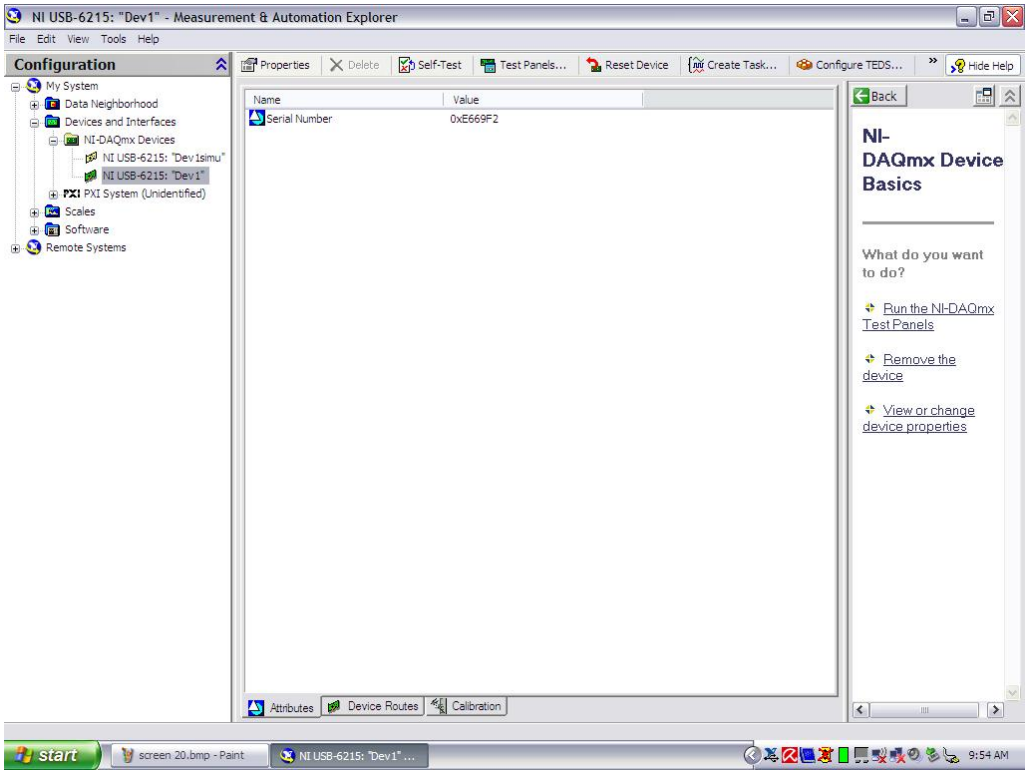
Right click with mouse on the "Dev1", and choose rename, or press F2. Change the name to something different than "Dev1". In this example the name is changed to "dev1simu", see Screen 34.

Screen 34



Now change the device name of the NI USB-6215 DAQ card to "Dev1". The DAQ-4 instrument should now work properly with AutoResp™ 4.

Screen 35



Please note: By changing the NI USB-6215 device to "dev1" another applications using devices from National Instruments might not work properly anymore.

6.1.2. Another USB device was improperly removed

If an USB device, like a USB memory stick, is not properly removed, while AutoResp™ 4 is running, there can be a connection problem with the DAQ-4 instrument. To solve this problem, close AutoResp™ 4. Then disconnect the USB cable between the PC and the DAQ-4 instrument. Wait 30 seconds. Then connect the cable and wait. When the green diode on the front side of the DAQ-4 instrument is flashing, the connection is re-established. Choose Continue experiment to avoid loosing data.

6.2 Relays are not working

Make sure the DAQ-4 instrument is connected with a power cable, and the Power button is ON.

