my-Control for Autoclavable and Single Use Bioreactors

SOFTWARE REFERENCE MANUAL

Software Version mE.2.9.X; Document Version 2.93

applikon
BIOTECHNOLOGY

TABLE OF CONTENTS

1 GENERAL

1.1 GENERAL INTRODUCTION

The Applikon ***my*-Control** for Autoclavable and Single Use Bioreactor Systems basically consists of the following parts:

- a bioreactor system (autoclavable or Single Use) with appropriate auxiliaries for process control,
- a ***my*-Control** for measurement and control of process variables (such as pH, temperature, dO_2, level, and stirrer speed) with corresponding actuators in order to keep process conditions at set point,
- a host (PC, Tablet or Smartphone) that is used as a Human Machine Interface (HMI).

The ***my*-Control** combines and supports actuators such as pumps, mass flow controllers and micro valves in order to optimize the use of limited bench space.

1.2 THE USER INTERFACE

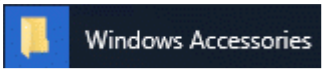
Through a network that is connected to the ***my*-Control** (TCP/IP communication), different kind of devices can be used as a User Interface (UI). Since the ***my*-Control** is addressed by using its IP address, the User Interface is also called the Web UI.
Examples:

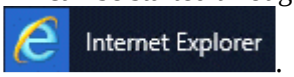
Web UI Device Type	**Connecting Network**
PC	LAN / WAN or Peer-to-Peer
Tablet	Wireless connection with WIFI-Router
Smartphone	Wireless connection with WIFI-Router

The ***my*-Control** is addressed by using its IP-address.
Start the Internet Browser at the WebUI-device and surf to the following address: http://IP-address*/. The ***my*-Control** WebUI will be displayed.

***The IP-address of the *my*-Control. The *my*-Control comes with a preset IP-address. This address can easily be customized. Refer to section 1.3 and Appendix A**

Refer to Appendix D of this manual in order to prevent instabilities in the network connection when the my-Control is the only controller directly connected to its controlling PC.

Internet Explorer IE11 and Google Chrome are supported as Internet browsers.
When working on a PC with Windows 10, IE11 can be started through the Accessories.
Press  > 

> 

.

After switching on the power of the ***my*-Control** and invoking the Web Interface through the Internet browser on the PC, the ***my*-Control** displays its Home Screen.

In the Hardware, Operator and Software Reference Manual, it is assumed that a PC is used as Web UI (***my*-Control** is operated with mouse-clicks).

1.3 CUSTOMIZING THE IP-ADDRESS

The ***my***-Control has a factory preset IP-address. This address can easily be customized.
The USB memory stick that comes with the ***my***-Control contains a directory called "Network" with a file called "network_settings.ini".
This file has three lines: 1 = the current IP-address, 2 = the subnet mask and 3 = the gateway. The three lines can be edited, using a text editor on a PC.

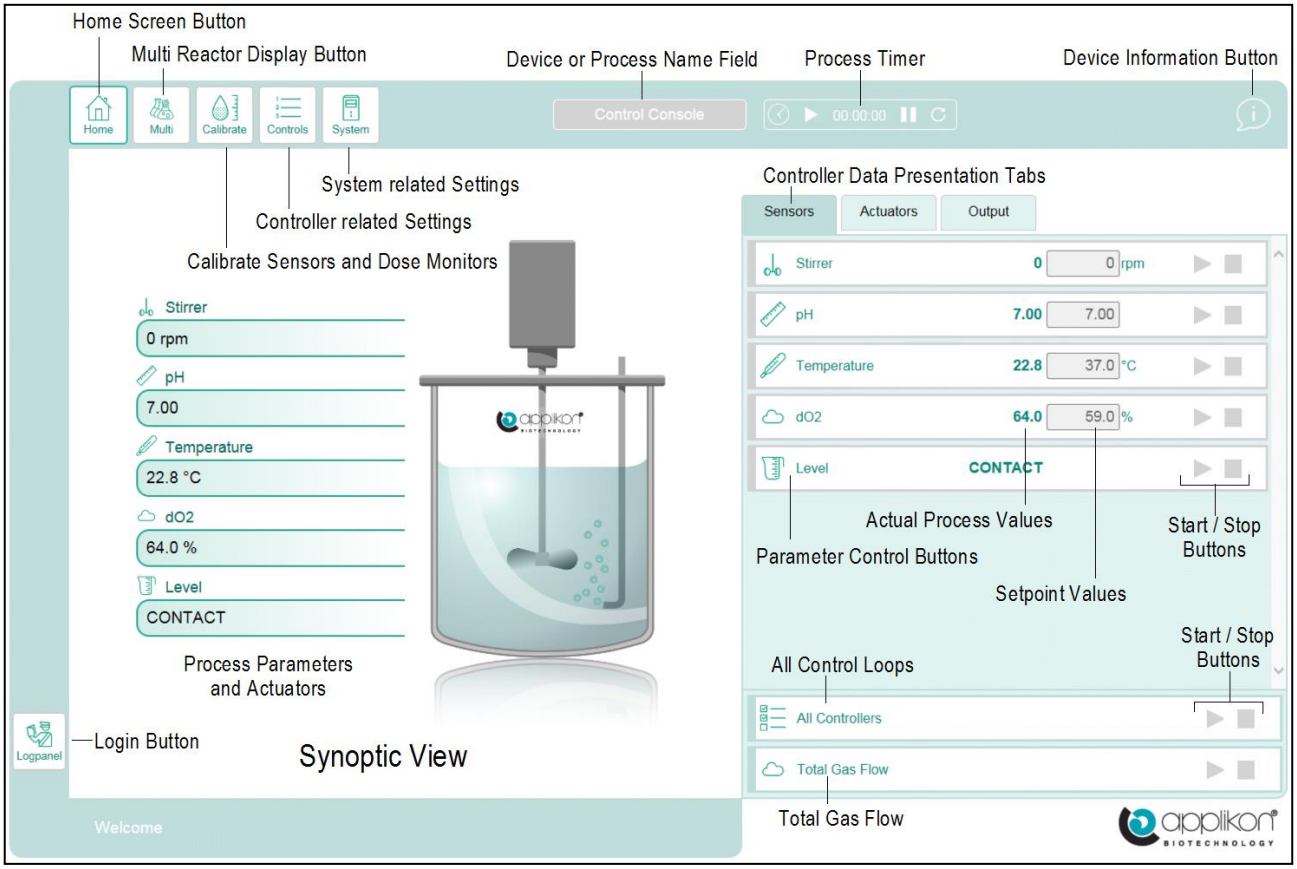
After editing the "network_settings.ini" file, it must be copied to the root of the USB-stick. **Make sure that the *my*-Control software files (Wx_xx.bin and LICENSE.DAT file) are not located in the root.**
Insert the USB-stick in the running ***my***-Control. The new IP-address and subnet mask are copied automatically.

After customizing the IP-address, it is advised to remove the "network_settings.ini" file from the root of the USB-stick. More information concerning this topic can be found at Appendix A (at the end of this manual).

1.4 HOME SCREEN

After switching on the power of the ***my***-Control and invoking the Web UI with the Internet browser, the ***my***-Control displays its Home Screen.

Example of the Home Screen in View mode (no user is logged in, control loops are "Idle"):

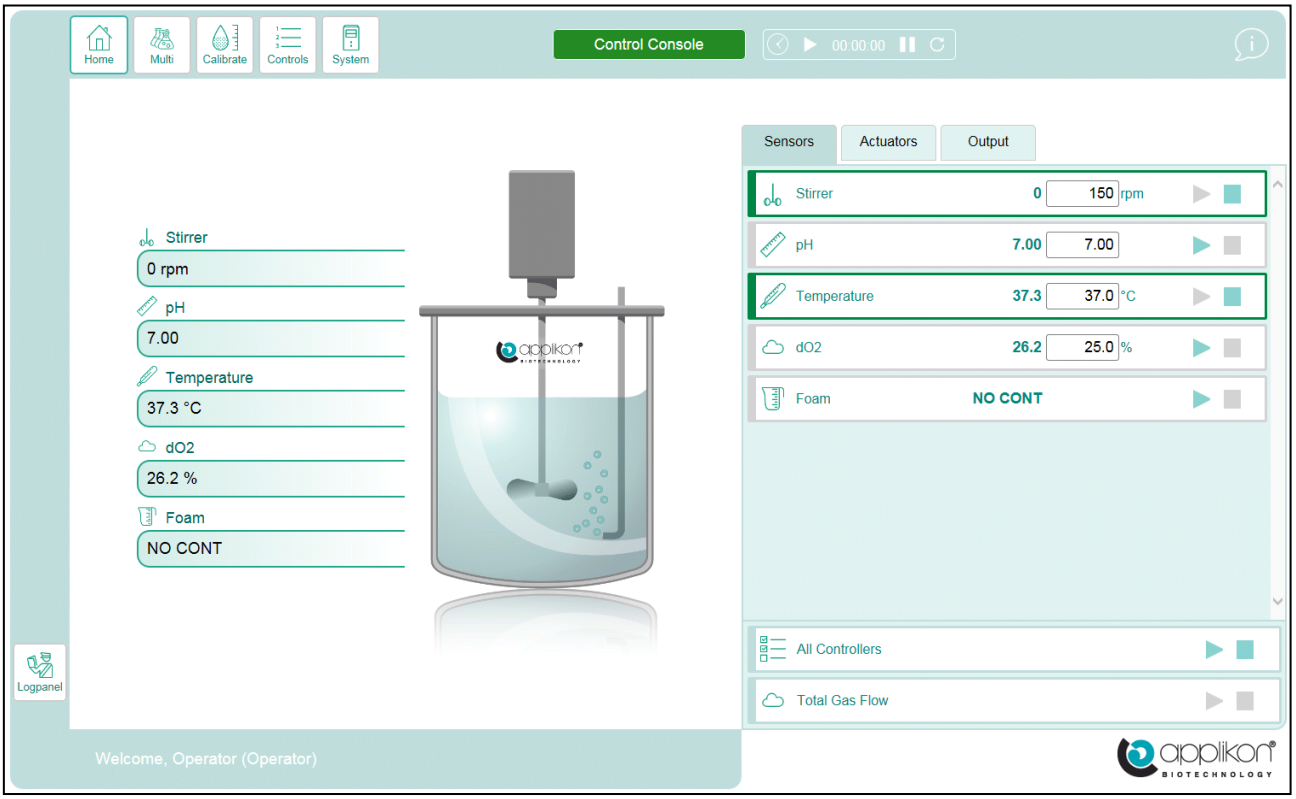


The Login button (

) can be used to login as Operator or System Engineer. For more information regarding the login procedure, refer to section 2.2.

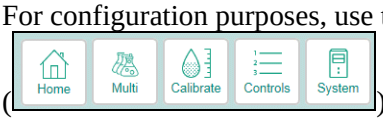
When the user is logged in as Operator or System Engineer, additional Access Rights are granted. For more information regarding Access Rights, refer to section 2.3.

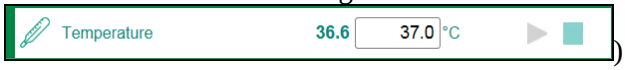
When the user is logged in as Operator and some control loops are running, the User Interface could be presented like:



When the zoom-factor of the selected Web browser is adjusted to < 100%, some details of the screen may not be presented correctly (pixels may be lost). Make sure to adjust the zoom factor of your browser to ≥ 100%.

The User Interface shows buttons, bar and process information fields. Instruction for use:

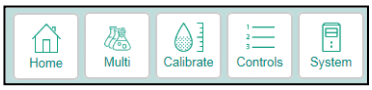
- For configuration purposes, use the buttons that are presented in the screen header (

).
- For daily operation of the controller (starting and stopping control loops and editing control parameters, the buttons and bars in the right-hand section of the screen (such as  and 

) can be used.

The presented buttons, bars and process information fields are described in the sections below.

1.4.1 BUTTONS IN THE SCREEN HEADER



In the left-hand corner of the screen header, four operational buttons are located.

- The 

button returns to the Home screen.
- The 

button switches to the Multiple Reactor Display mode. Refer to Chapter 6: Multiple Reactor Display Mode.
- The 

button opens the calibration options (Sensors or Actuators). Refer to Chapter 5: Calibration.
- The 

button is used to view or edit controller related settings. Refer to Chapter 4: Control Parameters.
- The 

button is used to view or edit system related settings. Refer to Chapter 3: System Setup.]

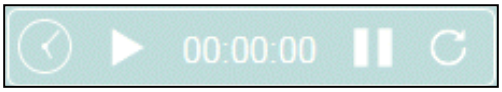
1.4.2 DEVICE OR PROCESS NAME FIELD

In the center of the screen header, a text field is presented.
When logged in as Operator or Engineer, the text in this field can be edited.
Press the text field and use the HMI device keyboard to edit the name.

Depending on the controller status, the Name Field will be presented with different background colors. See the table below.

Name Field	Description
	Grey is the basic background color of the Text Field. The control loops may be “Idle” or “Running”; no alarms.
	The green background color indicates that at least one control loop is “Running”; no alarms.
	The red background color indicates that a System or Process Alarm has been triggered.

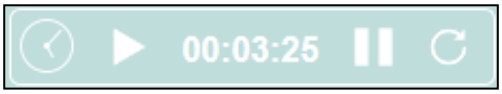
1.4.3 PROCESS TIMER



The Process Timer can be used to keep track of the time that has elapsed after inoculating the medium.

Pressing the Run icon () will start the timer. Pressing the Reset icon () will reset the presented Process Time.

Example of a running Process Timer:



Pressing the Pause icon () will hold the running Process Timer.

1.4.4 DEVICE INFORMATION BUTTON

At the right-hand side of the screen header, the Device Information button is located. Pressing this button will open the corresponding window:

The relevant versions of software and hardware are presented.

Press the Close Device Information button at the bottom of the dialog box to close the window.

1.4.5 LOGIN BUTTON

In the lower left corner of the screen, just above the screen footer, the Login button is located. For detailed information concerning the logging in, refer to section 2.2 of this manual.

The current login level can be derived from the icon and welcome message in the left-hand corner of the screen footer. When no explicit user is mentioned here, the controller is in the View mode (no user logged in).

Login Dialog	Description
Welcome	View Mode, no user has been logged in.
Welcome, Operator (Operator)	An Operator has been logged in; the name of the user is presented between parentheses "( )".
Welcome, Engineer (Engineer)	A System Engineer has been logged in; the name of the user is presented between parentheses "( )".

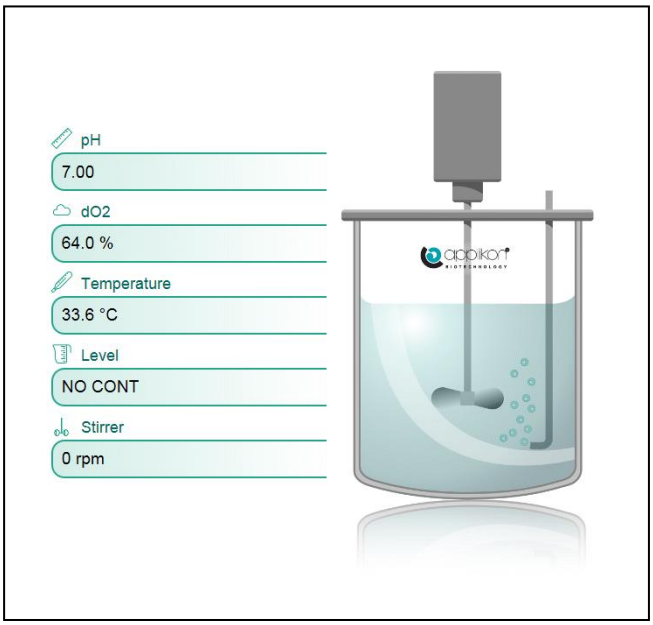
1.4.6 SYNOPTIC

The left-hand part of the Home screen is reserved for the Synoptic.

The Synoptic shows a representation of a stirred tank reactor.

At the left-hand side of this reactor, a number of (max = 8) process parameters and/or actuators are listed. The corresponding sensor value or actuator status is presented.

For more information concerning the Synoptic composition, refer to section 3.3.1.



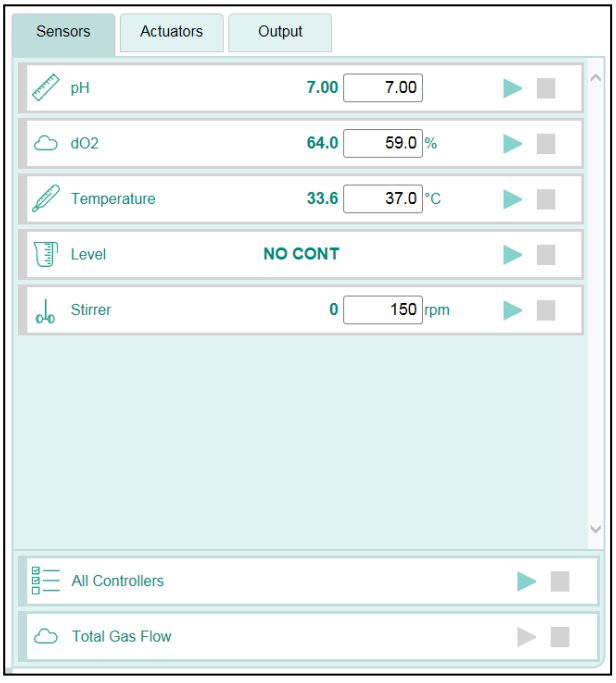
The representation of the sensor/actuator value in the Synoptic (such as 

) also serves as a button to open the corresponding control or actuator window.

1.4.7 CONTROLLER DATA PRESENTATION TABS

The right-hand section of the screen contains three tabs with information concerning:

- The Sensor tab shows the sensors that are configured in a control loop.
  For more information, refer to section 1.5 and section 3.2.2.
- The Actuator tab shows all available Actuators (refer to section 1.6) and
- The Output tab shows the controller output of the configured loops (refer to section 1.7).



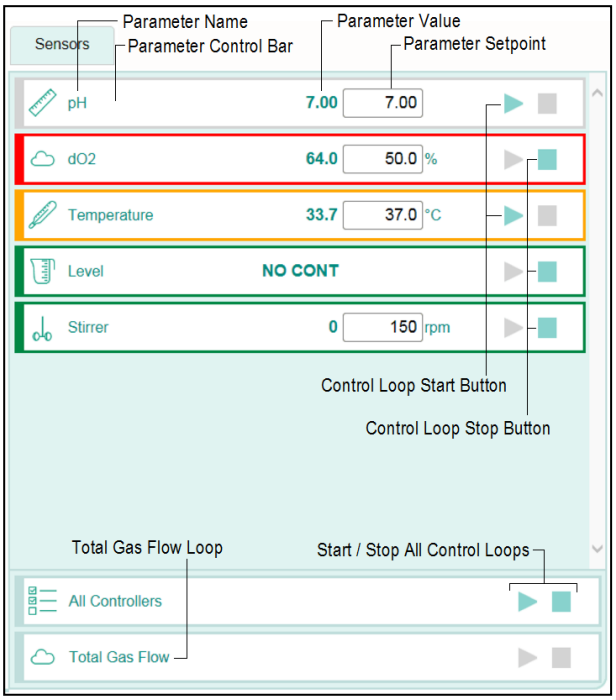
1.4.8 OPENING THE APPLIKON WEBSITE

In the right-hand corner of the screen footer, the Applikon logo (

) is presented. When this logo is pressed, the Applikon website will be opened in a second instance of the Internet browser (http://www.applikon-bio.com).

1.5 SENSOR TAB INFORMATION

The Sensor Tab displays the control parameters and control status together with current process value and defined setpoint value.



Depending on the controller status and current process value in relation to setpoint, different colors are used to indicate the status (refer to section 1.5.3).

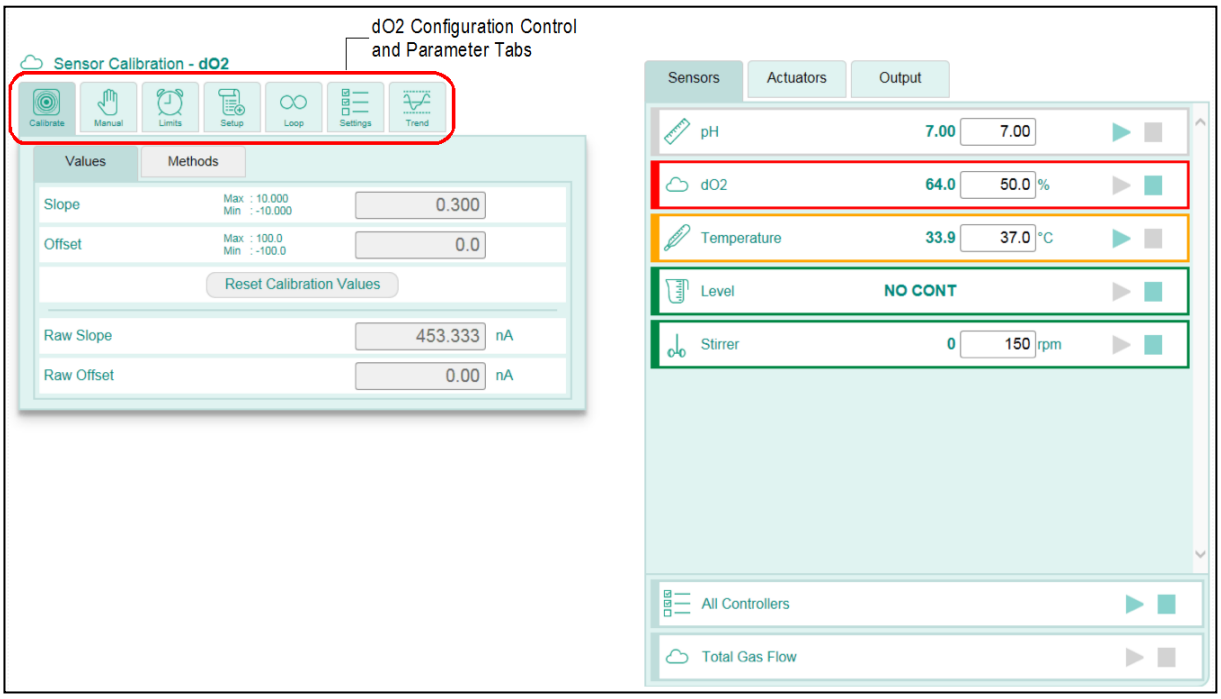
- The  or  buttons can be used to Start / Stop individual controllers.
- The  or  buttons in the  area can be used to start all idle controllers or to stop all running controllers.
- If the reactor is aerated through mass flow controllers, the total gas flow can be controlled. The  or  buttons in the  area at the bottom of the screen area can be used to start or stop Total Gas Flow Control.

Total Gas Flow control can only be achieved when all aeration gas flows are controlled through mass flow controllers.

1.5.1 DAILY CONTROLLER OPERATION

For daily operation of the controller, the right-hand section of the User Interface screen gives direct access to all properties and parameters of the configured control loops. When clicking on the graphical bar of a configured control loop (such as 

), the properties and parameters for this loop can be accessed at the left-hand section of the screen.
The different controller related tabs are displayed. Using these tabs, all controller related settings and calibrations can be viewed and edited.



The presented Control and Parameter tabs are presented in the table below:

Tab Symbol	Description
	Sensor Calibration (performing a sensor calibration and corresponding data presentation). The calibration routines for the different sensors are described in section 5.2.
	Manual Control of the assigned actuators. When the control loop is not running, the corresponding actuators can be controlled manually. Refer to section 4.3.
	Alarm and Interlock Limits for the control loop and Interlock Actuator assignment. The alarm and interlock limits are described in section 4.1.
	Controller Setup: control mode selection and control parameter settings. The controller setup options are described in section 4.2.
	Control Loop Actuator Assignment. The actuators that have been assigned to the control loop can be viewed and edited. Refer to section 4.4.
	Sensor Settings. Depending on the sensor type, specific sensor settings may be available. The sensor settings are described in section 4.6.
	Sensor Trend. The measured parameter values are presented in a trend. Maximum time span = 72 hours. The trend settings are described in section 4.7

If no actuators have been assigned to a control loop, the number of control and parameter tabs is reduced (only the calibration and actuator assignment tabs are displayed).

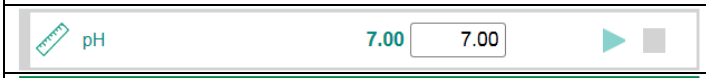
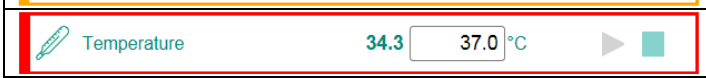
1.5.2 EDITING PARAMETER SETTINGS

Most of the Control and Parameter screens contain numerical settings.

If a numerical setting has been edited, the  button is used to accept and save the entry. The  button can be used to cancel a value that is not yet accepted.

1.5.3 COLORS OF THE SENSOR BUTTON AND BAR

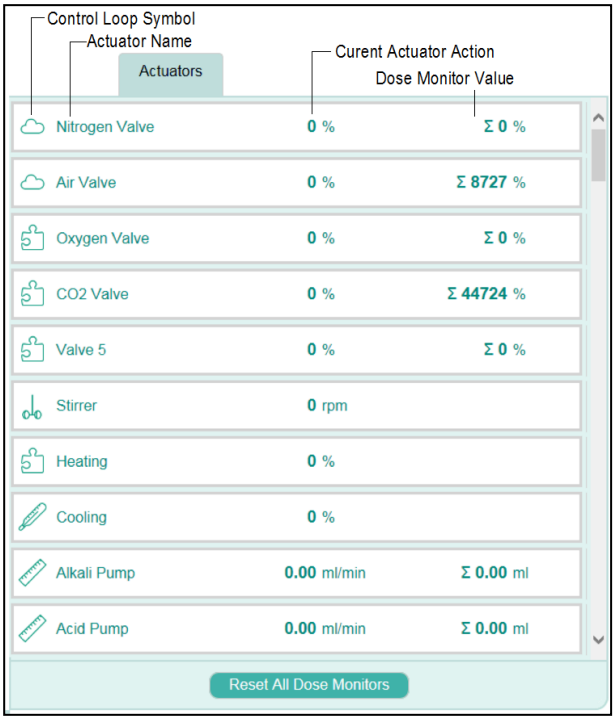
The table below lists the different colors that are used to present the process parameters:

Sensor Button and Bar	Description
	Controller not running Process Value within Alarm Limit range
	Controller is running Process Value within Alarm Limit range
	Controller not running Process Value outside Alarm Limit range
	Controller is running Process Value outside Alarm Limit range

The alarms mentioned in the table above, are related to measured process values and are called Process Alarms or Deviation Alarms.
Alarms that are related to the system performance and are called System Alarms.
The alarm presentation is described in section 1.8.

1.6 ACTUATOR TAB INFORMATION

When the Actuator tab has been selected at the right-hand section of the screen, the table with all available actuators will be presented.



The Actuator table contains four columns and a scroll bar:

- The Control Loop Symbol where the actuator has been assigned to.
- The Actuator Name.
- The current Actuator Action.
- The Dose Monitor value.

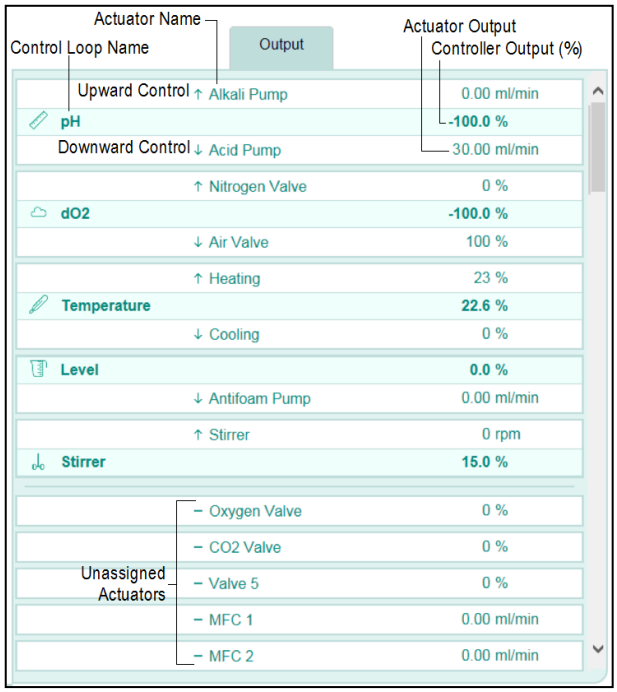
The scroll bar can be used to scroll through the list of all available actuators.

For each actuator (except the actuators for heating and cooling), the Dose Monitor function can be enabled or disabled. Refer to section 5.3.2.
If for an actuator the Dose Monitor function has been enabled, the integrated volume for this actuator will be presented in the actuator tab (e.g.: Σ 8727 ml). If the Dose Monitor function has been disabled, the integrated volume is not shown.

The presented Dose Monitor values can be reset to 0 by pressing the Reset All Dose Monitors button. When this button is pressed, all Dose Monitor values are reset to 0. Individual Dose Monitor values can be reset using the Dose Monitor calibration function. Refer to section 5.3.2.

1.7 OUTPUT TAB INFORMATION

When the Output tab has been selected at the right-hand section of the screen, the table with the Output of the different control loops will be presented.



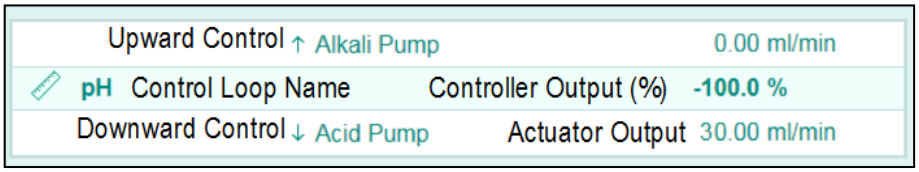
The Output table contains different columns and a scroll bar:

- The Control Loop name.
- The Actuator Name.
- The Controller and Actuator Output values.

Below the presented control loops, the unassigned actuators are listed.

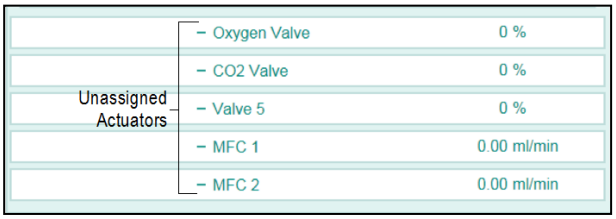
The scroll bar can be used to scroll through the list of all available actuators

Per individual control loop, the controller output and the activity of the assigned actuators are presented.



At the bottom of the control loop table, the unassigned actuators and the corresponding output status is presented:

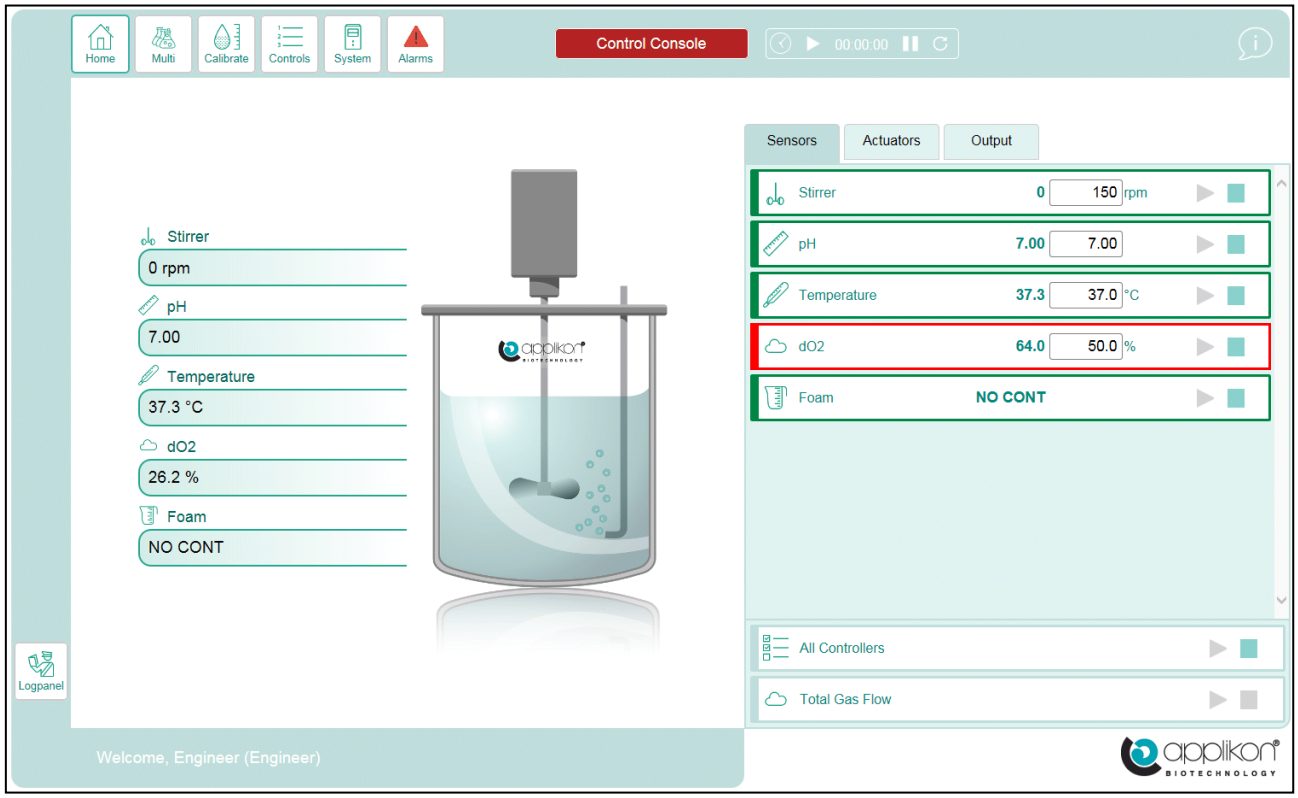
Move the scrollbar downward to inspect the other available actuators.



1.8 ALARM PRESENTATION

If a Deviation or System Alarm is detected, an Alarm button (

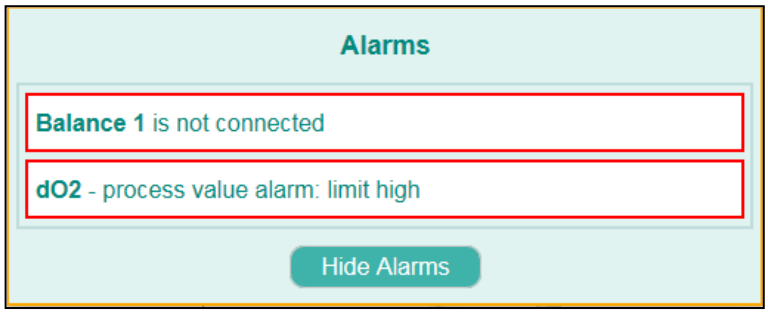
) will be presented in the header of the screen. The Device Name will be presented with a red background. See image below.



Pressing this button will open the list with the active alarm events.

By pressing the 

button, a list with active alarm events will be displayed. An example of this list is presented below:

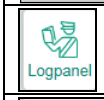
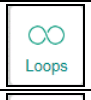
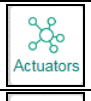
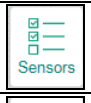


Press the 

button to hide the presented Alarm list.

1.9 GRAPHICAL PRESENTATION OF BUTTONS AND TABS

For the buttons in the User Interface, the following icons are used:

Button	Description	Button	Description
	Home Screen button		System menu button
	Login button		Communication Settings button (I/P address, subnet mask and gateway)
	Multiple Reactor Display Mode button		Bioreactor Type selection and Control Loop Configuration button
	Calibration Menu button		System Settings button (e.g. Synoptic definition and System Preferences)
	Sensor Calibration button		
	Dose Monitor Calibration button		Control Loop Tab, based on a pH sensor
	Control Parameter menu button		Control Loop Tab, based on a dO_2 sensor
	Alarm Limit definition button		Control Loop Tab, based on a Temperature sensor
	Controller Setup button (control type and parameters)		Control Loop Tab, based on a Level sensor
	Manual Actuator Control button		Control Loop Tab, based on an Analog Input
	Controller Configuration button (assign actuators per control loop)		Control Loop Tab, based on weight (balance input)
	Actuator Property button (edit actuator name, units, type and limits)		Control Loop Tab, based on a Biomass sensor (or Conductivity)
	Sensor Property button (edit sensor name, units and priority)		Control Loop Tab, based on a Redox sensor
	Totalized Gas Flow Control button (edit control settings and warnings)		
	Trend button (presents the parameter values in a trend)		

1.10 SENSOR AND ACTUATOR SYMBOL PRESENTATION

In the table below, the sensor and actuator symbols (as they are presented in the right side area of the Home screen) are listed:

Sensor Symbol	Description	Actuator Symbol	Description
	pH Sensor (potentiometric or optical)		Actuator, assigned to pH Control
	dO_2 Sensor (polarographic or optical)		Actuator, assigned to dO_2 Control
	Temperature Sensor		Actuator, assigned to Temperature Control
	Level Sensor		Actuator, assigned to Level Control
	Stirrer Speed Input		Stirrer Motor
	Analog Input		Actuator, assigned to a Control Loop that is based on an Analog Input
	Balance Input		Actuator, assigned to a Weight or Flow Control Loop
	Redox Sensor		Actuator, assigned to Redox Control
	Biomass (or Conductivity) Input		Actuator, assigned to Biomass Control
			Free Actuator, not assigned to a Control Loop

1.11 ENTERING TEXT AND NUMERIC VALUES

Text (such as parameter names) and numeric values can be entered using the external or internal keyboard.
If a normal PC monitor is used as User Interface, the external keyboard is used for entering alpha-numeric data.
If a PC monitor with Touch Screen (or tablet / smartphone) is used as User Interface, the internal keyboard will pop up as soon as data entry is required.

As soon as new data is typed, the  buttons will appear at the bottom of the active window.

Instead of using the <Enter> key, the  button can be used to save the entry. Pressing the  button cancels the entry without saving it.

2 AUTHORIZATION

2.1 LOGIN LEVELS

The ***my***-Control has different authorization (login) levels:

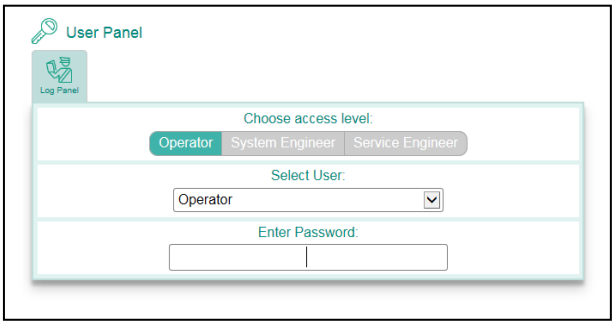
- View level (initial level; no password required, viewing rights only)
- Operator level (operator password required, access to functions concerning daily operations)
- System engineer level (system engineer password required, access to functions concerning system setup)
- Service engineer level (reserved for the Applikon service engineer, to run diagnostic tests, etc.)

Automatic Logout function: When logged in as Operator or System Engineer, after a predefined period of time without any operation at the User Interface, the ***my***-Control may automatically return to the View level. This option can be defined in the System > Settings > Specific Preferences screen. For more information, refer to section 3.3.1.

2.2 LOGIN PROCEDURE

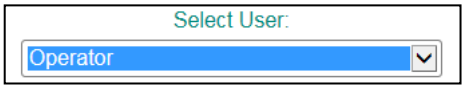
When the my-Control is in the View mode, in the left-hand corner of the screen footer the Welcome message is displayed.

1. Press the Logpanel button to enter the Login screen.



2. Select the proper authorization level. By default, the Operator level is preselected. This selection may be changed by pressing the System Engineer button.
   In this example, the user is logged in as Operator.

