Xuri Cell Expansion System W25

User Manual

cytiva.com

Table of Contents

1 Introduction

About this chapter

This chapter includes important user information, intended use of the system, and lists of important concepts and user documentation.

In this chapter

1.1 Important user information

Read the *Operating Instructions* before operating the product

All users must read the entire separate *Operating Instructions* before installing, operating, or maintaining the product.

Always keep the *Operating Instructions* at hand when operating the product.

Do not operate the product in any other way than described in the user documentation. If you do, you may be exposed to hazards that can lead to personal injury and you may cause damage to the equipment.

Intended use

Xuri™ Cell Expansion System W25 is intended to be used as laboratory and manufacturing equipment for cell cultivation. The system shall not be used for clinical or diagnostic purposes.

Prerequisites

In order to operate Xuri Cell Expansion System W25 in the way it is intended:

- you have a general understanding of how the client computer and Microsoft® Windows® operating systems work.
- you are acquainted with the use of general laboratory equipment and with handling of biological materials.
- you have read and understood the Safety instructions chapter in the *Operating Instructions* .
- the system is installed according to the instructions in the *Operating Instructions*.
- a user account has been created according to *UNICORN Administration and Technical manual* .

Safety notices

This user documentation contains safety notices (WARNING, CAUTION, and NOTICE) concerning the safe use of the product. See definitions below.

WARNING

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury. It is important not to proceed until all stated conditions are met and clearly understood.

CAUTION

CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury. It is important not to proceed until all stated conditions are met and clearly understood.

NOTICE

NOTICE indicates instructions that must be followed to avoid damage to the product or other equipment.

1.2 About this manual

Purpose of this manual

The *Xuri Cell Expansion System W25 User Manual* provides you with instructions and information how to run Xuri Cell Expansion System W25. It also includes relevant guidance for practical handling and maintenance of the system units.

Scope of this document

This manual covers Xuri Cell Expansion System W25, including the rocker, CBCU, pump, UNICORN™ software and accessories.

Typographical conventions

Software items are identified in the text by ***bold italic*** text.

Hardware items are identified in the text by **bold** text.

In electronic format, references in *italics* are clickable hyperlinks.

Notes and tips

Note: *A note is used to indicate information that is important for trouble-free and optimal use of the product.*

Tip: *A tip contains useful information that can improve or optimize your procedures.*

1.3 Associated documentation

Introduction

This section describes the user documentation that is delivered with the product, and how to find related literature that can be downloaded or ordered from Cytiva.

User documentation for Xuri Cell Expansion System W25

The table below describes the user documentation for Xuri Cell Expansion System W25, which is available from the ***Help*** menu in UNICORN or on the user documentation CD.

Document	Main contents
Xuri Cell Expansion System W25 Operating Instructions (29064612)	Instructions needed to install, operate and maintain Xuri Cell Expansion System W25 in a safe way. Includes basic UNICORN 7.x system control functions.
Xuri Cell Expansion System W25 User Manual (29064622)	Detailed system descriptions and instructions on how to run, maintain and troubleshoot Xuri Cell Expansion System W25. Includes UNICORN 7.x system control functions, method creation and handling, together with evaluation and presentation of data.
Xuri Cell Expansion System W25 Cue Card (29087822)	Brief instructions providing an overview of how to run the system.
UNICORN Quick Installation Guide (29414475)	Guide for installation of UNICORN.
UNICORN Administration and Technical manual	Overview and detailed description of network setup and complete software installation. Administration of UNICORN and the UNICORN database.
UNICORN Online Help	Dialog descriptions for UNICORN 7.x.
User Documentation CD	CD containing the listed manuals and translated versions of Xuri Cell Expansion System W25 Operating Instructions.

1.4 Abbreviations

Introduction

This section explains abbreviations that appear in the user documentation for this product.

Abbreviations

Concepts and abbreviations used in this manual are explained in the table below.

Concept/abbreviation	Explanation
Cellbag™ bioreactor	The disposable container in which the cells are cultured.
DO	Dissolved oxygen.
DO sensor	Optical sensor for measurement of dissolved oxygen. Attached to DO configured Cellbag bioreactors.
Single mode	Operating mode with one Cellbag bioreactor on the rocker.
Dual mode	Operating mode with two Cellbag bioreactors on the same rocker. Cultivation is monitored and controlled independently in the two bioreactors.
pH sensor	Optical sensor for pH measurement. Attached to pH configured Cellbag bioreactors.
Xuri Cell Expansion W25 CBCU	Control unit for gas mixing, pH and DO control.
Xuri Cell Expansion W25 Pump	The pump unit.
Xuri Cell Expansion System W25 rocker	The rocker.
Tray	Tray for Cellbag, mounted on the rocker. Different tray sizes are available for different culture capacities.
Bioreactor system	The entire system, including rocker, CBCU, and pump, together with Cellbag bioreactor and filter heater.
UNICORN	The software used for controlling and monitoring the system.

2 System description

About this chapter

This chapter gives an overview of Xuri Cell Expansion System W25 and describes the different bioreactor system units.

In this chapter

2.1 System overview

Introduction

Xuri Cell Expansion System W25 is intended for cell cultivation.

A disposable Cellbag bioreactor is placed on a rocker and filled with gas, partially filled with culture medium, and inoculated with cells. Gas transfer and mixing of culture is accomplished by wave-induced agitation, performed by the rocker unit.

The cell culture volume range per Cellbag bioreactor is 0.3 to 25 L depending on bioreactor size, and working volume may be expanded up to 10 times during one cultivation.

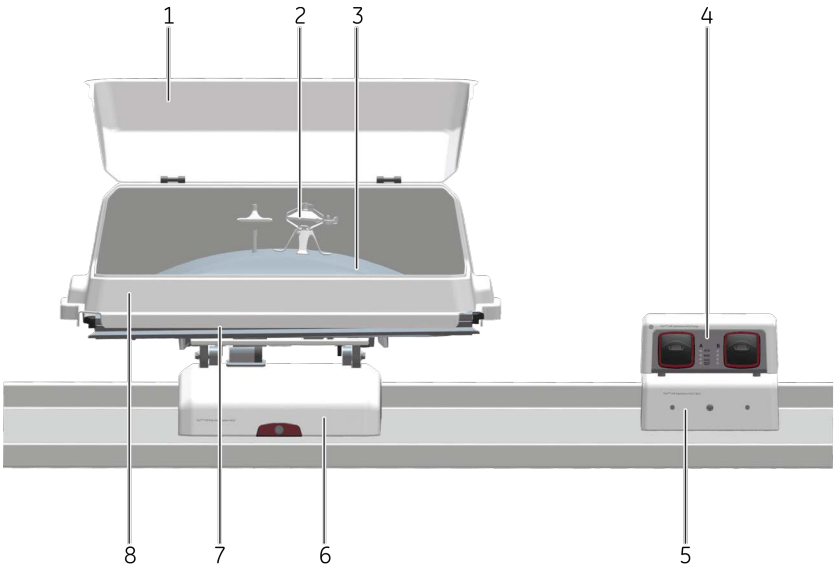
The system, composed of the rocker, Xuri Cell Expansion W25 CBCU and Xuri Cell Expansion W25 Pump , enables measurement and control of pH, DO, weight and media distribution, and provides different gas flow and gas mixing possibilities.

- In ***single mode*** , the system supports culture in one Cellbag bioreactor at one time. The rocker is connected to one Xuri Cell Expansion W25 CBCU and up to three Xuri Cell Expansion W25 Pump units.
- In ***dual mode*** , the system supports culture in two Cellbag bioreactors placed on the same tray. The rocker is connected to up to two Xuri Cell Expansion W25 CBCU units and up to three Xuri Cell Expansion W25 Pump units for independent control of culture conditions in the two bioreactors.

The system is controlled from a PC running UNICORN software version 7 or later. The system can also be controlled from a supervisory control and data acquisition (SCADA) system, such as the DeltaV™ control system, using the integrated OPC server. Contact Cytiva for instructions and guidance for OPC.

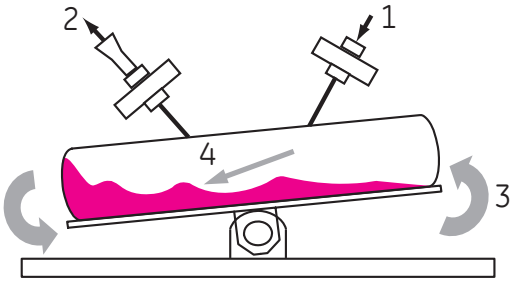
Illustration of the system

The illustration below shows the main system units for use in single mode with one Xuri Cell Expansion W25 Pump . Dual mode uses two Xuri Cell Expansion W25 CBCU units for controlling the two Cellbag bioreactors independently. Both single and dual modes can support up to three Xuri Cell Expansion W25 Pump units.



Part	Description
1	Hatch
2	Filter heater
3	Cellbag bioreactor
4	Xuri Cell Expansion W25 Pump
5	Xuri Cell Expansion W25 CBCU
6	Xuri Cell Expansion System W25 rocker
7	Tray
8	Lid

Illustration of wave motion



Stage	Description
1	Inflowing gas from the CBCU enters the Cellbag bioreactor through the inlet vent filter. The gas flow inflates the bag and oxygenates the culture.
2	Metabolic waste gases leave the Cellbag bioreactor through the outlet vent filter. The pressure control valve maintains a constant overpressure inside the Cellbag bioreactor.
3	The rocking mechanism sets the rocking platform in motion.
4	Wave motions are induced by the rocking. The culture is cautiously mixed, and gases are transferred into the culture.

Available controlled parameters

The table below describes the controlled parameters for the fully configured bioreactor system. The controlled parameters of your configuration may vary from the list below. In dual mode, all parameters except rocking speed, angle and motion may be controlled independently in the two Cellbag bioreactors.

Parameter	Description
Temperature	The system can control temperature between room temperature plus 5°Cand 40°C.
Rocking speed	Rocking speed can be set between 2 and 40 rpm.
Rocking angle	Rocking angle can be set between 2 and 12 degrees.
Rocking motion	Rocking motion can be set between 15% and 100%, and is by default set to 30%. A rocking motion of 15% gives a uniform motion with almost constant angular velocity throughout the movement, and 100% gives a smooth, completely sinusoidal motion.
Gas flow	The system can control the gas flow into the cellbag between 0.02 and 1.00 lpm.
Media distribution	The system can control culture medium addition and removal. Two different modes exist, media addition and perfusion.
pH	pH is measured and controlled between pH 6 and pH 8. Three different modes of pH regulation exist, with CO_2, CO_2/base, and acid/base.
DO	DO is measured between 0% and 250% and controlled between 0% and 100% air saturation. Three different modes of DO regulation exist, with O_2, speed, and O_2/speed.
CO_2	CO_2 concentration in gas mix can be controlled between 0% and 15% and measured between 0% and 20%.
O_2	O_2 concentration in gas mix can be measured between 0% and 50%, and controlled between 0%and 50% with N_2 and between 21% and 50% with air.

2.2 Xuri Cell Expansion System W25 rocker

Introduction

The rocker is the main unit of the system. Through the rocker, weight is measured, and temperature, rocking speed, rocking angle and rocking motion are controlled.

The rocker contains four load cells for monitoring the weight of the Cellbag bioreactor and content. The placement of the load cells allows independent weight measurement of the two Cellbag bioreactors in dual mode.

The rocker also contains an embedded microprocessor, which allows the system to be controlled independently of the performance of the connected network and client computer.

For rocker specifications, see *Rocker specifications, on page 244*.

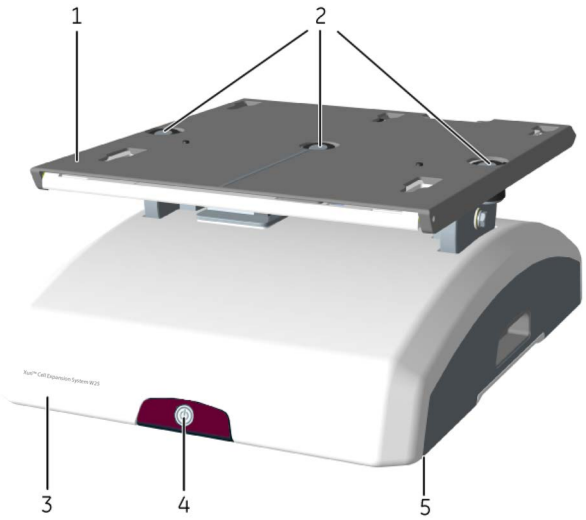
Rocking parameters

The adjustable rocking parameters are rocking speed, rocking angle and rocking motion. These factors, in combination with the cell culture volume, have a direct impact on the oxygen transfer rate and mixing time in the Cellbag bioreactor.

The rocking motion sets how large part of the rocking cycle that has a sinusoidal angular velocity. It can be adjusted to be more or less sinusoidal. The minimum value, 15%, gives a uniform motion with almost constant angular velocity throughout the movement, resulting in a step-wise rocking. The maximum value, 100%, gives a sinusoidal motion with slower angular velocity in the end positions and faster in the middle of the movement, resulting in a smoother rocking.

Front view of the rocker

The illustration below shows the front view of the rocker.



Part	Description
1	Rocker platform
2	Temperature sensors
3	Rocker base
4	**Power** button
5	Location of adjustable foot

Power button

The **Power** button indicates the status of the rocker according to the list below.

Light indicator	Image	Description
No light		The power is OFF.
Green flashing light		The rocker is starting up.
Green steady light		The power is ON and the rocker is operational.
Red flashing light		The rocker failed to connect to other components in the system.
Red steady light		Indicates an error of the rocker.

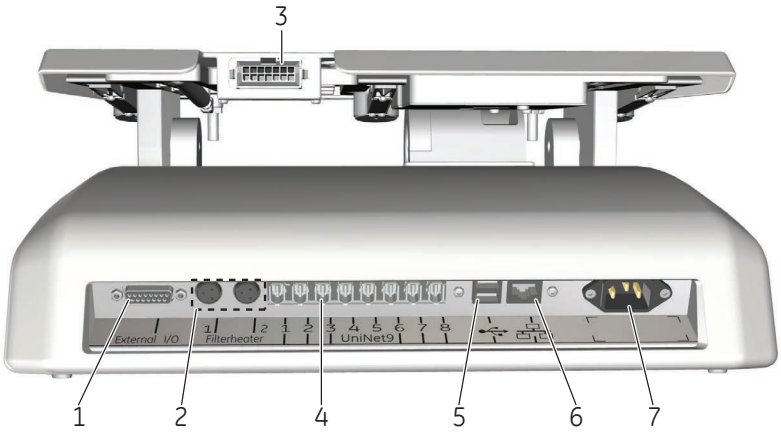
Adjustable foot

The adjustable foot is placed in the front right corner of the rocker base when viewed from the front. It is used to distribute weight evenly over the four rocker feet.

Use the supplied adjustable foot wrench to adjust the foot.

Rear view of the rocker

The illustration below shows the rear panel of the rocker.



Part	Description
1	15-pin D-sub connector, used for digital and analog I/O signals
2	Filter heater connectors
3	Tray connector
4	UniNet-9 ports
5	USB ports
6	Ethernet connector
7	Power connector ***Note:*** *The rocker is fitted with internal electrical fuses that are not user-replaceable.*

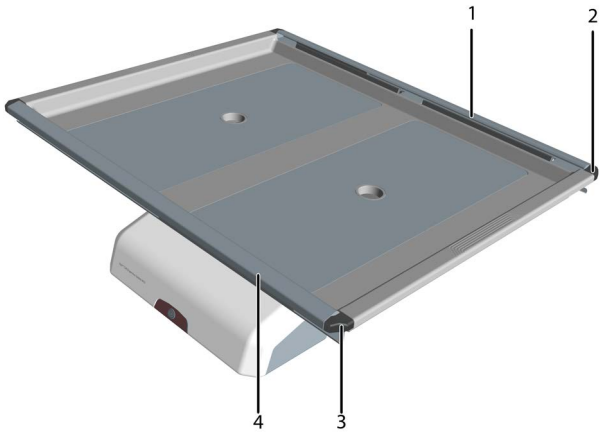
Tray and lid sizes

Trays and lids are available in the different sizes listed below:

Trays	Lids
Tray 10	Lid 10
Tray 20	Lid 20
Tray 50	Lid 50

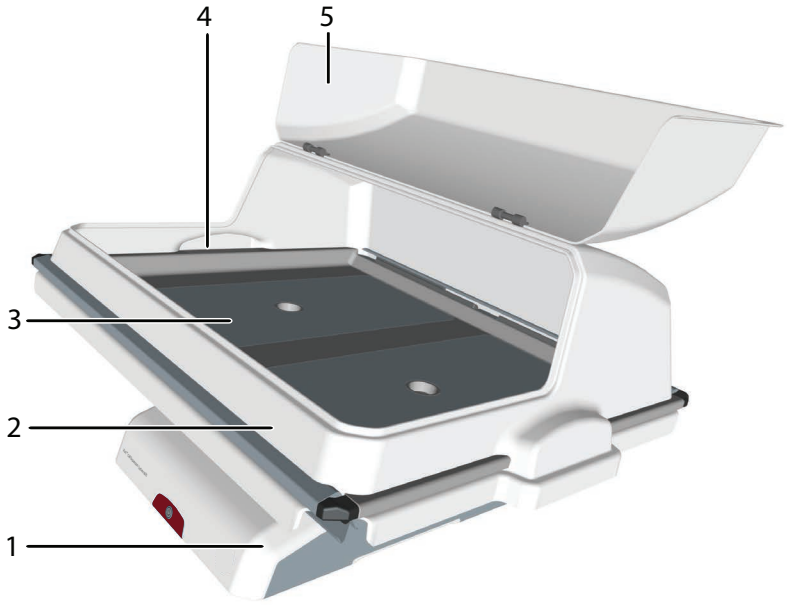
Illustrations of tray and lid

The illustration below shows the rocker with Tray 50 attached.



Part	Description
1	Bag clamp (upper)
2	Bag clamp opener (one in each upper corner)
3	Bag clamp opener (one in each lower corner)
4	Bag clamp (lower)

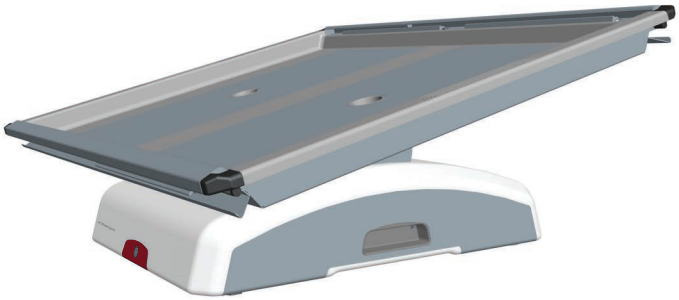
The illustration below shows the rocker with Tray 50 and Lid 50 mounted.



Part	Description
1	Rocker base
2	Lid
3	Tray
4	Tubing exit
5	Hatch

Prepare for tilt

When the system enters ***END*** mode, the tray prepares for tilt if ***System Settings →Rocker →Prepare for tilt at END*** is set to ***Yes***. This moves the rocker to the mechanical end position, which is 14 degrees from horizontal. This position can also be set by executing the manual instruction ***Rocker →Prepare for tilt***. See illustration below.



Tilt position

In order to facilitate tray change in system setup and sampling and harvest during and after cell cultivation, it is possible to position the tray with the attached Cellbag bioreactor(s) into an upright position called tilt position. Follow the instructions below to put the tray into tilt position.

The tray is shown without attached Cellbag bioreactor in the images below.

NOTICE

Take care when tilting the rocker tray with full Cellbag bioreactor(s) attached.

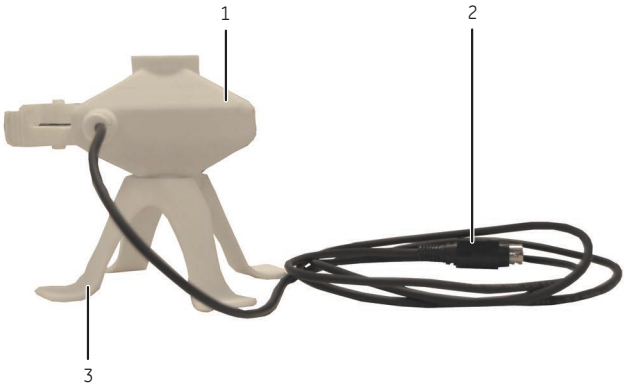
Step	Action
1	Prepare for tilt as described above or select the largest possible angle in UNICORN. Do not tilt the tray from an angle lower than 12°.

Step	Action
2	Hold the textured grip area on each side of the tray and pull the tray towards you.

The illustration below shows the tilt position:

Filter heater

The filter heater prevents condensation and clogging of the outlet vent filter on the Cellbag bioreactor.



Part	Description
1	Filter heater
2	Connector for connection to the rocker
3	Filter heater stand

2.3 Xuri Cell Expansion W25 CBCU

Introduction

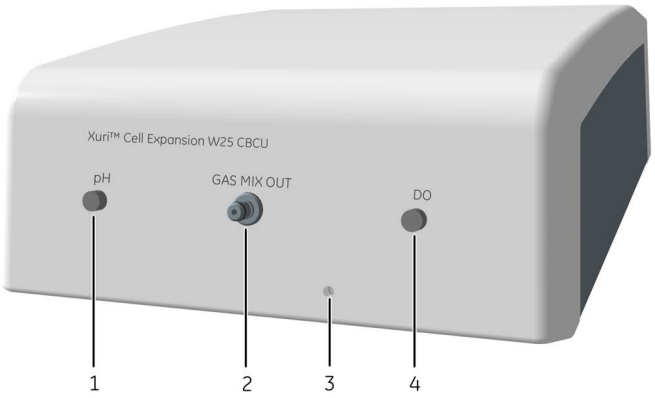
The control unit, Xuri Cell Expansion W25 CBCU, is connected to the rocker via a UniNet-9 connector. The full configuration mixes air/N_2, O_2, and CO_2 gas, and contains O_2 and CO_2 sensors, a mass flow controller, an optical pH sensor reader, and an optical DO sensor reader. Three configurations are available:

- *Xuri Cell Expansion W25 CBCU pH*: CO_2, O_2 and pH.
- *Xuri Cell Expansion W25 CBCU DO* : CO_2, O_2 and DO.
- *Xuri Cell Expansion W25 CBCU Full*: CO_2, O_2, pH and DO.

For CBCU specifications, see *Xuri Cell Expansion W25 CBCU specifications, on page 245*.

Front view of Xuri Cell Expansion W25 CBCU

The illustration below shows the front panel of a fully configured CBCU. The configuration of your CBCU may vary from the configuration shown below.



Part	Component	Description
1	**pH** port	Connector for pH sensor fiber cable.
2	**GAS MIX OUT**	Gas outlet for connection to Cellbag bioreactor.
3	Status LED	Indicates the CBCU operating status.
4	**DO** port	Connector for DO sensor fiber cable.

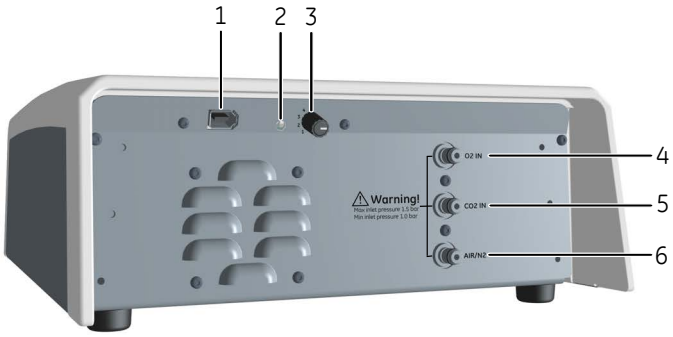
Status LED

The status LED indicates the CBCU operating status according to the following table.

Light indicator	Description
Steady green light	The CBCU is ready for operation.
Green flashing light	The CBCU is operating.
Red flashing light	Indicates an internal error, but the CBCU is still operating.
Steady red light	Indicates an internal error, and the CBCU is not operating.

Rear view of Xuri Cell Expansion W25 CBCU

The illustration below shows the rear panel of a fully configured CBCU.



Part	Component	Description
1	UniNet-9 port	Power connection to the rocker.
2	CAN indicator LED	Indicates system connection status.
3	CAN ID switch	Switch for setting the CBCU unit number for system recognition.
4	**O2 IN**	Inlet connection for O_2 supply.
5	**CO2 IN**	Inlet connection for CO_2 supply.
6	**AIR/N2**	Inlet connection for air or N_2 supply.

CAN ID

The CAN ID is a unit number used by UNICORN to recognize the CBCU that is connected to the system.

The CAN ID is set by turning a switch on the CBCU rear panel (see illustration above). The CAN ID should always be set to position 1 for use in single mode. For dual mode, set the CAN ID to 1 for the CBCU connected to the left Cellbag bioreactor, and to 2 for the CBCU connected to the right Cellbag bioreactor.

Tubing and connectors

Tubing and connectors for gas flow as listed below are delivered with the Xuri Cell Expansion W25 CBCU. Tubing and connectors for liquid flow must be obtained separately.

Tubing

Item	Inner diameter	Outer diameter	Length
Tygon™ E3603	1/8" (3.2 mm)	1/4" (6.4 mm)	147.6" (375 cm)
Silicone	3/16" (4.8 mm)	3/8" (9.5 mm)	7.9" (20 cm)

Connectors

Item	Inner diameter
Reducer connector, gas tubing	1/8" to 3/16" (3.2 to 4.8 mm)
Connector, CBCU	1/8" (3.2 mm)

2.4 Xuri Cell Expansion W25 Pump

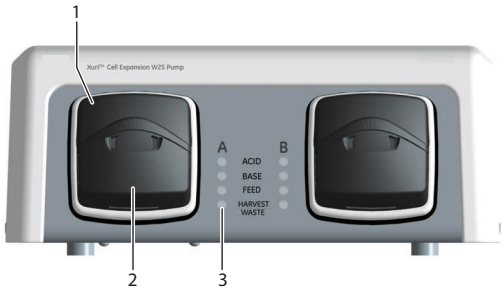
Introduction

Xuri Cell Expansion W25 Pump is a peristaltic pump unit that includes two roller pumps. It pumps fluid for feed, harvest/waste, and pH control with acid and base.

For specifications of the pump, see *Xuri Cell Expansion W25 Pump specifications, on page 246* or the data file for Xuri Cell Expansion System W25, available for download from cytiva.com.

Front view of the pump

The illustration below shows the front panel of the pump.



Part	Description
1	Pump head flip top
2	Pump head
3	Status LEDs for pumping function per pump head

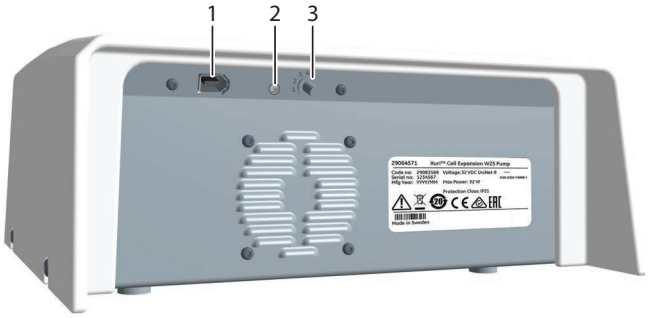
Status LEDs

The status LEDs indicate the pumping function status according to the following table.

Light indicator	Description
Steady green light	The pumping function is ready for operation.
Green flashing light	Pumping is ongoing.
Red flashing light	Indicates an internal error, but the pump is still operating.
Steady red light	Indicates an internal error, and the pump is not operating properly.

Rear view of the pump

The illustration below shows the rear panel of the pump.



Part	Component	Description
1	UniNet-9 port	Power connection to the rocker.
2	CAN indicator LED	Indicates system connection status.
3	CAN ID switch	Shows the unit number of the pump for recognition by the system.

CAN ID

The CAN ID is a unit number used by UNICORN to recognize the particular pump unit that is connected. If more than one pump unit is connected, the units are distinguished by their CAN IDs.

The CAN ID is set by turning a switch on the pump rear panel (see illustration above). The switch has four CAN ID positions, marked 1, 2, 3, and 4, respectively. The CAN ID should be set to position 1 for the first pump, position 2 for the second pump and so on.

Tip: *The pumps are identified in UNICORN by their CAN ID. Label each pump unit with its CAN ID to simplify identification of the physical pump.*

2.5 Cellbag bioreactor

Introduction

Cell cultivation is performed inside the Cellbag bioreactor. The Cellbag bioreactor is delivered gamma irradiated and ready for use. It is intended for single use only and should be discarded after use.

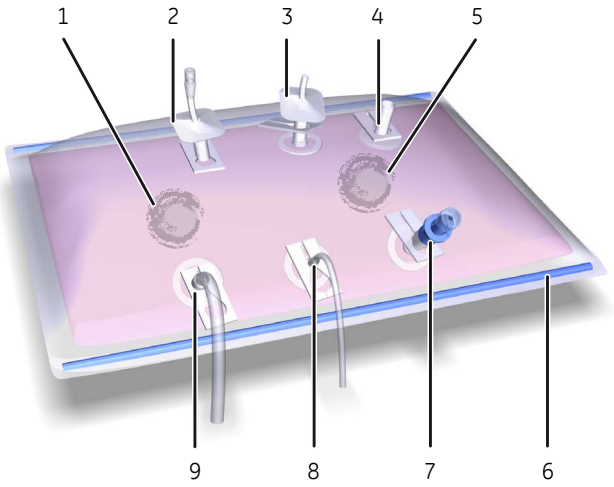
Cellbag bioreactor options

The Cellbag bioreactors are available in different configurations, of varying sizes and equipped with various ports. Cellbag bioreactors with internal cell retention filters are available for perfusion culture. If required, it is possible to customize the Cellbag bioreactors. The following bag sizes are available for Xuri Cell Expansion System W25:

- 2 L
- 10 L
- 20 L (single mode only)
- 50 L (single mode only)

Illustration of Cellbag bioreactor

The illustration shows a general Cellbag bioreactor. The configuration of your Cellbag bioreactor may vary from the configuration shown below.



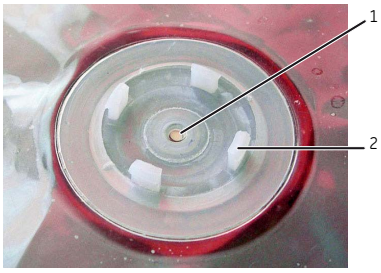
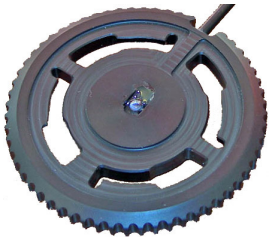
Part	Component	Description
1	pH bag sensor port	The pH bag sensor port is located on the underside of the bag and holds an optical sensor for online pH control of the cell culture.

Part	Component	Description
2	Outlet vent filter with pressure control valve	The filter prevents contamination of the bag contents by airborne particles of 0.2 µm or larger. The pressure control valve maintains a constant over-pressure inside the Cellbag bioreactor.
3	Inlet vent filter	The filter removes airborne particles of 0.2 µm or larger from the gas flow before it enters the Cellbag bioreactor.
4	Addition port	Addition port equipped with a Luer quick connector.
5	DO bag sensor port	The DO bag sensor is located on the underside of the bag and holds an optical sensor for online dissolved oxygen control of the cell culture.
6	Cellbag rod	The Cellbag rod fixes the Cellbag bioreactor to the tray.
7	Clave™ sampling port	Sampling port equipped with a self-sealing Luer fitting.
8	Addition port	Addition port equipped with a Luer quick connector.
9	Addition/ harvest port	Addition/harvest port equipped with a MPC quick connector.

Note: *The inlet and outlet vent filters are distinguished by the pressure control valve on the outlet filter.*

pH and DO sensors

The Cellbag bioreactor may be equipped with optical sensors for monitoring pH and dissolved oxygen (DO). The sensors are light sensitive and should be protected from excessive light. The sensors are located in the center of a sensor port on the Cellbag bioreactor and must be coupled to a sensor adapter, see table below.

Part	Description
Bag sensor port	The sensor port is located on the underside of the Cellbag bioreactor. The actual sensor (white/yellow for pH, pink/black for DO is located in the center (1) of the sensor port, see image below. The sensor adapter is attached to the sensor port by the four pins (2). 
Sensor adapter	The sensor adapter is located at one end of an optical fiber cable. The optical lens of the fiber cable is located in the center of the sensor adapter. The fiber cable is connected to a sensor reader in the CBCU. The fiber cable is connected to the pH or DO port on the CBCU front panel. 

2.6 UNICORN software overview

About this section

This section gives an overview of the general operation of the UNICORN software: a complete package for control, supervision and evaluation of cell cultivation runs. It also describes how to access the help utility that is included in UNICORN. Refer to *Chapter 3 The UNICORN software, on page 36* for more information.

Note: *Software illustrations in these instructions are examples, and may differ from your software in some details.*

In this section

2.6.1 General UNICORN operation

UNICORN modules overview

UNICORN consists of four modules: ***System Control***, ***Evaluation***, ***Administration*** and ***Method Editor***.

The main functions of the modules are described in the table below.

Module	Main functions
System Control	Start, view and control runs.
Evaluation	Open results, evaluate runs and create reports.
Administration	Perform user and system setup, system log and database administration.
Method Editor	Create and edit methods.

Enter a UNICORN module

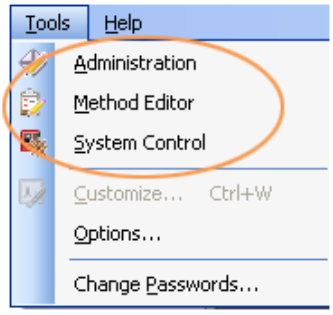
To enter a module:

- click the ***Taskbar*** button of the module of interest,

or

- choose the module of interest in the ***Tools*** menu in any of the other software modules.

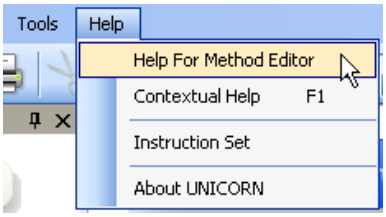
  The illustration below shows the ***Tools*** menu of the ***Evaluation*** module.



2.6.2 UNICORN help

Access the help utility

A comprehensive help utility is included in the UNICORN software. The table below describes how to access the different parts of the help utility.

If you want to...	then...
find information about a UNICORN module	select ***Help*** →***Help for...*** in the UNICORN module of interest 
find information about the item currently selected and in focus (e.g., a pane, a dialog, or a method phase)	• press the **F1** key with the item of interest selected and in focus or • click the ***Help*** icon in the open dialog 
navigate the online help	• select ***Help*** →***Help for...*** in any of the UNICORN modules (see illustration above) • in the ***TOC*** (Table of contents) pane, expand the headings of interest to navigate the content structure • click the heading of interest to open a section
search for a specific term in the online help	• select ***Help*** →***Help for...*** in any of the UNICORN modules (see illustration above) • in the ***Search*** pane, enter the term of interest in the input field • click the ***Search*** button 

If you want to...	then...
access manuals in PDF format	• select ***Help*** →***Help for...*** in any of the UNICORN modules (see illustration above) • in the ***TOC*** pane, expand the heading ***UNICORN 7.x online documentation portal*** and select ***Documentation overview*** • in the ***PDF manuals*** section, click one of the text links
find information about an instruction	In the ***Method Editor*** module: • open a method • select the instruction of interest in the ***Instruction box*** in the ***Text instruction*** pane • press the **F1** key In the ***System Control*** module: • select ***Manual*** →***Execute Manual Instructions*** • expand a heading and select the instruction of interest • press the **F1** key *or* click the ***Help*** icon in the dialog 

3 The UNICORN software

About this chapter

This chapter gives an overview of how to work with the four UNICORN modules. Detailed information about the UNICORN software is available in the UNICORN user documentation and in the *UNICORN Online Help*.

In this chapter

3.1 Administration

Introduction

The ***Administration*** module is used to manage all functions of the UNICORN software. Refer to *UNICORN Administration and Technical manual* for more information.

Icons in the Administration module

The table below shows the ***Administration*** module icons.

Icon	Function
	***User Setup*** is used to manage user access to UNICORN.
	***Access Groups and Network Users*** is used to manage access groups and network users.
	***E-mail Setup*** is used to set up an e-mail account for automated system messages.
	***UNICORN and System Log*** provides the system administrator with records of usage and activity.
	***System Properties*** is used to define the system and edit system properties.
	***Database Management*** is used for maintenance of the database.

3.2 System control

Introduction

The ***System Control*** module is used to start, view, and control a manual or method run.

System Control panes

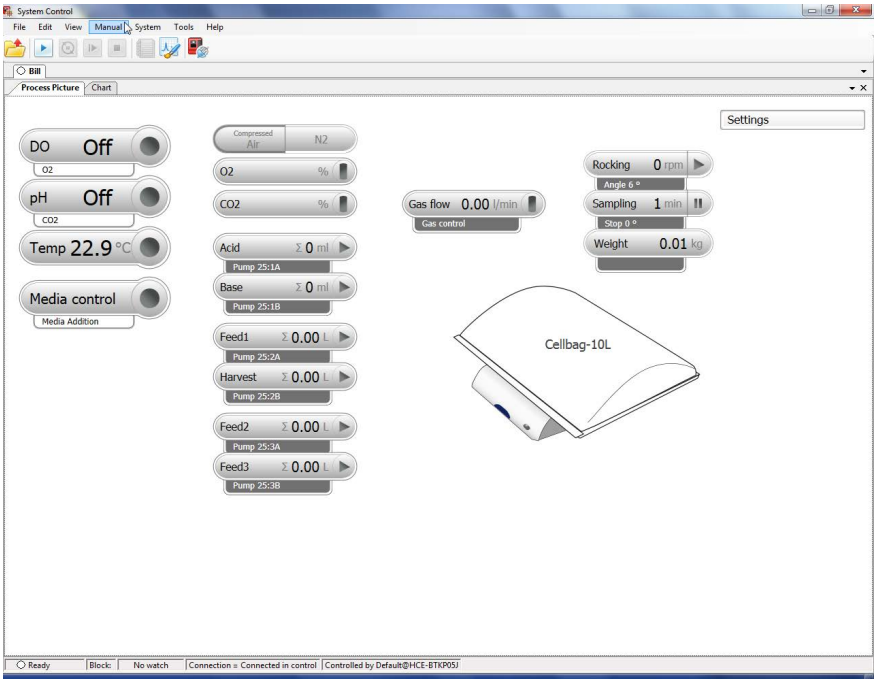
As illustrated below, two tabs are available in the ***System Control*** module by default. The ***Process Picture*** tab allows manual interactions with the system and provides feedback on run parameters. The ***Chart*** tab shows a graphical presentation of data throughout the run. Process picture, charts, run logs, and run data can be displayed either as separate tabs or as docked panes in the same window.

More details of how to work with the process picture may be found in the sections listed in the table below:

Section	Content
Section 5.4 Perform cultivation, on page 196	Information on how to perform a run.
Section 5.4.2 Monitor and control the run, on page 198	Working with the process picture during a run.

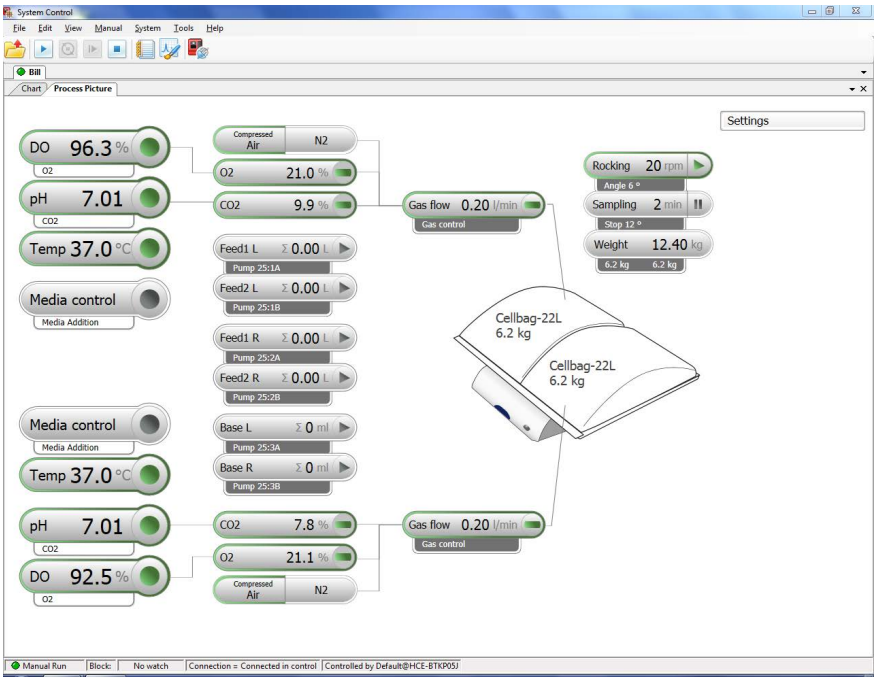
Refer to *Section 5.4 Perform cultivation, on page 196* for information on how to perform a run.

Tip: *To get more information than is shown in the **Process Picture**, select **View** →**Run Data** to open the **Run Data** pane which presents current data in numerical values.*



Items in the process picture reflect the components included in the system (for example, the illustration above shows a system in single mode equipped with three pumps).

In dual mode, the process picture shows two Cellbag bioreactors on the rocker picture, with separate control icons for the individually controlled parameters in each bioreactor. Icons for the left-hand bioreactor are in the upper half of the process picture and icons for the right-hand bioreactor in the lower half.



Identifying system components in the process picture

This section describes how to identify the units in the process picture with respect to the Cellbag bioreactors in single and dual mode.

