BIOTECH

Instructional Documentation

USD 3238

# mPath™ Control Tower and mPath Link Software

## User Manual

# Contents

# 1. Safety Symbols and Statements

## 1.1 Types of Safety Symbols

All safety symbols: warning, prohibition, mandatory and Globally Harmonized System (GHS) can / will be accompanied by additional text and signs to explain the reason for the warning, explain the nature of the prohibition, and explain the reason for the action.

**Table 1**

ISO 7010 safety signs and symbols

| Color | Meaning / Purpose | Example | Description | Instruction and Information |
|---|---|---|---|---|
| Red | Prohibition / Danger |  | Red ring and diagonal bar with black symbol on white background | Specifies behavior that is prohibited because it would result in an immediate or potential risk of personal injury or threat to health / life. |
| Yellow | Warning / Caution |  | Yellow triangle with black border and black symbol | Warns of hazards which could result in personal injury or threat to health. |
| Blue | Mandatory / Information |  | Blue circle with white symbol | Specifies an action required or informs of information to safeguard personal health and / or avoid risk of personal injury. |
| Red | GHS Hazards |  | Red diamond, white background with a black symbol | Classifies the hazards of chemical products and communicates health and safety information. |

## 1.2 Safety Messages and Warnings

**Table 2**

Safety signs and symbols within this document

Safety is the responsibility of the individual installing, using, or maintaining the equipment and any others who may be involved in the operation. It is important that the safety instructions are read and followed.

| Symbol | Definition / Meaning |
|---|---|
|  | Prior to operating, the instructions must be read in entirety |
|  | Highlights important information regarding instructions for use |
|  | **Do not:**<br>- Use the equipment in any way ither than stated in this manual. Doing so could result in personal injury and damage to the equipment.<br>- Block ventilation holes<br>- Attempt to power up the equipment if it is damages in any way. Contact Pall for advice.<br>- Use the equipment if you suspect a fault. Switch off and disconnect the equipment immediately and contact Pall for advice. |
|  | Caution potential risk to equipment |
|  | Caution risk of crush injury. |
|  | Caution hot surface. |
|  | Caution possibility of electric shock |

## 1.3 Danger Levels

The following danger levels are used in safety messages throughout this manual.

**Table 3**

Danger levels within this document

| | |
|---|---|
| **Danger:** | Will lead to severe injuries or death |
| **Warning:** | May lead to severe injuries or death |
| **Caution:** | May lead to light or moderate injuries |
| **Alert:** | May lead to material damage |

# 2. System Overview

## 2.1 Introduction

Your mPath unit control tower has been designed to be used with Pall unit products. It is intended for use in research & development, process development and small-scale GMP manufacturing.

The mPath control tower system is capable of supporting cGMP cell culture processes on the iCELLis® Nano unit, and Xpansion® multiplate unit and Allegro™ XRS 25 single-use unit systems. The mPath control tower also includes four extra IO (Input / Output) ports to allow user configuration.

The mPath control tower does not have a user interface (UI) present on the casing. It has been designed to work with mPath Link, a supervisory control, and data acquisition (SCADA) platform where the user can remotely view and control their unit from a network enabled device. Access to full features of mPath Link is dependent on the IT environment in which the software is installed. For further details, consult the Pall IT Technical Advisory Note reference USD 3222.

mPath Link UI and SCADA software is delivered as standard on a mPath Link server (part numbers in Table 4) which is configured as a server. All required software is pre-installed with default recipes to aid the user in a quick start scenario.

**Table 4**

mPath Link Part Numbers

| Part Number | Description |
|---|---|
| MPATHLINKV2 – LT | mPath Link server lite – single session & device |
| MPATHLINKV2 | mPath Link server full – unlimited sessions & devices |
| MPATHLINKV2-U– LT | mPath Link server lite – single session & device (existing Pall Link users transferring to mPath Link) |
| MPATHLINKV2-U | mPath Link server full – unlimited sessions & devices (existing Pall Link users transferring to mPath Link) |
| MPATHLINKV2-LTSW | mPath Link lite – single session & device (software only no server) |
| MPATHLINKV2-SW | mPath Link lite – unlimited sessions & devices (software only no server) |

The design of the software is such that up to 10 control towers and user interfaces can be supported from one server. Additional units may reduce performance. To support larger installs a more powerful server or multiple servers may be required.

The software is recipe focused allowing the user to create, save, edit, delete, archive and duplicate recipes. The recipe then can be scheduled against an integrated calendar
within the software to allow lab managers to arrange unit availability and plan
resource requirements.

The mPath control tower can provide two mixed gas supplies – primary and secondary – to the unit. Each mixture may be generated from four compressed gases: carbon dioxide, nitrogen, oxygen, and air which are supplied to the tower.

Primary is typically a mix of carbon dioxide, oxygen and air or nitrogen (air and nitrogen are interchangeable without an impact on calibration). Secondary is typically a mix of carbon dioxide, air, or nitrogen.

An additional feature on the mPath control tower is a rapid inflate option which allows the operator to quickly inflate their biocontainer with compressed air.

The mPath control tower can be delivered with or without peristaltic pumps depending on the unit being connected to the tower. If the pump option is chosen, three variable speed Watson Marlow ♦ 314D pump heads, accommodating tubing with bore sizes of up to 8 mm are fitted as standard.

# 3. Site Requirements

## 3.1 Responsibilities

A Pall engineer will be responsible for installing and commissioning the hardware to ensure that it is properly installed and operational. The user is responsible for ensuring that the workspace is prepared in advance to allow the Pall engineer to carry out the installation efficiently.

*The installation of the hardware cannot begin until the checklist has been completed and returned to the Pall engineer. The site preparation checklist must be completed as accurately as possible to help minimize installation time.*

*A user who has been designated to be responsible for the normal use and upkeep of the hardware must be present during the installation. This allows the user to be trained on the basic hardware operation.*

## 3.2 Size and Weight of Equipment

**Table 5**

Size and weight of the mPath equipment.

| Dimensions (W X D X H) | Weight |
|---|---|
| 230 mm x 600 mm x 450 mm<br>(H = 590 mm with hangers attached) | 20 kg |

## 3.3 Space Requirements for Equipment Operation

The mPath unit control tower is intended for indoor use only. Choose an appropriate location to install the equipment taking into consideration the following:

- The equipment should be placed on a solid, level and even surface to minimize the risk of the equipment falling over.
- When using hanging load cells ensure control tower is placed on an even surface, which is not subject to vibration.
- Ensure the space around the equipment is clear to allow ventilation through the underside and rear of the equipment.
- No exposure to direct sunlight.
- Not positioned near any water sources or heat sources. In the event of a major liquid spillage in or near the unit control tower, isolate the system from the electricity supply.
- Ensure a well illuminated and well-ventilated working environment.
- The equipment will require access to the rear and left side panels during installation and setup.

- Access to the left, front and right panels will be required in normal use.
- The equipment needs to be powered from an AC power supply.
- The AC power supply should provide a safety earth connection.
- The AC switch on the rear of the equipment should be easily accessible without having to move the equipment.

## 3.4 Power Requirements

- When connecting the instrument, check the electrical cable for damage. If the cable is undamaged then first connect the cable to the instrument, and then connect the cable to the electricity supply.
- The mPath unit control tower should only be connected to an AC current limited (16A) supply that has protective ground using the IEC power supply cord provided. Do not replace the detachable power supply cord with an inadequately rated cord. Doing so could compromise safety.
- The detachable power supply cord is used as an electrical disconnect device.
  Do not position the equipment so that it is difficult to remove the supply cord from the AC supply.
- The equipment has an AC power switch on the rear. The power switch has two positions indicated by graphical symbols:
- | On – equipment powered ○ Off – equipment powered off
- The AC power switch is illuminated when in the on position.
- Avoid contact with water and other solvents.
- In the event of a major liquid spillage in or near to the unit control tower, isolate the unit from the electricity supply.
- The equipment contains no internal user-serviceable parts. Do not remove covers or attempt to repair the equipment. Doing so will void the warranty.
- Repairs must be undertaken by Pall authorized service personnel only. Faulty unqualified repair work may cause accidents or injury to the operator.
- Do not use extension cords.
- The plug must be disconnected from the power source before changing the fuse.
- The fuse in the AC power inlet must only be replaced with the type and rating marked on the equipment.
- This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules.

## 3.5 Gases

- It is the user's responsibility to provide a clean, dry, oil free, analytical grade source of each compressed gas regulated from 2 (29 psi) to 6 bar (87 psi) or below as mass flow control towers are sensitive to dirt and pressure spikes.
- Gases from local compressors or generators must be filtered and dried.
- It is recommended that Pall sub-micron filters are installed in each gas line. Recommended: Pall Gaskleen® GLF6101FP4 filters.

*When using the stated filter, male ¼ in. NPT to 6 mm push to connect stubs are also required.*

- The mPath bioreactor control tower is designed for use with and calibrated for the gases carbon dioxide, oxygen, nitrogen, and air at pressures between 2 bar (29 psi) and 6 bar (87 psi). Use caution when working with the gases and ensure all gas tubing is fully inserted into the push to connect fittings on the bioreactor control tower.
- The use of gases other than those listed above is not recommended.
- The maximum inlet pressure of 6 bar (87 psi) must not be exceeded.
- All pneumatic tubing used must be rated to withstand the gas pressures used (up to 6 bar / 87 psi).
- The operator should check the tubing and connectors for damage before each use.
- Ensure the environment in which the mPath bioreactor control tower is being operated has appropriate gas alarms enabled.

**Table 6**

Gas connections overview.

| Gases | Mains Gas In | Gas Out / Delivery | Recommended Tubing for Connections |
|---|---|---|---|
| Air, oxygen, nitrogen, and carbon dioxide | Pneumatic push-fit connector (for each gas) | Quick connectors 6 mm | Pneumatic tubing 6 mm OD |

The optional with PN CCTOOLKIT1 supplied by Pall includes tubing and tubing connectors to enable the easy installation of the hardware and connection of gas lines.

## 3.6 Environment

*Alert*
*This equipment was designed for indoor use only (ambient temperatures of +16 °C to +30°C). It may occasionally be subjected to temperatures between +5 °C and +40 °C without degradation of its safety.*

The mPath control system can be operated under the following ambient environmental condition:

- Indoor use only.
- Altitude up to 2000 m.
- The ambient temperatures must be between 5 °C (41 °F) and 40 °C (104 °F).
- Maximum relative humidity of 80% for temperatures up to 31 °C decreasing linearly to 50% relative humidity at 40 °C.

Electrical supply voltage fluctuations allowable of up to +/- 10% of the nominal voltage.

# 4. Unpacking and Installing

## 4.1 Packaging Details

The mPath bioreactor control tower is supplied in packaging to help reduce the risk of damage to the equipment during transit. The equipment is heavy and suitable precautions should be taken when lifting or moving the packaged equipment to help prevent personal injury or damage to the equipment. It is recommended that the packaged equipment be lifted by two people.

Inspect the packaging for signs of damage. Place the packaging on a solid and even surface with the arrows pointing in the up direction. Open the packaging from the top. Before attempting to remove the equipment, check the internal packaging for signs of damage.

Carefully lift the equipment from the packaging and place it on a solid and even surface. Check the equipment for any signs of damage.

If the packaging or equipment is damaged in any way, contact Pall for advice.

Ensure the equipment AC on/off switch on the rear panel is in the **off** position, and the switch on the AC power supply socket is **off** if one is fitted.

Ensure that the Emergency Stop button is **not** engaged by twisting it to the right-hand side.

**Table 7**

Packaging details.

| Dimensions (Packaging) | Weight |
|---|---|
| H = 610 mm, L = 699 mm, W = 330 mm | 25 kg |

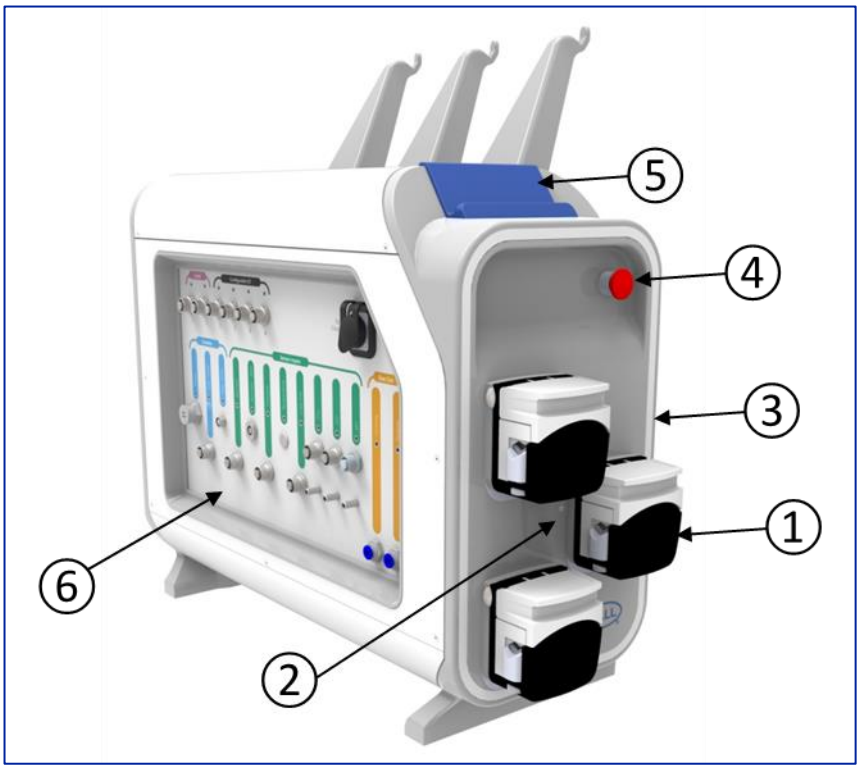
## 4.2 Installation

- The mPath bioreactor control tower should be handled with care as appropriate for a sensitive electronic instrument.
- The mPath bioreactor control tower weighs 20 kg when fully assembled; care should be taken when lifting. Only lift or move the equipment using the rear hand hold at the bottom and lip at the top of the top face. It is recommended that the equipment be lifted or moved by two people.
- Before attempting to move the mPath bioreactor control tower, disconnect from power supply, disconnect gas lines, remove hanging biocontainers, remove cables connecting control tower and bioreactor as well as any tubing from peristaltic pumps.
- To connect the bioreactor control tower to a network, please refer to the Pall IT Technical Advisory Note reference USD 3222.
- A Pall service engineer will aid with the first installation of the bioreactor control tower. *Warranty may be void if installation is carried out without Pall specialist present.