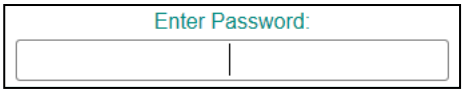
3. Select one of the defined users of the selected level. Initially, only one user per level is defined.
   Press the dropdown menu sign ( ).
   The defined users with Operator rights will be presented.



4. Enter the numeric Operator Password in the password area.

   The default password for Operator and Engineer = 0000.

   The minimum password length is 4 characters.



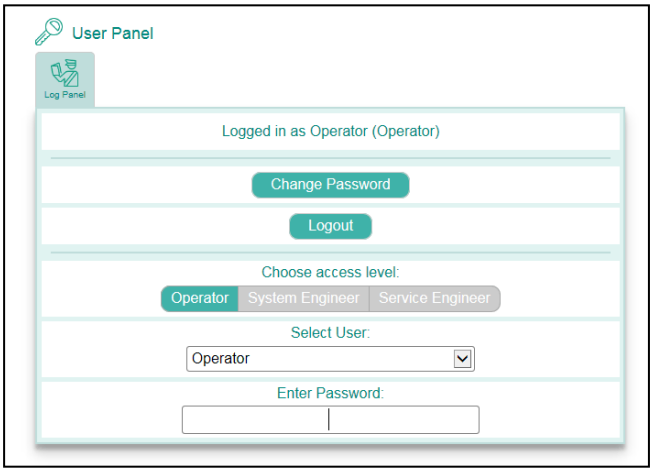
5. The user is now logged in at Operator Level. In the left-hand corner of the screen footer, the message Welcome, Operator (Operator) will be displayed.
   The Operator name between the parentheses ( ) presents the authorization level.

The steps that are described above, describe logging in at Operator Level. For logging in at System Engineer Level, the same routine can be used (selecting System Engineer level and password).

Depending on the authorization level, the User Panel has a specific layout.

When logged in at Operator level, it is allowed to:

- Change the password,
- Logout and
- Login as another user.



When logged in at Engineer level, it is allowed to:

- Change the password,
- Create a new user,
- Remove an existing user
- Logout and
- Login as another user.

2.3 AUTHORIZATION TABLE

The table below lists the accessibility for the different login levels:

Function	VIEW (not logged in)	Operator	System Engineer
View Status of Process Parameters	X	X	X
View Controller Status	X	X	X
View Actuator Status	X	X	X
View Device Information	X	X	X
Login (access control)	X	X	X
View Alarms	-	X	X
Sensor Calibration	-	X	X
Edit Set points	-	X	X
Edit Alarm Limits	-	X	X
Manual Control Actuators	-	X	X
Dose Monitor Calibration	-	X	X
Reset Dose Monitor Values	-	X	X
Start / Stop Controllers	-	X	X
Controller Output Limits / Timer Function	-	X	X
Level Control Timing	-	X	X
Tubing Pump Control	-	X	X
Change Password and Logout time Remote Access	-	-	X
Edit Controller Settings	-	-	X
Edit Actuator Configuration, Name and Par. Layout	-	-	X
Configure Synoptic	-	-	X
Configure Parameter Overview	-	-	X
Restart Controllers after Power Failure	-	-	X
Restart Controllers after Emergency Stop	-	-	X

2.4 USER MANAGEMENT

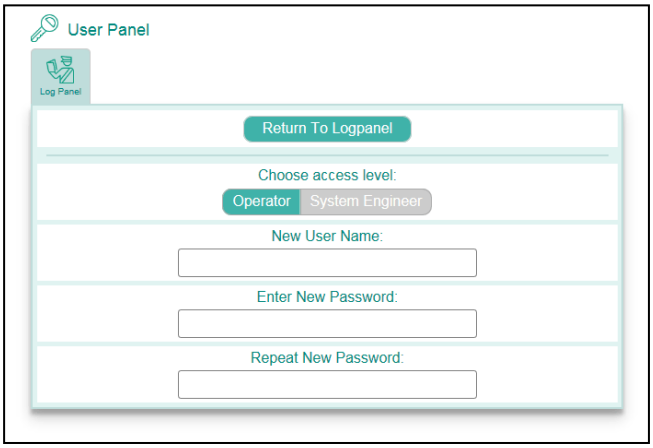
By default, one Operator and one System Engineer exist as users.
The ***my***-Control software supports a total of 21 different Operators and 21 different Engineers as users.
The users are discriminated by name.
It is not allowed to create a new user with a name that already exists. For each user, a password must be defined.

2.4.1 CREATING NEW USERS

A user with Engineer rights can create new users (Operators or Engineers).

Procedure:

1. Login as user with System Engineer rights (see section 2.2).
2. Press the Create A New User button.
3. Select the authorization level of the user to be created (leave it at Operator level or press the System Engineer button).
4. Enter the New User Name and the corresponding password. Enter the password a second time for confirmation.



5. When the creation of the new user has been successfully completed, the message User succesfully created will be presented in the middle of the User Panel. In the screen image, this message is indicated by a red rectangle.

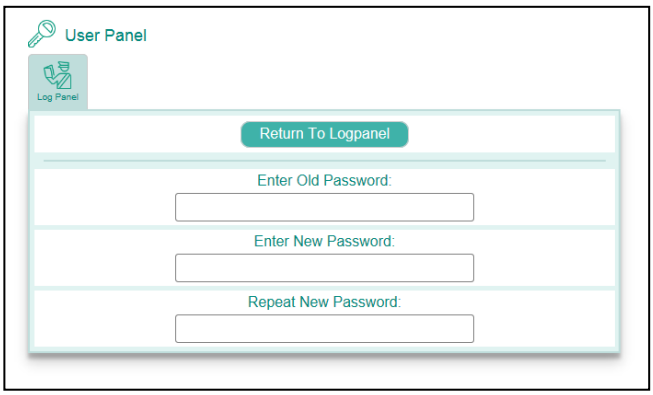
- After creating new users, they will be presented in the dropdown list at the next login.
- The process of creating new users may be repeated until 21 Operators and 21 System Engineers exist.

2.4.2 CHANGING THE PASSWORD OF AN EXISTING USER

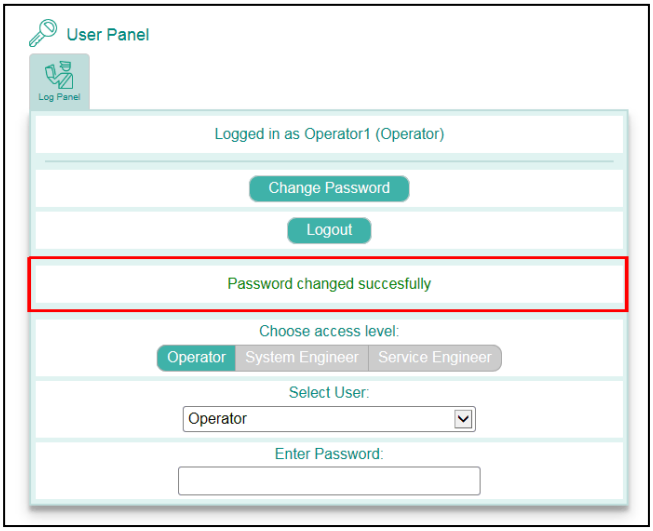
Any existing user (Operator or Engineer) can change her or his password at any time.

Procedure:

1. Press the Logpanel button to open the User Panel screen.
   Press the Change Password button.
   Enter the existing password and the new password.
   Repeat entering the new password for confirmation.



2. When the password has successfully been changed, the message Password changed succesfully will be presented in the middle of the User Panel screen.
   In the screen image, this message is indicated by a red rectangle.



2.4.3 DELETING AN EXISTING USER

Users may be deleted as long as at least one user with Operator rights and one user with Engineer rights remains.

Procedure:
Below, the procedure for deleting an existing Operator is described. Deleting an existing System Engineer is performed in a similar manner.

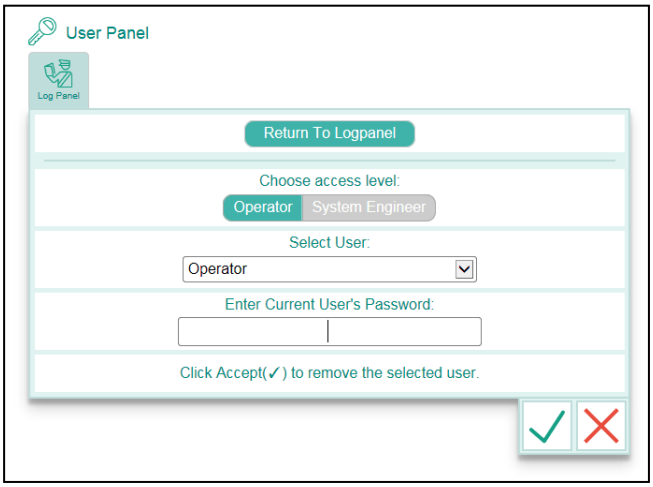
1. Login as user with Engineer rights. Refer to section 2.2.

2. Press the Remove A User button to open the Remove User window:

3. Choose the required access level (Operator or System Engineer).

4. Use the dropdown menu to select the user that needs to be removed.

   Enter your password and press the ✓ button to confirm the removal of the selected user



5. When the user has successfully been removed, the message User removed succesfully will be presented in the middle of the User Panel screen. In the screen image, this message is indicated by a red rectangle.

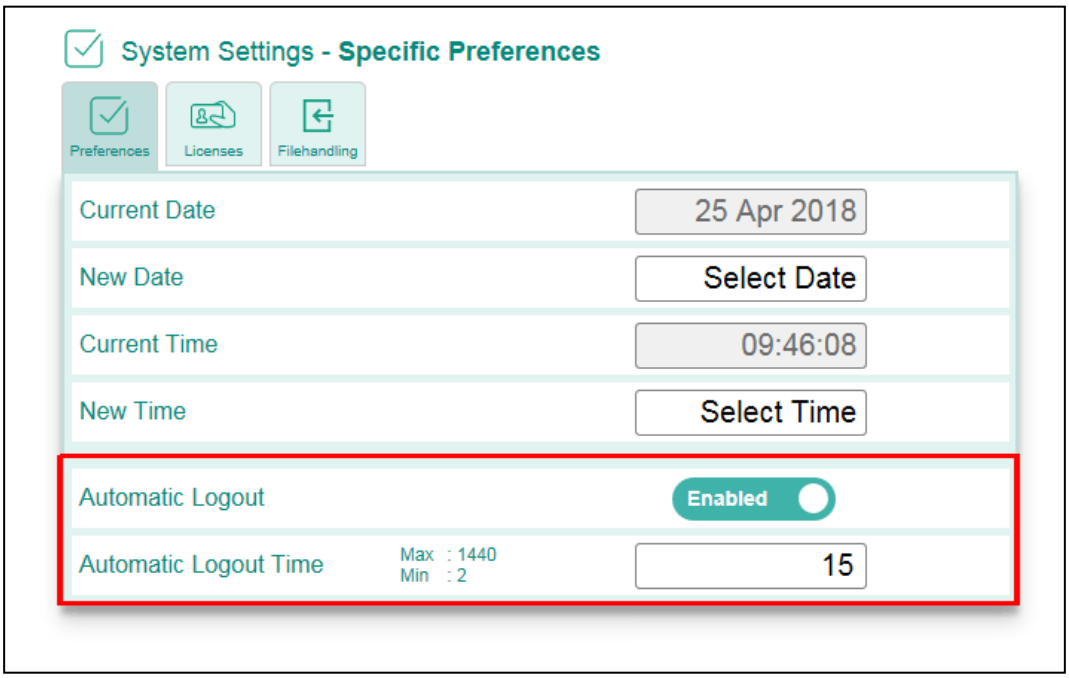
2.5 EDITING THE AUTOMATIC LOGOUT INTERVAL

When logged in as Operator or System Engineer, after a predefined period of time without any operation at the User Interface, the ***my*-Control** will automatically return to the View level. This interval is initially set to 15 minutes but can be adjusted (or be disabled) by a user with System Engineer rights.

Navigate to System > Settings > Tab: Specific Preferences (

).

In the screen image below, the Automatic Logout settings area is indicated with a red rectangle.



In the presented example, the Automatic Logout option is enabled. This option can be disabled by pressing the 

button. The toggle button will change in

. By pressing this button a second time, the option will be enabled again.

The Automatic Logout interval may be edited. Allowable time range: 2 ….. 1440 minutes.

3 SYSTEM SETUP

For editing the System Setup, System Engineer rights are required.

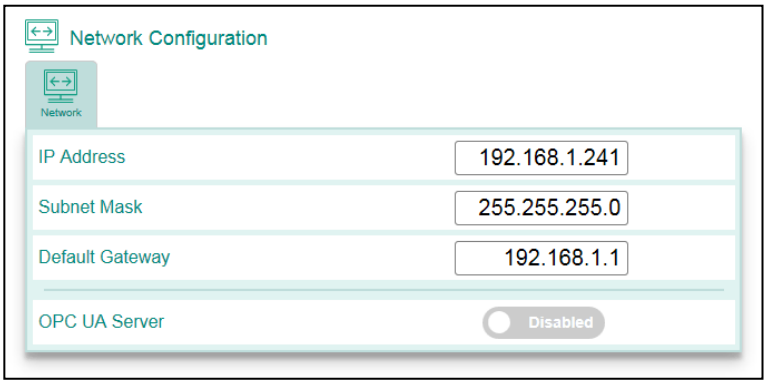
The System Setup is accessed through the System button and it contains the following sub-buttons:

Network view the network settings	Configure edit the system configuration	Settings Edit system settings

3.1 NETWORK SETTINGS

Press the Network button. The displayed communication window is used to recall the current communication settings:

- IP-address,
- Subnet mask and
- Default gateway



The settings are “Read Only”.
The current settings can be edited according to the instructions in section 1.3 of this manual.

3.1.1 ENABLING THE OPC UA OPTION

The option that is described below, is licensed. This means that a license is required to be able to use this option. Enabling the OPC UA Server is related to the type of communication between the Applikon Controller and a Supervisory Control and Data Acquisition (SCADA) software application.

By pressing the Disabled button (which then turns into Enabled), one can start to communicate with Applikon controller directly via OPC UA. The OPC UA server is disabled by pressing this Enabled button (which will then revert to Disabled).

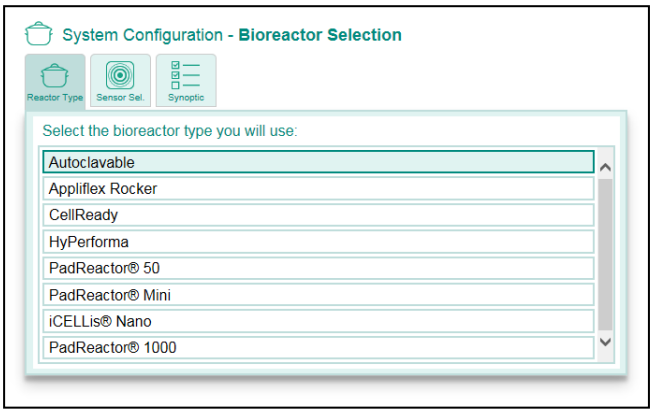
Any changes to control loops (installation of sensors and/or actuators) require a restart of the OPC server (by disabling and then re-enabling the OPC UA server via the relevant buttons), or, alternatively, by restarting the controller.

The description of the OPC and OPC UA tags is available on request.

3.2 SYSTEM CONFIGURATION

Press the 

button to open the System Configuration screen.
The displayed system configuration window has three tabs, representing:



- 

: Bioreactor type selection
- 

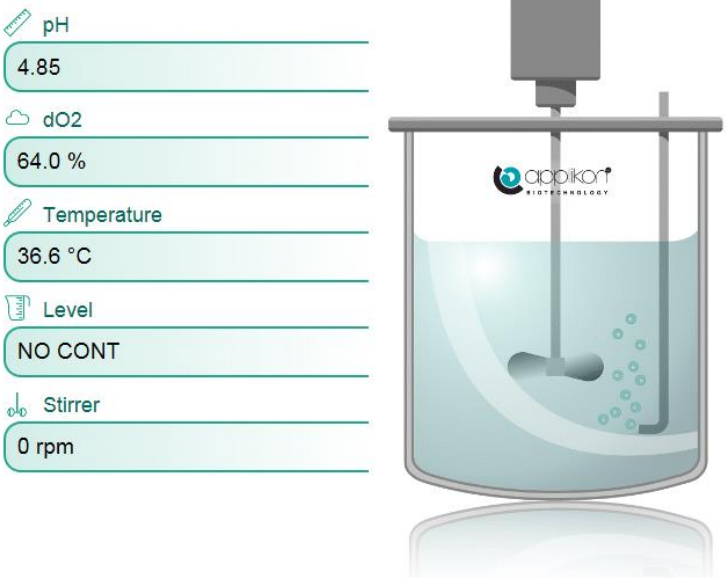
: Sensors to be used in a Control Loop
- 

: the Synoptic in the Home screen

3.2.1 BIOREACTOR TYPE SELECTION

By default, the Autoclavable bioreactor type has been selected.

In the Home screen, the bioreactor is presented by a glass Stirred Tank reactor.

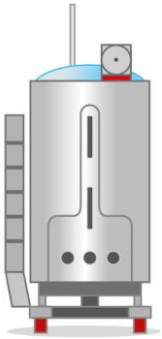
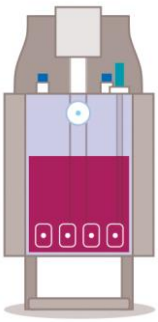
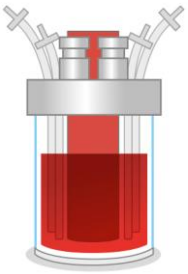
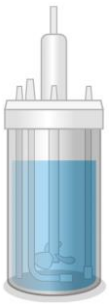


If required, another reactor type can be selected by clicking on it.

Press the presented  button to select or  to cancel.

Selecting another type of bioreactor will load a different reactor image and the default set of PID controller settings for the selected reactor type. See the next page.

The table below presents the different images for the other selectable bioreactors:

					
AppliFlex RB*	CellReady SUB	HyPerforma SUB	PAD Reactor	iCELLis nano	AppliFlex ST**

*RB is the abbreviation of “Rocked Bioreactor”.
**ST is the abbreviation of “Stirred Tank” bioreactor.

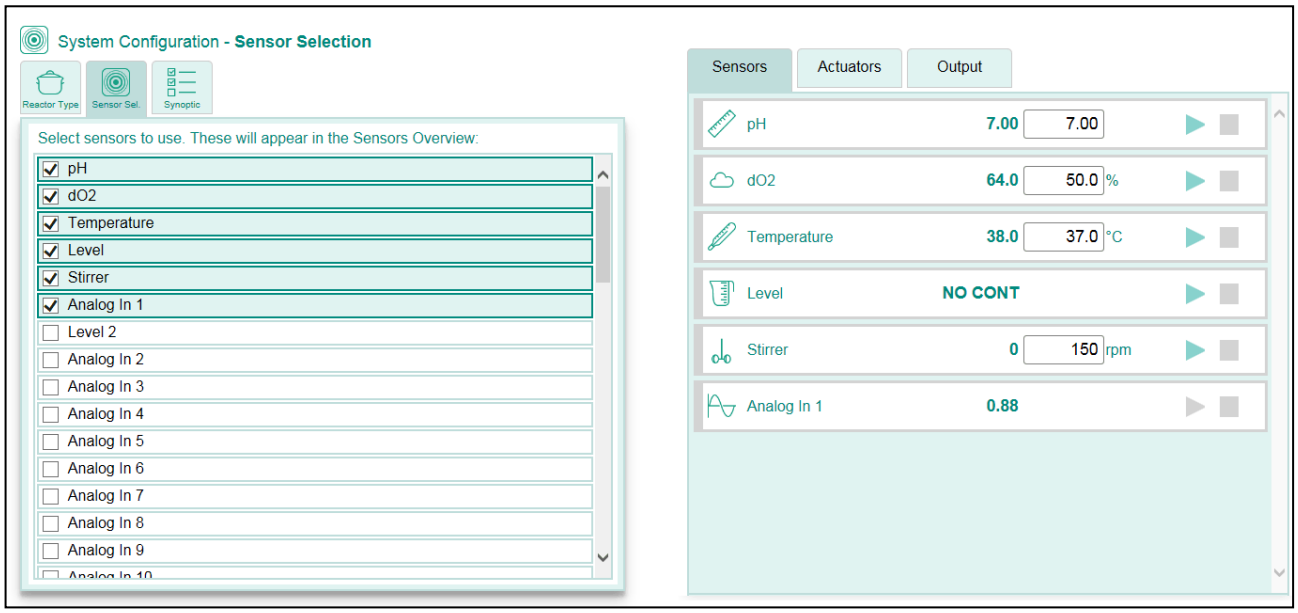
Table with default PID control settings for pH, temperature and dO_2 control:

	PID Control Parameters	Autoclavable Bioreactor	AppliFlex RB	CellReady Bioreactor	HyPerforma SUB	PadReactor®	iCELLis® nano	ApplFlex ST
pH	P	50	50	50	50	50	500	50
	I (sec)	0	0	0	0	0	0	0
	D (sec)	0	0	0	0	0	0	0
	Cycle Time (sec)	5	5	5	5	5	5	5
	Dead Band	0.10	0.10	0.10	0.10	0.00	0.02	0.1
Temp	P	100*	100	100	100	100	25	100*
	I (sec)	2700	2700	2700	2700	2700	3000	2700
	D (sec)	0	0	0	0	0	150	0
	Cycle Time (sec)	5	5	5	5	5	5	5
dO_2	P	7	7	7	7	7	2	7
	I (sec)	1500	1500	1500	1500	1500	1250	1500
	D (sec)	0	0	0	0	0	0	0
	Cycle Time (sec)	5	5	5	5	5	5	5

* The default PID settings for the temperature control loop are P = 100 when a heating blanket is configured and P = 20 with a thermo electric heater/cooler (my-Control) or an internal thermo circulator (ez2-Control).

3.2.2 SENSOR SELECTION FOR CONTROL

Press the Sensor Selection tab.
The list of installed inputs (sensors and other analog inputs) is presented. The screen image below shows an example of a possible sensor configuration:



Each input has a checkbox (☐) next to it. By checking the checkbox (☑), the corresponding sensor is selected to be presented at the right-hand area of the Home screen.

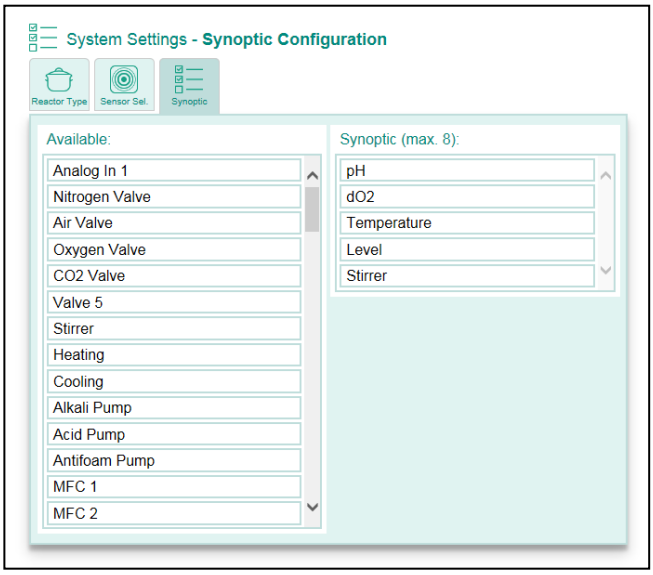
The changed sensor selection can be accepted and saved by pressing the ✓ button. The sensor presentation in the right-hand screen area will be updated.

All selected inputs will be placed on top of the list.

The sensor presentation sequence in both the right and left-hand part of the screen depends on the Screen Priority parameter that can be entered for each sensor. Refer to section 4.6 of this document

3.2.3 SYNOPTIC CONFIGURATION

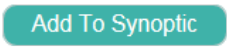
Press the Synoptic tab. The Synoptic Configuration will be presented at the left side of the screen.



The Synoptic Configuration consists of two columns.

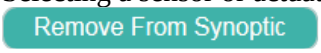
- The left column shows all configured sensors / analog inputs and installed actuators that are not yet presented in the Synoptic.
- The right column shows the current Synoptic selection.

The current Synoptic Configuration can be edited by:

- Selecting a sensor or actuator from the left column and pressing the appearing 

button

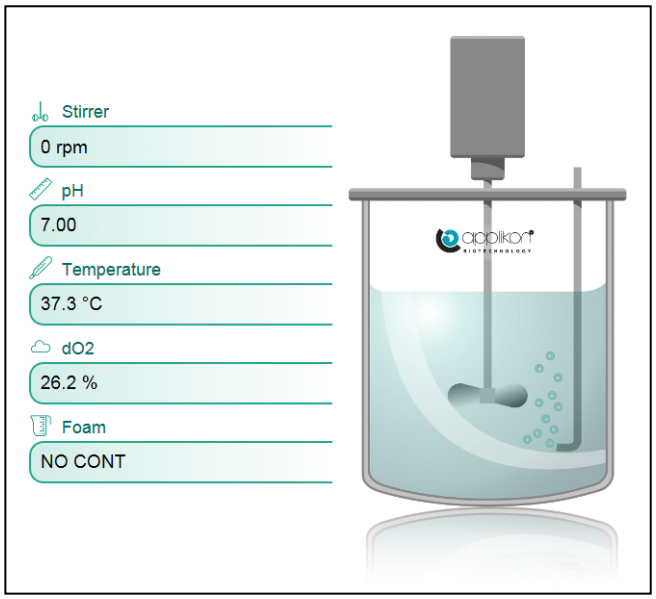
or by

- Selecting a sensor or actuator from the right column and pressing the appearing 

button

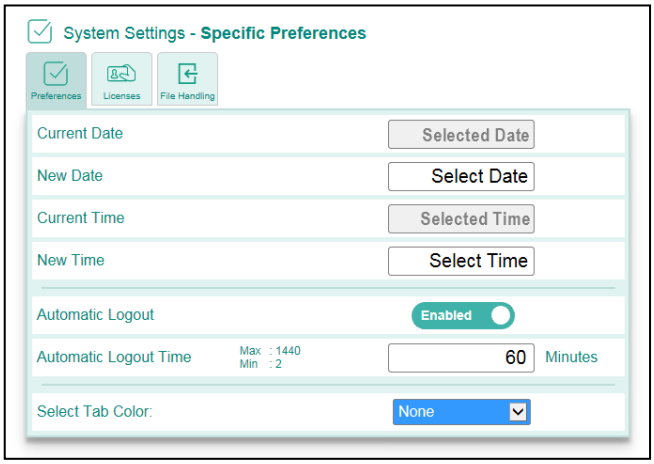
Any changes in the Synoptic Configuration must be confirmed by pressing the  button.

The Synoptic Configuration that is listed in the above image, is presented in the adjacent image (autoclavable reactor is selected).



3.3 SYSTEM SETTINGS

Press the Settings button.



The displayed system settings window has three tabs, representing:

- 

: Specific Preferences (device settings),
- 

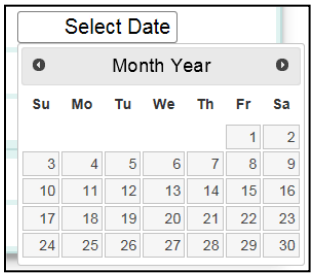
: List of Installed Licenses and
- 

: Import / Export (file handling).

3.3.1 SPECIFIC PREFERENCES

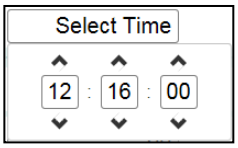
The Specific Preferences window concerns the following issues:

- Set current date,
- Set current time,
- Defining the Automatic Logout settings



The **date** can be set by clicking on the New Date (Select Date) data field.
The calendar will appear to select the date from.

The selected date can be confirmed by pressing the  button.



The **time** can be set by clicking on the New Time (Select Time) data field.
The hours, minutes and seconds can be set.

The selected time can be confirmed by pressing the  button.

Defining the **Automatic Logout** settings is described in section 2.5.

The **Select Tab Color** option is used in combination with the Multiple Reactor Display Mode. Using this mode, the individual reactor systems can be identified with a unique color.
By default, no Tab Color has been selected.
Open the dropdown menu to open the list of available colors. Use the mouse pointer to select a color and press the  button to save the selection.

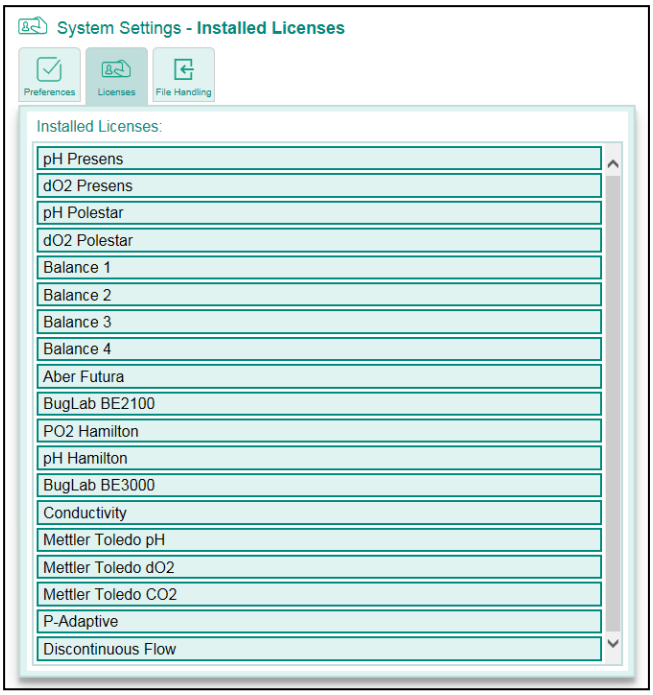
When a Tab Color has been selected, it will be shown in the upper left corner of both the Single Reactor screen and the corresponding Slot of the Multiple Reactor screen.
For information regarding the Multiple Reactor Display mode, refer to chapter 6.

Example of the Mint Green Tab Color selection:

3.3.2 INSTALLED LICENSES

Pressing the Licenses tab opens the list of installed licenses.

Example of the list of installed licenses:



This list is “Read Only”.
For installing additional licenses, refer to Appendix C.

3.3.3 FILE HANDLING (IMPORT AND EXPORT) 

The File Handling tab supports file transfer to and from a USB memory stick that can be inserted at the rear of the cabinet.

Sensors or balances with USB-connectors may cause a conflict with the USB stick. As a result, the USB stick is not detected. Temporarily remove the sensor/balance.

When the File Handling tab is pressed, the presented window shows three different selections:

- File Handling Type
- File Direction
- Filename.

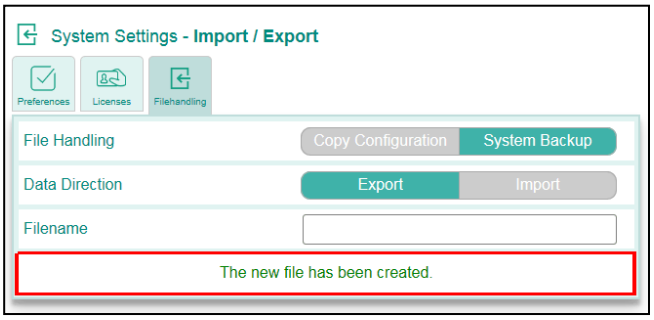
File Handling Type:
Two different file transfer options are available:

- The Copy Configuration selection is used to transfer (copy) the parameters and settings of this device to other devices with the same hardware configuration (saving time and effort). The configuration file that is created includes all parameters and settings (like parameter names, control loop configurations, etc.). Calibration parameters of the sensors and other device specific data is not included.
- The System Backup button is used to create a copy of the full configuration file of the device, including device specific data like the IP-address and calibration data of the configured sensors. This option can be used to make a full backup of this specific device.

Exporting a File:

- Insert a USB memory stick at one of the USB ports at the rear of the control cabinet.
- Select either Copy Configuration or System Backup and select the Export option.
- Type the name of the file that will be transferred in the text area.
- Press the  button to start the transfer action.

The message The new file has been created will be presented at the bottom of the window. In the adjacent image, the message is indicated by a red rectangle.



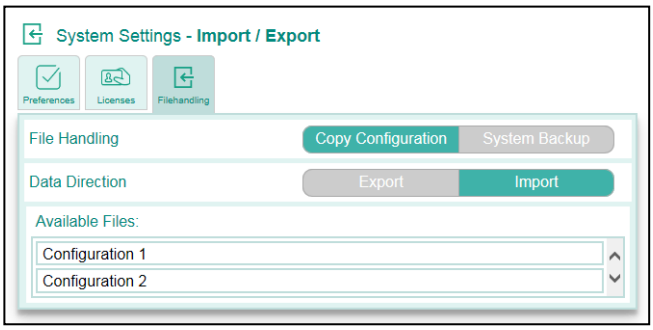
The exported file can be found on the USB-stick in the following directory structure:
Location of Configuration file: USB:\Applikon\Engineer\Copy\<filename>.copy
Location of backup file: USB:\Applikon\Engineer\Backup\<filename>.backup

Licenses are excluded from the Export routine:

Licenses for extended sensors and/or actuators are excluded from the export routine. Licenses that have been installed on a device (refer to section 3.3.3) are not part of the configuration. Purchased Licenses have been assigned to a certain device (to the internal MAC-address of the device) and can be re-installed if necessary.

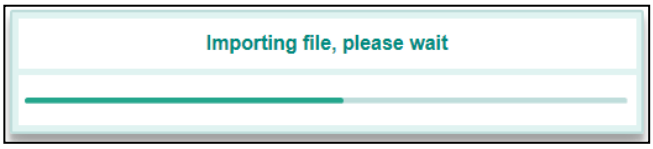
Importing a file:

Created Configuration and/or System Backup files can be imported at any moment from the USB-stick.



- Select the Import option.
- Select either the type Copy Configuration or System Backup. Any previously exported files that are detected at the connected USB memory stick will be reported. In this example, two Configuration Files are reported.
- Select the file that needs to be imported by clicking on it and press the  button to start the transfer action.

During the file import interval, the progress is presented in the time bar:
This may take a few minutes.



4 CONTROL PARAMETERS

The Control Parameter menu is accessed through the 

button and contains the following sub-buttons:

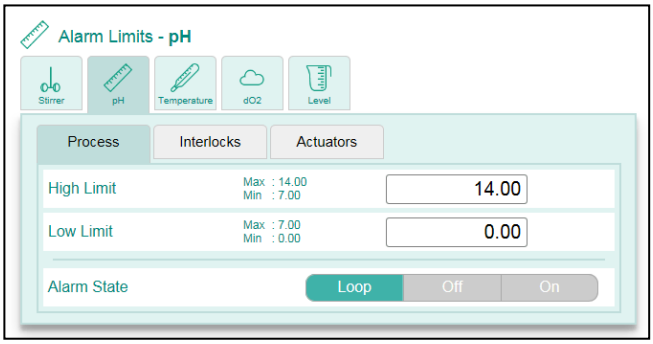
Control Button	Description
	Limits Button: enables editing lower and upper alarm limits of process parameter values; see section 4.1.
	Setup Button: enables editing the controller setup: type of PID control (fixed / dynamic) and editing PID parameters; see section 4.2.
	Manual Operation Button: performs manual actuator actions; see section 4.3.
	Control Loops Button: configures actuators in control loops; see section 4.4.
	Actuator Button: enables editing the actuator properties; see section 4.5.
	Sensor Button: enables editing the sensor properties; see section 4.6.
	Total Gas Flow Control Button: enables configuring Total Gas Flow control; see section 4.8.
	Trend Button: opens the Trend screens of the different process parameters; see section 4.7

In this chapter, the different Control Parameters are described.

4.1 EDITING ALARM LIMITS

Press the 

button.
The displayed alarm limits window shows all sensor tabs that are configured in a process control loop.
The adjacent image shows the Alarm Limits window for the pH sensor.



For each sensor (except the Level/Foam sensor), three page tabs are available:

- Process: definition of Lower and Upper Alarm Limits / status of the Alarm function (refer to section 4.1.1),
- Interlock: definition of Lower and Upper Interlock Limits / status of the Interlock function (refer to section 4.1.2 and section 4.1.4),
- Actuator: assignment of actuator actions to Interlock events (refer to section 4.1.3) and
- Cascade: Only for the Stirrer Control Loop the limit the stirrer speed range when it is used as actuator in the dO_2 Control Loop (refer to section 4.1.5).

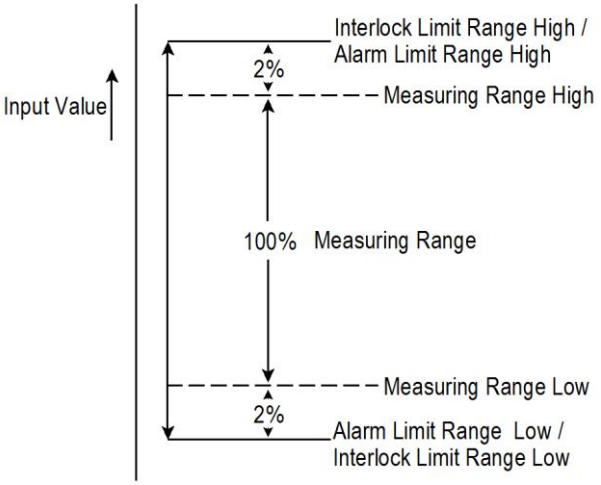
The minimum and maximum values for the Alarm Limits depend on the measuring range, Interlock value and setpoint value (only if a control loop is defined).

Rules for the minimum and maximum value for the Alarm Limits (all three conditions below must be met):

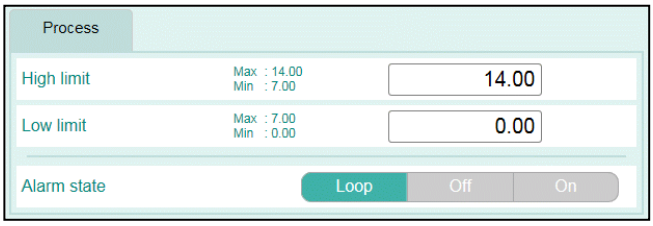
1. The Alarm Limit cannot exceed the Interlock Limit.
   In expression:
   - Alarm Limit Low ≥ Interlock Limit Low,
   - Alarm Limit High ≤ Interlock Limit High.

2. The Alarm Limits may exceed the Measuring Range by 2%.

3. If the input is configured in a control loop, the corresponding Setpoint value must be between the Alarm Limit values.
   In expression:
   - Alarm Limit Low ≤ Setpoint,
   - Alarm Limit High ≥ Setpoint.



4.1.1 PROCESS TAB



The Process tab of the Alarm Limits screen enables the setting of Lower and Upper Alarm Limits.
If required, click on the data field and enter a new value.

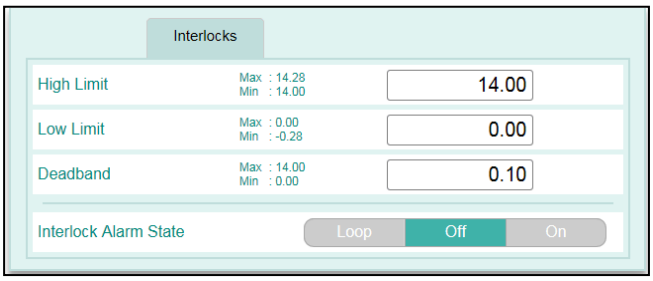
Do not forget to press the  button in order to save the changes.

If the Process Value exceeds one of the Alarm Limits, a Process Alarm will be triggered.
An occurring Process Alarm can be assigned to the Central Alarm Output (for detailed information concerning the output connections, refer to the Hardware Manual).

Process Alarm Condition: three options are supported (see the description in the table below).