- The left- and right-hand Cellbag bioreactors in dual mode are controlled by the CBCU units with CAN ID 1 and 2 respectively. They are shown on the left and right sides of the tray in the process picture. To avoid confusion, place the physical CBCU units on the left and right sides of the tray as viewed from the front of the rocker.
- Connections between the Cellbag bioreactor(s) and the respective monitor and active control units are indicated by connection lines in the process picture.
- Pump units are identified in the process picture as ***1, 2*** or ***3*** according to their CAN ID setting, and the pump heads on each unit are designated ***A*** (left) and ***B*** (right).

  In dual mode, pump roles for the left and right Cellbag bioreactors are labelled ***L*** and ***R*** respectively.

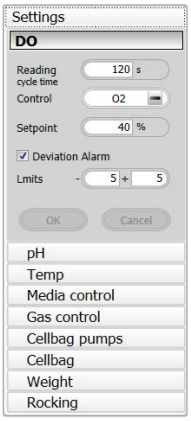
Examples:
Pump 25 →***1B*** refers to the right-hand pump head on the pump unit with CAN ID 1.
Pump 25 →***2A*** refers to the left-hand pump head on the pump unit with CAN ID 2.

Tip: *Label the CBCU and pump units with their CAN ID settings to simplify correlation of the physical units with the process picture.*

In dual mode, place the pumps connected to the left and right Cellbag bioreactors on the left and right sides of the rocker respectively.

Actions in the Process Picture pane

It is possible to interact with the ***Process Picture*** pane in the following ways:

If you want to...	then...
Activate or deactivate pH and DO measurement and control	Hold the cursor over the right-hand side of the button, and turn ***Reading*** and/or ***Control*** on or off as required. You can only switch the ***Control*** setting if ***Reading*** is on, and you cannot turn ***Reading*** off if ***Control*** is on. 
Activate or deactivate other functions	Click on the right-hand side of the button. The text on the button shows the current value of the function. 
Open the settings for a function	Click on the left-hand side of the button.  The example below shows the settings for dissolved oxygen, ***DO***. 
Adjust the settings	Enter appropriate values in the ***Settings*** dialog and click ***OK*** or press enter.

System Control toolbar icons

The table below shows the ***System Control*** toolbar icons that are referred to in this User Manual.

Icon	Function
	***Open Method Navigator***: Opens the ***Method Navigator*** where available methods are listed.
	***Run***: Starts a method run.
	***Hold***: Suspends the method run.
	***Continue***: Resumes a process, for example, a method run that is on hold.
	***End***: Permanently ends the method run.
	***Customize***: Opens the ***Customize*** dialog where curve settings, run data groups and run log contents can be set.
	***Connect to Systems***: Opens the ***Connect to Systems*** dialog where systems can be connected, and currently connected users are displayed.

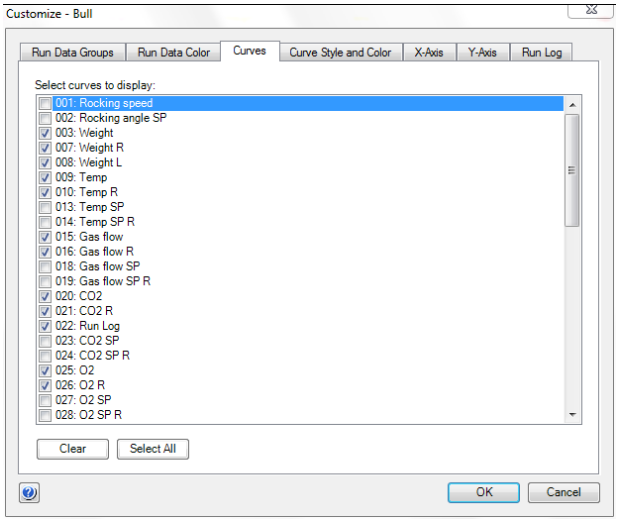
Curves

Monitor signals and instrument settings are shown in the chart as curves. The curves are also saved in a result file, which can be opened in the ***Evaluation*** module. The default view shows the most commonly used curves. The user may customize which curves to display and the color and style of the displayed curves.

Note: *All curves are saved in the result file regardless of the curves displayed.*

Note: *The complete ranges of the signals are saved in the result file regardless of factors such as scaling and zooming that are used during the run.*

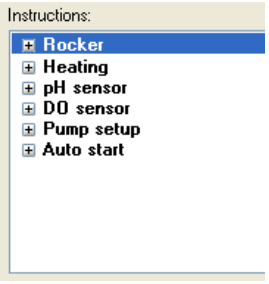
Follow the instructions below to customize which curves to show in the chart. Refer to the online help for further information about the tabs in the ***Customize*** dialog.

Step	Action
1	In the ***System Control*** module: • click the ***Customize*** icon  or • select ***Tools*** →***Customize...*** *Result:* The ***Customize*** dialog opens.
2	Select the ***Curves*** tab. 
3	Check the boxes for the curves you want to show in the chart and then click ***OK***.

System settings

Each installed instrument has a set of default parameter values, called system settings. The ***System Settings*** dialog in ***System Control*** is used to view and edit the system setting for the currently selected instrument before the run is started. Follow the instructions below to change the ***System Settings***.

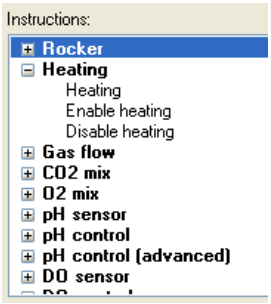
Available settings are described in *Section 8.5 Control settings, on page 250*.

Step	Action
1	In the ***System Control*** module, select ***System*** →***Settings***. *Result:* The ***System Settings*** dialog opens with the ***Instructions*** displayed. An example is shown below. 
2	Select the instruction to edit from the list. Click the + symbol to show the instructions for each category. The instructions in each category differ depending on the instrument configuration.
3	Select settings and choose parameter values for the selected instruction. Click ***OK.*** Settings will apply until they are changed.
4	To return to the default values defined in the instrument configuration, click ***Set Parameters To Strategy Default Values***.

Manual instructions

It is possible to interact manually with an ongoing run using ***Manual instructions***. Follow the instructions below to perform manual instructions.

Note: *It is also possible to interact with the system manually directly from the* ***Process Picture****.*

Step	Action
1	In the ***System Control*** module: • select ***Manual*** →***Execute Manual Instructions*** or • use the shortcut **Ctrl+M**. *Result:* The ***Manual instructions*** dialog opens. 
2	In the ***Manual instructions*** dialog: **a.** Click the + symbol to show the instructions for the instruction group that you want to modify. **b.** Select the instruction that you want to modify. **c.** Enter the new values for the instruction.
3	To execute several instructions at the same breakpoint, select and edit an instruction and click ***Insert***. Repeat for several instructions. ***Note:*** *To update parameter fields during run, check the* ***Auto update...*** *box.*
4	To perform the instructions, click ***Execute***.

Run data

The ***Run Data*** pane shows the current values of some parameters, for example rocking motion and accumulated time. To change the ***Run Data*** display, select ***View*** →***Run Data***, right click in the ***Run Data*** pane and:

- select ***Run Data Groups*** →***Detailed*** to show more details

  or
- select ***Customize*** to customize the appearance of the ***Run Data*** pane.

3.3 Methods in UNICORN

About this section

This section describes how to create methods and work with predefined methods and text instructions. For information about dialogs in the ***Method Editor*** that are not described in this manual, refer to the online help.

In this section

3.3.1 Method editor

Introduction

In the UNICORN software, the instructions to control a bioreactor run can be defined in a method. The ***Method Editor*** module is used to create or edit such methods.

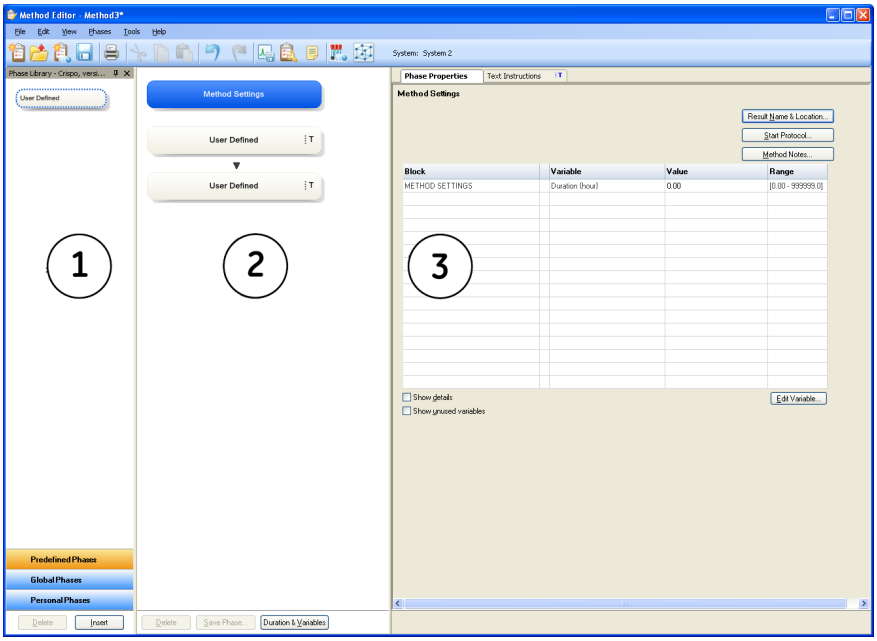
User defined methods and phases

A method consists of a number of phases, and each phase consists on turn of a number of instructions.

Refer to the *UNICORN Online Help* for more information about methods and phases and how to create a method.

Method Editor panes

As illustrated below, three panes are shown in the ***Method Editor*** by default. The available ***User Defined*** phase is found in the ***Phase Library*** (1), and an overview of the phases included in the active method is displayed in a ***Method Outline*** (2). Information about the method is presented in the right pane (3), containing the two tabs ***Phase Properties*** and ***Text Instructions***.



Method Editor toolbar icons

The table below shows the ***Method Editor*** toolbar icons that are referred to in this User Manual.

Icon	Function
	***New Method:*** Opens the ***New Method*** dialog where methods can be created.
	***Open Method Navigator***: Opens the ***Method Navigator*** where available methods are listed.
	***Save***: Saves the active method.
	***Print***: Opens the ***Print*** dialog from where a method can be printed.
	Start protocol: Opens the ***Start Protocol*** dialog, where settings for the start protocol can be made.
	***Method notes***: Opens the ***Method Notes*** dialog, where notes can be added to the method.
	***Scouting***: Opens the ***Scouting Variables*** dialog, which is used to repeat a series of method runs.
	***New method queue***: Opens the ***Method Queue*** dialog.

3.3.2 Method creation

Predefined method

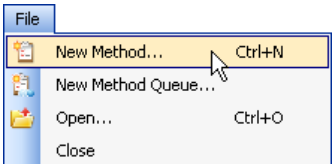
Follow the instructions below to create a new method using a predefined method as template:

Step	Action
1	In the ***Method Editor***:

- click the ***Create a new method*** icon in the ***Toolbar***

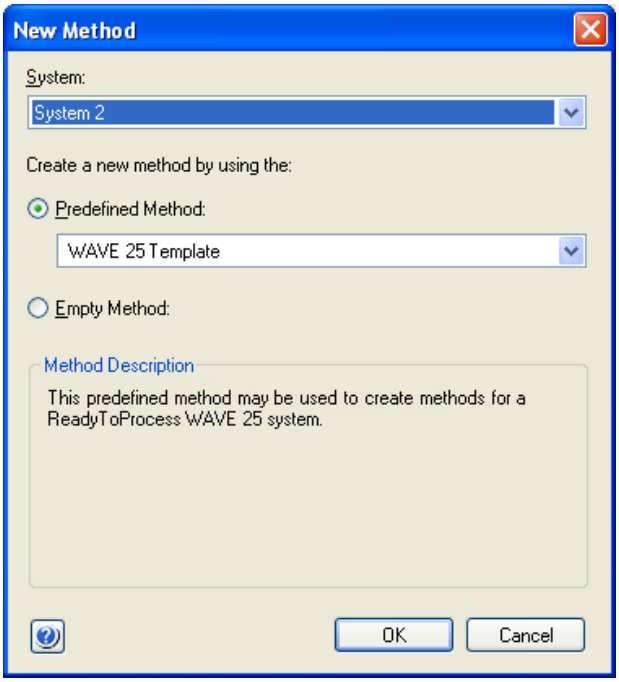
or

- select ***File*** → ***New Method...***



Result:

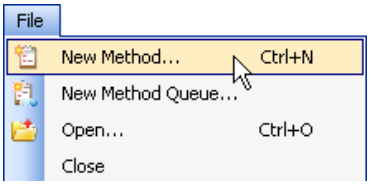
The ***New Method*** dialog opens.

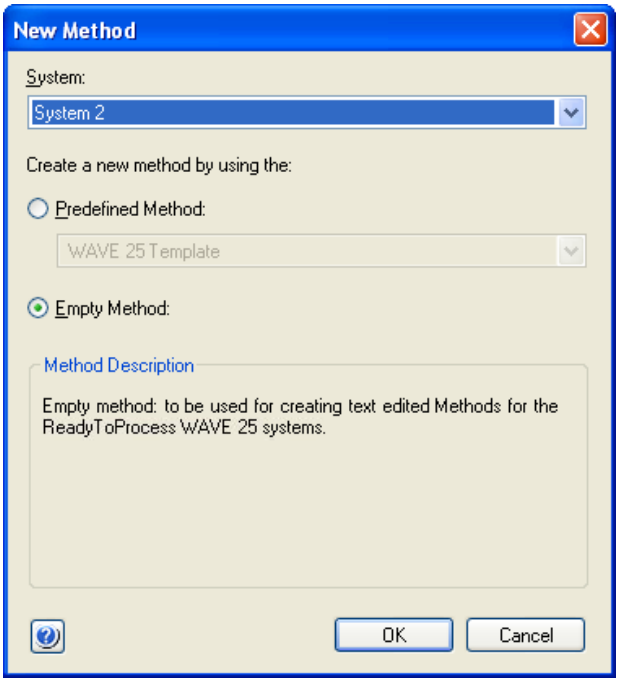


Step	Action
2	In the ***New Method*** dialog: **a.** select a ***System*** **b.** select a ***Predefined Method*** **c.** click ***OK*** *Result:* The ***Method Outline*** pane shows the mandatory ***Method Settings*** phase for the chosen method and the ***Text Instructions*** pane shows all the instructions that defines the method. The ***Phase Properties*** pane shows the default settings for the currently highlighted phase.

Empty method

Follow the instructions below to create a new empty method:

Step	Action
1	In the ***Method Editor***: • click the ***Create a new method*** icon in the ***Toolbar***  or • select***File*** →***New Method...***  *Result:* The ***New Method*** dialog opens.

Step	Action
2	 In the ***New Method*** dialog: **a.** select a ***System*** **b.** select the ***Empty Method*** radio button **c.** click ***OK*** *Result:* An empty method that consists of the mandatory ***Method Settings*** phase is created.

3.3.3 Work with methods

Open a method

Follow the instructions below to open an existing method in the database.

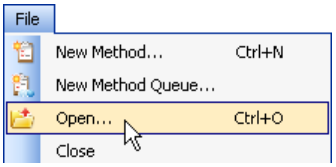
Note: *The **Method Editor** illustrated in diagrams can be used for single mode of operation only.*

Step	Action
1	In the ***Method Editor***:

- Click the ***Open Method Navigator*** icon in the ***Toolbar***

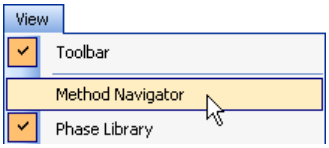
or

- select ***File*** →***Open...***



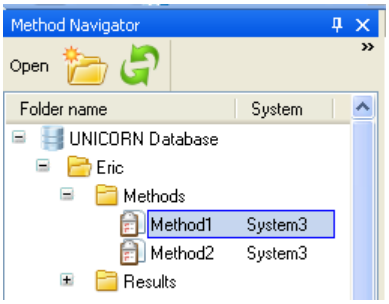
or

- select ***View*** →***Method Navigator***



Result:

The ***Method Navigator*** is displayed.

Step	Action
2	Select the method to be opened in the ***Folder name*** column. 
3	To open the method, • Click the ***Open*** button located in the toolbar of the ***Method Navigator*** pane  or • double-click the selected method or • right-click on the method name and select ***Open*** from the context menu. *Result:* The method is opened and displayed in the ***Method Outline*** pane with included phases. You can continue to edit the phases of the method using ***Phase Properties***, or manually text edit the method in the ***Text Instructions*** pane".

Add a user defined phase to the method outline using drag-and-drop

Follow the instructions below to add a user defined phase to the method outline using drag-and-drop:

Step	Action
1	Select the ***User Defined*** phase in the ***Phase Library*** pane and drag-and-drop the phase to the requested position in the ***Method Outline*** pane. *Result:* The phase is included in the method at the requested position.

Step	Action
2	When the ***User Defined*** phase has been added to the ***Method Outline***, the phase name is enabled for editing.

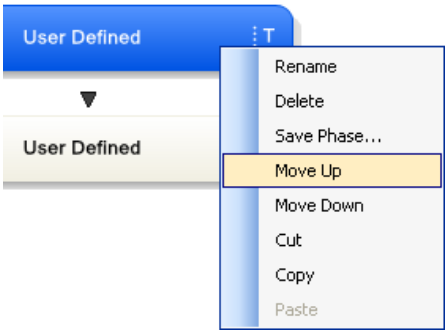
Type a name for the phase and press the **Return** keyboard key.

Note:

*The **User Defined** phase is marked with the letter **T**, meaning that it is text edited. This phase contains only **Base** and **End_Block** instructions, so any functional instructions must be added by hand. To include instructions for the **User Defined** phase, select the **Text Instructions** tab. The **Phase Properties** tab will only show the variables used in this phase. See* *Section 3.3.4 Text instructions, on page 59* *for information about how to work with instructions in the **Text Instructions** pane.*

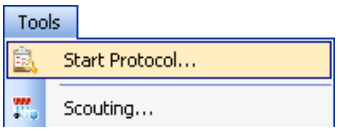
Rearrange phases within a method

Follow the instructions below to rearrange phases within a method:

Step	Action
1	Select the phase to be moved in the ***Method Outline*** pane.
2	• Drag-and-drop the phase to the requested position in the ***Method Outline*** pane. *Result:*The phase is moved to the requested position. *or* • Right-click the phase and select ***Move up*** or ***Move down***.  *Result:*The phase is moved one step up or down in the ***Method Outline***.

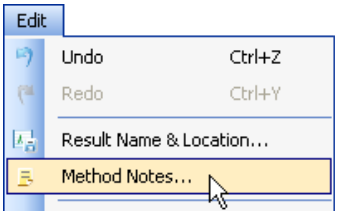
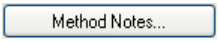
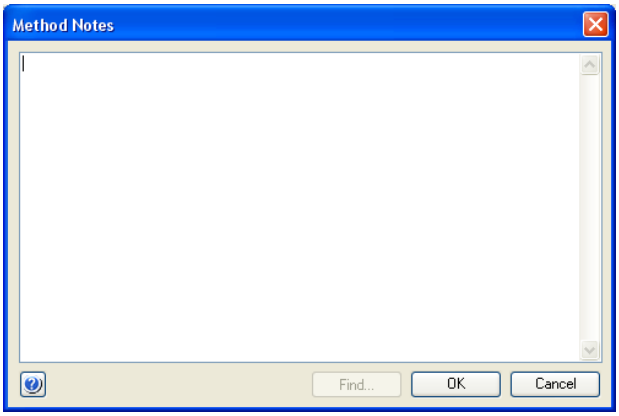
Set up a *Start Protocol*

Follow the instructions below to set up a ***Start Protocol*** to be displayed before the method run starts.

Step	Action
1	In the ***Method Editor***: • click the ***Start Protocol*** icon  or • select ***Tools*** →***Start Protocol...***  or • click the ***Method Settings*** phase and click the ***Start Protocol...*** button in the ***Phase Properties*** tab  *Result:* The ***Start Protocol*** dialog opens.
2	In the ***Start Protocol*** dialog: **a.** Select items to display at method start. When selecting a method item, a description is shown to the right. ***Result Name and Location*** is selected by default. **b.** Click ***OK*** to confirm and close the dialog.

Add/edit Method Notes

Follow the instructions below to add notes to a method or edit existing notes.

Step	Action
1	In the ***Method Editor***: • click the ***Method Notes*** icon  or • select ***Edit*** →***Method Notes...***  or • click the ***Method Settings*** phase and click the ***Method Notes...*** button in the ***Phase Properties*** tab  *Result:* The ***Method Notes*** dialog opens.
2	 In the ***Method Notes*** dialog: **a.** Enter/edit notes about the method. If notes already have been entered, it is possible to search for specific words using the ***Find...*** button. **b.** Click ***OK*** to confirm and close the dialog.

3.3.4 Text instructions

Introduction

When a user defined phase in the ***Method Editor*** is selected, the corresponding phase block is selected in ***Text Instructions*** when changing to the ***Text Instructions*** tab.

Changes made in the ***Phase Properties*** pane are automatically updated in the ***Text Instructions*** pane.

Text editing a method

Adding, editing or deleting any blocks or instructions in a phase in the ***Text Instructions*** area means text editing of the method. When a method has been text edited, one or several of the phases displayed in the ***Method Editor*** window are affected depending on the type of editing performed.

The letter ***T*** next to the phase name in the ***Method Editor*** window indicates that the phase has been text edited.

Help for the instructions

It is possible to display help for the text instructions in the ***Instruction Box***.

Follow the steps below to display the help text for an instruction:

Step	Action
1	In the ***Instruction Box***, select the appropriate instruction for which to display help.
2	Press **F1** on the keyboard. *Result:* A dialog with help text for the selected instruction will be displayed.

Insert a new instruction

Follow the steps below to insert a new text instruction in the ***Text Instructions*** area:

Step	Action
1	Select a block and display the instructions within the block.
2	Select the instruction in the block after which you want to add the new instruction.

Step	Action
3	Open the ***Instruction Box*** if it is hidden. Do the following:

a. Set the appropriate breakpoint in the ***Breakpoint*** box.

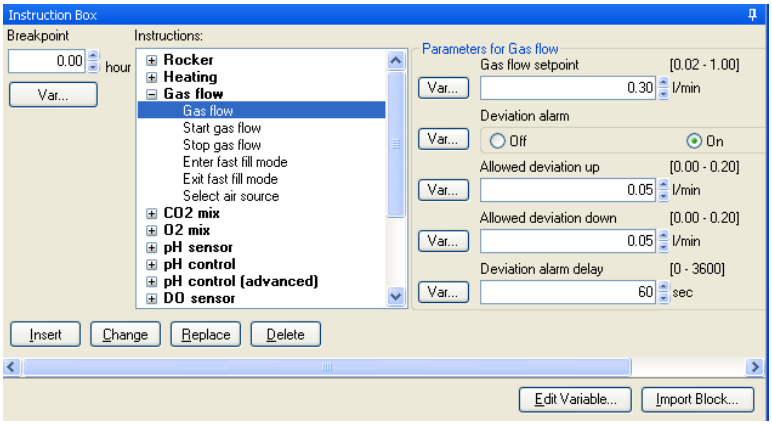
Note:

*A **Breakpoint** defines when an instruction will be executed. The time set is relative to the start of the block.*

b. Choose the instruction type and the instruction in the ***Instructions*** field. For basic help on each instruction, select the instruction and press **F1**.

c. Type values for instruction parameters in the ***Parameters*** text boxes.

The allowed range is shown in brackets beside the text box. If a scroll bar appears at the right side of the ***Parameters*** field, additional parameters are available.



4	Click the ***Insert*** button.

Result:

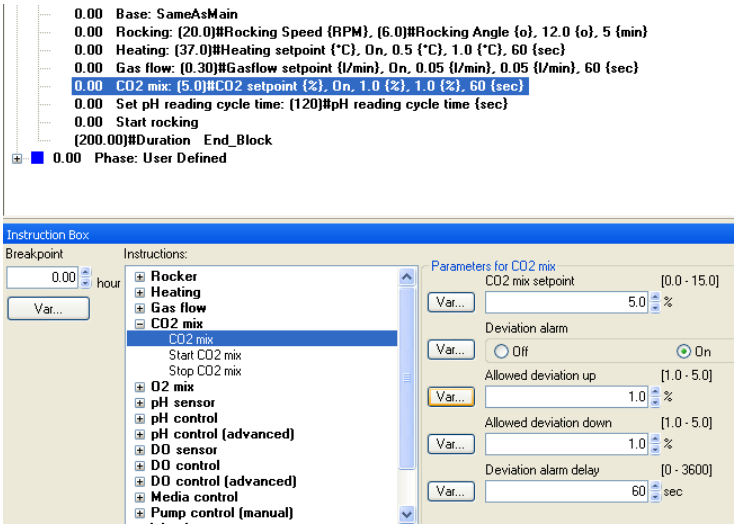
The instruction will be inserted in the block:

- at the position of the breakpoint of the new instruction, if there are no other instructions at that breakpoint
- immediately after the currently highlighted instruction, if the highlight is at the same breakpoint as the new instruction
- as the first or last instruction, if none of the instructions at the desired breakpoint is highlighted. The insertion point depends on the breakpoint value of the currently selected instruction. For example, if the breakpoint for the current instruction is lower than that for the new instruction it is inserted as the first instruction at that breakpoint.

Define new variables

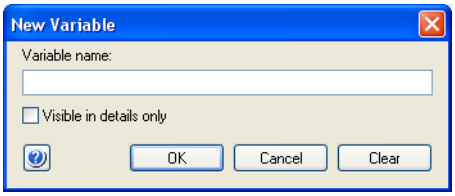
Only one variable that affects block length (breakpoint) may be defined within each block. However, any number of parameters may be defined as variables within a block. Follow the instructions below to define a new variable.

Step	Action
1	Select the instruction where you want to define the variable in the ***Text Instructions*** area. *Result:* The parameters for the instruction are shown in the ***Instruction Box***.
2	**a.** Locate the breakpoint or the required parameter in the ***Instruction box***. **b.** Click the ***Var...*** button.



Result:

The ***New Variable*** dialog opens.

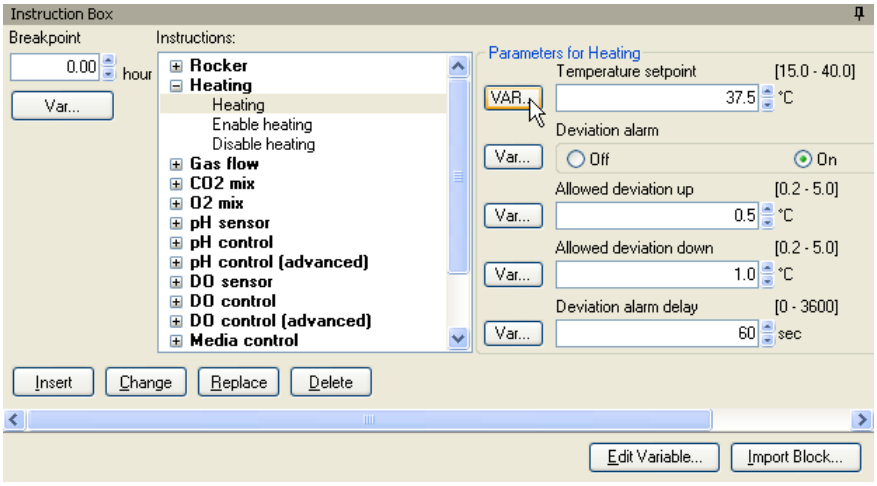


Step	Action
3	**a.** Type a name for the variable. **b.** Select the ***Visible in details only*** checkbox if you want to set the variable as a detailed variable. Detailed variables become visible in the ***Variable List*** if the ***Show details*** checkbox is selected. This option can be used to simplify the workflow later. **c.** Click ***OK***. *Result:* The ***Var...*** button changes to ***VAR...*** to confirm the new variable. ***Note:*** *If a breakpoint is defined as a variable, changing the variable value in the* ***Variable List*** *tab when the method run is started will shift other instruction breakpoints accordingly.*
4	Click ***Change***. *Result:* The variable is saved and displayed in the ***Text Instructions*** area.

Identifying variables in the instruction box

Parameters that are defined as variables in the text method are also indicated in the ***Instruction Box*** for the selected instruction in the ***Text Instructions*** area.

When the instruction is shown in the ***Instructions*** field of the ***Instruction Box***, the text on the button to the left of the parameter field is displayed as ***VAR...***. The button text for parameters not having associated variables is ***Var...***.



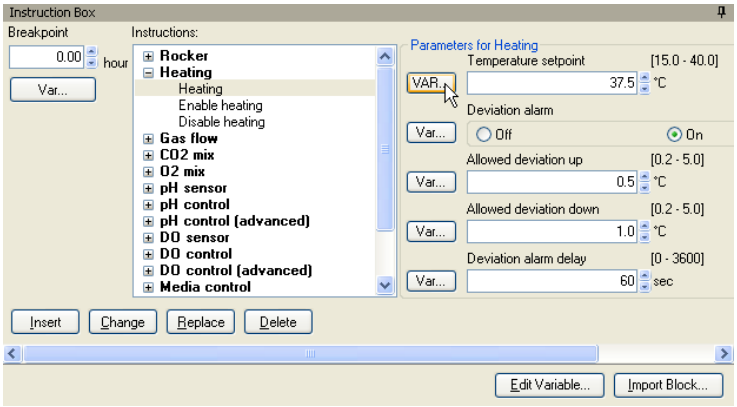
Edit variables

Editing a variable includes renaming and deleting the variable and choosing whether the variable should be a detailed variable or not.

Edit a variable using the Edit variable button

Follow the instructions below to edit a variable using the ***Edit Variable*** button:

Step	Action
1	**a.** In the ***Instruction Box***, click ***Edit Variable...***.

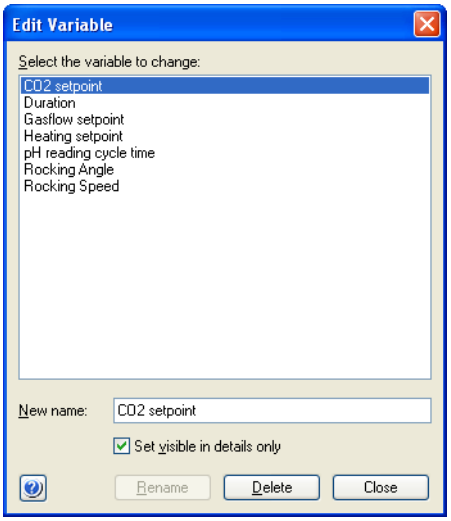


b. Alternatively select the ***Phase Properties*** tab to display the phase variables, select the variable and click ***Edit Variable...***.

Result:

The ***Edit Variable*** dialog opens displaying all variables (if opened from the ***Text Instructions*** pane) or the phase variables (if opened from the ***Phase Properties*** tab).

Step	Action
2	Select the variable to be edited (if not already selected). Do one or several of the following as appropriate:



a. Type in a new name in the ***New name*** field and click ***Rename***.

b. Check the ***Set visible in details only*** if the variable should be a detailed variable. Uncheck the box to set it to a normal variable.

c. Click ***Delete*** to delete the variable.

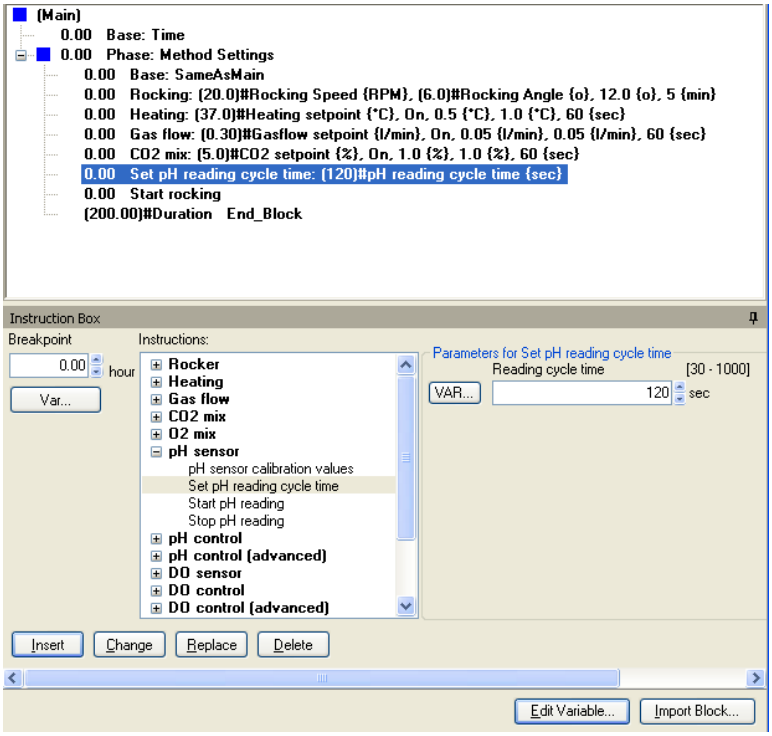
Confirm that you want to delete the variable in the dialog that appears.

3	Click ***Close*** to close the dialog.

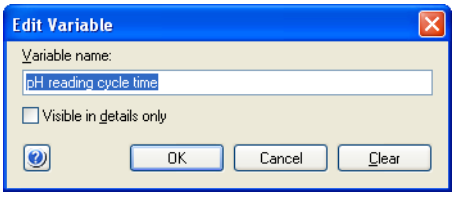
Edit a variable using the VAR.. button in the Instruction Box

Follow the instructions below to edit a variable using the ***Instruction Box***:

Step	Action
1	Select the instruction containing the variable to be edited in the ***Text Instructions*** area. *Result:* The parameters for the instruction are shown in the ***Instruction Box***.



2	Click the ***VAR...*** button for the appropriate variable. *Result:* The ***Edit Variable*** dialog opens.



Step	Action
3	Do one or several of the following as appropriate: **a.** Type in a new name in the ***Variable name*** field. **b.** Check the ***Visible in details only*** if the variable should be a detailed variable. Uncheck the box to set it to a normal variable. **c.** Click ***Clear*** to delete the variable.
4	Click ***OK***.
5	To save the changes, click ***Change*** in the ***Instruction Box***. *Result:* The text instruction is updated.

3.3.5 Save a method

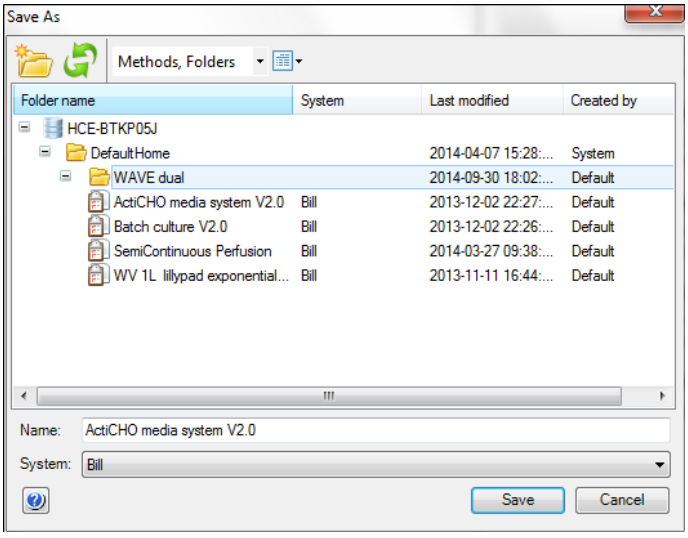
Introduction

Methods and phases are saved in the UNICORN database.

Individual, edited phases may be saved to the ***Phase Library*** for later use in other methods on systems having the same instrument configuration and component configuration.

Save a method

Follow the instructions below to save a method in UNICORN.

Step	Action
1	• Click the ***Save the Method*** icon  or • select ***File*** →***Save*** or ***File*** →***Save As***. *Result* • If the method has been named and saved previously, the changes are saved immediately. • Otherwise, the ***Save As*** dialog opens. Proceed with steps 2-4 below.
2	Browse for an appropriate folder, or create a new one. 

Step	Action
3	**a.** Select the folder in which to save the method. **b.** Enter a method ***Name.*** **c.** Select for which ***System*** to save the method
4	Click ***Save***. *Result:* The method is saved in the database. ***Note:*** *For some systems an error message will appear if you are trying to save the method for:* • *a system using another instrument configuration and/or another component configuration than the method originally was created for* *and* • *the settings in the method depend on the component configuration.* *It will still be possible to save the method but the phases in the method will be marked with an error symbol. In order to be able to subsequently run the method, either the method must be text edited or the component configuration of the system changed in the* ***Administration*** *module.*

Save a phase

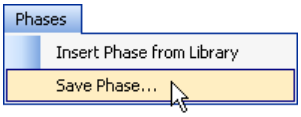
Follow the instructions below to save a phase to the ***Phase Library***:

Step	Action
1	Select the phase to be saved in the method outline. ***Note:*** *A* ***Method Settings*** *phase cannot be saved as a separate phase with a new name. If properties for the* ***Method Settings*** *phase are changed, the changes will be saved with the method.*

Step	Action
2	• click the ***Save Phase...*** button below the ***Method Outline*** pane

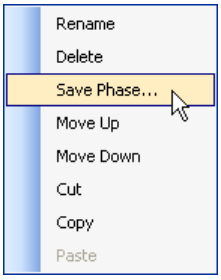
or

- select ***Phases*** →***Save Phase...***

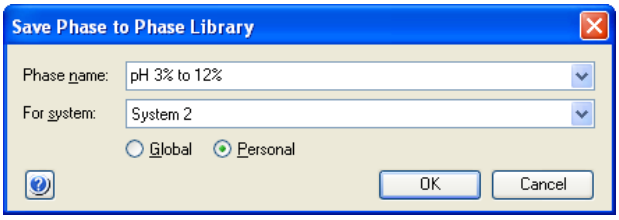


or

- right-click the phase and select ***Save Phase...***



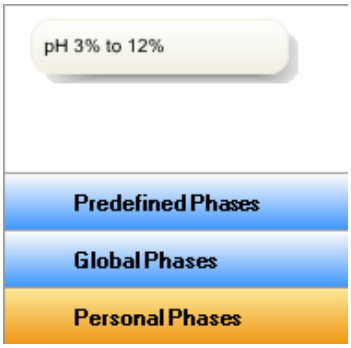
Result:
The ***Save Phase to Phase Library*** dialog opens.



3	• Type a ***Phase name***

or

- Choose a phase from the ***Phase name*** drop-down list. This phase will be replaced by the phase with the new settings.

Step	Action
4	In the ***For system*** field, the system that was selected when the current method was set up will be displayed by default. To save the phase for another system, choose the appropriate system from the ***For system*** drop-down list. ***Note:*** *Only systems using the same instrument configuration and component configuration as the system that was selected when the current method was set up will be displayed in the* ***For system*** *field.*
5	**a.** Select if the phase shall be ***Global*** (available for all users) or ***Personal*** (for your own use only). **b.** Click ***OK***. *Result:* The phase is saved and is available in the ***Global Phases*** or ***Personal Phases*** panel of the ***Phase Library***. 

3.3.6 Scouting

Introduction

Scouting is used to repeat a series of method runs automatically using different settings or with predetermined changes in the values for one or more ***Variables***. A ***Scouting scheme*** is defined as part of the method. This chapter gives an overview of scouting and the scouting workflow and describes how to set up and edit a ***Scouting scheme***. Scouting is ideal for relatively simple variable combinations.

Set up a scouting scheme

Follow the instructions below to set up a ***Scouting*** scheme where a variable is varied. In this example, the rocking speed is varied.

Note: *The **Start protocol** will only be displayed before the first run in the **Scouting** experiment.*

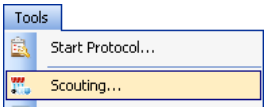
Step	Action
1	Create a method and decide appropriate run parameters to be varied in the experiment. The run parameters to be varied should be defined as ***Variables*** in your method. See *Section 3.3.2 Method creation, on page 49* for information about how to create methods. See subsection Edit variables in section *Section 3.3.4 Text instructions, on page 59* for information about how to define new variables.

Step	Action
2	In the ***Method Editor***:

- Click the ***Scouting*** icon in the toolbar

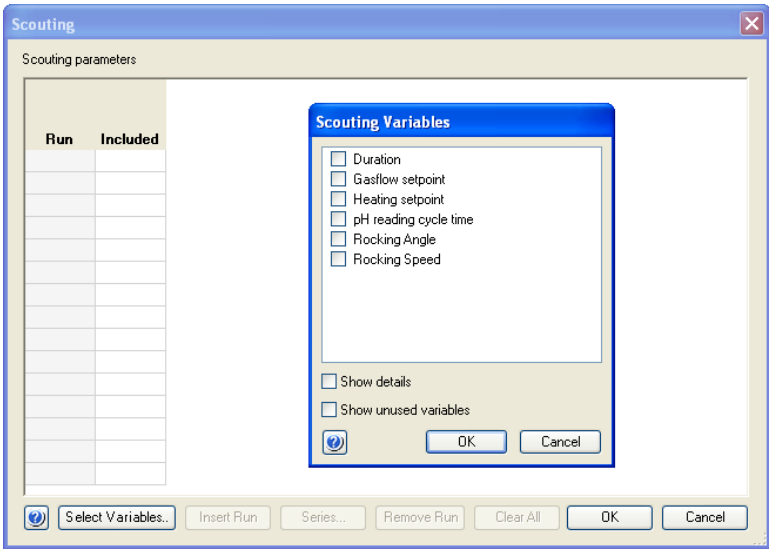
or

- Select ***Tools*** → ***Scouting***



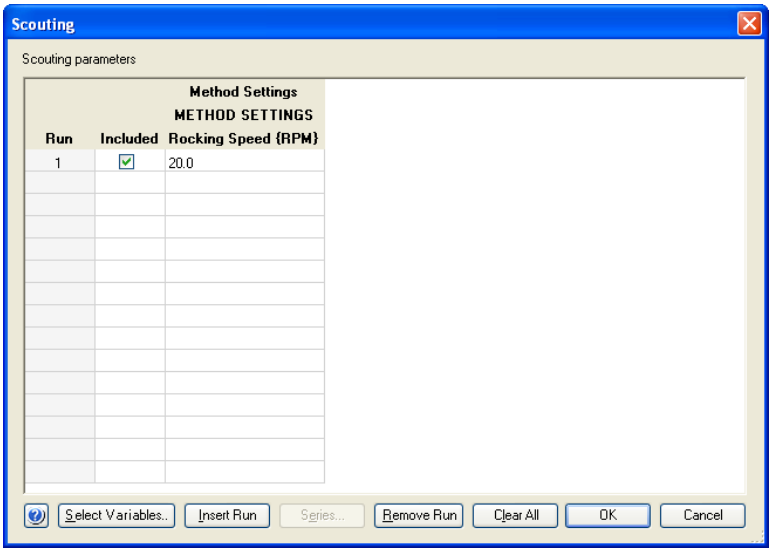
Result:

The ***Scouting*** dialog opens with the ***Scouting Variables*** dialog displayed on top.