## 4.3 Hardware Overview

**Figure 1**

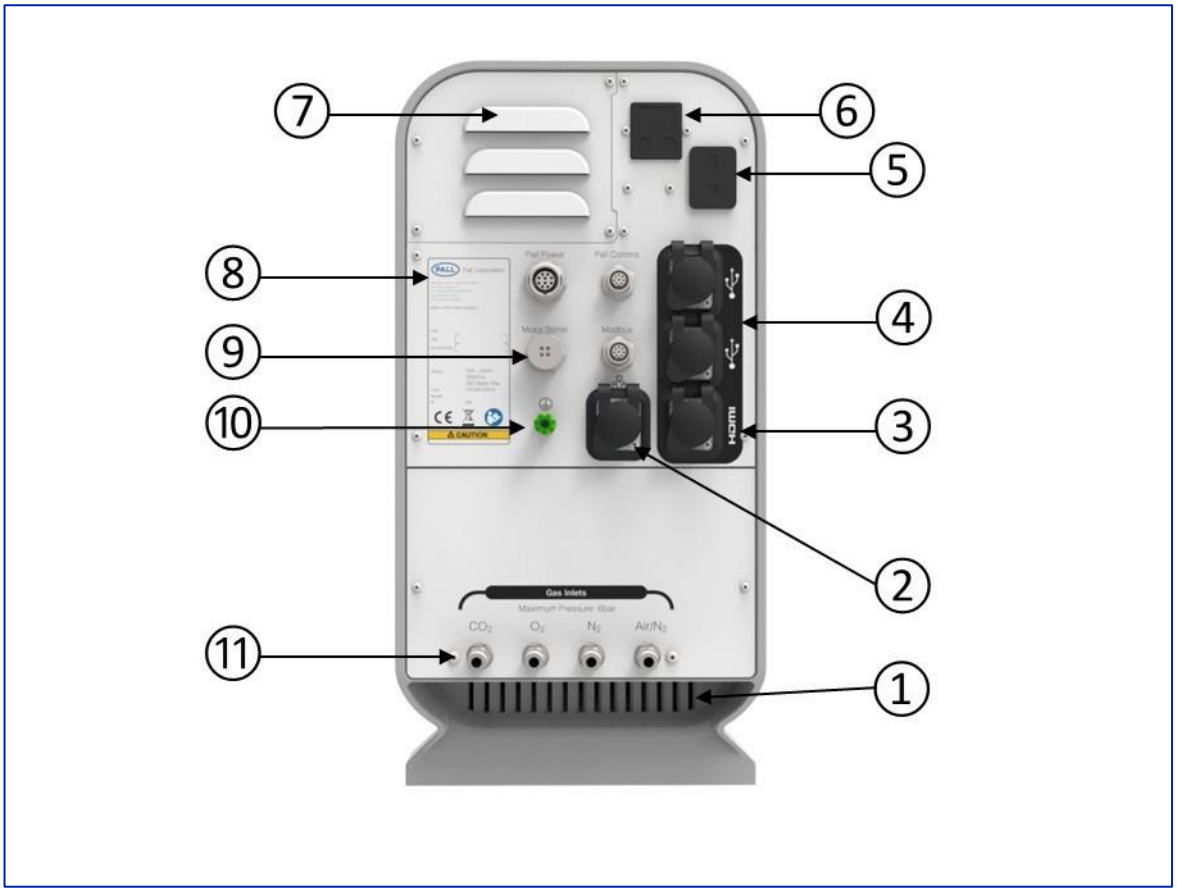
Labelled overview of mPath control tower




| No. | Item | Description |
|---|---|---|
| 1 | Peristaltic pumps. *Only on part numbers:* MPATHBRXPS2P3 MPATHBRXPS0P3 | Three variable speed Watson-Marlow♦ 314D pump heads are located on the front of the control tower. These pumps are designed to operate with tubing bore sizes in the range 0.5 mm to 8 mm |
| 2 | Pump status LEDs. *Only on part numbers:* MPATHBRXPS2P3 MPATHBRXPS0P3 | Three LEDs provide the user with information on the status of the pumps |
| 3 | Status illumination | An illuminated ring is located on the front of the control tower to provide the user with general alarm status |
| 4 | Emergency stop | An E-stop is located on the front of the control tower. This is an E-stop for the control tower only! |
| 5 | Tablet dock | The user can set up recipes and monitor progress through a tablet computer or HDMI touchscreen that may be docked on top of the control tower. A charging point is available on the connector panel and an HDMI output on the rear of the instrument |
| 6 | Connector panel | The connector panel provides for a range of sensor inputs (both electrical and optical) and control outputs |

**Figure 2**

Labelled overview of mPath control tower rear panel



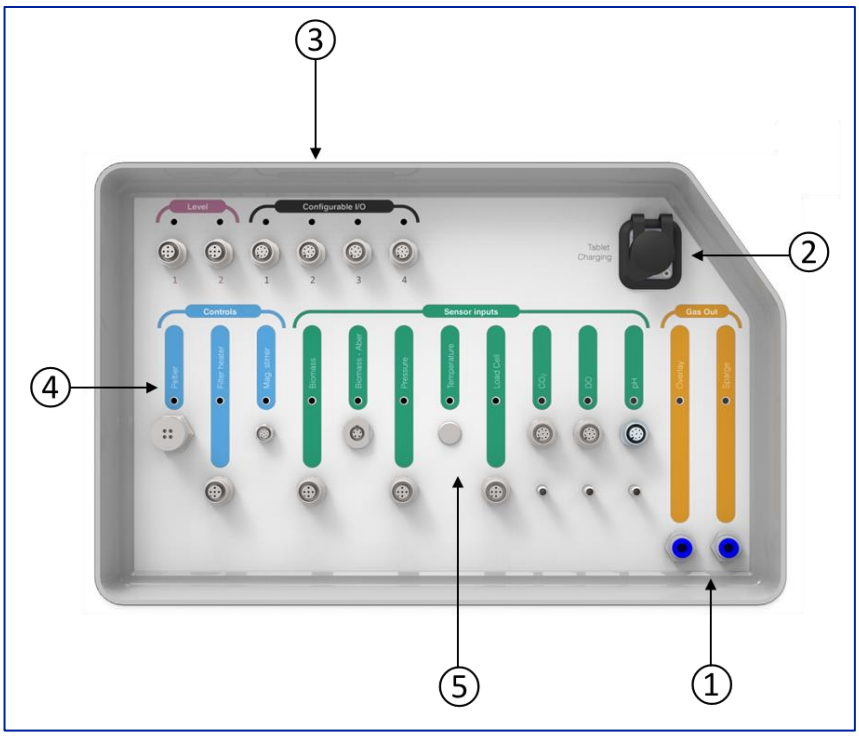

| No. | Item | Description |
|---|---|---|
| 1 | Ventilation exhaust | To allow air used for cooling to exit the mPath control tower |
| 2 | Ethernet | Network connection |
| 3 | HDMI | Monitor connection |
| 4 | USB (x2) | Keyboard and mouse connections |
| 5 | AC power on / off switch | The equipment can be switched on/off using the AC power on/off switch on the rear panel |
| 6 | AC Inlet and fuse | Power to the equipment is provided through the AC inlet using one of the three supplied detachable power cords (UK, EU or US power plugs) |
| 7 | Ventilation inlet | To allow external air to be drawn into the mPath control tower for cooling |
| 8 | Product label | Product and safety information |
| 9 | Bioreactor connections | Connectors that allow a variety of Pall range laboratory scale bioreactors to interface with the mPath control tower |
| 10 | Ground | For peripheral equipment requiring a ground connection |
| 11 | Gas inlets | Four 6 mm quick-fit connectors that can be connected to pressurised supplies of air, nitrogen, carbon dioxide and oxygen, 2 (29 psi) - 6 bar (87 psi) supply pressure. |

**Figure 3**

Product safety label


**Figure 4**

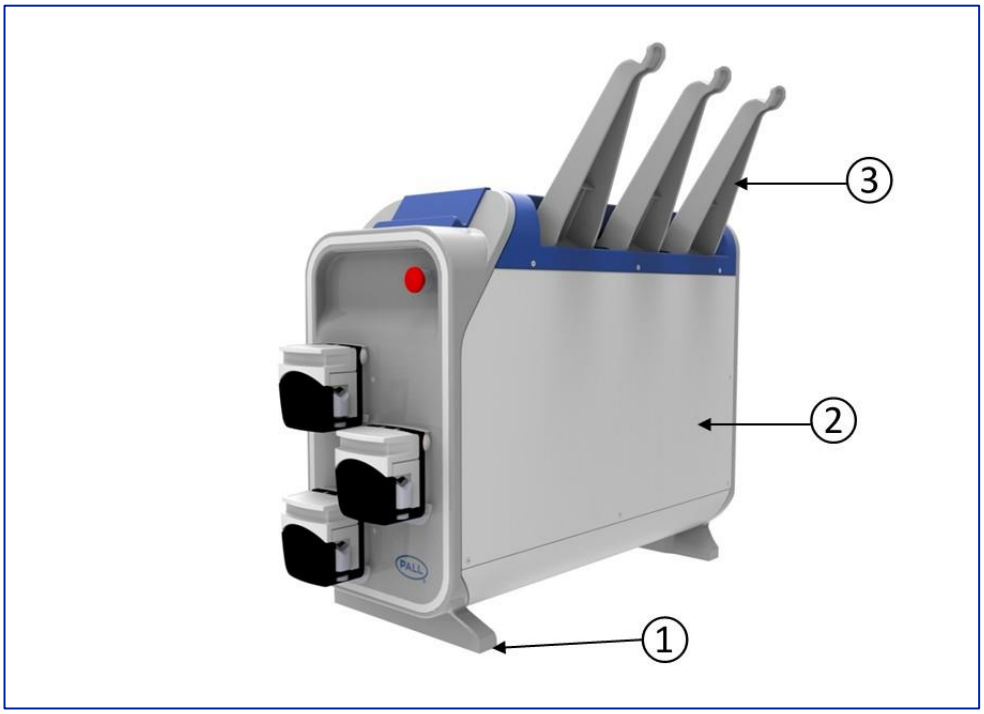
mPath control tower left side panel



| No. | Item | Description |
|---|---|---|
| 1 | Gas outlets | The control tower provides two gas outlets (Primary and Secondary) which provide a controlled flow/mixture of the inlet gases:<br>Primary provides gas mixes of $CO_2$, Air/$N_2$, $N_2$ and $O_2$<br>Secondary provides gas mixes of $CO_2$ and Air/$N_2$ |
| 2 | Tablet charging connection | A USB charging port that can be used to charge a docked tablet is also provided (No data transfer capability) |
| 3 | Configurable I/O | The control tower provides four M12 A-coded 8-way female connectors that offer a range of I/O signals |
| 4 | Bioreactor control connections | Electrical connections that control bioreactor functions such as heaters and stirring systems<br>Mag Stirrer – 2mag♦ bioMIX drive stirrer connection<br>Filter Heater - M12, A-coded, 5-way, female connector, 0 - 24 V<br>Peltier - controllable supply for Peltier heater/cooler or resistive heater - output is presented on an M12 T-coded<br>4-way female connector, 0 to ± 21 V, 0 to ± 4 A. |
| 5 | Bioreactor sensor connections | Electrical and optical connections<br>pH and DO – electrochemical and fiber optic<br>$CO_2$ – electrochemical<br>Load Cell – M12, A-coded, 5-way, female connector, 24 V supply, 1 x 0 - 20 mA input.<br>Temperature – PT 100<br>Pressure – M12, A-coded, 5-way, female connector, 24 V supply, 1 x 0 - 20 mA input or 1 x 0 - 10 V input<br>Biomass – M12, A-coded, 5-way, female connector, 0 - 20 mA.<br>Biomass – Aber♦ biomass Modbus communication |

**Figure 5**

mPath control tower right side



| No. | Item | Description |
|---|---|---|
| 1 | Instrument feet | The instrument is mounted on feet that elevate the instrument to allow access to all surfaces for cleaning and for convenience in routing control cables to bioreactor vessels placed on the opposite side of the control tower |
| 2 | Maintenance access panel | Pall qualified service engineers can access the control tower through removable panels on both sides |
| 3 | Biocontainer weighing system | The weighing system consists of load cells within the instrument and removable hangers that provide a method for monitoring the weight of up to 3 biocontainers – maximum volume 2 liter per biocontainer hanger – maximum total volume 4.5 liters. |

# 5. Connecting the mPath Control Tower

*Alert*
*The power must be switched off prior to making connections between the mPath control tower and units.*

## 5.1 Communications

**Figure 6**

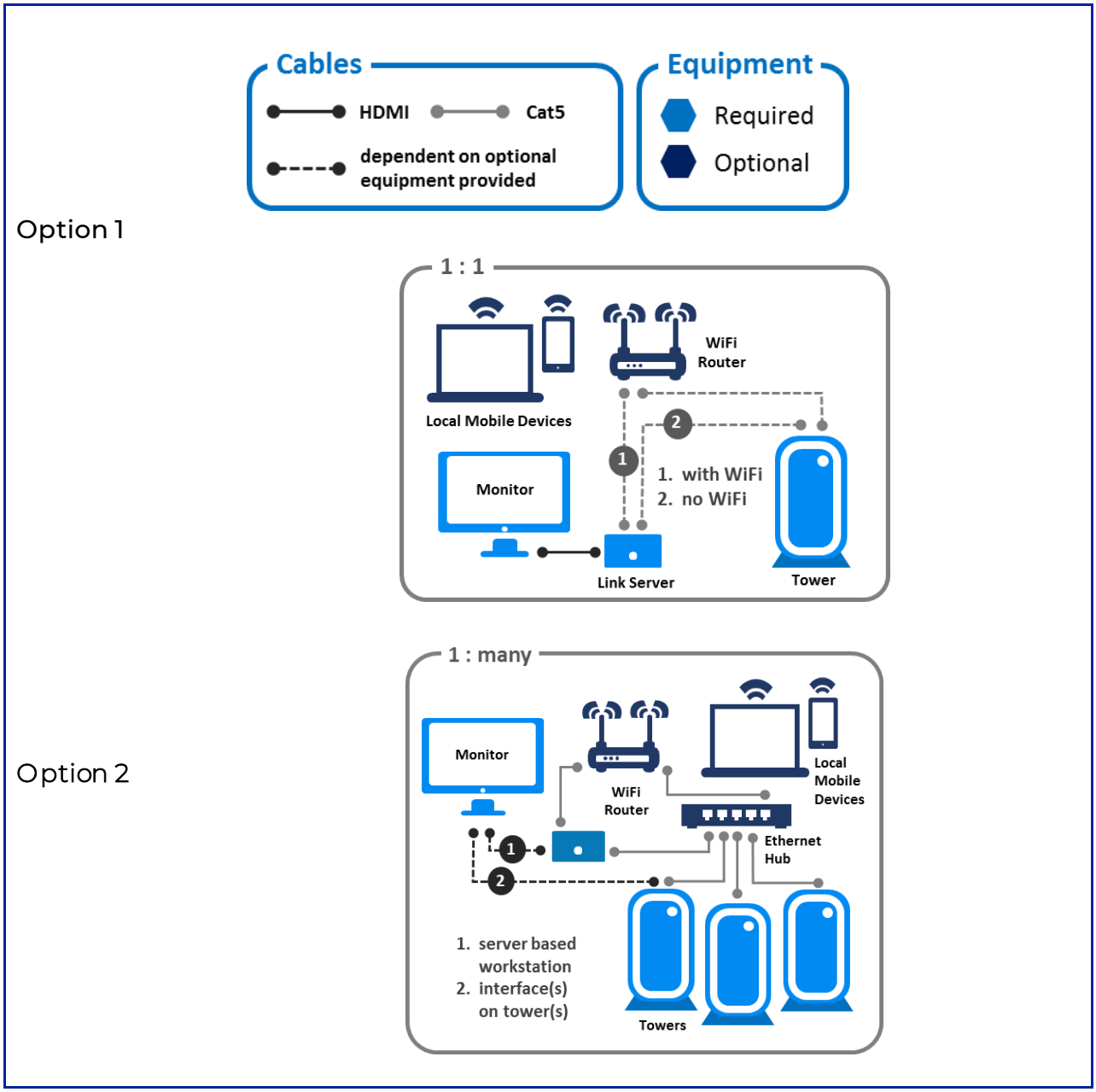
Rear panel ethernet connection.

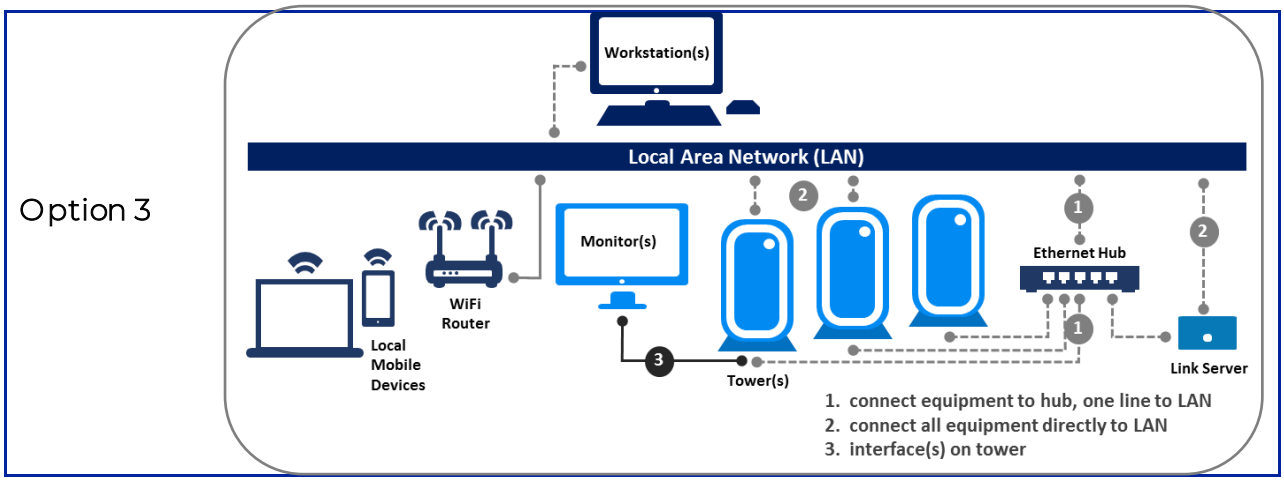

Depending on your choice of network communications determined from the Pall IT Technical Note reference USD 3222:

- Use the Ethernet port on the rear of the mPath control tower and connect it to the appropriate network point via a CAT6 Ethernet patch cable or directly connect to the mPath Link server as shown by the options above.
- Perform the same task with the mPath Link server. Connect CAT6 Ethernet patch cable to the Ethernet port located at the rear of the unit to the appropriate network point.

**Figure 7**

Network communication options.






From the instructions in the Pall IT Technical Advisory Note reference USD 3222, the Pall bioreactor installation specialist will use the IP address set by your IT department to configure the mPath bioreactor control tower.