Alarm State	Description
Loop	Occurring Process Alarms will only be reported and assigned to the Central Alarm Output when the Controller is Running
Off	Occurring Process Alarms will never be reported and assigned to the Central Alarm Output
On	Occurring Process Alarms will always be reported and assigned to the Central Alarm Output

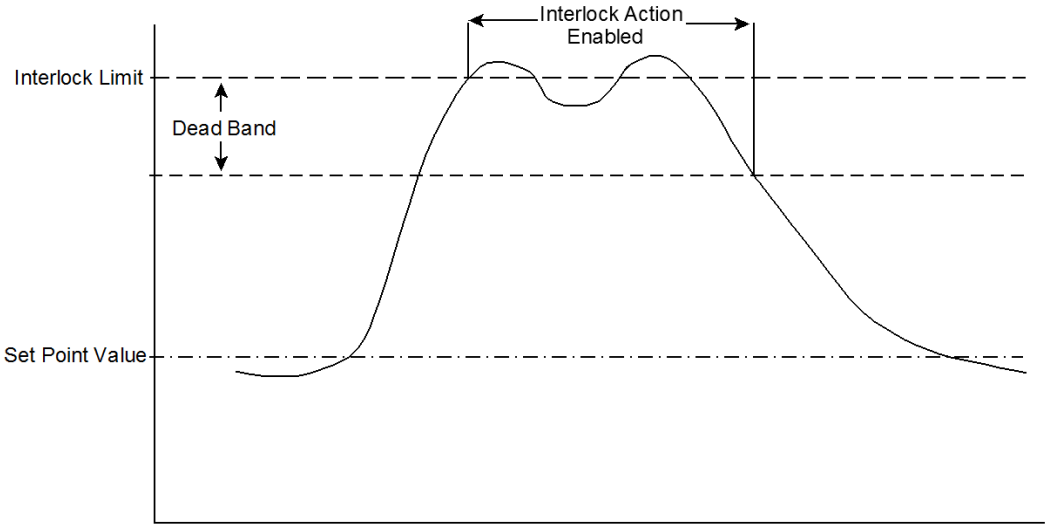
4.1.2 INTERLOCK TAB



The Interlock Limits tab enables setting a Low and High Interlock Limit value for each controlled process parameter.
In case the current process parameter value exceeds one of the limits, a defined Interlock action can be performed.
The Interlock limits can be edited by clicking the on data field and entering a new value.

Do not forget to press the  button in order to save the changes.

The **Dead Band** setting is used to prevent frequent activation of the interlock when the process value drifts around the Interlock limit.
The Dead Band setting prevents frequent switching of the assigned actuator(s).
See the image below:



Interlock Condition: three options are supported (see the description in the table below).

Interlock State	Description
Loop	Defined Interlock Actions will only be performed when the Controller is Running
Off	Defined Interlock Actions will never be performed
On	Defined Interlock Actions will always be performed

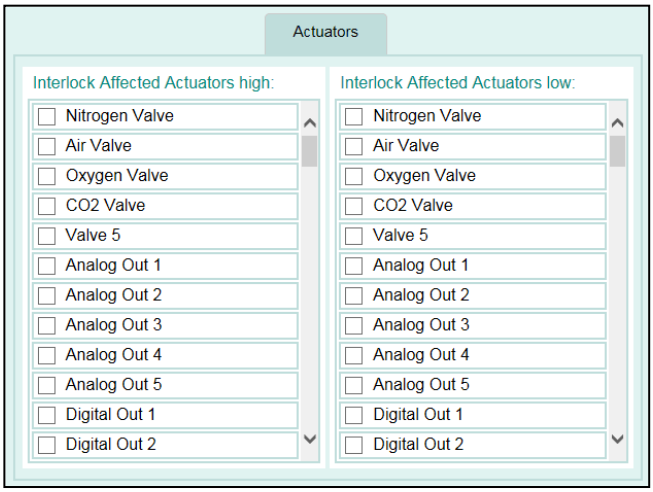
4.1.3 ACTUATORS TAB (INTERLOCK ACTION)

In case the Process Values exceeds one of the Interlock Limits and the Interlock State condition is fulfilled (see table on the previous page), one or more defined actuators will be switched to their default position (will be switched off) until the process value is within the Interlock Limit range again.

The Actuators tab presents two lists with all available actuators.

- The list at the left side assigns actuators to the High Interlock Limit.
- The list at the right side assigns actuators to the Low Interlock Limit.

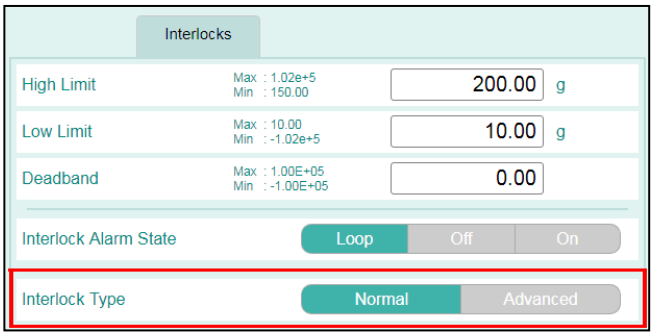
Check the checkbox of the actuator(s) that must be switched by the Interlock.
It is allowed to select more than one actuator per list.



Any configured external actuators (like an External Stirrer or a Temperature Control Unit) are excluded from the list of selectable interlock actuators.

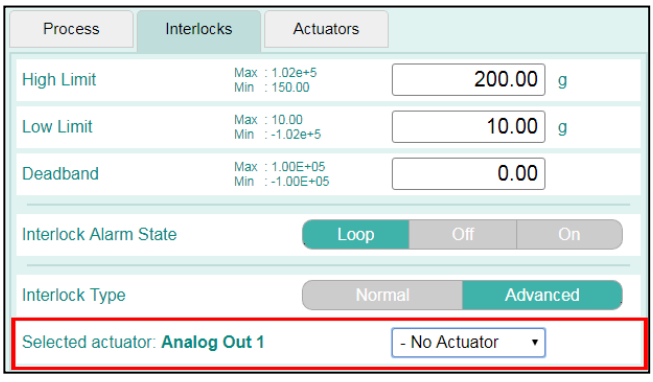
4.1.4 ADVANCED LOW INTERLOCK SETTING

When a control loop is based on an Analog Input (e.g. for an external stirrer) or Balance (e.g. for weight control), an Advanced Interlock option is available in the Interlock tab.
In the adjacent screen image, the extra option is indicated by a red rectangle.
The Advanced Interlock option can be activated by selecting the Advanced option and saving the selection by pressing the ✓ button.



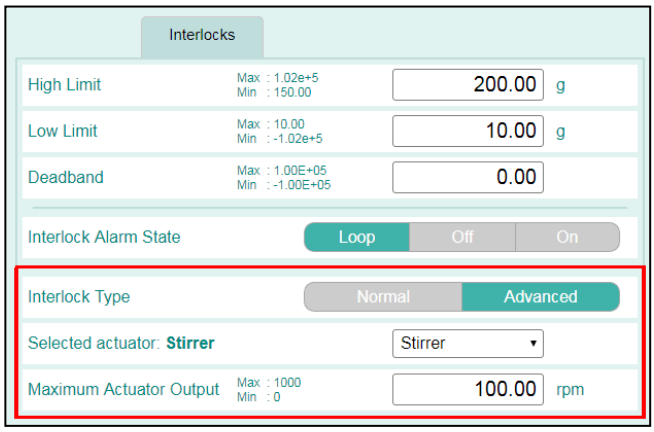
An additional screen area is presented with a drop down list of available actuators.

When the Interlock Type is set to Normal, the actuators that are assigned to this interlock will behave as described in section 4.1.3.
However, when the Interlock Type is set to Advanced, the output level of a specific actuator that can be assigned to the Advanced Low Interlock can be defined.



Application example:
The weight of the bioreactor is measured or controlled and has a Low Interlock Limit of 10 kg (10,000 g). When the Low Interlock Limit is exceeded, the liquid level in the bioreactor will have become too low for the normal stirrer speed. Using the Advanced Interlock, the stirrer speed can be limited to a certain lower value (e.g. 100 rpm).

Procedure:
Select the stirrer actuator from the presented list (by scrolling through the list and clicking on it) and save the current selection by pressing the button.



An extra data field is introduced, called Maximum Actuator Output.
Enter the value of 100 (rpm) as described in the application example above.

Press the button to save the value.

Limitations of the Advanced Low Interlock setting:

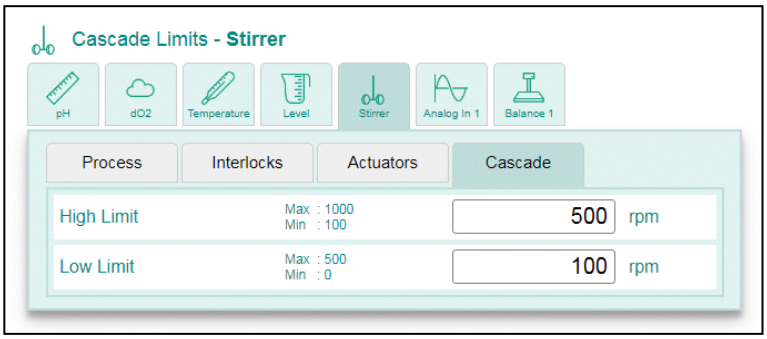
- The Advanced Interlock option is only available for control loops that are based on analog inputs and balances.
- Per control loop, the predefined output value of only one actuator can be assigned to the Low Interlock Limit.
- If the Advanced Interlock action conflicts with any Normal Interlock action, the action of the Normal Interlock will be performed.

4.1.5 STIRRER SPEED CASCADE LIMITS

The Stirrer can be used as actuator (for upward control) in dissolved oxygen control; refer to section 4.4.1. An increased stirrer speed will improved the dispersion of the sparged gas bubbles and consequently improve the oxygen mass transfer from gas to liquid phase.

However, in this case stirrer speed limits are required to keep the stirrer speed in a specific range.

Therefore, the Alarm Limits – Stirrer screen contains an additional tab called Cascade where the Cascade Limits can be set.



The Cascade Limits in presented example (Low Limit = 100 rpm and High Limit = 500 rpm) mean that:

- If the Stirrer is configured as actuator for upward control (or Below Setpoint) in the dO_2 Control Loop,
- During a running dO_2 Control Loop, the stirrer speed will be in the range of 100 – 500 rpm, depending on the actual Controller Output,
- If the CO = 0%, the stirrer speed will be 100 rpm,
- If the CO = 100%, the stirrer speed will be 500 rpm,
- If the CO = between 0 and 100%, the stirrer speed will be proportional to the Controller Output..

If the Stirrer is not configured as actuator in the dO_2 Control Loop, the stirrer speed can be manually set between the limits that are presented in the upper left hand corner of the Stirrer Settings > Limits screen (in this example: between 0 and 1000 rpm).

If the Stirrer Speed Cascade Limits are used, the Actuator Output Limits as set in the Controls > Actuators > Stirrer Settings screen must remain at the default values for the stirrer motor. Refer to section 4.5.2.

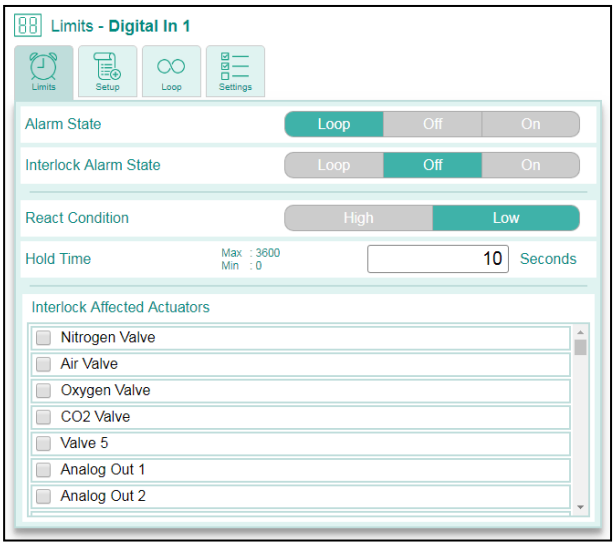
4.1.6 INTERLOCK SETTINGS FOR DIGITAL INPUTS

Interlocks can also be defined for (generic or specific) Digital Inputs.
Generic digital inputs: DI1 . . .DI16
Specific digital inputs: Foam, Level, Pressure Switch.

The Pressure Switch is a dedicated hardware module that is used in combination with Single Use Bioreactor bags that have limited operating pressure. When the pressure limit is exceeded, Pressure Switch control can be used to close actuators like the gas supply valves.

The Digital Input or Pressure Switch must be selected as “Sensor to be Used”. Refer to section 3.2.2.

Generic and specific digital inputs have modified Limit functions (see image). It can be used for the following settings:



Alarm or Interlock State:

- Loop: The defined Alarm or Interlock Actions will only be performed when the Controller is Running.
- Off: The defined Alarm or Interlock actions will never be performed.
- On: The defined Alarm or Interlock actions will always be performed.

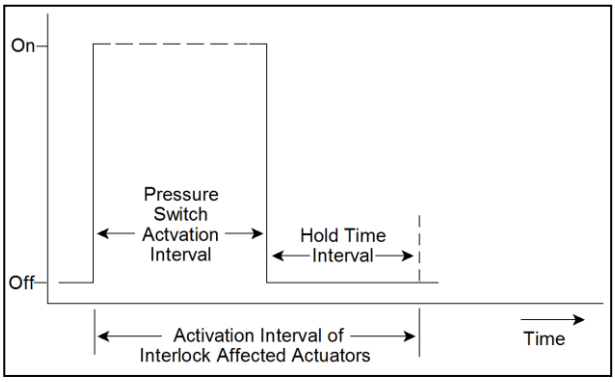
React Condition:
This selection determines the activation condition:

- High: the Alarm and Interlock will be triggered when the input status is High.
- Low: the Alarm and Interlock will be triggered when the input status is Low.

The names of the Digital Inputs states (in this example “High” and “Low”) can be edited. Refer to section 4.6.4.

Hold Time:
The Hold Time can be used to prevent frequent activation of the assigned actuators.
Application example: the Pressure Switch is used to prevent high pressure in the single use reactor bag:

- As soon as the input signal gets high, the gas inlet valves are closed.
- When the input signal becomes low again, the Interlock Affected Actuators will only be deactivated after the Hold Time has elapsed.



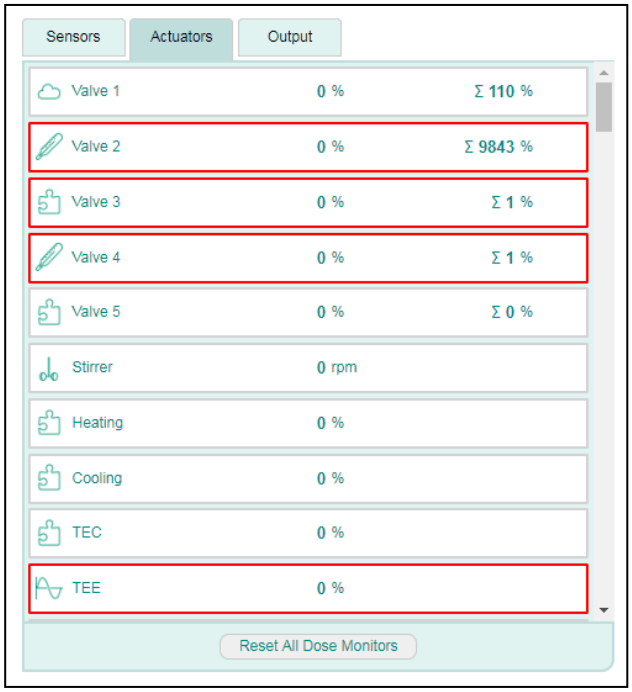
Interlock Affected Actuators:
Select the actuator(s) that need to be affected by the Interlock by checking its checkbox(es) (☐) in the list of presented actuators. Press the ✓ button to save the selection.
The selected actuators will be indicated with a check mark and a green line (such as ☑ Air Valve).

4.1.7 PRESENTATION OF INTERLOCKED ACTUATORS

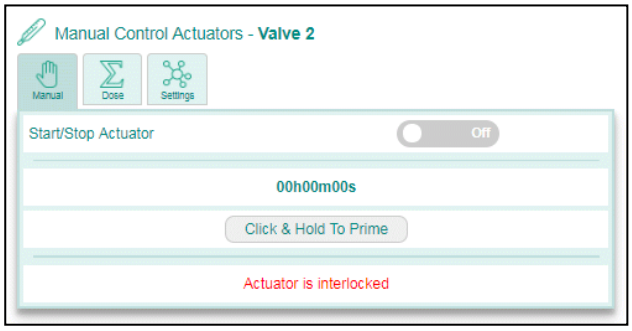
Interlocked actuators are indicated using a red rectangle in the Actuator list and cannot be controlled (manually or automatically).

Some examples of the presentation of Interlocked Actuators are given:

1) When the Actuators tab is selected in the right section of the Home screen, any Interlocked actuator will be presented in a red rectangle.



2) When one of the Interlocked actuators is selected (by pressing its bar), it will be presented at the left side of the Home screen. Below, the Manual Control tab of Valve 2 is shown; the Off button is disabled and the Click & Hold To Prime button is greyed out. An additional text area is created with the message Actuator is interlocked.



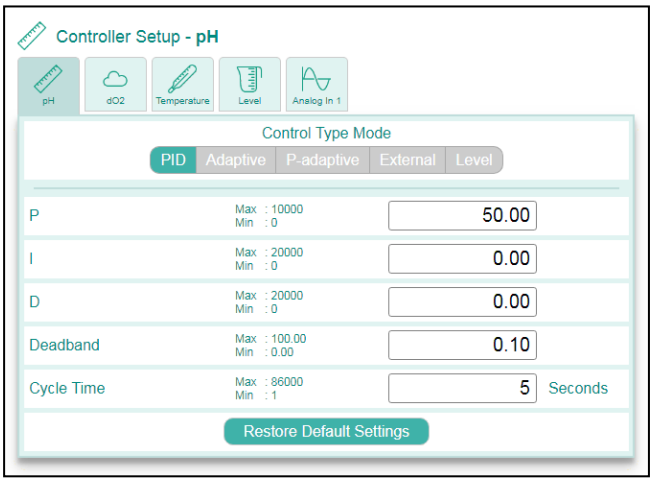
3) When the Output tab is selected in the right section of the Home screen, any Interlocked actuator will be presented in red text (see image at the right):

4.2 CONTROLLER SETUP

Press the 

button to open the Controller Setup screen with parameters for the individual control loops.

The adjacent screen image shows the Controller Setup for the pH control loop.



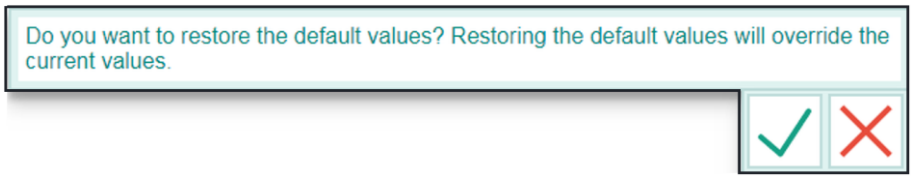
Control Parameters for PID control (default selection):

- P (Proportional Gain),
- I (Integral Time Interval),
- D (Derivative Time Interval),
- Cycle Time and
- Dead Band.

By default, control loops that are based on an analog input (such as a sensor) are set to PID control. For detailed background information concerning the PID-algorithm and parameter settings, refer to the PID Control Manual that comes with the control device.

The Dead Band parameter is a standard setting for pH control. For other controllers, the Dead Band parameter can be selected as an option (refer to section 4.6.2: dO_2 Sensor Settings and section 4.6.3: Analog Input Sensor Settings).

Clicking on the Restore Default Settings button will reset the PID control parameters to their default values. However, a confirmation is required (see image).



Press the  button to proceed or press  to return to the Controller Setup screen.

4.2.1 CONTROL TYPE SELECTION

In the upper part of the Controller Setup screen, the Control Type can be selected:

Depending on the sensor type, different kinds of control algorithm can be selected.
In the table below, an overview of all Control Types (for all sensors) is presented:

Control Type	Description
PID	P(roportional), I(ntegral) and D(erivative) Control with fixed control parameters
Adaptive	Adaptive PID Control with dynamic control parameters
P-Adaptive	Optional: refer to the PID Control Manual (license is required to enable this option)
External	External Control, to be used with external control units (like a Temperature Control Unit)
Level	Level Control
Flow	Optional: refer to the Balance Connection for Flow and Weight Control Manual (license is required to enable this option)
TCUSP	Directs the Temperature Setpoint value to a Temperature Control Unit

The different Control types are described in the sections below.

4.2.1.1 PID CONTROL

PID control represents an algorithm that is based on three different control elements:

- Proportional control: depending on the difference between process value and setpoint, an actuator action is performed. When the process value equals setpoint, the actuator action is 0.
- Integral control: depending on the integrated difference between process value and setpoint, an actuator action is performed. In this way, a continuous offset from setpoint can be corrected.
- Derivative control: depending on the trend of the process value in relation to setpoint, an actuator action is performed. In this way, process value overshoot or undershoot can be decreased.

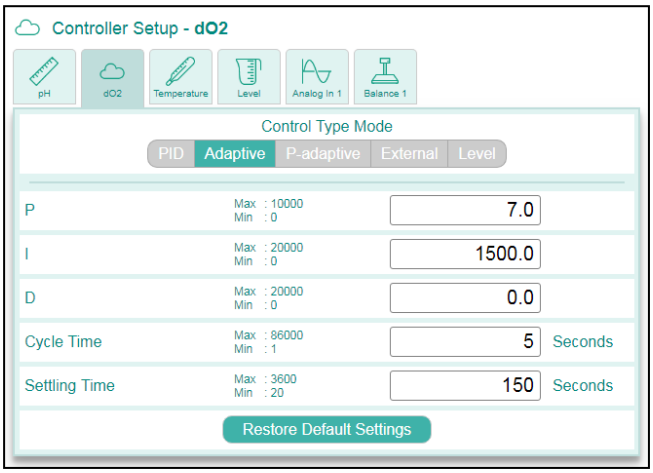
Parameters in PID control:

Parameter	Description
P-gain	Proportional gain; causes a controller output that is proportional to the deviation
I-interval	Integrates the deviation to correct for a systematic offset
D-interval	Evaluates the trend and prevents a large overshoot
Cycle Time	Defines the Control Loop refresh time
Dead Band	Prevents excessive actuator actions when the process value is fluctuating around setpoint

For a comprehensive description of the PID Control Settings, refer to the PID Control Manual.

4.2.1.2 ADAPTIVE CONTROL

Adaptive control is characterized as PID control with dynamic control parameters.
When this type of control is selected, the initial values of the control parameter can be defined.
Example for adaptive dO_2 control:



During fermentation / cultivation with adaptive control, the parameter values will be optimized on regular bases. The actual PID parameters can always be recalled through this Control Setup screen.
Before starting a new process, you may decide to keep the current control parameters or to reset the control parameters to their default or other values.

Using Adaptive control, an extra parameter called Settling Time is presented. This parameter represents the interval without identification after updating the control parameters.

For more information about Adaptive Control, refer to the PID Control Manual, section 1.4.

4.2.1.3 P-ADAPTIVE CONTROL

By using the P-Adaptive control option, the relation between Process Value and Controller Output changes as soon as the setpoint value has been exceeded.

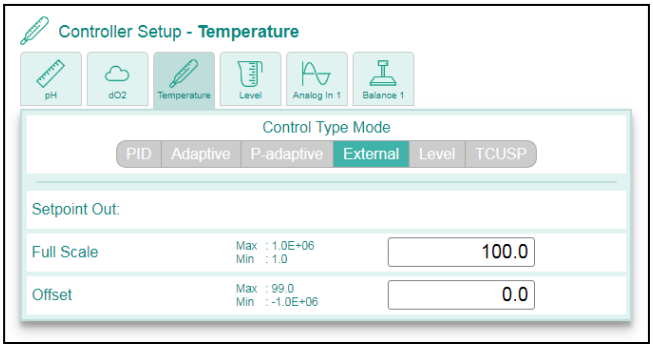
The use of the P-Adaptive control mode is licensed. If the license has not been installed, this option will not be available.

For a more detailed description of the P-Adaptive control mode, refer to the PID Control Manual.

4.2.1.4 EXTERNAL CONTROL

The External control option can be used to direct a measured Process Value to an Analog (4-20mA) Output.

The screen image shows the Temperature Control Setup screen.



Two parameters can be set:
Output value for Full Scale (corresponding with 20 mA)
Output value for Offset (corresponding with 0 mA).

Application examples:

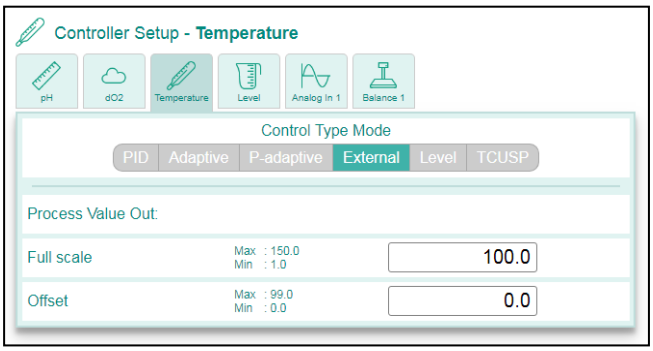
- Directing an input signal to an Analog Output, e.g. for recording purposes:
  A Sensor or Analog Input is configured as a Control Loop with an Analog Output assigned to it as "Actuator Above Setpoint".
  When External Control is selected for this input, the Offset and Full Scale values will correspond with the 4 and 20 mA limits of the Analog Output.

- Connecting a stand-alone (external) stirrer as actuator for the Stirrer Control Loop:
  The analog output of the external stirrer controller is connected to an Analog Input of the ***my***-Control that is configured as a Control Loop with an Analog Output assigned to it as "Actuator Below Setpoint".
  When External Control is selected for this input, the Offset and Full Scale values of the external stirrer controller will correspond with the 4 and 20 mA limits of the Analog Output.
  The external stirrer control loop can either be used as stand-alone controller or be assigned as actuator in the cascade of another control loop (e.g. the dO_2 control loop).

- Connecting an external Temperature Control Unit with integrated PID control capabilities:
  The Temperature Sensor is configured as a Control Loop with an Analog Output assigned to it as "Actuator Below Setpoint" and another Analog Output as "Actuator Above Setpoint".
  When External Control is selected for this input, the Offset and Full Scale values for both the Temperature Setpoint and current Process Value (that will be sent to the TCU) will correspond with the 4 and 20 mA limits of the Analog Outputs.

Screen examples of External Control:

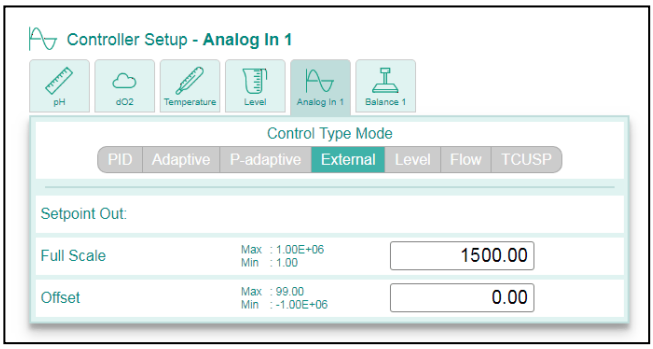
Analog Input value directed to Analog Output:
Also refer to section 4.4.5.
Analog Input 1 has been configured in a control loop with Analog Output 1 as “actuator above setpoint”.



Control Setup is set to External.

The values for Offset and Full Scale of Analog Output 1 can be defined. In this example, 4mA corresponds with the value 0 while 20mA can be interpreted as the value 100.

Connection of External Stirrer:
For configuring the control loop, see section 4.4.6.
The analog (0-10V or 4-20mA) output of the external stirrer is connected to Analog Input 1 and is configured in a control loop with Analog Output 1 as “actuator below setpoint”.

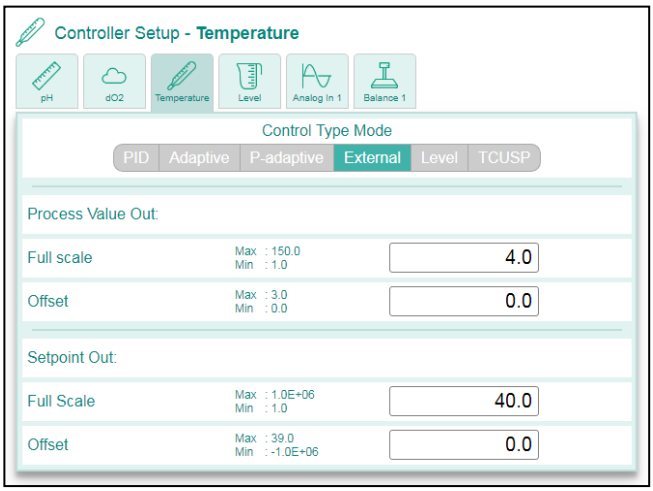


Control Setup is set to External.

The values for Offset and Full Scale of Analog Output 1 can be defined. In this example, 4mA corresponds with the value 0 while 20mA can be interpreted as the value 1500 (rpm).

In case of connecting an external stirrer, the Analog Input must be calibrated by using a Tachometer. Perform a 2-point calibration routine (resp. at 10 and 90% of the stirrer speed range). Refer to section 5.2.8.

Connection of an External Temperature Control Unit:
For configuring the control loop, see section 4.4.7.
Both the actual Temperature Sensor value and required Setpoint for the PID controller of the external TCU are directed to the TCU through Analog Output 1 and 2.
Analog Output 1 is assigned as “actuator above setpoint” and represents the Process Value (actual temperature).
Analog Output 2 is assigned as “actuator below setpoint” and represents the Setpoint Value (actual temperature).

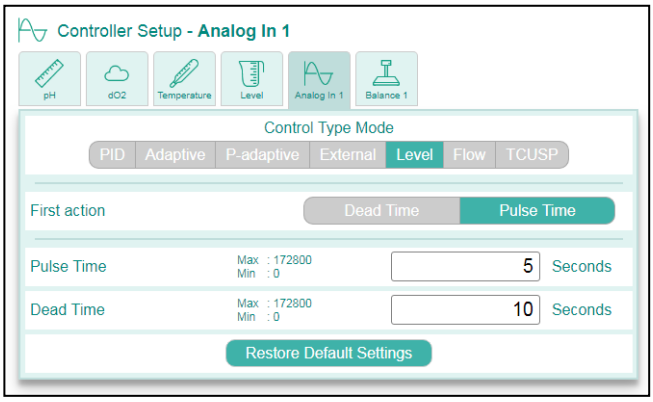


Control Setup is set to External.

The values for Offset and Full Scale for Setpoint and Process Value can be defined.
In this example, 4mA corresponds with 0 degrees while 20mA represents a temperature of 40 degrees.

4.2.1.5 LEVEL CONTROL

This section describes the options for using the Level control mode for an analog input.



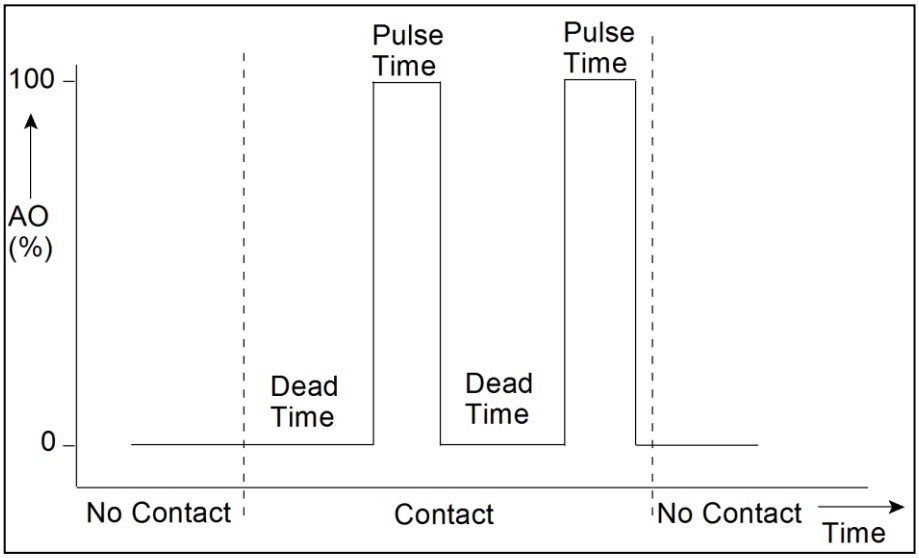
When Level Control is selected, the control parameters consist of a Pulse Time and a Dead Time. Both intervals are expressed in seconds.

As First Action, either Dead Time or Pulse Time can be selected.

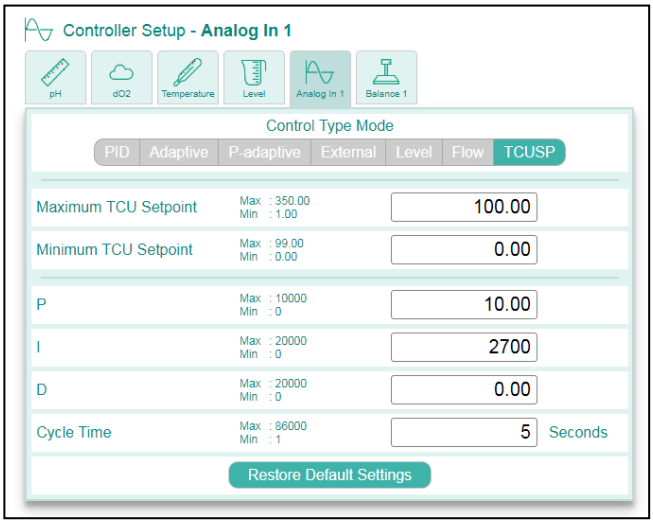
When a Level (or foam) Control Actuator Action is required, a sequence of Pulse Time and Dead Time is initiated (starting with either Pulse or Dead Time).
The Level Control action will stop as soon as the detected level has returned to normal.

- During the Pulse Time interval, the assigned actuator is ON
- During the Dead Time interval, the assigned actuator is OFF

The sum of dead time and pulse time equals the Cycle Time of the control loop.
Graphical example of Level control (First Action = Dead Time):



4.2.1.6 EXTERNAL TCU WITH SETPOINT CONTROL



When this option is used, the Temperature Setpoint of the TCU is set by the Applikon Controller.
This setpoint is directed to the TCU through an analog (4-20mA) output.
For information concerning the control loop configuration, see section 4.4.8.

Note:
In case of a stepwise temperature setpoint change at the controller, the output value to the TCU will follow in a controlled manner (by ramping up/down). In this way, temperature overshoot (or undershoot) in the reactor is decreased.
The Integral part of the control algorithm will correct the difference between temperature setpoint and the measured Process Value.
The algorithm of the TCUSP control mode is described in the PID Control Manual (chapter 2: Control Variables and Parameters).

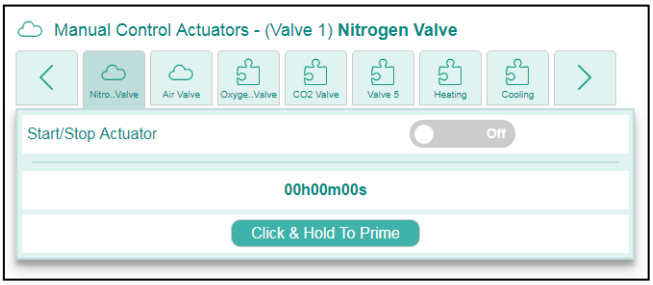
TCU Setpoint range:
The values for the Minimum and Maximum TCU Setpoint are used to match the range of the analog output with the input range of the TCU.
In this example, 0ºC will correspond with 4mA and 100ºC will correspond with 20mA.

The Restore Default Settings button resets the PID parameter values to P=10, I=0 and D=0 and Cycle Time=5sec.

4.3 MANUAL ACTUATOR CONTROL

Pressing the 

button will open the Manual Control screen for all actuators.
An actuator can be selected by pressing one of the tabs at the top of the screen (the tabs show the actuator name and the icon of the control loop that they are assigned to).



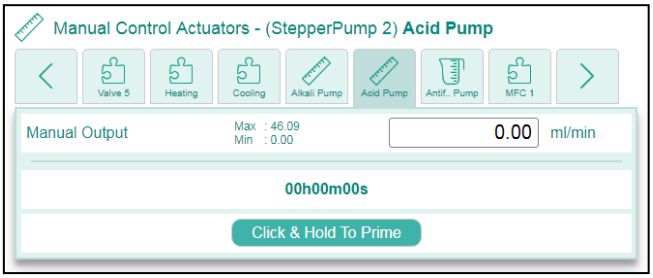

For information concerning the presented icons in the actuator tabs, refer to section 1.10

Since the total number of actuators easily exceeds the number of tab positions in the Manual Control screen, the scroll buttons  and  can be used to scroll through the list. The keyboard cursor keys of the device that is used as Web UI can also be used as scroll buttons!

The layout of a specific Manual Control screen depends on the actuator type (analog or digital actuator).

- Analog actuators (such as variable speed pumps and mass flow controllers):
  Example of the Variable Speed Acid Pump:
  Enter the required pump speed (in ml/min) and press the  button to execute the operation.
  Enter the value 0 press the  button to stop the pump.
  Pressing the 

  button enables priming the pump tubing. As long as the button is pressed, the pump will be primed.



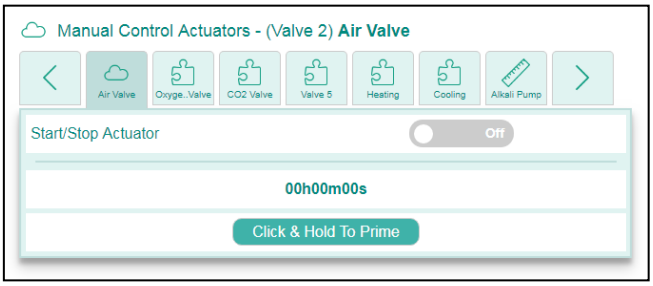

The presented output engineering unit (in this example ml/min) depends on the defined Actuator HMI Settings. Refer to section 4.5.1.

- Digital actuators (such as valves that can be switched ON or OFF):
  Example of the air valve:
  Press the

  button to switch the output On. The button will turn green (

). Press the  button to confirm.
  Pressing the 

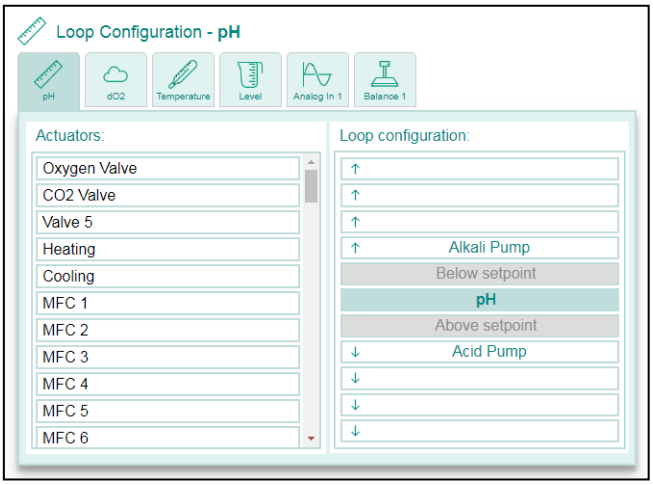
  button enables priming the valve tubing. As long as the button is pressed, the valve will be opened.



4.4 CONTROL LOOP CONFIGURATION

The control software supports different kinds of process control. In the sections below, configuring the different control types is described.