Note:

When editing a scouting scheme, only the ***Scouting*** *dialog is displayed.*

Step	Action
3	**a.** In the ***Scouting Variables*** dialog, select the appropriate variables to be varied by checking the appropriate boxes. • Check the ***Show details*** box if you want to display variables defined as detailed variables in your method. These are rarely used as scouting variables. • Check the ***Show unused variables*** box if you want to display variables currently not used in the method. **b.** Click ***OK***. *Result:* The ***Scouting*** dialog is updated with the selected variables and their default values.  It is possible to insert runs one by one (see step 4) or insert series of runs (see step 5).

Step	Action
4	To insert runs one by one:

a. In the ***Scouting*** dialog, select a row in the ***Scouting parameters*** table and click Insert Run.

Result:

A new row is added below the selected run. The variable value from the selected row is copied to the new run. Each chosen variable is displayed in a separate column.

		Method Settings
		METHOD SETTINGS
Run	Included	Rocking Speed {RPM}
1	☑	20.0
2	☑	20.0

b. In this example, click in the ***Rocking Speed {RPM}*** column for the appropriate run and edit the rocking speed value.

Note:

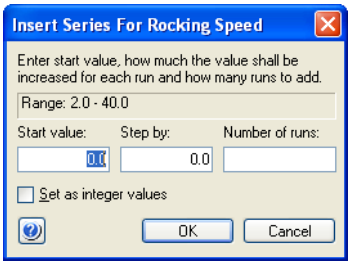
*Changing variable values in the scouting scheme does not change the values in the **Variable List** in the **Duration and Variables** dialog accessed from the **Method Editor** or in the text instructions. The actual variable values used for each run in the scouting scheme are saved in the result file. To change the default values, the variable values must be edited in the **Phase Properties** pane.*

c. Repeat until all runs are included using the correct variable values.

Note:

*The scouting scheme can also be edited just prior to starting the method run in the **Start Protocol**. Here variable values can be changed and individual runs included or excluded.*

Step	Action
5	To insert a series of runs: **a.** Click in the appropriate variable column in the ***Scouting parameters*** table and click Series... . This button is activated for variables with continuous values, such as flow rates or pressure limits. *Result:* The ***Insert Series*** dialog for the selected variable opens.



6	In the ***Insert Series*** dialog: **a.** Enter ***Start value:***, ***Step by:*** and ***Number of runs:***. In this example, 20, 2 and 5. **b.** Click ***OK***. *Result:* The ***Scouting parameters*** table is updated.

Scouting parameters

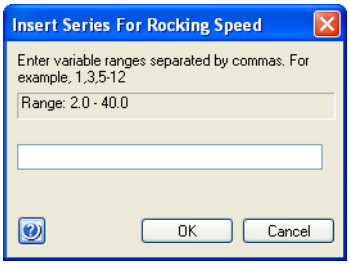
		Method Settings
		METHOD SETTINGS
Run	Included	Rocking Speed (RPM)
1	☑	20.0
2	☑	20.0
3	☑	22.0
4	☑	24.0
5	☑	26.0
6	☑	28.0

Step	Action
7	Alternatively, to enter either consecutive or non-consecutive integer values:

a. Check the ***Set as integer values*** box in the ***Insert Series*** dialog.

Result:

The following alternative ***Insert Series*** dialog for the selected variable opens.



b. Enter the appropriate range, for example: 20-23,25-28

c. Click ***OK***.

Result:

The ***Scouting parameters*** table is updated.

Scouting parameters

		Method Settings
		METHOD SETTINGS
Run	Included	Rocking Speed {RPM}
1	☑	20.0
2	☑	20.0
3	☑	21.0
4	☑	22.0
5	☑	23.0
6	☑	25.0
7	☑	26.0
8	☑	27.0
9	☑	28.0

8 Click ***OK*** in the ***Scouting*** dialog to save the scouting scheme.

Save the method.

3.3.7 Method queues

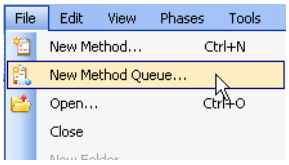
Introduction

This section describes how to create and edit method queues in UNICORN. For information on how to create and edit individual methods, see *Section 3.3.2 Method creation, on page 49*.

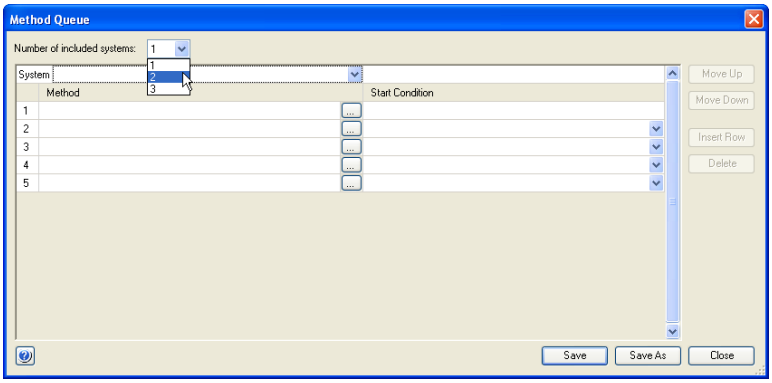
A method queue in UNICORN is a linked set of methods to be run. The method queue can contain methods to be run on up to three different systems. Each system may have up to ten methods queued.

Create a method queue

Follow the instructions below to create a method queue.

Step	Action
1	In the ***Method Editor***: • click the ***New Method Queue*** icon in the ***Toolbar***  or • Select ***File*** →***New Method Queue...***  *Result:* The ***Method Queue*** dialog opens.

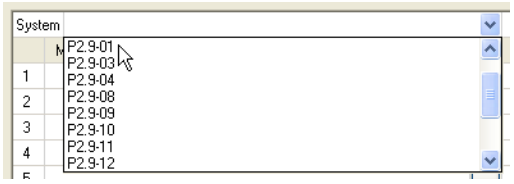
Step	Action
2	In the ***Method Queue*** dialog, choose the ***Number of included systems*** from the drop down list.



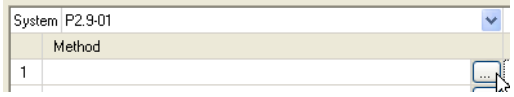
Result:

A separate method queue block will be added to the dialog for each additional system if required.

3	Choose a system for each method queue block from the ***System*** drop down list.



4	Choose a ***Method*** to add to a method queue by pressing the browse button.



Result:

The ***Select Method*** dialog opens.

Step	Action
5	In the ***Select Method*** dialog, browse to the required method and click ***OK***. *Result:* The method is added to the method queue. ***Note:*** *For reasons of system compatibility, the individual methods should be saved for the system on which they are queued.*

Step	Action
6	Select a ***Start Condition*** for the method from the drop-down list.

a. ***At queue start***

The method will begin at the start of the method queue. Only available for the first method for each system.

b. ***Immediately after the previous method has ended***

The method will start when the previous has ended on the queue for that system.

c. ***Wait...***

The method will start after a specified ***Wait*** time has elapsed since the previous method in the queue for the system has ended. A separate dialog will open where the ***Wait*** time can be specified in ***Hours*** and ***Minutes***. The delay time will be shown in the ***Method Queue*** dialog once entered.

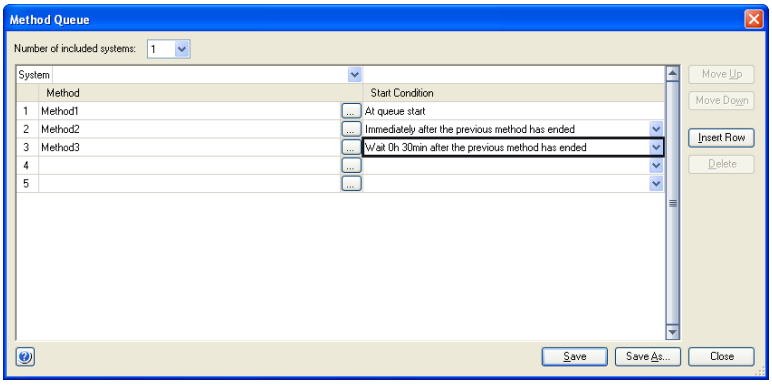
d. ***At ready command...***

The method will start when a ***Ready*** instruction in a method on another system has been executed. Using this start condition it is possible to connect methods running on different systems. A separate dialog will open where the ***System*** and ***Method*** can be chosen.

Note:

*The first **Method** for the first **System** will always have its **Start Condition** set to **At queue start**.*

Available ***Start Conditions*** are:



7	Repeat steps 4 to 6 to add further methods to the ***Method*** list for each required system.

Step	Action
8	Click ***Save*** or ***Save As*** to save the completed method queue. ***Note:*** *An error dialog will be displayed if any of the methods are incompatible with the system on which they are queued.*

3.4 Evaluation in UNICORN

About this section

The ***Evaluation*** module in UNICORN 7.x includes the basic functionality needed to evaluate the results of a run. How to use the ***Evaluation*** module is described in the integrated ***Getting Started*** view and in tool tips in the software.

This section describes how to use the ***Evaluation Classic*** module which includes additional features and requires a separate license.

In this section

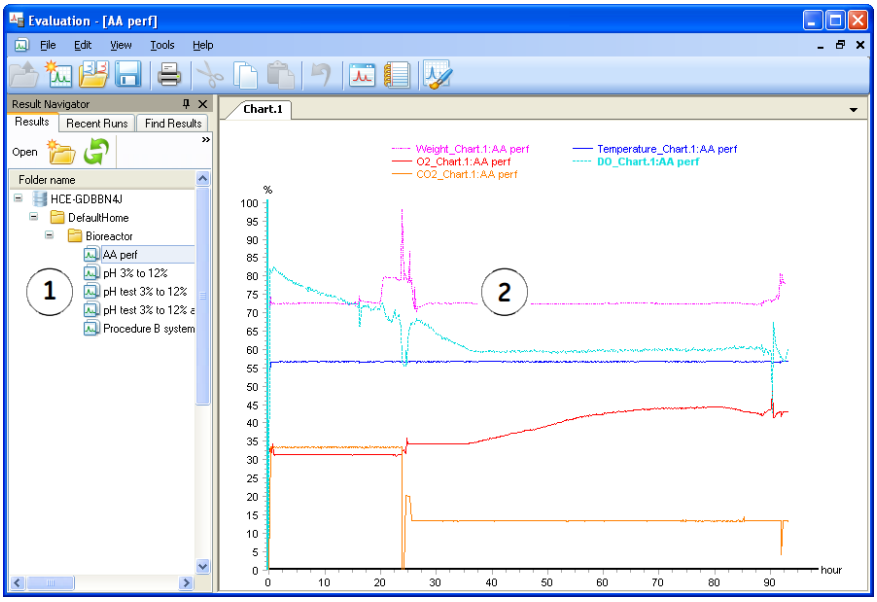
3.4.1 Evaluation

Introduction

The ***Evaluation*** module is used to evaluate the results from bioreactor runs. Evaluation is described in detail in this manual and in *UNICORN Online Help*.

Evaluation panes

As illustrated below, the ***Evaluation*** module contains two panes. When a result is opened from the ***Result Navigator*** (1) the ***Chart*** pane (2) is displayed. In the ***Evaluation*** module it is also possible to view the complete documentation of the results, and to generate reports. Refer to the UNICORN Online Help for more information about result evaluation.



Evaluation toolbar icons

The table below shows the ***Evaluation*** toolbar icons that are referred to in this User Manual.

Icon	Function
	***Open Result Navigator***: Opens the ***Result Navigator*** where available results are listed.

Icon	Function
	***Save***: Saves the changes made to the current result.
	***Print***: Opens the ***Print charts*** dialog from where a chart can be printed.
	***Report***: Opens the ***Create report*** dialog where a report of the result can be created.
	***View Documentation***: Opens the ***Documentation*** dialog that contains the complete documentation for a manual or a method run.
	***Customize***: Opens the ***Customize*** dialog where for example curve settings can be set.

3.4.2 Open and view results

Introduction

All contents of the result files are opened in the ***Evaluation*** module where you can analyze the results and compile reports. The ***Evaluation*** module user interface and toolbar icons are described in *Section 3.4.1 Evaluation, on page 83*.

This section also describes how to highlight curves in a chart, read curve values using a marker and save curve data as a ***Snapshot***.

Open a result in the Evaluation module

Click the ***Open Result Navigator*** icon to access the result files that are located in folders accessible to you.

There are four ways to open a result from the ***Result Navigator***:

- Select a result and click the **Enter** key

  or
- Double-click a result

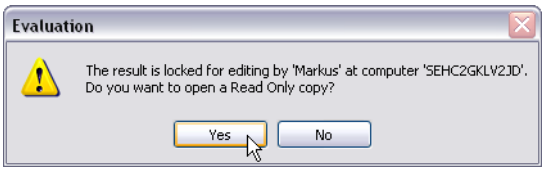
  or
- Right-click a result and choose ***Open*** from the shortcut menu

  or
- Select a result and click the ***Open*** toolbar icon in the ***Result Navigator***.

*Result*The result is opened in the chart pane.

Only one result at a time may be opened this way. If you open a new result, the previous result will automatically close. However, you may open several charts from different results using ***File*** →***Open to Compare***. Refer to Online help for furhter information.

Note: *When working in a network environment, it is not possible to edit the same result file from two different locations simultaneously. If the result is already open at another network workstation, you can only open it in read-only mode. A message similar to the illustration below will open.*



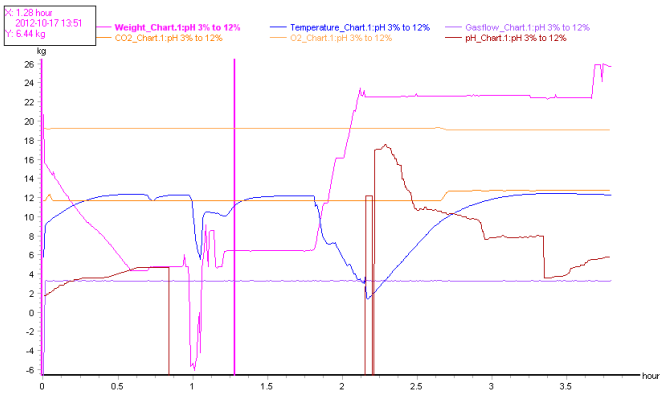
Highlight or select a curve

You can highlight or select an individual curve in the chart. The table below describes the differences:

If you...	Then...
hold your mouse pointer over a curve segment	a pop-up box will display the curve name.
hold your mouse pointer over a curve name	the curve and the short line segment in front of the curve name become bold.
click a curve segment or a curve name	the Y-axis shows the values for this specific curve.

Insert a vertical marker

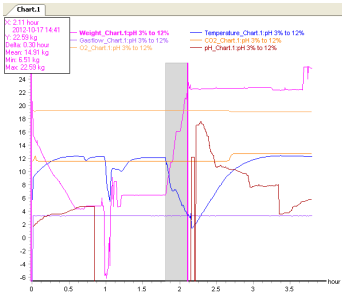
The vertical marker is used to measure the values for a specific curve position. Right-click in the chart and choose ***Vertical marker***. Move the marker along the X-axis and read the X-axis and Y-axis values of the selected curve in the box in the top left corner of the chart.



Note: *The marker will measure the curve that currently is selected if several curves are displayed in the chart. The marker will have the same color as the selected curve.*

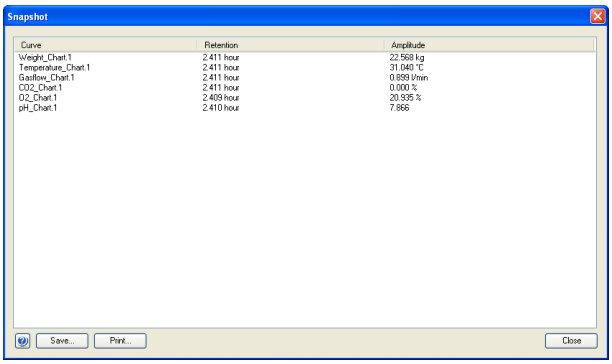
Set marker reference

You can use the vertical marker for more measurements than just the readings from a specific curve position. Follow the instructions below to use the marker to determine ***Delta*** and ***Mean*** Y-axis values.

Step	Action
1	**a.** Position the marker where you want to begin the measurement. **b.** Right-click and choose ***Set vertical marker reference point***. *Result:* The reference point is set to the position shown in the box in the top left corner of the chart.
2	**a.** Drag the marker to the point where you want the measurement to end. *Result:* The measured area is colored as illustrated below: 
3	**a.** Read the ***Delta*** and ***Mean*** values from the box: 

Snapshots

Follow the instructions below to take a ***Snapshot*** of all the curve values at the marker position.

Step	Action
1	**a.** Insert a vertical marker where you want to take the ***Snapshot***. **b.** Right-click and choose ***Snapshot*** from the shortcut menu. *Result:* The ***Snapshot*** dialog opens. 
2	• Click the ***Save*** button to save the ***Snapshot*** *Result*: The ***Save As*** dialog opens and you can save the ***Snapshot*** as a text file. or • Click the ***Print*** button to print the ***Snapshot*** *Result*: The ***Print*** dialog opens and you can print the ***Snapshot*** using the selected printer. ***Note:*** *Snapshots taken during the method run are saved directly to the result and can be accessed by clicking the* ***Snapshot*** *sub-tab in the* ***Result Information*** *tab of the* ***Documentation*** *dialog.*
3	Click the ***Close*** button to close the ***Snapshot*** dialog.

Note: *The snaphot will record only the values of curves that are displayed. Curves that are filtered will not be recorded.*

3.4.3 Run documentation

Introduction

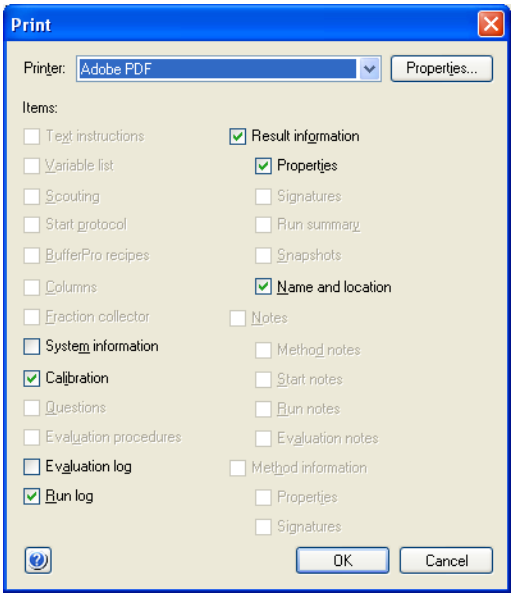
The full documentation for a run is stored in the result. This section contains:

- an instruction how to view and print the run documentation,
- a list and short descriptions of the contents of the run documentation,
- an instruction how to save the text instructions from a method run as a new method.

View and print the run documentation

Follow the instructions below to view and print the run documentation.

Step	Action
1	Open a result in the ***Evaluation*** module.
2	• Choose ***View*** →***Documentation*** or • Click the view ***Documentation*** icon.  *Result*: The ***Documentation*** dialog opens. See further information about the tabs and contents below.
3	**a.** Click the ***Print*** button. *Result:* The ***Print*** dialog opens.

Step	Action
4	**a.** Select the documentation items you want to print. ***Note:*** *Items that do not contain any information cannot be selected. If you select a group heading (e.g., **Result information**) all sub-headings that contain information will automatically be selected.* 
5	Click the ***OK*** button to print the selected items.

The documentation tabs

The table below describes the contents of the ***Run Documentation*** tabs. Refer to the online help for more information about each tab.

Note: *Some of the items listed below may be excluded from the **Run Documentation**. Tabs will be shown only for items that have been included in the method.*

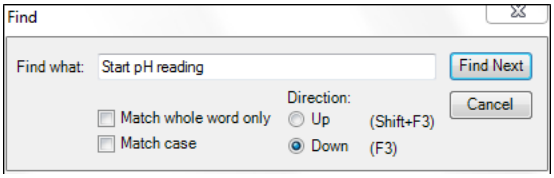
Documentation tab	Contents
Result Information	The ***Result Information*** tab contains general information about the result.

Documentation tab	Contents
Method Information	The ***Method Information*** tab shows the general ***Properties*** of the method: • Name • When and by whom the method was created • When and by whom the method was last modified • The system and ***Instrument Configuration*** that the method was created for Click the ***Details*** button to view comprehensive information about the ***Instrument Configuration***. The ***Method Information*** tab also contains a listing of all the electronic signatures that have been added to the method, under the sub-tab ***Signatures***.
Start Protocol	The ***Start Protocol*** tab shows the method items that were included in the ***Start Protocol*** at the start of the method run.
System Information	The ***System Information*** tab shows the system settings during the method run, for example • Heating settings • pH and DO sensor settings • Pump setup
Calibration	The ***Calibration*** tab shows a calibration report for the system.
Run Log	The ***Run Log*** tab shows selected log entries and feedback.
Evaluation Log	The ***Evaluation Log*** tab lists all of the evaluation operations that have been performed for the result during all sessions, including at the end of the method run. The log also shows when the result has been accessed without editing after the end of the method run.
Variable List	The ***Variable List*** tab shows all the method variables and corresponding values, listed by the method block where they appear. The list can show detail and/or unused variables. At this stage, the variable values are no longer possible to edit.
Scouting	The ***Scouting*** tab shows the scouting parameter settings. This tab corresponds to the ***Scouting*** settings in the ***Method Editor***.

Documentation tab	Contents
Text Instructions	The ***Text Instructions*** tab shows all the text method instructions from the method. These instructions can be saved as a new method. This is described in *Save the method used for the run as a new method, on page 93* in this section.
Notes	The ***Notes*** tab shows all notes that have been made regarding the method, the method run and the subsequent evaluation. The notes are divided into the following sub-tabs: • ***Method Notes*** • ***Start Notes*** • ***Run Notes*** • ***Evaluation Notes*** You can add new notes on the ***Evaluation Notes*** sub-tab. ***Note:*** *Click the **Find** button to search for specific text in the **Notes**.*

Search for log entries

The table below describes how to find specific text in the logs.

Step	Action
1	Select the log tab where you want to perform your search.
2	**a.** Click the ***Find*** button. *Result:* The ***Find*** dialog opens. 

Step	Action
3	**a.** Type the text you want to locate in the ***Find what:*** textbox. ***Note:*** *Your previous search text may be shown in this box if you have used the search function before.* **b.** Select additional search criteria: • ***Match whole word only*** • ***Match case*** • Search ***Up*** • Search ***Down***
4	**a.** Click the ***Find Next*** button. *Result:* The first log entry where the search text is found is marked.

Save the method used for the run as a new method

Follow the instructions below to save the method with the variables that were used for the run as a new method.

Step	Action
1	Select the ***Text Instructions*** tab.
2	**a.** Click the ***Save as*** button. *Result:* The ***Save As*** dialog box opens.
3	**a.** Select the appropriate destination folder. **b.** Type a name in the ***Name*** text box. **c.** Select a system from the ***System*** droplist.
4	**a.** Click ***OK***. *Result:* The method is saved.

3.4.4 Generate and print a predefined report format

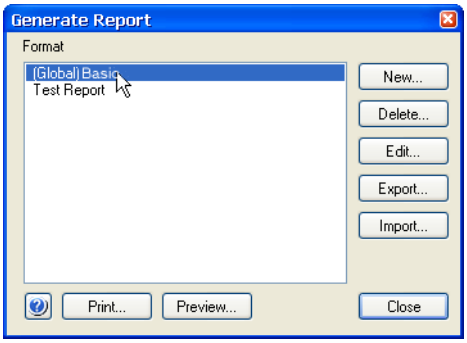
Introduction

This section describes how to generate and print a report using a format that has been defined and saved.

Should you need to store your reports in an electronic format you can also save them as PDF files. This section describes how to do this.

Generate and print the report

Follow the instructions below to select a format and print the report:

Step	Action
1	• Choose ***File*** →***Report***. or • Click the ***Report*** icon.  *Result*: The ***Generate Report*** dialog opens.
2	**a.** Select a ***Format*** for the report.  ***Note:*** *Global report formats are noted by the text* ***Global*** *before the report format name in this list.*

Step	Action
3	• Click the ***Preview*** button to view the report in the ***Customize Report*** window and click the ***Print*** icon  or • Click the ***Print*** button. *Result*: The ***Print*** dialog opens.
4	**a.** Select a printer from the ***Printer*** droplist. **b.** Select a ***Print Range***, all pages or just selected pages. **c.** Select a number of copies.
5	**a.** Click the ***OK*** button. *Result:* The report is printed on the selected printer.

Note: *Select **Edit mode** in **Customize Report** to change the layout. You can either print the edited format from this mode and exit **Customize Report** without saving the changes or save the edits when you exit.*

Save the report in PDF format

Follow the instructions below to save the generated report as a PDF file.

Step	Action
1	Perform steps 1 to 2 in the *Generate and print the report, on page 94* instruction above.
2	Click the ***Preview*** button to view the report in the ***Customize Report*** window
3	Select ***File*** →***Save As PDF***. *Result:* The ***Save As*** dialog opens.
4	**a.** Browse for a folder and ***File name*** for the report. **b.** Click ***Save***. *Result:* The report is created as a PDF file and saved in the location specified in the dialog.

3.4.5 Create a new report format

Introduction

This section describes how to create a new, customized report format. You can choose from a variety of objects to include in a report, including charts, methods, documentation, free text and more. You can also place, align and size the objects as you please.

Note: *Click the **Preview/Edit mode** button to toggle between the **Preview** mode which is for view only, and the **Edit mode** where you can edit the report items. The editing actions in this section are only available in the **Edit mode**.*

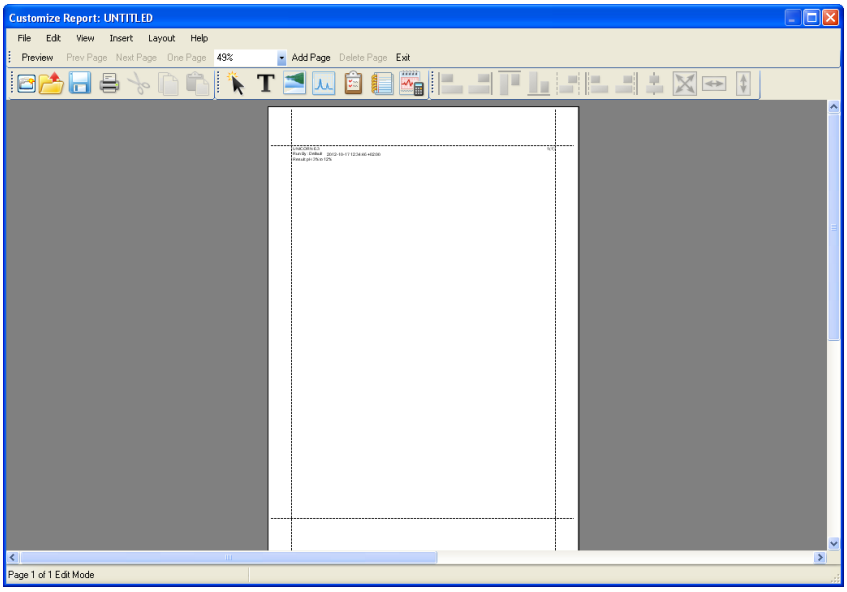
Open the Customize Report window

Follow the instructions below to open the ***Customize Report*** in ***Edit mode*** to create a new report format.

Step	Action
1	Open a result in the ***Evaluation*** module.
2	• Select ***File*** →***Report***. or • Click the ***Report*** icon.  *Result*: The ***Generate Report*** dialog box opens.
3	**a.** Click the ***New*** button. *Result:* The ***Customize Report*** window opens in ***Edit mode***.

The Edit mode window

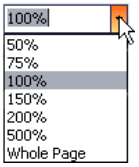
The illustration below shows the ***Customize Report*** window in ***Edit mode*** with a blank report open:



Toolbar commands in the Customize Report window

The table below describes the different functions of the toolbar command buttons in the ***Customize Report*** window:

Toolbar button	Function
Preview/Edit mode	This button toggles between a print preview of the report and the ***Edit mode***.
Prev Page	This button displays the previous page or pair of pages (if there is more than one page).
Next Page	This button displays the next page or pair of pages (if there is more than one page).
One Page/Two Pages	This button toggles between single page view and pairs of pages view (if there is more than one page).

Toolbar button	Function
	Select the magnification of the view in this droplist.
Add Page	This button adds a blank page to the report.
Delete Page	This button deletes the current page from the report.
Exit	This button closes the ***Customize Report*** window.

Note: *The general toolbar icons are described below. The toolbar icons for specific formatting operations are described in the instructions for how to use the functions.*

General toolbar icons

The table below describes the different functions of the general toolbar icons in the ***Customize Report*** window:

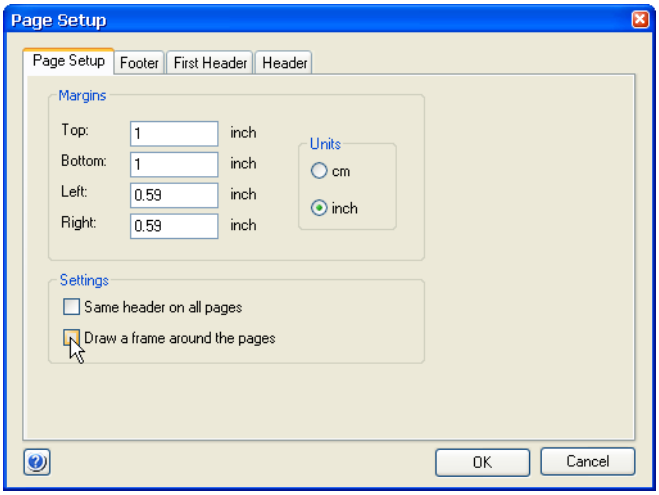
Icon	Function
	Opens a new, blank report. ***Note:*** *You can also choose the **File** →**New** menu command.*
	Opens the ***Open Report Format*** dialog. You can choose to open a previously defined format for editing. ***Note:*** *You can also choose the **File** →**Open** menu command.*
	Saves the edited report format. ***Note:*** *You can also choose the **File** →**Save** menu command.*
	Cuts the selected object from the report. ***Note:*** *You can also choose the **Edit** →**Cut** menu command.*

Icon	Function
	Copies the selected object in the report. ***Note:*** *You can also choose the **Edit** →**Copy** menu command.*
	Pastes a copied or cut object from the clipboard into the report. ***Note:*** *You can also choose the **Edit** →**Paste** menu command.*

Change the page layout

The page layout is changed in the ***Page Setup*** dialog. Follow the instructions below to set up the page layout:

Step	Action
1	• Double-click anywhere on the report page (not on an object) or • Right-click (not on an object) and choose ***Properties*** from the shortcut menu or • Choose the ***Edit*** →***Page setup*** menu command. *Result*: The ***Page Setup*** dialog box opens.



Step	Action
2	**a.** Type new values for the ***Margins*** if necessary. **b.** Select the appropriate ***Settings*** and ***Unit***. ***Note:*** *An extra **Header** tab will appear if you de-select the option to have the same header on all pages. The **First Header** tab is used for the first page header only, and the **Header** tab is used for all subsequent pages.*
3	**a.** Click the ***First Header*** tab. **b.** Select all the items you want to include in the header from the ***Select Items*** list. **c.** Click the ***Font*** button to change the font for all items if necessary.
4	**a.** Type header text in the ***Free text*** box and click the ***Font*** button to alter the default font if necessary. This text will be placed on top of the header. **b.** Type the report title in the ***Report title*** box and click the ***Font*** button to alter the default font if necessary. The title is centered immediately above the page contents.
5	If you want to have a line under or over the header, select the appropriate option in the ***Layout*** field.
6	**a.** Repeat steps 3 to 5 on the ***Footer*** tab and the subsequent pages ***Header*** tab. ***Note:*** *All **Header** and **Footer** tabs contain the same options. You can have all information in either the header or footer or split information between the header and footer as required.*
7	Click ***OK*** to apply the changes.

Report items toolbar icons

The table below describes the different functions of the report items toolbar icons in the ***Customize Report*** window:

Icon	Function
	Adds free text.
	Adds a picture.

Icon	Function
	Adds a chart.
	Includes a method.
	Adds documentation.
	Adds an evaluation log.

Add objects to the report

Follow the instructions below to add objects to the report.

Step	Action
1	• Click the appropriate icon in the ***Report items*** toolbar. or • Choose an object from the ***Insert*** menu.
2	**a.** Press and hold the left mouse button on the report page, and drag out a box to the size of the item you want to insert. ***Note:*** *The mouse pointer shows a symbol for the type of item you have selected.* **b.** Release the mouse button. *Result:* A ***Setup*** dialog opens. The dialog is specific to the type of item that you want to insert. For more information about the setup dialogs for each object, refer to the online help.
3	**a.** Select the desired ***Settings***, for example ***Start on new page***, and click ***OK***. *Result:* The object is inserted onto the page.

Note:
- *If you want to edit an object later, double-click the object box.*
- *The size of the object in **Edit mode** does not always correspond to the size in the printed report. Click **Preview** in the toolbar for a print preview.*

Move and resize objects freely

The table below describes how to select, move and resize objects freely:

If you want to...	then...
select a single object,	• click the ***Select*** icon,  • click the object of interest.
select several objects,	• click the ***Select*** icon, • press and hold the **Ctrl** key while you click the objects.
move the selected object(s),	click on the objects, hold down the left mouse button and drag the object(s) to the new position.
resize the selected object(s),	click one of the object border anchors, either in the corners or in the middle of a border, and drag the box to the new size. ***Note:*** *Some **Text** objects cannot be resized.*

Alignment toolbar icon functions

Objects can be placed in exact positions and sized in relation to other objects. The table below describes the function of the ***Alignment*** toolbar icons in the ***Report Editor***:

Icon	Function
	**Align left** Matches the left alignment of all selected objects to that of the high-lighted object.
	**Align right** Matches the right alignment of all selected objects to that of the high-lighted object.
	**Align top** Matches the top alignment of all selected objects to that of the high-lighted object.

Icon	Function
	**Align bottom** Matches the bottom alignment of all selected objects to that of the highlighted object.
	**Adjust to margins** Stretches the selected object(s) to the left and right margins.
	**Adjust to left margin** Adjusts the selected object(s) to the left margin.
	**Adjust to right margin** Adjusts the selected object(s) to the right margin.
	**Adjust to center** Adjusts the selected object(s) to the center of the page.
	**Make same size** Adjusts the selected objects to the same size as the highlighted reference object.
	**Make same width** Adjusts the selected objects to the same width as the highlighted reference object.
	**Make same height** Adjusts the selected objects to the same height as the highlighted reference object.

Note: *The **Make same size** and **Make same width** functions can only be used to resize the width of charts, free text and picture objects.*

Save the report format

Follow the instructions below to save the finished report format:

Step	Action
1	• Choose ***File*** →***Save***. or • Click the ***Save*** icon.  *Result*: The ***Save Report Format*** dialog box opens.
2	**a.** Type a name for the format. **b.** Select if you want to save the format for global use. **c.** Select if you want to save the format as default. ***Note:*** *The name for the default format will automatically be changed to* `DEFAULT`.
3	**a.** Click ***OK*** to save the format.

3.4.6 Edit an existing report format

Introduction

This section describes how to edit an existing report format.

Note: *Click the **Preview/Edit mode** button to toggle between a print preview of the report and an editing mode. The editing actions are only available in the **Edit mode**.*

Edit a saved report format

Follow the instructions below to edit a saved report format in the ***Evaluation*** module.

Step	Action
1	Open a result file.
2	• Select ***File*** →***Report*** or • Click the ***Report*** icon.  *Result*: The ***Generate Report*** dialog opens.
3	**a.** Select a report format to edit. **b.** Click the ***Edit*** button. *Result:* The ***Customize Report*** window opens.
4	**a.** Make the necessary changes to the report format. ***Note:*** *Once you have made a change, the title bar of the window will add the word **Modified** to the report format name.*
5	• Select ***File*** →***Save*** or • Click the ***Save*** icon. *Result*: The edited format is saved.

Step	Action
6	To return to the ***Evaluation*** module window: • Select ***File*** →***Exit*** or • Click the ***Exit*** button.
7	• Click the ***Close*** button to close the ***Generate Report*** dialog. or • Select another report format to edit.

Note: *See Section 3.4.5 Create a new report format, on page 96 for instructions about how to add or edit report items. You can also select* ***File*** →***Save As*** *in the* ***Customize Report*** *window, to save the edited format under another name and keep the original report format unchanged.*

4 System control description

About this chapter

This chapter describes important differences between single and dual mode, together with details of pH, DO and media control. It also contains recommended operating conditions and verification procedures for the system functions.

In this chapter

4.1 Single and dual operation modes

Introduction

Xuri Cell Expansion System W25 supports cell cultivation in ***single*** and ***dual*** modes:

- In single mode, the system supports culture in one Cellbag bioreactor at one time. The rocker is connected to one Xuri Cell Expansion W25 CBCU and up to three Xuri Cell Expansion W25 Pump units.
- In dual mode, the system supports culture in two Cellbag bioreactors placed on the same tray. The rocker is connected to up to two Xuri Cell Expansion W25 CBCU units and up to three Xuri Cell Expansion W25 Pump units for independent control of culture conditions in the two bioreactors.

Select an operation mode

To configure the system for single or dual mode, access the system properties as described in *Section 5.2.3 Configure system properties, on page 173* and uncheck or check ***Dual*** respectively.

4.2 Temperature measurement and control

Description

Heating is provided by the tray heater plate, and controlled through sensors integrated in the rocker. The heater power output is automatically adjusted according to the Cellbag bioreactor size and media volume, to provide accurate, stable and fast temperature control. To minimize the risk for overheating, heating is only active when the rocker is in motion.

When using a Cellbag bioreactor that only covers half the tray in single mode (for example, a 10 L bag on Tray 20), place the bioreactor on the left-hand side of the tray.

In dual mode, different temperature setpoints can be used for the two Cellbag bioreactors, provided they are not too widely separated. A difference of 10°C between the setpoints can be maintained at an ambient temperature of 21°C. The difference is reduced by 1°C for every °C increase in the ambient temperature (for example, a difference of 6°C can be maintained at ambient temperature 25°C).

4.3 pH and DO measurement and control

About this section

This section describes the pH and DO measurement and control principles of Xuri Cell Expansion System W25.

In this section

4.3.1 pH and DO measurement principles

Introduction

In order to monitor and control pH and DO of a culture using Xuri Cell Expansion System W25, it is necessary to use Cellbag bioreactors equipped with optical pH and DO sensors. The optical pH and DO sensors comprise a luminophoric dye immobilized on a substrate that is integrated into the Cellbag bioreactor. Pulses of light from a LED on the pH monitor produce a responsive light signal from the sensor that indicates the pH or DO surrounding the sensor. An optical fiber cable transfers the light signals.

Light and temperature sensitivity

The optical sensors are subject to photobleaching, which means its properties are affected by light. This includes ambient light as well as the light from the LED. To reduce photobleaching avoid unnecessary exposure of the Cellbag bioreactor to light. For example:

- Keep the Cellbag in its protective black bag until shortly before use.
- Use the Rocker lid.

The LED output is automatically regulated to provide suitable amplitude for optimal performance and life time of the sensor. The sensor is also temperature sensitive. The pH and DO modules include temperature compensation for use within a few °C around the calibration temperature as printed on the Cellbag label.

Sensor calibration

Calibration parameters for the pH and DO sensors are printed on the Cellbag label. The calibration principles are described in *pHOPT calibration values, on page 261* and *DOOPT calibration values, on page 270*. Calibration should be adjusted before each run as described in *Section 5.3.5 Prepare the sensors, on page 193*.

DO air saturation and atmospheric pressure

DO is measured as percent air saturation. 100% air saturation represents the oxygen content of a certain solution at the current temperature and atmospheric pressure when it has been equilibrated in an environment of air. Air saturation is a relative measurement. The oxygen content measured in for example mg/L depends on factors such as the composition of the solution, temperature and atmospheric pressure due to different weather conditions or altitude.

If a DO sensor is calibrated for 100% air saturation under equilibrated conditions at one atmospheric pressure, such as 950 mbar, it will not show 100% air if the same content is later equilibrated at another atmospheric pressure, say 1050 mbar. The difference is approximately 1% air saturation/10 mbar.