7.Index

8. Appendix

8.1 pO_2 kPa table

File: PO2 kPa.xls

Partial pressure of oxygen (pO2) at different barometric pressures and temperatures = ((Pbp-Pvap)*.2094)

Temperature (deg C)	0	2	4	6	8	10	12	14	16	18	20	25	30	35	37	40
Pvap (kPa)	0,61	0,71	0,81	0,93	1,07	1,23	1,40	1,60	1,82	2,06	2,34	3,17	4,24	5,62	6,28	7,38
Pbp (kPa)																
97,32	20,256	20,237	20,215	20,191	20,163	20,132	20,097	20,058	20,013	19,964	19,909	19,742	19,526	19,248	19,117	18,895
97,59	20,312	20,292	20,271	20,246	20,218	20,187	20,152	20,113	20,068	20,019	19,963	19,796	19,579	19,301	19,169	18,947
97,85	20,367	20,348	20,326	20,302	20,274	20,242	20,207	20,167	20,123	20,073	20,018	19,850	19,633	19,353	19,221	18,999
98,12	20,423	20,403	20,382	20,357	20,329	20,298	20,262	20,222	20,178	20,128	20,072	19,904	19,686	19,406	19,274	19,050
98,39	20,478	20,459	20,437	20,412	20,384	20,353	20,317	20,277	20,233	20,183	20,127	19,958	19,739	19,459	19,326	19,102
98,65	20,534	20,514	20,492	20,467	20,439	20,408	20,372	20,332	20,288	20,237	20,182	20,012	19,793	19,512	19,378	19,154
98,92	20,589	20,570	20,548	20,523	20,495	20,463	20,427	20,387	20,342	20,292	20,236	20,066	19,846	19,564	19,431	19,206
99,19	20,645	20,625	20,603	20,578	20,550	20,518	20,482	20,442	20,397	20,347	20,291	20,121	19,900	19,617	19,483	19,257
99,45	20,700	20,681	20,658	20,633	20,605	20,573	20,537	20,497	20,452	20,402	20,345	20,175	19,953	19,670	19,536	19,309
99,72	20,756	20,736	20,714	20,689	20,660	20,628	20,593	20,552	20,507	20,456	20,400	20,229	20,007	19,722	19,588	19,361
99,99	20,811	20,791	20,769	20,744	20,716	20,684	20,648	20,607	20,562	20,511	20,454	20,283	20,060	19,775	19,640	19,413
100,25	20,866	20,847	20,825	20,799	20,771	20,739	20,703	20,662	20,617	20,566	20,509	20,337	20,114	19,828	19,693	19,464
100,52	20,922	20,902	20,880	20,855	20,826	20,794	20,758	20,717	20,671	20,620	20,563	20,391	20,167	19,881	19,745	19,516
100,79	20,977	20,958	20,935	20,910	20,881	20,849	20,813	20,772	20,726	20,675	20,618	20,445	20,221	19,933	19,797	19,568
101,05	21,033	21,013	20,991	20,965	20,937	20,904	20,868	20,827	20,781	20,730	20,672	20,499	20,274	19,986	19,850	19,620
101,32	21,088	21,069	21,046	21,021	20,992	20,959	20,923	20,882	20,836	20,784	20,727	20,553	20,328	20,039	19,902	19,672
101,59	21,144	21,124	21,102	21,076	21,047	21,015	20,978	20,937	20,891	20,839	20,782	20,607	20,381	20,092	19,955	19,723
101,85	21,199	21,180	21,157	21,131	21,102	21,070	21,033	20,992	20,946	20,894	20,836	20,661	20,435	20,144	20,007	19,775
102,12	21,255	21,235	21,212	21,187	21,158	21,125	21,088	21,047	21,000	20,948	20,891	20,715	20,488	20,197	20,059	19,827
102,39	21,310	21,290	21,268	21,242	21,213	21,180	21,143	21,102	21,055	21,003	20,945	20,770	20,542	20,250	20,112	19,879
102,65	21,366	21,346	21,323	21,297	21,268	21,235	21,198	21,157	21,110	21,058	21,000	20,824	20,595	20,303	20,164	19,930
102,92	21,421	21,401	21,378	21,353	21,323	21,290	21,253	21,212	21,165	21,113	21,054	20,878	20,649	20,355	20,216	19,982
103,19	21,477	21,457	21,434	21,408	21,379	21,346	21,308	21,267	21,220	21,167	21,109	20,932	20,702	20,408	20,269	20,034
103,45	21,532	21,512	21,489	21,463	21,434	21,401	21,363	21,321	21,275	21,222	21,163	20,986	20,756	20,461	20,321	20,086