4.4.1 PID CONTROL LOOPS



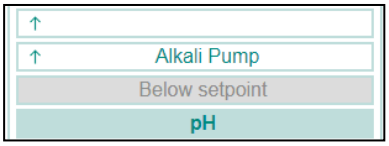
Press the Loops button to enter the control loop configuration window.
The tabs at the top of the screen present the configured control loops.
When the number of configured loops exceeds the available space, the scroll buttons (and) are introduced.
The keyboard cursor keys of the device that is used as WebUI can also be used as scroll tabs!
Use these tabs to view and / or edit the control loops.

The control loops can be configured by assigning actuators to it. The procedure below shows how to add an actuator to a Control loop.

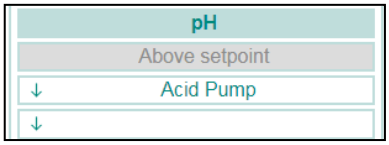
Procedure:

- Select a control by clicking on one of the tabs at the top of the screen. In this example, the pH Control loop is selected.

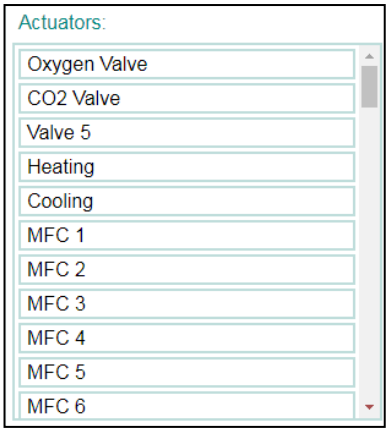
- The actuators that are currently presented to act Below Setpoint are presented as:
  Actuators that are used below setpoint are used for Upward Control.



- The actuators that are currently presented to act Above Setpoint are presented as:
  Actuators that are used above setpoint are used for Downward Control.



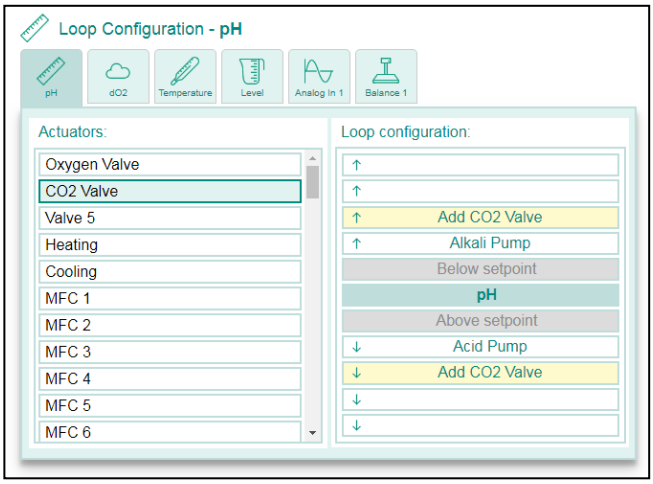
- At the left side of the screen, the list of available actuators is presented.
  Use the Scrollbar to examine all selectable actuators.
  An actuator can be selected by clicking on it. The selected actuator will be highlighted and will be projected as both actuator “Below” and “Above” setpoint.(light yellow color).
  See next page

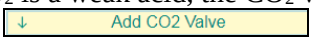


- The presented image shows an example of adding the CO_2 valve as actuator to a pH Control loop where the alkali pump (for upward control) and an acid pump (for downward control) have already been assigned as actuators.

  In the actuator list at the left side of the screen, the CO_2 Valve has been selected.

  In the Loop Configuration section at the right side of the screen, the CO2 Valve is projected (in light yellow) as actuator for both upward and downward control.

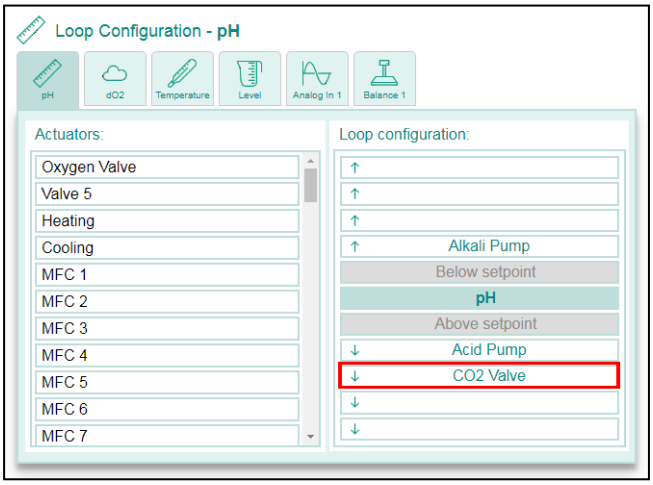


- Since CO_2 is a weak acid, the CO_2 valve is an actuator for downward pH control. Press the 

button for downward control.

- The CO_2 valve will be added as actuator for downward control to the pH Control loop. See image (the added actuator is indicated with a red rectangle).

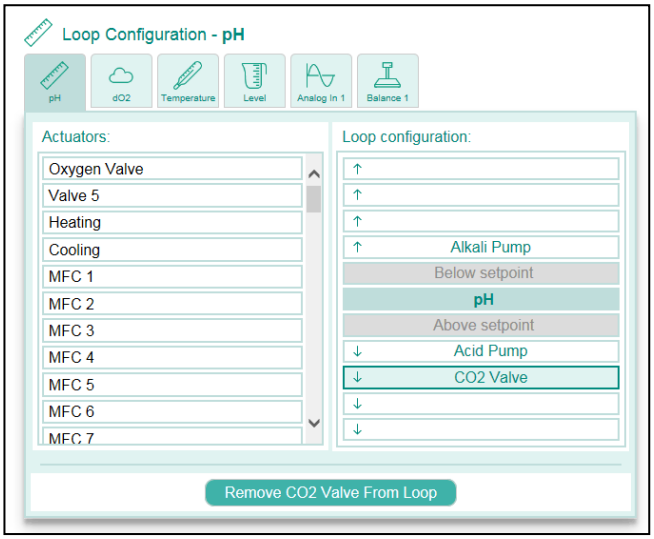
  Press the  button to confirm.



An actuator can be removed from the control loop configuration:

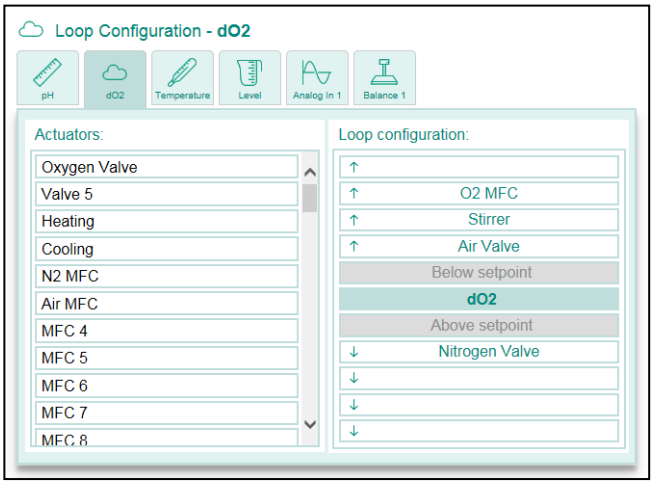
- Click on the actuator that needs to be removed from the loop.
- The selected actuator is highlighted and the 

button is presented at the bottom of the Loop Configuration window. Press this button to remove the CO_2 valve as actuator from the loop.



Example: Configuring the dO_2 control loop with four actuators

Actuator for Downward control	Actuator for Upward control
Nitrogen valve	Air valve
	Stirrer
	Oxygen MFC



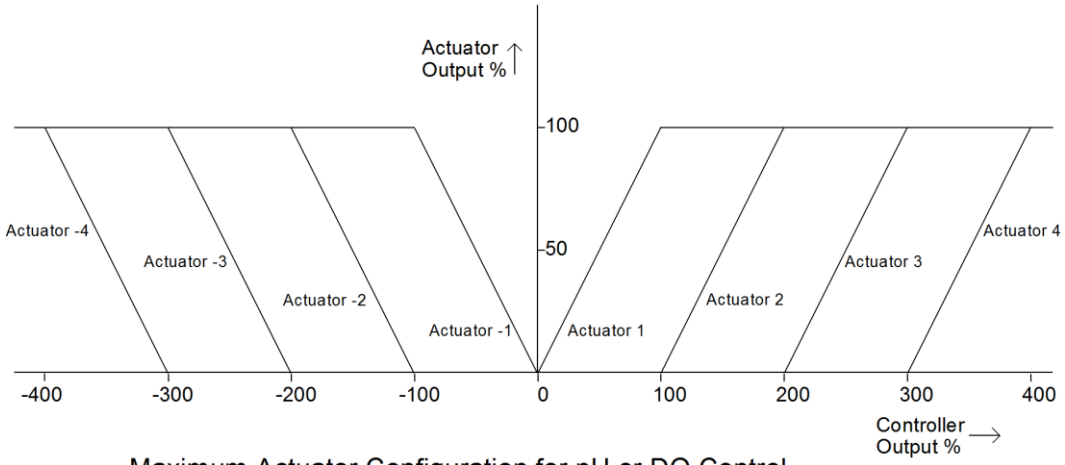
- Remove any assigned actuator by selecting it and pressing the Remove Actuator From Loop button (one by one).
- Select the following actuators from the list and assign them one by one to the dO_2 control loop below setpoint (upward control) by pressing the ✓ button:
  - Air Valve,
  - Stirrer and
  - Oxygen MFC.
- Select the Nitrogen Valve actuator from the list and assign it to the dO2 control loop above setpoint (downward control) by pressing the ✓ button.

When another screen is opened while the new configuration was not saved, the new setting will be lost.

4.4.2 BASIC CONFIGURING RULES FOR PID CONTROL LOOPS

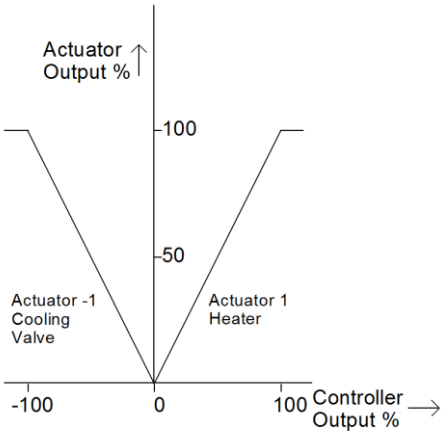
- The controller output for pH and dO_2 may vary between -400 to +400% (max. four actuators above or below set point)
- The controller output for Temperature varies between -100 to +100% (max. one actuator above or below set point)
- The Level or Foam controller only has one actuator (actuator output is either 0 or 100%)
- The Stirrer Speed controller only has one actuator (stirrer motor; actuator output varies from 0 – 100%)

Graphical presentation of the maximum actuator configuration of the pH or dO_2 Control loop:



Maximum Actuator Configuration for pH or DO Control

Graphical presentation of the maximum actuator configuration of the Temperature control loop:



Maximum Actuator Configuration for Temperature Control

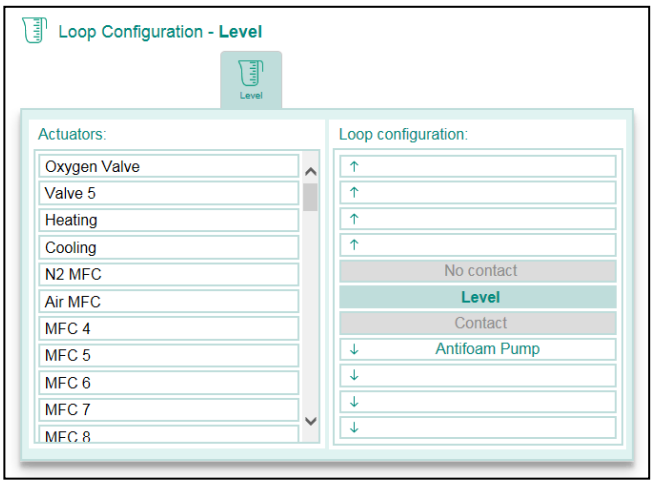
For comprehensive information concerning process control and actuator cascades, refer to the included PID Control Manual.

4.4.3 LEVEL / FOAM CONTROL LOOP

For Level / Foam and sensitivity selection, refer to section 4.6.1: Level / Foam Sensor Settings.

By configuring the Level / Foam Control loop, an actuator can be assigned to the type of action.
It can either be assigned to be activated when “Contact” or “No Contact” is detected.

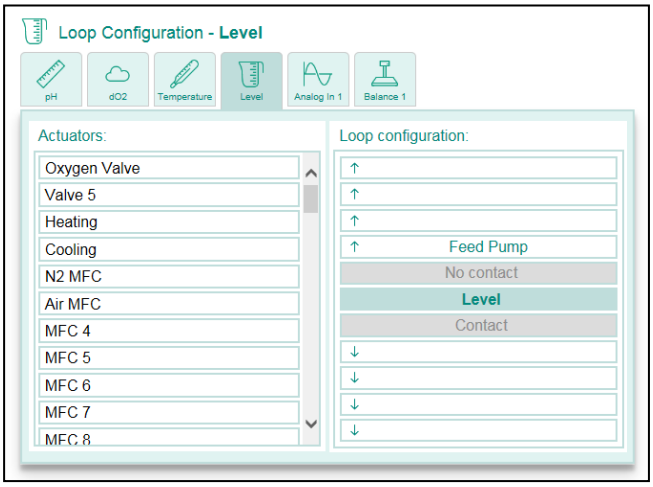
The adjacent image shows the configuration for a Foam Control loop.
The Antifoam Pump has been assigned as actuator to be activated when “Contact” has been detected.



The current actuator assignment can be removed by selecting the actuator and pressing the Remove Antifoam Pump From Loop button.

Assigning a new actuator can be performed by selecting an actuator from the list and clicking on the actuator at the proper side of the control loop and pressing the corresponding button.

The image below shows the configuration of a Feed Control loop. The Feed Pump will be activated when No Contact between Level Sensor and medium is detected.



4.4.4 CONFIGURING THE PRESSURE SWITCH FOR CONTROL

The Pressure Switch is a hardware device that can be installed inside the ***my***-Control cabinet.
Its switching point is set to the pressure limit of the used Single Use Bioreactor.

The Pressure Switch is a dedicated control device that reacts on exceeding the pressure limit.
Its reaction consists of closing actuators (e.g. the gas inlet valves).

The Pressure Switch can be configured in two steps:

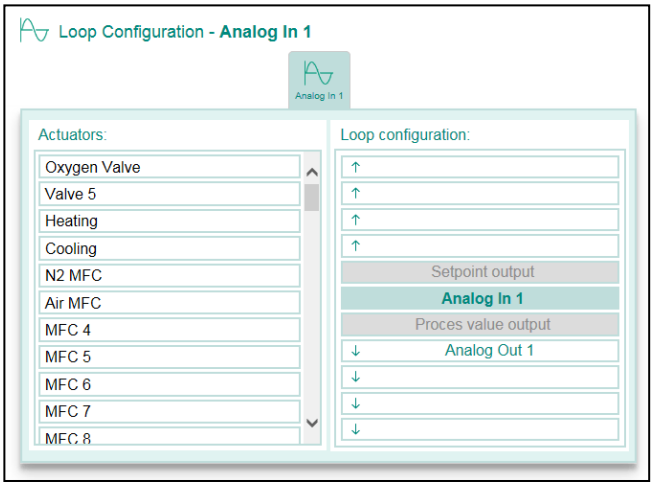
- Selecting the Pressure Switch as a Sensor to be Used. Refer to section 3.2.2: Sensor Selection for Control.
- Configuring the required (Interlock) action. Refer to section 4.1.6.

4.4.5 ASSIGNING AN INPUT SIGNAL TO AN ANALOG OUTPUT

Input or sensor signals can directly be assigned to a 4-20mA Analog Output (without any control action). This can be achieved by configuring the input in a Control Loop with the Analog Output as Actuator "Above Setpoint" and setting the Control Loop to External Control.

Configuration example: Value of Analog Input 1 to be assigned to Analog Output 1.

For information concerning the Output Parameter settings, refer to section 4.2.1.4 (External Control).

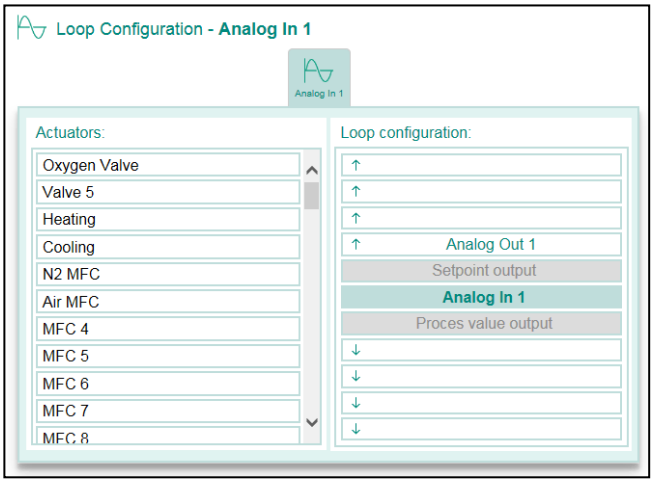


4.4.6 CONFIGURING AN EXTERNAL STIRRER

This section describes the connection of an external stirrer.
The analog (0-10V or 4-20mA) output of the external stirrer can be connected to an Analog Input of the ***my***-Control. The stirrer speed setpoint can be generated from the ***my***-Control.
This can be achieved by configuring the input in a Control Loop with an Analog Output as Actuator "Below Setpoint" and setting the Control Loop to External Control.

Configuration example: Stirrer speed value of the external stirrer is connected to Analog Input 1 and Analog Output 1 is used to direct the Setpoint Value to the external stirrer.

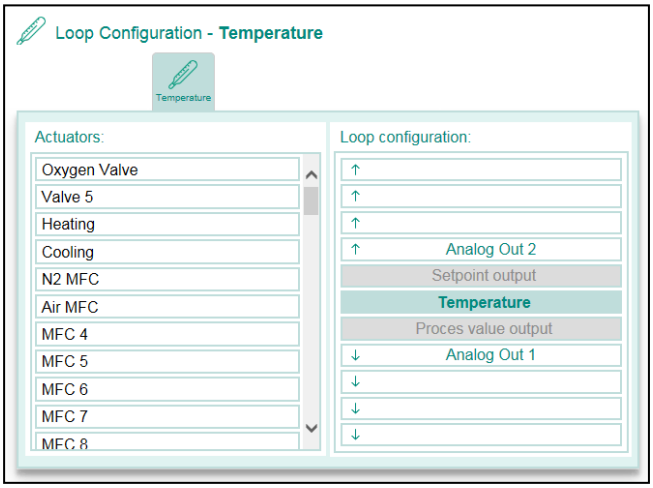
For information concerning the Output Parameter settings, refer to section 4.2.1.4 (External Control).



4.4.7 CONFIGURING AN EXTERNAL TEMPERATURE CONTROL UNIT (1)

This section describes the connection of an external Temperature Control Unit (TCU) with its own PID control capabilities.
The bioreactor temperature is measured with the standard Pt-100 temperature sensor.
One Analog 4-20mA Output is used to direct the actual bioreactor temperature to the TCU. Another 4-20mA Analog Output is used to direct the setpoint value to the TCU.
This setup can be achieved by configuring the temperature sensor in a Control Loop with one Analog Output as Actuator "Below Setpoint" and another Analog Output as Actuator "Above Setpoint". The Control Loop must be set to External Control.

Configuration example: The Temperature Input is configured in a Control Loop with two assigned Analog Outputs (one for the actual Process Value and one for the Temperature Setpoint).



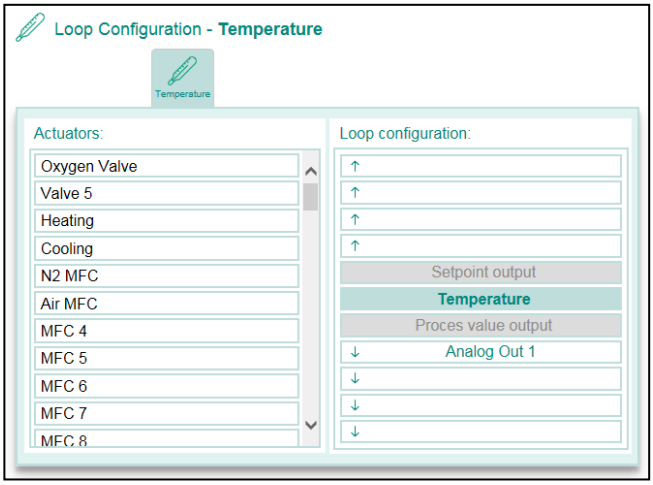
For information concerning the Output Parameter settings, refer to section 4.2.1.4 (External Control).

4.4.8 CONFIGURING AN EXTERNAL TEMPERATURE CONTROL UNIT (2)

This section describes a second option to connect an external Temperature Control Unit (TCU). In this case, the Temperature Setpoint of the controller is directed to the TCU through a 4-20mA analog output.

The bioreactor temperature is measured with the standard Pt-100 temperature sensor.
An Analog 4-20mA Output is used to direct the temperature setpoint to the TCU.
This setup can be achieved by configuring the temperature sensor in a Control Loop with one Analog Output as Actuator “Below Setpoint”. The Control Loop must be set to TCUSP.

Configuration example: The Temperature Input is configured in a Control Loop with one assigned Analog Outputs (for the Temperature Setpoint).



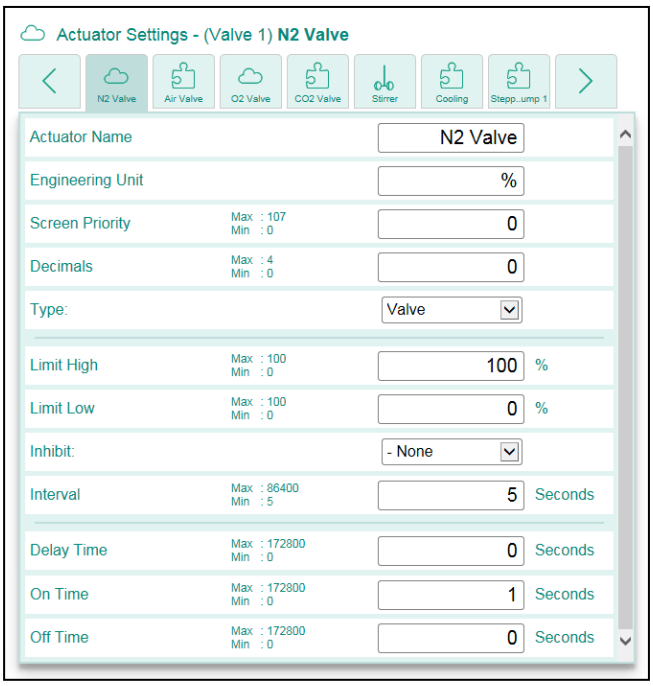
For information concerning the Output Parameter settings, refer to section 4.2.1.6 (External TCU with Setpoint Control).

4.5 ACTUATORS

Press the 

button to open the Actuator Settings screen.
At the top of the screen, the available actuators are presented.

Since the number of actuators easily exceeds the number of tab positions in the Actuator Settings screen, the scroll buttons  and  can be used to scroll through the list of presented actuators. The keyboard cursor keys of the device that is used as WebUI can also be used as scroll buttons!

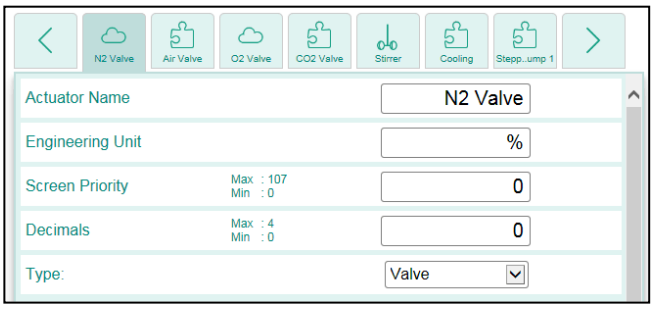


The presented Actuator Settings screen is divided in different parts (the screen layout depends on the selected actuator). For actuators such as the nitrogen gas valve (see the presented image above), three areas with different settings are presented:

- The upper part of the screen contains the HMI Settings (displayed actuator name, engineering units, screen priority, amount of decimal places and actuator type).
- The middle part of the screen contains the Actuator Limits, Inhibit and Interval information.
- The lower part contains the Timer function settings*. The layout of this section of the screen depends on the actuator type.

*The Timer function can be used for actuators that are currently not in use for other purposes. For more information concerning this function, refer to section 4.5.3.

4.5.1 ACTUATOR HMI SETTINGS



The HMI Settings area in the upper part of the Actuator Settings screen contains data fields for:

- The displayed actuator name,
- The engineering unit,
- The screen priority value,
- The amount of Decimal places and
- The actuator type.

The **Displayed Name** can be edited by clicking on the corresponding data field.
The existing name can be edited.

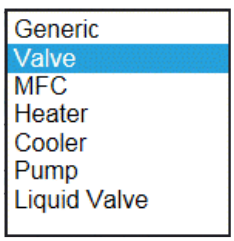
The displayed **Engineering Unit** of the actuator capacity (in this case %) is used for **presentation purposes only**. If the flow of the actuator is calibrated, the unit may be "ml / min". Both volume and time units can be edited individually.
Note:
Changing the Engineering Unit (e.g. from "ml" to "L") will not affect the actuator action.

The **Screen Priority** number determines the position of the actuator in the actuator list. The lower the priority number, the higher the position of the actuator in the list.
Allowed Screen Priority values: 0 - 107
Default setting of the actuator screen priorities:

Actuator Name	Priority Value	Actuator Name	Priority Value
Valve 1 - 5	0 - 4	Analog Output 1 - 4	28 - 31
Stirrer	5	Analog Output 5 - 13	32 - 40
Heating Blanket	6	Digital Output 1 - 8	41 - 48
TE Condenser	8	Digital Output 9 - 16	49 - 56
TE Element	9	Digital Output 17 - 56	57 - 96
Stepper Pump 1 - 6	10 - 15	Micro Valve 1 - 6	97 - 102
Digital Pump 1 - 3	16 - 18	Valve 6 - 8	103 - 105
Thermo Circulator	19	Rocker	106
Mass Flow Ctrl 1 - 8	20 - 27	Roller	107

The number of **Decimal** places determines the presentation of the Actuator Output (such as in the Advanced Settings area of this Actuator Settings screen and in the Output Value Monitor screen). By default, the number of decimal places of the Actuator Output of valves is set to 0. Allowable range for this parameter = 0 . . . 4.

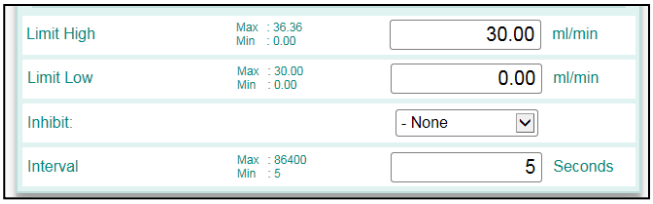
The **Actuator Type** setting is used to assign the actuator category. The dropdown list is opened by clicking on  . Select one of the options.



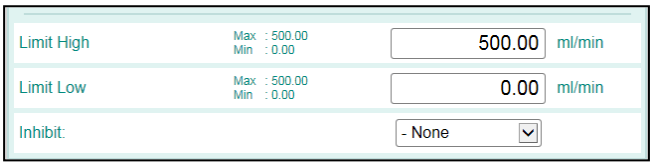
4.5.2 ACTUATOR LIMITS, INHIBIT AND INTERVAL

The lower section of the Actuator Settings screen contains the Actuator Limits, Inhibit and Interval definition.
The layout of this section of the Actuator Settings screen depends on the type of actuator.

Variable Speed Pumps
Available parameters:
- Low and High Actuator Limits,
- Inhibit actuator and
- Interval time.

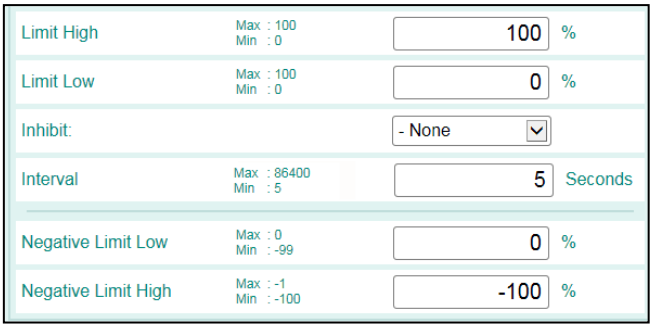


Gas Mass Flow Controllers:
Available parameters:
- Low and High Actuator Limits and
- Inhibit actuator.

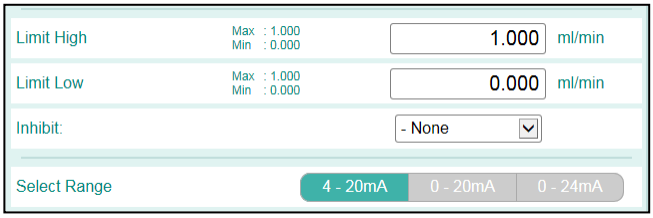


Thermo Circulator or Thermo Electric Element:
Available parameters:
- Low and High Actuator Limits,
- Inhibit actuator,
- Interval Time and
- Negative Low and High Actuator Limits.

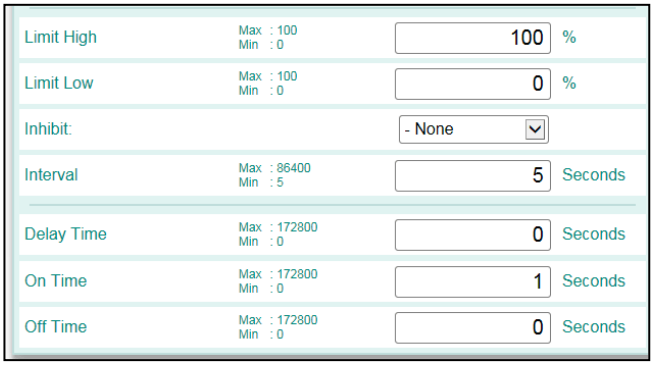
The Thermo Circulator and Thermo Electric Element are two-sided actuators (can heat up or cool down). Therefore, two additional (negative) limits are presented (related to downward control).



Analog Outputs:
Available parameters:
- Low and High Actuator Limits,
- Inhibit actuator and
- Actuator Output Range selection (4-20mA, 0-20mA or 0-24mA).

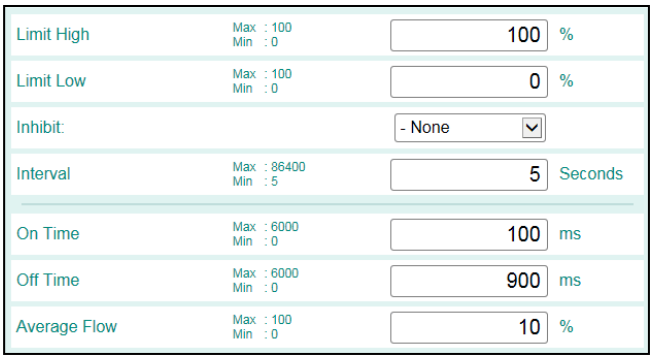


Gas Valves and Heating or Cooling actuators:
Available parameters:
- Low and High Actuator Limits,
- Inhibit actuator,
- Interval Time,
- Delay Time and
- On and Off Time (for Timer function).



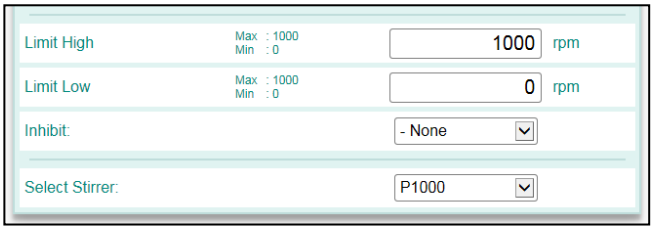
Micro (Liquid) Valves:
Available parameters:

- Low and High Actuator Limits,
- Inhibit actuator,
- Interval Time,
- On and Off Time and
- Flow.



Stirrer:
The Stirrer is a special analog actuator.
Available parameters:

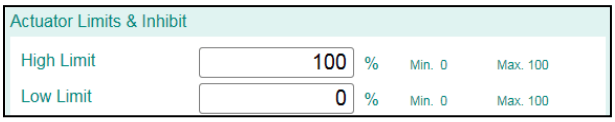
- Low and High Actuator Limits,
- Inhibit actuator and
- Stirrer type.



For a Stirrer that is configured as actuator in the dO_2 Control Loop, the Actuator Output Limits must be kept at their default values. Otherwise, the Actuator Output Limits will interfere with the settings for the Stirrer Speed Cascade Limits.

The parameters for the different actuator types are described in the sections below.

4.5.2.1 LOW AND HIGH ACTUATOR LIMITS



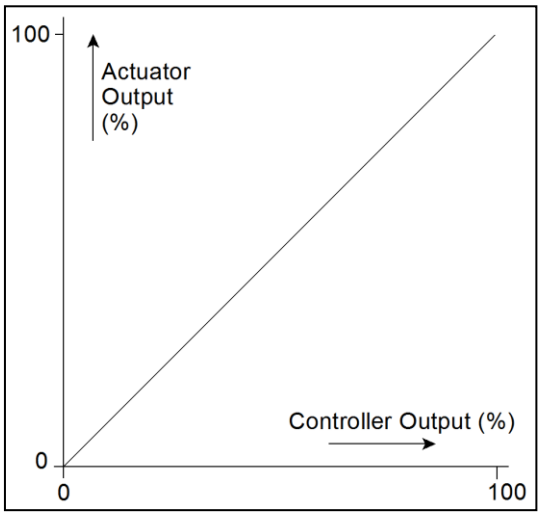
The Low and High Actuator Limits are values that correspond with 0 and 100% Controller Output.
Also refer to section 3.2.2 of the PID Control Manual.

When the Low and High Actuator Limit values are set to 0 and 100%, the Actuator Output range equals Control Output range.
In numbers:

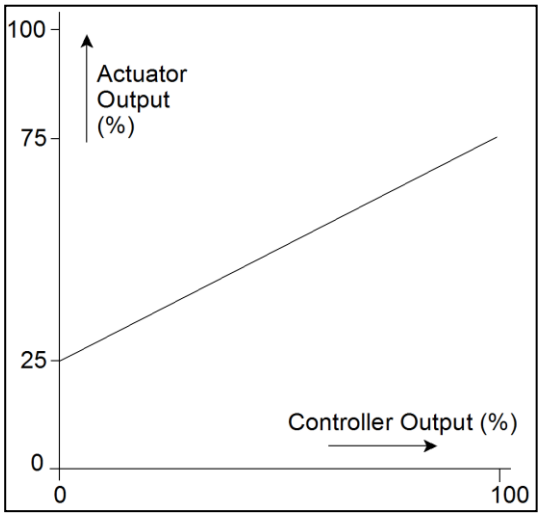
- 0% Controller Output = 0% Actuator Output
- (+/-) 100% Controller Output = 100% Actuator Output

The Low and Actuator High Limits are presented in the engineering unit that is specified in the HMI Settings part at the top of the screen.

The relation between Controller Output and Actuator Output, however, may be configured in a different manner by editing the Actuator Limits. See image below:



Limit Range 1:
Lower limit actuator output limit = 0%
Upper limit actuator output limit = 100%

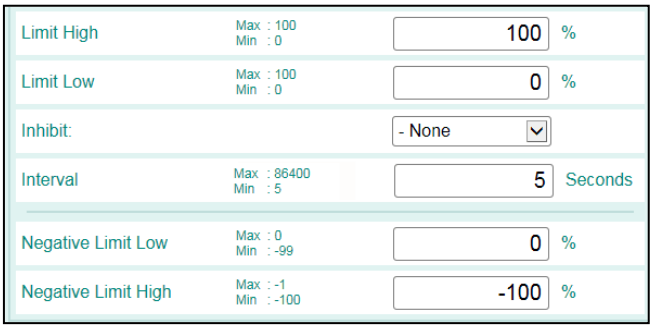


Limit Range 2:
Lower actuator output limit = 25%
Upper actuator output limit = 75%

Enter the new values for low and high limits and press the  button to save the entries.

Actuator Limits regarding Two-sided Actuators:
Two-sided actuators like the Thermo Circulator and the Thermo Electric Element (Heater / Cooler) have limits for both upward and downward control.

The Low and High Limits are used regarding upward control (heating). The Negative Low and High Limits are used regarding downward control (cooling).



4.5.2.2 INHIBIT ACTUATOR

Basically, the Inhibit assignment is a general function that is available for all actuators.
In practice, it is used to add a digital output to an analog output in such manner that the digital output is closed when the analog output value equals 0%.

Below, three application examples are described:

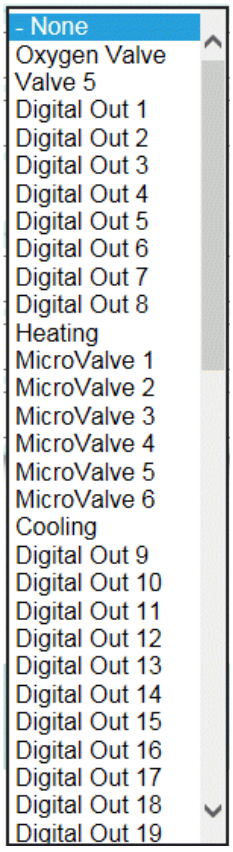
Example 1: Mass flow controllers may not be completely closed at 0% actuator output. Therefore, a digital output is used as Inhibit actuator for a mass flow controller. When the actuator output for the mass flow controller = 0%, the Inhibit actuator will close the corresponding gas inlet solenoid valve.

Example 2: Variable speed pumps that are connected to an analog output, may still have a small positive displacement at 0% actuator output. For this reason, a digital output is used as Inhibit to make sure that the pump is fully stopped.

Example 3: An external stirrer that is connected to an analog output may still turn very slowly at 0% actuator output. A digital output can be used as Inhibit to make sure that the external stirrer stops.

The Inhibit actuator can be assigned by clicking on the dropdown sign ( ). The list with available digital actuators / outputs will be presented (see the adjacent list image). Use the scroll bar to scroll through the actuator list and select one of the available outputs.

Press the button to save the selection.



4.5.2.3 ACTUATOR INTERVAL

The Output Interval parameter is used for digital (discrete) outputs (such as valves and fixed speed pumps). The interval is divided in proportional ON and an Off parts.

The default Interval setting = 5 sec.
Allowable Interval range: 5 . . .86400 sec.

For additional information regarding this parameter, refer to the PID Control Manual, section 3.2.1.

4.5.2.4 ANALOG OUTPUT RANGE SELECTION (ANALOG OUTPUTS ONLY)

Analog outputs have a standard output range of 4 – 20 mA.
This means that:

- 0 % Actuator Output corresponds with 4 mA and
- 100 % Actuator Output corresponds with 20 mA.

This standard range, however, may be changed to either 0 – 20 mA or 0 – 24 mA.
The standard output range can be changed by clicking one of the other two ranges in the selection bar.

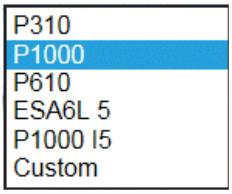
Press the  button to save the selection.