At delivery, the DO configured Cellbag bioreactors have sensors that are factory calibrated at a certain atmospheric pressure. This pressure is stated on the DO label as **CalP** and shall be entered together with the other calibration values for DO. To compensate for differences in atmospheric pressure from where the bag was calibrated to where the cell culture will be performed, it is possible to adjust the DO calibration. To do this select ***System*** →***Calibrate*** →***DO sensor*** in UNICORN.

O_2 measurement and altitude

The O_2 sensor measures the relative O_2 concentration in terms of volume percent (vol %). The O_2 concentration in the atmosphere is 21 vol% independently of altitude above sea level and weather conditions. Since the most relevant parameter from a cell cultivation perspective is the dissolved oxygen expressed as mg/L, different cell growth conditions will be obtained depending on the ambient pressure.

For instance, at 2000 m above sea level the ambient pressure is 0.8 bar (800 hPa). The relative O_2 concentration is 21 vol%, but compared to the conditions at sea level, where the ambient pressure is 1.013 bar (1013 hPa), the absolute O_2 concentration in ambient air at 2000 m corresponds to (800/1013) × 21 = 16.6 vol% of that at sea level.

Different growth conditions will therefore be obtained at high altitudes as compared to sea level.

4.3.2 pH and DO control principles

Introduction

pH and DO can be regulated through different control schemes as described in this section. Each control mode can be either automatic or manual.

The reading and control cycle

The reading cycle time is the time between two consecutive measurements.

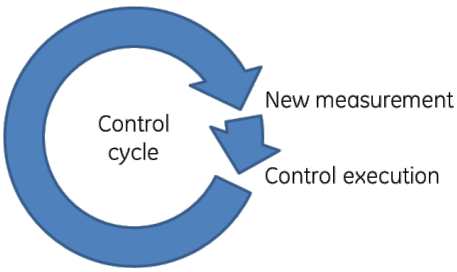
The reading ***Cycle time*** is set from the ***Process Picture*** under ***Settings →pH*** and ***Settings →DO***, or with the manual instructions ***Set pH reading cycle time*** or ***Set DO reading cycle time***.

When the control is off, the reading cycle time setting defines time between measurements. When the control is on, the reading cycle time will be overridden by the control cycle time.

Note: *Using DO reading with a short cycle time will shorten the lifetime of the sensor. For cultivations lasting more than 3 days, a cycle time of at least 60 s is recommended.*

Measurements and control actions are synchronized. When a control is started, the measurement cycle time is set by the control and overrides any previously entered reading cycle time. The control is executed after each new measurement.

When the pH control executes, it sets the CO_2 setpoint for the next control cycle (***CO2*** mode), or starts the acid or base pump (***Acid/Base*** mode) for a limited time (0%-75% of the next control cycle).



When the DO control executes, it sets the O_2 setpoint for the next control cycle (***O2*** mode), or sets the rocking speed setpoint for the next control control cycle (***Speed*** mode).

Automatic and manual mode

The pH and DO control software automatically calculates the following parameters suitable for the actual control case, taking into account the bag size and gas flow setpoint:

- Cycle time
- PID parameters

- Acid and base flow for pH control
- Transition delay time between CO_2 and base in the ***CO2/Base*** control scheme and O_2 and speed in the ***O2/Speed*** control scheme

The automatic parameters can be overridden with manually entered values. If any of the automatically computed values are overridden, a hand symbol (✋) appears close to the relevant icon in the ***Process Picture***. A tool tip shows which parameters are overridden when the cursor is placed over the symbol.

Deviation alarms

If the reading has been outside the specified deviation limits of the setpoint for a certain time, a deviation alarm is activated by default.

The deviation alarm can be deactivated from the process picture using the checkbox under the pH or DO settings or with the manual instruction ***pH control (general)*** or ***DO control (general)***.

After a change of the setpoint, the deviation alarm check is inactive until the reading is within the deviation limits of the new setpoint. If the interval within the deviation limits is not reached within a time limit computed by the pH or DO control, the deviation alarm is triggered.

In the pH control ***CO2*** mode, the time limit is equal to 40 times the automatically computed control cycle time. In ***Acid/Base*** mode, the time limit is equal to 90 minutes.

In the DO control ***O2*** mode, the time limit is equal to 40 times the automatically computed control cycle time. In ***Speed*** mode, the time limit is equal to 180 minutes.

Inactivation

If any of the conditions for running the pH or DO control is not fulfilled, the control will be stopped. In this state the control remains inactive until all the necessary conditions are fulfilled.

If the control is stopped, a red or orange frame will be visible around the pH/DO icon in the process picture, and a message dialog will show why the control is inactive.

- An orange frame indicates that the inactivation is due to a user or system action, like entering sampling mode or feed/harvest auto calibration.
- A red frame indicates that the inactivation is due to an error.

4.4 pH control

About this section

Xuri Cell Expansion System W25 has automated pH control. In general, PID parameters and cycle times do not need to be entered or tuned, acid and base flow rates do not need to be calibrated or tuned. Refer to *Section 8.5.7 pH measurement, on page 261* and *Section 8.5.8 pH control, on page 263* for information about pH control settings.

In this section

4.4.1 pH control schemes

Introduction

pH control operates according to one of three schemes, constructed from two control modes alone or in combination. The table below summarizes the control schemes. Control modes are described in detail in the sections that follow.

Control scheme	Description	Control modes used
CO2	pH control by change of CO_2 concentration in the gas mix.	***CO2***
Acid/Base	pH control by addition of acid and base.	***Acid/Base***
CO2/Base	• pH control by change of CO_2 concentration in the gas mix, and by base addition. • Control starts in ***CO2*** mode and then switches automatically between ***CO2*** and ***Acid/Base*** mode as required. • In ***Acid/Base*** mode, acid is blocked.	***CO2*** ***Acid/Base*** (acid blocked)

Modes of pH control

There are two modes of pH control:

- Optimal mode
- Traditional deadband mode

Optimal mode of pH control

In the optimal mode of pH control, the pH is controlled effectively tight around the pH setpoint that is set by the user. The optimal mode of pH control uses the three control schemes.

Traditional deadband mode of pH control

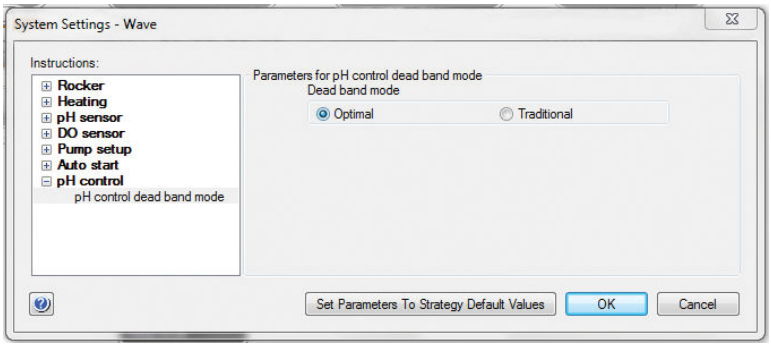
A deadband is defined individually for the acidic and basic sides of the pH setpoint. When the control output is in the deadband, the control is not executed. That is, the pumps do not run and the CO_2 is maintained at the minimum CO_2 setpoint. pH deadband prevents the pH control from switching between small acid/CO_2 and base additions.

The traditional deadband mode of pH control involves controlling the pH to reach the limit of the pH deadband set by the user. The traditional deadband mode of pH control can be used in all three control schemes.

Select pH control mode

Select the mode of pH control in deadband before starting a run.

Follow the steps below to select the mode of pH control in deadband:

Step	Action
1	Select ***System*** →***Settings*** in the ***System Control*** module.
2	Select ***pH control*** from the list and click the ***+*** symbol to view the available alternatives.
3	Click on alternative ***pH control deadband mode***.
4	Click one of the radio buttons ***Optimal*** or ***Traditional*** to select mode. ***Note:*** *The selected mode of deadband cannot be changed during a run.* 
5	Click ***OK*** to confirm the selection.

4.4.2 CO2 control mode

Introduction

At every execution of the CO_2 control, a PID regulator computes the CO_2 setpoint for the next control cycle. The CO_2 setpoint is by default limited to the range 0.0% to 15.0%. This range can be narrowed using the manual instruction ***pH control (CO2)***.

Note: *If CO_2 is delivered by a source with pulsed supply, the resulting variations in inlet pressure to the CBCU may lead to fluctuations in the CO_2 mix. For example, with a CO2 setpoint of 7.5%, the actual CO_2 levels may fluctuate between 7% and 8%.*

PID parameters and cycle time

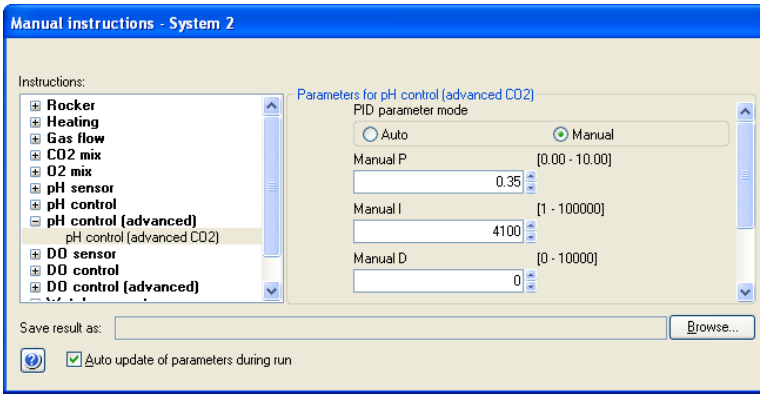
The control dynamics vary with Cellbag bioreactor size and depend on the gas flow rate. The PID-parameters and the cycle time are therefore automatically computed with respect to the bag size and gas flow setpoint.

To optimize the control behavior, the automatic PID parameters are not the same when approaching a new setpoint as when keeping the setpoint. The automatic D parameter is always zero.

Tuning PID parameters and cycle time

If further tuning of PID parameters and/or cycle time is needed, follow these steps:

Step	Action
1	Open ***Tools*** →***Customize*** and select the tab ***Run Data Groups***. Select the ***Auto pH CO2 P***, ***Auto pH CO2 I*** and ***Auto pH CO2 D*** and click ***OK***. *Result:* The automatic PID parameters are shown as ***Run Data***.
2	Register the values both when approaching the new setpoint, and when keeping the setpoint. ***Tip:*** *The automatically computed values are a good starting point for the tuning.*

Step	Action
3	Open the manual instruction ***pH control (advanced)*** →***pH control (advanced CO2)*** and select ***Manual PID parameter mode*** and/or ***Cycle time mode*** and enter the applicable values. When elaborating with a manual I parameter, remember that increasing the I parameter will reduce the integrating effect and vice versa.  Click ***Execute***.

4.4.3 Acid/Base control mode

Introduction

At every control execution in ***Acid/Base*** control mode, a PI regulator computes the pump run time. The pump run time is given in percent of the cycle time in the range -75 to 75, where the negative part corresponds to the acid pump, and the positive part corresponds to the base pump. When using the ***CO2/Base*** control scheme, the control output range is restricted to 0 to 75, to only allow base.

In the ***Acid/Base*** control mode, the flow rates of the acid and base pumps are adaptive to the actual control case. They are automatically and individually set by the software, based on the weight of the content in the Cellbag bioreactor and the molarity of the acid and base. The flow rate is further discussed below.

PI parameters and cycle time

The automatically computed PI-parameters are static in the Acid/Base control mode. They can be seen as default parameters. The same holds for the automatic cycle time. These automatic values should be good enough for most cases, and no tuning is expected to be needed.

In the acid/base controller, the I-part of the output is only updated when the pH measurement is close to the setpoint. When elaborating with a manual I-parameter, remember that increasing the I-parameter will reduce the integrating effect and vice versa.

Tuning of PI parameters and cycle time

If tuning of the PI parameters or cycle time is needed, follow these steps:

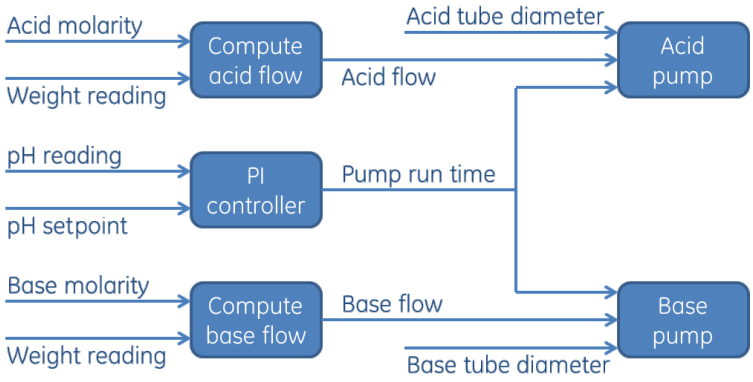
Step	Action
1	Open ***Tools*** →***Customize*** and select the tab ***Run Data Groups***. Select the ***Auto pH acid/base P*** and ***Auto pH acid/base I*** and click ***OK***. *Result:* The automatic PI parameters are shown as ***Run Data***.
2	Open the manual instruction ***pH control (advanced)*** →***pH control (advanced acid/base)*** and select ***Manual PID parameter mode*** and/or ***Cycle time mode*** and enter the applicable values. Click ***Execute***.

Flow rate

Xuri Cell Expansion System W25 automatically computes flow rates for acid and base. There is no need for calibration or tuning of acid/base flow rates.

To make this automation work, the following input data needs to be correct:

- The molarity of the acid and base used, entered as equivalents of HCl or NaOH concentrations. If weaker acids or bases are used, enter the estimated equivalent molarity of HCl or NaOH.
- The weight measurement, corresponding to the weight of the content of the Cellbag. Make sure the scale is tared correctly.
- The inner diameter of the acid and base tubing, allowing the flow rate to be converted to pump speed in rpm. A pump calibration will make the relation more precise, but entering the tube diameter is normally sufficient for pH acid/base control.



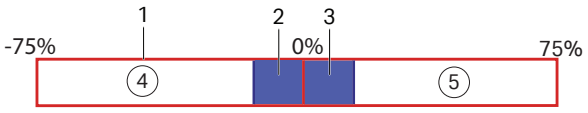
If the automatically computed flow rate is outside the range that can be achieved with the entered tube diameter, the pH control software will inform the user that a different tubing size is required for optimal control.

If desired, manual flow rates for acid and base can be entered using the manual instruction ***pH control (advanced acid/base)***. This will override the automatically computed flow rates.

Deadband

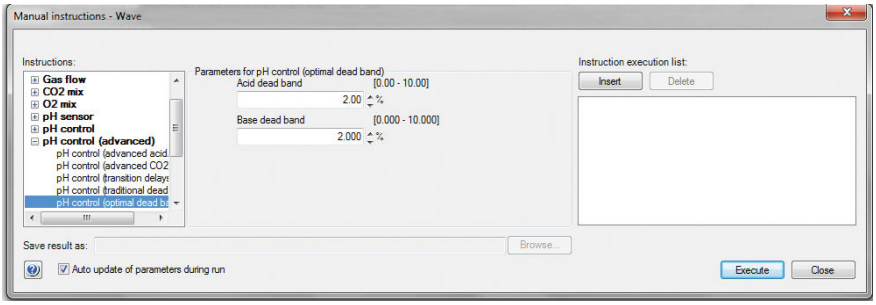
A deadband is defined for acid and base individually. When the control output is in the deadband, the pumps will not run. pH deadband prevents the pH control from switching between small acid and base additions.

Optimal mode of pH control



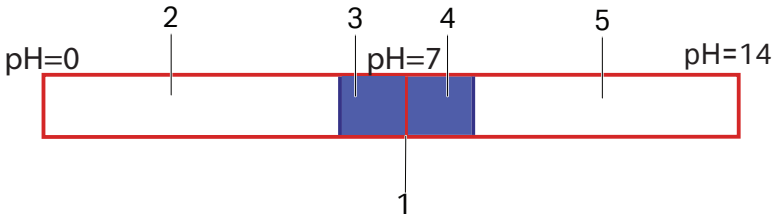
Number	Description
1	pH setpoint
2	Control output
3	Acid deadband
4	Acid
5	Base

In the optimal mode of pH control, the deadband removes all acid/base additions with a pump run time less than or equal to a given percentage of the cycle time. The default deadband is set to 2.0%. This means that only pump run times larger than 2.0% of the cycle time are executed. The deadband prevents the control from switching between small acid and base additions. Using deadband values close to zero gives a precise control, but also risk unnecessary switching between acid and base. Increasing the deadband values results in less precise control, and may in extreme cases lead to the setpoint never being reached. The default value of 2.0% is found to be a good compromise. The deadband can be changed in ***System →Manual Instructions →pH control (optimal acid/base)***.



Traditional deadband mode of pH control

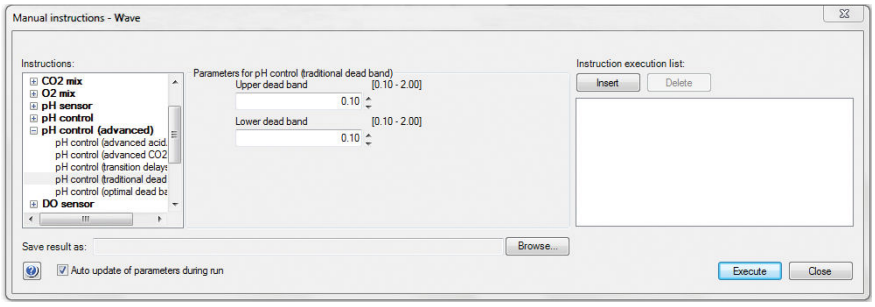
The user can set a pH deadband in traditional deadband mode, which is defined in terms of pH units having an upper pH limit and a lower pH limit. For example, if pH set point is 7.0 and the user defined deadband is ± 0.2, then pH control is inactive from 6.8 to 7.2.



Number	Description
1	pH setpoint
2	(Acid) pH control on
3	Acid or CO2 deadband
4	Base deadband
5	Base pH control on

The implementation of traditional pH deadband is common in a wide range of bioreactors. The traditional pH deadband is operational in all three pH control schemes.

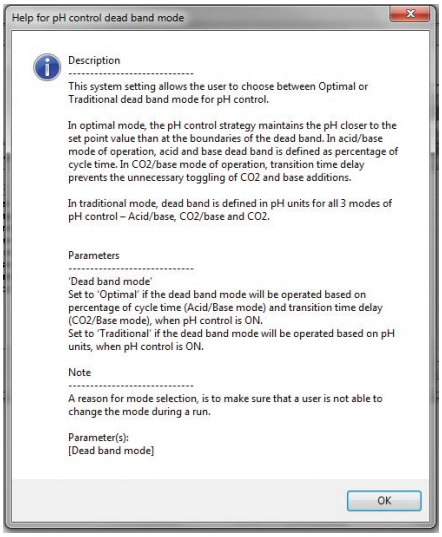
An upper limit and a lower limit of the deadband can be set by the user. The default upper and lower deadband values are set to 0.1. The deadband can be set between 0.1% to 2 pH units on each sitde of the setpoint.



While residing in traditional deadband, in the CO2 and the CO2/Base scheme of control, the minimum CO2 % that is set by the user is maintained.

For examples of process pictures for the different pH control schemes, see *Process picture when in traditional deadband mode, on page 199*.

The help text for the traditional deadband mode provides valuable information. Click the symbol  with the question mark in the blue square in the left corner of the screen to launch the help text.

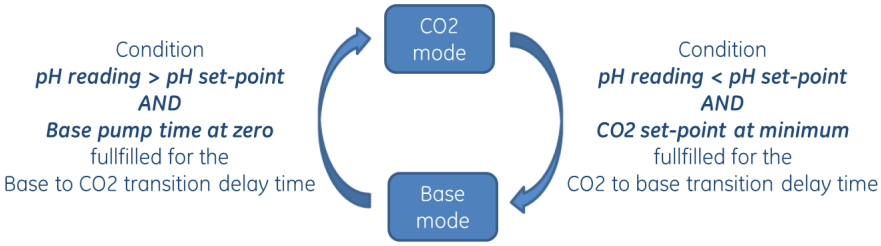


4.4.4 pH control transition delays

CO2/Base control scheme

The ***CO2/Base*** control scheme combines the ***CO2*** and ***Base*** control modes. It always starts in ***CO2*** mode and can then switch back and forth between ***CO2*** and ***Base*** mode as long as the control is on. To avoid unnecessary switching between ***CO2*** and ***Base*** mode, the transitions between the modes are delayed. This delay is called transition delay time.

The condition for transition must be fulfilled for a certain time before the transition takes place. The transition delay times are set automatically and individually by the pH control. The values can be overridden with manual values using the manual instruction ***pH control (transition delays)***.



If the pH CO_2 controller is at its minimum CO_2 setpoint, and the pH reading is below the pH setpoint, a time counter is started. When the time counter reaches the set ***CO2 to base transition delay time***, the transition to base mode takes place. If the pH base controller is at its minimum output (0%), and the pH reading is above the pH setpoint, a time counter is started. When the time counter reaches the ***Base to CO2 transition delay time***, the transition to CO_2 mode takes place.

Cycle time and transition delays

From UNICORN IC 2.0.9.0 and onwards, in auto mode of control, for as long as the setpoint is not changed:

- the cycle time is set to a maximum of 300 s, and
- the transition time delay is set to 600 s for all cellbag sizes and gas flows.

This time is set when the system turns from both CO_2 to Base and Base to CO_2. In case of a pH setpoint change, the transition times in UNICORN IC 2.0.8.0 will apply for various cellbag sizes and gas flow rates to allow the process to naturally drift to the new setpoint.

4.5 DO control

About this section

Xuri Cell Expansion System W25 has automated DO control using O_2. In general, PID parameters and cycle times do not need to be entered or tuned. Refer to *Section 8.5.9 DO measurement, on page 270* and *Section 8.5.10 DO control, on page 272* for information about DO control settings.

In this section

4.5.1 DO control schemes

Description

DO control operates according to one of three schemes, constructed from two control modes alone or in combination. The table below summarizes the control schemes. Control modes are described in detail in the sections that follow.

Note: *Dual mode does not support control schemes involving rocker speed, since the speed cannot be adjusted independently for the two bioreactors.*

Control scheme	Description	Control modes used
O2	DO control by change of O_2 concentration in the gas mix.	***O2***
Speed	DO control by change in rocking speed.	***Speed***
O2/Speed	• DO control by change of O_2 concentration in the gas mix, and by changing the rocking speed. • Control starts in ***O2*** mode and then switches automatically between ***O2*** and ***Speed*** mode as required.	***O2*** ***Speed***

4.5.2 O2 control mode

Introduction

At every execution of the O_2 control, a PID regulator computes the O_2 setpoint for the next control cycle. There are two different O_2 setpoint ranges. If compressed air is selected as gas source to the CBCU the range is 21% to 50%, if N_2 is selected, the range is 0% to 50%.

PID parameters and cycle time

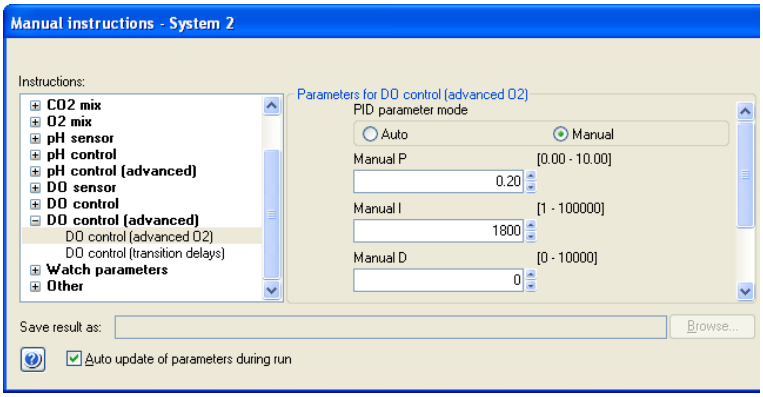
The control dynamics differ between the different bag sizes and depend on the rate of gas flow. The PID-parameters and the cycle time are therefore automatically computed with respect to the bag size and gas flow setpoint.

To optimize the control behavior, the automatic PID parameters are not the same when approaching a new setpoint as when keeping the setpoint. The automatic D parameter is always zero.

Tuning PID parameters and cycle time

If further tuning of PID parameters and/or cycle time is needed, follow these steps:

Step	Action
1	Open ***Tools*** →***Customize*** and select the tab ***Run Data Groups***. Select the ***Auto DO O2 P***, ***Auto DO O2 I*** and ***Auto DO O2 D*** and click ***OK***. *Result:* The automatic PID parameters are shown as ***Run Data***.
2	Register the values both when approaching the new setpoint, and when keeping the setpoint. ***Tip:*** *These automatic values are a good starting point for the tuning.*

Step	Action
3	Open the manual instruction ***DO control (advanced)*** →***DO control (advanced O2)*** and select ***Manual PID parameter mode*** and/or ***Cycle time mode*** and enter the desired values. When adjusting a ***Manual I*** parameter, remember that increasing the I parameter will reduce the integrating effect and vice versa.  Click ***Execute***.

4.5.3 Speed control mode

Introduction

At every execution of the speed control, the DO reading is compared with the DO setpoint. If the DO reading is below the DO setpoint, the rocking speed setpoint is increased. If the DO reading is above the DO setpoint, the rocking speed setpoint is decreased.

The settings of the DO speed mode can be set from the ***Process Picture*** or by using the manual instruction ***DO control (speed)***.

Speed control cannot be used in dual mode.

Speed step

The ***Speed step*** parameter defines the size of the change of the rocking speed setpoint.

Maximum and minimum rocking speed

The ***Max*** and ***Min*** speed parameters define the interval in which the DO controller can set the rocking speed setpoint.

Deadband

The upper and lower deadband parameters defines the deadband interval around the DO setpoint. When the DO reading is in that interval, no change of the rocking speed setpoint will take place.

Cycle time

The cycle time parameter sets the cycle time of the DO speed control. This cycle time will override the DO reading cycle time when the DO control is on.

4.5.4 O2/Speed control scheme

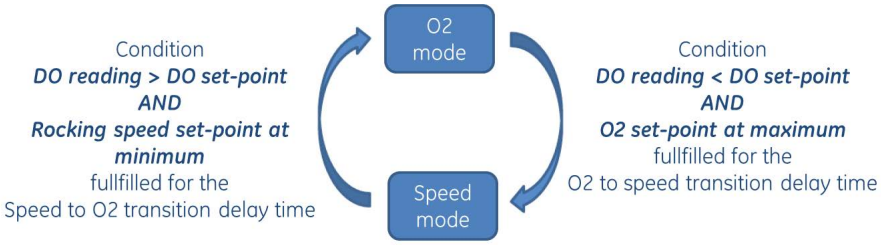
Description

The ***O2/Speed*** control scheme combines the ***O2*** and ***Speed*** control modes. It always starts in ***O2*** mode and can then switch back and forth between ***O2*** and ***Speed*** mode as long as the control is on. To avoid unnecessary switching between ***O2*** and ***Speed*** mode, the transitions between the modes are delayed. This delay is called transition delay time.

The O2/Speed control cannot be used in dual mode.

Transition delays

The condition for transition must be fulfilled for a certain time before the transition takes place. The transition delay times are set automatically and individually by the DO control. The values can be overridden with manual values using the manual instruction ***DO control (advanced) →DO control (transition delays)***.



If the DO O_2 controller is at its maximum O_2 setpoint 50%, and the DO reading is below the DO setpoint, a time counter is started. When the time counter reaches the set ***O2 to speed transition delay time***, the transition to ***Speed*** mode takes place. If the DO speed controller is at its minimum rocking speed setpoint, and the DO reading is above the DO setpoint, a time counter is started. When the time counter reaches the ***Speed to O2 transition delay time***, the transition to O_2 mode takes place.

Cycle time and transition delays

From UNICORN IC 2.0.9.0 and onwards, in auto mode of control, for as long as the setpoint is not changed:

- the cycle time is set to a maximum of 300 s, and
- the transition time delay is set to 600 s for all cellbag sizes and gas flows.

This time is set when the system turns from both O_2 to Speed and Speed to O_2. In case of a pH setpoint change, the transition times in UNICORN IC 2.0.8.0 will apply for various cellbag sizes and gas flow rates to allow the process to naturally drift to the new setpoint.

4.6 Media control

About this section

The media control has two modes: ***Media addition*** and ***Perfusion***, as described in the following sections. A complete description of all settings and output data is found in *Section 8.5.11 Media control, on page 276*.

Media control can be used in dual mode, but the accuracy will be lower than in single mode (see *Section 4.6.1 Weight measurement, on page 133*).

In this section

4.6.1 Weight measurement

Introduction

Media control relies on continuous measurement of the weight of the bioreactor contents, and maintains the weight at the setpoint by controlled addition of media using the feed pump.

Principles of weight measurement

Cellbag bioreactor and cell culture weights are measured by four load cells, placed at the corners of the rocker unit. In dual mode, the separate weight of each Cellbag bioreactor is calculated from the weight distribution between the load cells. It is important for correct weight measurements that the rocker is placed on a flat stable surface, and that the measurements are tared before each cultivation. See *Tare the scale, on page 190* for instructions on how to tare the weight measurement.

The load cells are temperature-sensitive. It is important that a constant ambient temperature is maintained for the duration of a run.

Limitations in dual mode

In single mode, all four load cells contribute to the weight measurement of the single Cellbag bioreactor. In dual mode, the separate weights of the two bioreactors are calculated from the weight distribution between the load cells, with a predominant contribution from two of the load cells for each bioreactor. The accuracy of the total weight measurement is the same as in single mode, but the accuracy of separate Cellbag weights is slightly reduced.

Dual weight measurements are primarily used to support regulation of temperature and pH, and the reduced accuracy is adequate for this purpose. Media control of culture in dual mode will have somewhat reduced accuracy compared with single mode.

The left and right bioreactor weights are displayed in the process picture with a resolution of 0.1 kg. This is useful, for example, when filling the bioreactor with medium, but cultivation in single mode or the use of an external scale is recommended if high weighing accuracy is required.

The accuracy of separate weight measurements also depends on the position of the Cellbag bioreactors on the tray. A sideways displacement of a bioreactor by 10 mm may add about 3% of the load to the weighing error. Since the bioreactor may move during rocking, it is important to make sure that the bench (and therefore the rocker) is stable and horizontal.

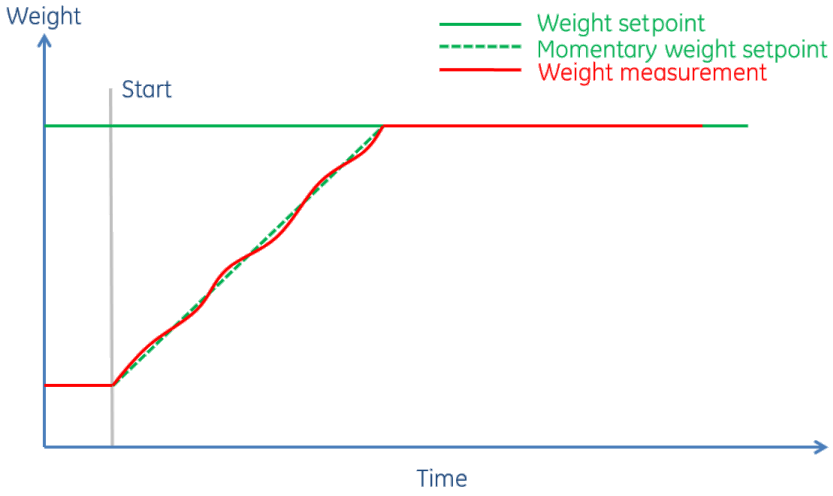
4.6.2 Media addition

Media addition principles

The media addition mode will fill the Cellbag bioreactor by running the feed pump at the desired flow rate until the weight setpoint is reached.

To keep the desired feed rate, the media control uses a transitional weight setpoint, that is ramped towards the given weight setpoint. It is called momentary weight setpoint, and the ramping speed corresponds to the feed rate.

The feed flow is adjusted by a regulator to keep the weight measurement at the momentary weight setpoint.



When the weight setpoint is reached, the feed pump is stopped but the control is still on and will start the feed pump again if the weight decreases.

Pump calibration

The feed pump flow is regulated to keep the momentary weight setpoint. No precise calibration of the feed pump is necessary, but it is important that the correct inner diameter of the tubing is set.

Calibrating the pump before running media addition can give more accurate measurement of the accumulated feed volume.

4.6.3 Perfusion

Introduction

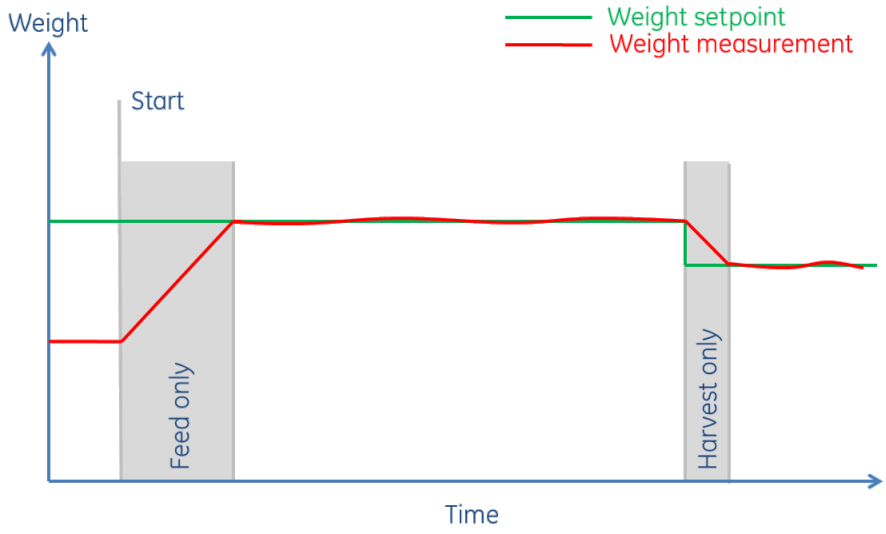
In perfusion mode the feed pump will add medium at a desired flow, and the harvest/waste pump flow is controlled by a regulator to keep the given weight setpoint.

The true feed flow is dependent of how well the feed pump is calibrated. To make the calibration more convenient and to compensate for tubing wear out, auto calibration of the feed and harvest/waste pumps is enabled by default.

Perfusion principles

When starting the media control, the feed or harvest/waste pump will run alone until the weight setpoint is reached. When the setpoint is reached, "normal perfusion" starts and both pumps will run. If the weight setpoint is changed while in "normal perfusion", one of the pumps will run alone until the new setpoint is reached.

The figure below shows a run where the control is started with the measured weight below the weight setpoint. After a while, the setpoint is decreased.



Pump calibration

In perfusion mode, the actual feed flow rate depends on the accuracy of pump calibration.

When auto calibration is not used, at least the feed pump must be calibrated manually. It is however recommended to also calibrate the harvest/waste pump, since unnecessary warnings for harvest/waste filter clogging might be given otherwise. The accumulated volume will be more precisely computed if the pump is calibrated.

For a detailed description of pump calibration see *Section 6.2 Pump calibration, on page 210*.

Auto calibration

Auto calibration is a convenient and precise way of letting the system calibrate the feed and harvest/waste pumps automatically. The system runs the feed and harvest/waste pumps one at the time, carefully measures the weight before and after running the pump, and then computes the weight difference used as calibration input to the pump.

The auto calibration function provides a convenient and precise option for automatic calibration of the feed and harvest pumps. The steps in auto calibration are listed below.

Step	Action
1	A message is sent to inform the user that auto calibration has started.
2	The pumps stop.
3	The system pauses for 15 seconds.
4	Weight measurements are averaged over a period of 30 seconds.
5	The harvest/waste pump runs at the perfusion flow rate setpoint for 2 to 30 minutes depending on the setpoint value.
6	The system pauses for 15 seconds.
7	Weight measurements are averaged over a period of 30 seconds.
8	A calibration command is sent to the harvest/waste pump, estimating the pumped volume by the measured weight difference between the second and the first weight average.
9	The feed pump runs at the perfusion flow rate setpoint for 2 to 30 minutes depending on the setpoint value.
10	Weight measurements are averaged over a period of 30 seconds.
11	A calibration command is sent to the feed pump, calculating the pumped volume from the measured weight difference between the third and the second weight average (assuming a density equal to 1).
12	The results of auto calibration can be seen in the feed and harvest calibration factor curves in the curve data chart.

An advantage of auto calibration compared with manual procedures is that it is performed on the system as set up for the run, with no open tubing ends or manual measurement of pumped volume.

Auto calibration calculates volume flow rates from measured weight using a liquid density equal to 1. If the density of the medium differs from 1, the flow rate given in L/day should be read as kg/day instead.

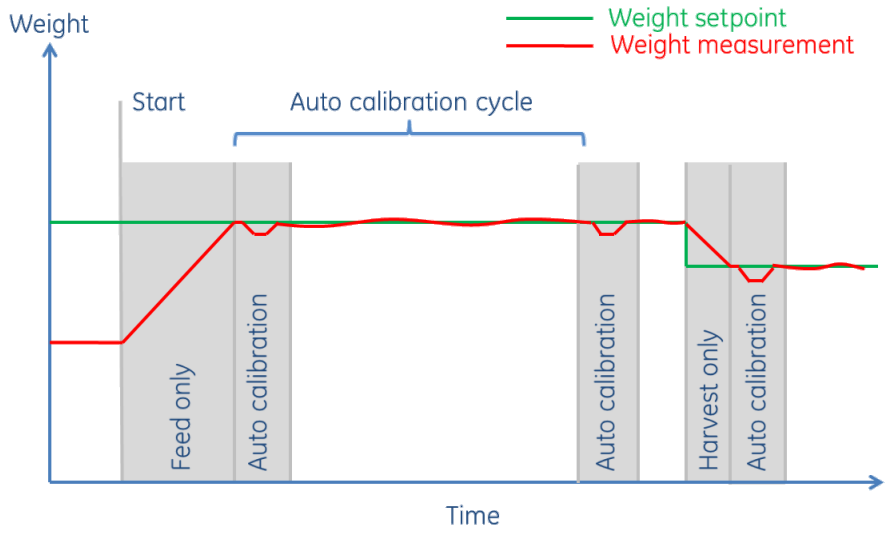
If perfusion is running at the weight setpoint with both pumps operating and the auto calibration disabled, enabling auto calibration will trigger an immediate auto calibration.

Note: *During auto calibration, it is important that the weight measurements are not disturbed by external influences such as touching the system or instability of the bench. If an auto-calibration is disturbed, disable and re-enable the function to trigger a new auto calibration.*

The accuracy of auto calibration may be slightly lower in dual mode than in single mode (see Limitations in dual mode, on page 133).

Auto calibration cycle

The figure below shows auto calibrations during a perfusion run. The first auto calibration is done when the weight setpoint is reached. This calibration replaces the manual calibration needed before starting if auto calibration is disabled. After that, the auto calibration is repeated with the interval given in the manual instruction ***Media control (general)***. When changing the flow rate or the weight setpoint, a new auto calibration will be done. Thereafter they will continue with the given frequency.



Auto calibration criteria

The calibration volume is depending on the flow rate, and is computed to make an optimal compromise between pump time and accuracy. The pump calibration run time is limited between 2 and 30 minutes for each pump. A low flow rate will give a long calibration time and a high flow rate will give a short calibration time.

If the flow rate setpoint is below 3.43 L/day, no auto calibration can be done, since achieving a volume large enough to get the desired accuracy would demand a pump run time longer than 30 minutes.

If auto calibration is enabled, and the criteria above cannot be fulfilled, the media control cannot start unless the flow rate is increased or the auto calibration is disabled.

Recommended weight setpoints

The media control will not start if the weight setpoint is outside the possible range shown in the table below.

Cellbag size (L)	Recommended weight setpoint (kg)	Permitted weight setpoint (kg) (SW limited)
2	0.5 to 1.0	0.2 to 1.0
10	2.5 to 5.0	1.0 to 5.0
20	5.0 to 10.0	2.0 to 10.0
22	5.0 to 10.0	2.0 to 10.0
50	12.5 to 25.0	5.0 to 25.0

For the perfusion to work satisfactory, it is important to ensure that the harvest/waste filter and harvest/waste out-port is completely covered by liquid through the whole rocking cycle.

If the harvest/waste out-port is not always covered by liquid, unnecessary warnings for harvest/waste filter clogging might be given. If auto calibration is used, it will not calibrate the harvest/waste pump correctly.

Emergency stop of pumps

To avoid overfilling or draining the Cellbag due to for example lack of feed media, harvest/waste filter clogging or tubing error, the feed or harvest/waste pump will stop when the weight measurement deviates more than 10% from the weight setpoint. The stopped pump will start again when the setpoint is reached.

4.6.4 Deviation alarm

Alarm conditions

By default, a deviation alarm is activated. It will send a message when the weight reading has been outside the specified toleration limits of the weight setpoint for a certain time.

The deviation alarm can be deactivated using the manual instruction ***Media control (general)***.

During media addition, the deviation alarm is acting on the momentary weight setpoint.

During perfusion, the deviation alarm is active only in normal perfusion when both pumps are running.

4.6.5 Media control inactivation

Description

If any of the conditions for running the ***Media control*** is suddenly not fulfilled when running the control, the control will turn into ***inactive*** state. In this state the control is not doing anything until all the necessary conditions are fulfilled again. Then the control will then start again.

When the control inactivate, a red or orange frame will be visible around the Media control icon in the process picture. A message dialog will show why the control is inactive.

- An orange frame indicates that the inactivation is due to sampling mode.
- A red frame indicates that the inactivation is due to an error.

4.7 Recommended operating conditions

Introduction

This section includes recommendations for gas flow, rocking speed and rocking angle. Suitable settings for temperature, pH, DO, CO_2 and O_2 are selected depending on the application and system configuration. For more information about rocker control settings, refer to *Section 8.5.1 Rocking control, on page 251*.