8.2 Oxygen solubility

Oxygen solubility in mg O2/liter/kPa at different temperatures and salinities

From Green & Carrit (1967). J. Mar. Biol. 25; 140-147.   1 kPa = 7,501 mmHg

Salinity (o/oo)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
Temperature (deg C)																			
0	0,6976	0,6878	0,6781	0,6685	0,6591	0,6498	0,6406	0,6316	0,6227	0,6139	0,6053	0,5967	0,5883	0,5800	0,5719	0,5638	0,5559	0,5480	0,5403
1	0,6788	0,6694	0,6600	0,6509	0,6418	0,6329	0,6241	0,6154	0,6068	0,5984	0,5900	0,5818	0,5737	0,5657	0,5579	0,5501	0,5424	0,5349	0,5274
2	0,6608	0,6517	0,6428	0,6339	0,6252	0,6166	0,6082	0,5998	0,5916	0,5834	0,5754	0,5675	0,5597	0,5520	0,5444	0,5369	0,5295	0,5223	0,5151
3	0,6436	0,6349	0,6263	0,6178	0,6094	0,6011	0,5929	0,5849	0,5769	0,5691	0,5614	0,5537	0,5462	0,5388	0,5315	0,5243	0,5171	0,5101	0,5032
4	0,6272	0,6188	0,6104	0,6022	0,5942	0,5862	0,5783	0,5706	0,5629	0,5553	0,5479	0,5405	0,5333	0,5261	0,5190	0,5121	0,5052	0,4984	0,4917
5	0,6114	0,6033	0,5953	0,5874	0,5796	0,5719	0,5643	0,5568	0,5494	0,5421	0,5349	0,5278	0,5208	0,5139	0,5071	0,5004	0,4937	0,4872	0,4807
6	0,5963	0,5885	0,5808	0,5731	0,5656	0,5582	0,5508	0,5436	0,5365	0,5294	0,5225	0,5156	0,5089	0,5022	0,4956	0,4891	0,4827	0,4763	0,4701
7	0,5818	0,5743	0,5668	0,5595	0,5522	0,5450	0,5379	0,5310	0,5241	0,5172	0,5105	0,5039	0,4974	0,4909	0,4845	0,4782	0,4720	0,4659	0,4598
8	0,5680	0,5607	0,5535	0,5463	0,5393	0,5324	0,5255	0,5188	0,5121	0,5055	0,4990	0,4926	0,4863	0,4800	0,4739	0,4678	0,4618	0,4558	0,4500
9	0,5547	0,5476	0,5406	0,5338	0,5270	0,5203	0,5136	0,5071	0,5006	0,4943	0,4880	0,4818	0,4756	0,4696	0,4636	0,4577	0,4519	0,4461	0,4405
10	0,5419	0,5351	0,5283	0,5217	0,5151	0,5086	0,5022	0,4959	0,4896	0,4834	0,4774	0,4713	0,4654	0,4595	0,4537	0,4480	0,4424	0,4368	0,4313
11	0,5297	0,5231	0,5165	0,5101	0,5037	0,4974	0,4912	0,4851	0,4790	0,4730	0,4671	0,4613	0,4555	0,4498	0,4442	0,4387	0,4332	0,4278	0,4224
12	0,5179	0,5115	0,5052	0,4989	0,4928	0,4867	0,4806	0,4747	0,4688	0,4630	0,4573	0,4516	0,4460	0,4405	0,4351	0,4297	0,4244	0,4191	0,4139
13	0,5067	0,5005	0,4943	0,4882	0,4823	0,4763	0,4705	0,4647	0,4590	0,4534	0,4478	0,4423	0,4369	0,4315	0,4262	0,4210	0,4158	0,4107	0,4057