4.5.2.5 STIRRER TYPE SELECTION

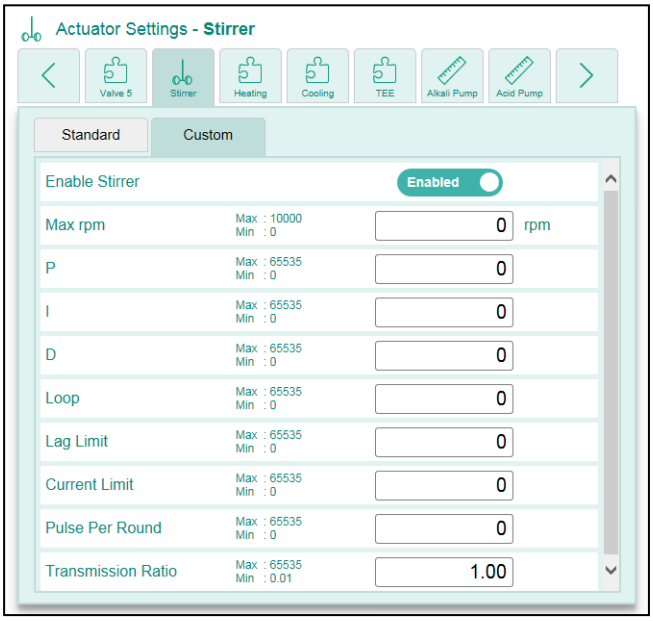
This section describes the selection of the analog Direct Current stirrer motor. If a stepper motor stirrer is used in combination with a MiniBio bioreactor, the stirrer motor selection option is not available.

The configured Stirrer Type may be selected by opening the dropdown list (click on ).

The dropdown list contains different specific options (depending on the installed power supply):



The dropdown list for the Stirrer Type also contains the option "Custom".
If the Custom option is selected, the Stirrer Settings screen will have an extra tab where the relevant settings can be entered. See image below.



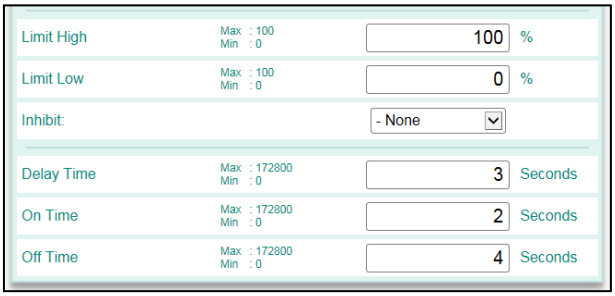
Finalize the customized stirrer definition by pressing the  button to save the selection.

4.5.3 FREE ACTUATOR CONFIGURATION (TIMER DEFINITION)

Digital (discrete) actuators and micro valves that are not configured in a control loop (indicated by an icon such as 

), can be configured as a (stand-alone) timer.

Delay Time, On and Off Times (digital outputs, valves and fixed speed pumps only):
When digital outputs, valves or fixed speed pumps are not used in a control loop, they can be used as independent outputs with a timer function.

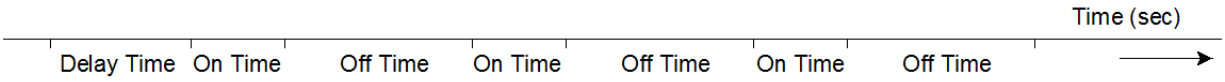


The timer function is defined by
- An Actuator Delay Time,
- An Actuator On Time and
- An Actuator Off Time.

Those intervals can be used to create a stand-alone **Timer** function in combination with **Manual Control** (

button).

The Timer is defined by a Delay time, an Off time and an On time. The Delay time only will elapse once.
Example of a timer with:
- Delay Time = 3 sec.
- On Time = 2 sec.
- Off Time = 4 sec.



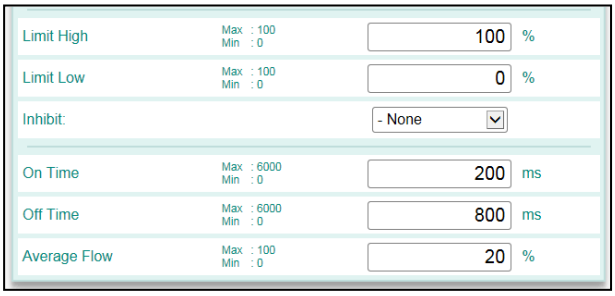
When both the Off time and the On time are > 0 sec., the Timer is defined.

The Timer can be started by starting the actuator manually (select the actuator and press the 

button in the Manual tab (
). The Timer is stopped by stopping the actuator manually (

button).
The Timer function can be disabled by resetting the Delay time and Actuator Off time to 0 sec.

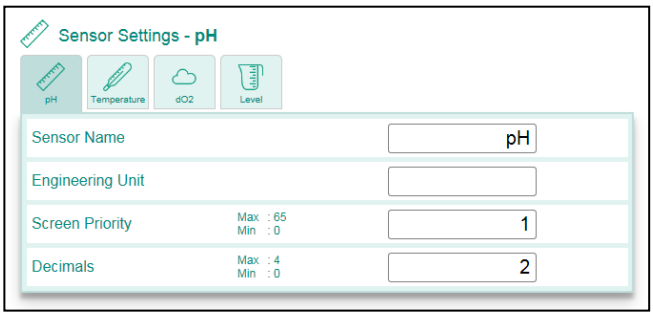
On/Off Times and Flow (micro valves only):
When micro valves are not used in a control loop, they can be used as independent outputs with a timer function (just like the Timer that is described above).



The On and Off times of the micro valve Timer can be defined, resulting in a relative flow (%):
The sum of On and Off time equals the Cycle Time.
The given Flow represents the ratio of On time and Cycle Time. The micro valve Timer can be used (started, stopped and disabled) in the same way as the Timer for digital outputs.

It is allowed to define a Timer function for an actuator that is assigned to a control loop. However, if the control loop is running, the timer function cannot be performed.

4.6 SENSORS



Click on the 

button to open the sensor screen The configured sensors are presented as tabs at the top of the screen.

Per sensor, the following data fields are presented:

- Displayed Name: when this data field is selected, the alpha-numeric keyboard can be used to enter a new sensor name.
- Engineering Unit: when this data field is selected, the alpha-numeric keyboard can be used to enter a new sensor engineering unit.
- Screen Priority: when this data field is selected, the numeric keypad can be used to enter a new screen priority number.
- Decimals: the process parameter value (in this example: pH) is presented with a preset number of decimals. The number of decimal places for each parameter can be set in the range of 0 . . 4.

The **Screen Priority** number of the sensor indicates the order of succession of the parameters in the configuration list. The default ranking of the parameters is presented in the table below:

Input Name	Priority Value	Input Name	Priority Value	Input Name	Priority Value
Stirrer	0	dO_2 LumiSens (optical)	26	Rocker (Scinus)	55
pH	1	PO_2 Hamilton (optical)	27	Roller(Scinus)	56
Temp	2	pH Hamilton	28	pH Mettler	57
dO_2	3	Balance 1 - 4	29 - 32	dO_2 Mettler	58
Level (1)	4	Aber Futura Biomass	33	dCO_2 Mettler	59
Level (2)	5	Digital Input 1 - 8	34 - 41	pH Smart Sensor*	60
Analog Input 1 - 8	6 - 13	Digital Input 9 - 16	42 - 49	dO_2 Smart Sensor*	61
Analog Input 9 - 16	14 -21	Pressure Switch	50	pH Sensor (SU)	62
pH Presens (optical)	22	Redox	51	dO_2 Sensor (SU)	63
dO_2 Presens (optical)	23	BugLab BE2100	52	Temp Sensor (SU)	64
pH Polestar (optical)	24	BugLab BE3000	53	Turbidity Sensor (SU)	65
dO_2 Polestar (optical)	25	Conductivity Aber Futura	54		

*The presented pH and dO2 Smart Sensor positions are reserved for future use.

Depending on the sensor type, additional settings may be presented:

- Foam / level: the Sensor Settings are used to discriminate between Level and Foam and to select the sensitivity (low or high).
- dO_2: the Sensor Settings are used to discriminate between saturation with air or with oxygen (100% air saturation equals 20% oxygen saturation) and to enable or disable the Temperature Compensation on the sensor signal. Also the options Sample Correction and Dead Band (as parameters in the control loop settings) can be enabled.
- Analog inputs: the Sensor Settings are used to enable the options Sample Correction and Dead Band.
- Optical pH and dO_2 sensors: the Sensor Settings are used to set the calibration data for the Optic Sensor patches.

- Balances: the Sensor Settings are used to define the sensor tag, to enable Sample Correction or to enable the Dead Band as parameter in the control loop.
- Biomass Monitors: the Sensor Settings are used to set sensor specific parameters.
- For information concerning the Rocker and Roller settings, refer to their dedicated manuals.

The Optical pH and dO_2 sensors, the Balances for Feed Control and Biomass Monitors are USB sensors that have their own User Manuals. For more and specific data concerning these inputs, refer to the corresponding User Manual.

Editing the amount of **Decimal** places is used to customize the presentation of the process parameters.
The image below show an example of the presentation of the measured temperature with one and two decimals:

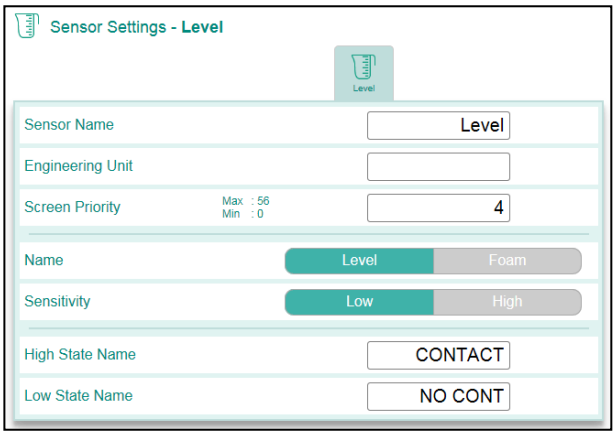
For the Decimal parameter setting = 1:

For the Decimal parameter setting = 2:

The specific settings for the Foam / Level sensor, dO_2 sensor and an Analog Input are described in the section below.

4.6.1 LEVEL/FOAM SENSOR SETTINGS

The Level sensor is either used for level or foam detection.
Sometimes, a detected contact between sensor and medium means that the perfusion or harvest pump must be started. In other applications, losing contact between sensor and medium means that the feed pump must be started.
If foam detection is configured, detection of foam means that the antifoam pump must be started.



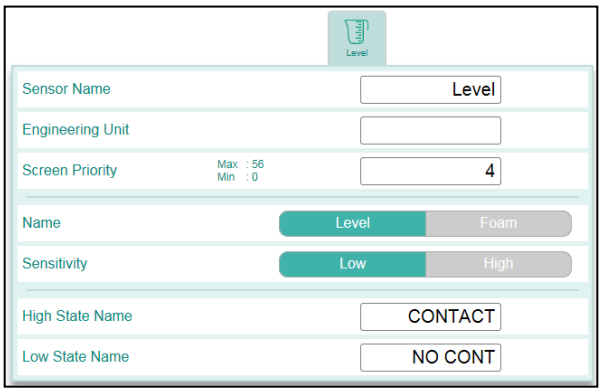
The additional HMI Settings for the Level / Foam Sensor consist of:

- The Sensor Name: Level or Foam and
- The Sensitivity: Low or High.

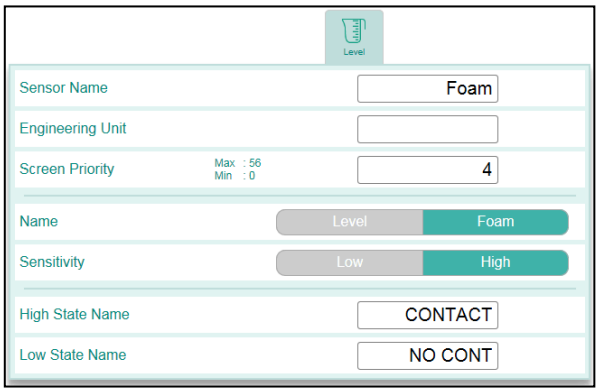
Control loop name:
By default, the name of the control loop is set to Level. Click on the Foam button to change the name to Foam.

Sensitivity:
The default sensitivity (for level detection) is Low (the medium in the bioreactor contains enough salts to ensure high conductivity; therefore, low sensitivity of the level sensor is preferred).
For foam detection, it is advised to select high sensitivity. Press the High button to change the setting.

Advised settings for the Level / Foam sensor:



Settings for Level sensing

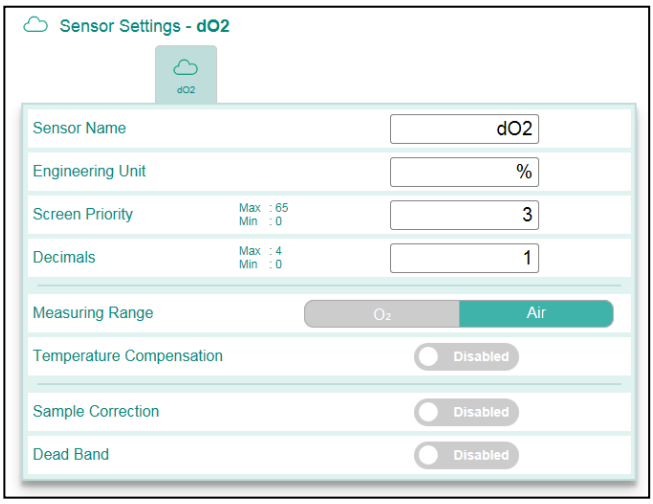


Settings for Foam sensing

- The required situation (“Contact” or “No Contact”) for the Level / Foam Control loop is determined while configuring the control loop. Refer to section 4.4.3.
- The names for the High and Low State of the Level or Foam sensor (default names are CONTACT and NO CONT) can be edited by selecting the name field and typing a new name.

4.6.2 DISSOLVED OXYGEN SENSOR SETTINGS

For the Dissolved Oxygen sensor, the following additional settings are presented:



The **measuring range** (oxygen or air):
If Air is selected as measuring range, the sensor calibration must be performed using air saturation. The dO_2 value will be expressed in % air saturation.
If O_2 is selected as measuring range, the sensor calibration is performed using O_2 saturation. The dO_2 value will be expressed in % O_2 saturation.

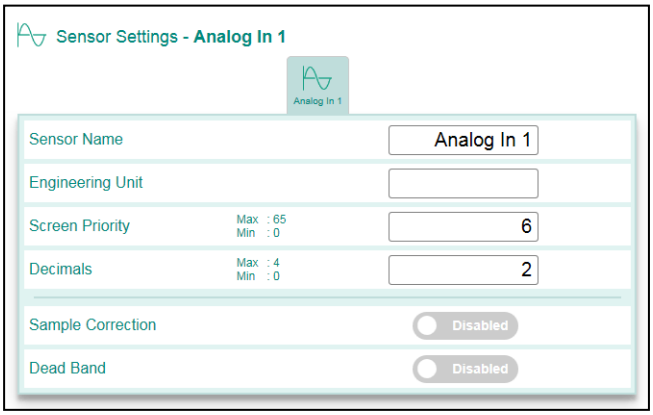
The **Temperature Compensation** capability can be enabled or disabled.
By default, the Temperature Compensation is Disabled. It can be enabled by pressing this button (it will turn green: Enabled). The measured dO_2 value depends on the medium temperature (temperature changes of the medium affect both the gas solubility of the medium and the sensor sensitivity).
However, when the sensor calibration and measurements are both carried out at the same process temperature, the Temperature Compensation option can remain disabled.

The **Sample Correction** option can be enabled to correct the measured dO_2 value during the process. By default, the Sample Correction option has been switched off (Disabled).
The Sample Correction option for the dO_2 sensor affects the sensor sensitivity (slope); the dO_2 sensor offset remains unchanged.
Note: The Sample Correction function allows adjustment of the measured value based on a reference measurement, e.g. an off-line measured dO_2 value. However, since the environmental conditions (temperature, pressure and dO_2 concentration in air) are different than the process conditions, an off-line dO2 measurement will probably be less accurate than the measured process value.

Enabling the **Dead Band** option affects the control algorithm. It is used to define a range around set point without actuator activity.
The Dead Band is a standard parameter of the pH Controller, but it can also be activated for dO_2 control.
By default, the Dead Band parameter for dO_2 Control has been Disabled. It can be enabled by pressing this button (it will turn green: Enabled).
For more information concerning this option, refer to the PID Control Manual, section 2.2: Control Parameters.

4.6.3 ANALOG INPUT SETTINGS

Analog Inputs are used to connect external devices to the Applikon controller.
In this way, additional control loops can be defined.



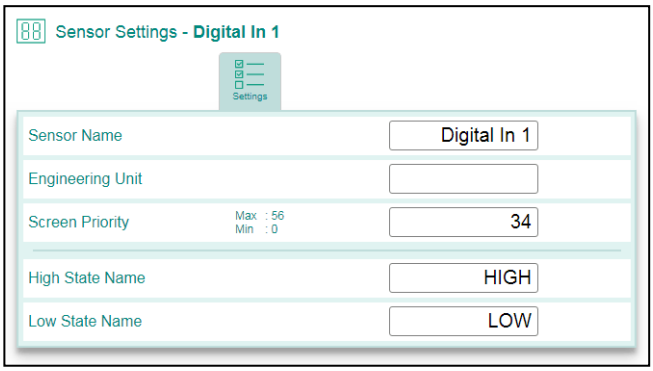
The **Sample Correction** option can be enabled to correct the measured input value during the process. By default, the Sample Correction option has been Disabled.
For more information concerning this option, refer to section 5.2.2 (Sample Correction Option) of this document.

Enabling the **Dead Band** option affects the control algorithm. It is used to define a range around set point without actuator activity.
The Dead Band is a standard parameter for the pH Controller, but it can also be activated for Analog Input control.
By default, the Dead Band parameter for Analog Input Control has been Disabled. It can be enabled by pressing this button (it will turn green: Enabled).
For more information concerning this option, refer to the PID Control Manual, section 2.2: Control Parameters.

4.6.4 DIGITAL INPUT SETTINGS

Digital Inputs are used to connect external devices to the Applikon controller.
In this way, the status of an external device or process can be recorded.

The names for the High and Low State of the digital inputs (default names are HIGH and LOW) can be edited by selecting the name field and typing a new name.



4.7 TREND DISPLAY

When the 

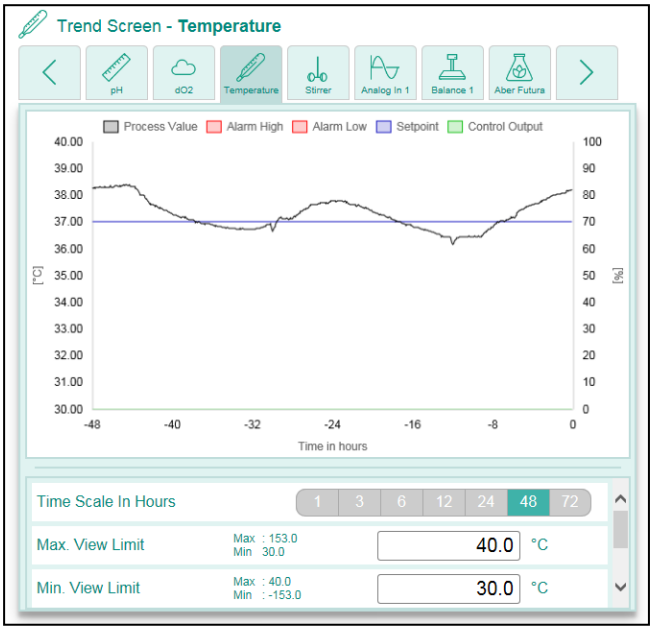
button is pressed, the Trend screen will be displayed.

In this example, the Trend screen for Temperature is presented (Setpoint and Process Value only).

The Trend screen has two Y-axes, one at the left side (for the Process Value, ºC) and one at the right (for the Controller Output, %).

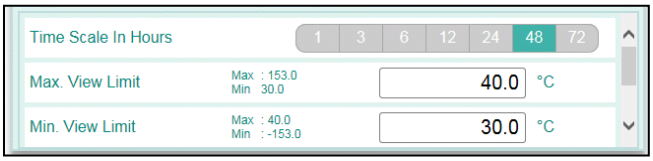
The X-axis consists of a Time Span in hours.

In the screen area below the Trend, the Time Scale (in hours) can be selected (between 1 and 72 hours):

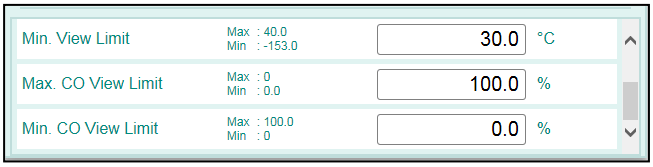


The lower and upper range value for these Y-axes can be defined at the area below the Trend:

Below the Time Scale selection bar, the Minimum and Maximum range values for the temperature can be defined.



By moving the Scroll bar downward, the Minimum and Maximum range values for the Controller Output (%) can be defined.



After editing the selection, the  button can be used to save the new settings.

In the Trend, the following color code is used:
Black line = Process value,
Blue line = Setpoint value,
Red lines = Lower and Upper Alarm Limit values,
Green line = Controller Output value.

4.8 TOTAL GAS FLOW CONTROL

In most cases, the number of gases that are used in biotechnology is limited to four:
- Nitrogen gas for downward dO_2 control,
- Air for upward dO_2 control,
- Oxygen gas for upward dO_2 control and
- Carbon dioxide gas for downward pH control.

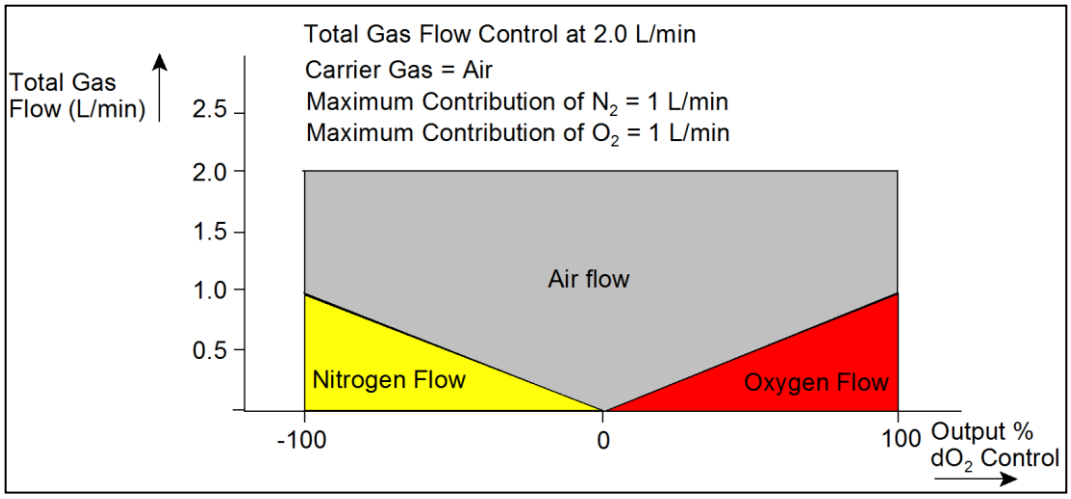
During fermentation or cultivation, the required flow of the different gases to keep the process conditions at setpoint will vary. However, to keep the aeration of the bioreactor at a constant level (to maintain a reproducible amount of shear), it may be necessary to control the total gas flow.
For this reason, the Total Gas Flow Control option has been established.

Total Gas Flow control can be used in addition to other control loops (like pH, dO_2 and temperature control).
To the control loop, a carrier gas (like air) and one or more additional gases are assigned.

Practical options and limitations for the number of assigned mass flow controllers:

- Four Mass Flow Controllers and corresponding gas solenoid valves can be installed inside the my-Control (e.g. for N_2, air, O_2 and CO_2 like in the example above)
- The software, however, is capable of handling actuator configurations with eight mass flow controllers and gas solenoid valves. The extra MFCs and valves must be mounted externally.

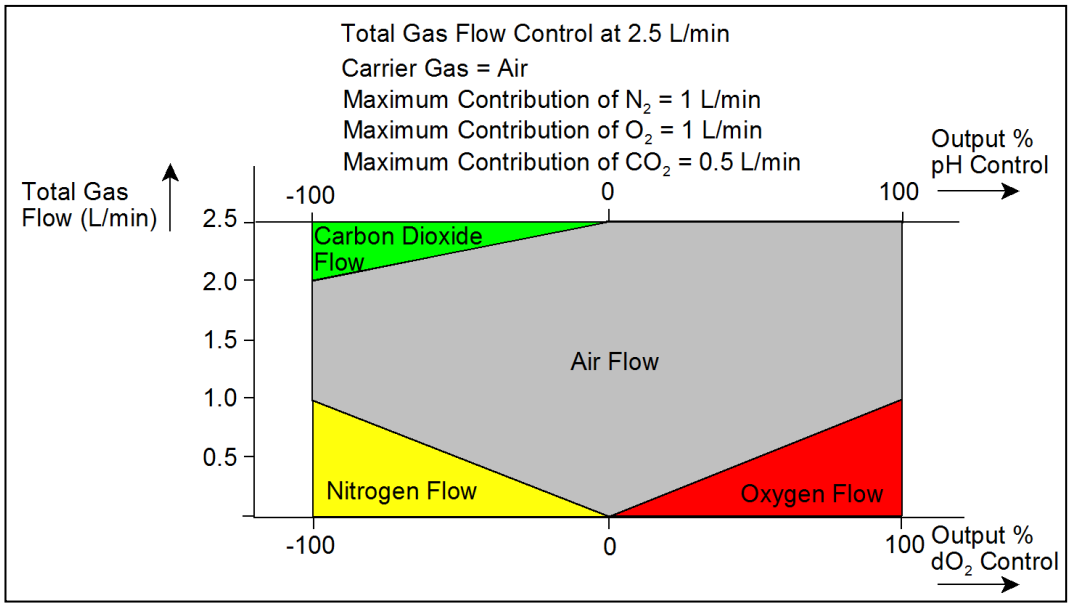
Graphical example of the combination of dO_2 control and Total Gas Flow control:
Equipment setup:
- Total Gas Flow Setpoint = 2 L/min
- When the Process Value equals Setpoint, the output of the dO_2 controller = 0% (no nitrogen or oxygen is supplied; the supplied gas consists of air only).
- When the Process Value > Setpoint, the output of the dO_2 controller is < 0% and air is partly replaced by nitrogen gas; maximum nitrogen flow = 1 L/min.
- When the Process Value < Setpoint, the output of the dO_2 controller is > 0% and air is partly replaced by oxygen; maximum oxygen flow = 1 L/min.



On the next page an example is given of a combination of pH and dO_2 control with Total Gas Flow control.

Graphical example of the combination of pH and dO_2 control with Total Gas Flow control:
The previous example is extended with pH control. The CO_2 mass flow controller has been assigned as actuator for downward pH control.
The total gas flow setpoint = 2.5 L/min.
The diagram below has two different X-axes:

- The controller output of the dO_2 control loop is presented as standard X-axis
- The controller output of the pH control loop is presented at the top of the diagram.



4.8.1 CONFIGURING A TOTAL GAS FLOW CONTROL LOOP

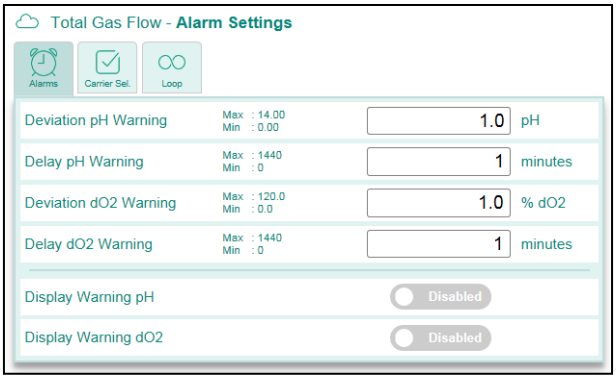
The Total Gas Flow control option requires mass flow controllers in the gas supply lines. Valves or any other gas supply cannot be used.

Before configuring a Total Gas Flow control loop, it is advised to verify all the Mass Flow Controller use the same engineering unit (e.g. L/min or mL/min). Open the MFC Settings screens for the individual MFCs and check the set Engineering Unit (refer to section 4.5.1).

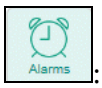
Before configuring a Total Gas Flow control loop, it is advised to verify if the Mass Flow Controller flow range has been set to the proper value. Open the Dose Monitor Settings screens for the individual MFCs and check the Current Factor value (refer to section 5.3.1).

Click on the 

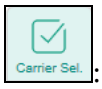
button to open the Gas Flow Configuration window.



At the top of this window, three tabs are available:



: Alarm Settings tab (see section 4.8.4),



: Carrier Selection tab (see section 4.8.2) and

: Loop Configuration tab (see section 4.8.3).

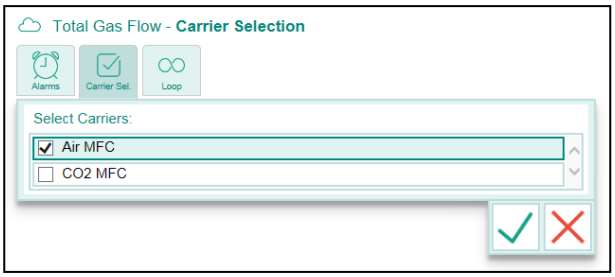
The different Gas Flow Configuration screens are described in the sections below.

4.8.2 SELECTING A CARRIER GAS

The first step in the Total Gas Flow configuration process is selecting the carrier gas.

Press the 

tab to open the Carrier Selection window.



The available Mass Flow Controllers (that are not configured in a control loop) are presented in the Carrier Selection screen.

Click on one of the Mass Flow Controllers (in most cases the MFC for air) to select its gas as carrier.

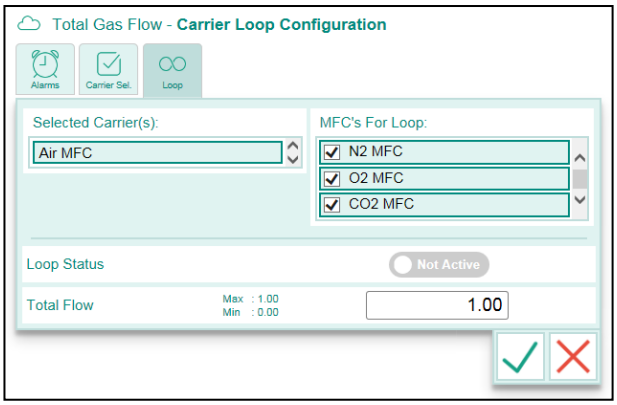
Click on the  button to save the selection.


Each selected Carrier Gas represents a Total Gas Flow Control loop. By selecting more than one carrier gas in the Carrier Selection window, different gas flow control loops can be configured and be run at the same time.

4.8.3 CONFIGURING THE TOTAL GAS FLOW CONTROL LOOP

Select the 

tab in the Gas Flow Configuration window.
The created Total Gas Flow Control loop with air as carrier gas is presented in the list of Selected Carriers (left hand side column).



If more than one carrier gas (more than one control loop) has been defined, the left hand side column will contain more than one item. The defined control loops can be setup by selecting the corresponding carrier gas.

In this example, only one Total Gas Flow Control loop has been defined (with air as carrier gas). Three other MFCs have been selected to be part of the loop.

In order to be able to activate the Total Gas Flow control loop, a valid Total Flow setpoint value needs to be set.

A valid Flow setpoint is defined as follow:

- The minimum Flow value is equal to the sum of the maximum flows of all assigned MFCs
- The maximum Flow value is equal to the maximum flow of the carrier MFC

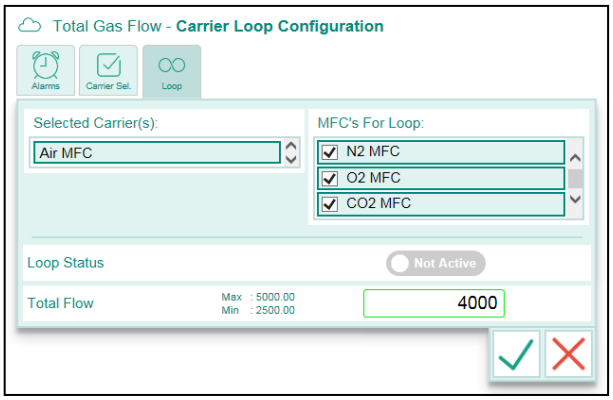
Note that actuator limits will be taken into account, when the assigned MFC is configured to a regular control loop (e.g. pH, dO2).

For example, when we have the following MFCs configured for a Total Gas Flow control loop:

Air, as carrier:	5000 mL/min
N2, assigned to dO2 control loop:	1000 mL/min
O2, assigned to dO2 control loop:	1000 mL/min
CO2, assigned to pH control loop:	1000 mL/min, limited to 500mL/min by actuator limit

In this case the flow setpoint has to be at least 2500mL/min (sum of 1000mL/min N2, 1000mL/min O2 and 500mL/min CO2) and can be maximum 5000mL/min (flow capacity of the carrier gas).

At the bottom of the window, the setpoint value for the Total Gas Flow Control loop can be inserted (e.g. 4000 ml/min).



As soon as the Total Gas Flow Control loop has been defined and the setpoint value has been saved by pressing the  button, the loop can be started by pressing the

button (as a result, it will turn green: 

).

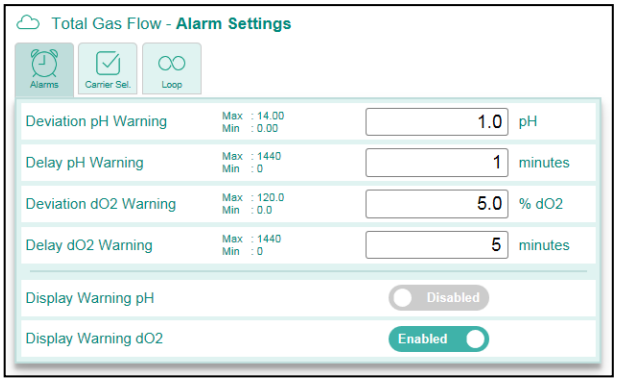
4.8.4 TOTAL GAS FLOW CONTROL WARNINGS

Gas flows that are realized because of Total Gas Flow control may cause the pH or dO2 Process Value to drift away from setpoint. Therefore a warning procedure concerning a possible conflict between the dO_2 or pH control loops and the Total Gas Flow control loop is established. These warnings can be configured at the Total Gas Flow configuration window.

Press the Alarm Settings (

) tab in order to enable / disable Alarm messages that are related to Total Gas Flow control.

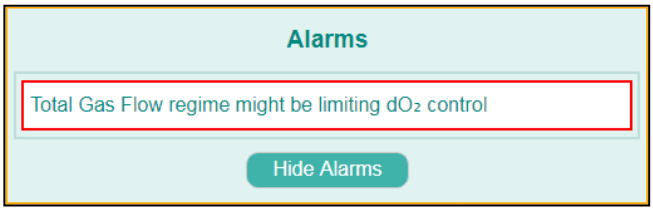
Press the Disabled button to enable the corresponding Display Warning; the toggle button will turn green (Enabled).
Changing the Display Warning status needs to be saved by pressing the  button.



Conditions for the Display Warning regarding dO_2:

- Display Warning dO_2 has been enabled and
- Both dO_2 control and Total Gas Flow control are running and the difference between Process Value and Setpoint remains larger than the allowed deviation for more than the defined time.

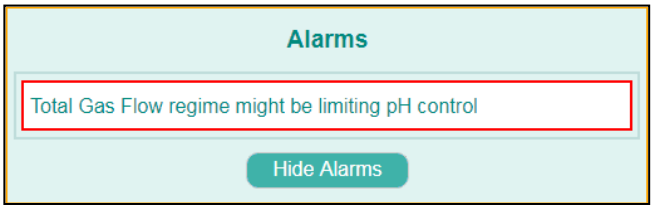
When both conditions have been fulfilled, the adjacent message will be displayed:
This message can be hidden by pressing the Hide Alarms button (the Alarm status remains unchanged).



Conditions for the Display Warning regarding pH:

- Display Warning pH has been enabled and
- Both pH control and Total Gas Flow control are running and the difference between Process Value and Setpoint remains larger than the allowed deviation for more than the defined time.

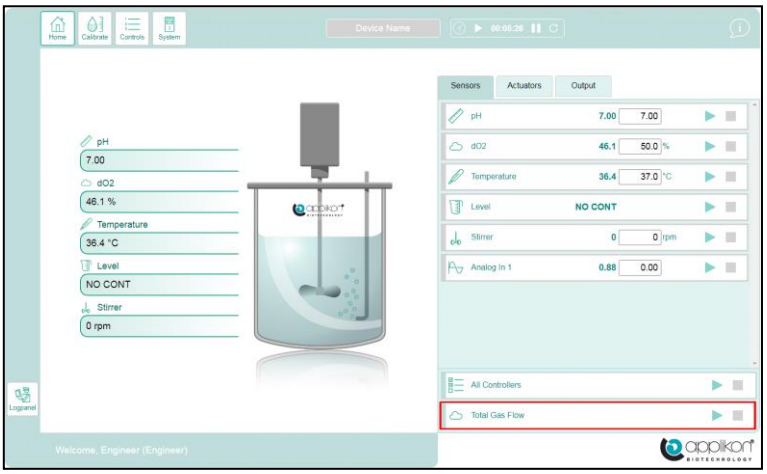
When both conditions have been fulfilled, the adjacent message will be displayed:
This message can be hidden by pressing the Hide Alarms button (the Alarm status remains unchanged).



The warning regarding an assumed conflict between Total Gas Flow and pH control may be misleading (e.g. when the Total Gas Flow configuration does not contain CO_2). In this case, the warning for the pH control loop can be disabled.

4.8.5 STARTING AND STOPPING TOTAL GAS FLOW CONTROL

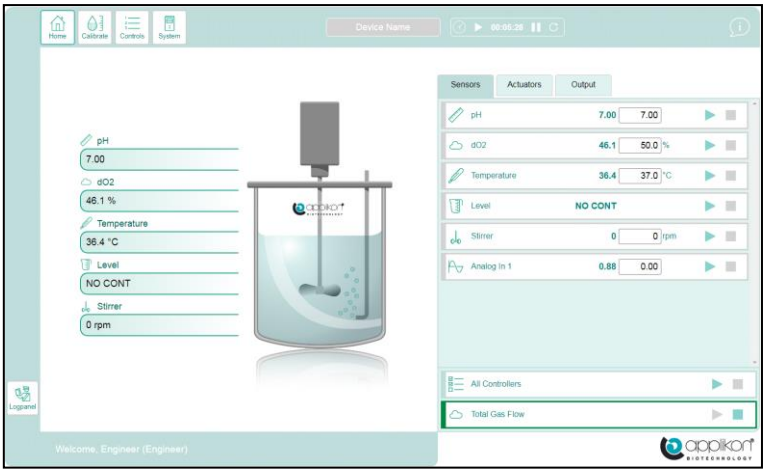
After completing the Total Gas Flow control loop configuration, return to the Home screen.
Total Gas Flow Control can be started by pressing the  button in the corresponding area at the lower right corner of the screen.



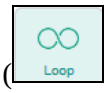
In the presented image, the Total Gas Flow area is indicated by a red rectangle.

Pressing the  button will start all configured Total Gas Flow Control loops at the same time.

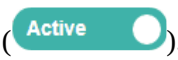
When starting the Total Gas Flow Control loop(s), the corresponding area is highlighted with a green banner and the  button is greyed out (), while the Stop button () is activated.



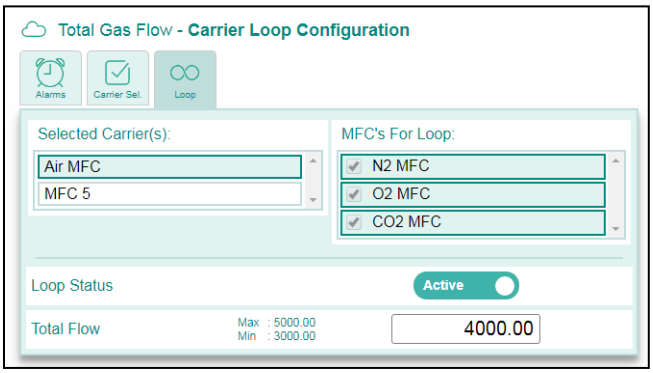
If more than one Total Gas Flow Control loop has been defined, the loops can also be started or stopped individually.