Rocking speed and angle

The optimal agitation for a process is determined by the cell culture oxygen demand and the cellular shear sensitivity. Rocking speed and angle should be set so that sufficient mixing and oxygen transfer is provided without excessive foaming.

Note: *Cells cultivated at low rocking speed and angle may form a sediment on the sensors in the Cellbag bioreactor, reducing the reliability of the sensors.*

- The culture volume affects mixing and oxygen transfer rate. Lower volumes give faster oxygen transfer and mixing.
- Increasing the rocking speed and angle will result in faster oxygen transfer and mixing.
- If no clear wave appears inside the Cellbag bioreactor, increase the rocking speed. (If the speed is limited by other parameters, try decreasing the speed slightly.)
- For cultures with high oxygen demand, such as a suspension CHO cells, rocking speed and angle can be increased up to for example 30 rpm and 8 degrees, respectively.
- For shear sensitive cells, such as adherent cells on microcarriers, rocking speed and/or angle can be decreased down to 10 rpm and 4 degrees, if sufficient oxygen transfer and mixing is maintained.

Each new cell line and process requires optimization of operating conditions. The table below shows typical rocking speed and gas flow settings for suspension cell culture.

Cellbag bioreactor size (L)	Culture volume (L)	Rocking speed (rpm)	Rocking angle (°)	Gas flow (Lpm)
2	0.3	10 to 20	2 to 4	0.05 to 0.2
	1	20 to 30	6 to 8	0.05 to 0.2
10	0.5	10 to 20	2 to 4	0.1 to 0.3
	5	20 to 30	6 to 8	0.1 to 0.3
20	1	10 to 20	2 to 4	0.2 to 0.5
	10	20 to 30	6 to 8	0.2 to 0.5

Cellbag bioreactor size (L)	Culture volume (L)	Rocking speed (rpm)	Rocking angle (°)	Gas flow (Lpm)
50	5	10 to 20	2 to 4	0.5 to 1.0
	25	20 to 30	6 to 8	0.5 to 1.0

Note: *When cultivating in a 50 L Cellbag bioreactor at maximum working volume of 25 L, rocking speed and angle multiplied should not exceed 240 rpm degrees. For example, if the rocking angle is set to 8 degrees, the rocking speed should not be set higher than 30 rpm.*

Rocking motion

The rocking motion factor determines how much of the rocking cycle is used for accelerating and decelerating the rocker motion at the turning points. For example, with the default setting of 30%, 15% of the rocking cycle is used for accelerating after the turning point and 15% for decelerating before the turning point. The rocking speed is constant for the remaining 70% of the cycle. The rocking motion factor can be set between 15% and 100%. A lower factor will give slightly higher oxygen transfer rate and mixing capacity whereas higher factors profiles can reduce shear forces, which is especially important when cultivating adherent cells on microcarriers.

Gas flow

The gas flow rate has little effect on oxygen transfer and can therefore be kept constant throughout the entire run.

When setting the gas flow rate the following should be taken into consideration:

- A high gas flow can cause unnecessary evaporation
- A low gas flow can slow down pH and DO control when using CO_2 and O_2 gas.
- A too low gas flow can lead to insufficient inflation of the Cellbag bioreactor.

Refer to the table in *Rocking speed and angle, on page 141* for recommendations on suitable gas flow rates.

Recommendations to reduce foaming

To reduce foaming, the following should be taken into consideration:

- Higher agitation rates can contribute to excessive foaming. This can be reduced by adding antifoam, or by decreasing the rocking speed and/or angle.
- Excessive foaming occurs if the Cellbag bioreactor is not rigidly inflated. Check that the gas flow is sufficient and that the pressure relief valve is functioning.

4.8 System verification

Introduction

This section describes verification procedures for the rocker function, temperature control and gas flow. Before verification, set up and start the system. System verification is recommended before the first cultivation, and if the system has not been used for a long period.

Use the same verification procedures in dual mode, applied to each Cellbag bioreactor where appropriate.

For more information about system control settings, see *Section 8.5 Control settings, on page 250*.

Verification of rocker function

Follow the instructions below to verify that the rocker operates correctly.

Step	Action
1	Start the rocking by clicking the right-hand side of the ***Rocking*** button. *Result:* The rocking is activated and the ***Rocking*** button gets green. 
2	Follow these instructions to make sure that the rocking speed functions properly: **a.** Enter the desired speed in ***Settings*** →***Rocking*** →***Speed*** in the ***Process Picture***. Click ***OK***. *Result:* The rocking speed changes to the set value. **b.** Try some different setpoints of the rocking speed, and make sure that the rocking speed changes.
3	Follow these instructions to make sure that the rocking angle functions properly: **a.** While the tray is rocking, enter the desired rocking angle in ***Settings*** →***Rocking*** →***Angle*** in the ***Process Picture***. Click ***OK***. *Result:* The rocking angle changes to the set value. **b.** Try some different setpoints of the rocking angle, and make sure that the rocking angle changes.

Step	Action
4	Follow these instructions to make sure that the rocking motion functions properly: **a.** While the tray is rocking, select ***Manual*** →***Execute Manual Instructions***, and open the instruction ***Rocker*** →***Set rocking motion***. Enter the desired rocking motion factor (see *Rocking motion, on page 142*). Click ***OK***. *Result:* The rocking motion changes to the set value. **b.** Try some different setpoints of the rocking motion and make sure that the motion changes.
5	If the rocking speed, rocking angle or rocking motion appear not to function correctly, refer to *Section 7.2 Xuri Cell Expansion System W25 rocker, on page 216*.
6	Stop the rocking by clicking the right-hand side of the ***Rocking*** button.

Verification of temperature control

Follow the instructions below to verify that the temperature control is functioning correctly.

Step	Action
1	Attach a Cellbag bioreactor and fill with at least the minimum volume of liquid.
2	Make sure that the ***Temp*** button in the ***Process Picture*** displays the ambient temperature.
3	Make sure that the rocking is on. Heat will not be applied to a motionless rocker to avoid local overheating in the Cellbag bioreactor.
4	Start the heating by clicking the right-hand side of the ***Temp*** button. *Result:* The heating is activated and the ***Temp*** button gets green. 

Step	Action
5	Enter the temperature 40.0 in ***Settings*** →***Temp*** →***Setpoint*** in the ***Process Picture***. Click ***OK***. *Result:* The temperature starts to increase to the set temperature value. **CAUTION** To avoid overheating, do not operate the heater without liquid in the Cellbag bioreactor on the tray.
6	Select the ***Chart*** tab and make sure that the temperature curve shows the increase in temperature.
7	If the temperature control appears not to function correctly, refer to *Section 7.2 Xuri Cell Expansion System W25 rocker, on page 216*.
8	Stop the heating by clicking the right-hand side of the ***Temp*** button.
9	Stop the rocking by clicking the right-hand side of the ***Rocking*** button.

Verification of gas flow

Follow the instructions below to verify that the gas flow is functioning correctly.

Step	Action
1	Make sure that the desired gas supplies are connected to the system. Refer to *Section 5.1.6 Connect gas to the system, on page 164*.
2	In the ***Process Picture***, click the ***Compressed Air*** button to select compressed air, or the ***N2*** button to select N_2.
3	Enter the gas flow setpoint 0.50 in ***Settings*** →***Gas control*** →***Gas flow*** →***Setpoint*** in the ***Process Picture***. Click ***OK***.
4	Start the gas flow by clicking the right-hand side of the ***Gas flow*** button. *Result:* The gas flow starts to increase to the gas flow setpoint. 

Step	Action
5	Verify that the overpressure alarm is functioning by blocking the gas flow in the **Gas mix** tubing. *Result:* After about 5 seconds an overpressure alarm should be activated and the gas flow should stop automatically. If the gas flow appears not to function correctly, refer to *Section 7.3 Xuri Cell Expansion W25 CBCU, on page 220*.
6	Stop the gas flow by clicking the right-hand side of the ***Gas flow*** button.

Verification of CO_2

Follow the instructions below to verify that CO_2 is functioning correctly.

Step	Action
1	Start the gas flow by clicking the right-hand side of the ***Gas flow*** button.
2	Enter a gas flow setpoint, for example 0.2 L/min, in ***Settings*** →***Gas control*** →***Gas flow*** →***Setpoint***. Click ***OK***.
3	Enter a CO_2 setpoint, for example 5%, in ***Settings*** →***Gas control*** →***CO2*** →***Setpoint***. Click ***OK***.
4	Wait for a few minutes and verify that the ***Process Picture*** shows a correct measurement. If the gas flow appears not to function correctly, refer to *Section 7.3 Xuri Cell Expansion W25 CBCU, on page 220*.

Verification of O_2

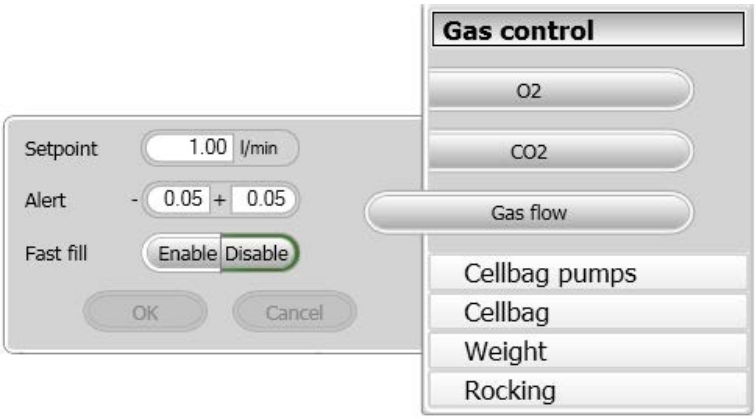
Follow the instructions below to verify that O_2 is functioning correctly.

Step	Action
1	Enter an O_2 setpoint, for example 30%, in ***Settings*** →***Gas control*** →***O2*** →***Setpoint***. Click ***OK***.
2	Wait for a few minutes and verify that the ***Process Picture*** shows a correct measurement. If the gas flow appears not to function correctly, refer to *Section 7.3 Xuri Cell Expansion W25 CBCU, on page 220*.

Verification of fast fill function

Follow these instructions to make sure that the ***Fast fill*** functions properly:

Step	Action
1	Open ***Settings*** →***Gas control*** →***Gas flow*** from the ***Process Picture*** in ***System Control***.
2	Set ***Fast fill*** to ***On***.



3	Start the gas flow by clicking the right-hand side of the ***Gas flow*** button in the ***Process Picture***. *Result:* The gas flow is maximized to 3 L/min for 20 minutes or until ***Fast fill*** is manually turned off. The cellbag is inflated.
4	Stop the gas flow when the cellbag has been fully inflated, by clicking the right-hand side of the ***Gas flow*** button.

5 Operation

About this chapter

This chapter describes how to operate Xuri Cell Expansion System W25.

In this chapter

5.1 Set up the system

About this section

This section describes how to prepare the bioreactor system for cell cultivation. For illustrations and descriptions of the system, refer to *Chapter 2 System description, on page 11*.

In this section

5.1.1 Select the tray and Cellbag bioreactor

Select the Cellbag bioreactor size and corresponding tray according to application requirements and system configuration. See the table below for guidelines.

Culture volume/ bioreactor (L)	Cellbag bioreactor size (L)	Tray	
		Single mode	Dual mode
0.3 to 1	2	Tray 10, Tray 20	Tray 20
0.5 to 5	10	Tray 10, Tray 20	Tray 20
1 to 10	20	Tray 20	N/A
1 to 10	22	Tray 50	Tray 50
5 to 25	50	Tray 50	N/A

Note: *To use a 20 L or 50 L Cellbag bioreactor, the system must be configured for single mode.*

Note: *Depending on application and configuration it might be possible to cultivate below the recommended minimum volume. However, it is highly recommended to stay above this volume for applications that require high agitation, and pH and DO control. The temperature, pH, and DO sensors need to be submerged in liquid throughout the complete rocking cycle to function correctly.*

5.1.2 Attach and detach tray

Introduction

This section describes how to attach and detach a tray to and from the rocker platform. These operations should preferably be performed without a Cellbag bioreactor on the tray.

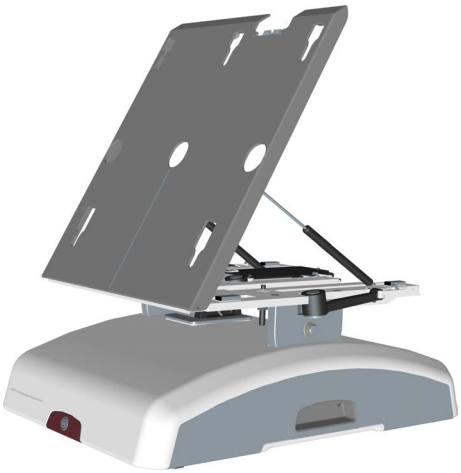
CAUTION

Due to the size and weight of Tray 50, at least two persons are recommended for installing the tray.

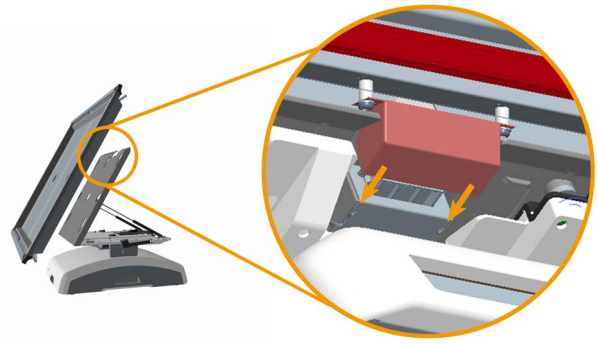
Attach tray

The tray can be attached to the rocker platform in tilt position and in normal position. Tilt position is recommended, as described in the instructions below.

Step	Action
1	Tilt the rocker platform by pulling the upper edge towards you.



2	Lift the tray into the same angle as the rocker platform.

Step	Action
3	Fit the tray on to the rocker platform. The attachment pins on the tray engage with the holes in the platform. Attach the pins on the upper edge first, then slide the tray down making sure that the lower pins engage with the respective holes. ***Note:*** *Make sure that the holes for the temperature sensors on the rocker platform fit into the holes in the tray.* 
4	Make sure that the connector on the tray is plugged into the tray connector on the back of the rocker platform. 

Detach tray

The tray can be detached from the rocker platform in tilt position and in normal position. Tilt position is recommended, as described in the instructions below.

Step	Action
1	Hold the textured grip area on each side of the tray and slide it upwards so that the attachment pins on the tray disengage from the holes in the rocker platform.

2	Pull the tray towards you.

Note:

If the tray is detached with the rocker in normal position, you will need to lift the tray by the upper edge before sliding it away from you.

5.1.3 Prepare pH and DO sensors

Instructions

Follow the instructions below to connect the sensor adapters to the pH and DO bag sensor ports.

NOTICE

Be careful to connect the sensors to the correct ports on Xuri Cell Expansion W25 CBCU. Identification stickers are provided to label the connectors.

NOTICE

In dual mode, be careful to connect the sensors for the left and right Cellbag bioreactors to the correct Xuri Cell Expansion W25 CBCU. This is easier if the respective Xuri Cell Expansion W25 CBCU units are placed on the left and right sides of the rocker respectively.

Step	Action
1	Remove the Cellbag bioreactor from its protective cover bag.

NOTICE

Exposure to intense light will cause deterioration of the optical sensors on the Cellbag bioreactor. To avoid unnecessary light exposure, remove the protective cover bag just prior to use.

2	Place the Cellbag bioreactor on a steady surface with the bag sensor ports facing upwards. The optical sensor spots have different colors. The spot on the pH sensor bag port is white/yellow and the spot on the DO sensor port is pink/black. If both pH and DO sensors are used, a separate fiber cable is needed for each sensor.

Step	Action
3	Attach the sensor adapter, with the optical lens facing the sensor port, by inserting the four pins of the port into the corresponding holes of the adapter.

Note:

The sensor adapter can be fastened in any of four orthogonal directions. Select the most convenient direction.

4	Rotate the sensor adapter clockwise to fix the pins on the sensor port to the adapter. A distinct "click" will indicate that the adapter is securely fastened.

Note:

When rotating the sensor adapter, make sure not to exert any force on the fiber cable.

Step	Action
5	Place the Cellbag bioreactor on the tray with the optical sensors facing downwards.

NOTICE

Make sure that the optical fiber cables are not placed between the Cellbag bioreactor and the temperature sensor on the tray. This could lead to erroneous temperature reading and control, resulting in overheating.

6	To keep track of the optical fiber cables, mark the cables with the supplied stickers.
7	Bundle the optical fiber cables on one side of the tray. Fit the lid and make sure the tubing and cables are placed in the tubing exit. See *Illustrations of tray and lid, on page 19*.
8	Connect the pH sensor cable to the **pH** port on the CBCU front panel.

9	Connect the DO sensor cable to the **DO** port on the CBCU front panel.

5.1.4 Attach the Cellbag bioreactor

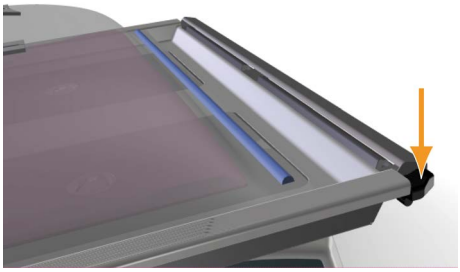
Instructions

Follow the instructions below to attach the Cellbag bioreactor to the tray.

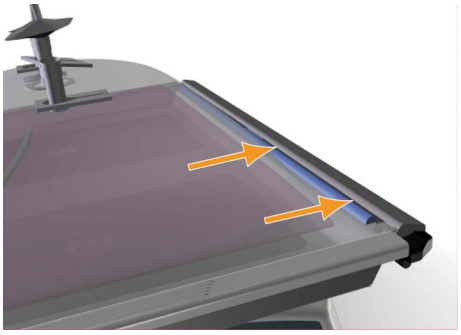
Note: *When using a Cellbag bioreactor that only covers half of the tray in single mode, such as a 10 L bag on Tray 20, position the bag on the left side of the tray.*

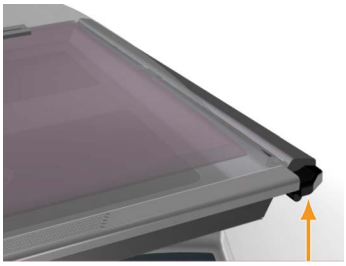
Note: *In dual mode, ensure that each Cellbag bioreactor is centrally positioned on the respective grey heating pad. Weight measurement resolution will be compromised if the bioreactor is not correctly placed.*

Step	Action
1	Push the bag clamp openers in the upper corners of the tray downwards. This opens the upper bag clamps. ***Note:*** *For a Cellbag bioreactor that covers the whole tray, open both bag clamps. In dual mode or with a bioreactor that covers only half the tray, only one clamp needs to be opened.*



2	Insert the upper Cellbag rod into the opened bag clamp.



Step	Action
3	If the clamp does not close automatically, gently push the bag clamp opener upwards to secure the upper end of the Cellbag bioreactor. Do not use force. Gently pull on the bioreactor to make sure it is attached. 
4	Repeat the above steps to attach the lower Cellbag rod to completely secure the Cellbag bioreactor on the tray.
5	Mount the lid on top of the tray.

NOTICE

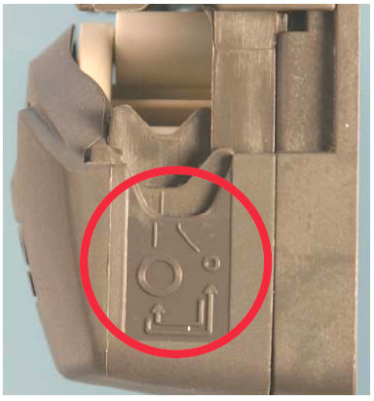
Keep the Cellbag bioreactor covered with the lid throughout the cultivation to protect the optical sensors from excessive light exposure.

5.1.5 Prepare the pump

Tubing holder positions

The pump head has two different holder positions to accommodate tubing with different sizes. The inner position is for small tubing and the outer position is for large tubing (see *Pump tubing sizes, on page 159*).

Inner position for small tubing.



Outer position for large tubing

Pump tubing sizes

The table below lists tubing sizes supported by Xuri Cell Expansion W25 Pump , with the range of flow rates provided by each size. The wall thickness of the tubing should be 1.6 mm (1/16").

Note: *Pump tubing is not supplied with the system. Suitable tubing must be purchased separately.*

Tubing inner diameter		Tubing holder position	Flow rate range (mL/min)[1]
Millimetres	Inches		
0.5	1/50	Inner	0.01 to 4.6
0.8	1/32	Inner	0.02 to 8.6
1.6	1/16	Inner	0.07 to 28
2.4	3/32	Inner	0.15 to 58
3.2	1/8	Inner	0.24 to 95
4.0	5/32	Outer	0.34 to 135
4.8	3/16	Outer	4.3 to 170

[1] Flow rates are limited in media control. Maximum flow rates can be achieved in manual control.

NOTICE

Using larger tubing with the tubing holder in its inner position will reduce flow rate and tubing life.

Using smaller tubing with the tubing holder in its outer position will not secure the tubing correctly and may lead to rupture.

Adjust tubing holder position

Use a pointed tool such as a ball pen to adjust the tubing holder positions on both sides of the pump head. Follow the instructions below to change the tubing holder position.

Step	Action
1	Make sure that the pump is not running.
2	Open the flip top of the pump head completely.

Step	Action
3	Place the pointed tool in the small depression in the tubing holder on one side of the pump head.

4	Press down and move the tubing holder to the required position until it clicks into place.

5	Release the pressure. The tubing holder rises into the new position.

6	Repeat the above steps to adjust the tubing holder on the other side of the pump head.

NOTICE

Make sure that the tubing holder position is the same on both sides of the pump head.

NOTICE

Make sure that the tubing holder position is not caught in between the inner or outer position, as this may cause erroneous flow rates and abnormal tube wear.

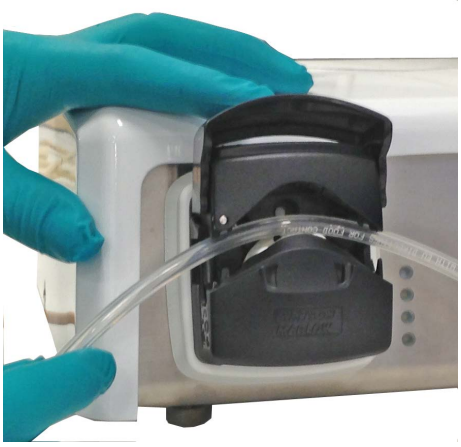
Load tubing

Follow the instructions below to load tubing in the pump head and connect tubing to the Cellbag bioreactor.

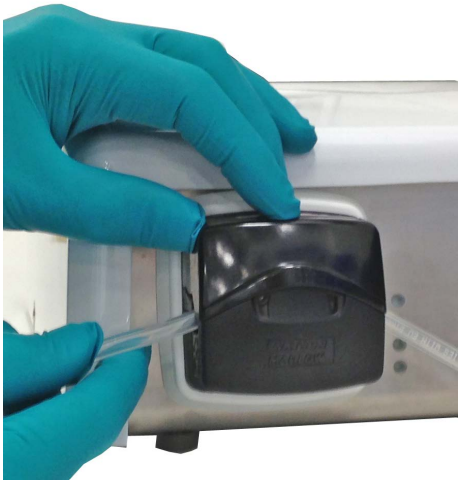
Step	Action
1	Make sure that the pump is switched off.
2	Open the flip top of the pump head completely.

3	Check that the tubing holder is adjusted to the correct position for your size of tubing. See instructions above.

Step	Action
4	Place the tubing between the rotor rollers and the track, pressed against the inner wall of the pump head.



5	Lower the flip top until it clicks into its fully closed position.



6	Connect inlet and outlet tubing to the Cellbag bioreactor, for example acid, base, feed and harvest/waste.

Note: *The pumping direction is indicated by the arrow on the pump head.*

5.1.6 Connect gas to the system

Gas mix

The Cellbag bioreactor requires gas flow to stay inflated and to provide ventilation. The CBCU enables different gas mixing possibilities. Compressed air or N_2 can be mixed with CO_2 and/or O_2 to obtain the desired gas mix.

Compressed air or N_2 is connected to **AIR/N2** on the CBCU. CO_2 and O_2 are connected to **CO2 IN** and **O2 IN**, respectively, on the CBCU rear panel.

NOTICE

In dual mode, be careful to connect the air and gas for the left and right Cellbag bioreactors to the correct CBCU. This is easier if the respective CBCU units are placed on the left and right sides of the rocker respectively.

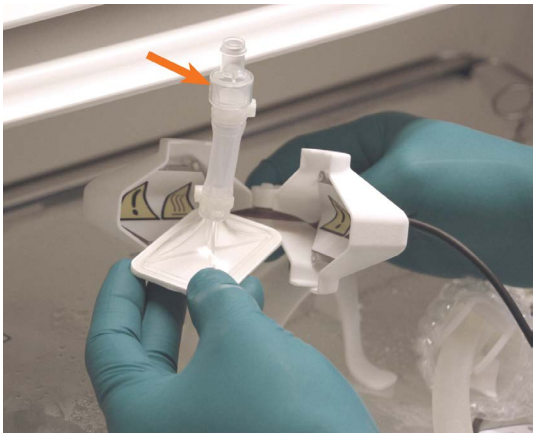
Set up aeration and gas supply

Follow the instructions below to connect gas to the bioreactor system.

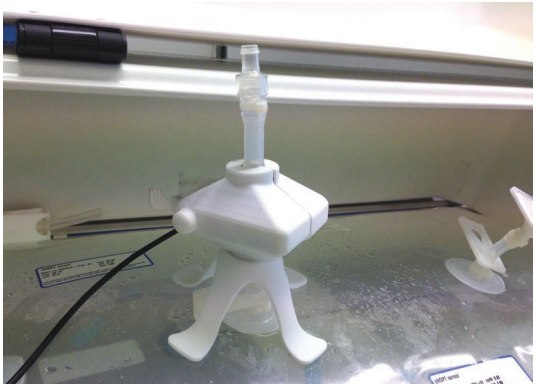
Step	Action
1	Attach the filter heater to the outlet vent filter of the Cellbag bioreactor. In dual mode, make sure that the filter heaters are correctly placed with respect to the left and right bioreactors.

Note:

The inlet and outlet vent filters are distinguished by the pressure control valve on the outlet filter (indicated by an arrow in the illustration below). Do not attach the filter heater to the inlet vent filter.



The image below shows the filter heater mounted on the stand on the Cellbag bioreactor.



Step	Action
2	Connect tubing from the **GAS MIX OUT** on the CBCU front panel to the inlet vent filter of the Cellbag bioreactor.

3	Connect the desired gas source, air or N_2, at 1.0 to 1.5 bar to **AIR/N2** on the CBCU rear panel.

4	If applicable, connect the CO_2 gas source at 1.0 to 1.5 bar to **CO2 IN** on the CBCU rear panel.

5	If applicable, connect the O_2 gas source at at 1.0 to 1.5 bar to **O2 IN** on the CBCU rear panel.

NOTICE

Make sure to keep the inlet pressures within the stated limits (1.0 to 1.5 bar). Excessive pressure may cause internal tubing to loosen.

NOTICE

An unsteady inlet pressure will affect the speed of the gas flow and also the gas mix.

5.1.7 Connect the filter heater to the rocker

Follow the steps below to connect the filter heater(s) to the rocker.

Step	Action
1	Connect the filter heater cable to the filter heater port on the rocker rear panel.
2	Attach the filter heater to the outlet vent filter of the cellbag bioreactor. In Single mode for Bag 20 L and Bag 50 L, Filter heater (L) is enabled by default. To use two filter heaters during single mode, Filter heater (R) must be enabled.
3	Activate Filter Heater (R) in Single mode, if applicable. **a.** Select ***System settings***. **b.** Click ***Rocker***. **c.** Click ***Enable Filter heater (R)***.

5.2 Start and configure the system

About this section

This section describes how to start the system, log on to UNICORN, connect the system to UNICORN and configure the system in the software.

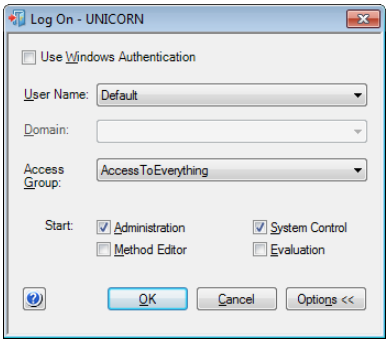
In this section

5.2.1 Start the system and log on to UNICORN

Follow the instructions below to start the system and log on to UNICORN. The workstation must have a valid e-license.

For more information about e-licenses, refer to *UNICORN Quick Installation Guide (29414475)*.

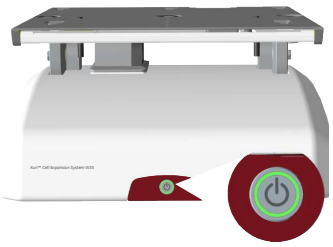
Step	Action
1	Switch on the client computer.
2	Start the UNICORN software.
3	Provide your ***User Name*** and ***Password*** to log on to UNICORN. Access credentials are assigned by your UNICORN administrator. According to the properties of your user account, you may be able to select an ***Access Group***.



Note:

*If **Use Windows Authentication** is checked, you may log on using your Windows username and password.*

4	Press the **Power** switch to start the rocker. *Result:* The **Power** button flashes green during start-up, and then lights steadily when the rocker is operational.



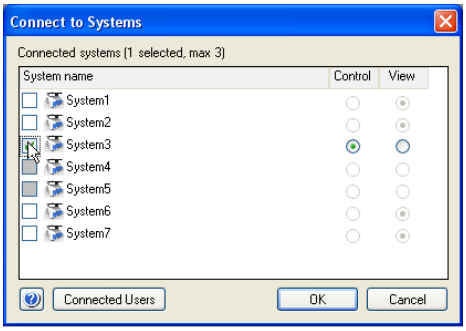
5.2.2 Connect to the system

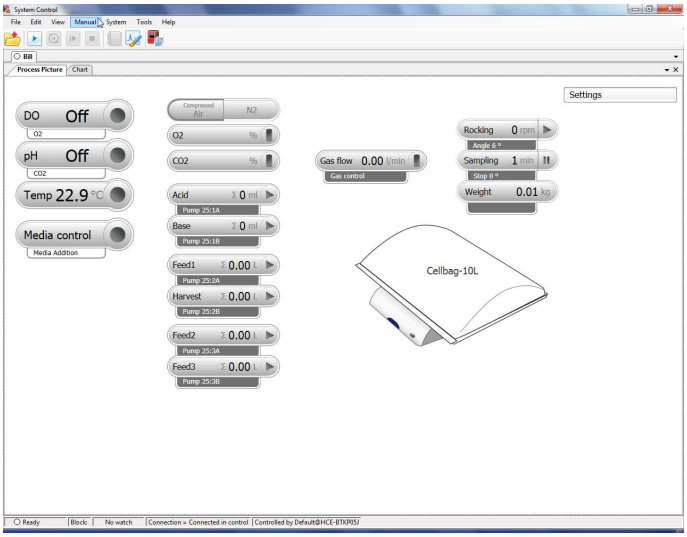
Follow the instructions below to connect the system to UNICORN.

Step	Action
1	When the indicator light on the rocker front panel shows a steady green light, click the ***Connect to Systems*** icon in the ***System Control*** module.

Result:

The ***Connect to Systems*** dialog opens.



Step	Action
2	In the ***Connect to Systems*** dialog: **a.** Select the system. **b.** Select ***Control*** mode. **c.** Click ***OK***. *Result:* The ***Process Picture*** appears.  ***Note:*** *The detailed appearance of the process picture will vary according to your system setup.* ***Tip:*** *If UNICORN is unable to connect to the selected system, see Section 7.6.2 UNICORN System Control, on page 238.*

5.2.3 Configure system properties

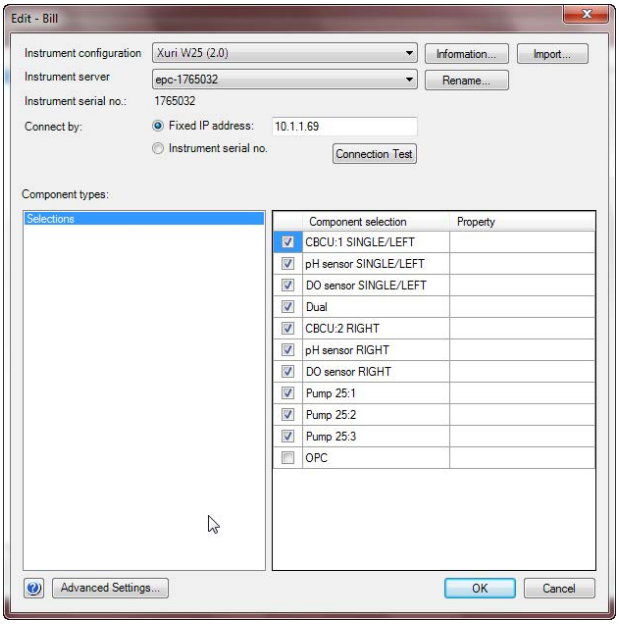
Edit the system properties whenever the configuration of the system is changed, for example:

- to switch between single and dual modes.
- to change the system setup, for example if a CBCU or pump has been added or removed.
- to change the ***Instrument Configuration*** of the system.

  The ***Instrument Configuration*** is the system specific control software. It is provided on a DVD with the system, and is also available for download. Contact your Cytiva representative if you need help to download the ***Instrument Configuration***.

Follow the instructions below to edit the system properties.

Step	Action
1	Open the ***Administration*** module in the ***Tools*** menu. Click ***System Properties***.
2	Select your system in the ***System Properties*** dialog and click ***Edit***. ***Note:*** *Only systems that are switched on and connected to the computer can be edited.*



Step	Action
3	All available components are shown in the ***Component selection*** list. **a.** Click the check-boxes to select or de-select components. **b.** Make sure the components selected match the units connected to the system.
4	Click ***OK*** to apply the changes.

5.2.4 Configure system settings

Introduction

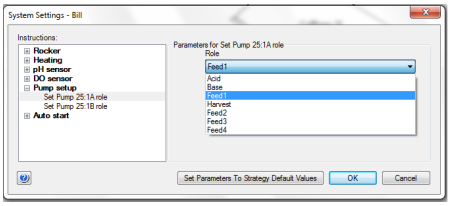
In ***System Settings***, system parameters are defined, such as:

- pump roles, which need to be assigned to the individual pump heads before starting a run;
- whether heating should be automatically enabled when the rocking starts (IC 2.0.4.0 and lower versions);
- whether heating should be automatically disabled when the rocking starts (IC 2.0.5.1 and higher versions);
- whether calibration values for pH and/or DO sensors should be reset at the end of the run;
- whether rocking, gas mix and temperature control should be resumed on restart after power loss;
- whether voltage or current should be used for analog inputs.

Assignment of pump roles to pump heads

Pump roles need to be assigned to the individual pump heads before starting a run. Follow the instructions below to assign pump roles. See *System settings, on page 43* for general instructions on how to configure the system settings.

Step	Action
1	Select ***System*** →***Settings*** in the ***System Control*** module.
2	Select ***Pump setup*** from the list and click the ***+*** symbol to view the available pump heads.

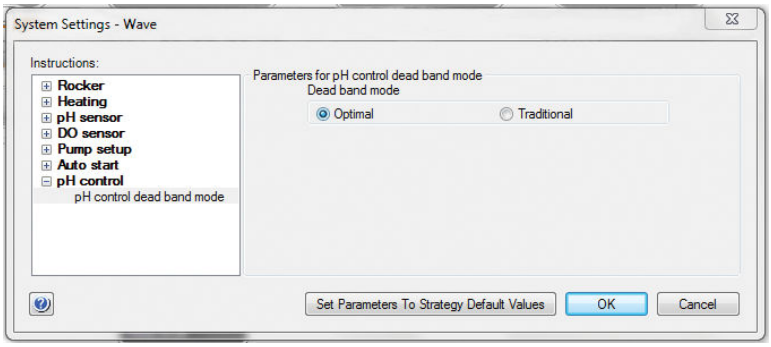


Step	Action
3	Assign roles to pump heads according to the requirements of the cultivation process. In single mode, available roles are ***Acid***, ***Base***, ***Feed1***, ***Harvest***, ***Feed2***, ***Feed3*** and ***Feed4***. In dual mode, available roles are ***Acid***, ***Base***, ***Feed1***, ***Harvest***, ***Feed2***, ***Feed3*** for the left and right functions separately, identified by the suffix ***L*** and ***R***. ***Note:*** *Media addition in media control and perfusion mode uses only* ***Feed1*** *of the available* ***Feed*** *roles. Do not select other* ***Feed*** *roles for pump heads intended for these purposes.* ***Examples:*** **a.** For pH control using acid and base in single mode, assign ***Acid*** to one pump head and ***Base*** to another. **b.** For pH control using acid and base in dual mode, assign ***Acid L*** and ***Base L*** to separate pump heads for the left Cellbag bioreactor, and ***Acid R*** and ***Base R*** to separate pump heads for the right bioreactor. **c.** For media addition in dual mode, assign ***Feed1 L*** to a pump head for the left Cellbag bioreactor, and ***Feed1 R*** to a pump head for the right bioreactor.
4	A given pump role cannot be assigned to more than one pump head. If a role that is already assigned to a pump head is given to a second pump head, the second assignation will apply and the first pump head will be set to ***Not defined***. Check the assignment of all pump heads to make sure that there are no conflicts before clicking ***OK***.
5	To return to the default values defined in the instrument configuration, click ***Set Parameters To Strategy Default Values***.

Select mode of pH control in deadband

Follow the instructions below to select the mode of pH control in deadband.

Step	Action
1	Select ***System*** →***Settings*** in the ***System Control*** module.
2	Select ***pH control*** from the list and click the ***+*** symbol to view the available alternatives.

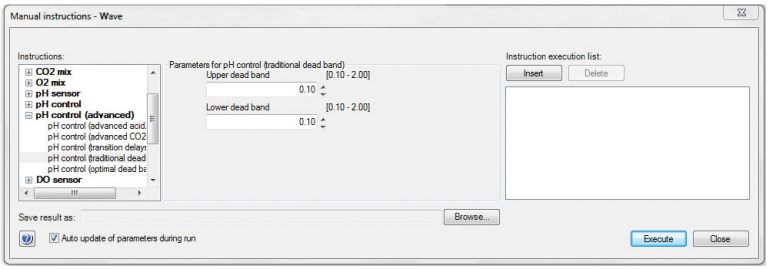
Step	Action
3	Click on alternative ***pH control deadband mode***.
4	Click one of the radio buttons ***Optimal*** or ***Traditional*** to select mode. ***Note:*** *The selected mode of deadband cannot be changed during a run.* 
5	Click ***OK*** to confirm the selection.

Select upper and lower limits of traditional deadband

Follow the instructions below to select the upper and lower limits of traditional deadband before starting a run.

Step	Action
1	Select ***System*** →***Manual Instructions*** in the ***System Control*** module.
2	Select ***pH control (advanced)*** from the list and click the ***+*** symbol to view the available alternatives..
3	Click on alternative ***pH control (deadband)***.
4	In the ***Upper dead band*** field, select the upper limit by clicking the small arrows to the right of the field. The limits are selected in the range of 0.10 to 2.00 pH units.

Step	Action
5	In the ***Lower dead band*** field, select the lower limit by clicking the small arrows to the right of the field. The limits are selected in the range of 0.10 to 2.00 pH units.

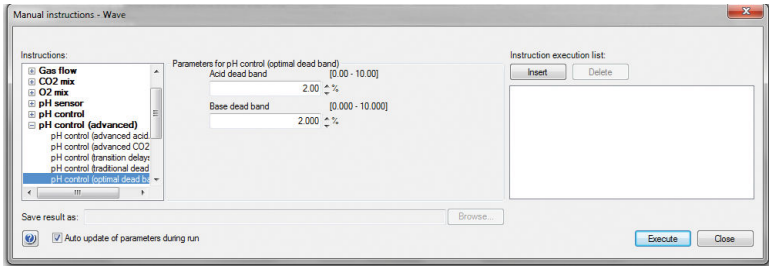


6	Click ***Execute*** to apply the selection.

Select acid/base deadband in optimal mode of pH control

Follow the instructions below to select the acid/base deadband in optimal mode of pH control before starting a run.

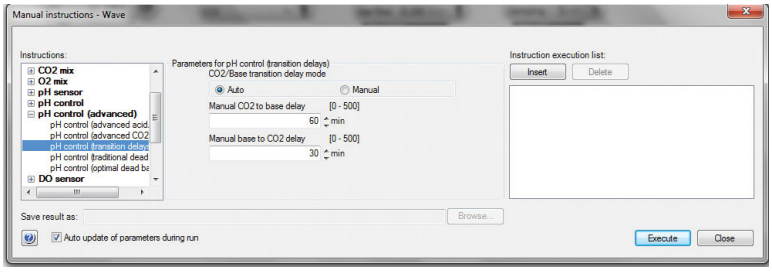
Step	Action
1	Select ***System*** →***Manual Instructions*** in the ***System Control*** module.
2	Select ***pH control (advanced)*** from the list and click the ***+*** symbol to view the available alternatives.
3	Click on alternative ***pH control (optimal deadband)***.
4	In the ***Acid dead band*** field, select the acid range of optimal deadband in % cycle time by clicking the small arrows to the right of the field. The limits are selected in the range of 0.00% to 10.00%.
5	In the ***Base dead band*** field, select the base range of optimal deadband in % cycle time by clicking the small arrows to the right of the field. The limits are selected in the range of 0.00% to 10.00%.



Step	Action
6	Click ***Execute*** to apply the selection.