14	0,4959	0,4898	0,4839	0,4780	0,4721	0,4664	0,4607	0,4551	0,4496	0,4441	0,4387	0,4333	0,4281	0,4229	0,4177	0,4126	0,4076	0,4026	0,3977
15	0,4855	0,4796	0,4738	0,4681	0,4624	0,4568	0,4513	0,4459	0,4405	0,4352	0,4299	0,4247	0,4196	0,4145	0,4095	0,4046	0,3997	0,3948	0,3901
16	0,4755	0,4698	0,4641	0,4586	0,4531	0,4476	0,4423	0,4370	0,4317	0,4266	0,4214	0,4164	0,4114	0,4065	0,4016	0,3968	0,3920	0,3873	0,3827
17	0,4659	0,4603	0,4549	0,4494	0,4441	0,4388	0,4336	0,4284	0,4233	0,4183	0,4133	0,4084	0,4035	0,3987	0,3940	0,3893	0,3846	0,3800	0,3755
18	0,4567	0,4513	0,4459	0,4407	0,4354	0,4303	0,4252	0,4202	0,4152	0,4103	0,4054	0,4006	0,3959	0,3912	0,3866	0,3820	0,3775	0,3730	0,3686
19	0,4478	0,4426	0,4374	0,4322	0,4271	0,4221	0,4171	0,4122	0,4074	0,4026	0,3979	0,3932	0,3886	0,3840	0,3795	0,3750	0,3706	0,3662	0,3619
20	0,4393	0,4342	0,4291	0,4241	0,4191	0,4142	0,4094	0,4046	0,3999	0,3952	0,3906	0,3860	0,3815	0,3770	0,3726	0,3683	0,3640	0,3597	0,3555
21	0,4311	0,4261	0,4212	0,4163	0,4114	0,4066	0,4019	0,3972	0,3926	0,3880	0,3835	0,3791	0,3747	0,3703	0,3660	0,3617	0,3575	0,3534	0,3493
22	0,4233	0,4184	0,4135	0,4087	0,4040	0,3993	0,3947	0,3901	0,3856	0,3812	0,3767	0,3724	0,3681	0,3638	0,3596	0,3554	0,3513	0,3473	0,3432
23	0,4157	0,4109	0,4062	0,4015	0,3969	0,3923	0,3878	0,3833	0,3789	0,3745	0,3702	0,3659	0,3617	0,3575	0,3534	0,3494	0,3453	0,3413	0,3374
24	0,4084	0,4037	0,3991	0,3945	0,3900	0,3855	0,3811	0,3767	0,3724	0,3681	0,3639	0,3597	0,3556	0,3515	0,3475	0,3435	0,3395	0,3356	0,3318
25	0,4014	0,3968	0,3923	0,3878	0,3833	0,3790	0,3746	0,3703	0,3661	0,3619	0,3578	0,3537	0,3497	0,3457	0,3417	0,3378	0,3339	0,3301	0,3263
26	0,3947	0,3902	0,3857	0,3813	0,3770	0,3727	0,3684	0,3642	0,3601	0,3560	0,3519	0,3479	0,3439	0,3400	0,3361	0,3323	0,3285	0,3248	0,3211
27	0,3882	0,3838	0,3794	0,3751	0,3708	0,3666	0,3624	0,3583	0,3542	0,3502	0,3462	0,3423	0,3384	0,3346	0,3308	0,3270	0,3233	0,3196	0,3160
28	0,3819	0,3776	0,3733	0,3691	0,3649	0,3608	0,3567	0,3526	0,3486	0,3447	0,3408	0,3369	0,3331	0,3293	0,3256	0,3219	0,3182	0,3146	0,3110
29	0,3759	0,3717	0,3674	0,3633	0,3592	0,3551	0,3511	0,3471	0,3432	0,3393	0,3355	0,3317	0,3279	0,3242	0,3205	0,3169	0,3133	0,3098	0,3063
30	0,3701	0,3659	0,3618	0,3577	0,3537	0,3497	0,3457	0,3418	0,3380	0,3341	0,3304	0,3266	0,3229	0,3193	0,3157	0,3121	0,3086	0,3051	0,3017