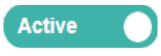
Open the Gas Flow Configuration window (

tab).
Select one of the configured carriers.
The corresponding Total Gas Flow Control loop can be started individually by pressing the Press the

button. This toggle button will turn green (

). Press the  button to confirm the activation and the loop will be started.



Individual Total Gas Flow Control loops can be stopped by pressing the 

button followed by the  button to save. The button will turn grey (

).

5 CALIBRATION

The Calibration menu is accessed through the 

button and it contains the following sub-buttons:

The 

button initiates Sensor calibration

The 

button initiates Actuator Factor calibration

5.1 SENSOR (INPUT) CALIBRATION; THEORETICAL BACKGROUND

Sensor or Input calibration is a way to standardize measured Process Parameter values.
This is achieved by measuring "conditioned samples" such as pH-buffers for calibration of the pH sensor.
In this way, per input a 1-point or 2-point calibration is performed, resulting in a value for:

- Offset: deviation from 0
- Slope: sensitivity or gain of the sensor (input)

In this section, some background information is given.

5.1.1 PH-SENSOR CALIBRATION

A pH-sensor is normally calibrated with two buffer solutions of pH=7.00 and pH=4.00. These buffer solutions are commercially available.

It is not advised to us a buffer solution of pH=9, since alkaline solutions are less stable and less accurate (larger temperature dependency)!

The pH sensor is measuring a mV-signal that is converted to the pH unit:

$$pH = 7.\overline{00} - \frac{mV}{U_N}$$

where: pH = the measured value expressed in pH
mV = the measured value expressed in mV
U_N = the Nernst Potential (temperature dependent constant)

$$U_N = 0.1984 \times (273.16 + t)$$

where: t = the (buffer) temperature in ^oC

The Nernst Potential U_N is also called the Theoretical Sensitivity of the sensor. By dividing the real sensor sensitivity by the Theoretical Sensitivity U_N, the Slope of the sensor is calculated

A 2-point pH sensor calibration results in:
Offset value: the difference between the mV reading at pH=7 and 0mV, converted to a pH value
Slope value: real sensor sensitivity divided by the Nernst Potential at the given temperature
Expected Offset value: $< \pm$ 0.30 pH
Expected Slope value: 0.95 . . . 1.05

A 1-point calibration must be performed with buffer pH=7.00 and will only deliver an Offset (slope value = 1.00).

pH sensor calibration is performed before the bioreactor is autoclaved (autoclaving does not influence the sensitivity of the sensor). Refer to section 5.2.3.

5.1.2 TEMPERATURE-SENSOR CALIBRATION

Temperature measurements are carried out using a Pt-100 sensor.
A Pt-100 sensor is based on a temperature sensitive resistor. The sensitivity of this sensor is defined in International Standards (such as IEC/DIN/EN 751). The Pt-100 sensors of Applikon Biotechnology comply with these standards (accuracy = 1/3 DIN).

Consequently, for the temperature sensor only a 1-point calibration has to be performed to correct for any specific deviations in the sensor setup.
Calibration frequency: once every 3 months . . . once a year.

Procedure:
Prepare a beaker with ice-water (fill a beaker of 250-500 ml beaker with ice cubes and add 50 ml of water to facilitate heat transfer). Add a stirrer bar to the beaker and stir for approx. 15 minutes. The aqueous solution will be cooled down to 0 °C. Insert the temperature sensor in the solution and calibrate it. It will deliver an Offset value. Expected Offset value: $< \pm 0.8$ °C.
Refer to section 5.2.4 (Calibrating the Temperature Sensor).

5.1.3 dO_2-SENSOR CALIBRATION

The dissolved oxygen concentration is measured by a sensor that uses the Clark-cell principle (oxygen passes a gas permeable PTFE membrane and is reduced at the Pt-cathode of the polarographic cell).
The reduction reaction consumes electrons that are measured as a current in the cell (nA).

Since the polarographic cell does not supply any current at 0% dO_2, the dO_2-sensor calibration is normally performed as a 1-point calibration of the slope (quasi 2-point calibration, assuming that the first calibration point (0% dO_2) corresponds with 0 nA).
The normal procedure is to autoclave the reactor and fill it with sterile medium. Let the bioreactor condition at process temperature while it is sufficiently aerated for at least 15 minutes.

The solubility of gas in aqueous solutions depends on both its temperature and salinity. Therefore it is important that the reactor remains stable at the process temperature.

The sensor behaviour will become less ideal over time. Therefore it is advised not only to perform a 1-point calibration of the dO_2-sensor, but also to verify the 0% reading after performing the calibration. This is achieved by purging the reactor with nitrogen for at least 15 minutes (other process conditions are still maintained). All dissolved oxygen will be driven out of the medium. The actual reading of the calibrated dO_2 sensor must decrease to < 0.5 % dO_2. If the dO_2-reading does not drop that far, the sensor needs maintenance before the next fermentation run is started (refer to the sensor manual that comes with it).

The dO_2-sensor calibration will deliver a Slope value.
Expected Slope value: 2.0 . . 4.0 at 25 °C
1.5 . . 3.0 at 37 °C
Refer to section 5.2.5 (Calibrating the dO_2 Sensor)

5.1.4 LEVEL/FOAM-SENSOR CALIBRATION

The level/foam sensor calibration differs from the other types of sensors. It does not measure concentration in any way; it only detects contact.
Sensitivity selection (foam) is therefore the only calibration action. Refer to section 4.6.1 (Level/Foam Sensor Settings).

5.1.5 STIRRER SPEED CALIBRATION

The stirrer speed is digitally communicated by the motor encoder as a feedback signal. This input signal does not need any calibration.

5.1.6 ADDITIONAL ANALOG (0-10VDC) INPUTS

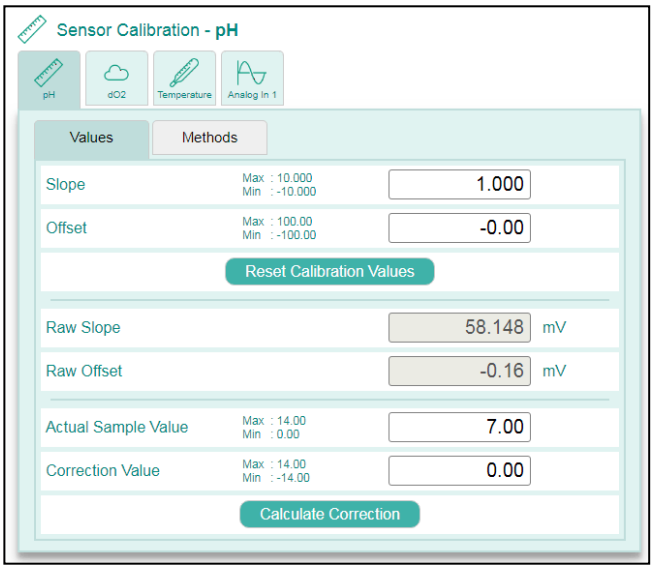
Third party devices, with an output range of 0 – 10 VDC, can be connected to an analog input of the ***my***-Control. The analog inputs can be defined as additional control loop.
Calibrating the analog inputs is performed using a Volt-simulator (2-point calibration).
Connect the simulator to the input and generate a 1.00 VDC signal. This value corresponds with 10% of the measuring range of the connected device.
Generate a 9.00VDC signal. This value corresponds with 90% of the measuring range of the connected device.
Refer to section 5.2.8 (Calibrating an Analog Input).
This type of calibration is normally performed once in the lifetime of the measuring setup!

5.2 SENSOR CALIBRATION ROUTINE

The sensor calibration routine of the controller consists of a standard algorithm for all sensor types.

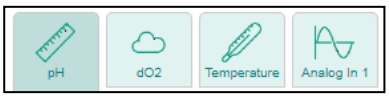
When a calibration routine is activated, other functions of the controller are still enabled. If necessary, calibration routines for different sensors can be run simultaneously.

Press the Sensors button to enter the Sensor Calibration window (pH sensor).



At the top of the presented window, the configured sensors are presented in tabs.

In this example, the following tabs are displayed:



- pH (selected, indicated by a darker background),
- Dissolved oxygen,
- Temperature and
- An Analog Input

Per selected Sensor, two different tabs are available for calibration data and performing the sensor calibration. The table below describes the different tabs.

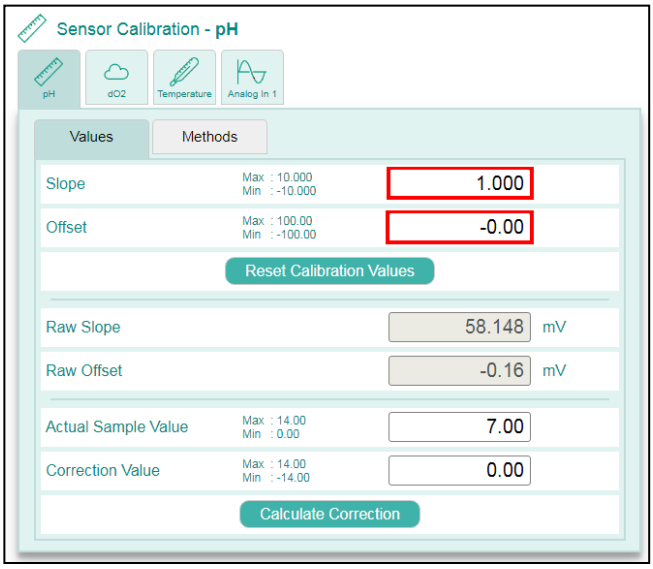
Calibration Tab	Description
Values	Presents the current calibration data (values for Slope and Offset) and Sample Correction* information.
Methods	Enables the execution of the 1-point or 2-point Sensor Calibration by pressing the corresponding Start button.

*The Sample Correction option is available for the pH sensor. The Sample Correction option can optionally be enabled for the dO_2 sensor and for the Analog Inputs.

The way of presenting the calibration data depends on the sensor type. In the case of the pH and dO_2 sensors, the calibration values for offset and slope are also displayed as raw values. For other sensors, the calibration values are only displayed in calibrated units:

- pH sensor: raw value is displayed in mV/pH (slope) and mV (offset)
- dO_2 sensor: raw value is displayed in nA/% (slope) and nA (offset)
- Other sensors: no raw value is displayed

5.2.1 ENTERING VALUES FOR SLOPE AND OFFSET



If the calibration values are known (e.g. from a previous calibration), the values for Slope and Offset can be entered manually.

Select the Values tab, click in the value field for respectively Slope or Offset and enter a new value using the numeric keypad.

Press the  button to confirm the changes.

The entered values for Slope and Offset can be reset to 1.000 and 0.00 respectively by pressing the Reset Calibration Values button.

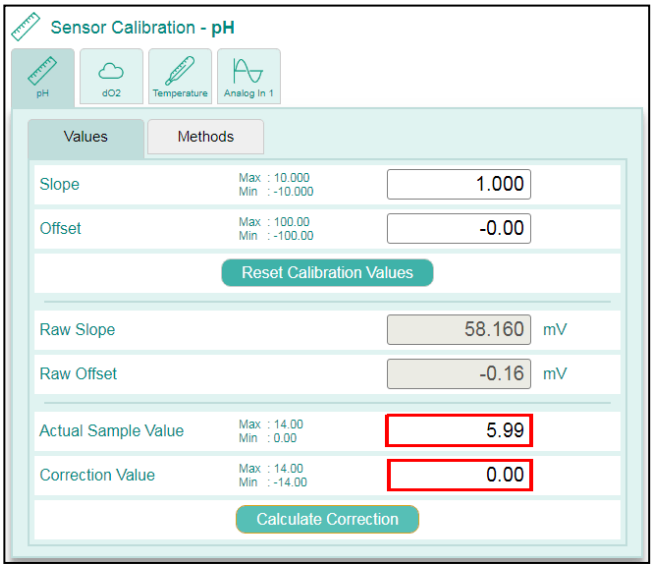
5.2.2 SAMPLE CORRECTION OPTION

The Sample Correction option is mostly used for pH measurements. This function can also be enabled for the dO_2 Sensor and any Analog Inputs. This section describes the Sample Correction option for pH. For other sensors or inputs, the option is similar.

During the cultivation, the Sample Correction option is used to correct the on-line measured pH value with data from off-line pH measurements in samples. Only the current offset is corrected by entering the off-line measured value.

Off-line measurement of the acidity of a sample of the culture must be carried out under strict conditions:

- pH measurement in the sample must be carried out directly after sampling: any CO_2 or NH_3 that escapes from the sample will cause the current pH value of the sample to change.
- off-line pH measurement must be carried out at process temperature: changes in temperature of the sample will introduce measuring errors (caused by a shift in the equilibrium between H_3O^+ and its salt form).



The Sample Correction can either be performed:

- By entering the off-line measured value at the “Actual Sample Value” field or
- By entering the difference between on-line and off-line measured values at the “Sample Correction Value” field.

By pressing the Calculate Correction button, the correction is enabled.

Press the  button to save the correction.

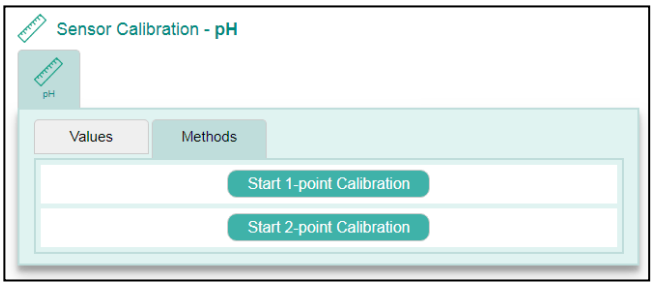
For the dO_2 Sensor and the Analog Inputs, the Sample Correction option can be enabled in the Sensor Settings screen.

5.2.3 CALIBRATING THE pH SENSOR

The pH sensor is normally calibrated before it is mounted in the bioreactor.
It is advised to calibrate the sensor with two buffer solutions (pH = 7.00 and pH = 4.00). This means that a 2 point calibration is performed. The sequence of the buffer solutions is not relevant. It does not matter if buffer pH 4 is used as first or second buffer solution.

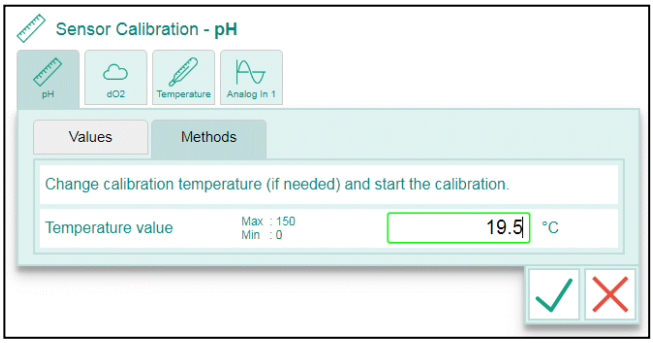
Step 1:
Open the pH Sensor Calibration window and select the Methods tab.

Press the Start 2-point Calibration button.

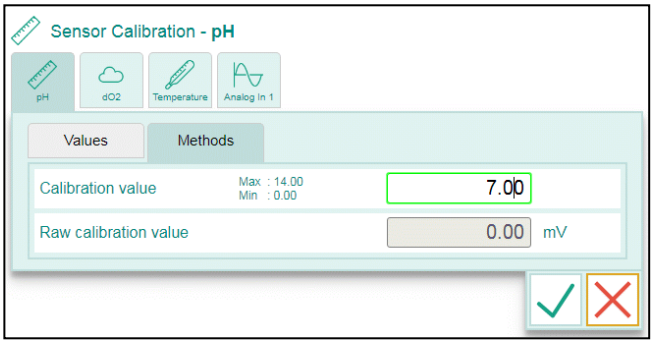


Step 2:
Enter the temperature of the first buffer solution. The readings of the pH sensor are temperature dependent. Therefore, the temperature of the buffer solutions must be entered.

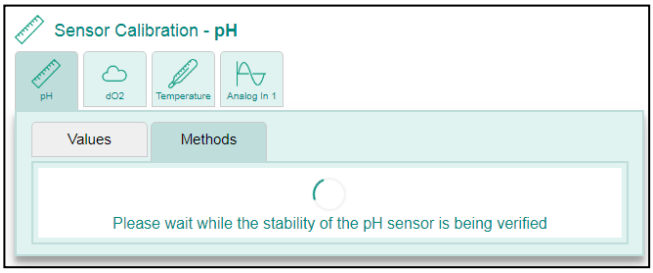
Type the numeric temperature value in the presented data field and press the ✓ button.



Step 3:
Enter the pH value of the first buffer solution (e.g. 7.00).
Rinse the pH sensor and carefully wipe it dry (do not rub). Immerse the pH sensor in the first buffer solution.
Type the numeric pH value of the first buffer solution in the presented data field and press the ✓ button.

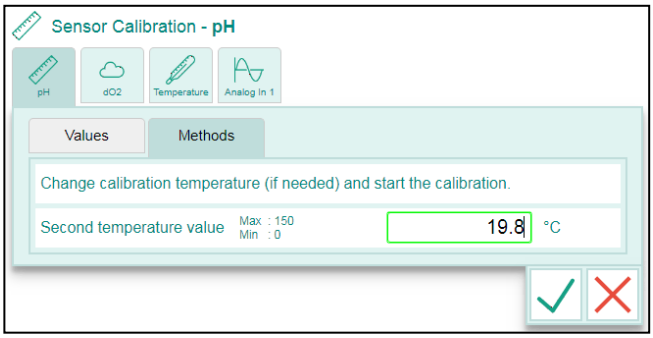


The sensor value will now be monitored to verify the stability.
As soon as a stable value has been obtained, the calibration routine will be resumed.

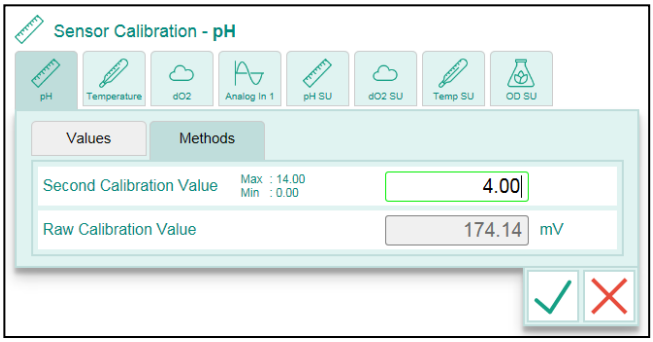


Step 4:
Enter the temperature of the second buffer solution.

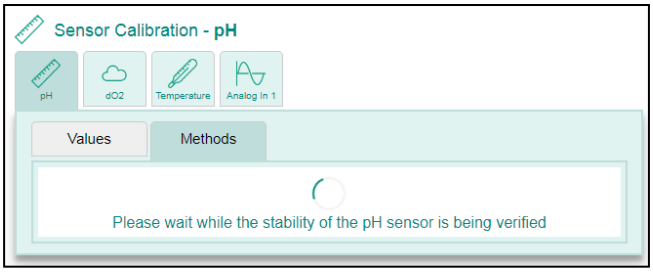
Type the numeric temperature value in the presented data field and press the ✓ button.



Step 5:
Enter the pH value of the second buffer solution (e.g. 4.00).
Rinse the pH sensor and carefully wipe it dry (do not rub). Immerse the pH sensor in the second buffer solution.
Type the numeric pH value of the second buffer solution in the presented data field and press the ✓ button.



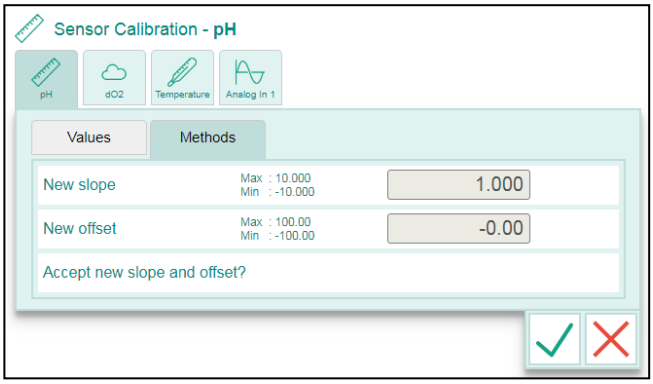
The sensor value will now be monitored to verify the stability.
As soon as a stable value has been obtained, the calibration routine will be resumed.



Step 6:
Finalizing the pH sensor calibration.
The calculated values for Slope and Offset are presented:

Slope = 1.000 *
Offset = -0.00 **

Press the ✓ button to accept the presented calibration data.

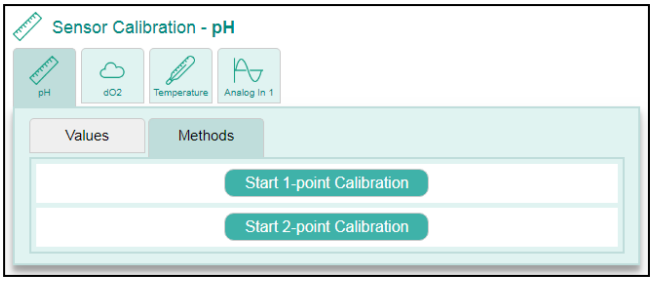


* The presented Slope is the calculated Slope value divided by the theoretical Slope value (Nernst potential).
** The presented Offset is the calculated deviation at pH=7.

The calibration routine can be cancelled at any time by pressing the ✗ button.

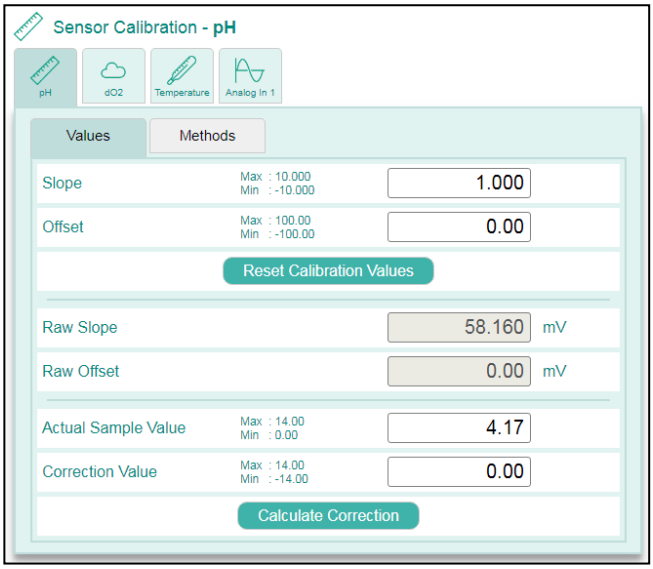
After accepting the calculated calibration data (slope and offset), the initial screen is presented again.

Press the Values tab to return.



After performing the pH sensor calibration and returning to the Values tab, the calculated slope and offset are displayed.

The obtained calibration data can be reset to their default values by pressing the Reset Calibration Values button.



Performing a **1-point calibration** for the pH sensor:
Since by performing a 1-point pH sensor calibration only the sensor offset will be corrected, carrying out this routine is not advised.

However, if a 1-point calibration is required, press the Start 1-point Calibration button.
In a sequence, the following data must be entered:

- Temperature of the buffer solution
- Value of the buffer

The obtained value for the offset (slope will be set to 1.00) will be presented.

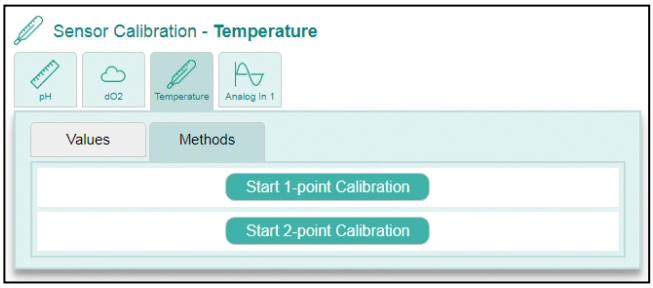
Press the ✓ button to accept the presented calibration data (or press the ✗ button to reject the values).

5.2.4 CALIBRATING THE TEMPERATURE SENSOR

The Pt-100 temperature sensor must be calibrated before it is mounted in the bioreactor.
The sensor can be calibrated in ice water (temperature will be 0 °C).

Step 1:
Open the Temperature Calibration routine and select the Methods tab.

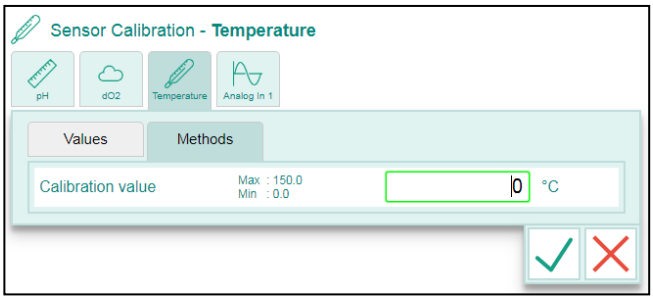
Press the Start 1-point Calibration button.



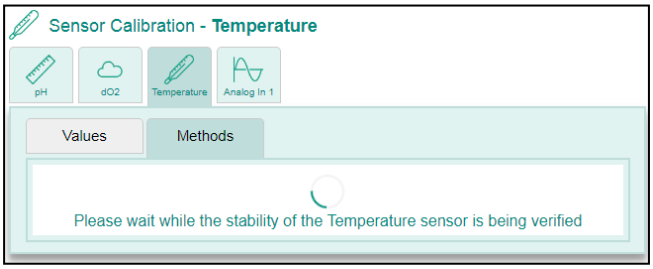
Step 2:
Prepare a beaker with melting ice. Add a magnetic stirrer bar to the beaker and put it on top of a magnetic stirring device.
Insert the Pt-100 sensor in the beaker and let it condition for several minutes.
The temperature in the beaker will be 0 °C.

Enter the value of the current temperature (0 °C)

and press the button to proceed..



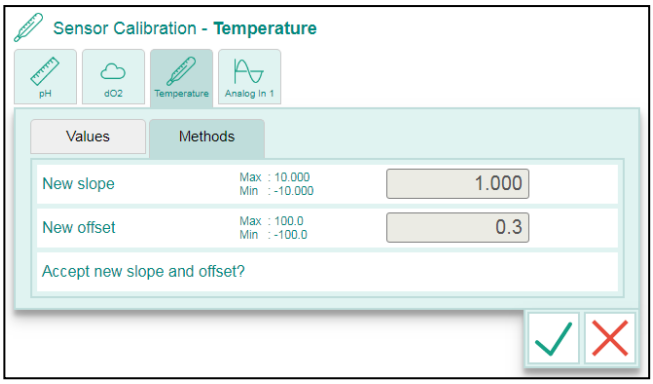
The sensor value is monitored to verify the stability. As soon as a stable value has been obtained, the calibration routine will be resumed.



Step 3:
The obtained offset value for the Pt-100 sensor is presented (the slope will be set to 1.00).

Press the button to accept the presented calibration data.

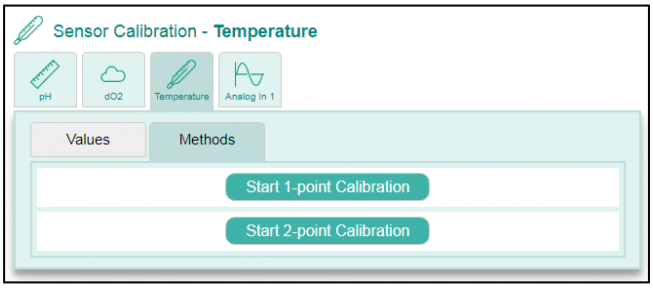
The 1-point calibration routine is now completed.



The calibration routine can be cancelled at any time by pressing the button.

A **2-point calibration** routine for the Pt-100 temperature sensor can be performed as well, however not used very often.

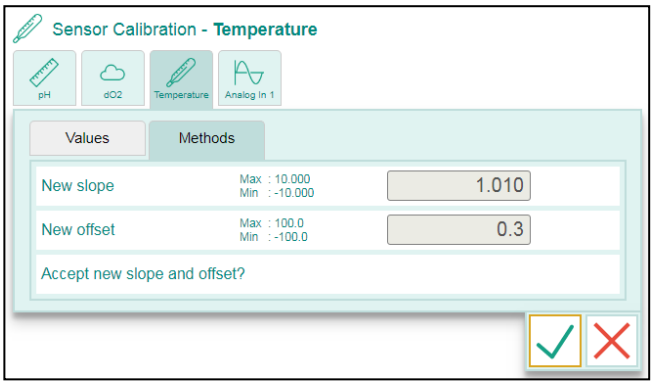
Press the Start 2-point Calibration button.



In a sequence, the following data must be entered:

- First calibration temperature (e.g. 0 °C for ice water)
- Second calibration temperature (e.g. 100 °C for boiling water at an ambient pressure of 1015 mbarg).

The obtained values for the slope and offset will be presented. Example:



Press the ✓ button to accept the presented calibration data (or press the ✗ button to reject the values).

The 2-point calibration routine is now completed.

5.2.5 CALIBRATING THE dO_2 SENSOR

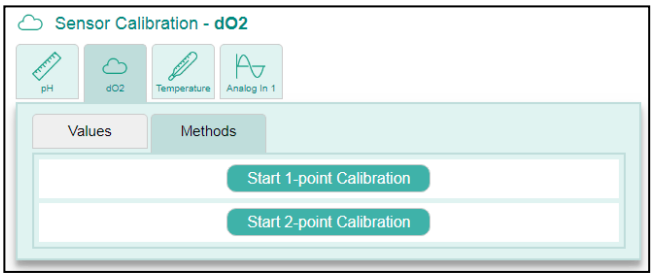
The dO_2 sensor is calibrated after autoclaving the bioreactor. The medium must be conditioned at process temperature and it is advised to have the pH control loop at setpoint. Aerate the bioreactor by opening the air inlet valve(s) for approx. 20 minutes in order to saturate the medium with air.

Before starting the dO_2 sensor calibration:

- Make sure that the dO_2 sensor has been polarized (controller switched on) for at least 4 hours and
- Verify the selected sensor settings (measuring range and temp compensation). Refer to section 4.6.2.

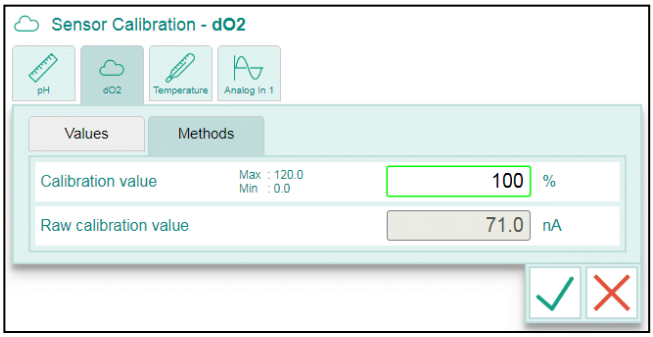
Step 1:
Open the dO_2 Calibration routine and select the Methods tab.

Press the Start 1-point Calibration button.



Step 2:
The calibration value (100% air saturation) can be entered.

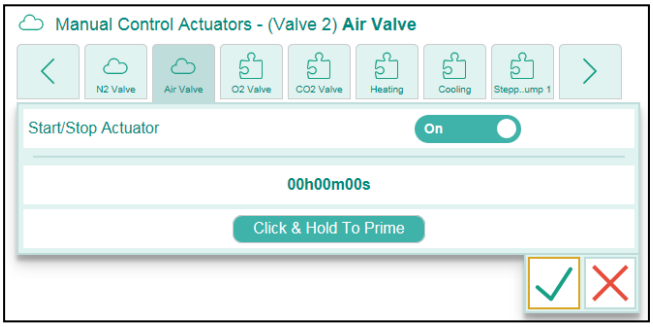
However, before pressing the button, the medium must be saturated with air.



To achieve this, the Air Valve must be opened.

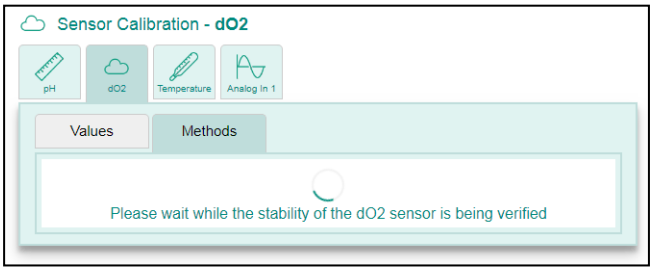
Press the Controls button, followed by the Manual button.

Select the Air Valve tab and press the Off button to switch it to On. Aerate the medium for approx. 20 minutes.

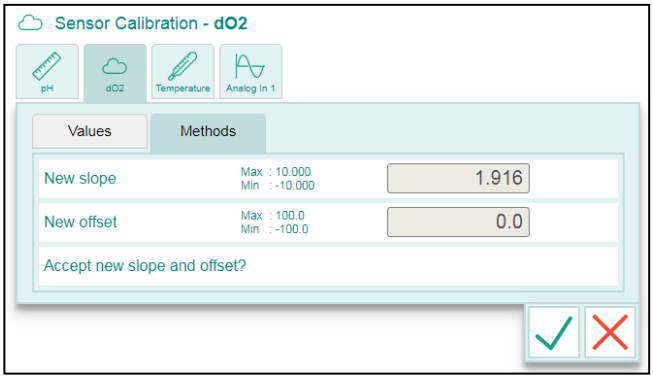


Return to the Calibration menu and press the button.

The sensor value is monitored to verify the stability. As soon as a stable value has been obtained, the calibration routine will be resumed.



Step 3:
The obtained slope value for the dO_2 sensor is presented (the offset will be set to 0.00).



Press the  button to accept the presented calibration data (or press the  button to reject the values).

The 1-point calibration routine is now completed.

If nitrogen gas is available for aeration, it is advised to perform a dO_2 sensor quality check.
Close the air inlet valve and purge the bioreactor with nitrogen for approx. 20 minutes. All oxygen will be driven out of the bioreactor.
Monitor the value of the dO_2 sensor. If this value does not drop below 0.5% air saturation, the sensor requires maintenance before the next fermentation / culture is started.
It is advised to record the measured value for future reference (in this way, preventative maintenance can be anticipated).

A 2-point dO_2 sensor calibration can be performed as well (not advised).
In a sequence, the following data must be entered:

- First calibration value (for air saturation)
- Second calibration value (for nitrogen saturation)

After performing the 2-point calibration, calibration data for both slope and offset will be calculated.

5.2.6 STIRRER CALIBRATION

- **Combination of Internal Stirrer Controller and Stirrer Motor**:
  The standard stirrer motor is equipped with an Encoder (digital feedback of the stirrer speed). Therefore, no stirrer speed calibration option is available.
- **Combination of an External Stirrer Controller and a random Stirrer Motor** (Tachometer required);
  The analog stirrer speed output of the motor is used as feedback signal to an analog input of the ***my***-Control. Use a Tachometer to measure the actual stirrer speed (rpm). Calibration procedure:
  - Start the 2-point calibration routine of the corresponding analog input,
  - Manually set the external stirrer controller to 10% of the stirrer speed range and enter the measured stirrer speed in rpm (first calibration point),
  - Manually set the external stirrer controller to 90% of the stirrer speed range and enter the measured stirrer speed in rpm (second calibration point).
  The analog input calibration routine is now completed.

5.2.7 LEVEL / FOAM SENSOR CALIBRATION

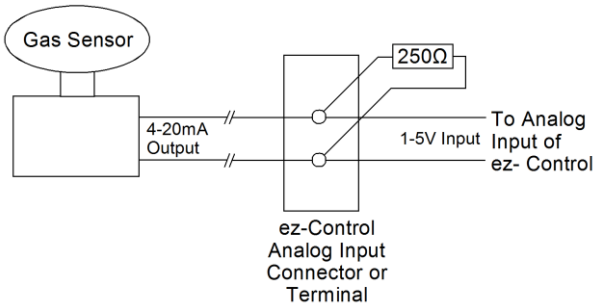
- The level / foam sensor is a stainless steel device that only measures the difference between “Contact” and “No Contact”. Therefore, no level or foam sensor calibration option is available.

5.2.8 CALIBRATING AN ANALOG INPUT

Analog inputs have a measuring range of 0 – 10 VDC. The input range can be calibrated by using an external mV-Simulator.

Due to decreased linearity of the Analog Input Amplifier in the lower segment (0 . . 0.1V) and upper segment (9.9 . . 10V) of the input range, it is recommended to calibrate the analog input using a 2-point calibration procedure with calibration points occurring in the range of 1 . . 9V.

Example: Calibrating the Bluesens O_2 and CO_2 Gas Sensing Modules (connected to extended analog inputs):
The Gas Sensors are equipped with a 4-20mA analog output.
The cable between the gas sensor and the controller is equipped with a 250Ω resistor that is shunted across the poles of the analog input of the controller. As a result, the 4-20mA signal is converted to a 1-5V signal.



The Extended analog inputs for the O_2 and CO_2 gas sensing modules are (factory) calibrated with an external mV-Simulator. The calibration data is listed in the adjacent table (2-point Calibration):

Gas	Extended I/O Input Value	Calibrated Value
O_2	1 V	0 %
	5 V	25 %
CO_2	1 V	0 %
	5 V	10 %

The name and engineering unit of the analog input can be defined through the Sensor Settings screen.

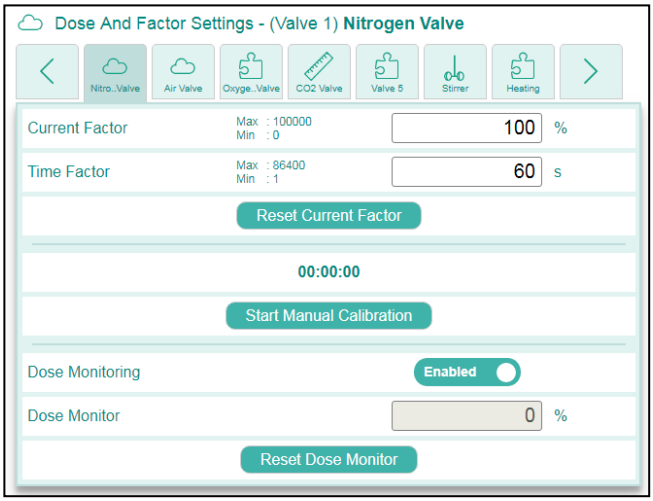
5.3 ACTUATOR FACTOR SETTINGS

The Actuator Factor is defined as the conversion factor between “Actuator Output %” and “Actuator Action” (e.g. pump flow in ml/min). Calibration of the Actuator Factor is performed by activating the actuator for a certain period of time and measuring the transferred mass (in case of pumps).

Calibrating the Actuator Factor is only allowed when the corresponding control loop is switched off.

Press the Dose button in order to open the Dose and Factor Settings window.

At the top of the window, the available actuators are presented.
The actuators are sorted by the corresponding priority numbers (refer to section 4.5.1: Actuator HMI Settings).



Default Actuator Factors and Engineering Units:
- For digital actuators (like valves and fixed speed pumps) = 100%.
- For analog actuators (like variable speed pumps and mass flow controllers) = 1 ml/min.

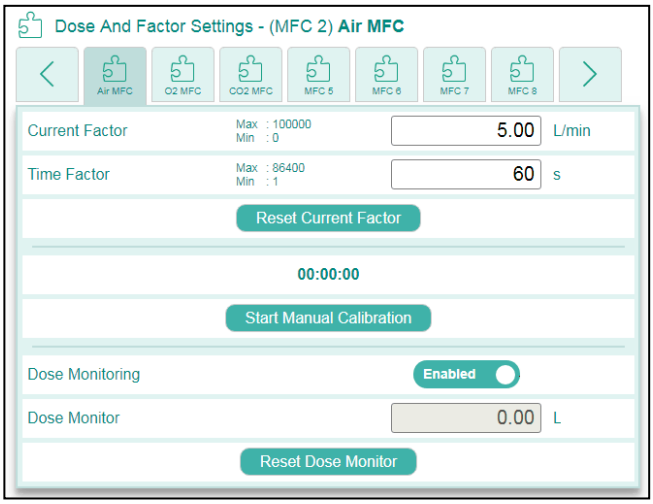
The engineering unit for the Actuator Factor can be edited in the Actuator Settings window (refer to section 4.5.1).