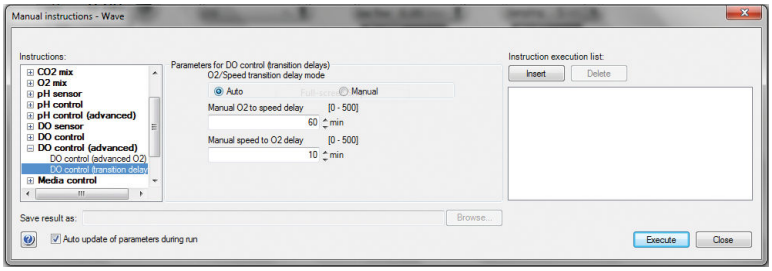
Select transition delays in CO2/Base in optimal mode of pH control

Follow the instructions below to select the transition delays in Auto/Manual mode before starting a run.

Step	Action
1	Select ***System*** →***Manual Instructions*** in the ***System Control*** module.
2	Select ***pH control (advanced)*** from the list and click the ***+*** symbol to view the available alternatives.
3	Click on alternative ***pH control (transition delays)***.
4	Click one of the radio buttons ***Auto*** or ***Manual*** to select mode. ***Note:*** *In the Manual mode of DO control, the transition delay may be changed to ranges mentioned in the respective tabs for both CO2 to Speed and Speed to CO2 transitions.*
5	In the ***Manual CO2 to base delay*** and ***Manual base to CO2 delay*** fields, select the transition delays by clicking the small arrows to the right of the field. The limits are selected in the range of 0 to 500 minutes. The transition delay times set in the Auto mode of DO control (advanced) can be visualized under the ***CO2 to Speed*** and ***Speed to CO2*** tabs. 
6	Click ***Execute*** to apply the selection.

Select transition delays in DO Control

Follow the instructions below to select the transition delays in DO/Speed mode before starting a run.

Step	Action
1	Select ***System*** →***Manual Instructions*** in the ***System Control*** module.
2	Select ***DO control (advanced)*** from the list and click the ***+*** symbol to view the available alternatives.
3	Click on alternative ***DO control (transition delays)***.
4	Click one of the radio buttons ***Auto*** or ***Manual*** to select mode. ***Note:*** *In Manual mode of DO control, the transition delay may be changed to ranges mentioned in the respective tabs for both O2 to Speed and Speed to O2 transitions.*
5	In the ***Manual O2 to speed delay*** and the ***Manual speed to O2 delay*** fields, select the transition delays by clicking the small arrows to the right of the fields. The limits are selected in the range of 0 to 500 minutes. The transition delay times set in Auto mode of DO control (advanced) can be visualized under the ***O2 to Speed*** and ***Speed to O2*** tabs. 
6	Click ***Execute*** to apply the selection.

5.2.5 Start a run

Introduction

This section describes how to start a manual or method-controlled run. Data collection begins when the run starts.

For further information on methods, refer to *Section 3.3 Methods in UNICORN, on page 46*.

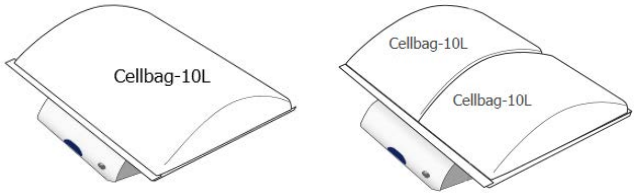
Note: *Pressing the **Power** button on the rocker while the rocker is switched on shuts down the system and stops any ongoing run.*

Start a manual run

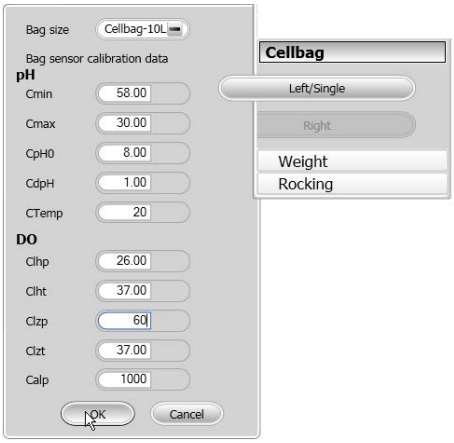
Follow the instructions below to start a manual run.

Step	Action
1	Change the Cellbag settings as required. In dual mode, make sure the settings are correctly entered for both bioreactors.

a. Click the Cellbag icon. In dual mode, click the appropriate side of the icon.



b. If pH and/or DO control will be used, enter the appropriate calibration data (printed on the Cellbag label).

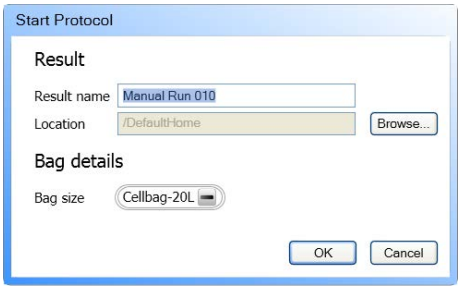


c. Click ***OK***.

Result:

The ***Start Protocol*** dialog for the manual run opens.

Step	Action



2 On the displayed page in the ***Start Protocol***:

a. Type the ***Result name*** and click '***Browse*** to change the ***Location*** of where the result is saved if necessary.

b. Select the correct ***Bag size*** (two sizes are listed in dual mode).

c. Click ***OK***.

Result:

The manual run starts.

Start a method run

To start a run, perform one of the following tasks:

- select one of the predefined method templates provided, or
- select from the saved methods in the system, or
- follow the instructions below to create a new method using a predefined method as template.

Step	Action

1 In ***Method Editor*** do either of the following:

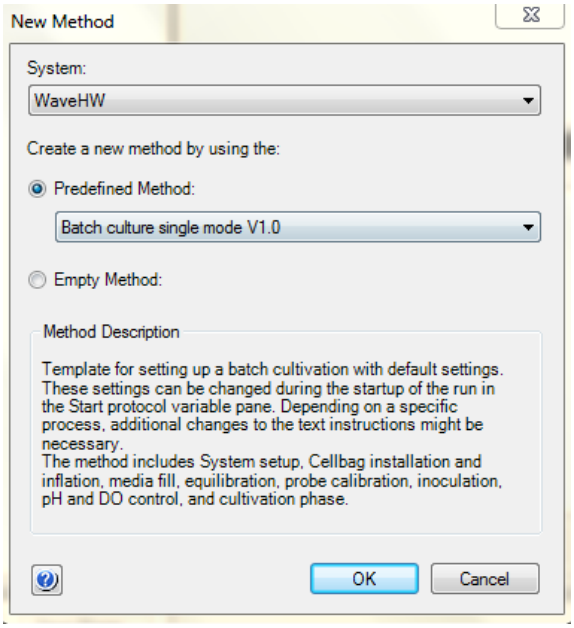
- click the ***Create a new method*** icon in the ***Toolbar***

  or

- select ***File:New Method***

Result:
The ***New Method*** dialog opens.

Step	Action
2	In the ***New Method*** dialog, select a System.



3	Select one of the predefined method templates.
4	Click ***OK***. *Result:* The ***Method Outline*** pane shows the mandatory ***Method Settings*** phase for the chosen method. The ***Text Instructions*** pane shows all the instructions that define the method. The ***Phase Properties*** pane shows the default settings for the currently highlighted phase.

Hold or stop the run

To interrupt a method during a run you may use the ***Hold*** or ***End*** icons in ***System Control***. A held method run can be resumed by using the ***Continue*** icon. See the instructions in the table below.

At the end of a method the run stops automatically. All functions stop, including rocking and data logging, and an acoustic end signal sounds and ***End*** is displayed in the ***Run Log***. This also applies when ending a manual run.

Tip: *In **System Settings**, it is possible to set **Prepare for Tilt at END**.*

If you want to...	then...
temporarily hold the method	click the ***Hold*** icon.  ***Note:*** *When a method is put on hold, the system control is maintained, but no new instructions are given.*
resume a method run	click the ***Continue*** icon.  ***Note:*** *An ended method cannot be continued.*
resume a method run or a manual run after the system has entered the ***Error and Alarm*** state	click the ***Continue*** icon. 
permanently end the run	click the ***End*** icon. 

Note: *When you end a method run prematurely, you will be prompted to save or discard the partial result.*

5.3 Prepare for cultivation

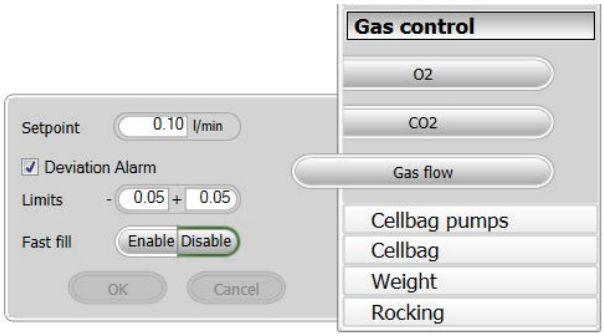
About this section

This section describes the how to prepare the system for cell cultivation. For illustrations and descriptions of the system, refer to *Chapter 2 System description, on page 11*.

In this section

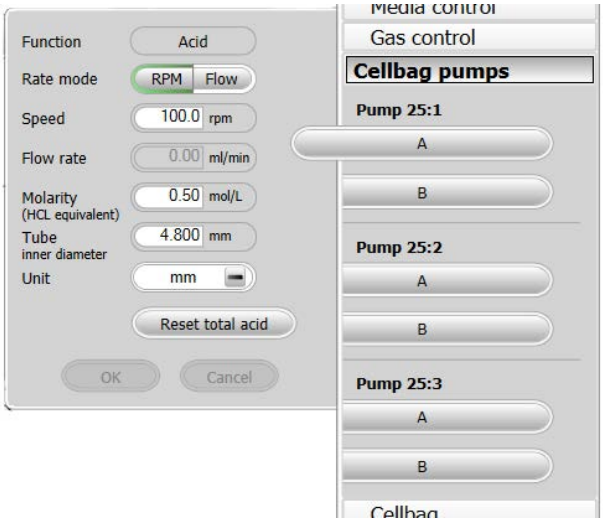
5.3.1 Inflate the Cellbag bioreactor

Follow the instructions below to inflate the Cellbag bioreactor.

Step	Action
1	Make sure that all ports on the Cellbag bioreactor are closed and that inlet and outlet filters are open.
2	Open ***Settings*** →***Gas control*** →***Gas flow*** from the ***Process Picture*** in ***System Control***.
3	Enable ***Fast fill***. This will maximize the gas flow during the first 20 minutes. ***Note:*** *Fast fill is disabled in the illustration below.* 
4	Turn on ***Gas flow*** from the ***Process Picture*** by pressing the right-hand side of the ***Gas flow*** button. *Result:* The Cellbag is inflated.

5.3.2 Adjust pump parameters

Follow the instructions below to adjust the pump parameters.

Step	Action
1	Adjust the pump parameters for each pump under ***Settings*** →***Cellbag pumps***. Enter the ***Tube inner diameter*** and if the pump function is acid or base, enter the molarity. ***Note:*** *The acid/base control is tuned with NaOH and HCl. If you are using acid or base with a different pK value you should set the* ***Molarity*** *parameter to the equivalent molarity of NaOH or HCl for optimal pH control.* 
2	If you are preparing a perfusion cultivation, calibrate the feed and harvest/ waste pumps to reach optimal precision.

5.3.3 Final checks before cultivation

Final checks before cultivation

Follow the instructions below to verify the system before filling the Cellbag bioreactor with medium.

Step	Action
1	Verify that the tray is correctly attached to the rocker platform.
2	Verify that the lid is mounted on the tray to protect the optical sensors on the Cellbag bioreactor from excessive light.
3	If using both pH and DO sensors, verify that the optical fiber cables are not mixed up. Mark the cables with the supplied stickers.
4	Verify that the pH or DO sensor cables are not positioned betweeen the temperature sensor and the Cellbag bioreactor.
5	Verify that the pH and DO sensor adaptors are connected correctly.
6	Verify that the filter heater is connected.
7	Verify that the Cellbag bioreactor is firmly inflated and secured to the tray. The Cellbag bioreactor should be taut but not creased.
8	Verify that gas flow is released through the outlet pressure relief valve. This may be done by attaching a piece of tubing with one end submerged in a beaker of water to the pressure relief valve. Formation of gas bubbles in the water will confirm the relief valve function.

5.3.4 Add and equilibrate culture medium

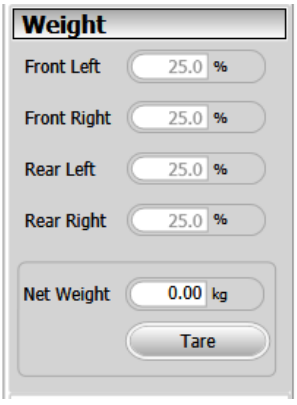
Tare the scale

Tare the scale with all the equipment on the tray, such as lid, Cellbag bioreactor, and filter heater before starting a run. For optimal control, the measured weight should be the same as the weight of the culture. The weight measurement is used as input for the regulation of temperature, pH, and media control.

In dual mode, it is important for correct weight measurement to tare the scale, even if the weight distribution appears to be even.

Note: *Load cells are temperature-sensitive. Keep the ambient temperature constant to minimize effects on weight measurement.*

Follow the instructions below to tare the scale.

Step	Action
1	Set the rocker stop angle to 0° and check that the tray is in a horizontal position.
2	Open ***Settings*** →***Weight*** from the ***Process Picture*** in ***System Control***.  In dual mode, the weights of the two bioreactors are displayed separately.
3	Check that the weight distribution is even by reading the weight percentage values for the rocker feet. The values should not differ more than ±5%, and the optimal weight distribution is 25% on each load cell. Turn the adjustable foot if necessary, see *Figure 2.1, on page 17*.
4	Make sure that the lid and all other equipment that will be used during the run is placed on the tray, and that no tubing weighs down the tray.
5	Click ***Tare***.

Add culture medium

Follow the instructions below to fill the Cellbag bioreactor with culture medium.

Note: *The high pressure alarm may be triggered as the bioreactor is filled, depending on gas and liquid flow rates. The alarm may be ignored provided that it is no longer active when filling is complete.*

Step	Action
1	Open ***Rocking*** from the ***Process Picture***. Set the ***Stop Angle*** to ***12.0*** and click ***OK***. ***Note:*** *The risk that air bubbles are trapped by the optical sensors is minimized with the tray at an angle. The angle can be adjusted to make sure that the medium reaches all optical sensors during filling. Using medium at room temperature or culture temperature reduces the risk of air bubble formation.*
2	Slowly transfer the desired volume of medium into the Cellbag bioreactor using a pump or gravity flow. ***Tip:*** *To automatically fill the bag to a desired weight, use* ***Media Addition*** *from* ***Settings →Media control*** *in the* ***Process Picture****.*
3	Check if there are visible gas bubbles on the optical sensors. See pH reading and DO reading, respectively, in *Section 7.3 Xuri Cell Expansion W25 CBCU, on page 220* for advice on how to remove bubbles. ***Note:*** *Such bubbles may be difficult to see. For the pH sensor, an indication of gas bubbles is that the initial pH reading deviates more than about 0.5 units from a reference measurement.*

Equilibrate to operating conditions

Follow the instructions below to equilibrate the medium to operating conditions.

For recommendations on operating conditions, refer to *Section 4.7 Recommended operating conditions, on page 141*.

Step	Action
1	Set the desired rocking speed and angle in ***Settings*** →***Rocking*** in the ***Process Picture***. Start the rocking by clicking the right-hand side of the ***Rocking*** button.  ***Note:*** *When using Tray 50, the value of rocking speed multiplied by rocking angle may not exceed 240 (e.g., with a rocking angle of 12° the rocking speed is limited to 20 rpm).*
2	Set the desired gas flow in ***Settings*** →***Gas control*** →***Gas flow*** in the ***Process Picture***. Start the gas flow by clicking the right-hand side of the ***Gas flow*** button.
3	If applicable, turn on CO_2 mixing by clicking the right-hand side of the ***CO2*** button in the ***Process Picture***.
4	Set the required temperature setpoint.
5	Click the right-hand side of the ***Temp*** button to start heating.
6	Equilibrate the medium for at least 2 hours.

5.3.5 Prepare the sensors

Important

Do not start pH or DO reading until the medium is fully equilibrated to operating conditions. The sensors do not give reliable measurements until then.

Equilibrate the culture medium with 100% air to calibrate DO sensors for 100% air saturation. If you use air mixed with 0% to 10% CO_2, the sensors can be calibrated over the range 100% to 90% air saturation.

Do not calibrate DO sensors for 100% air saturation if N_2 is used instead of air.

Note: *CO_2 regulation is slow, so it takes some time before the CO_2 concentration reaches the setpoint.*

NOTICE

Do not move the rocker during a run, since this could damage the scale function and disturb the weight measurement.

Prepare the DO sensor

Follow the instructions below to prepare the DO sensor.

Note: *In dual mode, adjust the sensor calibration on each Cellbag bioreactor separately.*

Step	Action
1	When the medium is equilibrated to operating conditions, move the cursor over the DO sensor icon in the ***Process Picture***, and set ***Reading On*** in the menu that appears. Wait until the value is stable.
2	Select ***System*** →***Calibrate*** in ***System Control***.
3	Select ***DO sensor*** in the ***Monitor to calibrate*** drop down menu.
4	Enter percentage of air saturation (90% to 100% depending on CO_2 concentration) in the ***Enter reference DO*** field.
5	Click ***Calibrate***.
6	Close the ***Calibration*** dialog.
7	Select ***Settings*** →***DO*** in the ***Process Picture***.
8	Enter the desired values for ***Control*** and ***Setpoint***. Check the ***Deviation Alarm*** and set the alarm limits if desired.

Step	Action
9	Click ***OK***.

Prepare the pH sensor

Follow the instructions below to prepare the pH sensor.

Note: *In dual mode, adjust the sensor calibration on each Cellbag bioreactor separately.*

Step	Action
1	When the medium is equilibrated to operating conditions, move the cursor over the pH sensor icon in the ***Process Picture***, and set ***Reading On*** in the menu that appears. Wait until the value is stable.
2	Click the right-hand side of the ***Sampling*** button to prepare for sampling. *Result:* The system will enter sampling mode. ***Note:*** *The system will be in sampling mode as many minutes as set in* ***Settings →Rocking →Sampling →Pause*** *and at an angle set in* ***Settings →Rocking →Sampling →Stop angle*** *in the* ***Process Picture****.*
3	Take a sample to verify that the pH value shown by the system matches the pH measured with a calibrated reference instrument. If the deviation is larger than approximately 0.5 pH units, make sure that no air bubble is present. For instructions on how to remove air bubbles, see *pH reading, on page 225*.
4	Continue with the calibration adjustment only if the deviation is less than 0.5 pH units.
5	Select ***System →Calibrate*** in ***System Control***.
6	Select ***pH sensor*** in the ***Monitor to calibrate*** drop down menu.
7	Enter the actual pH value in the ***Enter reference pH*** field.
8	Click ***Calibrate***.
9	Close the ***Calibration*** dialog.
10	Select ***Settings →pH*** in the ***Process Picture***.
11	Enter the desired values for ***Control*** and ***Setpoint***. Check the ***Deviation Alarm*** and set the alarm limits if desired.

Step	Action
12	Click ***OK***.

5.4 Perform cultivation

About this section

This section describes the basics of performing a cultivation. During the cultivation, key parameters are monitored and the settings can be adjusted.

In this section

5.4.1 Inoculate the culture

Instructions

Follow the instructions below to inoculate the Cellbag bioreactor.

Note: *Make sure that the key culture parameters pH, DO and temperature are stable before inoculation.*

Step	Action
1	Make sure that the inlet tubing and the tubing connected to the inoculum container are clamped.
2	Using sterile techniques, connect tubing from the inoculum container to the inlet tubing, using e.g. tube fusing equipment or a ReadyMate™ connector.
3	Unclamp the inlet tubing and inoculum container tubing.
4	Transfer the desired volume of inoculum into the bag using a pump or gravity flow.

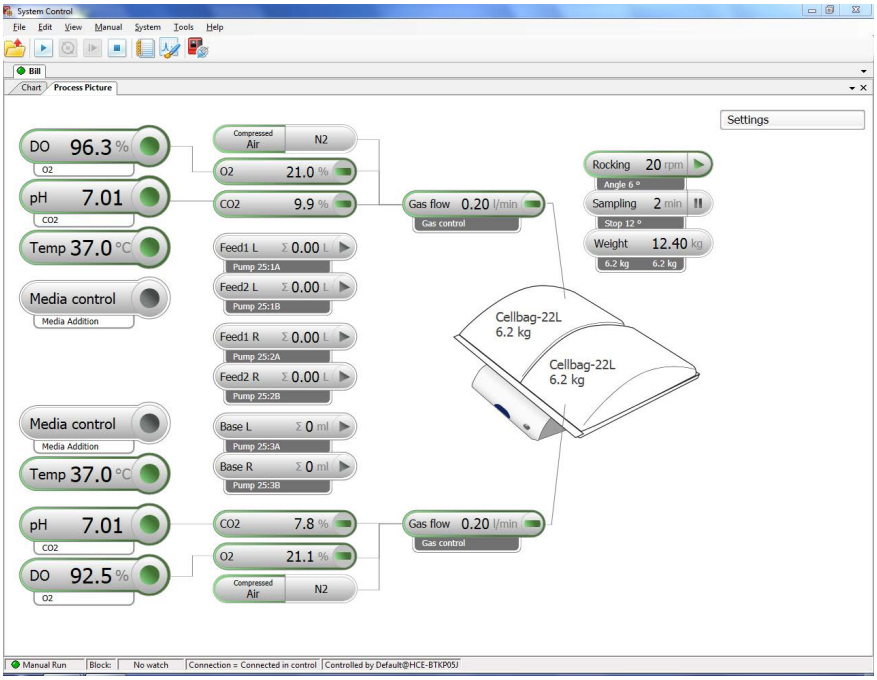
5.4.2 Monitor and control the run

Introduction

You may follow and control the ongoing run in the ***System Control*** module. The current system status is shown in the ***System state*** panel in the ***Run Data*** pane. For example, it may show ***Ready***, ***Manual Run*** or ***Method Run***, whether optimal or traditional deadband is used for pH control.

Process picture

The ***Process Picture*** displays the real-time process parameters during a run, and can be used to control the run. An example of the ***Process Picture*** is shown in the illustration below. Details vary according to the system configuration.



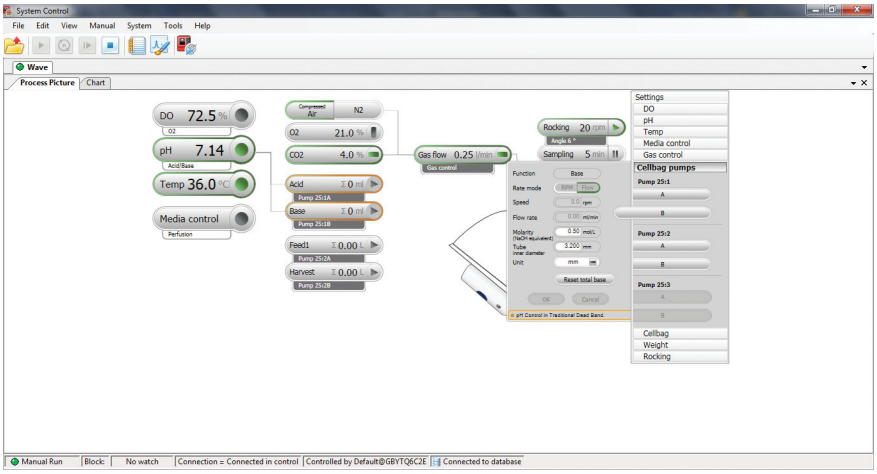
The button colors indicate the current state of the respective function as shown in the table below.

Color	Indication
White	The function is inactive.
Gray	The function is disabled due to higher level control
Green	The function is active and is working normally.
Orange	The function needs attention. Click on the button to open the related settings and to see more information.
Red	The function is not working properly. Click on the button to open the related settings and to see an explanation of the problem.

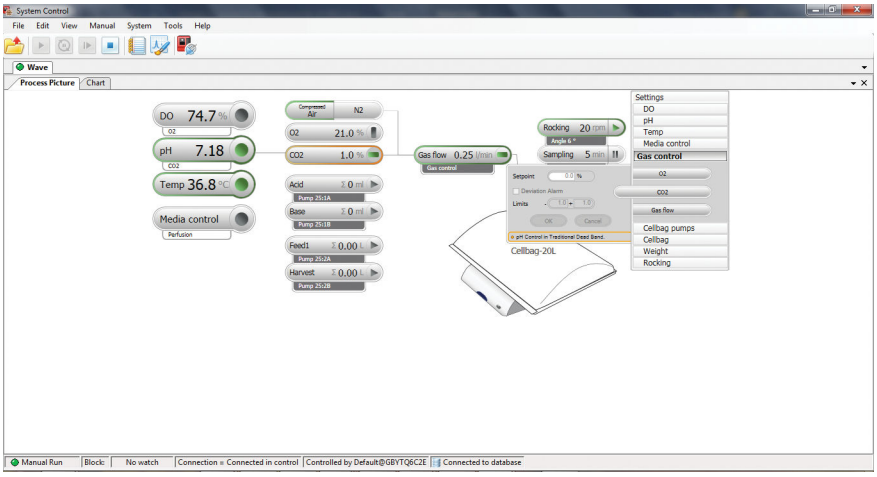
Process picture when in traditional deadband mode

A few examples of different ***Process Picture*** displays when the system is in traditional deadband mode are shown below.

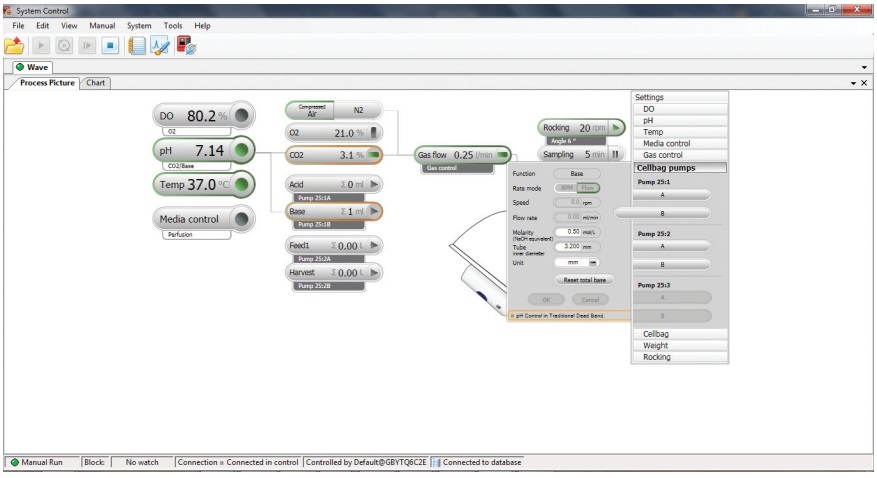
The following example shows the ***Process Picture*** display when the system is in acid/base deadband mode.



The following example shows the ***Process Picture*** display when the system is in CO_2 deadband mode.



The following example shows the ***Process Picture*** display when the system is in CO_2/ Base deadband mode.



Sample the culture

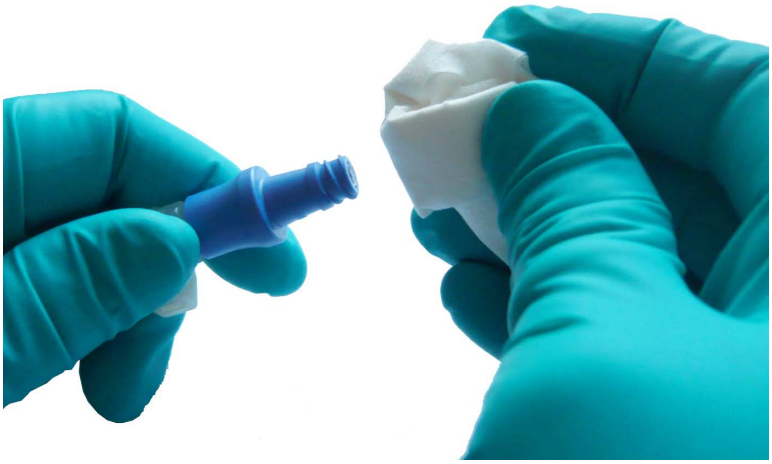
Samples may be taken several times during the run using the same sampling connector. Before taking a sample, make sure that the sampling connector is firmly attached to the luer-lock coupling of the cellbag bioreactor by screwing it clockwise.

Follow the instruction below to take samples from the Cellbag bioreactor.

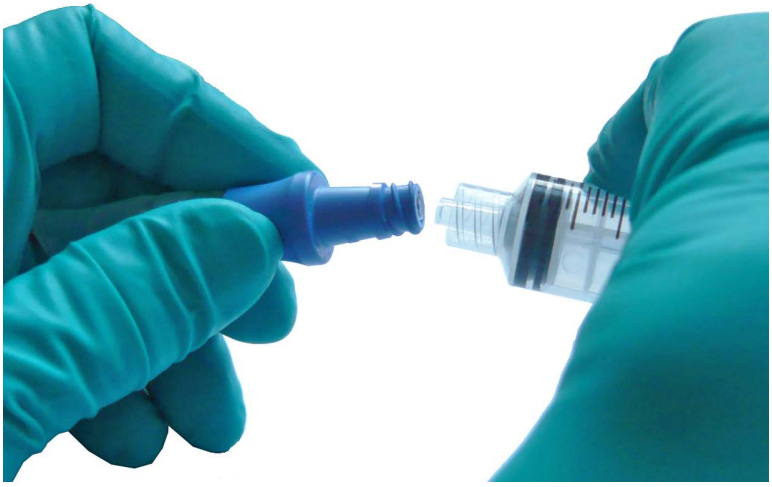
Step	Action
1	Stop the rocking motion from the ***Process Picture***.

Step	Action
2	Click the right-hand side of the ***Sampling*** button to prepare for sampling. *Result:* The system will enter sampling mode. ***Note:*** *The system will remain in sampling mode for the number of minutes set in* ***Settings*** *→****Rocking*** *→****Sampling*** *→****Pause****, at an angle set in* ***Settings*** *→****Rocking*** *→****Sampling*** *→****Stop angle****. The time remaining in sampling mode is displayed in a countdown timer.* ***Note:*** *For small culture volumes, it may be necessary to position the tray into tilt position during sampling.*
3	Remove the cap from the blue sampling connector.

Step	Action
4	Wipe the top of the sampling connector with 70% alcohol, or equivalent.



5	Attach a sterile disposable syringe with luer connector onto the sampling connector.



6	Release the tubing clamp and withdraw a sample into the syringe.
7	Remove the syringe and wipe the top of the sampling connector again with 70% ethanol and replace the cap.

Step	Action
8	Pinch the sampling connector tubing a few times to ensure that any liquid in the tubing drains back into the Cellbag bioreactor.
9	Close the tubing clamp. Sampling mode duration is set from ***Settings*** →***Rocking*** →***Sampling*** →***Pause*** in the ***Process Picture***.

Scale up cultivation

Cellbag bioreactors have a large range in operating volume. This allows efficient scale-up and eliminates tedious sequential transfers. Start at low volume and add fresh medium to the Cellbag bioreactor as the cells grow. Up to a 1:10 expansion is possible in one single bag.

An example of an inoculum expansion sequence is described below.

Step	Action
1	Start with 300 mL medium in a 2 L Cellbag bioreactor. Add inoculum.
2	When cells reach approximately 3×10^6 cells/mL, add culture medium up to a volume of 1 liter.
3	When the cells again reach 3×10^6 cells/mL, transfer using a tube-fuser to a 20 L Cellbag bioreactor containing 2 liters of culture medium.
4	When the cells in the 20 L Cellbag bioreactor reach 3×10^6 cells/mL, add culture medium up to a volume of 10 liters and continue cultivation.

Exchange culture medium

Follow the instructions below to exchange culture medium in the Cellbag bioreactor, for example when working with microcarriers.

Note: *To avoid oxygen depletion, the culture medium exchange should be performed in less than one hour.*

Step	Action
1	Stop the gas flow by clicking the right-hand side of the ***Gas flow*** button in the ***Process Picture***.
2	Stop the rocking by clicking the right-hand side of the ***Rocking*** button in the ***Process Picture***.
3	Clamp off the inlet and outlet vent filters.
4	Select ***Manual*** →***Execute Manual Instructions***, and send the instruction ***Rocker*** →***Prepare for tilt***.

Step	Action
5	Hold the textured grip area on each side of the tray, and pull the tray upwards and against you to position the tray into tilt position.
6	Allow particulates (including cells and microcarriers, if applicable) 10 to 15 minutes to settle.
7	Connect tubing to the harvest port on the Cellbag bioreactor. The other end of the tubing should be connected to a sterile harvest vessel.
8	Using a pump or gravity flow, remove the desired amount of supernatant culture liquid by manually manipulating the flexible wall of the Cellbag bioreactor.
9	Disconnect the tubing and reconnect fresh culture medium to refill the Cellbag bioreactor.
10	Open the inlet and outlet vent filter clamps.
11	Start the rocking by clicking the right-hand side of the ***Rocking*** button in the ***Process Picture***.
12	Start the gas flow by clicking the right-hand side of the ***Gas flow*** button in the ***Process Picture***.

Perfusion culture

During perfusion culture, cell-free harvest/waste is withdrawn and fresh medium is added continuously.

Requirements

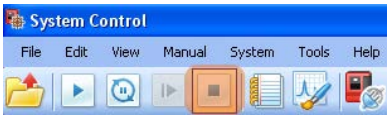
- Cellbag bioreactors with internal perfusion filter or connected to external retention filters
- Harvest/waste and feed pump

See *Section 4.6.3 Perfusion, on page 135* for information on perfusion mode. Contact a Cytiva application specialist for advice on setting up perfusion culture.

5.4.3 End a run

End cultivation and harvest the culture

Follow the instructions below to end the run and harvest the culture.

Step	Action
1	Prepare the harvest vessel.
2	Click the stop button in the toolbar in ***System Control*** to stop the run.  When asked if you want to end the run, click ***OK***. ***Note:*** *By default, the tray will prepare for tilt at the end of the run. This setting can be changed in* ***System Settings →Rocker →Prepare for tilt at END****.*
3	Hold the textured grip area on each side of the tray, and in one movement, pull the tray upwards and against you to position the tray into tilt position.
4	Connect tubing from the Cellbag bioreactor to the harvest vessel.
5	Empty the Cellbag bioreactor using a pump or gravity flow.
6	Disconnect the tubing from the Cellbag bioreactor to the harvest vessel.

Procedures after harvest

Follow the instructions below when the cultivation is finished and the culture is harvested.

Step	Action
1	Clamp off the inlet and outlet vent filters of the Cellbag bioreactor.
2	Disconnect the tubing from the inlet vent filter on the Cellbag bioreactor.
3	Disconnect any other tubing and cables still connected to the Cellbag bioreactor.
4	Release and remove the empty Cellbag bioreactor from the tray by pressing down the bag clamp opener.

Step	Action
5	Follow applicable national and/or local regulations for disposal of the Cellbag bioreactor.
6	Turn off all gas supplies.

Shut down the system

Follow the instructions below to shut down the system.

Step	Action
1	Disconnect the software from the system in UNICORN.
2	Press the **Power** button on the rocker front panel. The light flashes green while shutting down. ***Note:*** *If the rocker fails to shut down, press and hold the **Power** button pressed for more than 4 seconds to force a shutdown.*
3	Clean the bioreactor system units.

6 Maintenance

About this chapter

This chapter describes the required maintenance procedures for Xuri Cell Expansion System W25. It also gives an overview of the calibration procedures needed for the system to function properly.

In this chapter

Maintenance manager

The maintenance manager in UNICORN keeps track of the usage of different components and shows alerts when it is time for maintenance and service. For detailed information about the maintenance manager, refer to *UNICORN Administration and Technical manual*.

6.1 Calibration

Calibration schedule

For the system to function properly, several calibrations may be performed. See tables below.

Before each cultivation

Perform the following calibrations and adjustments before each cultivation

Calibration	Instruction
Pump	Enter tubing inner diameter in the ***Settings*** →***Cellbag pumps*** dialog. For perfusion cultivation, enable auto-calibration or calibrate the feed and harvest pumps. see *Section 5.3.2 Adjust pump parameters, on page 188*.
DO sensor	Adjust the calibration, see *Section 5.3.5 Prepare the sensors, on page 193*.
pH sensor	Adjust the calibration, see *Section 5.3.5 Prepare the sensors, on page 193*. Repeat the calibration adjustment during cultivation if required.

When required

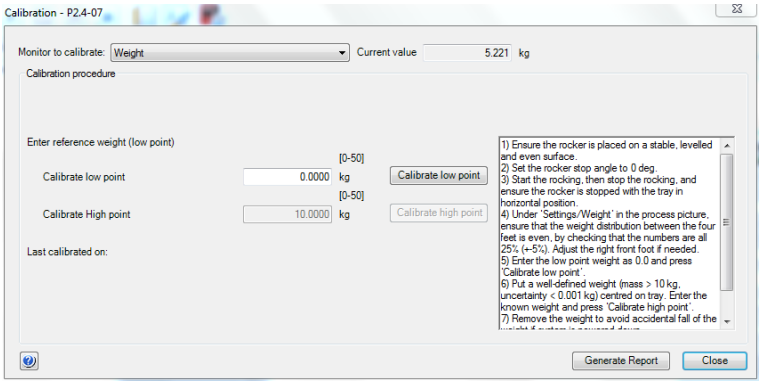
Perform the following calibrations when required or at least once a year.

Calibration	Instruction
Scale	Contact Cytiva service personnel for assistance if needed. ***Note:*** *Scale calibration is recommended after moving the rocker, or when the load is changed considerably. For* ***Calibrate High point****, use a weight that is as close as possible to the load that will be applied to the tray during use.*
Tempera-ture	Contact Cytiva service personnel for assistance if needed. Service personnel use special equipment to achieve more accurate calibration.
CO_2 and O_2 sensors	Calibration of CO_2 and O_2 sensors requires special competence and may impair system performance if performed incorrectly. Contact Cytiva service personnel for assistance.

Calibration instruction

Follow the instructions below to perform a calibration. The example is a scale calibration.

Note: *For OPC users, calibration can be accessed from the manual instruction dialog by selecting the OPC component.*

Step	Action
1	Select ***System*** →***Calibrate*** in ***System Control***. *Result:* The ***Calibration*** dialog opens. 
2	Select the appropriate monitor in the ***Monitor to calibrate*** drop down menu.
3	Follow the instructions in the right-hand field and enter the correct values in the ***Calibration procedure*** field, and click ***Calibrate*** for each value.
4	Close the ***Calibration*** dialog.

6.2 Pump calibration

Introduction

Pump calibration is normally not necessary for pH and media control purposes, provided that the inner diameter of the pump tubing is correctly set. Calibration is however recommended if high precision is required or when running perfusion with auto calibration disabled.

Tube inner diameter

Always set the tube inner diameter correctly. If the tube inner diameter is not set correctly, the following can happen:

- The requested flow may be out of range for the given tube diameter. This will prevent the media control from starting and result in warnings in pH control.
- The pH and media control performance may deteriorate.
- It may not be possible to calibrate the pump, since the calibration result will be too far from the expected value.

Pump calibration procedure

The pumps can be calibrated at a desired flow or RPM. Before calibration, the pump head must be set in desired rate mode (flow or RPM), and the flow or RPM setpoint be set to desired value.

Follow the instructions below to calibrate a pump. Parameters may be set either in the process picture or using manual instructions.

Step	Action
1	Enter the inner diameter of tubing used.
2	Set ***Rate mode*** to ***Flow*** or ***rpm***. Calibration will be performed in terms of flow rate or pump speed according to this setting.
3	Enter the desired setpoint (as flow rate or rpm according to the ***Rate mode*** setting).
4	Click ***Settings*** →***Calibrate*** and choose which pump to calibrate.
5	Enter the desired calibration run time and click ***Start pump***. Run the calibration for sufficient time to collect a reliably measurable volume of liquid.
6	When the pump stops, enter the collected volume and click ***Finish calibration***.

Calibration of acid and base pumps

The acid and base pumps can be calibrated at desired flow or RPM. Before calibration, the pump head must be set in desired rate mode (flow or RPM), and the flow or RPM set-point be set to desired value.

Follow the instructions below to calibrate a pump. Parameters may be set either in the process picture or using manual instructions.

Step	Action
1	Enter the inner diameter of tubing used.
2	Set ***Rate*** to ***Flow*** or ***rpm***. Calibration will be performed in terms of flow rate or pump speed according to this setting.
3	Enter the desired setpoint (as flow rate or rpm according to the setting).
4	Click ***Settings*** →***Calibrate*** and choose which pump to calibrate.
5	Enter the desired calibration run time and click ***Start pump***. Run the calibration for sufficient time to collect a reliably measurable volume of liquid.
6	When the pump stops, enter the collected volume and click ***Finish calibration***.

Calibration of feed and harvest/waste pumps

The feed and harvest/waste pumps are calibrated at the flow entered as the media control flow rate setpoint.

- Make sure that the flow rate set-point is entered correctly before calibrating the feed or harvest/waste pump.

Media addition mode

No calibration is needed in media addition mode, since the correct flow is ensured by a transitional weight set-point (see *Section 4.6.2 Media addition, on page 134*).

Perfusion mode

The pumps are calibrated automatically by the system. However, when running at a low flow rate (below 3.43 L/day), auto calibration is not available and manual calibration is needed (see *Section 4.6.3 Perfusion, on page 135*).

Perfusion is not supported in dual mode.

Calibration factor

After calibrating a pump (manually or using auto calibration), the calibration factor is recomputed. The calibration factor is the relation between the expected flow to rpm conversion for the selected tube diameter and the result of the calibration. For feed and harvest/waste pumps, this value can be observed in the curve data chart.