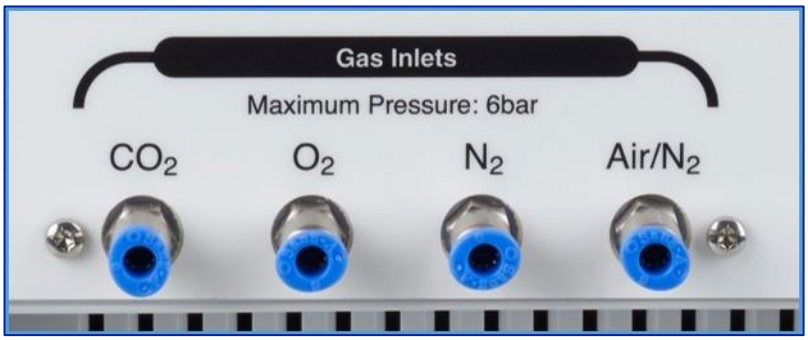
The mPath Link server along with each bioreactor control tower require a unique static IP address when networked. All IP addresses must be within the same domain range. When adding new control towers to an existing mPath Link system, ensure domain ranges match.

If you wish to install the mPath Link software on a server/computer of your choice, please contact your local Pall service or field applications specialist.

## 5.2 Gas Connections

**Figure 8**

Rear panel gas connections.




The gas specifications are described in the gases section.

Using 6 mm, 6 bar rated gas tubing and tubing connectors (optional PN CCTOOLKIT1) gases should be connected from the utilities gas regulators (2 - 6 bar) to the rear panel gas connections on the control system and from the control system to the unit.

Connect the Primary and Secondary outlet ports, if required, from the left-hand side of the mPath bioreactor control tower to the unit in use with 6 mm pneumatic tubing.

- Primary provides gas mixes of CO2, air/N2, N2 and O2.
- Secondary provides gas mixes of CO2 and air/N2.

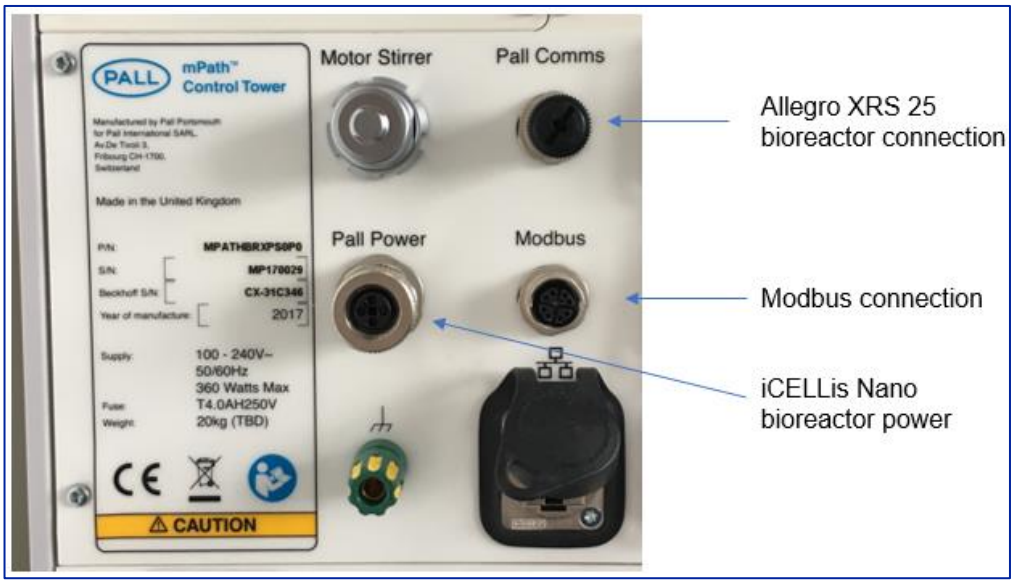
To safely connect gas outlets to the bioreactor gas inlet line, push-to-connect to ¼ inch hose barb connectors should be used (included in PN CCTOOLKIT1).

## 5.3 Rear Panel Unit Connections

Certain permanent connections to your chosen bioreactor are located on the rear panel of the tower. Connect these at this point.

**Figure 9**

Rear panel bioreactor connections




**Allegro XRS 25 bioreactor** – Ensure the Allegro XRS 25 bioreactor is powered off before making any connections. Connect the communication cable to the Pall Comms port.

**iCELLis Nano bioreactor** – Connect the docking station communication cable to Pall Power and connect the Modbus cable to the Modbus port on the rear panel of the mPath control tower.

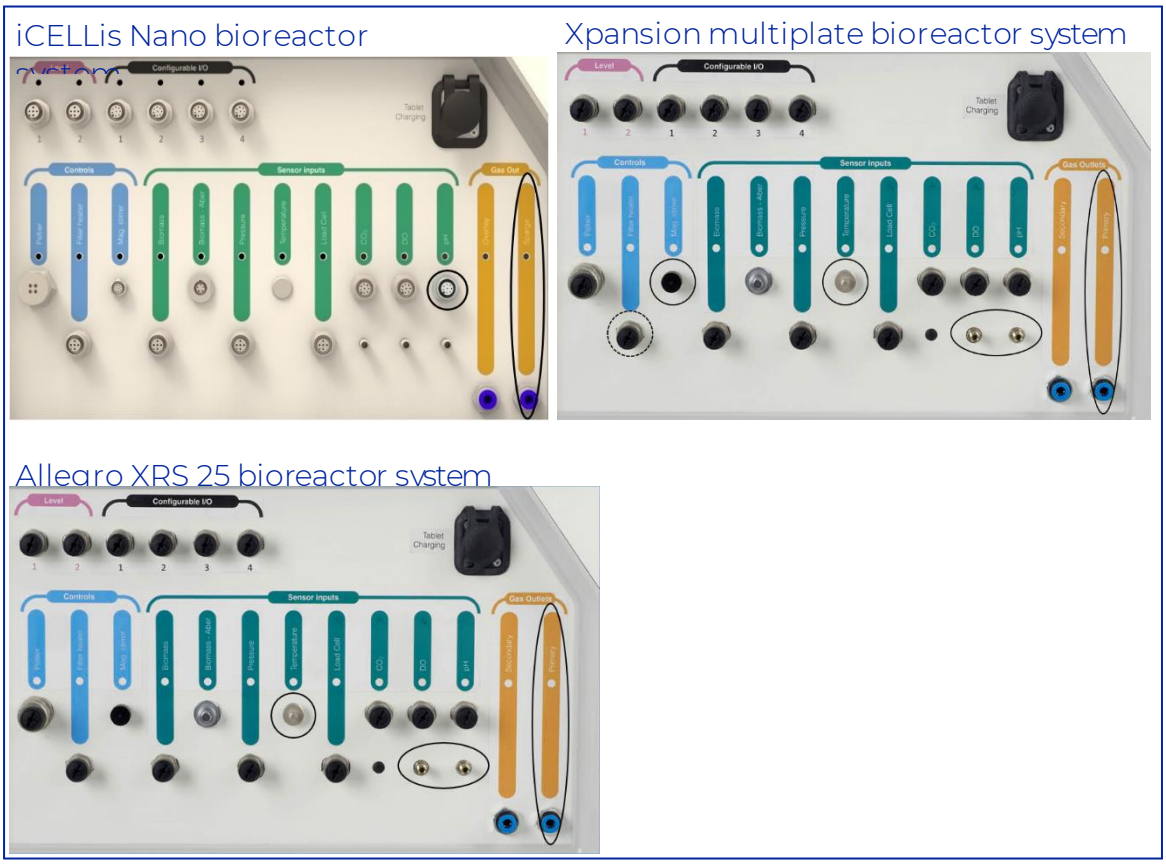
**Xpansion bioreactor** – No connections from the rear of the bioreactor are made.

*The iCELLis Nano bioreactor docking station does not have a power button. It will power on once the mPath control tower is powered on.*

## 5.4 Side Panel Connections

Ensure single-use bioreactor vessel is installed before proceeding. Please refer to the respective product installation guide for detailed instructions on the required connections. Connect all required inputs and outputs at this point.

**Figure 10**
Side panel connections.




## 5.5 Power on the Bioreactor Control Tower

After completing the previous steps, connect the control tower AC inlet to an AC supply using one of the supplied detachable power cords (UK, EU or US power plugs). Once the control tower is connected, switch on the power via the AC on / off switch.

The status ring on the front of the equipment will flash blue when the equipment is switched on. After approximately 40 seconds the status ring will display a solid blue color or flashing pink.

If the status ring does not show a solid blue color or flashing pink after approximately 40 seconds, refer to Troubleshooting in Section 16.2.

The iCELLis Nano and Xpansion bioreactors will power on together with the mPath control tower. The Allegro XRS 25 bioreactor should be powered on by its respective power switches (see the product user manuals).

## 5.6 Enabling Network Communications

At this point, network communications between the mPath bioreactor control tower and the mPath Link Server are to be established.

*Please ensure you have read the Pall IT Technical Advisory Note reference USD 3222 before proceeding.*

The Pall installation engineer will assist during the following steps to ensure that the mPath bioreactor control tower and the mPath Link server are communicating via the IP addresses provided on the network configuration you have chosen.

- Connect a monitor to the HDMI port on the mPath Link server.
- Power on the mPath Link computer by ensuring the power cord is connected to an electricity supply, preferably on an uninterruptible power supply, then press the power button located on the front. The power button should light blue when powered on.
- Connect a monitor or touch screen to the HDMI port on the rear of the bioreactor control tower. It is important to plug the keyboard and mouse in first before making the HDMI connection.
- The Pall engineer, using their unique passcodes, will set the IP address and Sub Net mask for the mPath bioreactor control tower that you have provided.
- The Pall engineer will then ensure the Pall Link server is set with the IP address provided.

*The mPath Link server does not need to be next to the mPath control tower. It is only required to be on the same network as the control tower.*

# 6. Unit Defaults

To allow quick and easy use of mPath Link, the selectable units have been pre-programmed. These default settings can be accessed, edited, imported and exported from the 'Unit Defaults' tab found within the settings tab at the bottom right of the screen.

When a user creates a unit, the populated settings are taken from the unit defaults and a default recipe is created. Any changes made in the unit defaults will only be taken into effect when a new unit is created.

As stated above, mPath Link already has built in default settings for each of its units. The following sections will explain how the defaults are configured and how changes can be made, if required, to suit specific processes.

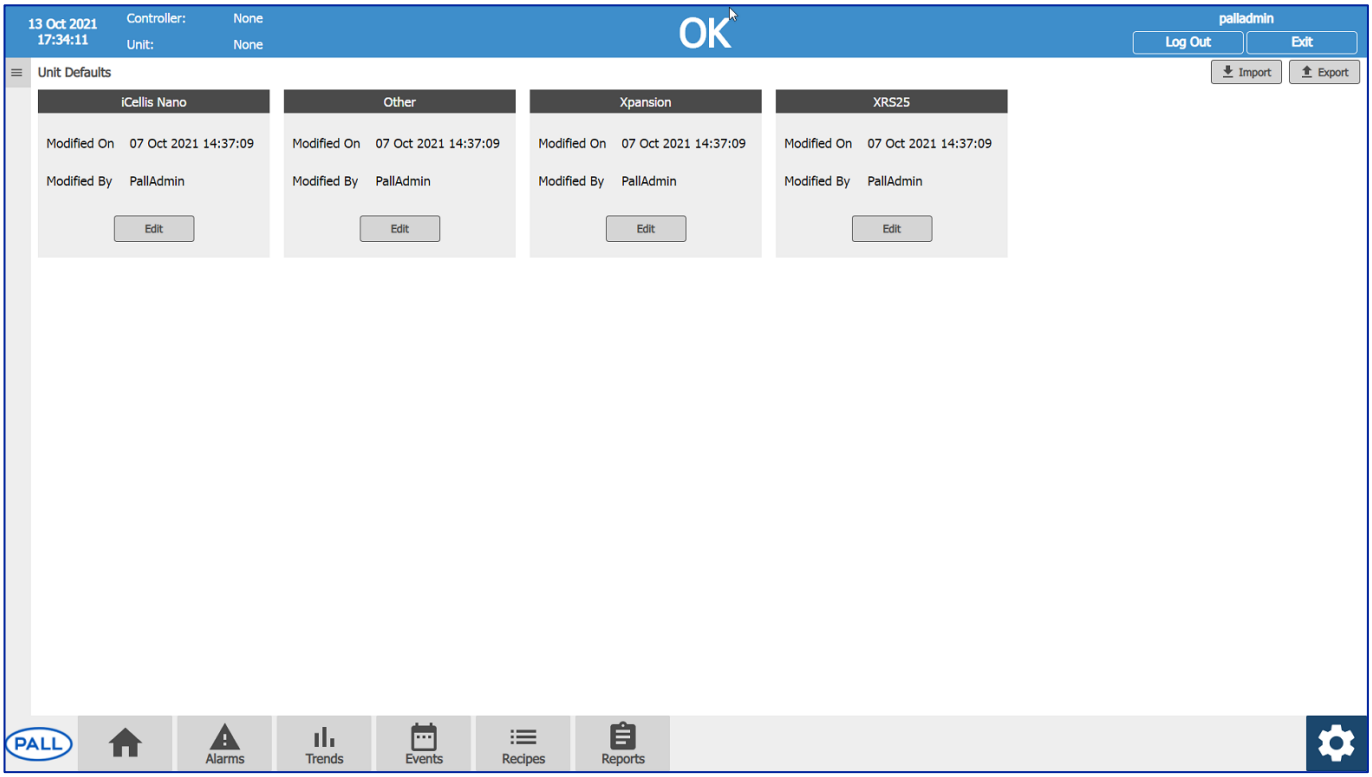
If you do not want to make any changes to the default settings proceed to the next section.

## 6.1 Configuration of Defaults

In the unit defaults screen, all the compatible units with mPath Link can be found.

**Figure 11**

Unit defaults screen




### 6.1.1 Import/Export

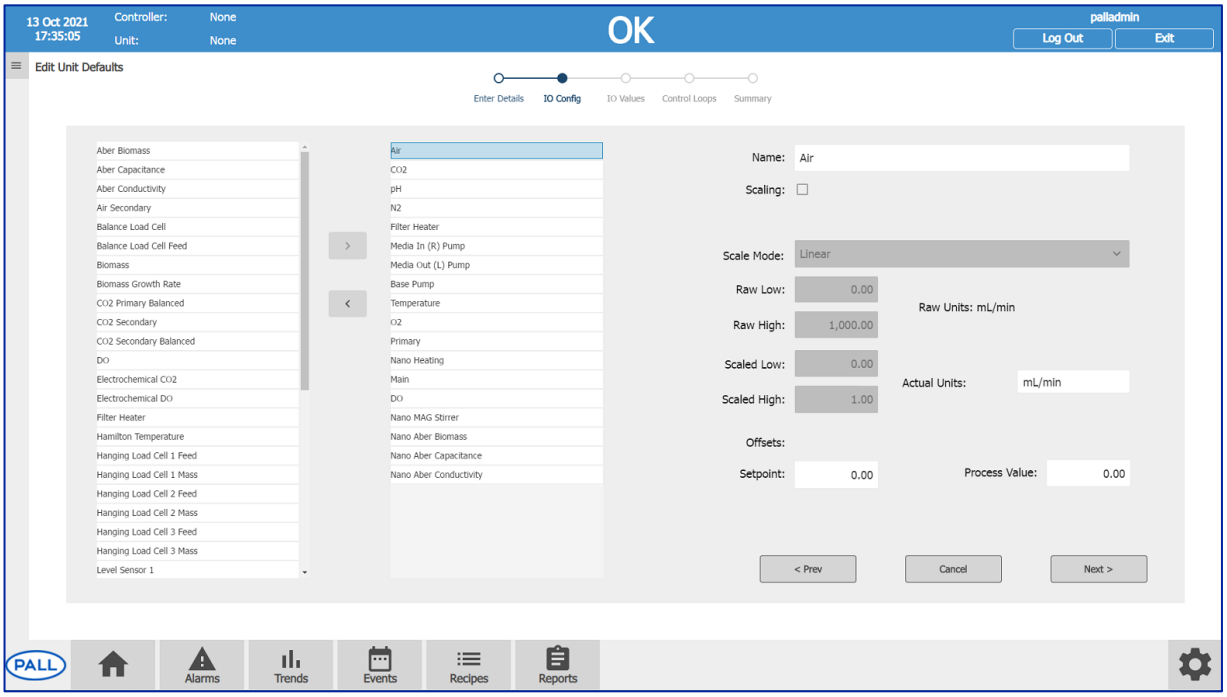
Unit defaults can be imported or exported to a separate mPath Link application using the buttons in the top right. Selecting export will give the user the option to save a json file of the unit defaults to a location of their choice. When the json file is imported, all existing unit defaults will be overwritten with the 'modified on' and 'modified by' fields being updated. Note that units will have to be recreated for the changes to the defaults to apply.

### 6.1.2 Unit Default Screen Details

- To view or edit any of the parameters in a unit configuration press the 'Edit' button.
- The first page that displays is the 'Details' tab allowing the name and calibration type to edited. Pall would recommend only changing the name if at all in this page.
- Press 'Next' button to navigate to the I/O config tab,

**Figure 12**

I/O config screen.