The Dose and Factor Settings window for the different actuators contains the following options:
- Calibrating and / or resetting the Actuator Factor and Time Factor
- Starting the Manual Calibration routine
- Enabling / disabling the Dose Monitor function
- Resetting the (enabled) Dose Monitor value

These options are described in the sections below.

5.3.1 SETTING OR CALIBRATING THE ACTUATOR AND TIME FACTOR

If the capacity of an actuator is known (e.g. in case of a Mass Flow Controller), this given capacity can be entered as Current Actuator Factor.



Example of the Actuator Settings for an Air Mass Flow Controller:
The Mass Flow Controller was factory calibrated at 5.000 L/min.
This value can be entered in the Dose and Factor Settings screen by pressing the Factor data field and entering the value 5.00.

Save this value by clicking on the  button.

The default Time Factor = 60 seconds (to convert the time in seconds to minutes). When the Time Factor is set to 3600, the calculated Actuator Factor will be expressed as volume per hour.

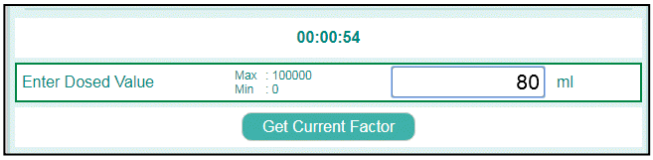
If the value of the Current Actuator Factor is not known (e.g. in case of a tubing pump), the factor can be calibrated by activating the actuator for a certain period of time and measuring the result.
This can be performed by using the Manual Calibrate option. Pressing the Start Manual Calibration button will activate the actuator and start the presented timer. When the result of the actuator activation can be quantified, the Stop Manual Calibration button can be pressed and the new Actuator Factor can be calculated.

Example of the Actuator Factor calibration for a tubing pump:

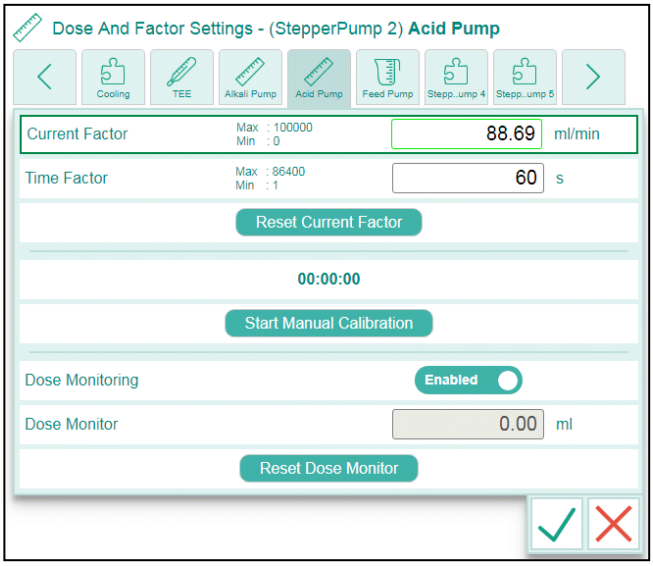
Step 1: Prepare a beaker or graduated cylinder to collect the added volume. Put the delivery side of the pump tubing in the beaker or cylinder.

Step 2: Open the Dose and Factor Settings window for the pump and press the Manual Calibrate Start Manual Calibration button. The pump will be started; the counter presents the duration of the active period. Collect the added liquid. Press the Stop Manual Calibration button as soon as the collected liquid can be measured with appropriate accuracy.

Step 3: The measured output of the pump can be entered in the presented data field.



Step 4: When the output has been entered, pressing the Get Current Factor button starts the calculation of the Actuator Factor for the pump:



The presented value for the Current Factor is the result of added volume per calibration time interval.

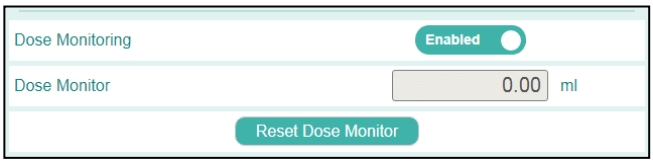
The presented value can be saved by pressing the  button (or can be rejected by pressing the  button.

The Current Factor can be reset to its default value (1.00 ml/min) by pressing the Reset Current Factor button.

5.3.2 DOSE MONITOR FUNCTION

If the Actuator Factor has been calibrated (or set to a known value), the Dose Monitor function can be enabled. This function will integrate the actuator activity in time and present the cumulative actuator activity in the calibrated engineering unit.

Below the Manual Calibration area, the Disabled / Enabled toggle button can be found. By pressing this button, its status is changed.

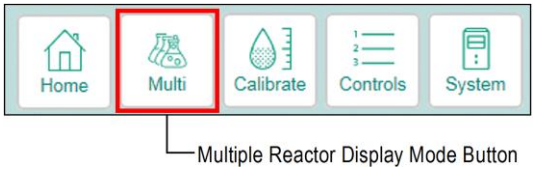


Switching between activity modes must be confirmed by pressing the  button.

The reported Dose Monitor value can be reset to 0 ml by pressing the Reset Dose Monitor button.

When the Dose Monitoring function has been disabled, the presentation of the integrated volume and the Reset button are hidden as well:

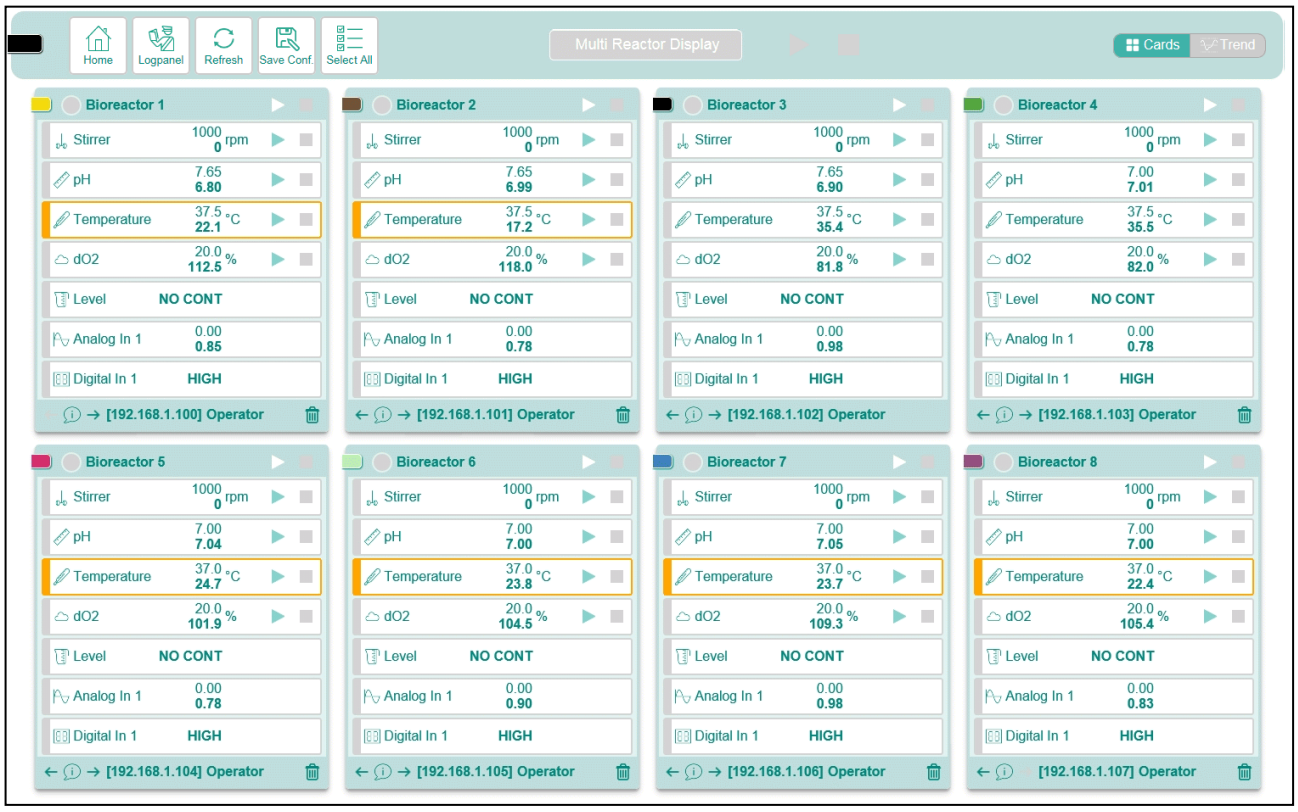
6 MULTIPLE REACTOR DISPLAY MODE



At the left side of the screen header, right of the Home button, the Multi button is presented.

When this button is pressed, the User Interface switches to the Multiple Reactor Display mode.
In this way, up to 56 of the most relevant Process Parameters that are derived from up to 8 reactors can be presented in one view.

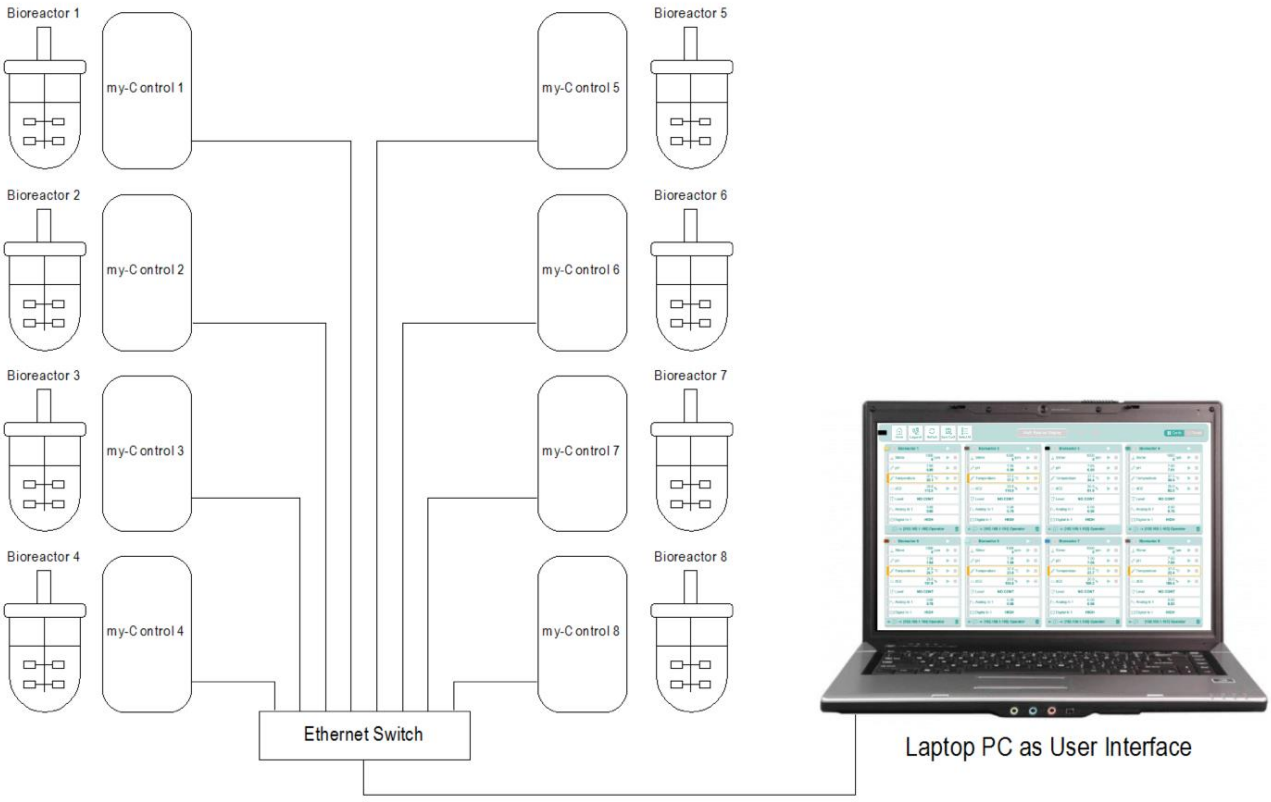
Example: the image below presents the User Interface in the Multiple Reactor Display mode. Eight bioreactors have been configured and connected to the PC that serves as User Interface:



In the section below, the user options in the Multiple Reactor Display mode are described.

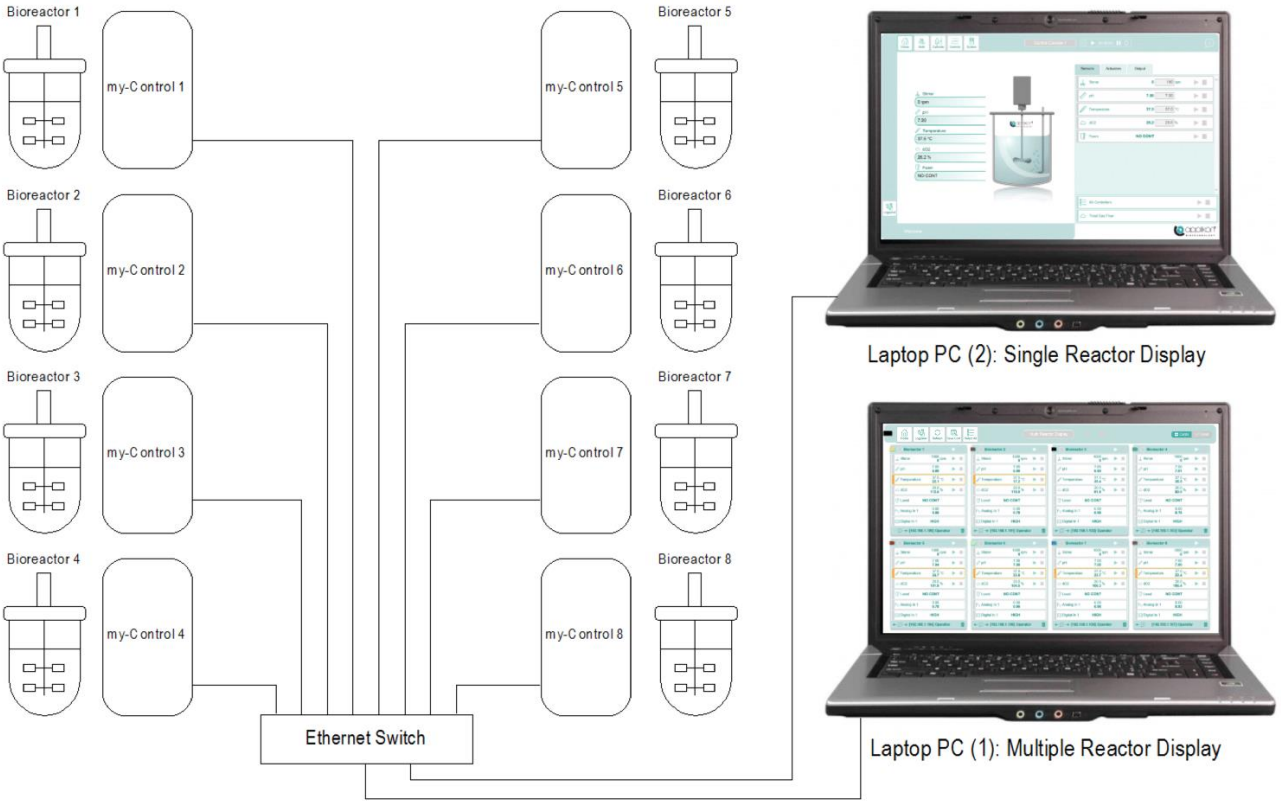
6.1 MULTIPLE REACTOR CONNECTION

Using the Multiple Reactor Display mode requires the connection of more than one reactor system (my-Control) to the device that is selected to serve as User Interface. In the example below, eight bioreactor systems are connected to a laptop PC:



This example shows the configuration of one User Interface for more than one bioreactor systems. However, it is also allowed to connect more than one User Interface to the collection of Bioreactor Systems; refer to the next page.

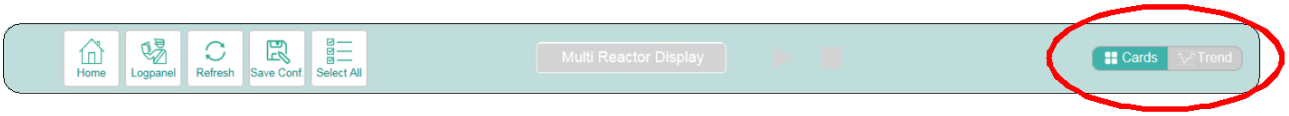
When one or more Bioreactor Systems are connected to an Ethernet Switch, they may be connected to several User Interfaces. This means that a running process can be monitored at different locations at the same time.
The image below shows an example of eight Bioreactor Systems with two laptop PCs as User Interface. One of the PCs is switched to the Multiple Reactor Display mode. The other one is used to present one of the individual Bioreactor Systems.



Although running processes can be monitored by different User Interfaces, only one user can be logged in at the time. If a user is logged in through the Multiple Reactor Interface, the other (individual) users at the my-Control will be logged off.
Also refer to section 6.4 (Logging on to the Multiple Reactor Interface).

6.1.1 DISPLAY MODE

At the right side of the screen header, the Display Mode can be selected (Cards or Trend). The screen header is presented below. The selection buttons are indicated by a red oval:

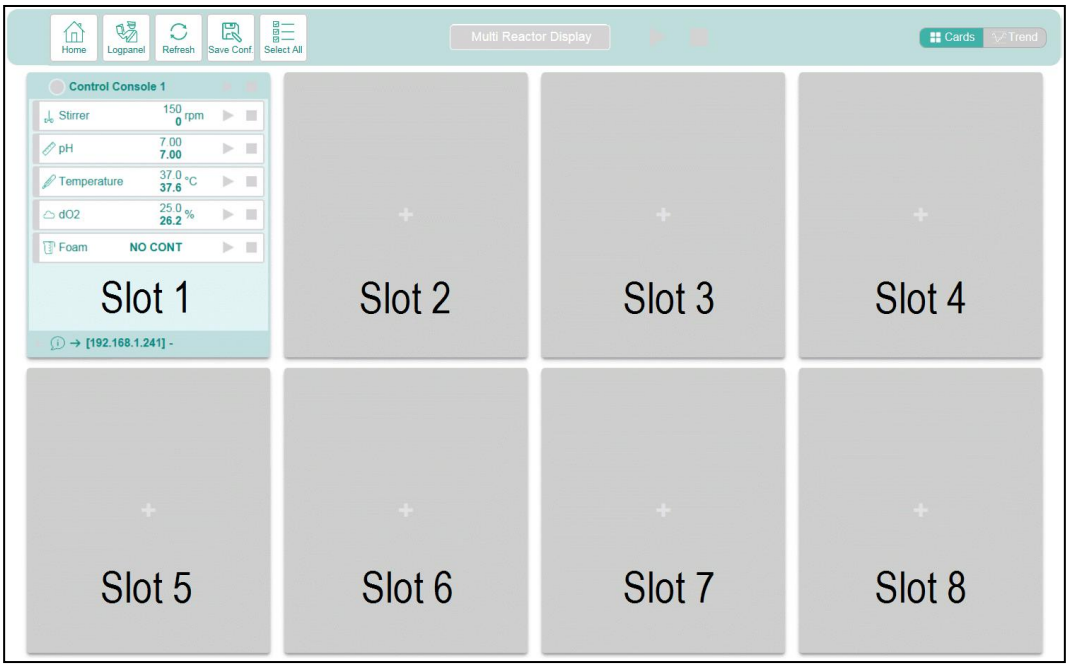


For configuring the Multiple Reactor Interface, the Cards display mode must be selected.
To view the trends of the different process parameter values, the Trend display mode can be selected.
For information concerning the Trend display mode, refer to section 6.7.

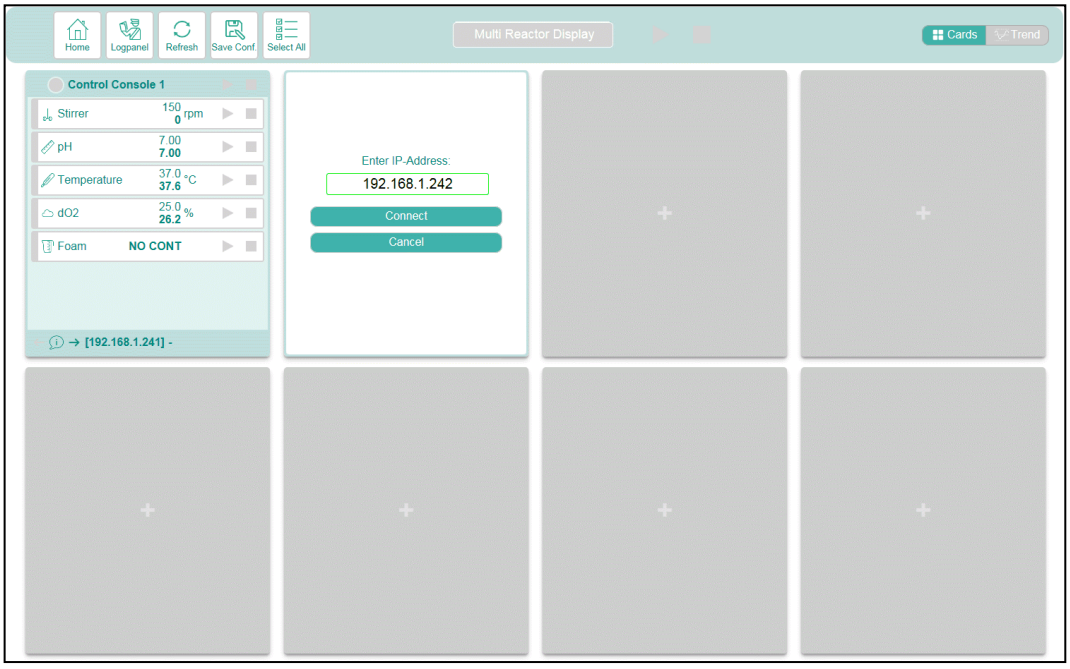
6.2 CONFIGURING A MULTIPLE REACTOR SETUP

When no Multiple Reactor configuration has been setup and the 

button in the screen header of a User Interface in the Single Reactor Display mode is pressed, it will switch to the Multiple Reactor Display mode with only one configured reactor in the rectangular area (Slot) in upper left corner of the screen. The IP-address of the presented reactor in Slot 1 is displayed at the bottom of the Slot. See the image below:



If more my-Controls have been connected to the device that is used as User Interface (e.g. through an Ethernet Switch), the other seven slots can be configured as well. Click with the pointer in one of the empty Slots. As a result, the IP-address of another my-Control is requested. Enter the IP-address of a second my-Control:



Press the Connect button in order to establish the connection.
The image below shows a second Bioreactor System that is presented in a second Slot at the right side of the first Slot.

This process of adding Bioreactor Systems to the User Interface can be repeated until all Slots are used.

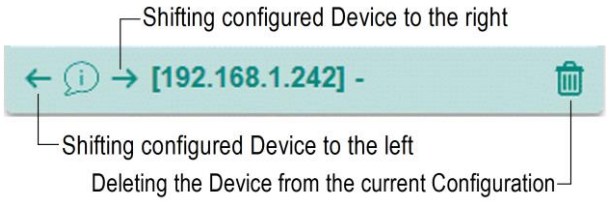
For rules concerning the IP-address format, refer to Chapter 6 (Appendix A): Customizing the IP-Address.

6.2.1 SAVING THE MRI CONFIGURATION

The created Multiple Reactor Interface configuration can be saved by pressing the Save Conf. button that is presented in the screen header. Pressing this button will send the created configuration to the individual controllers where it will be stored.

6.2.2 EDITING THE MRI CONFIGURATION

The created Multiple Reactor Interface configuration can be edited by using options that are presented at the bottom of each Slot (see image).

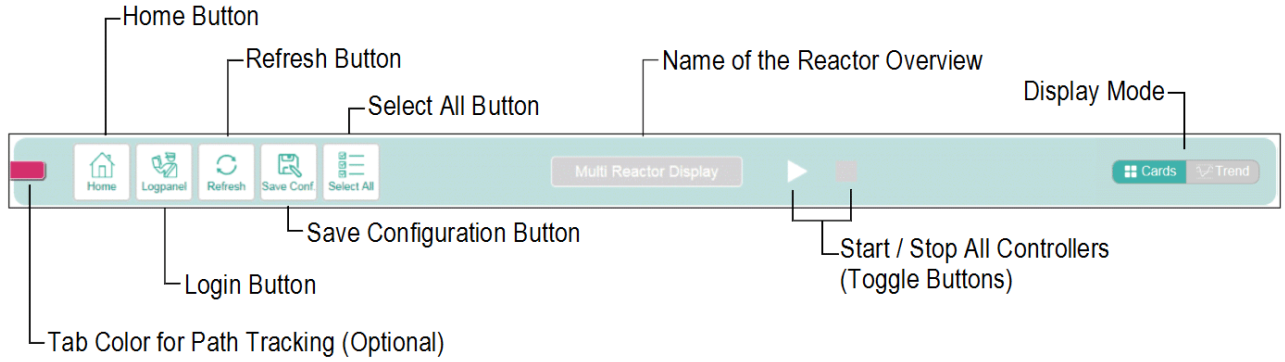


- Clicking on the arrows at both sides of the Device Information button can be used to shift the selected device one position to the right or to the left.
- Clicking on the trash can icon in the lower right corner of the Slot will delete the configured Device. Note that the primary Device cannot be deleted (the primary device means the my-Control that was used to access the Multiple Reactor Interface).

In the sections below, the layout of the Multiple Reactor screen is described.

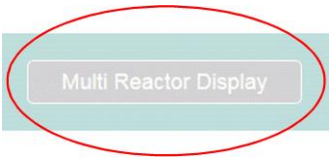
6.3 MULTIPLE REACTOR SCREEN HEADER

When the User Interface has been switched to the Multiple Reactor Display mode, the screen header will have the following layout:



Button	Description
	Home Button: when this button is pressed, the User Interface will switch back to the (previous) Single Reactor Display mode. If the Tab Color of the individual my-Control(s) have been set (refer to section 3.3.1 of this manual), the colored tab ( ) at the left side of the Home button will indicate the reactor that will be presented after pressing the Home button.
	Login Button: when this button is pressed, the Login dialog window will be presented. The Multiple Reactor Interface has its own authorization properties. Refer to section 6.4. Logging in at the Multiple Reactor Interface can overrule any logged in users at Single Reactor (local) level.
	Refresh Button: when this button is pressed, the Multiple Reactor Display will be refreshed. This is especially useful when the settings of a Bioreactor System have been edited through another User Interface.
	Save Configuration Button: when pressing this button, the current configuration will be saved at all configured controllers. This option is especially useful to save the final layout of the Multiple Bioreactor Display.
	Select All Button: by pressing this button, all configured Slots will be selected. This option is used to apply single Slot commands to all Slots. Refer to section 6.6.

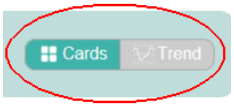
The title in the center of the screen header is used to identify the configured Multiple Reactor screen.
This title can be edited by a logged on user with Engineer rights.



The Start / Stop buttons at the right side of the title are used to start or stop all configured reactor systems simultaneously.

The Start ( ) button will start all connected / controlled Bioreactor Systems. When the systems are running, the Start button will be greyed out and the Stop ( ) button will become active. When the Stop button is pressed, all connected / controlled systems will be stopped.
When some of the connected / controlled systems are running, both the Start and Stop buttons are active at the same time.

The display mode can be selected by pressing the grey colored option.

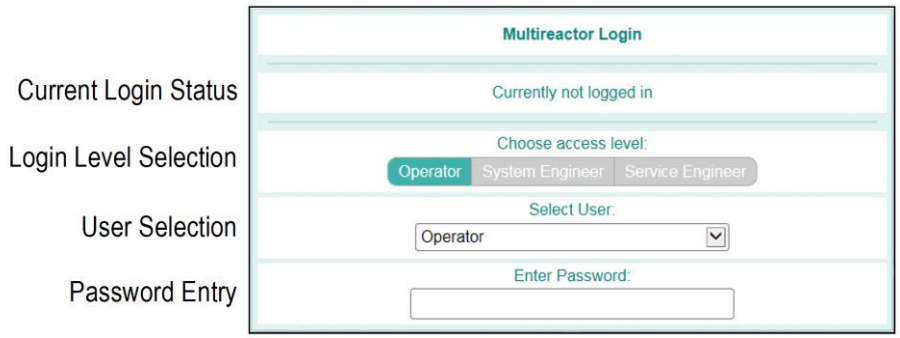


6.4 LOGGING ON TO THE MULTIPLE REACTOR INTERFACE

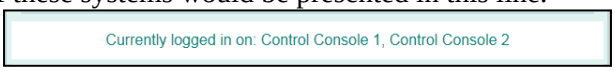
The Multiple Reactor Display mode can be used to monitor multiple processes in one view without interfering with the individual Reactor Systems.
However, when the user is logged on to the Multiple Reactor Interface, control of the individual systems is taken over. Controller setpoints may be edited and control loops may be started or stopped. Also, sensors can be calibrated.

Press the 

button in the screen header to open the Login dialog box.



- The Current Login Status line shows to which of the systems the user has been logged in. In this example, the user has not been logged in. If the user would have been logged in to one or more Reactor Systems, the name of these systems would be presented in this line.



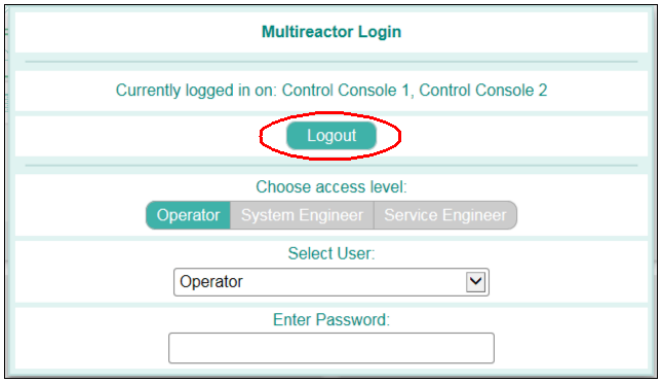
Example:

- The Login Level Selection line allows the option to login at three different levels:
  - as Operator to Start or Stop control loops, calibrating sensors and to edit controller setpoint settings,
  - as Engineer in order to edit the configuration of the Multiple Reactor screen or
  - as (Applikon) Service Engineer for maintenance purposes.
- The User Selection line allows the selection of a specific user. The dropdown menu will show the configured users within the selected group (Operators or Engineers). Select one of the presented users.
- The Password Entry line is used to enter the password that belongs to the selected user.

When logging in was successful, the name of the logged in user will be presented at the bottom section of each Slot.

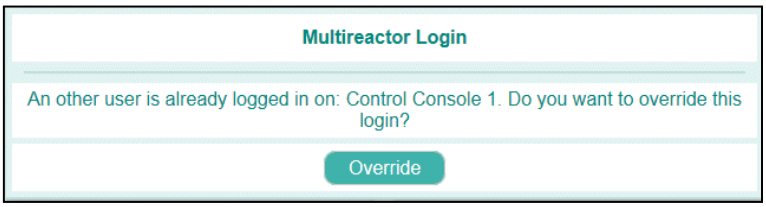

As soon as a user logs in to the Web Interface of one of the individual Bioreactor Systems, this is indicated at the Multiple Reactor Interface by removing the user name of the corresponding Slot.

When a user has logged in to the Multiple Reactor Interface, the Login dialog box will contain the Logout button:



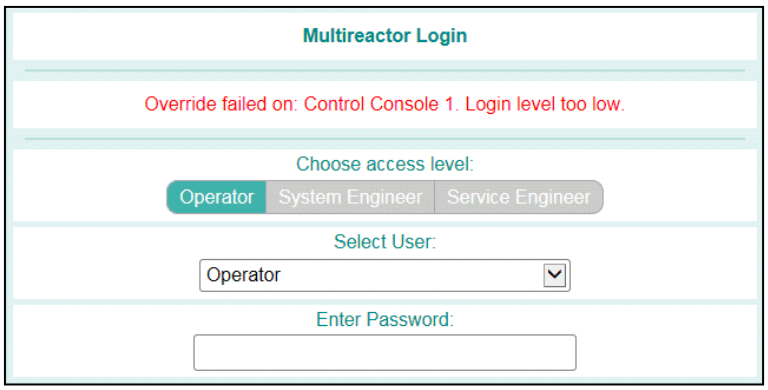
6.4.1 OVERRIDING OTHER USERS

When logging in at the Multiple Reactor Interface, any other user with granted access to controllers at local level must be overruled.
During the login process, after selecting the access level and user name / password, a warning with the following content may be prompted:



By clicking on the Override button, the logged in users with the same or a lower authorization level will be logged out.

However, if the logged in user has a higher authority than the new user, the login attempt will be denied and the following message will be prompted:



Repeat the login attempt at a higher authority level (Engineer rights).

6.4.2 RESTRICTIONS FOR LOGGING IN TO THE MULTIPLE REACTOR INTERFACE

For logging in to the Multiple Reactor Interface, the following restrictions are valid:

- The dropdown menu at the User Selection line will only show users that are present / have been created on every controller that is configured in the Multiple Reactor Interface.
  For example:
  Eight controllers have been configured in the Multiple Reactor Interface. On seven controllers, a user called “Peter” has been created. Since this user is missing at the 8th controller, the name will not be present in the user dropdown list of the Multiple Reactor Interface. Once Peter has been added as user in the 8th controller, this name will also be present in the Multiple Reactor Interface dropdown list of users.

and

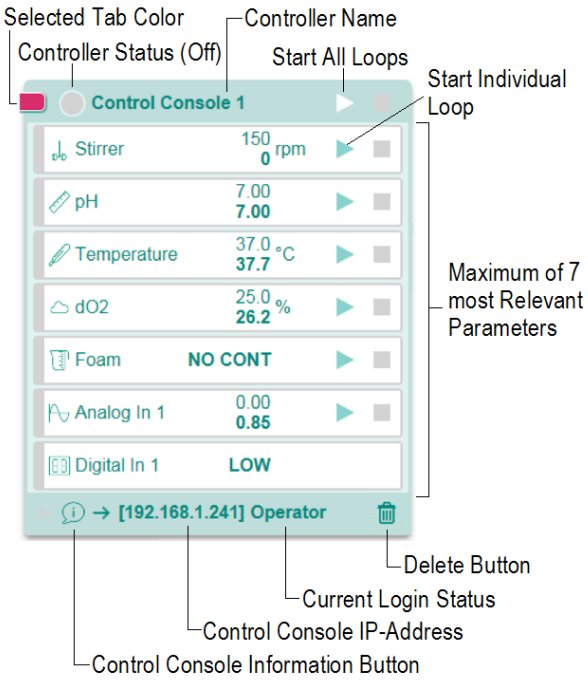
- The common user (the user that has been authorized to access all connected controllers) must have a single unique password. If one or more controllers connected to the Multiple Reactor Interface have registered a different password for this user, access to these specific controllers will not be granted.

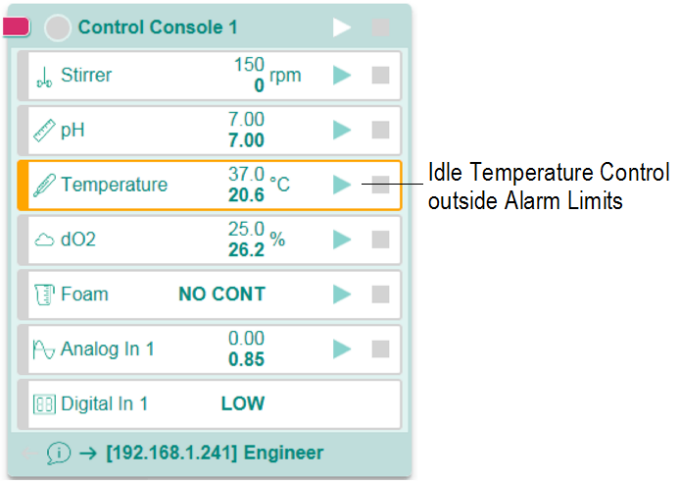
If the default my-Control users (Operator and Engineer) with passwords 0000 are still intact, they can be used to access all connected controllers at Operator and Engineer level.

6.5 SLOT LAYOUT AND DATA PRESENTATION

Depending on the status of the individual controller, the corresponding Slots of the Multiple Reactor Interface show the following information and buttons:

- The selected color of the reactor tab,
- The controller status,
- The controller name,
- The start / stop button for all control loops,
- The seven most relevant process parameters,
- The device information button,
- The controller IP-address,
- The name of the logged on user and
- The delete button.

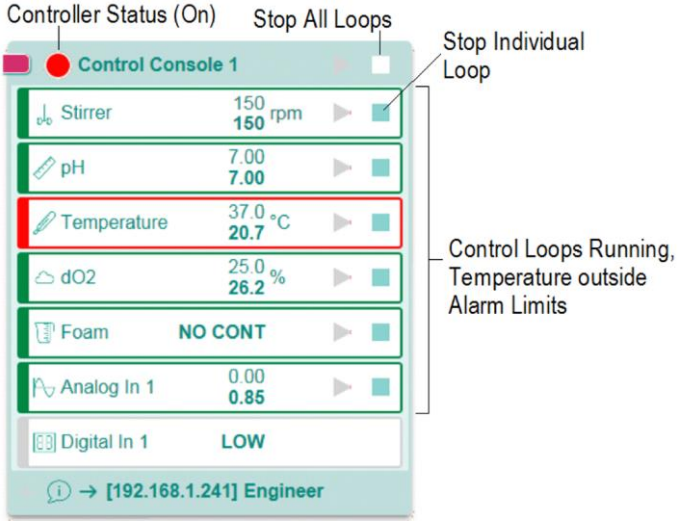




When a Process Parameter value of an Idle control loop (in this case Temperature) exceeds an Alarm Limit, the parameter is indicated by an orange rectangle.

Control loops that have been switched on (Digital Input 1 is not configured as a control loop), are indicated by a green or a red rectangle.

- Process Parameter values with a green rectangle do not exceed the Alarm Limits.
- If the rectangle is red however (as for Temperature in this example), the process parameter value exceeds one of the Alarm Limits.



For additional remarks concerning the presented information in each Slot, see the next page.

6.5.1 TAB COLOR

The color of the Tab in the upper left corner of the Slot is defined as Specific Preference of the corresponding my-Control. Refer to section 3.3.1 of this manual.
The color of the Tab is used for identification of the reactor system. By default, the Tab Color is undefined.

6.5.2 CONTROLLER STATUS

The status of the Controller is represented by a colored circle. The table below shows the different options:

Status	Description
	If the Controller Status = grey, all Control Loops are in the Idle mode.
	If the Controller Status = green, at least one Control Loop is running and the Process Parameter values of the running controllers are within the Alarm Limits.
	If the Controller Status = red, it can be caused by failing hardware (System Alarm, independent of Control Loop status) or by a Process Alarm for a running Control Loop (Process Value exceeding an Alarm Limit).

6.5.3 CONTROLLER NAME

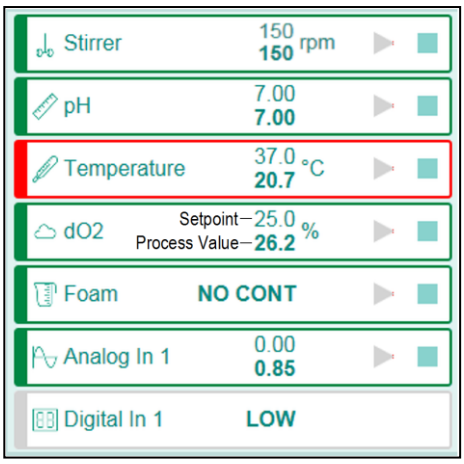
The Controller Name that is presented at the top of each Slot is a copy of the Device Name of the corresponding my-Control. Refer to section 1.4.2 of this manual.