Warning and rejection limits

The pumps will give a warning if the observed calibration volume is outside the range -30% to 10% of the expected value. The calibration will be rejected if the observed calibration volume is outside the range -60% to 30% of the expected value.

6.3 Cleaning

Cleaning procedure

To prevent microbial or cross contamination, Xuri Cell Expansion System W25 should be cleaned after each cultivation. The system must be turned off and unplugged before cleaning.

- Clean the exterior of the system units with a damp cloth and a suitable cleaning agent.
- Make sure to clean the temperature sensor arms on the underside of the rocker platform. If dirt accumulates in these arms, they may not function properly, which could cause incorrect temperature regulation.

Recommended cleaning agents

All system units can be cleaned with ethanol, isopropanol and Virkon™ at suitable concentrations. Refer to *Section 8.4 Chemical resistance, on page 249*.

7 Troubleshooting

This chapter describes troubleshooting and corrective actions for Xuri Cell Expansion System W25.

If the suggested actions in this guide do not solve the problem or if the problem is not covered by this guide, contact your Cytiva representative for advice.

In this chapter

7.1 Xuri Cell Expansion System W25

Alarm messages

For many of the problems that may occur, UNICORN displays an alarm message on the screen. Follow the instruction shown to resolve the problem.

System units not recognized

Error symptom	Possible cause	Corrective action
CBCU not recognized by UNICORN.	Incorrect CBCU CAN ID.	Check and if necessary change CAN ID using the switch on the CBCU rear panel. See *CAN ID, on page 25* for details. The system must be switched off before the CAN ID is changed, and then restarted.
	CBCU is not selected as a component.	Click ***Edit*** in ***System Properties*** in the ***Administration*** module and add the CBCU as a component.
Pump not recognized by UNICORN.	Incorrect pump CAN ID.	Check and if necessary change CAN ID using the switch on the pump rear panel. See *CAN ID, on page 28* for details. Each pump must have a unique CAN ID value. The system must be switched off before the CAN ID is changed, and then restarted.
	Pump is not selected as a component.	Click ***Edit*** in ***System Properties*** in the ***Administration*** module and add the pump as a component.
CBCU and/or pump not recognized by UNICORN.	Gap between occupied UniNet-9 ports on the rocker rear panel.	Reposition the connectors or insert jumpers in the unused positions between the occupied ports.
	One or more connected pumps is not defined in UNICORN.	Read the displayed message when you connect to the system in ***System Control***. Make sure all available components are selected for the system. See *Section 5.2.3 Configure system properties, on page 173*.

7.2 Xuri Cell Expansion System W25 rocker

Rocking

Error symptom	Possible cause	Corrective action
Rocker does not initialize properly.	Faulty safety fuses.	Try to restart the system a few times. If the system still does not initialize properly, shut it down and contact Cytiva service personnel.
When starting the run, the rocker moves too slowly during the first cycle.	It takes a while for the rocker to initialize after turning on the power.	None. This is normal.
Rocker is not rocking.	Rocker is in an error state.	• Check the current alarms. • Reset power to the unit. • If you still get motor alarms, contact Cytiva service personnel.
	Tray is in tilt position.	• Make sure that the tray is in normal position. • If this does not help, contact Cytiva service personnel.
Rocker stops rocking.	Rocker is mechanically restricted from moving.	Locate and remove the restricting object.
Incorrect rocking angle.		
Rocking speed varies.	DO control using speed is enabled. If the DO deviates from the setpoint, the rocking speed changes.	This is normal when DO control is enabled. If not required, disable DO control from the process picture.
Power button flashes red.	Rocker does not have any connection to the UNICORN database.	Verify the connection between the rocker and the client computer or network.
	System units such as CBCU or pump defined in the system setup in UNICORN are not connected to the rocker.	Disable the missing components in UNICORN. See *Section 5.2.3 Configure system properties, on page 173*.
		Connect the missing components to the rocker.

Error symptom	Possible cause	Corrective action
	An internal error has occured in the embedded computer of the rocker.	Read any warning message carefully and follow the instructions. If problem persists, contact Cytiva service personnel.
System does not shut down when the power button is pressed.	The embedded computer of the rocker fails to shut down.	• Wait one minute. If the system still does not shut down, keep pressing the power button to force system shut down. • If problem persists, contact Cytiva service personnel.
Rocking starts when sending another command than ***Start rocking***.	At the first command sent to the system, the system enters ***Run*** state and the rocker is initialized and makes a few movements.	None. This is normal.

Temperature

Error symptom	Possible cause	Corrective action
No heating although heating is enabled in UNICORN. Frame around the temperature button is orange.	Rocker is not rocking.	Make sure that the rocker is rocking. The heater is automatically turned off when rocking is turned off.
	The tray size is not recognized.	Contact Cytiva service personnel.
	Bag size is not set.	Set the bag size in ***Settings*** →***Cellbag*** in the ***Process Picture***.
	The heater is in an error state.	Contact Cytiva service personnel.
Too slow or too fast heating.	Bag size setting is incorrect.	Check and if necessary reset the bag size setting. When changing the bag size, the rocking must be turned off.
	Incorrect weight measurement.	• Make sure that the rocker is placed in a horizontal position. • Check that the weight shown in the ***Process Picture*** matches the actual weight of the culture medium. If not, tare the scale with the weight of the content in the Cellbag entered as ***Net Weight***.

Error symptom	Possible cause	Corrective action
Temperature control is not functioning or displayed temperature appears to be incorrect.	Temperature sensor is not in contact with the culture medium.	• Make sure that there is enough culture medium in the Cellbag bioreactor to cover the temperature sensor, also when the rocker is rocking. • Check that no crease with resulting air pocket has formed on the Cellbag bioreactor film covering the sensor. • Make sure that the pH or DO cables are not in contact with the temperature sensor.
	Temperature sensor needs calibration.	Calibrate the temperature sensor. See *Section 6.1 Calibration, on page 208*. If needed, contact Cytiva service personnel.

Weight

Error symptom	Possible cause	Corrective action
No weight reading.	Scale does not function properly.	Contact Cytiva service personnel.
Incorrect weight displayed.	The weight distribution on the rocker feet is not even.	Use the tare functionality and even the weight distribution according to the instructions in *Section 5.3.4 Add and equilibrate culture medium, on page 190*.
	The rocker is not placed on a horizontal surface.	Place the rocker on a horizontal surface.
	The tare was not done before adding the load (Cellbag bioreactor etc.).	Enter correct net weight and press tare. If correct weight is unknown remove all load (Cellbag bioreactor etc.) from tray and tare (zero) the scale.
	Mechanical obstructions to the rocker.	• Check that the tray is firmly locked in position. • Check that no tubing is pulling on the Cellbag bioreactor during rocking. • Check that the movement of the rocker is not obstructed.
	Scale needs calibration.	Calibrate the scale. See *Section 6.1 Calibration, on page 208*. If needed, contact Cytiva service personnel.

Error symptom	Possible cause	Corrective action
Incorrect readings in dual mode.	Cellbag bioreactors not centred on the respective halves of the tray.	Check bioreactor placement.
	Tare omitted or incorrectly performed.	Tare the scale before or after filling the Cellbag bioreactors. See *Tare the scale, on page 190*.
Weight reading fluctuates or drifts.	Rocker support unstable.	Check that the table is rigid, flat and horizontal.

7.3 Xuri Cell Expansion W25 CBCU

General

Error symptom	Possible cause	Corrective action
Status LED flashes red.	An internal error has occurred, but the CBCU is still operating.	Check any warning message and follow the instruction. If problem persists, contact Cytiva service personnel.
Status LED shows a steady red light.	An internal error has occurred, and the CBCU is not operating.	Check any warning message and follow the instruction. If problem persists, contact Cytiva service personnel.
CAN indicator LED flashes.	An internal error has occurred, and the CBCU is not operating properly. ***Note:*** *This is normal the first seconds during power up.*	Contact Cytiva service personnel.

Gas flow

Error symptom	Possible cause	Corrective action
No gas flow, or fluctuating gas flow, and a high pressure alarm is activated.	Gas flow has shut down or is restricted due to high pressure caused by blockage in gas tubing or vent filters.	• Make sure that all inlet and outlet lines are open. • Disconnect the **N_2/Air** and **Gas mix out** tubing and locate the blockage.
	Clogged Cellbag bioreactor outlet vent filter.	• Check that the Filter heater functions properly. • If the outlet gas flow is blocked by foam, reduce the rocking angle or decrease the rocking speed. • If problem persists, transfer the contents to another Cellbag bioreactor.
External gas source is connected but the gas flow shows zero.	Blocked gas tubing.	Disconnect the **N_2/Air** and **Gas mix out** tubing and locate the blockage.

Error symptom	Possible cause	Corrective action
	External gas source is connected but the tube regulator is not opened.	Open the external gas tube regulator.

CO_2 mix

Error symptom	Possible cause	Corrective action
No CO_2 reading or the communication with the CO_2 sensor does not work.	CO_2 sensor is broken.	Contact Cytiva service personnel.
No immediate response when CO_2 mix is started or when setpoint is changed.	It takes up to several minutes for the CO_2 control to reach the new setpoint.	This is normal. Wait 5 to 10 minutes.
Display shows a CO_2 concentration in air which deviates from the expected value (0.0%).	Minor deviations can appear, for example due to temperature variations.	If the deviation is large, the offset CO_2 concentration can be adjusted. Contact Cytiva service personnel.
CO_2 reading keeps drifting down.	CO_2 gas supply pressure is too low.	Check that the CO_2 supply pressure is between 1.0 and 1.5 bar.
Erratic CO_2 control.	CO_2 supply is not properly connected.	Check that the CO_2 gas is properly connected and at the correct pressure (between 1.0 and 1.5 bar).
	Connections for CO_2, O_2, N_2 or air have been mixed up.	
	Incorrect setpoint.	Check the setpoint.

O_2 mix

Error symptom	Possible cause	Corrective action
No O_2 reading.	O_2 sensor is broken.	Contact Cytiva service personnel.

Error symptom	Possible cause	Corrective action
Display shows an O_2 concentration in air which deviates from the expected value (21.0%).	Minor deviations can appear, for example due to temperature variations.	If the deviation is large, the O_2 offset can be adjusted, contact Cytiva service personnel.
O_2 reading keeps drifting down.	O_2 gas supply pressure is too low.	Check that the O_2 supply pressure is between 1.0 and 1.5 bar.
Erratic O_2 control.	O_2 supply is not properly connected.	Check that the O_2 gas is properly connected and at the correct pressure (between 1.0 and 1.5 bar).
	Incorrect setpoint.	Check the setpoint.
	Incorrect gas supply (air or N_2) is connected.	Check that the gas supply chosen in UNICORN matches the connected gas supply (air or N_2).
	O_2 sensor is broken.	Contact Cytiva service personnel.

pH control

Error symptom	Possible cause	Corrective action
pH control does not start.	Some of the criteria for starting the pH control are not fulfilled.	Read the message in the pop-up dialog. If possible, take action according to the information and try again.
pH control using CO_2 seems to react too slow or too fast (undershooting/overshooting).	The bag size setting is incorrect which will optimize the control for another gas volume.	Set the bag size to the correct value.
	The control is using manually entered control parameters not optimal for the actual case.	Use the manual instruction ***pH control (advanced)*** →***pH control (advanced CO2)*** to set ***PID parameter mode*** and ***Cycle time mode*** to ***Auto***. See *Manual instructions, on page 44*.
	The CO_2 range is too narrow.	Use the manual instruction ***pH control*** →***pH control (CO2)*** to set the desired CO_2 range for pH control.

Error symptom	Possible cause	Corrective action
	The automatically selected control parameters are not optimal for the actual case.	Use the manual instruction ***pH control (advanced)*** →***pH control (advanced CO2)***. Set ***PID parameter mode*** and/or ***Cycle time mode*** to ***Manual***, and enter desired values for PID parameters and cycle time. See *Manual instructions, on page 44*. To get an initial suggestion of the PID parameters, look at the automatically selected parameters by selecting them as run data under ***Tools*** →***Customize***.
pH control using acid or base seems to react too slow or too fast (undershooting/overshooting).	The molarity of acid or base is not entered correctly.	Enter the correct molarity of the acid and base used. See *Flow rate, on page 120* and *Section 5.3.2 Adjust pump parameters, on page 188* for more information.
	The inner diameter of the tubing used for acid and base is not entered correctly.	Enter the correct inner diameter of the tubing used for acid and base.
	The weight measured by the system is not corresponding to the weight of the cell culture medium.	Make sure that the rocker scale is tared, so that the measured weight corresponds to the weight of the cell culture medium. See *Section 5.3.4 Add and equilibrate culture medium, on page 190* for more information.
	The control is using manually entered control parameters not optimal for the actual case.	Use the manual instruction ***pH control (advanced)*** →***pH control (advanced acid/base)*** to set PID parameter, cycle time and flow mode to ***Auto***. See *Manual instructions, on page 44*.
	The automatically selected control parameters are not optimal for the actual case.	Use the manual instruction ***pH control (advanced)*** →***pH control (advanced acid/base)***. Set ***PID parameter mode***, ***Cycle time mode*** and/or ***Flow mode*** to ***Manual***, and enter desired values for PID parameters, cycle time and flow. See *Manual instructions, on page 44*. To get an initial suggestion of the PID parameters, look at the automatically selected parameters by selecting them as run data under ***Tools*** →***Customize***.

Error symptom	Possible cause	Corrective action
pH control using acid or base is doing too many small injections instead of doing larger ones more seldom.	The deadband is set too low.	Check what the actual deadband values are by selecting them as run data under ***Tools →Customize***. Use the manual instruction ***pH control (advanced) →pH control (advanced acid/base)***. Increase the deadband value for acid and/or base. See *Manual instructions, on page 44*.
pH control using acid or base is doing large injections with long time distance, instead of doing smaller ones more often.	The deadband is set too high.	Check what the actual deadband values are by selecting them as run data under ***Tools →Customize***. Use the manual instruction ***pH control (advanced) →pH control (advanced acid/base)***. Decrease the deadband value for acid and/or base. See *Manual instructions, on page 44*.
In control scheme ***CO2/Base***, the transitions between CO_2 and base are longer or shorter than desired.	The automatically computed transition delay time is not optimal for the actual cell culture.	Check what the actual trasition delay time values are by selecting them as run data under ***Tools →Customize***. Use the manual instruction ***pH control (advanced) →pH control (transition delay)***. Set ***CO2/Base transition delay mode*** to ***Manual*** and enter desired values for transition delays. See *Manual instructions, on page 44*.
	The control is using a manually entered transition delay time not optimal for the actual case.	Use the manual instruction ***pH control (advanced) →pH control (transition delay)***. Set ***CO2/Base transition delay mode*** to ***Auto***. See *Manual instructions, on page 44*.
pH control is inactive.	Some of the criteria for running the pH control are no longer fulfilled.	Read the message in the pop-up dialog. If possible, take action according to the information and make sure that the control turns active again.
	Rocker is in sampling mode.	None. If the pH control is using acid or base, it is inactive while the rocker is in sampling mode.
	Auto calibration of feed and harvest/ waste pumps is active.	None. If the pH control is using acid or base, it is inactive during auto calibration.

pH reading

Error symptom	Possible cause	Corrective action
No pH reading (***Off*** is displayed).	pH reading is not started.	Open ***Settings*** →***pH*** from the ***Process Picture***, and set ***Reading*** to ***On***.
pH reading is inactive (0.0 is displayed, and the frame around the ***Process Picture*** button is red).	Repeated errors from the the sensor has turned the reading into an inactive state. New reading attempts are made with asked reading frequency until a valid reading is returned, or the reading is stopped.	Read the warning messages for more information. Check the possible causes and corrective actions below.
	pH sensor cable is not connected properly or is defective.	Check both ends of the cable. Make sure that all four pins of the sensor port is gripping the sensor adapter and that the fiber cable is properly connected to the **PH** port on the CBCU front panel.
		If both pH and DO sensors are used, check that the sensor cables are not mixed up. If so, correct the connections of the pH and DO sensors. Note that it may take one reading cycle before correct values are shown.
		Check that the correct calibration values as stated on the Cellbag have been entered. See *Section 5.3.4 Add and equilibrate culture medium, on page 190* for more information. ***Note:*** *The value CpH0 may have changed after recalibration. This is normal.*
	Temperature of the culture medium has not reached process temperature.	Turn off the pH reading until the culture medium is equilibrated.
	pH inside the Cellbag bioreactor is outside the readable range (appr. pH 5 to 9).	If possible, adjust the Cellbag bioreactor conditions to a pH within the working range. ***Note:*** *It is a risk that the pH sensor has been damaged, especially if the pH has been above pH 10.*

Error symptom	Possible cause	Corrective action
Initial pH reading is unstable and/or deviates considerably (i.e., more than approximately 0.5 pH units from an offline measurement).	A gas bubble may be trapped on the pH sensor.	Tap the pH sensor from the underside to remove the bubble. This may require forceful manipulation, and the Cellbag bioreactor may need to be partly disconnected from the tray. ***Note:*** *The gas bubble may be very difficult to see.*
Fluctuating pH. Variation in pH caused by the rocking should be less than 0.05 pH units.	The rocking disturbs the pH readings.	Check that the fiber cables are not pinched or moving excessively. Place all the fiber cables in the tubing exit. Stop the rocking and observe the pH readings.
		Check that the volume in the Cellbag bioreactor is not less than the specified minimum volume.
Incorrect pH reading.	Entered pH calibration values are not correct for the bag used.	Check the pH label on the bag, enter the correct values and perform an offset calibration.
	The pH sensor is degraded due to long use, light exposure or presence of substances that are harmful to the sensor, like strong bases or ethanol.	The sensor is no longer useful for pH measurement. Automatic pH control can no longer be performed.
	A gas bubble may be trapped on the pH sensor.	Tap the pH sensor from the underside to remove the bubble. This may require forceful manipulation, and the Cellbag bioreactor may need to be partly disconnected from the tray. ***Note:*** *The gas bubble may be very difficult to see.*

DO control

Error symptom	Possible cause	Corrective action
DO control does not start.	Some of the criteria for starting the DO control are not fulfilled.	Read the message in the pop-up dialog. If possible, take action according to the information and try again.

Error symptom	Possible cause	Corrective action
DO control using O_2 seems to react too slow or too fast (undershooting/overshooting).	The bag size setting is incorrect which will optimize the control for another gas volume.	Set the bag size to the correct value.
	The control is using manually entered control parameters not optimal for the actual case.	Use the manual instruction ***DO control (advanced)*** →***DO control (advanced O2)*** to set ***PID parameter mode*** and ***Cycle time mode*** to ***Auto***. See *Manual instructions, on page 44*.
	The automatically selected control parameters are not optimal for the actual case.	Use the manual instruction ***DO control (advanced)*** →***DO control (advanced O2)***. Set ***PID parameter mode*** and ***Cycle time mode*** to ***Manual***, and enter desired vaules for PID parameters and cycle time. See *Manual instructions, on page 44*. To get an initial suggestion of the PID parameters, look at the automatically selected parameters by selecting them as run data under ***Tools*** →***Customize***.
	A gas bubble might be present on the DO sensor.	Tap the DO sensor from the underside to remove the bubble. This may require forceful manipulation, and the Cellbag bioreactor may need to be partly disconnected from the tray. ***Note:*** *The gas bubble may be very difficult to see.*
DO control using O_2 is not using O_2 concentrations below 21% to lower the DO, although N_2 is connected to CBCU.	The setting for gas source is not set to ***N2***.	Select N_2 as gas source so that the DO control can handle O_2 setpoints below 21%.
DO control using speed seems to react too slow or too fast (undershooting/overshooting).	The entered parameters for cycle time, speed step, max/min speed and deadband are not optimal for the actual case.	Laborate with the parameters. There is no automatical parameter mode for DO control using speed.

Error symptom	Possible cause	Corrective action
	A gas bubble might be present on the DO sensor.	Tap the DO sensor from the underside to remove the bubble. This may require forceful manipulation, and the Cellbag bioreactor may need to be partly disconnected from the tray. ***Note:*** *The gas bubble may be very difficult to see.*
In control scheme ***O2/Speed***, the transitions between O_2 and speed are longer or shorter than desired.	The automatically computed transition delay time is not optimal for the actual cell culture.	Check what the actual transition delay time values are by selecting them as run data under ***Tools*** →***Customize***. Use the manual instruction ***DO control (advanced)*** →***DO control (transition delay)***. Set ***O2/Speed transition delay mode*** to ***Manual*** and enter desired values for transition delays. See *Manual instructions, on page 44*.
	The control is using a manually entered transition delay time not optimal for the actual case.	Use the manual instruction***DO control (advanced)*** →***DO control (transition delay)***. Set ***O2/Speed transition delay mode*** to Auto. See *Manual instructions, on page 44*.
DO control is inactive.	Some of the criteria for running the DO control are no longer fulfilled.	Read the message in the pop-up dialog. If possible, take action according to the information and make sure that the control turns active again.

DO reading

Error symptom	Possible cause	Corrective action
No DO reading (***Off*** is displayed).	DO reading is not started.	Open ***Settings*** →***DO*** from the ***Process Picture***, and set ***Reading*** to ***On***.
DO reading is inactive (0.0 is displayed, and the frame around the ***Process Picture*** button is orange).	Repeated errors from the the sensor has turned the reading into an inactive state. New reading attempts are made with asked reading frequency until a valid reading is returned, or the reading is stopped.	Read the warning messages for more information. Check the possible causes and corrective actions below.

Error symptom	Possible cause	Corrective action
	Temperature of the culture medium has not reached process temperature.	Turn off the DO reading until the culture medium is equilibrated.
	DO fiber optical cable is not connected properly or is defective.	Check that the correct calibration values as stated on the Cellbag have been entered. See *Section 5.3.4 Add and equilibrate culture medium, on page 190* for more information. ***Note:*** *The value CIhp and CIht may have changed after recalibration.*
The initial DO reading is much higher than expected (approximately 300% air saturation when 100% air saturation is expected).	DO fiber optical cable is not connected properly or is defective.	Check both ends of the fiber cable. Make sure that all four pins of the sensor port is gripping the sensor adapter and that the fiber cable is properly connected to the **DO** port on the CBCU front panel.
		If both pH and DO sensors are used, check that the fiber cables are not mixed up. If so, correct the connections of the pH and DO sensors. Note that it may take one reading cycle before correct values are shown.
		Check that the correct calibration values as stated on the Cellbag have been entered. See *Section 5.3.4 Add and equilibrate culture medium, on page 190* for more information. ***Note:*** *The value CIhp and CIht may have changed after recalibration.*
The initial DO reading deviates from what is expected, error is typically around 10% air saturation.	This is normal and may be caused by differences in temperature, atmospheric pressure and composition of the gas.	1. Check that the correct calibration values have been entered. 2. If problem persists, perform an offset calibration. ***Note:*** *If for example 5% CO_2 is added to air flowing through the Cellbag the DO will be reduced with approximately the same percentage value.*

Error symptom	Possible cause	Corrective action
Incorrect DO reading.	A gas bubble may be trapped on the DOOPT II sensor.	Tap the DOOPT II sensor from the underside to remove the bubble. This may require forceful manipulation, and the Cellbag bioreactor may need to be partly disconnected from the tray.

Media control

Error symptom	Possible cause	Corrective action
Media control does not start.	Some of the criteria for starting the Media control are not fulfilled.	Read the message in the pop-up dialog. If possible, take action according to the information and try again.
Media control is inactive.	Rocker is in sampling mode.	None. The media control is inactive while the rocker is in sampling mode.
	Some of the criteria for running the Media control are no longer fulfilled.	Read the message in the pop-up dialog. If possible, take action according to the information and make sure that the control turns active again.
In Perfusion mode, only the feed pump is running.	The weight is below the setpoint when the media control is started.	None. This is normal. The harvest/waste pump will start when the setpoint is reached.
	Auto calibration is enabled, and the feed pump is calibrating.	None. This is normal.
	The measured weight is more than 10% below the weight setpoint.	None. This is normal. The harvest/waste pump will start when the setpoint is reached.
In Perfusion mode, only the harvest/waste pump is running.	The weight is above the setpoint when the media control is started.	None. This is normal. The feed pump will start when the setpoint is reached.
	Auto calibration is enabled, and the harvest/waste pump is calibrating.	None. This is normal.

Error symptom	Possible cause	Corrective action
	The measured weight is more than 10% above the weight setpoint.	None. This is normal. The feed pump will start when the setpoint is reached.
In Perfusion mode, no pump is running.	***Auto calibration*** is enabled, and pumps are stopped for the auto calibration algorithm to measure the weight.	None. This is normal.
Auto calibration is set to ***On***, but no auto calibration takes place.	The weight setpoint has not yet been reached.	Wait for the setpoint to be reached, then the auto calibration will start.
	Media additon is selected as control mode.	Auto calibration is only done in perfusion mode.
The second auto calibration does not seem to occur.	The ***Auto calibration cycle*** is set to a long cycle time that has not yet elapsed.	Check what the actual ***Auto calibration cycle*** is, by selecting it as run data under ***Tools*** →***Customize***. Use the manual instruction ***Media control*** →***Media control (general)*** and set ***Auto calibration cycle*** to desired value. Also select ***Auto calibration cycle timer*** as run data under ***Tools*** →***Customize*** to see how many hours that are left to the next auto calibration.
After auto calibration, the flow of one or both of the pumps is no longer correct.	The weight measurements done by the auto calibration routine might have been disturbed by something, for example streched tubing, or someone touching the system.	Recalibrate the pump/pumps by first disabling, then enabling the auto calibration in the ***Process Picture***. A new auto calibration will then start. During the auto calibration, be sure that nothing interfers with the system.
The media control is automatically turned off.	None of the pumps started by the media control are no longer running.	Start media control again.

7.4 Xuri Cell Expansion W25 Pump

Error symptom	Possible cause	Corrective action
Pump flow appears to differ from set flow.	Incorrect pump holder position for the tubing used.	Check and adjust pump holder position. See *Section 5.1.5 Prepare the pump, on page 159*.
	The setting for tubing inner diameter is incorrect.	Reset the tubing inner diameter to correct value.
	Pump needs calibration.	Calibrate the pump. See *Section 6.1 Calibration, on page 208*.
Status LED on the pump rear panel is blinking red.	An internal error has occurred, but the pump is still operating.	Check any warning message and follow the instruction. If problem persists, contact Cytiva service personnel.
Status LED on the pump rear panel shows a steady red light.	An internal error has occurred, and the pump is not operating.	Check any warning message and follow the instruction. If problem persists, contact Cytiva service personnel.
CAN indicator LED is blinking	An internal error has occurred, and the CBCU is not operating properly. ***Note:*** *This is normal the first seconds during power up.*	Contact Cytiva service personnel.

7.5 Cellbag bioreactor

Overinflation

Error symptom	Possible cause	Corrective action
Cellbag bioreactor appears to be overinflated.	Too high gas flow.	Check that the gas flow to the Cellbag bioreactor does not exceed 1 Lpm and that the ***Fast fill*** function is turned off.
	Faulty relief valve.	Check that gas flows through the pressure control valve: • Attach a short length of tubing to the outlet valve. • Place the tubing end into water to 1 cm depth. *Result:*Bubbles indicate flow. • If no bubbles are observed, remove the pressure control valve. The pressure control valve may be blocked and removing it may allow continued operation.
	Outlet filter is closed off or blocked.	• Make sure that the outlet filter is not closed off or blocked. • If the outlet filter is clogged with foam, take action to reduce the foam. Decrease the rocking speed and/or rocking angle, add antifoam and/or slightly increase the gas flow rate.
	Faulty Cellbag bioreactor.	If the Cellbag bioreactor continues to overinflate, transfer the contents to another Cellbag bioreactor.

Underinflation

Error symptom	Possible cause	Corrective action
The Cellbag bioreactor appears to be underinflated.	Too low gas flow.	Check that there is sufficient gas flow to the Cellbag bioreactor.
	Inlet gas supply incorrectly connected.	Check that you have connected the inlet gas supply to the inlet filter (does not have the pressure control valve).

Error symptom	Possible cause	Corrective action
	Missing pressure control valve.	Check that the pressure control valve is present on the outlet filter.
The Cellbag bioreactor is underinflated and an alarm message in the pop-up dialog indicates blockage of gas flow.	Clogged inlet filter.	Check that the gas inlet flow path is unobstructed. ***Tip:*** *A small amount of condensate in the inlet filter is normal. However, if excessive condensate is formed:* • *Decrease the gas flow.* • *Insulate the tubing to the pressure control valve.*

7.6 Software problems

About this section

This section describes troubleshooting and corrective actions for UNICORN 7.x. Refer to *UNICORN Administration and Technical manual* for more troubleshooting.

In this section

7.6.1 Troubleshooting Method editor

Instructions in a method are marked with a red dot

Red instructions (instructions marked with a red dot) in a method are syntax errors and may have several causes. A phase containing syntax errors is marked in the method outline with an error symbol (a white cross on a red, circular background). The table below describes some solutions to syntax error problems.

Problem description	Solution
The method instructions do not correspond to the components you have chosen for your system.	Check your system components under ***System Properties*** in the ***Administration*** module and that the correct instrument configuration is selected.
Syntax errors are not corrected by changing the component configuration.	Close and reopen the method.
Syntax errors appear because the method was connected to the wrong system. That is, the instrument configuration of the system is incompatible with the method.	• Edit the method so it can be run on the currently chosen system. • Save the method for a system that has all components installed. ***Note:*** *The red instructions must be replaced or removed.* • Reselect the required component under ***System Properties*** in the ***Administration*** module (if the component is actually present on the system). Reopen the method and replace the red instructions with the corresponding instruction for the added component.
Syntax errors appear because the system's instrument configuration has been updated with a new instrument configuration that differs in the instruction set.	Select the red instruction and either delete it or replace it with a corresponding instruction (if available) from the ***Instruction box***. Repeat this for all red instructions before saving the method.

Export of a method to a network drive fails

Problem description	Solution
Export of a method to a network drive fails.	Ensure that the destination network drive is mapped and that you have the appropriate access rights.

Method cannot be created after new Instrument Configuration installation

Problem description	Solution
A new instrument configuration is installed. After this, it is still impossible to create a new method.	The ***Method Editor*** must be restarted after importing the new instrument configuration.

7.6.2 UNICORN System Control

User Access

Problem description	Solution
Username and password not accepted.	• The UNICORN administrator should check if the user account is locked (for example after too many unsuccessful log on attempts). • The UNICORN administrator can try to set a new password. • If a password reset does not work, the user profile may have to be deleted and a new profile created.
The log on dialog is inactive and a password cannot be entered.	1. Verify that no UNICORN window or module is opened. 2. Log off from Windows and log on again.

Access to UNICORN functions

Problem description	Solution
The ***Execute manual instruction*** menu command in the ***System Control*** module is gray. This means that you can establish a connection but cannot control the system.	• Check that no other user has a control mode connection. • Check that you have access rights to control the system manually.
The help viewer cannot be opened using help buttons or the **F1** key.	1. Open the MadCap help viewer from the Windows desktop icon. This is described in *The help viewer application in UNICORN Administration and Technical manual* . 2. Try the help button or **F1** key again.
The Microsoft Office Document Image Writer causes UNICORN to terminate.	This writer application will not work. Choose another option, for example a PDF writer application.
A user without access to the function ***Method End*** may still end a method using a ***Timer*** instruction.	Access to the ***Timer*** instruction must also be disabled if users are not allowed access to the ***Method End*** function.

Problem description	Solution
A manual run is started. A method run is then started and a start protocol opens. Before the start protocol is finished, an alarm is caused by the manual run. The start protocol cannot be completed and the method run cannot start at this point. This is because the alarm must be acknowledged first, but no message about this is issued.	Either stop the manual run which will allow the method run to start, or start another method. This will add the second method to the list of running methods and the first method is allowed to start.

System connections

Problem description	Solution
The connections are not available, i.e. the selection checkbox is grayed out.	• Check if the system has been deactivated. • Check that the power to the system is turned on. • Check that the rocker power button shows a steady green light. • Check the connection between the client computer and the system. • Check the firewall settings on the client computer. Refer to *UNICORN Administration and Technical manual* .
The connections are not available even though • the connection between the PC and system appears to be correct, and • the power is turned on.	1. Switch off the system. 2. Exit UNICORN. 3. Restart the system. 4. Log on to UNICORN.
A system is not available when you attempt to establish a connection.	• Check that you have access rights to the system. Access rights are not automatically assigned for a newly defined system. • The system may not be active. • Log off and log on again for access rights changes to be applied.
You receive the error message “Cannot connect to system...” in a network installation.	• Check that the rocker power button shows a steady green light. • Check that the computer from which you try to establish a connection is logged on to the network. • Check that the limit of five simultaneous connections to the system has not been exceeded. • Check the firewall settings on the client computer. Refer to *UNICORN Administration and Technical manual* .

Problem description	Solution
You receive the error message "Warning, system occupied" when trying to connect.	This error message is displayed if a system is defined and active in two different UNICORN database instances and is already connected in the other instance. It is not recommended to have a system defined and active in more than one UNICORN database instance.

7.6.3 Troubleshooting Evaluation

Maximum number of curves exceeded

The table below describes a problem and its solution.

Problem description	Solution
The maximum number of curves (100) is exceeded when importing curves.	Delete any unnecessary curves before importing more curves.

Export of archived result

The table below describes a problem and its solution.

Problem description	Solution
The export function is available when an archived result is selected. However, it is not possible to export an archived result. Instead the result that was selected before the archived result will be exported.	Do not export an archived result.

8 Reference information

This chapter contains system and component specifications for Xuri Cell Expansion System W25. For a list of semi-wetted materials, see the *Xuri Cell Expansion System W25 Product Documentation*.

In this chapter

8.1 System specifications

The table below lists the system specifications of Xuri Cell Expansion System W25.

Parameter	Data
System configuration	Benchtop system, external computer
Control system	UNICORN 7 or higher version
Rocker embedded PC operating system	Windows embedded standard 7
Connection between PC and instrument	Ethernet or network
Power supply	100 to 240 V ~, 50 to 60 Hz ***Note:*** *The rocker is fitted with internal electrical fuses that are not user-replaceable.*
Power consumption	Maximum 1500 VA
Enclosure protective class	IP 21
External air supply (per CBCU)	1.0 to 1.5 bar Normal use: 1.3 L/min Fast fill: 3.5 L/min
External CO_2 supply (per CBCU)	1.0 to 1.5 bar Normal use: 0.2 L/min Fast fill: 0.5 L/min
External O_2 supply (per CBCU)	1.0 to 1.5 bar Normal use: 0.7 L/min Fast fill: 1.7 L/min
Operating ambient temperature range	15°C to 32°C
Operating humidity range	20% to 80% relative humidity (noncondensing)

8.2 Component specifications

Equipment dimensions and weight

The table below lists the outer dimensions and weights of the bioreactor system units.

System unit	Dimensions, W x H x D (mm)	Weight (kg)
Rocker	404 x 205 x 560	24.0
CBCU	276 x 117 x 360	4.8
Pump	275 x 115 x 280	3.8
Tray 10	475 x 60 x 43	4.5
Tray 20	740 x 70 x 480	7.3
Tray 50	800 x 70 x 610	9.5
Lid 10	475 x 230 x 430	1.7
Lid 20	740 x 245 x 480	3.3
Lid 50	800 x 260 x 610	3.9

Rocker specifications

The table below lists the system specifications of the Rocker.

Parameter	Data
Rocking speed control range[1]	2 to 40 rpm
Rocking angle control range[1]	2° to 12°
Rocking speed profile range	15% to 100% The % value refers to the fraction of the angular displacement function that is sinusoidally shaped 15% gives an almost constant angular velocity 100% gives a sinusoidal rocking
Media weight control range	0.5 to 25 kg
Scale, absolute accuracy (single mode)	±(0.050 + 1% of load) kg
Scale, left/right absolute accuracy (dual mode)	±(0.1 + 6% of load) kg

Parameter	Data
Temperature sensor	Pt100 Class A
Temperature measurement range	2°C to 50°C
Temperature setpoint difference (dual mode)	Max 10°C at ambient 21°C Setpoint difference reduced by 1°C for each °C increase in ambient temperature (e.g., at ambient 25°C, max setpoint difference is 6°C)
Temperature control range	(Ambient temperature + 5°C) to 40°C
Temperature control accuracy (excl. measurement error)	±0.2°C

[1] For Tray 50, the product of rocking speed and rocking angle should not exceed 240 (e.g., with a rocking angle of 12° the rocking speed should not exceed 20 rpm).

Xuri Cell Expansion W25 CBCU specifications

The table below lists the primary system specifications of the CBCU.

Parameter	Data
Gas flow control range	50 to 1000 mL/min
Total gas flow accuracy (reference flow - setpoint)	±(10 + 3% of read value) mL/min
Fast fill flow	~3 L/min
CO_2 control range	0% to 15% CO_2
CO_2 measurement accuracy at 5% CO_2	±0.5% CO_2 when mixed only with air/N_2
CO_2 control accuracy (versus setpoint)	±0.4% CO_2
O_2 control range	0% to 50% O_2 when mixed with N_2 21% to 50% O_2 when mixed with air
O_2 measurement accuracy	±(0.6 + 1% of read value) within 0% to 50% O_2, when mixed only with air/N_2
O_2 control accuracy (versus setpoint)	±0.6% O_2
pH measurement range	pH 4.5 to 8.5
pH control range	pH 6.0 to 8.0

Parameter	Data
pH measurement accuracy	±0.05 pH within ±0.25 pH from offset calibration pH ±0.1 pH within 0.25 to 0.5 pH from offset calibration pH
pH control accuracy (versus setpoint)	±0.05 pH
DO measurement range	0% to 250% air saturation
DO measurement accuracy	±5% air saturation, excluding atmospheric pressure variations
DO control range	0% to 100% air saturation

Xuri Cell Expansion W25 Pump specifications

The table below lists the system specifications of Xuri Cell Expansion W25 Pump .

Note: *Different tubing dimensions are required to cover the full flow rate range of the pump (see Pump tubing sizes, on page 159). Pump tubing is not supplied with the system and must be purchased separately.*

Parameter	Data
Pump flow rate range	0.1 to 144 L /day (0.07 to 100 mL/min)
Pump flow rate accuracy	±(0.1 + 5% of read value) mL/min after calibration
Accumulated pumped volume accuracy	±10% of measured volume
Supported tubing dimensions	Inner diameter: 0.5 to 4.8 mm (1/50" to 3/16") Wall thickness: 1.6 mm (1/16")

8.3 Client computer specifications

Introduction

The table below lists client computer specifications for a UNICORN 7.x system for use with Xuri Cell Expansion System W25.

Xuri Cell Expansion System W25 is supplied with UNICORN 7.x, which requires Windows 7. If you wish to use Xuri Cell Expansion System W25 with an earlier version of UNICORN, contact Cytiva for assistance.

General computer specifications

Installation is supported for Windows 7 Professional, 32-bit or 64-bit, with Service Pack 1 or Windows 10 Professional 64-bit.

For information about compatibility between UNICORN versions and the supported operating systems and database versions see the UNICORN compatibility matrix at http://www.cytiva.com/UNICORNcompatibility.

	UNICORN Client	Database Server	Workstation installation	E-License Server
Min. free disk space	16 GB	10 GB	27 GB	500 MB
Min. available RAM	4 GB	4 GB	4 GB	2 GB
Disc format	NTFS	NTFS	NTFS	NTFS
Architecture	Quad-core processor or 4 logical processor	Quad-core processor or 4 logical processor	Quad-core processor or 4 logical processor	Multi-core processor

Note:

- *UNICORN is tested using the English (U.S.) Code 1033 operating system language version. Using other language versions of the operating system may cause errors.*
- *A screen resolution of 1280x1024 or higher is recommended. Parts of the UNICORN user interface may not be displayed properly using a lower resolution.*
- *Changing the default font and changing the font size from 100% in Windows may cause problems in the UNICORN user interface.*
- *The Windows basic color scheme is recommended[1].*
- *Using the Windows 7 Aero color scheme is not recommended.*
- *Windows power save features should be turned off to avoid conflicts with system operations.*

[1] *UNICORN must be closed when the color scheme is changed.*

- *UNICORN is not compatible with the Windows 7 feature High DPI Awareness, which allows the graphic user interface to be scaled. The interface scale must remain at 100% to avoid issues with clipping and misaligning of parts of the UNICORN user interface. Normally, the scale is set at 100% by default.*

8.4 Chemical resistance

The chemicals listed below have been approved for use with the bioreactor system.

Chemical	Concentration	Use	CAS no./EC no.
Alconox	N/A	Cleaning/Disinfection	N/A
DesiDos	N/A	Cleaning/Disinfection	N/A
Ethanol	70%	Cleaning/Disinfection	75-08-1/200-837-3
Hydrochloric acid	1 M	pH control	7647-01-0/231-595-7
Isopropanol	70%	Cleaning/Disinfection	67-63-0/200-661-7
Klercide	N/A	Cleaning/Disinfection	N/A
PBS solution	10×	Testing	N/A
Sodium bicarbonate	7.5%	pH control	144-55-8/205-633-8
Sodium carbonate	1 M	pH control	497-19-8/207-838-8
Sodium chloride	5 M	Testing	7647-14-5/231-598-3
Sodium hydroxide	1 M	pH control	1310-73-2/215-185-5
Sodium hypochlorite	1%	Cleaning/Disinfection	7681-52-9/231-668-3
Virkon	1%	Cleaning/Disinfection	N/A

8.5 Control settings

This section lists the different control settings that can be made in UNICORN.