- The I/O config tab populates the selected inputs and outputs required to run your unit.
- To add extra I/O, select the control element in the left-hand column and press the ">" button to move it to the selected I/O column.
- To remove any selected control elements, press the "<" button.
- The name of the I/O can be changed by entering a different Name in the 'Name' field.
- The I/O can be scaled to values that suit your process. Pall does not recommend making scale changes to the I/O that was defaulted upon opening Unit Defaults.
- Click the 'Turn on scaling' check box.
- The raw low and high values will be present as per the raw values of the I/O.
- Use the scaled low and high boxes to define scaling for the unit of measurement of the sensor. e.g. To change Air flow rate from mL/min to L/min, Raw low = 0 mL/min, Raw high = 1000 mL/min, scaled low = 0 L/min, scaled high = 1 L/min.
- There is also an option to create an offset on setpoint and process values.
- E.g If an offset of +1 is applied to setpoint the value sent to the controlling computer will be +1 larger than the setpoint entered by the user.
- The Allegro XRS 25 temperature input has a default offset of +0.5 °C because the PT100 which monitors fluid temperature is outside of the biocontainer. At 25L the distance between the PT100 and the fluid inside the biocontainer causes a temperature offset of 0.5 °C. The fluid is required to be maintained at 37 °C, therefore the default setpoint offset of 0.5 °C allows the fluid temperature to remain at 37 °C whilst the heater mat is heating to 37.5 °C.
- Offsets for lower operating volumes may need to be calculated by the user. PID terms may also need to be re-calculated.

### 6.1.3 I/O Values

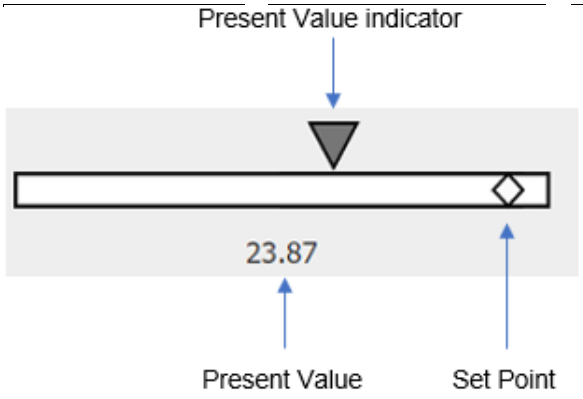
The I/O values screen is used to enter setpoints, range parameters and alarm values for each of the selected I/O. The values set here will automatically be present in a default recipe.

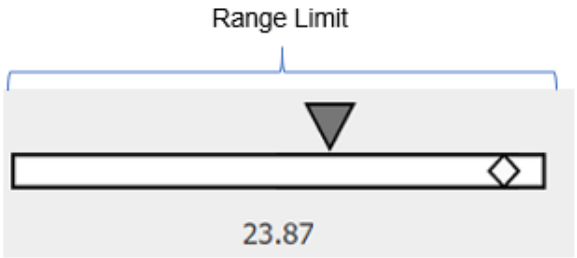
- To make changes, select the I/O from the I/O table on the left side of the screen.
- Click on a parameter in the table on the right side, it will highlight grey and then enter the desired value into the value box.
- The value is saved once entered. The value can be changed by re-selecting the box; entering a new value and pressing "enter".
- The user has the option to enter advanced parameters by switching the toggle from "Simple" to "Advanced"
- Below is a table describing each parameter.

**Table 8**

Setpoint parameters

| Tab | Parameter | Description |
|---|---|---|
| Setpoints | Units | Enter the units required for the specific control parameter |
| Setpoints | Setpoint/ setpoint value | Enter the control setpoint that is required once the batch is started |
| Setpoints | Reset Total Flow | Set to 1 if the total flow should be reset when recipe is loaded. (Only applicable to gases) |
| Setpoints | Process Value setpoint low | Defines the minimum set point value that can be entered |
| Setpoints | Process Value setpoint high | Defines the maximum set point value that can be entered |
| Setpoints | Process Value range low | process screen allowing quick visualization showing how close or far away the process value is from the set point. |
| Setpoints | Process: Value range high | Like above but this setting completes the range bar |




| | | |
|---|---|---|
| Setpoints | Name | Name of the selected parameter |
| Setpoints | Input maximum | 100% for single control action |
| Setpoints | Input minimum | 0% for single control action |
| Setpoints | Output maximum | This allows the user to set the maximum output of a parameter. For example, oxygen gas has a maximum flow rate of 1 L/min but the user can set it to 500 mL/min using the output maximum |
| Setpoints | Output minimum | This allows the user to set the output minimum of a parameter |
| Setpoints | Name | The user can give a specific name to each I/O |
| PID (Only available to inputs) | Control Mode | Turn on or off control. Set a 0 for off and a 2 for on. |

| | | |
|---|---|---|
| | | Active D Internal Element, Active P Internal Element, Output Max Limit, Output Min Limit, Stop I at output limit.<br><br>These settings control the behavior of the PID loop performance in terms of integral windup resetting and limiting. Pall does not suggest making changes in these fields. |
| PID | Conventional settings | |
| PID | Deadband | A deadband is a band of input values in the domain of a transfer function in a control system where the output is zero. The user can widen this band by inputting a value. The value is taken as both positive and negative. |
| PID | KD | Enter the value required for derivative control of the PID loop |
| PID | KI | Enter the value required for integral control of the PID loop |
| PID | KP | Enter the value required for proportional control of the PID loop |
| PID | Split Deadband | Deadband function when using split PID mode |
| PID | Split KD Negative | Enter the derivative value required for the negative controlling actuator. |
| PID | Split KD Positive | Enter the derivative value required for the positive controlling actuator. |
| PID | Split KI Negative | Enter the integral value required for the negative controlling actuator. |
| PID | Split KI Positive | Enter the integral value required for the positive controlling actuator. |
| PID | Split KP Negative | Enter the proportional value required for the negative controlling actuator. |
| PID | Split KP Positive | Enter the proportional value required for the positive controlling actuator. |
| | | Active D Internal Element, Active P Internal Element, Output Max Limit, Output Min Limit, Stop I at output limit.<br><br>These settings control the behavior of the PID loop performance in terms of integral windup resetting and limiting. Pall does not suggest making changes in these fields. |
| PID | Split Negative settings | |
| PID | Split PID | Set to True if split PID is to be used. |
| | | Active D Internal Element, Active P Internal Element, Output Max Limit, Output Min Limit, Stop I at output limit.<br><br>These settings control the behavior of the PID loop performance in terms of integral windup resetting and limiting. Pall does not suggest making changes in these fields. |
| PID | Split Positive settings | |
| Alarms | Critical high/warning high/ critical low/warning low | Defines the alarm limits that will be visible on the process value bar. |
| Alarms | Deadband | The alarm will not be triggered unless the present value crosses the setpoint + the deadband. |
| Alarms | Disable | The user is presented with the option to disable alarms. Even if alarm setpoint is passed, alarm will not trigger. |
| Alarms | Audible | Enables an audible alarm sound from the tower |
| Object Specific | Direction | Pumps – clockwise or anti-clockwise |
| Object Specific | Speed | This is the raw speed value being reported from the control parameter |
| Object Specific | Max X angle | Set the maximum angle of the X axis on the Allegro XRS 25 unit platform |
| Object Specific | Max Y angle | Set the maximum angle of the Y axis on the Allegro XRS 25 unit platform |
| Object Specific | Park X angle | Set the park angle of the X axis on the Allegro XRS 25 unit platform |
| Object Specific | Park Y angle | Set the park angle of the Y axis on the Allegro XRS platform |

# 7. Creating a Control tower and Unit

If required to run the desired unit, a control tower will need to be connected. The installation engineer will confirm that the IP addresses of both the mPath Bioreactor Control tower and mPath Link server have been set correctly, for the user to log into the application.

The Windows login details are:

Username: mPathLink

Password: mPathLink

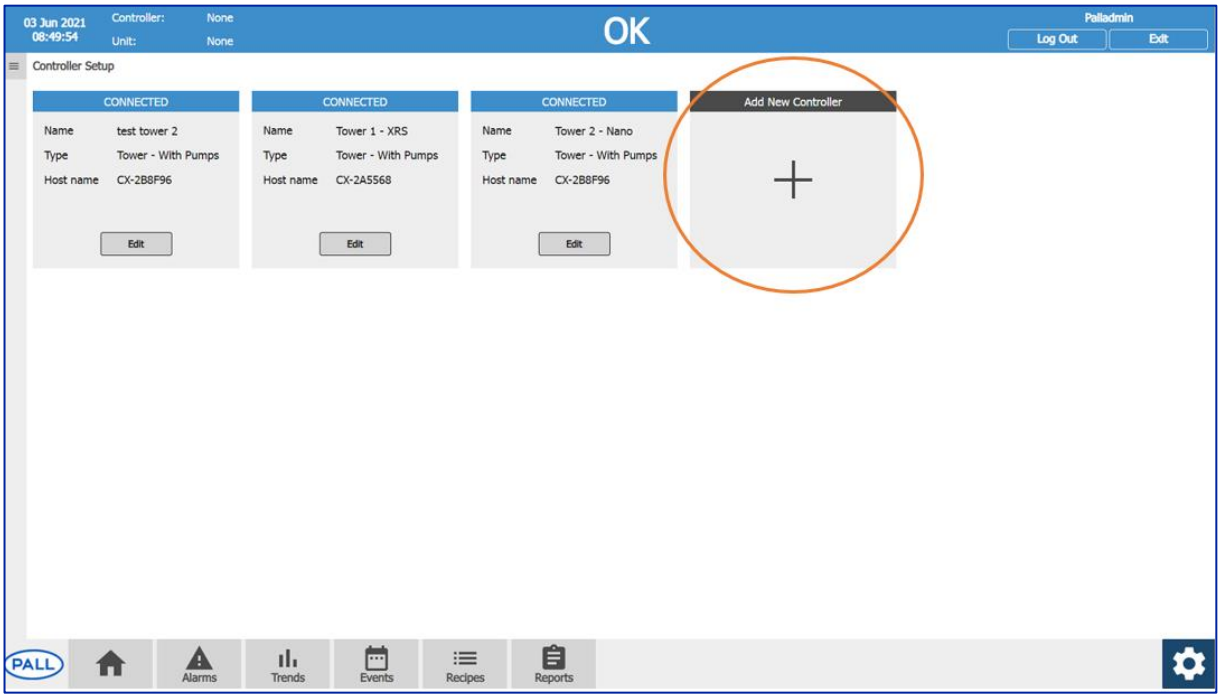
The software to run mPath Link is pre-installed on a mPath Link server. The Pall installation engineer will show you how to access it. Log into the mPath Link software.

## 7.1 Adding a Control tower

- Go to the settings tab and select control tower setup.
- Select the add new control tower icon

**Figure 13**

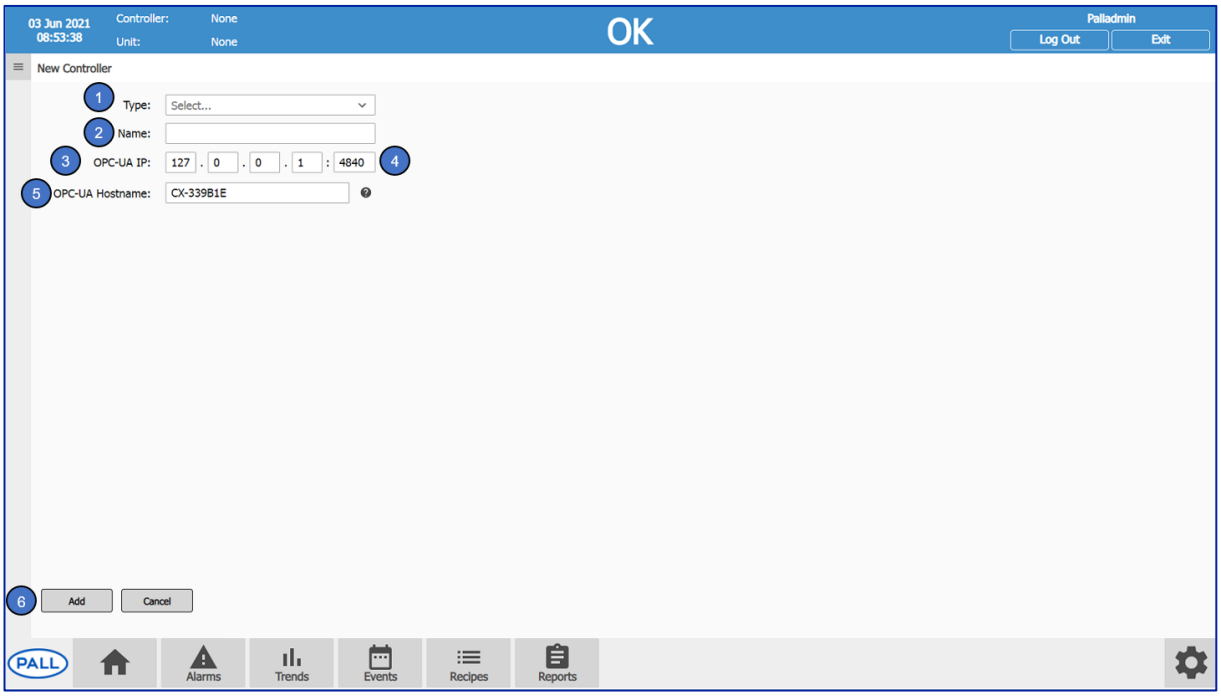
Adding a control tower



## 7.2 Creating a New Control tower

**Figure 14**

Creating a new control tower




Fields that are mandatory are marked with an asterisk.

1. Select the correct control tower from the drop-down list.
2. Give the control tower a name or identifier using alpha-numeric characters.
3. Enter the static IP address generated by your IT department for the control tower for OPC-UA IP.
4. Enter the port, usually 4 digits to the box next to the previously entered IP address.
5. Enter the CX number of the single board computer within the control tower into the OPC-UA Hostname box. (The CX number is located on the rear of the tower. Clicking the ? icon next to the OPC-UA name box shows the location of the CX number).
6. Press “ADD” to save the configuration:

- An option box will pop up asking if you wish to create a unit.
- Pressing “No” will return to the control tower setup page.
- Pressing “Yes” will open the unit setup page

If multiple control towers are required, they can be added by repeating the instructions above.

## 7.3 Creating a Unit

When the control tower has been created and is showing as 'Connected', follow the steps below to establish mPath Link communications between the control tower and the chosen unit.

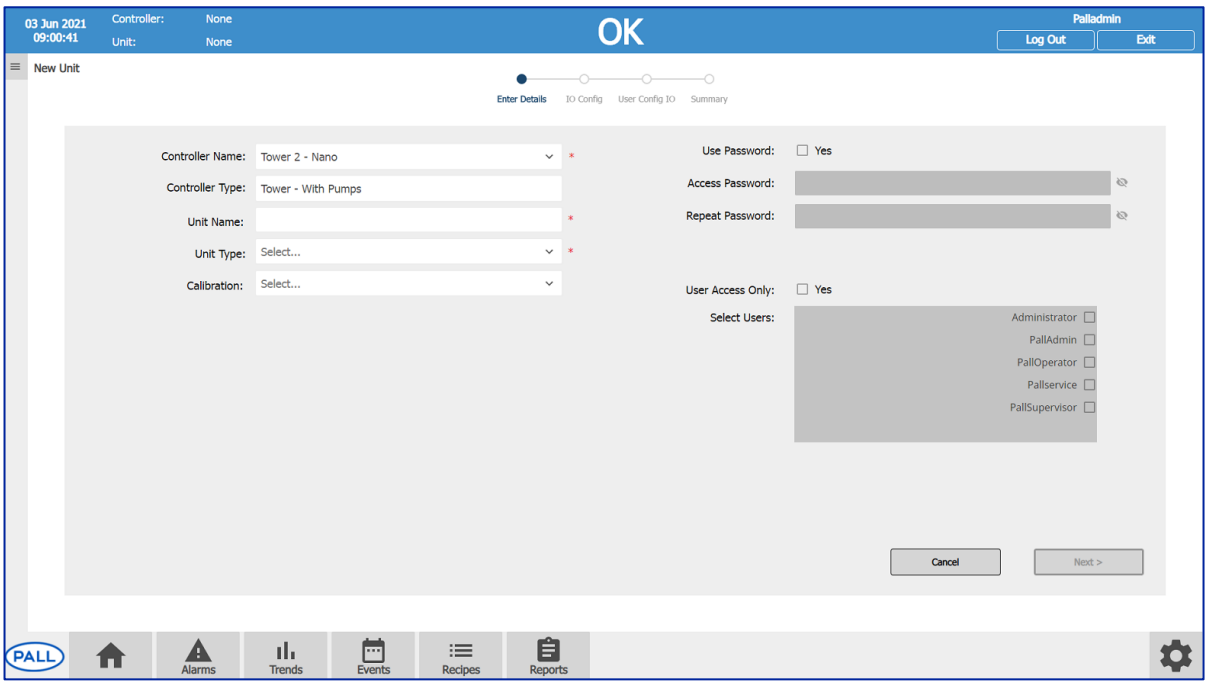
### Step 1

- When the control tower is created, there is the option to add a new unit. If this is not selected, then the steps below can be followed.
- Go to the settings tab and select unit setup
- Select the add new unit icon
- Select the control tower that will control the unit being connected from the drop-down list and the control tower type will automatically populate. Proceed to Step 2

### Step 2

**Figure 15**

Creating a new unit




- Select the type of unit required from the drop-down list*.
- Enter a name for your unit in the name option box.
- To add password access specific to this unit, click the "Yes" tick box next to use password and enter in the password of choice. To add specific user access to this unit, click the "Yes" tick box next to Only User Access and select the users to gain access.
- If there is no requirement for a password or specific user access proceed to next step.
- Navigate to the I/O configuration tab by pressing "NEXT" or by selecting I/O config on the indicator bar.