6.5.4 START / STOP BUTTONS

The Start and Stop buttons are used to start or stop individual control loops or all loops of the corresponding device.
The Start and Stop buttons are only active when the user of the Multiple Reactor Interface is logged in. For information regarding the Login-procedure, refer to section 6.4 of this manual.

6.5.5 PRESENTED PROCESS PARAMETERS

In the data section of the Slot, up to seven Process Parameters can be presented. This list is a copy of (part of) the Sensor Tab information that is presented at the right section of the Home screen of the corresponding Controller. Refer to section 1.5 of this manual.



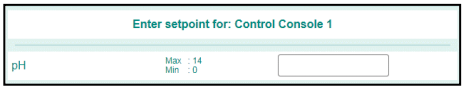
The parameter sequence in the list depends on the defined Sensor Priority value. The lower this value, the higher the position on the list. Refer to section 4.6.
Each presented control loop shows:

- The Setpoint value (straight letters) and
- The Process Value (bold letters).

When the user is logged on to the Multiple Reactor Interface, the following actions are allowed:

- Editing the Setpoint values and
- Calibrating the sensors.

When clicking on the current setpoint value of a control loop, a popup window appears to enter the new value.
Example for editing the pH setpoint for Control Console 1:



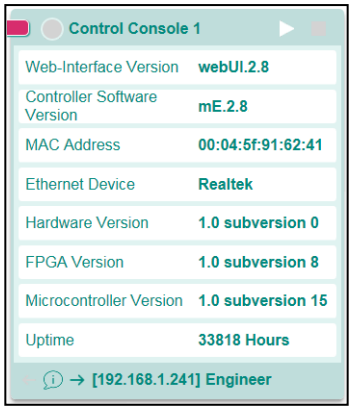
When clicking on a presented sensor name, the corresponding calibration routine is being addressed.

The Level / Foam sensor and Digital Inputs cannot be calibrated.

The calibration routine as presented in the Slot can be performed according to the specific calibration selection at the controller (1- or 2-point calibration).
However, the presentation of the calibration routine in the Slot of the Multiple Reactor Interface differs from the presentation of the calibration routine in the Single Reactor Interface (the presentation of the calibration steps and calibration data is more compact).

6.5.6 DEVICE INFORMATION

When clicking on the Device Information button ( ) in the lower left corner of the Slot, the most relevant selection of the Device Information data of the corresponding my-Control is presented. See image.
Also refer to section 1.4.4 of this manual.



6.5.7 CONTROLLER IP-ADDRESS

The Controller IP-Address (such as [192.168.1.241]) that is presented at the bottom of the Slot, between brackets, is used for two purposes:

- For device identification (just like the colored tab in the upper left corner of the Slot) and
- To switch from the Multiple Reactor Display mode to the Single Reactor Display mode.

When clicking on the IP-address, the Home screen of the corresponding my-Control will be presented.

This action can be reversed by pressing the Multi button in the screen header of the presented Single Reactor screen.

6.5.8 LOGGED ON USER PRESENTATION

At the bottom of the Slot, at the right side of the presented IP-Address, the name of the logged on user is presented.
When this position is empty, no user has been logged in to the Multiple Reactor Interface.

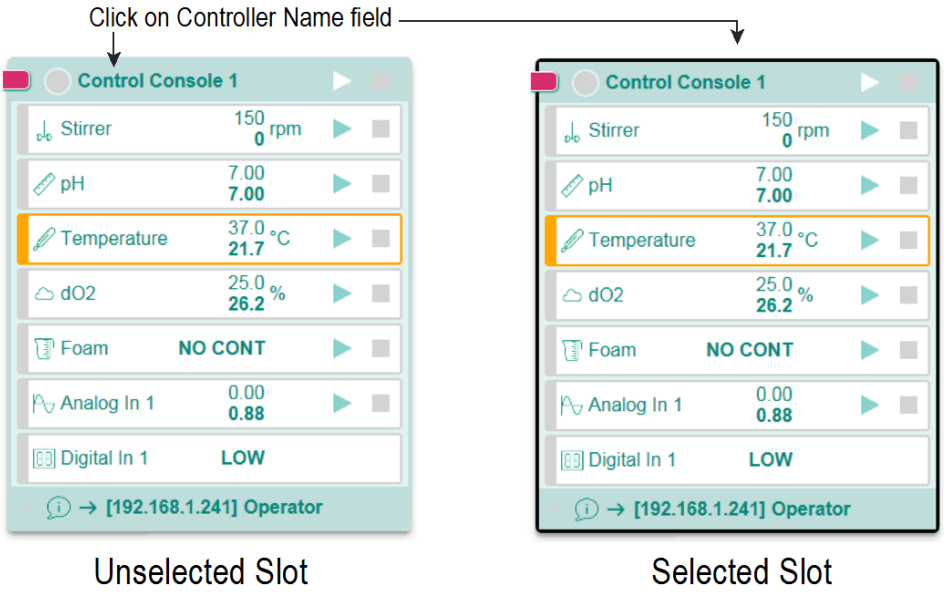
Logged on as Operator: ← → [192.168.1.101] Operator

Logged off: ← → [192.168.1.101] -

6.6 USING SLOT SELECTION

Slot selection is used to apply single slot commands to multiple Slots.

Slots can be selected by clicking on the Controller Name field. As a result, a black border identifies the selected Slot:



The screen header of the Multiple Reactor Interface contains the Select All (

) button. Pressing this button will select all configured Slots. Pressing the Controller Name field of one or more Slots will unselect these Slots.

The commands for an individual Slot can also apply to multiple Slots. See the explanation in the table below:

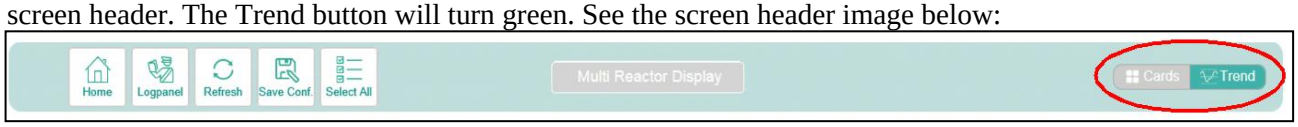
Command Entry	**Result for Unselected or Single Selected Slots**	**Result for Multiple Selected Slots**
Start / Stop individual Control Loop.	Starts or stops the individual Control Loop at this specific Slot	Starts or stops the individual Control Loop at all selected Slots
Start / Stop all Control Loops	Starts or stops all Control Loops at this specific Slot	Starts or stops all Control Loops at all selected Slots
Device Information Button	Opens the Information the Information table for this specific Slot	Opens the Information the Information table for all selected Slots
Edit Setpoint Value	Allows the entry of a new Setpoint value that applies for this specific Slot	Allows the entry of a new Setpoint value that applies for all selected Slots
Start Sensor Calibration	Starts the Calibration routine for this specific sensor in this specific Slot	Starts the Calibration routine for this specific sensor in all selected Slots

Performing a sensor calibration routine for selected Slots means that the same routine is active for all selected Slots at the same time. Remarks on the simultaneous sensor calibration:

- If an error message is generated for one of the sensors, the user has the option to either restart the routine or to reject the sensor that generated the error and to continue the routine for the other sensors.
- At the end of the calibration routine, the obtained calibration data (Slope and Offset) can be accepted or rejected individually.

6.7 TREND DISPLAY MODE

The Trend Display mode can be selected by clicking on the corresponding option at the right side of the screen header. The Trend button will turn green. See the screen header image below:



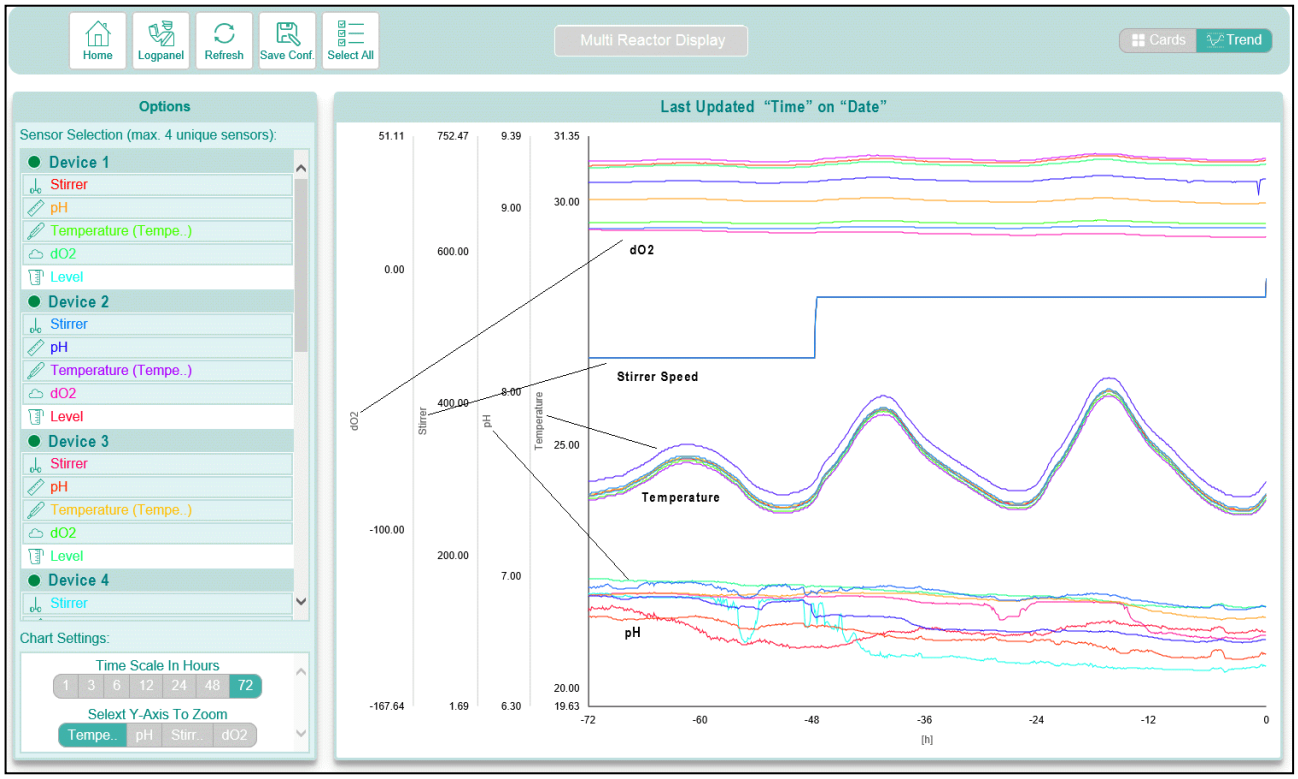
When the Trend Display mode has been selected, the trend of up to 32 process parameters (four sensor values of eight bioreactor systems) can be selected and be presented in a combined overview. In this way, the conditions in the different reactors can be compared.

For configuring the Trend screen, the following rules have to be taken into account:

- From each controller, a maximum of four sensors can be selected to be displayed,
- The four sensors of each reactor must belong to the defined group of four sensors,
- Sensors can be (de)selected by clicking on their presentation in the left section of the screen,
- If four sensors have already been selected, a new sensor can only be selected after deselecting one of the selected sensors.

The Trend screen can best be configured by selecting the four sensors of interest for the first reactor system and repeating this selection for the other reactors. The scroll bar at the right side of the controller presentation can be moved down to configure the sensors of all eight controllers.

Example of a Trend screen:



The line and text color for each parameter is automatically assigned. It cannot be edited.

When pointing at one of the graphical lines in the Trend area, the numerical coordinate of time and value is displayed.

6.7.1 ADJUSTING THE TREND AXES

The scale of the presented Trend time axis can be selected. Click on one of the available options:

The Y-axis for the four different parameters (sensors) can be selected to be customized (shifting the offset and scaling the axis). Follow the instructions below:
Select the Y-axis to be customized by clicking on the corresponding sensor:
The selected Y-axis is presented as a bold line.

- **Shifting the Offset of the selected group of sensors:** Move the mouse pointer to a location somewhere in the graph and press the left mouse button. The offset of the selected group of sensors can be shifted by moving the mouse pointer up or down.
- **Scaling the Axis of the selected group of sensors:** Move the mouse pointer to a location somewhere in the graph and scroll the mouse wheel. Scroll the mouse wheel up to zoom in, scroll the mouse wheel down to zoom out.

6.7.2 REFRESHING THE PRESENTATION OF THE TREND SCREEN

- The Trend screen is automatically refreshed every 5 minutes,
- The Trend screen is refreshed after editing its configuration (sensor selection, scaling of axes, etc.),
- The Trend screen is also refreshed when pressing the 

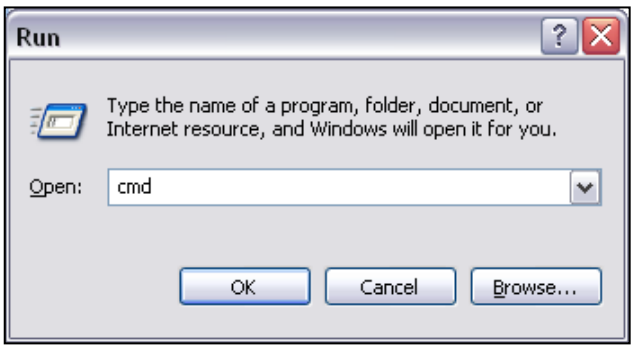
button in the screen header.

7 APPENDIX A: CUSTOMIZING IP-ADDRESS

The ***my***-Control IP-address can be edited according to the instructions below (the instructions assume that the ***my***-Control is connected with a PC with Windows 7 or Windows 10 as the operating system).

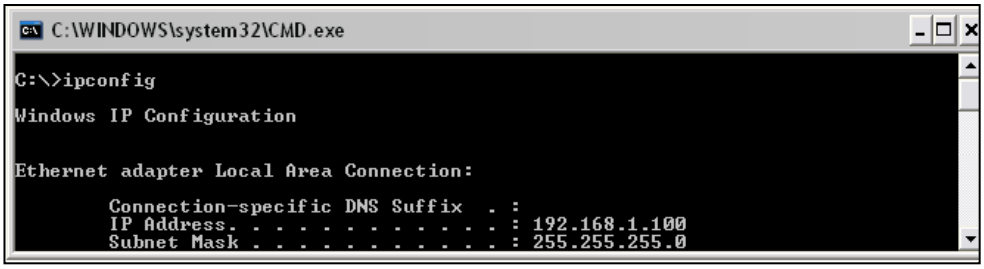
7.1 DETAILED INSTRUCTIONS FOR OS WINDOWS 7

When working with OS Windows 10, see section 7.2.

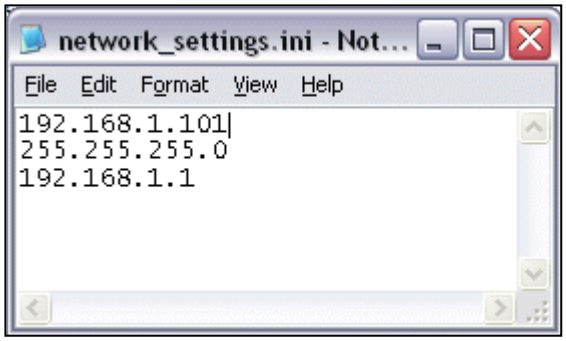


- Start the PC that will be used for connection with the ***my***-Control.
- Open the command prompt window by pressing Start > Run and enter the command cmd.

- In order to display the current IP-address and subnet mask, enter the "ipconfig" command. The response may look like:



- Connect the USB stick to the PC and locate the file "network_settings.ini". Open it with a text editor such as Notepad. Example:



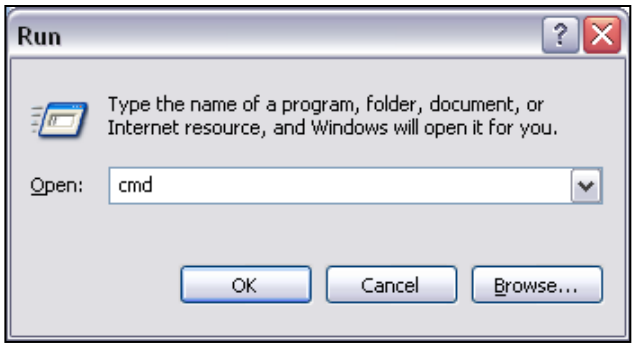
- The first line represents the IP-address, the second line the subnet mask and the third line the default gateway..

- For communication between the PC and the ***my***-Control, the range of the IP-address must be the same. In this example this means that the IP-address of the ***my***-Control must be set in the range between 192.168.1.1 and 192.168.1.254, excluding the IP-address of the PC.
  The first three sections of the default gateway range (in this example: 192.168.1) must be identical to the first three sections of the IP-address. The fourth default gateway section may be any unused number between 1 and 254 , but in most cases either 1 or 254 is used.

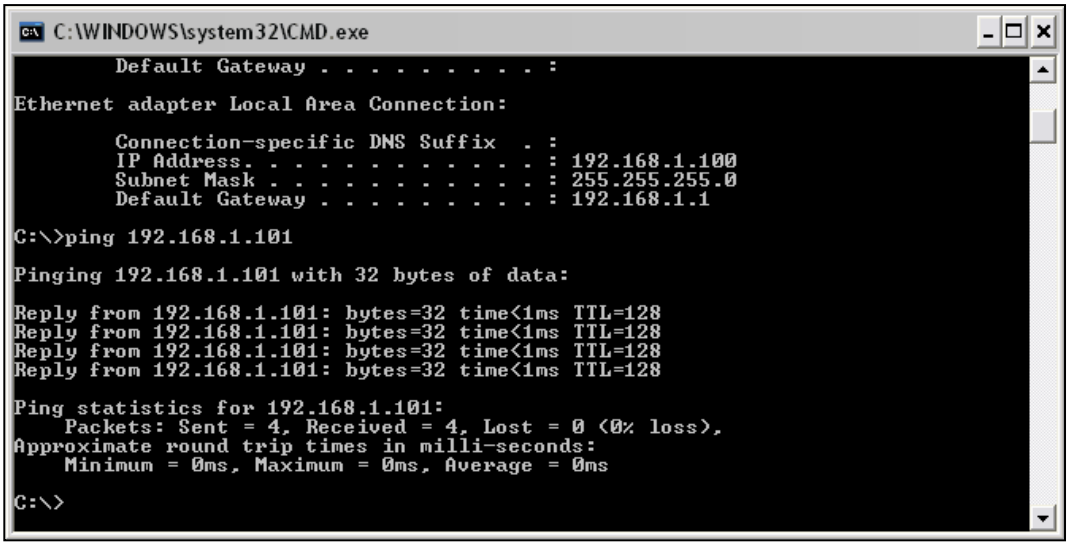
- Save the network_settings.ini file in the root of the USB stick. **Make sure that the *my*-Control software files (Wx_xx.bin and LICENSE.DAT file) are not located in the root.**

- Connect the USB-stick to the ***my***-Control. The new IP-address settings are automatically copied to the ***my***-Control.

Communication Verification:



- Connect the PC to the ***my*-Control** by using a cross cable (direct connection) or using a network (Ethernet with switch).
- Open the command prompt window by pressing Start > Run and enter the command cmd.
- Enter the "ping *IP-address*" command (where *IP-address* stands for the numeric address) and verify if communication between the PC and my-Control is operational.
- Example:
  IP-address of the PC = 192.168.1.100
  IP-address of the ***my*-Control** = 192.168.1.101
  Default gateway of the ***my*-Control** = 192.168.1.1



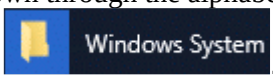
If the communication between the PC and the ***my*-Control** is working, customization of the IP-address has now been successfully completed. Remove the USB-stick from the ***my*-Control**.

While this is not required, it is advisable to remove the "network_settings.ini" file from the root of the USB-stick to avoid inadvertently assigning the same IP-address to another ***my*-Control**. This would create a network conflict.
Another reason for removing the .ini file is that if the network settings and the software/license files (Wx_xx.bin and LICENSE.DAT file) are located together in the root of the USB-stick, a different conflict will occur.

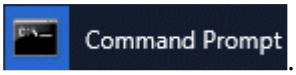
7.2 USING A PC WITH OS WINDOWS 10

When using a PC with Windows 10 as Operating System, the Command Prompt can be accessed by pressing the  button.

Scroll down through the alphabetical list.

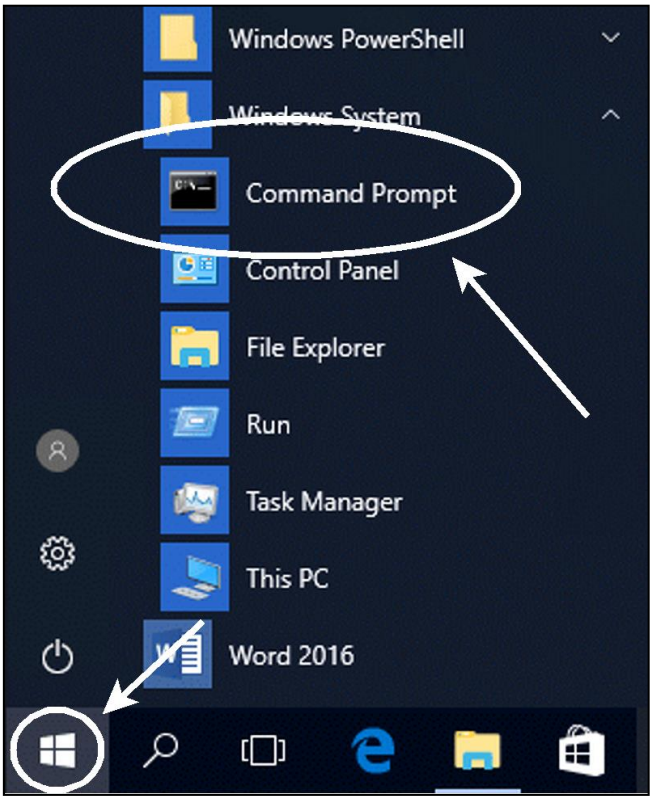
Click on 

.
The corresponding options are presented.

Select the option: 

.

Follow the detailed instructions that are given in section 7.1 (the Command Prompt options for Windows 10 are the same as those for Windows 7).

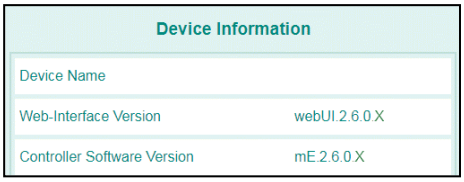


8 APPENDIX B: PERFORMING A SOFTWARE UPDATE

The ***my***-Control is a process control device that runs on the Control software.
The web-oriented User Interface runs on the Web User Interface software.

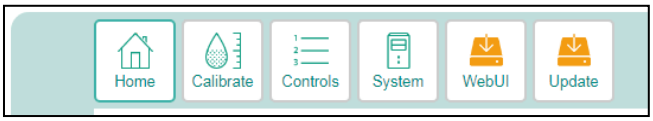
The Control software and Web UI software are independent programs that can be updated individually.

At the top of the Device Information window, the loaded software version is reported as a version for the Web Interface and a version for the Controller Software:



Any software updates must be saved to the root of a USB memory stick.
This USB stick must be inserted in to one of the two USB-ports at the rear of the running controller.

When the new Controller and Web User Interface software versions are detected by the controller, two additional buttons will be presented in the header of the WebUI display:



The 

button indicates the detection of a new version Control software.

The 

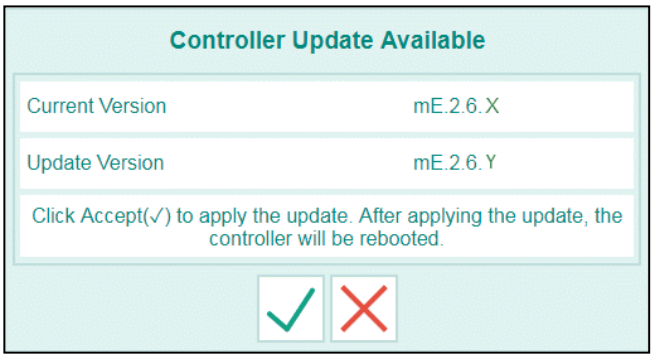
icon indicates the detection of a new version Web User Interface software.

If both versions can be updated at the same time, it is advised to start with updating the Control software.

8.1 UPDATING THE CONTROL SOFTWARE

Make sure that the controller is in an Idle state (no running fermentation or cultivation). Press the 

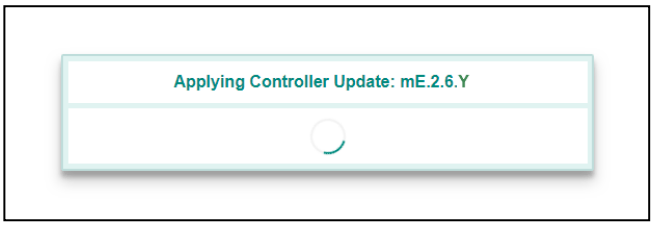
button to start the software updating routine.
A warning will be displayed, where:



Version mE.2.6.X is the current version and
Version mE.2.6.Y is the new version.

Press the  button to start the update process or press the  button to abort the update routine.

If installing the software update is confirmed, the new Control software version will be loaded and the controller will be rebooted.
Display message:



After rebooting the controller, the user must login again to obtain the proper authorization.

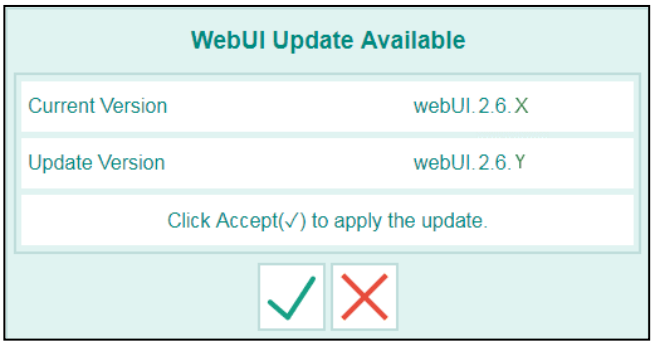
8.2 UPDATING THE WEB USER INTERFACE

Make sure that the conroller is in an Idle state (no running fermentation or cultivation). Press the 

button to start the software updating routine.

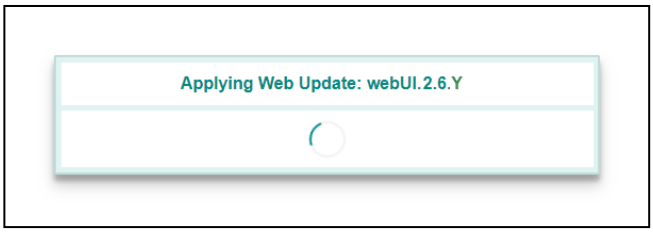
A warning will be displayed, where:

Version mE.2.6.X is the current version and
Version mE.2.6.Y is the new version.



Press the  button to start the update process or press the  button to abort the update routine.

If installing the software update is confirmed, the new Web User Interface software will be loaded. The controller will **not** be rebooted. Display message:



After loading the new Web User Interface, the user must login again to obtain the proper authorization.

9 APPENDIX C: ADDING / REMOVING LICENSES

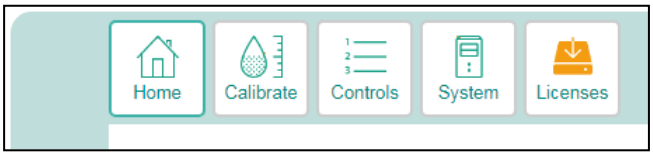
Some sensors and actuators come with a license.
If additional hardware has been installed, it may be necessary to install the corresponding license before the new hardware can be configured and used.

New licenses come in a license file. The license file must be saved to the root of a USB memory stick.

This USB stick must be inserted in to one of the two USB-ports at the rear of the running controller.

When a new license file has been detected by the controller, the 

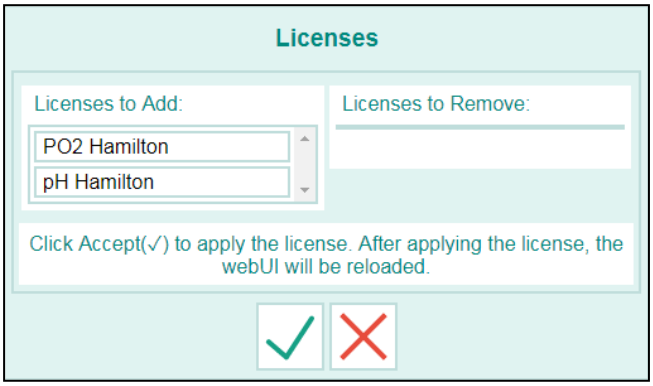
button will be presented.



The example below describes the addition of the license for the use of Hamilton pH and PO_2 sensors.

Press the 

button to start the installation of the new license.
Display Message:



Press the 
button to start installation of the new license, or
press the 
button to abort the update routine.

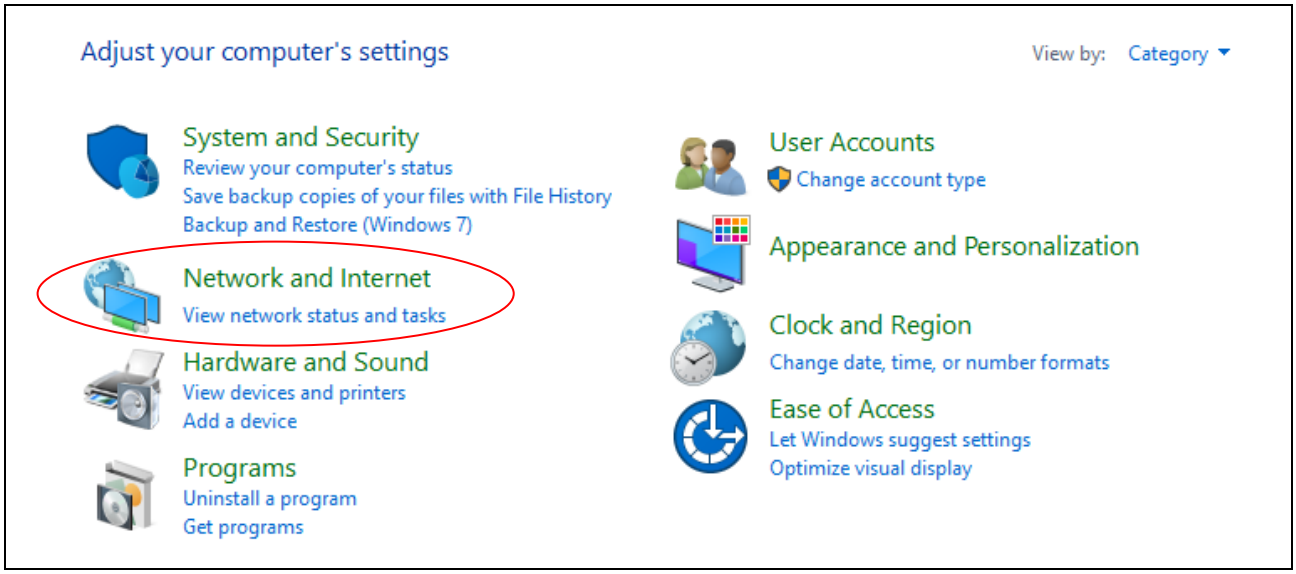
After installing the new license, the Web User Interface will be reloaded (logged on user will be logged out).

After loading the new Web User Interface, the user must login again to obtain the proper authorization.

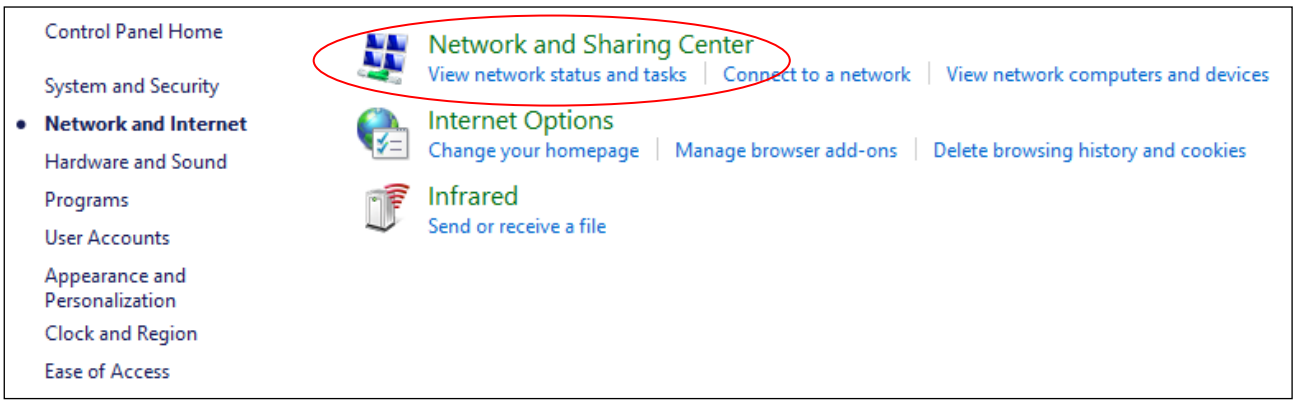
10 APPENDIX D: CONFIGURING THE NIC SETTINGS TO AVOID DISPLAY INSTABILITIES

When a **single** Applikon controller **with mE firmware** is connected to its host PC, instabilities in the web HMI may arise. This particular combination of circumstances can be avoided by configuring the PC as follows:

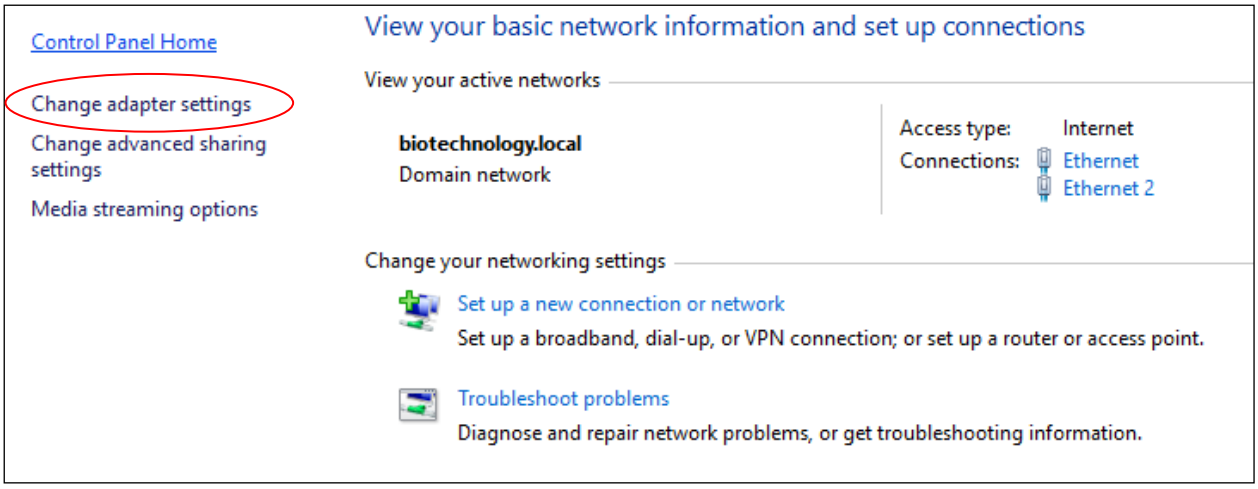
In Windows, start **Control Panel** and select **Network and Internet**:



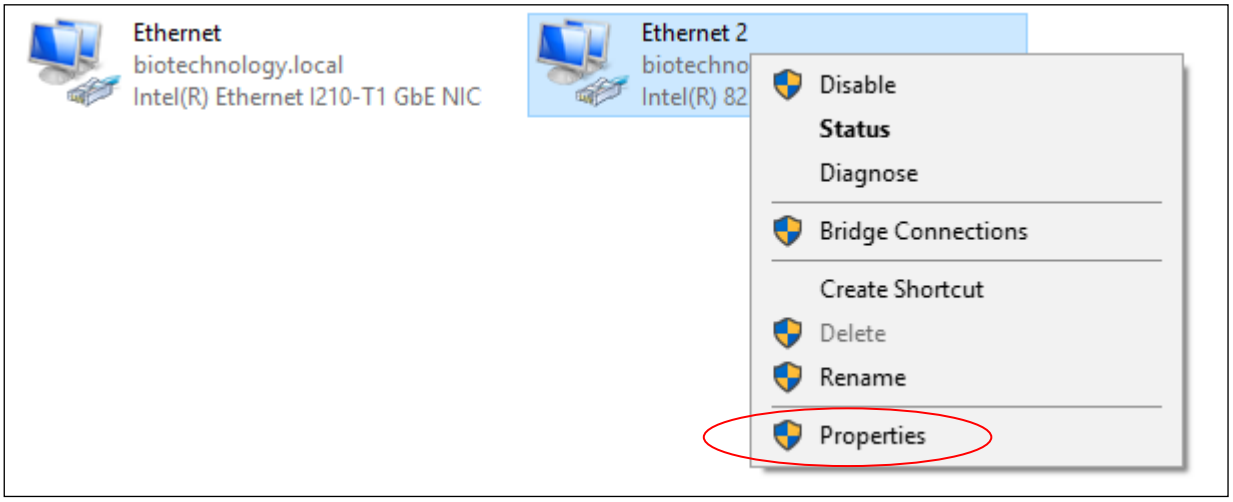
Select **Network Sharing Center**:



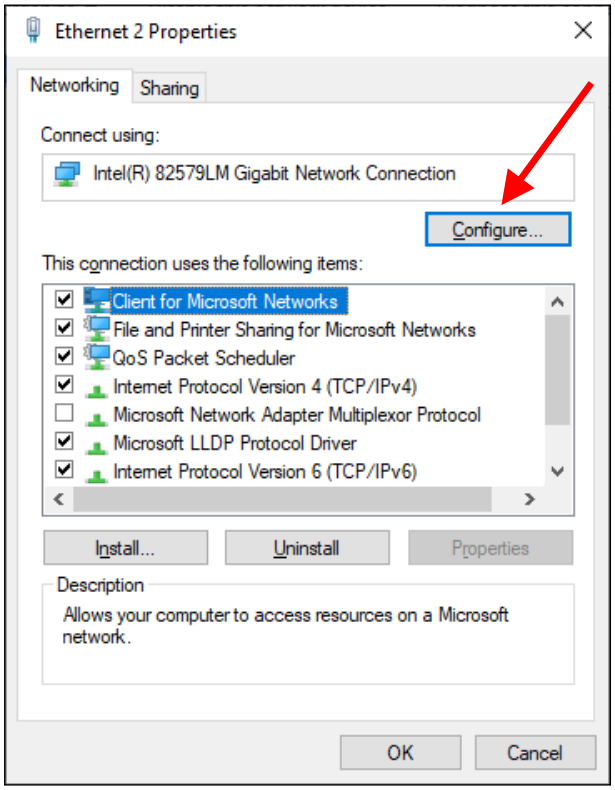
Select **Change adapter settings**:



If you see more than 1 adapter, select in any case the adapter that it is connected to the controller. Right click on it and select properties:



Click on **Configure**.



Select the **Advanced** tab.

In this tab, select the **Energy Efficient Ethernet** entry and set its Value to **disabled** using the drop-down at right.

Then scroll and search for the **Green Ethernet** option. Select it, if it is present and set its value to **Disabled**.

Finally, select the **Speed & Duplex** entry and set its value to **100 Mbps Full Duplex**.

This completes the configuration of the NIC.