In this section

8.5.1 Rocking control

Rocking control settings

The following table shows general settings used for rocking control.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Speed setpoint	The number of rocking cycles per minute.	***Settings: Rocking***	***Rocker: Rocking***	Y	-	-
Angle setpoint	The maximum angle between the tray and the horizontal plane during a rocking cycle.	***Settings: Rocking***	***Rocker: Rocking***	Y	-	Y
Stop angle	The angle between tray and horizontal plane the tray will settle at when the rocking is stopped. At a positive stop angle, the tray will lean towards the front side of the rocker and vice versa.	***Settings: Rocking***	***Rocker: Rocking***	Y	-	-
Sampling mode duration	The number of minutes the rocker will stay in sampling mode, before it automatically starts to rock again. See help text for ***Enter sampling mode*** instruction to learn more about sampling mode.	***Settings: Rocking***	***Rocker: Rocking***	Y	-	-
Cellbag size (total volume)	The Cellbag size defined in total volume (liquid and head space).	***Settings: Cellbag***	***Rocker: Cellbag size***	Y	-	-
Digital output	Sets the outputs of the digital output ports.	-	***Rocker: Digital output***	-	Y	-
Rocking motion	Defines the share of the rocking cycle where the speed curve is sinusoid. The lowest value (15%) provides a rocking motion similar to the Wave 20/50 system. The highest value (100%) will give a completely sinusoidal speed curve.	-	***Rocker: Set rocking motion***	-	Y	-
Auto start mode	By setting this parameter to ***Not resume activity***, rocking or heating will not start automatically at startup of the system at any time. When the parameter is set to ***Resume activity***, rocking and heating will start automatically at startup, if it was on when the system was shut down without given an END command.	-	***System settings →Auto start →Rocker***	-	-	-
Prepare for tilt at END	If ***No*** the rocking platform will not prepare for tilt at system END, if ***Yes***, the rocking platform will prepare for tilt at system END.	-	***System settings →Rocker***	-	-	-

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Analog input 1 input mode	Defines how signals from the analog 1 input port shall be interpreted. The input signal will be converted to a percentage [0 to 100]. To be able to select the two 'mA' options, the input port hardware must be reconfigured by Service.		***System settings →Rocker***	-	-	-
Analog input 2 input mode	Defines how signals from the analog 2 input port shall be interpreted. The input signal will be converted to a percentage [0 to 100]. To be able to select the two 'mA' options, the input port hardware must be reconfigured by Service.		***System settings →Rocker***	-	-	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

Rocking control output data

Data	Description	View from		
		PP	RD	CD
Rocking speed measurement	The actual rocking speed, measured by the rocker.	Y	-	Y
Time left in sampling mode	The time left until the rocker starts to rock when in sampling mode. Unit [s].	-	Y	-
Weight	The weight measured by the rocker. If tared correctly, it should correspond to the weight of the content of the Cellbag.	Y	Y	Y
Weight L	Shows the weight of the left Cellbag content in dual mode. The bags must be centered on each half of the tray and a tare must be performed to ensure accuracy of this measurement.	Y	Y	Y
Weight R	Shows the weight of the right Cellbag content in dual mode. The bags must be centered on each half of the tray and a tare must be performed to ensure accuracy of this measurement.	Y	Y	Y
Detected tray type	Shows the tray type detected by the rocker.	-	Y	-
Weight share front left	Percentage of the weight load on the front left load cell.	Y	-	-
Weight share front right	Percentage of the weight load on the front right load cell.	Y	-	-
Weight share rear left	Percentage of the weight load on the rear left load cell.	Y	-	-
Weight share rear right	Percentage of the weight load on the rear right load cell.	Y	-	-
Digital input 1	Shows if the digital input 1 is 0 or 1.	-	Y	-
Digital input 2	Shows if the digital input 2 is 0 or 1.	-	Y	-

Data	Description	View from		
		PP	RD	CD
Digital input 3	Shows if the digital input 3 is 0 or 1.	-	Y	-
Digital input 4	Shows if the digital input 4 is 0 or 1.	-	Y	-
Analog input 1	Shows the analog input 1 in percent.	-	Y	Y
Analog input 2	Shows the analog input 2 in percent.	-	Y	Y

Note: *The following abbreviations are used in the table: PP = **Process Picture**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

8.5.2 Heating control

Heating control settings

The following table shows general settings used for heating control.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Temperature setpoint	The temperature setpoint of the liquid in the Cellbag.	***Settings: Temp***	***Heating: Heating***	Y	-	Y
Deviation alarm	Enables or disables the deviation alarm.	***Settings: Temp***	***Heating: Heating***	Y	-	-
Allowed deviation up	Sets the extent to which the temperature can vary above the setpoint without triggering the deviation alarm.	***Settings: Temp***	***Heating: Heating***	Y	-	-
Allowed deviation down	Sets the extent to which the temperature can vary below the setpoint without triggering the deviation alarm.	***Settings: Temp***	***Heating: Heating***	Y	-	-
Deviation alarm delay	Sets the time for which the temperature must be outside the defined alarm limits before the deviation alarm is triggered. The timer is reset if the temperature falls back within the limits before the alarm is triggered.	-	***Heating: Heating***	-	Y	-
Heat enabling	When set to ***Enabled***, the heating will be on when the rocking is on. When set to ***Disabled***, the heating will be off.	-	***System settings →Heating →Heater enabling***	-	-	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

Heating control output data

Data	Description	View from		
		PP	RD	CD
Temperature measurement	The measured Cellbag temperature.	Y	-	Y

Note: *The following abbreviations are used in the table: PP = **Process Picture**; RD = **Run data**; CD = Curve data; Y = Yes; - = No or Not applicable.*

8.5.3 Gas flow control

Gas flow control settings

The following table shows general settings used for gas flow control.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Gas flow setpoint	The gas flow controller setpoint to the Cellbag.	***Settings: Gas control: Gas flow***	***Gas flow: Gas flow***	Y	-	Y
Deviation alarm	Enables or disables the deviation alarm.	***Settings: Gas control: Gas flow***	***Gas flow: Gas flow***	Y	-	-
Allowed deviation up	Sets the extent to which the gas flow can vary above the setpoint without triggering the deviation alarm.	***Settings: Gas control: Gas flow***	***Gas flow: Gas flow***	Y	-	-
Allowed deviation down	Sets the extent to which the gas flow can vary below the setpoint without triggering the deviation alarm.	***Settings: Gas control: Gas flow***	***Gas flow: Gas flow***	Y	-	-
Deviation alarm delay	Sets the time for which the gas flow must be outside the defined alarm limits before the deviation alarm is triggered. The timer is reset if the gas flow falls back within the limits before the alarm is triggered.	-	***Gas flow: Gas flow***	-	Y	-
Air source	If set to ***Compressed air***, compressed air shall be connected to the inlet on the back of the CBCU. If set to ***N2***, pressurized nitrogen shall be connected to the inlet on the back of the CBCU.	-	***Gas flow: Air source***	Y	-	-
Auto start mode	By setting this parameter to ***Not resume activity*** gas mixing will not start automatically at startup of the system at any time. When the parameter is set to ***Resume activity***, the gas mixing will start automatically at start-up, if it was on when the system was shut down (without first going to END).	-	***System settings →Auto start →CBCU***	-	-	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

Gas flow control output data

Data	Description	View from		
		PP	RD	CD
Gas flow measurement	The measured gas flow from the CBCU.	Y	-	Y

Note: *The following abbreviations are used in the table: PP = **Process Picture**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

8.5.4 CO_2 mix control

CO_2 mix control settings

The following table shows general settings used for CO_2 mix control.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
CO2 Mix setpoint	The gas mixer target CO_2 concentration setpoint.	***Settings→Gas control→CO2***	***CO2 mix: CO2 mix***	Y	-	Y
Deviation alarm	Enables or disables the deviation alarm.	***Settings→Gas control→CO2***	***CO2 mix: CO2 mix***	Y	-	-
Allowed deviation up	Sets the extent to which the CO_2 concentration delivered to the Cellbag can vary above the setpoint without triggering the deviation alarm.	***Settings→Gas control→CO2***	***CO2 mix: CO2 mix***	Y	-	-
Allowed deviation down	Sets the extent to which the CO_2 concentration delivered to the Cellbag can vary below the setpoint without triggering the deviation alarm.	***Settings→Gas control→CO2***	***CO2 mix: CO2 mix***	Y	-	-
Deviation alarm delay	Sets the time for which the CO_2 concentration must be outside the defined alarm limits before the deviation alarm is triggered. The timer is reset if the CO_2 concentration falls back within the limits before the alarm is triggered.	-	***CO2 mix: CO2 mix***	-	Y	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

CO_2 mix control output data

Data	Description	View from		
		PP	RD	CD
CO2 measurement	The measured CO_2 concentration from the CBCU.	Y	-	Y

Note: *The following abbreviations are used in the table: PP = **Process Picture**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

8.5.5 O_2 mix control

O_2 mix control settings

The following table shows general settings used for O_2 mix control.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
O2 Mix setpoint	The gas mixer target O_2 concentration setpoint.	***Settings→Gas control→O2***	***O2 mix: O2 mix***	Y	-	Y
Deviation alarm	Enables or disables the deviation alarm.	***Settings→Gas control→O2***	***O2 mix: O2 mix***	Y	-	-
Allowed deviation up	Sets the extent to which the O_2 concentration delivered to the Cellbag can vary above the setpoint without triggering the deviation alarm.	***Settings→Gas control→O2***	***O2 mix: O2 mix***	Y	-	-
Allowed deviation down	Sets the extent to which the O_2 concentration delivered to the Cellbag can vary below the setpoint without triggering the deviation alarm.	***Settings→Gas control→O2***	***O2 mix: O2 mix***	Y	-	-
Deviation alarm delay	Sets the time for which the O_2 concentration must be outside the defined alarm limits before the deviation alarm is triggered. The timer is reset if the O_2 concentration falls back within the limits before the alarm is triggered.	-	***O2 mix: O2 mix***	-	Y	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

O_2 mix control output data

Data	Description	View from		
		PP	RD	CD
O2 measurement	The measured O_2 concentration from the CBCU.	Y	-	Y

Note: *The following abbreviations are used in the table: PP = **Process Picture**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

8.5.6 Pump control

General pump settings

The following table shows general settings used for pump control.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Pump 25 → 1A role	Assigns pumphead 1A to Acid, Base, Feed or Harvest/Waste	-	***System settings → Set Pump 25 → 1A role***	Y	-	-
Pump 25 → 1B role	Assigns pumphead 1B to Acid, Base, Feed or Harvest/Waste	-	***System settings → Set Pump 25 → 1B role***	Y	-	-
Pump 25 → 2A role	Assigns pumphead 2A to Acid, Base, Feed or Harvest/Waste	-	***System settings → Set Pump 25 → 2A role***	Y	-	-
Pump 25 → 2B role	Assigns pumphead 2B to Acid, Base, Feed or Harvest/Waste	-	***System settings → Set Pump 25 → 2B role***	Y	-	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

Note: *All system settings are sent when any setting is sent. Therefore, check the role assigned to all pump heads before sending a 'role' command, to ensure that conflicting roles are not assigned to the different pump heads.*

Settings for manually running the pumps

The pump settings in this section (except the tubing inner diameter) are only valid when the pumps are started manually. When the pumps are used by pH or media control, these settings have no effect. Setting apply individually to each pump head.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Time mode	If ***Limited*** is selected the pump will run as long as given by ***Duration***. If ***Continuous*** is selected, the pump will run until stopped.	Always ***Continuous*** when started from PP.	***Pump control: Start pump***	-	-	-
Duration	The time for which the pump will run, if ***Time mode*** is set to ***Limited***. Otherwise this parameter has no effect.	-	***Pump control: Start pump***	-	-	-
Rate mode	Sets whether the flow or RPM setpoint will be used when the pump is started manually.	***Settings: Cellbag pumps***	***Pump control: Rate mode***	Y	-	-

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Pump RPM	The RPM at which the pump will run if started manually in RPM mode.	***Settings: Cellbag pumps***	***Pump control: Pump RPM***	Y[1]	-	-
Pump flow	The flow rate at which the pump will run if started manually in flow mode.	***Settings: Cellbag pumps***	***Pump control: Pump flow***	Y[2]	-	-
Tube inner diameter	The inner diameter of the tubing fitted to the pump.	***Settings: Cellbag pumps***	***Pump control: Pump flow***	Y	-	-

[1] Not shown in process picture when pump is used by pH or Media control, or in flow mode.
[2] Not shown in process picture when pump is used by pH or Media control, or in RPM mode.

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

Pump control output data

Output data is available separately for each pump head.

Data	Description	View from		
		PP	RD	CD
Actual flow	The estimated flow rate of the pump.	Y[1]	-	-
Actual speed	The pump rpm, obtained from the pump itself.	Y[2]	-	-
Accumulated volume	The estimated total volume since last reset.	Y	-	-
Time left of actual shot	This counter shows the remaining running time when the pump is running for a limited time. This is the case when the pump is started manually for a limited time, during calibration or when used as acid/base pump by pH control.	Y	-	-
Max possible flow	The maximum flow rate obtainable with the currently installed tubing.	-[3]	-	-
Min possible flow	The minimum flow rate obtainable with the currently installed tubing.	-[3]	-	-
Calibration factor	The current calibration factor for the pump.	-	-	Y

[1] Only shown in process picture when pump is running manually in RPM mode.
[2] Only shown in process picture when pump is used by pH or Media control, or is running manually in flow mode.
[3] Shown as tool-tip when entering flow.

Note: *The following abbreviations are used in the table: PP = **Process Picture**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

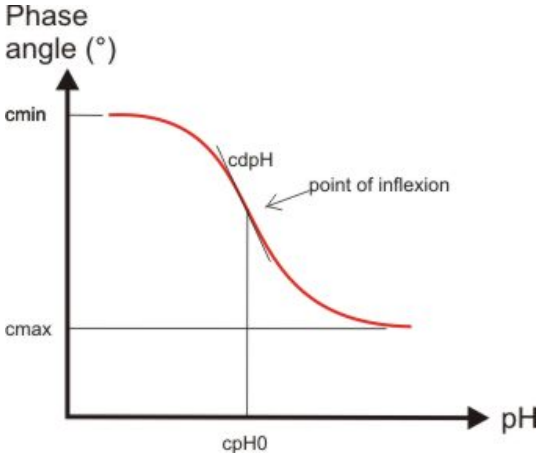
8.5.7 pH measurement

pHOPT calibration values

The pH surrounding the pH sensor is calculated from a measured variable called "the phase angle". The calculation is based on a transfer equation programmed in the pHOPT monitor. This transfer equation is defined by a set of constants, or, more correctly, a set of values that are specific for the mixture of the substances forming the luminophoric dye. This means that the dye properties, and consequently the transfer equation, may differ between different dye batches.

The constants for each batch (after gamma irradiation) are determined at the factory and are printed on the pHOPT label of the Cellbag as calibration values: **cmin**, **cmax**, **cpH0**, and **cdpH**.

The interpretation of the calibration values on the transfer equation is illustrated in the graph below:



A fifth calibration value, **ctemp**, is also necessary. It is not directly included in the transfer equation, but since the sensor is temperature dependent, the **ctemp** value is used for fine tuning the pH against the actual temperature.

Settings

The following table shows pH measurement related settings.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
cmin	Calibration value, high pH end of the sensor range.	***Settings: Cellbag***	pH sensor calibration values	Y	-	-
cmax	Calibration value, low pH end of the sensor range.	***Settings: Cellbag***	pH sensor calibration values	Y	-	-

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
cpH0	Calibration value, related to offset calibration.	***Settings: Cellbag***	pH sensor calibration values	Y	-	-
cdpH	Calibration value, related to resolution.	***Settings: Cellbag***	pH sensor calibration values	Y	-	-
ctemp	Calibration value, calibration temperature.	***Settings: Cellbag***	pH sensor calibration values	Y	-	-
Reading cycle time	The reading cycle when pH control is off.	***Settings →pH***	Set pH reading cycle time	Viewed when pH control is off	-	-
Reset calibration values at END	A ***System setting*** that defines if the pH calibration values shall be reset or not when the system goes to END.	-	***System settings →pH sensor →Reset calibration values at END***	-	-	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

Output data

Data	Description	View from		
		PP	RD	CD
pH measurement timer	The time left to next pH measurement.	-	Y	-
pH measurement cycle time	The actual measurement cycle time. This value is set by the user when pH control is off, and by pH control when the pH control is on.	Y	-	-
pH measurement	The latest measured pH value.	Y	-	Y
pH amplitude	A measure of the strength of the responsive pH signal received by the pH monitor.	-	-	Y

Note: *The following abbreviations are used in the table: PP = **Process Picture**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

8.5.8 pH control

Introduction

The following tables describe settings and parameters that can be used for pH control.

General settings

The following table shows general settings used for pH control.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Control scheme	Select ***CO2/Base*** for a combination of CO_2 and base as actuators, where the control always starts in ***CO2*** mode. Select ***Acid/Base*** for a combination of acid and base as actuators. Select ***CO2*** for using only CO_2 as actuator.	***Settings→pH***	pH control (general)	Y	-	-
pH setpoint	The pH target value.	***Settings→pH***	pH control (general)	Y	-	Y
Deviation alarm	Enables or disables the deviation alarm.	***Settings→pH***	pH control (general)	Y	-	-
Allowed deviation up	Sets the extent to which the pH can vary above the setpoint without triggering the deviation alarm.	***Settings→pH***	pH control (general)	Y	-	-
Allowed deviation down	Sets the extent to which the temperature can vary below the setpoint without triggering the deviation alarm.	***Settings→pH***	pH control (general)	Y	-	-
Deviation alarm delay	Sets the time for which the pH must be outside the defined alarm limits before the deviation alarm is triggered. The timer is reset if the pH falls back within the limits before the alarm is triggered.	-	pH control (general)	-	Y	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

CO2 control mode settings

The following table shows CO_2 control mode settings used for pH control.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Max CO2 concentration	The maximum CO_2 concentration setpoint allowed for the pH control.	-	pH control (CO2)	-	Y	-
Min CO2 concentration	The minimum CO_2 concentration setpoint allowed for the pH control.	-	pH control (CO2)	-	Y	-
PID parameter mode	When ***Auto*** is selected, the system will automatically set the PID parameters. When ***Manual*** is selected, the system will use the manual PID parameters set by this instruction.	-	pH control (advanced CO2)	A hand symbol is shown if set to ***Manual***	Y	-
Manual P	The P-parameter used if ***PID parameter mode*** is set to ***Manual***.	-	pH control (advanced CO2)	-	Y	-
Manual I	The I-parameter used if ***PID parameter mode*** is set to ***Manual***. Note, that increasing the I-parameter will reduce the integrating effect and vice versa.	-	pH control (advanced CO2)	-	Y	-
Manual D	The D-parameter used if ***PID parameter mode*** is set to ***Manual***.	-	pH control (advanced CO2)	-	Y	-
Cycle time mode	When ***Auto*** is selected, the system will automatically set the cycle time. When ***Manual*** is selected, the system will use ***Manual cycle time***.	-	pH control (advanced CO2)	A hand symbol is shown if set to ***Manual***	Y	-
Manual cycle time	The cycle time used if ***Cycle time mode*** is set to ***Manual***.	-	pH control (advanced CO2)	-	Y	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

CO2 control mode output data

Data	Description	View from		
		PP	RD	CD
Auto pH CO2 P	The P-parameter used if ***PID parameter mode*** is set to ***Auto***.	-	Y	-
Auto pH CO2 I	The I-parameter used if ***PID parameter mode*** is set to ***Auto***.	-	Y	-
Auto pH CO2 D	The D-parameter used if ***PID parameter mode*** is set to ***Auto***.	-	Y	-
Auto pH CO2 Cycle time	The cycle time used if ***Cycle time mode*** is set to ***Auto***.	-	Y	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

Acid/Base control mode settings

The following table shows Acid/Base control mode settings used for pH control.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Acid molarity	The molarity of the acid used expressed as equivalent HCl concentration (mol/L). If the strength (pK_a) of the selected acid differs from that of HCl, estimate the equivalent molarity. Entering lower molarity will result in addition of larger volumes by the pH control, and vice versa.	***Settings: Cellbag pumps***	pH control (acid)	Y	-	-
Base molarity	The molarity of the base used expressed as equivalent NaOH concentration (mol/L). If the strength (pK_b) of the selected acid differs from that of NaOH, estimate the equivalent molarity. Entering lower molarity will result in addition of larger volumes by the pH control, and vice versa.	***Settings: Cellbag pumps***	pH control (base)	Y	-	-
PID parameter mode	When ***Auto*** is selected, the system will automatically set the PID parameters. When ***Manual*** is selected, the system will use the manual PID parameters set by this instruction.	-	pH control (advanced acid/base)	A hand symbol is shown if set to ***Manual***	X	-
Manual P	The P-parameter used if ***PID parameter mode*** is set to ***Manual***.	-	pH control (advanced acid/base)	-	Y	-

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Manual I	The I-parameter used if ***PID parameter mode*** is set to ***Manual***.	-	pH control (advanced acid/base)	-	Y	-
Cycle time mode	When ***Auto*** is selected, the system will automatically set the cycle time. When ***Manual*** is selected, the system will use ***Manual cycle time***.	-	pH control (advanced acid/base)	A hand symbol is shown if set to ***Manual***	X	-
Manual cycle time	The cycle time used if ***Cycle time mode*** is set to ***Manual***.	-	pH control (advanced acid/base)	-	Y	-
Flow mode	When ***Auto*** is selected, the system will automatically set the acid/base flow. The automatically computed acid/base can be displayed as run data. When ***Manual*** is selected, the system will use the manual acid/base flow set by this instruction.	-	pH control (advanced acid/base)	A hand symbol is shown if set to ***Manual***	Y	-
Manual acid flow	The acid flow used if ***Flow mode*** is set to ***Manual***.	-	pH control (advanced acid/base)	-	Y	-
Manual base flow	The base flow used if ***Flow mode*** is set to ***Manual***.	-	pH control (advanced acid/base)	-	Y	-

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Acid dead band	The pH control output when using acid or base is a percentage of the cycle time, telling how much of the cycle time the acid or base pump shall run. The acid dead band defines the percentage interval in which the acid pump will not run. E.g., if the acid dead band is 2.0%, the output from the pH control needs to be above 2.0% for the acid pump to start.	-	pH control (advanced acid/base)	-	Y	-
Base dead band	The pH control output when using acid or base, is a percentage of the cycle time, telling how much of the cycle time the acid or base pump shall run. The base dead band defines the percentage interval in which the base pump will not run. E.g., if the base dead band is 2.0%, the output from the pH control needs to be above 2.0% for the base pump to start.	-	pH control (advanced acid/base)	-	Y	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

Acid/Base control mode output data

Data	Description	View from		
		PP	RD	CD
Auto Acid/Base P	The P-parameter used if ***PID parameter mode*** is set to ***Auto***.	-	Y	-
Auto Acid/Base I	The I-parameter used if ***PID parameter mode*** is set to ***Auto***.	-	Y	-

Data	Description	View from		
		PP	RD	CD
Auto pH acid/base cycle time	The cycle time used if ***Cycle time mode*** is set to ***Auto***.	-	Y	-
pH acid/base regulator output	The output of the acid/base control, expressed as pump run time in % of the cycle time. Negative values shall be interpreted as acid, positive values as base.	-	Y	Y

Note: *The following abbreviations are used in the table: PP = **Process Picture**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

Transition delay settings

The following table shows the transition delay settings used for pH control.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
CO2/Base transition delay mode	When ***Auto*** is selected, the system will automatically set the transition delay time. The automatically computed transition delay times can be displayed as run data. When ***Manual*** is selected, the system will use the manual transition delay times set by this instruction.	-	pH control (transition delays)	A hand symbol is shown if set to ***Manual***	Y	-
Manual CO2 to base delay	The transition delay time from CO_2 to base control used if ***CO2/Base transition delay mode*** is set to ***Manual***.	-	pH control (transition delays)	-	Y	-
Manual base to CO2 delay	The transition delay time from base to CO_2 control used if ***CO2/Base transition delay mode*** is set to ***Manual***.	-	pH control (transition delays)	-	Y	-

Transition delay output data

Data	Description	View from		
		PP	RD	CD
Auto CO2 to base transition delay	The CO_2 to base transition delay time used if ***pH CO2/base transition delay mode*** is set to ***Auto***.	-	Y	-

Data	Description	View from		
		PP	RD	CD
Auto base to CO2 transition delay	The base to CO_2 transition delay time used if ***pH CO2/base transition delay mode*** is set to ***Auto***.	-	Y	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

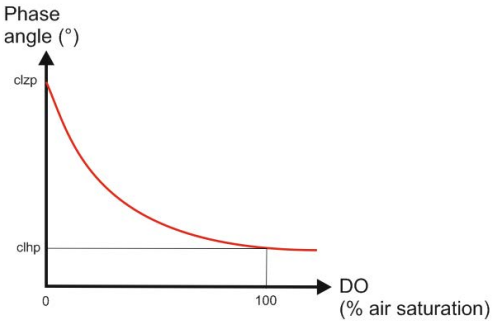
8.5.9 DO measurement

DOOPT calibration values

The DO surrounding the DO sensor is calculated from a measured variable called "the phase angle". The calculation is based on a transfer equation programmed in the DOOPT monitor. This transfer equation is defined by a set of constants, or, more correctly, a set of values that are specific for the mixture of the substances forming the luminophoric dye. This means that the dye properties, and consequently the transfer equation, may differ between different dye batches.

The constants for each batch (after gamma irradiation) are determined at the factory and are printed on the DOOPT label of the Cellbag as calibration values: **clhp**, and **clzp**.

The interpretation of the calibration values on the transfer equation is illustrated in the graph below:



The calibration values **clht** and **clzt** are temperatures recorded during the factory calibration. They are used by the DO monitor for temperature compensation.

The calibration value **calp** is the atmospheric pressure during the factory calibration. It is not used by the DO monitor, but is kept for informative purpose.

Settings

The following table shows DO measurement related settings.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
clhp	Calibration value, 100% air saturation.	***Settings: Cellbag***	DO sensor calibration values	Y	-	-
clht	Calibration value, temperature when determining clhp.	***Settings: Cellbag***	DO sensor calibration values	Y	-	-
clzp	Calibration value, 0% air saturation.	***Settings: Cellbag***	DO sensor calibration values	Y	-	-
clzt	Calibration value, temperature when determining clzp.	***Settings: Cellbag***	DO sensor calibration values	Y	-	-
calp	Calibration value, atmospheric pressure during calibration.	***Settings: Cellbag***	DO sensor calibration values	Y	-	-
Reading cycle time	The reading cycle when DO control is off.	***Settings: DO***	Set DO reading cycle time	Viewed when DO control is off	-	-
Reset calibration values at END	A ***System setting*** that defines if the DO calibration values shall be reset or not when the system goes to END.	-	***System settings →DO sensor →Reset calibration values at END***	-	-	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

Output data

Data	Description	View from		
		PP	RD	CD
DO measurement timer	The time left to next DO measurement.	-	Y	-
DO measurement cycle time	The actual measurement cycle time. This value is set by the user when DO control is off, and by DO control when the DO control is on.	Y	-	-
DO measurement	The latest measured DO value.	Y	-	Y
DO amplitude	A measure of the strength of the responsive DO signal received by the DO monitor.	-	-	Y

Note: *The following abbreviations are used in the table: PP = **Process Picture**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

8.5.10 DO control

Introduction

The following tables describe settings and parameters that can be used for DO control.

General settings

The following table shows general settings used for DO control.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Control scheme	Select ***Speed*** for using only rocking speed as actuator. Select ***O2*** for using only O_2 as actuator. Select ***O2/ Speed*** for a combination of O_2 and rocking speed as actuators, where the control always starts in O_2 mode. Only the ***O2*** scheme is available in dual mode.	***Settings→DO***	DO control (general)	Y	-	-
DO setpoint	The DO target value.	***Settings→DO***	DO control (general)	Y	-	Y
Deviation alarm	Enables or disables the deviation alarm.	***Settings→DO***	DO control (general)	Y	-	-
Allowed deviation up	Sets the extent to which the DO reading can vary above the setpoint without triggering the deviation alarm.	***Settings→DO***	DO control (general)	Y	-	-
Allowed deviation down	Sets the extent to which the DO reading can vary below the setpoint without triggering the deviation alarm.	***Settings→DO***	DO control (general)	Y	-	-
Deviation alarm delay	Sets the time for which the DO reading must be outside the defined alarm limits before the deviation alarm is triggered. The timer is reset if the DO reading falls back within the limits before the alarm is triggered.	-	DO control (general)	-	Y	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

O2 control mode settings

The following table shows O2 control mode settings used for DO control.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Max O2 concentration	The maximum O_2 concentration allowed for the DO control.	-	DO control (O2)	-	Y	-
Min O2 concentration	The minimum O_2 concentration allowed for the DO control.	-	DO control (O2)	-	Y	-
PID parameter mode	When ***Auto*** is selected, the system will automatically set the PID parameters. When ***Manual*** is selected, the system will use the manual PID parameters set by this instruction.	-	DO control (advanced O2)	A hand symbol is shown if set to ***Manual***	Y	-
Manual P	The P-parameter used if ***PID parameter mode*** is set to ***Manual***.	-	DO control (advanced O2)	-	Y	-
Manual I	The I-parameter used if ***PID parameter mode*** is set to ***Manual***. Note, that increasing the I-parameter will reduce the integrating effect and vice versa.	-	DO control (advanced O2)	-	Y	-
Manual D	The D-parameter used if ***PID parameter mode*** is set to ***Manual***.	-	DO control (advanced O2)	-	Y	-
Cycle time mode	When ***Auto*** is selected, the system will automatically set the cycle time. When ***Manual*** is selected, the system will use ***Manual cycle time***.	-	DO control (advanced O2)	A hand symbol is shown if set to ***Manual***	Y	-
Manual cycle time	The cycle time used if ***Cycle time mode*** is set to ***Manual***.	-	DO control (advanced O2)	-	Y	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

O2 control mode output data

Data	Description	View from		
		PP	RD	CD
Auto DO O2 P	The P-parameter used if ***PID parameter mode*** is set to ***Auto***.	-	Y	-
Auto DO O2 I	The I-parameter used if ***PID parameter mode*** is set to ***Auto***.	-	Y	-

Data	Description	View from		
		PP	RD	CD
Auto DO O2 D	The D-parameter used if ***PID parameter mode*** is set to ***Auto***.	-	Y	-
Auto DO O2 Cycle time	The cycle time used if ***Cycle time mode*** is set to ***Auto***.	-	Y	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

Speed control mode settings

The following table shows Speed control mode settings used for DO control. Speed control settings are not available in dual mode.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Max speed	The maximum rocking speed setpoint allowed for the DO control.	-	DO control (speed)	Y	-	-
Min speed	The minimum rocking speed setpoint allowed for the DO control.	-	DO control (speed)	Y	-	-
Speed step	The change of rocking speed setpoint at each control action when DO reading is outside dead band.	-	DO control (speed)	Y	-	-
Control cycle	The cycle time of the DO speed control, i.e., the time between each control action.	-	DO control (speed)	Y	-	-
Upper dead band	When DO reading is between DO setpoint and DO setpoint + upper dead band, there will be no control actions.	-	DO control (speed)	-	Y	-
Lower dead band	When DO reading is between DO setpoint and DO setpoint – lower dead band, there will be no control actions.	-	DO control (speed)	-	Y	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

Transition delay settings

The following table shows the transition delay settings used for DO control. Transition delay settings are not available in dual mode.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
O2/Speed transition delay mode	When ***Auto*** is selected, the system will automatically set the transition delay time. The automatically computed transition delay times can be displayed as run data. When ***Manual*** is selected, the system will use the manual transition delay times set by this instruction.	-	DO control (transition delays)	A hand symbol is shown if set to ***Manual***	Y	-
Manual O2 to speed delay	The transition delay time from O_2 to speed control used if ***O2/Speed transition delay mode*** is set to ***Manual***.	-	DO control (transition delays)	-	Y	-
Manual speed to O2 delay	The transition delay time from speed to O_2 control used if ***O2/Speed transition delay mode*** is set to ***Manual***.	-	DO control (transition delays)	-	Y	-

Transition delay output data

Transition delay output data is not available in dual mode.

Data	Description	View from		
		PP	RD	CD
Auto O2 to speed transition delay	The O_2 to speed transition delay time used if ***O2/speed transition delay mode*** is set to ***Auto***.	-	Y	-
Auto speed to O2 transition delay	The speed to O_2 transition delay time used if ***O2/speed transition delay mode*** is set to ***Auto***.	-	Y	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

8.5.11 Media control

Media control settings

The following table shows general settings used for media control.

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Media control mode	If ***Media addition*** is selected, the feed pump will run with the flow given by parameter ***Flow rate***, until the weight setpoint is reached. If ***Perfusion*** is selected, the feed or harvest/ waste pump will run with the flow given by parameter ***Flow rate***, until the weight setpoint is reached. Then both feed and harvest/waste pumps will run together, keeping the weight setpoint.	***Settings: Media control***	Media control (general)	Y	-	-
Weight setpoint	The weight target value.	***Settings: Media control***	Media control (general)	Y	-	Y
Weight deviation alarm	Enables or disables the deviation alarm.	***Settings: Media control***	Media control (general)	Y	-	-
Allowed deviation up	Sets the extent to which the weight can vary above the setpoint without triggering the deviation alarm.	***Settings: Media control***	Media control (general)	Y	-	-
Allowed deviation down	Sets the extent to which the weight can vary above the setpoint without triggering the deviation alarm.	***Settings: Media control***	Media control (general)	Y	-	-
Deviation alarm delay	Sets the time for which the weight must be outside the defined alarm limits before the deviation alarm is triggered. The timer is reset if the weight falls back within the limits before the alarm is triggered.	-	Media control (general)	-	Y	-

Setting	Description	Set from		View from		
		PP	MI	PP	RD	CD
Flow rate	The flow of the feed pump when media control is on. In perfusion, the harvest/waste pump will also start at this flow rate, and then do minor flow adjustments to keep the weight set-point.	***Settings: Media control***	Media control (general)	Y	-	-
Auto calibration	Select ***On*** to activate the auto calibration, and ***Off*** to deactivate it. ***Media control mode*** also needs to be set to ***Perfusion***, since no auto calibration will take place in ***Media addition***. When auto calibration is on, the feed and harvest/waste pumps will be calibrated automatically by the system when the weight SP is reached, then with the time interval given by ***Auto calibration cycle***. If an extra auto calibration is wanted, select ***Off***, and then ***On*** again.	***Settings: Media control***	Media control (general)	Y	-	-
Auto calibration cycle	If auto calibration is on, this parameter defines the time interval between the auto calibrations.	-	Media control (general)	-	Y	-

Note: *The following abbreviations are used in the table: PP = **Process Picture**; MI = **Manual instruction**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

Media control output data

Data	Description	View from		
		PP	RD	CD
Momentary/instant weight setpoint	In ***Media addition*** mode, the weight setpoint is ramped towards the user set weight setpoint. This output data shows the current value of the ramped setpoint.	-	Y	Y
Auto calibration cycle timer	The time left to start of next auto calibration (hours).	-	Y	-

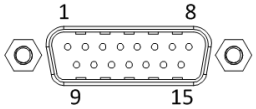
Note: *The following abbreviations are used in the table: PP = **Process Picture**; RD = **Run data**; CD = **Curve data**; Y = Yes; - = No or Not applicable.*

8.6 Digital and analog I/O connections

The rear panel of the rocker has a 15-pin male D-SUB connector, providing four digital inputs, four digital outputs and two analog inputs for connection to external equipment. This section describes the pinout specifications of this connector and details of the signals. Contact Cytiva if you require further details of the I/O specifications.

Pinout specifications

The illustration below shows the pin arrangement for the male D-SUB connector.



Signal	Pin	Function	Normal operation	Comments
AIN1_P	1	Analog In 1 Positive, 0 to 10 V/ to 1 to 20 mA (optional)	-0.5 to 11 V	Accuracy ±(0.5% reading + 1 digit) R_{in} ~50 kΩ (0 to 10 V) R_{in} ~500 Ω (0 to 20 mA)
AIN1_N	9	Analog In 1 Negative	-0.5 to 1.0 V	
AIN2_P	11	Analog In 2 Positive, 0 to 10 V/ 1 to 20 mA (optional)	-0.5 to 11 V	
AIN2_N	12	Analog In 2 Negative	-0.5 to 1.0 V	
DIN1	15	Digital In 1	< 0.8 V = Off > 2 V = On relative to DIN_COM	R_{in} ~1 kΩ
DIN2	8	Digital In 2		
DIN3	14	Digital In 3		
DIN4	6	Digital In 4		
DIN_COM	7	Digital In Common/ negative	-0.5 to 32 V	
DOUT1	2	Digital Out 1	-0.5 to 32 V	Solid state relay outputs supporting max 100 mA. Can sink or source.
DOUT2	3	Digital Out 2		
DOUT3	5	Digital Out 3		
DOUT4	10	Digital Out 4		

Signal	Pin	Function	Normal operation	Comments
DOUT_COM	4	Digital Out Common/ negative or positive		
NC	13	Not connected	N/A	

Signal specifications and handling

All signals

Maximum ratings for all signals and pins are -0.5 to 35 V relative to ground or chassis.

To avoid ground loops, signals are allowed to float a little relative to ground chassis: -0.5 to 1.0 V for analog in, and -0.5 to 32 V for digital in/out.

Digital signals

Digital inputs consist of optocouplers. A high level/on state corresponds to a voltage in the range 2 to 32 V DC.

Digital outputs consist of solid state optical relays, voltage range 0 to 32 V DC. The outputs are protected against overcurrent by 0.1 A fuses that reset automatically when the overcurrent condition is removed. Connect the Digital Out common pin as follows:

- For sourcing output, connect common to a positive voltage.
- For sinking output, connect common to the user equipment common.

The status of the digital inputs can be read by a ***Watch*** instruction in a method, allowing appropriate action to be programmed.

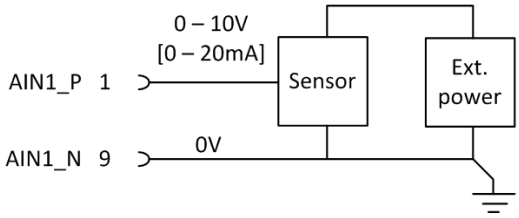
Analog signals

The analog input signal voltage range is 0 to 10 V DC, presented in UNICORN as 0% to 100%. One or both inputs can be changed by Cytiva Service to measure 0 to 20 mA/4 to 20 mA DC. There are currently no procedures for Cytiva Service to calibrate either of the analog inputs if one or both of them is changed to measure current, but the specified accuracy still applies.

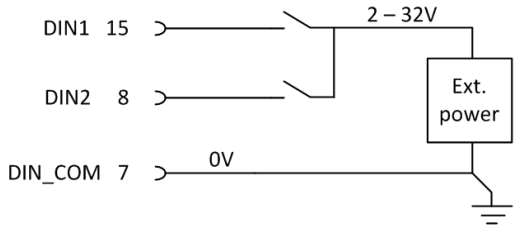
Accuracy is ±(0.5% reading + 1 digit).

Examples

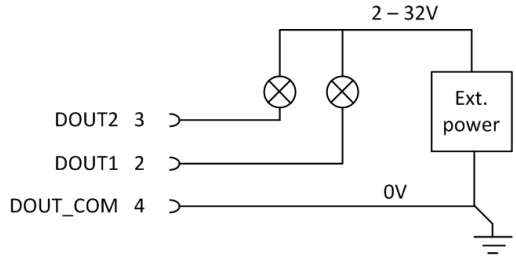
Analog In 1



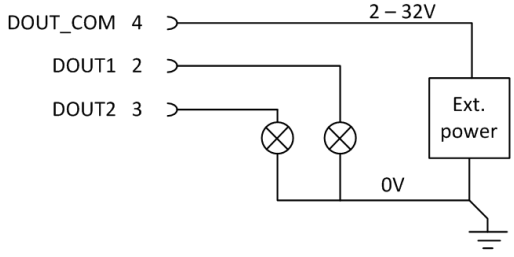
Digital In 1 and 2



Digital Out 1 and 2: example 1



Digital Out 1 and 2: example 2



8.7 Ordering information

Systems and accessories

Product	Description	Product code
Xuri Cell Expansion System W25	Rocker	29064568
Xuri Cell Expansion W25 CBCU pH	Gas flow/mix and pH	29064600
Xuri Cell Expansion W25 CBCU DO	Gas flow/mix and DO	29064599
Xuri Cell Expansion W25 CBCU Full	Gas flow/mix, pH, and DO	29064602
Xuri Cell Expansion W25 Pump	Pump	29064571
UNICORN 7.x WrkStn-pure-BP	License	29128116
UNICORN 7.x Remote	License	29115426
UNICORN 7.x Dry	License	29115427
UNICORN 7.x DVD pack, no license	Media only	29128020
UNICORN 7.x Manual package	Printed copies of UNICORN manuals	29127795
Tray 10	–	29065231
Tray 20	–	29065232
Tray 50	–	29065233
Lid 10	–	29065234
Lid 20	–	29065235
Lid 50	–	29065237
Filter heater	–	29065252
Bag sensor adaptor assembly 2.5 m	Fiber cable for pH and DO control	28984189

Spare parts

Product	Product code
UniNet cable 0.3 m	18110973
UniNet cable 1 m (CAN cable)	29028807
UniNet cable 2 m (for external modules)	29011366

Product	Product code
Mains cable (UK)	18110013
Mains cable, 120 V	19244701
Mains cable, 220 V	19244801
O-ring 5.1 × 1.6 mm, EPDM INDEX 100	18110767
Rubber feet kit	29052858
Tray handle, Cellbag locking handle	29091966
Jumper 1 IEC 1394	29956489
Adjustable foot wrench	29112525
Tubing kit CBCU	29112187
Ethernet cable	28400123

For ordering information for Cellbag bioreactors and accessories, see the Cellbag data file, product code 28951136.

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