*When selecting a unit type from the drop-down list, the other option allows the user to create a fully customizable unit. The user will have an additional option to choose if they wish to use electrochemical or fiber optic sensors.*

## Step 3

The IO config screen will give the user the opportunity to define the IO to connect to the unit:

Note: IO should be selected carefully since a unit cannot be edited once created.

- Displays available hardware to connect to the unit. Using the right arrow button will add the hardware to the unit and remove it from this list.
- Displays hardware that has already been added to the unit. This list will initially display the hardware as defined in the unit default. Hardware can be added or removed using the arrow buttons.
- A user defined name can be given to the hardware
- The hardware can be scaled as defined below
- Off sets can be defined for the set point and/or the process value

## To scale the I/O (Figure 17):

- Check the 'Scaling' check box.
- The raw low and high values will be present as per the raw values of the hardware.
- Use the scaled low and high boxes to define scaling for the unit of measurement of the sensor. e.g. To change Air flow rate from mL/min to L/min, Raw low = 0 mL/min, Raw high = 1000 mL/min, scaled low = 0 L/min, scaled high = 1 L/min.
- The offset feature will scale the setpoint or process value to a set positive or negative value. Example, a heater mat setpoint of 20 °C with an offset of + 1 °C means that the heater mat will show 20 °C but will actually be heating to 21 °C.
- If an offset is required on setpoint or process value, enter in the positive or negative offset amount into the fields shown by number 3. The offset will be applied to the inputted setpoint or process value.

**Figure 16**

Configuring unit I/O

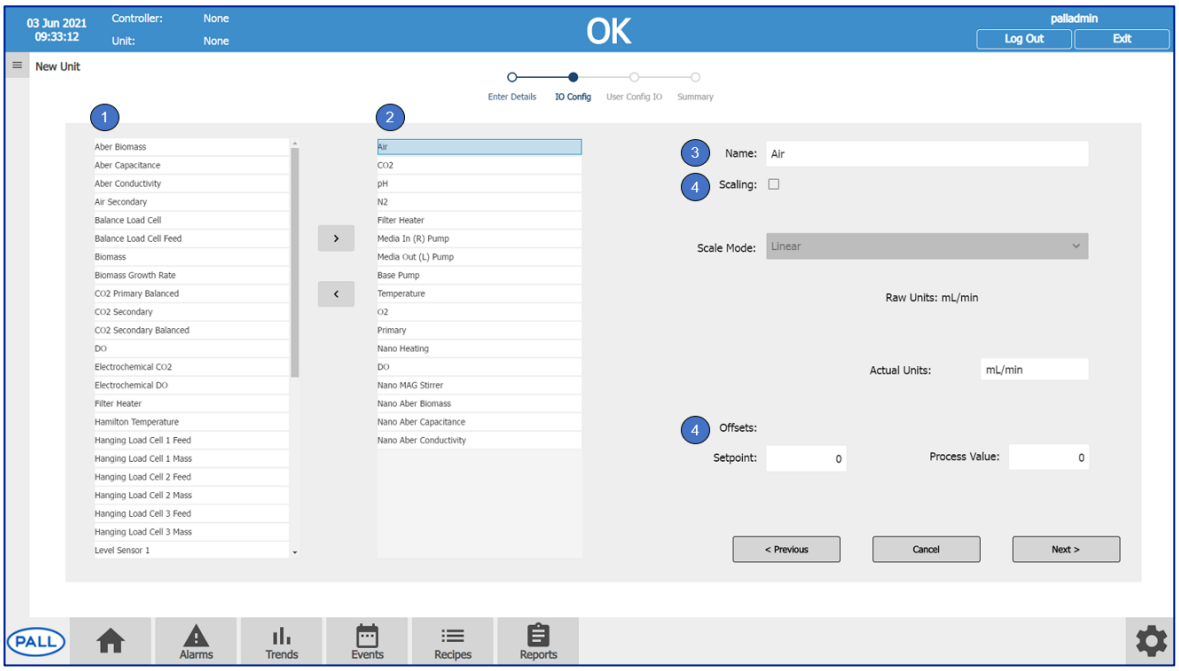
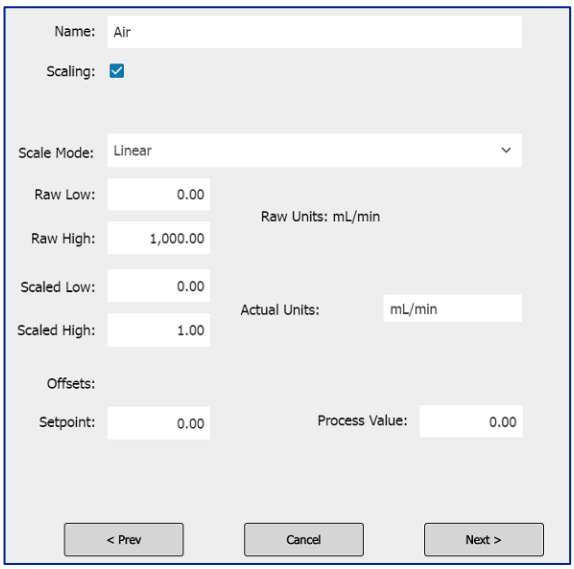


**Figure 17**

Scaling of I/O




As explained in section 6.1.2, The Allegro XRS 25 bioreactor temperature input has a default offset of +0.5 °C because the PT100 probe which monitors fluid temperature is outside the biocontainer. Offsets for lower operating volumes will need to be calculated by the user. PID terms may also need to be re-calculated.

- To add extra I/O, select the control element in the left-hand column and press the ">" button to move it to the selected I/O column.
- To remove any selected control elements, press the "<" button.
- Biomass, Biomass growth rate, Level sensor 1, Level sensor 2 and Pressure require additional configuration as these connections are customer specific.

## If any of the above are required, select them, and move to the selected I/O column:

- Click the 'Turn on scaling' check box.
- Enter the raw low and high values from the table 4 into the raw low and high boxes. Press "enter" after each entry.
- Use the scaled low and high boxes to define scaling for the unit of measurement of the sensor. E.g., Mag Stirrer, Raw low = 0 V, Raw high= 10 V, scaled low = 0 rpm, scaled high = 250 rpm. This means that at 10 V the Mag stirrer will be rotation at 250 rpm.
- Navigate to the User Configurable I/O tab by pressing "NEXT" or selecting the User Configurable I/O tab

**Table 7**

I/O Raw low and Raw high values

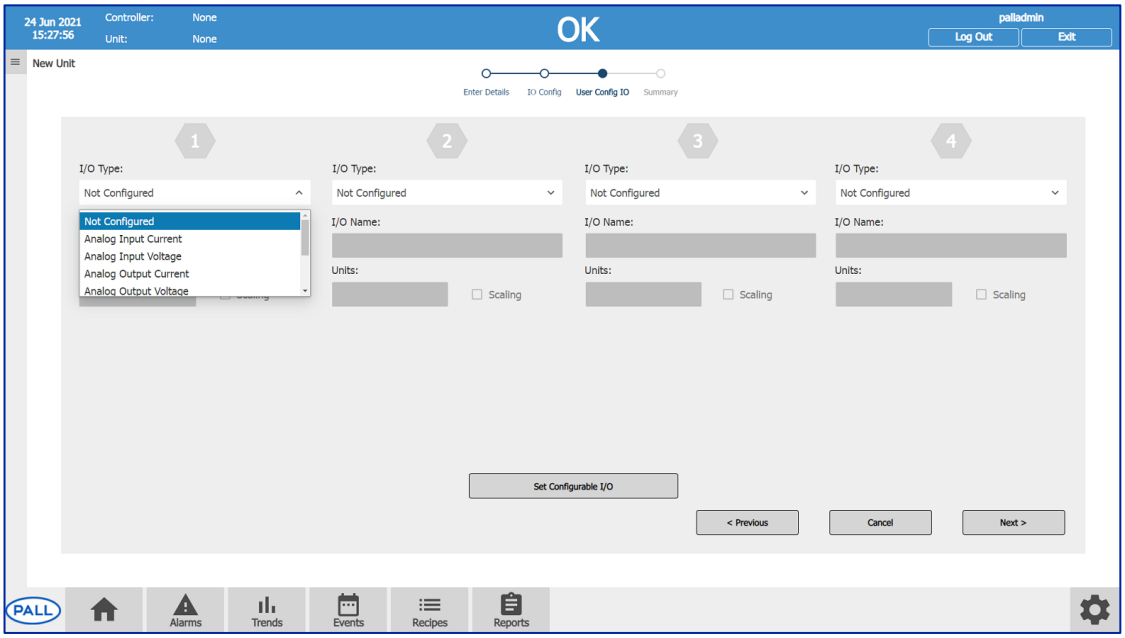
| I/O | Raw Low | Raw High |
|---|---|---|
| Biomass | 0 mA | 20 mA |
| Biomass growth rate | 0 mA | 20 mA |
| Level 1 | 0 mA | 20 mA |
| Level 2 | 0 mA | 20 mA |
| Pressure | 0 mA | 20 mA |
| Pressure | 0 V | 10 V |

**A full I/O list can be found in Appendix C.*

## 7.4 Creating User Configurable I/O

**Figure 18**

User configurable I/O




## Step 1

If the control tower permits, these ports can be used to connect inputs such as sensors or switches and outputs such as additional pumps or balances:

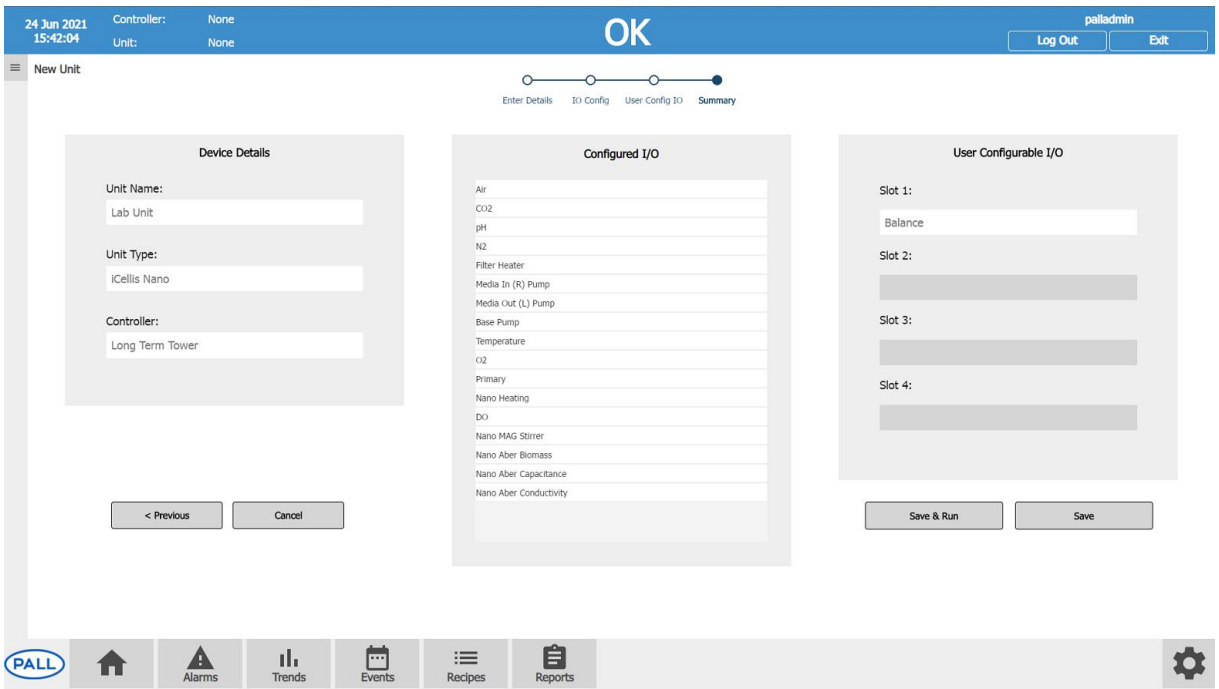
- Each configurable I/O connection is a M12 A-coded 8-way female connector.
- M12 A-coded 8-way male connectors (user supplied) will be required to connect to these ports.
- Each port can be configured as either analog or digital.
- Each port can also be configured as an input or output.
- The pins are set according to Table 8.
- Pin 1 can be used as either a 24 V digital output or power source to an external sensor. Pin 3 is the 0 V reference/return for all I/O signals.
- Select from the drop-down list under each I/O what type of signal is required.
- Set a I/O name.
- Enter the units required. As per the example about the units would be grams.
- Select the scaling tick box and enter in the raw low and high scale of the item being connected. E.g. Raw Low = 0 mA and Raw High = 20 mA.
- Below enter in the scaled low and high values required, eg: low = 0 and high = 1000
- Repeat for the remaining configurable I/O if required.
- Press “SET CONFIGURABLE I/O” button.
- If no user configurable I/O is required, navigate to the summary tab.

**Table 8**
User configurable I/O connection pins.

| Pin Number | Signal | Values |
|---|---|---|
| 1 | Digital output | 24 Volt |
| 2 | Digital input | 24 Volt |
| 3 | Ground | 0 Volt |
| 4 | Analog input | 0 - 10 Volt |
| 5 | Analog input | 0 / 4 - 20 mA |
| 6 | Analog output | 0 - 10 Volt |
| 7 | Analog output | 0 / 4 - 20 mA |
| 8 | Screen | None |

## Step 2

**Figure 19**
Unit setup summary screen




- A review of the settings selected in the previous steps is shown.
- Three options are presented:

1. Save – The configuration is saved, and the user is returned to the unit set-up page.
2. Save and run – The configuration is saved, and the system navigates to the batch screen where a default recipe will be loaded, and a batch started (section 9.4).
3. Cancel – The configuration will not be saved, and user will be returned to unit set up page.

# 8. Editing, Viewing and Deleting Control towers and Units

## 8.1 Editing a Previously Created Control tower

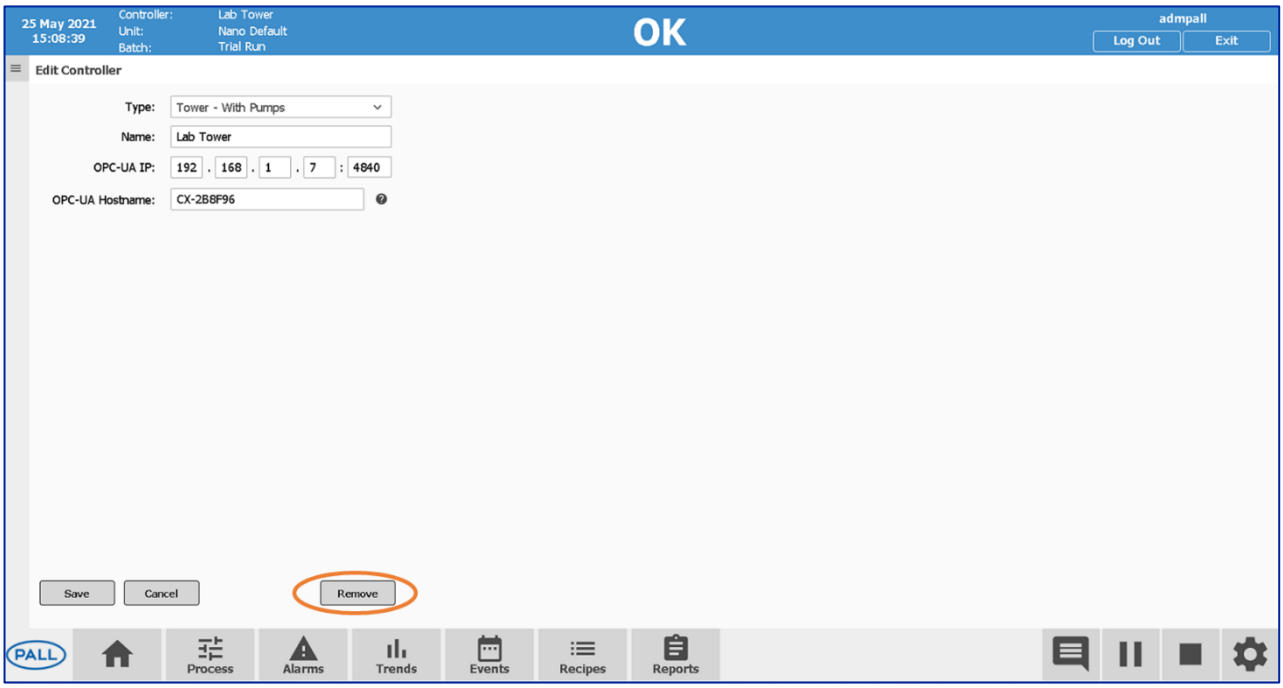
- Navigate to the control tower set up screen via the settings tab.
- Press “Edit” on the control tower you wish to edit.
- Make the changes required and press “SAVE”.