Constants:	-7,424	-0,1288	273,16
	4417	53,44	
	-2,927	-0,0444	
	0,04238	0,00071	

John Fleng Steffensen, 2002

8.3 DAQ-4 Instruction manual

The DAQ-4 instrument is used for data acquisition and relay controlling. It is designed to run with the software AutoResp™ 4, but it can be used with other applications.

LIST OF PARTS
DAQ-4 instrument
AutoResp™ 4
Power Cord
USB cable
4-fold extension cord for pumps, qty. 2
User manual

SETUP
To power up the instrument connect the power cord to the outlet 100-240 VAC 50-60Hz on the back side of the instrument. Connect the USB cable to an USB port on your PC and to the outlet on the front side of the instrument named PC.

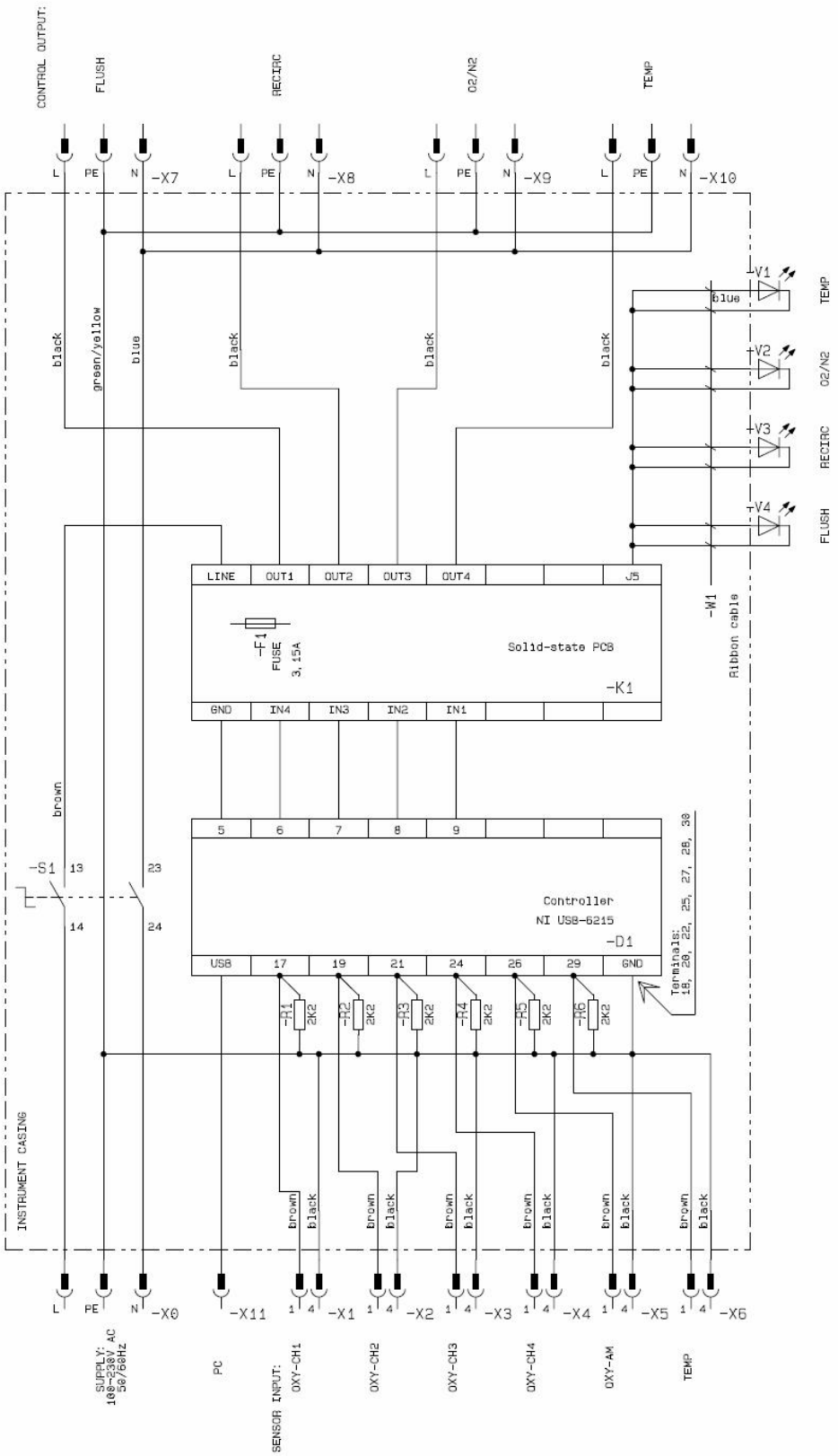
USING THE DAQ-4 FOR DATA ACQUISITION
The DAQ-4 instrument acquires data on 6 channels and converts the analog signals to 16 bit values. Connect the inputs to controller instruments, e.g. OXY-AM to an OXY-REG with a data cable. If you want to use controller instruments not from Loligo Systems make sure the input range is 0-5 VDC. The signal must be on pin 1 and GND on pin 4 on an input connector.