## 8.2 Removing a Control tower

- Navigate to the control tower set up screen via the settings tab.
- Press “Edit” on the control tower you wish to edit.
- Press the “Remove” button and confirm the pop-up message.

**Figure 20**

Removing a control tower




## 8.3 Viewing a Unit

- To view a previously created unit, navigate to the unit set up screen via the settings tab.
- Press “Select” on the unit to be viewed
- The next button or indicator bar can be used to view the unit configuration. Note that all screens are read only as unit configuration cannot be edited after creation.

## 8.4 Deleting a Unit

- To delete a unit, navigate to the unit set up screen via the settings tab.
- Press “Select” on the unit to be deleted.
- Press the “Remove” button and confirm the pop-up message.

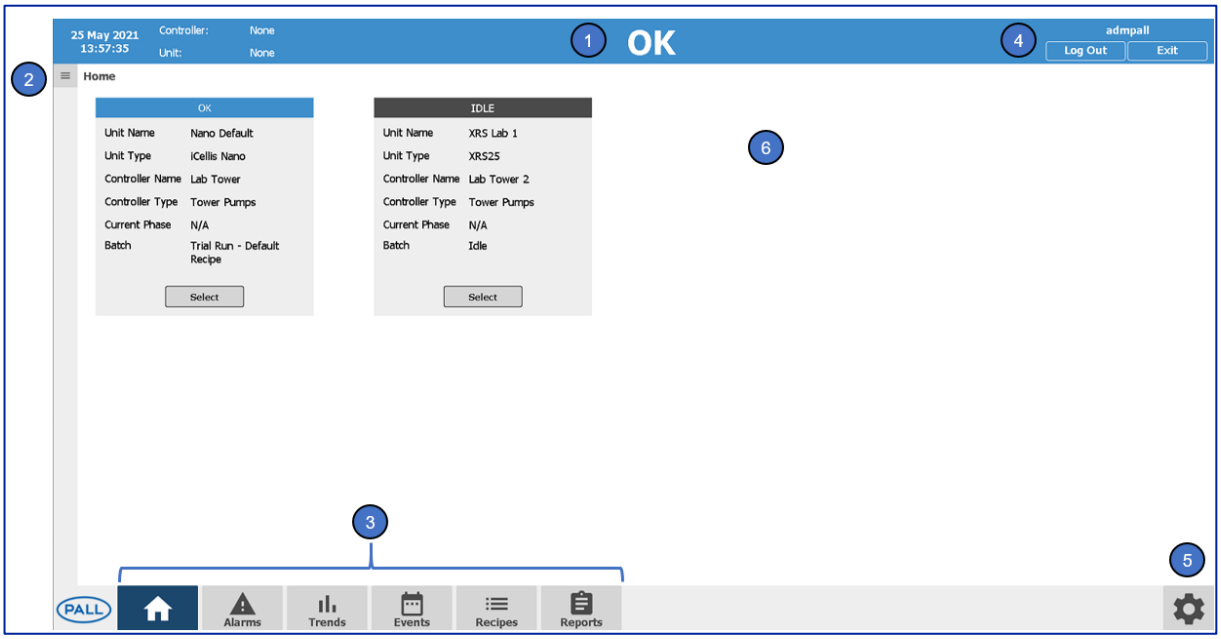
# 9. User Interface Interaction

## 9.1 User Interface Overview

The key aspects of the screen layout are displayed below:

**Figure 21**

User interface overview




| Item | Description |
|---|---|
| 1. Status bar | Will show the alarm status for a given unit in addition to the name of the selected control tower, unit and batch |
| 2. Side bar | Details all connected units. Clicking on the bar will navigate to the home screen of the selected unit. Note that when "system" is selected, screens navigated will relate to all connected units. When a unit is selected, screens will display unit specific content. |
| 3. Navigation bar | Allows the user to navigate to the desired area of the application. |
| 4. User display | Shows the currently logged in user with an option to log out. |
| 5. Settings tab | Allows the user to access system level settings |
| 6. Content area | Displays information relating to the selected screen |

## 9.2 System/Unit Level View

The side navigation bar allows the user to navigate between different connected units. Expanding the “burger menu” shows all connected units grouped by unit type. For units in alarm, they will appear beneath the “burger menu” with the unit name and a colored bar indicating the status. Selecting any of the unit names will navigate to that specific unit where selecting System > Dashboard allows the user to view information relating to the overall system and screens will not be filtered on a specific unit.

**Figure 22**

Expanded side navigation bar

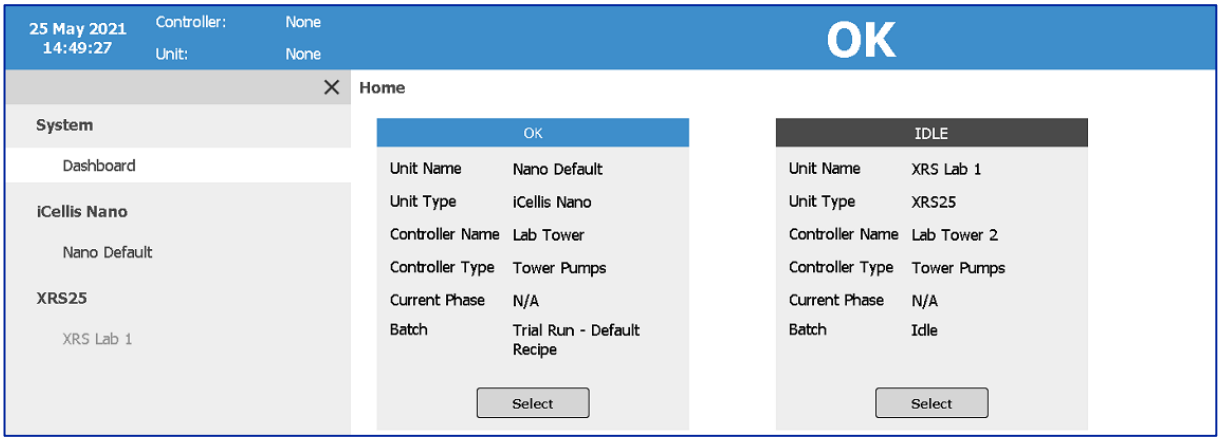
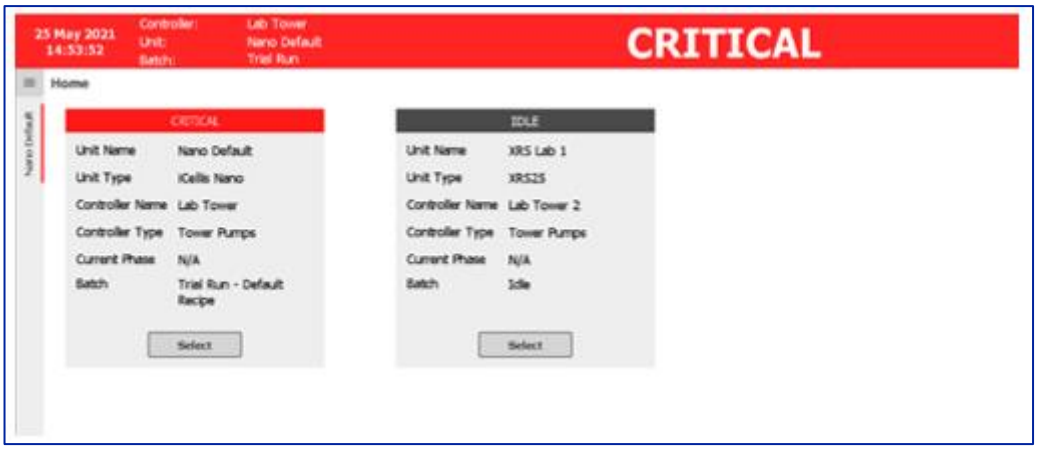



**Figure 23**

Alarming side navigation bar




Once a unit is selected from the side bar, the user will then be able to view information specific to that unit. Screens such as recipe management and Alarms will then be filtered to show information relating only to the specific unit. Additional actions will also be available when a batch is in progress and a unit is selected from the left side bar:

**Figure 19**
Additional actions when batch in progress


| Item | Description |
|---|---|
| 1 – Comment's button | Comments can be added which will be visible in the report (section 15). |
| 2 – Pause button | Selecting pause will bring up a confirmation window to pause the batch. Once paused, all control loops will stop, parameter set points will go to zero and the top banner will show as paused. A play button will become visible and once selected and confirmed, all control loops and parameters will return to the state they were in before being paused. |
| 3 – Stop button | Selecting stop will give the user the option to complete the batch. If confirmed, the batch will end, all parameters will go to the idle state and the top banner will show as idle. The user will have the option to enter a comment at the end of the batch. The action of stopping a batch **cannot be undone**. |

## 9.3 User Management

As standard, mPath Link software is supplied with a Pall PC where the mPath Link application comes with integrated operating system security. SCADA security can be linked with local operating system (Windows 10 as standard) or with an active domain control tower (for advanced, bigger system deployments).

2 basic user groups are set up to perform activities on the Windows level and 4 within the mPath Link software:

**Table 9**
Windows user groups

| Windows User Group | Description |
|---|---|
| Administrators | Windows specific: Administrators have complete and unrestricted access to the Windows operating system/domain |
| Users | Windows specific: Users are prevented from making accidental or intentional system-wide changes to the Windows operating system but will be able to run the mPath Link application |

**Table 10**
mPath Link software user groups

| mPath Link Software User Groups | Description |
|---|---|
| mPathLink Operator | mPath Link application - mPath Link Operators Group |
| mPathLink Supervisor | mPath Link application - mPath Link Supervisors Group |
| mPathLink Admin | mPath Link application - mPath link Administrators Group |
| mPathLink Service | mPath Link application - mPathLink Service Group |

Default users and passwords are set up as per the table below.

**Table 11**

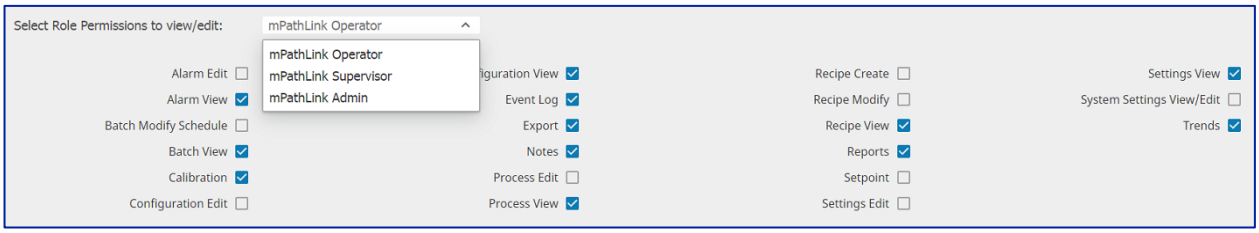
Windows and mPath Link passwords

| Username | Access Area | Member Of | Password |
|---|---|---|---|
| Administrator | Windows | Administrators | mPathLink |
| mPathLink | Windows | Users | mPathLink |
| PallOperator | mPath Link Application | Users, mPathLink Operator | mPathLinkOper |
| PallSupervisor | mPath Link Application | Users, mPathLink Supervisor | mPathLinkSuper |
| PallAdmin | mPath Link Application | Users, mPathLink Admin | mPathLinkAdmin |
| PallService | mPath Link Application | Users, mPathLink Service | *Classified* |

The mPath Link application user groups has a predefined set of access rights. A user with administrator access to the application can alter these permissions by going to the settings tab and selecting Users. From here, the user has the option to edit groups permissions via the tick boxes or restore the permissions to the defaults as supplied.

**Figure 24**

Users overview




### 9.3.1 Adding/Deleting Users

All user management is handled outside of application, on Windows level. Adding users to groups, removing users, setting password aging etc. can be performed only by members of the Administrator group.

To add new user, log in as an Administrator user

**Figure 25**

Administrator login

Right click on the Windows start icon and select Computer Management.

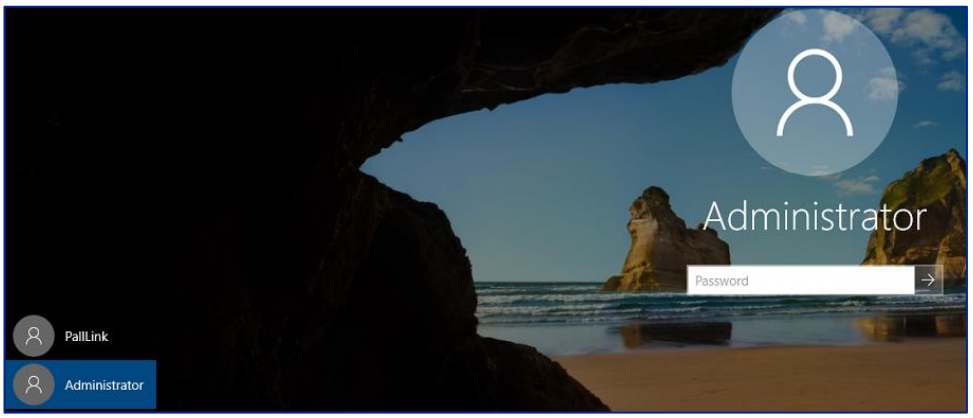
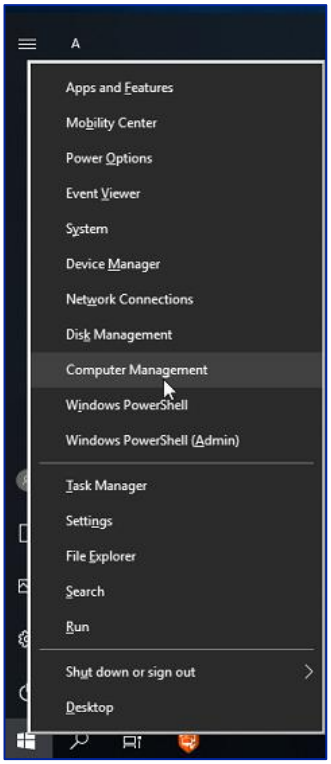


**Figure 26**

Computer Management

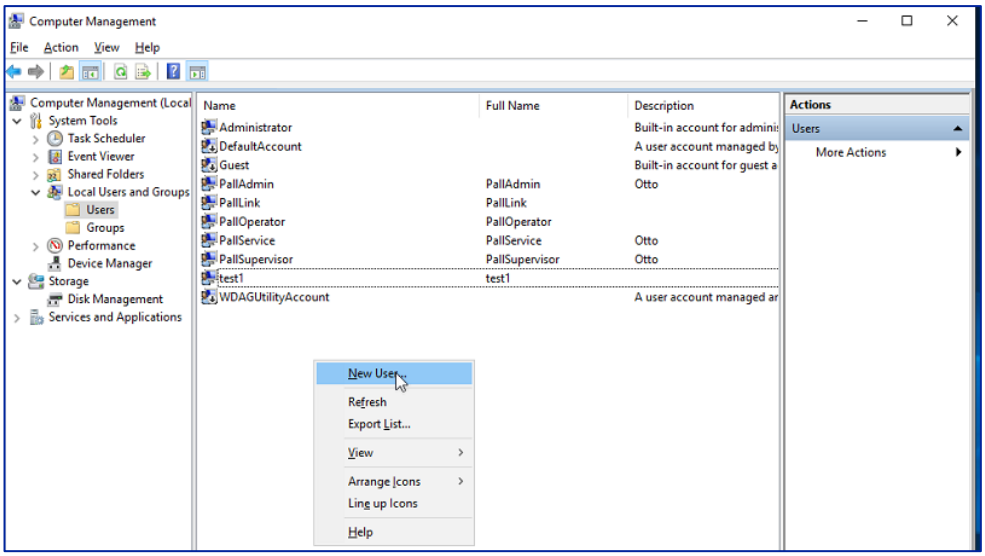



Go to Computer management, System Tools, Local Users and Groups, Users.

Right click and select “New User” to add new user.

**Figure 27**

Computer management

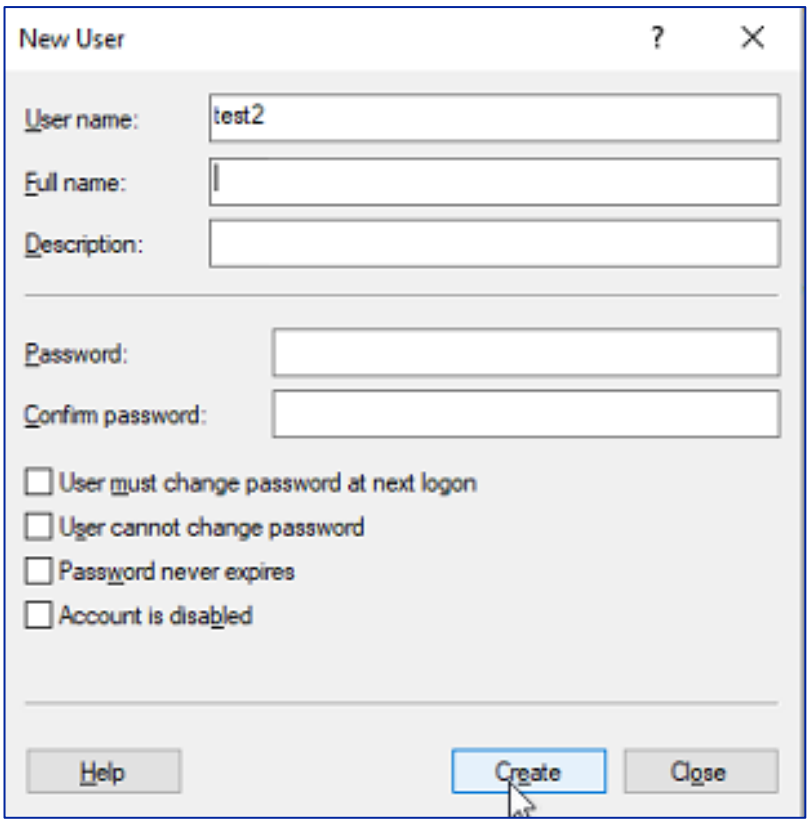



Enter all necessary details and click “create”.

If the option to change password at next logon option is selected, then the user will need to login to Windows (will be prompted to change the password) first to be capable of successfully logging in to the mPath Link application.

**Figure 28**

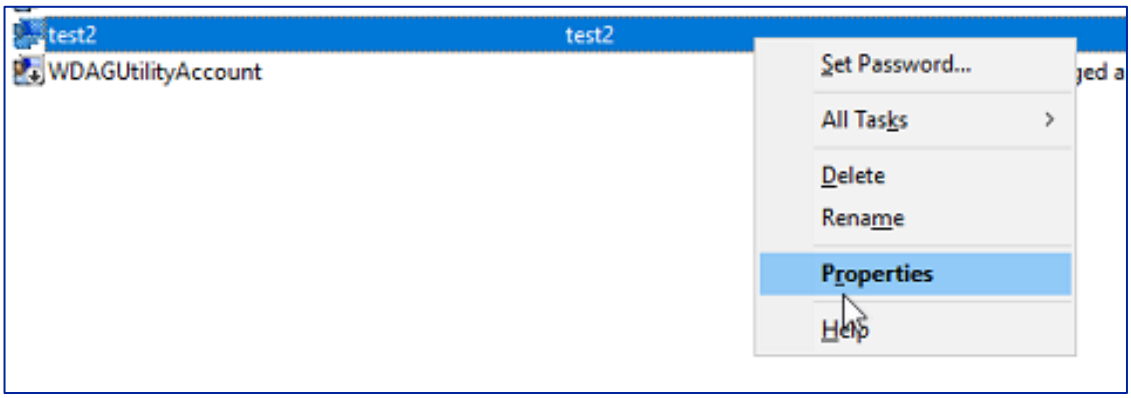
Create new user




Right click on newly created user and select properties to configure adequate privileges.

**Figure 29**

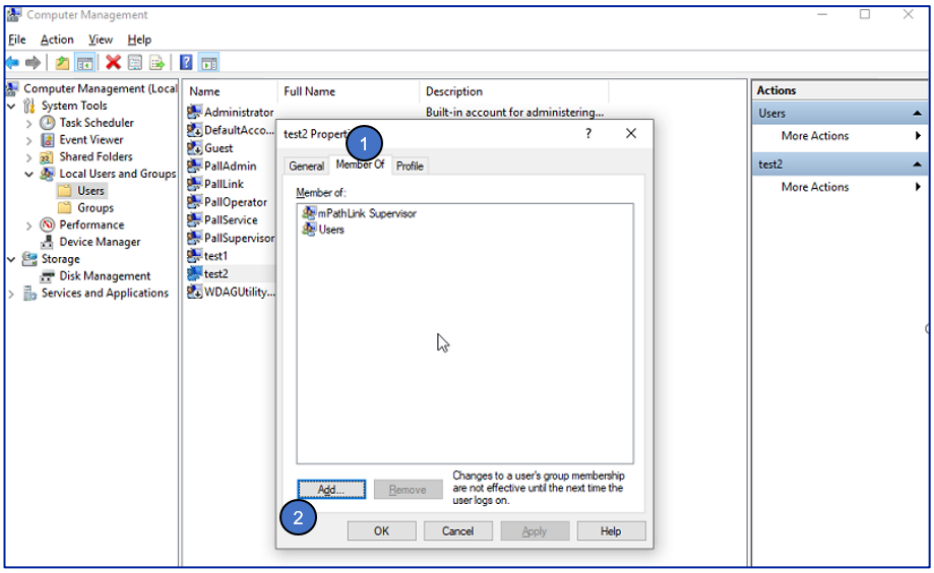
User privileges




Select “Member Of” tab and click “Add”

**Figure 30**

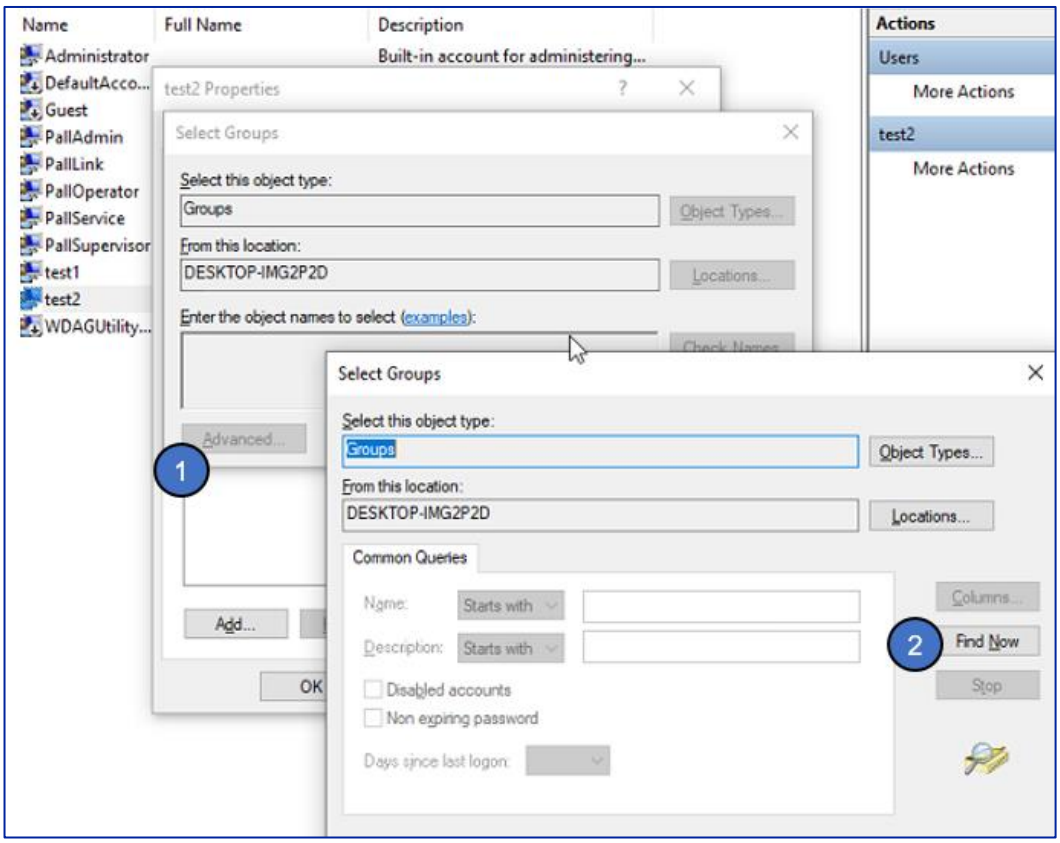
"Member Of" configuration




Click on "Advanced" and "Find Now".

**Figure 31**

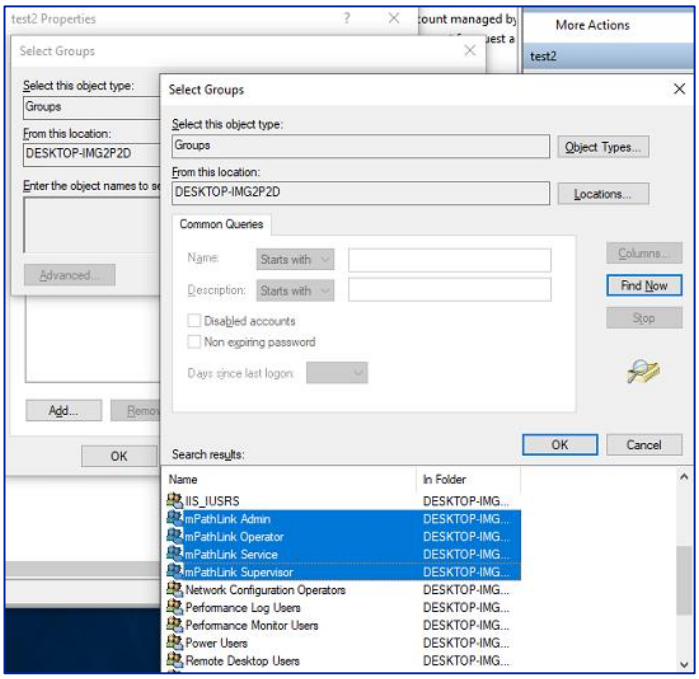
Advanced "Member Of" configuration



The list of available User Groups will appear. Select the adequate roles depending on whether the user is Admin, Operator, Service or Supervisor. Click OK.

**Figure 32**

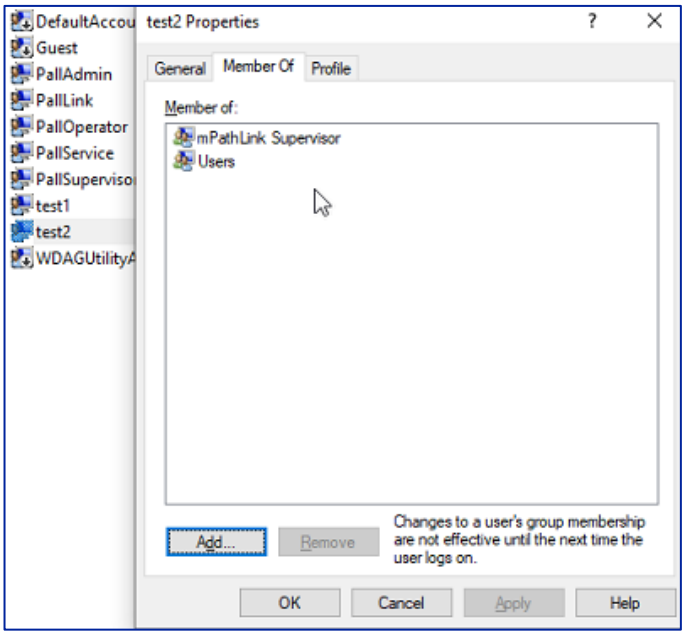
User groups "Member Of" configuration




By default, the new user will be part of two groups the Windows Users group, and one of the mPathLink software groups (in this example, Supervisor). Click OK.

**Figure 33**

Supervisor setup



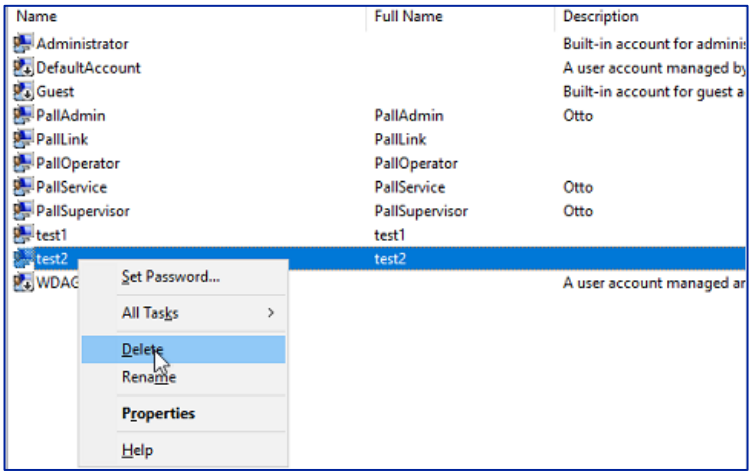
The newly created user will be capable of logging in to the mPath Link software, and privileges will be set automatically based by the group they were assigned to.

To delete the user, login as a user who is a member of administrators group, go to Computer management, System Tools Local Users and Groups, Users.

Right click on the user that needs deleting and select Delete.

**Figure 34**

Deleting user

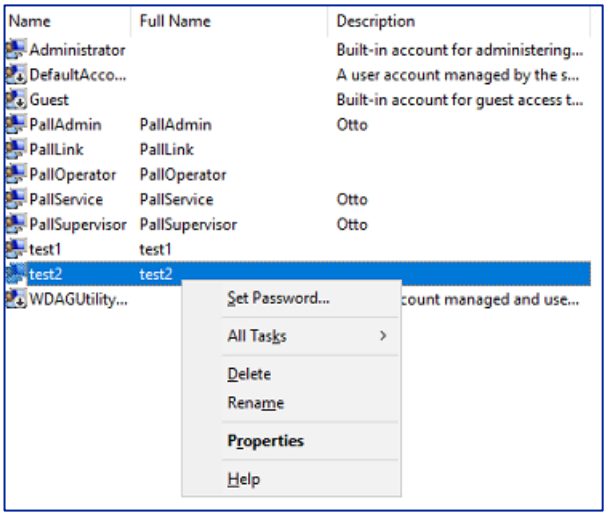



### 9.3.2 Editing existing users

To edit existing user right, click on the user. It is possible to set password, delete and rename a user from the context menu.

**Figure 35**

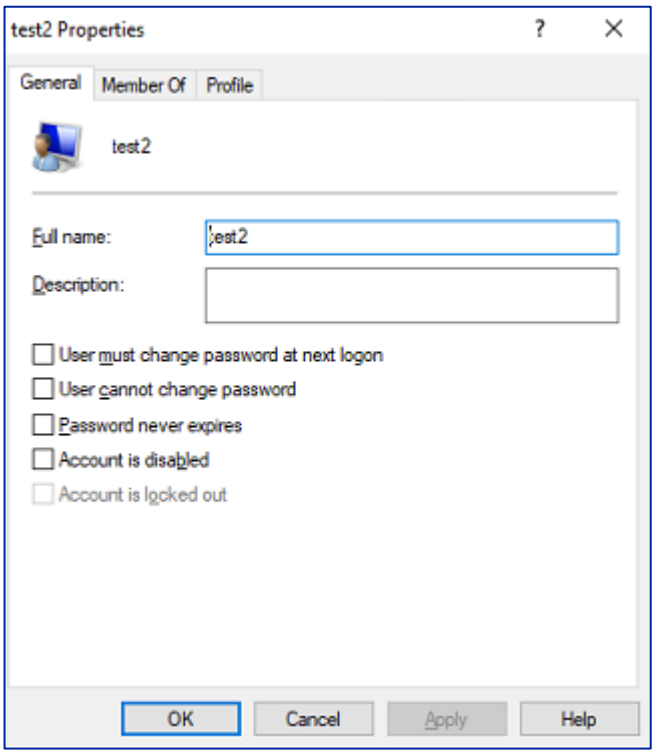
Editing existing user




To access advanced options, click on properties. Various actions are available here including the possibility to disable an account.