Using the DAQ-4 in other applications
It is possible to use the DAQ-4 instrument with other applications than AutoResp™ 4. See Table 3 for input connections and the wiring diagram on Figur 1.

Table 3

DAQ-4 connector	NI-USB 6215 pins	Channel name
OXY-CH 1	17	Ai1
OXY-CH 2	19	Ai2
OXY-CH 3	21	Ai3
OXY-CH 4	24	Ai4
OXY-AM	26	Ai5
TEMP	29	Ai6
GND	18, 20, 22, 25, 27, 28 and 30	n.A.

Figur 1


CONTROL OUTPUT:
FLUSH
RECIRC
O2/N2
TEMP
L PE N -X7
L PE N -X8
L PE N -X9
L PE N -X10
+V1
+V2
+V3
+V4
blue
black
green/yellow
blue
black
black
black
black
LINE OUT1 OUT2 OUT3 OUT4 J5
-F1
FUSE
3.15A
Solid-state PCB
-K1
GND IN4 IN3 IN2 IN1
-W1
Ribbon cable
brown
-S1
13
14
23
24
5 6 7 8 9
Controller
NI USB-6215
-D1
USB 17 19 21 24 26 29 GND
Terminals:
18, 20, 22, 25, 27, 28, 30
-R1 2K2
-R2 2K2
-R3 2K2
-R4 2K2
-R5 2K2
-R6 2K2
INSTRUMENT CASING
brown
black
L PE N -X0
-X11
-X1
-X2
-X3
-X4
-X5
-X6
SUPPLY:
100-230V AC
50/60HZ
PC
SENSOR INPUT:
OXY-CH1
OXY-CH2
OXY-CH3
OXY-CH4
OXY-AM
TEMP

For using the LEDs and the relays see Table 4 and the wiring diagram on Figur 1

Table 4

DAQ-4 connector	NI-USB 6215 pins	Channel name line1
FLUSH	6	D0
RECIRC	7	D1
O_2/N_2	8	D2
TEMP	9	D3
GND	5	n.A.

Through the Solid state PCB in the DAQ-4 instrument it is possible to connect up to 500 W equipment to every relay.

SPECIFICATIONS

Specifications range

-20°C to +60°C

Common specifications

Supply voltage (universal): 21.6-253 VAC, 50-60 Hz or 19.2-300 VDC

Internal consumption:	3.2 W
Max. consumption:	3.5 W
Isolation voltage (test / operation):	2.3 kVAC / 250 VAC
Signal- / noise ratio:	Min. 60 dB (0-100 kHz)
Response time, programmable:	0.4-60 s
Calibration temperature:	20-28°C
Accuracy:	≤±0.1% of reading
Temperature Coefficient:	≤±0.01% of reading/ °C
EMC immunity influence:	≤±0.5% of reading
Potentiometer input, min:	10 Ω
Potentiometer input, max:	100 kΩ

Relay outputs

Relay function:	Setpoint
Hysteresis, in % / display counts:	0.1-25% / 1-2999
On and Off delay:	0-3600 s
Sensor error detection:	Make / Break / Hold
Max. voltage:	250 VRMS
Max. current:	2 A / AC
Max. AC power:	500 VA
Max. current at 24 VDC:	1 A

8.4 TMP-REG manual

The instruction manual for the TMP-REG instrument is included as an individual document. Please look into the DAQ-PAC-F4X package.

8.5 OXY-REG manual

The instruction manual for the OXY-REG instrument is included as an individual document. Please look into the DAQ-PAC-F4X package.

8.6 OXY-4 Instruction manual

The instruction manual for the OXY-4 fiber optic instrument from PreSens manual is included as an individual document. Please use this manual for further information about the OXY-4 mini instrument and the OXY-4 software. Please look into the DAQ-PAC-F4X package.