**Figure 36**

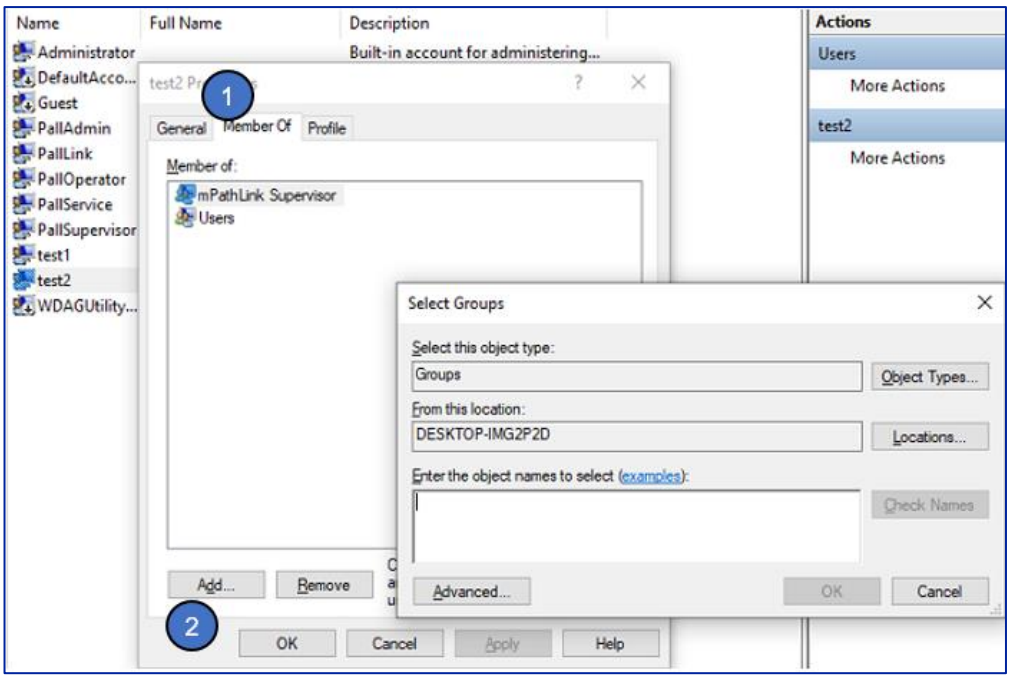
Actions when editing existing user




To change the existing user's group membership, click on the "Member Of" tab and click add.

**Figure 37**

User group selection




It is recommended that the user is a member of only one mPathLink group at the time.

## 9.4 Quick Start Batch – from a Pall Default Recipe

The mPath Link software has been designed to allow as much or as little customization as the user wishes.

The software includes standard default recipes for each supported unit. The default recipes can be viewed, edited, or duplicated. Using or editing a default recipe reduces set up time allowing a batch to be run quickly with little configuration. The other option is to create a new recipe. The other option is to create a new recipe.

## 9.5 Running a batch from a Pall Default Recipe

After creating a unit, if save was selected, the main process screen will load with a default recipe specific to the chosen unit, and the batch will be started automatically. Alternatively, you can find default recipes in the recipe manager. The default recipe loaded allows the user to set setpoints, select control options and alarms manually. All control is as per the created recipe. Default recipes can be edited with the general operation of the application. Default recipes can also be edited.

# 10. Operation

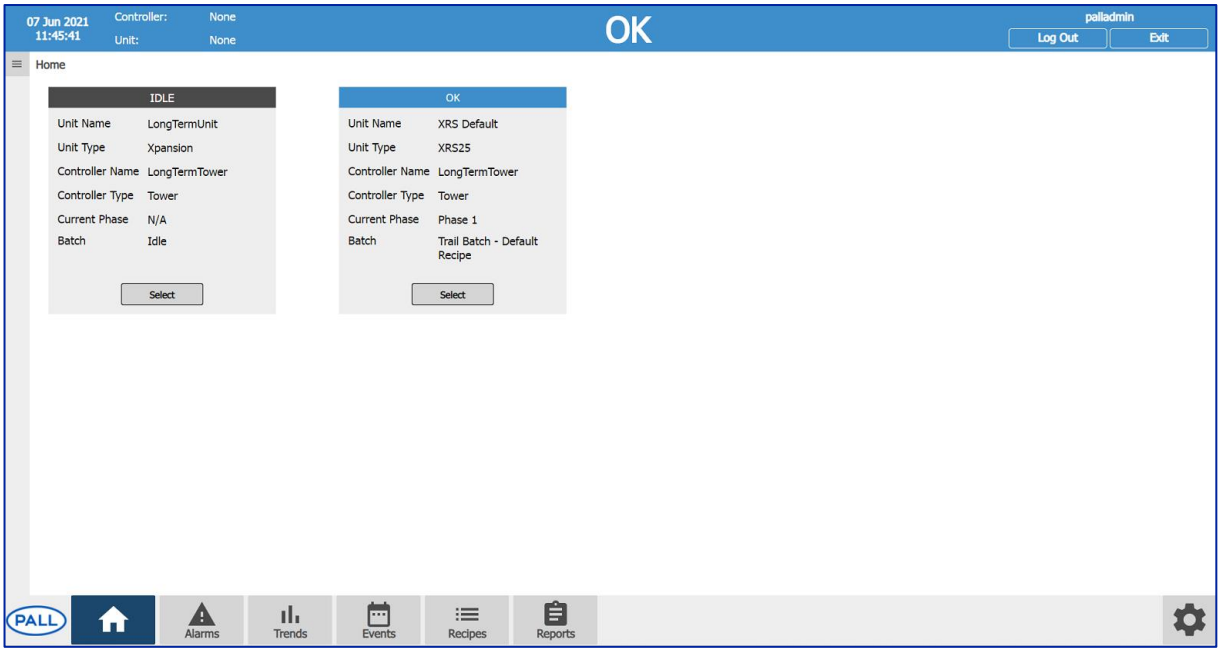
## 10.1 Home Screen

### 10.1.1 System Level Home Screen

When "System > Dashboard" is selected from the left side bar, the user can navigate to the home icon to see an overview of all connected units.

**Figure 38**

System level home screen

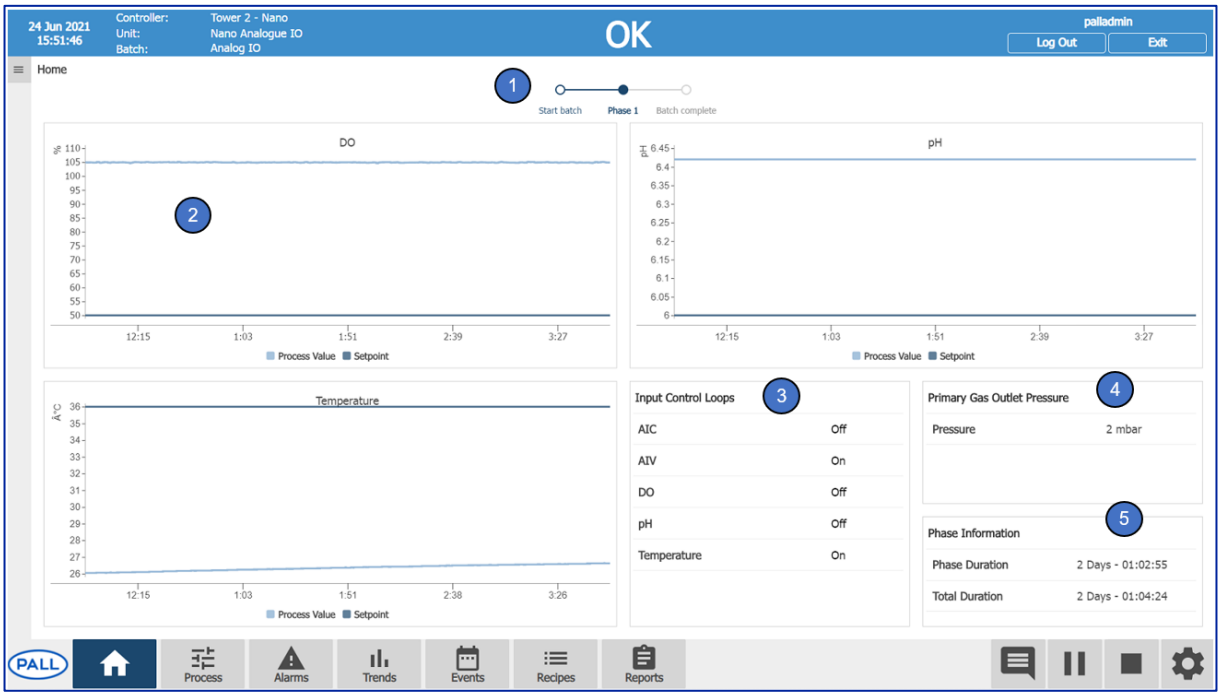



Selecting a unit from this view will then navigate the user to that unit specific home screen.

### 10.1.2 Unit Level Home Screen

**Figure 39**

Unit level home screen




Key elements of the screen are detailed below:

| Item | Description |
|---|---|
| 1 – Batch progress tracker | When a batch is running, the batch progress tracker will highlight the phase the batch is in. When no batch is running it will be hidden. |
| 2 – Mini trends | Content area displays process value and set point for pH, DO and temperature over the previous 4 hours. |
| 3 – Control loop overview | Displays the control loops that have been configured and whether they are in auto or manual mode. |
| 4 – Primary gas pressure | Current primary gas outlet pressure is displayed |
| 5 – Phase information | Current time in phase is displayed in addition to total batch duration. |

## 10.2 Recipes

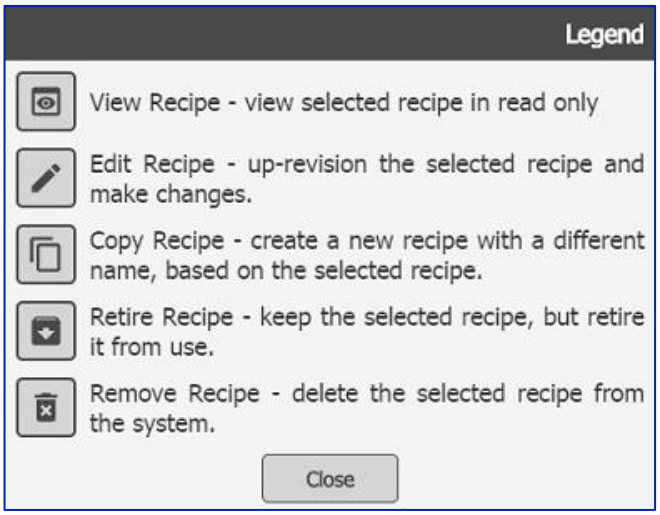
Recipes allow the user to run batches using customized control loops, phases, parameters, alarms, and trends. Control loops, setpoints, alarm values and trend parameters are all created within the recipe manager.

A default recipe is created each time a new unit is created. The default recipe for a given unit can be viewed, edited or duplicated by selecting the desired unit from the side navigation bar followed by selecting recipes > Manage from the main navigation. Using or editing a default recipe reduces set up time, allowing a batch to be run quickly with little configuration. All recipes held within the mPath Link application can be viewed when "System > Dashboard" is selected from the side navigation bar.

The help icon explains all actions possible from the recipe management screen.

**Figure 40**

Recipe management actions



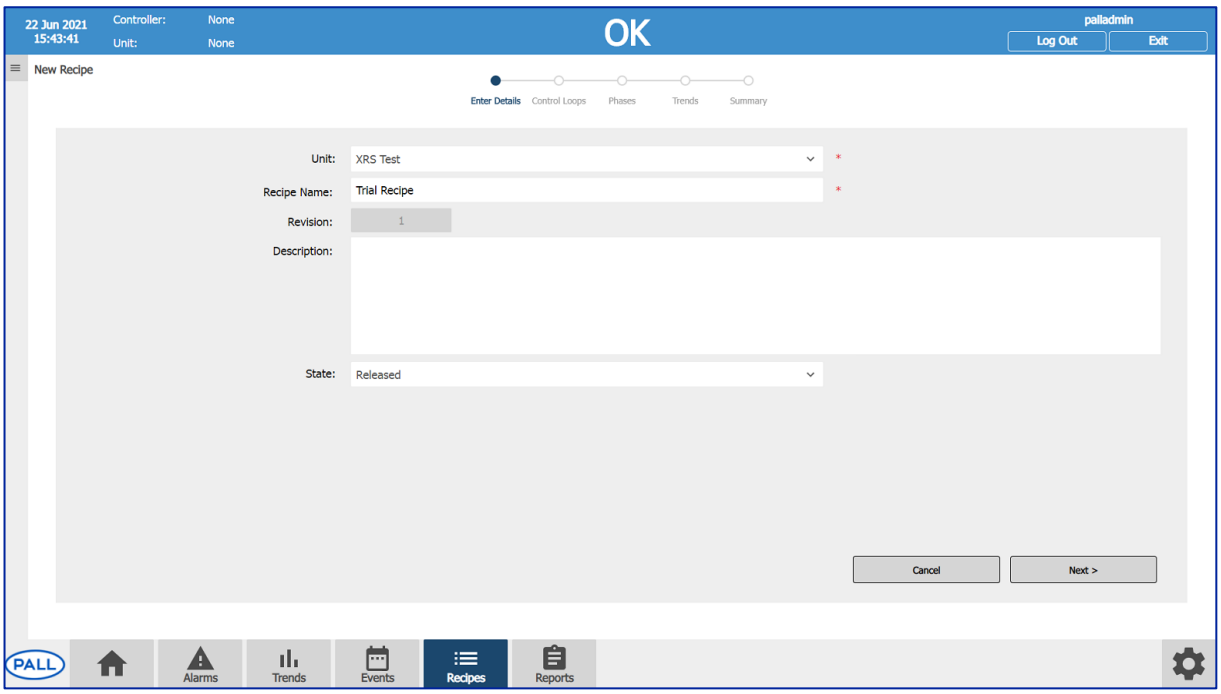

### 10.2.1 Creating a New Recipe

If a fully customized process is required, a new recipe can be created where all parameters are blank to start from. It is recommended that this is only carried out by experienced users.

- Navigate to Recipes > Manage.
- Select "new".
- Select a unit from the drop-down list to run this recipe. (Only previously created units will show in this list. If a unit is not present.
- The recipe must be given a name or identifier; a revision can be set along with a description if required.
- Select the state of released, retired or unreleased from the drop down.
- Navigate to the Control loop configuration screen by pressing "Next" or by selecting the control loops step.

**Figure 41**

Recipe enter details screen

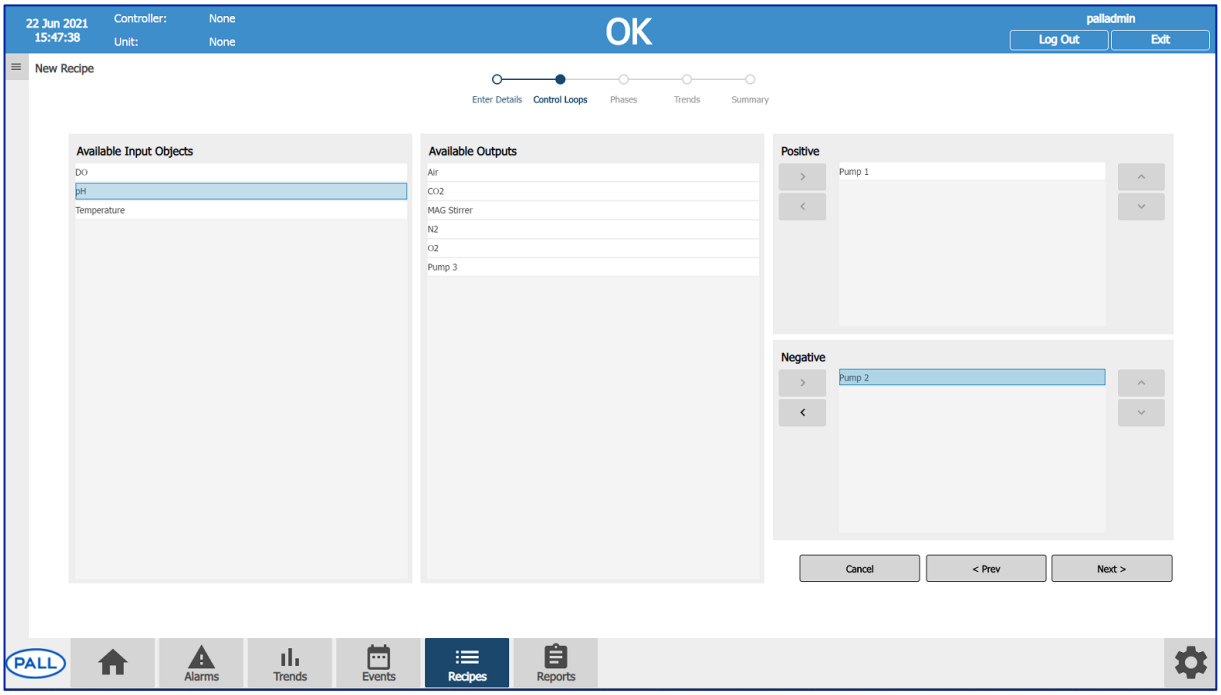



### 10.2.2 Control Loop Configuration

- Allowable parameters (input objects) are displayed in the left table which were defined at the time of unit creation.
- Once an available input object has been selected, the desired child can be selected from the outputs list (parent, child terminology used to define how control loops are set up).
- From the list, select a control action (child output) to move to the positive or negative columns. For positive control, the control action will increase the parameter under control from the present value towards the setpoint. For negative control, the control action will decrease the parameter under control from the present value towards
the setpoint.
- Multiple control actions can be added to the positive or negative columns. The Up and Down arrows are used to set the priority of the control parameters.
- Navigate to Phases screen by pressing "Next" or by selecting the Phases step.

**Figure 42**

Recipe control loops screen




### 10.2.3 Phases

The Phases screen is used to enter setpoints, range and alarm values for each of the selected parameters. The values set here will automatically load once the recipe is selected when a batch is started. Initially a single-phase recipe is created although additional phases can be added with a transition based on either time or process parameter.

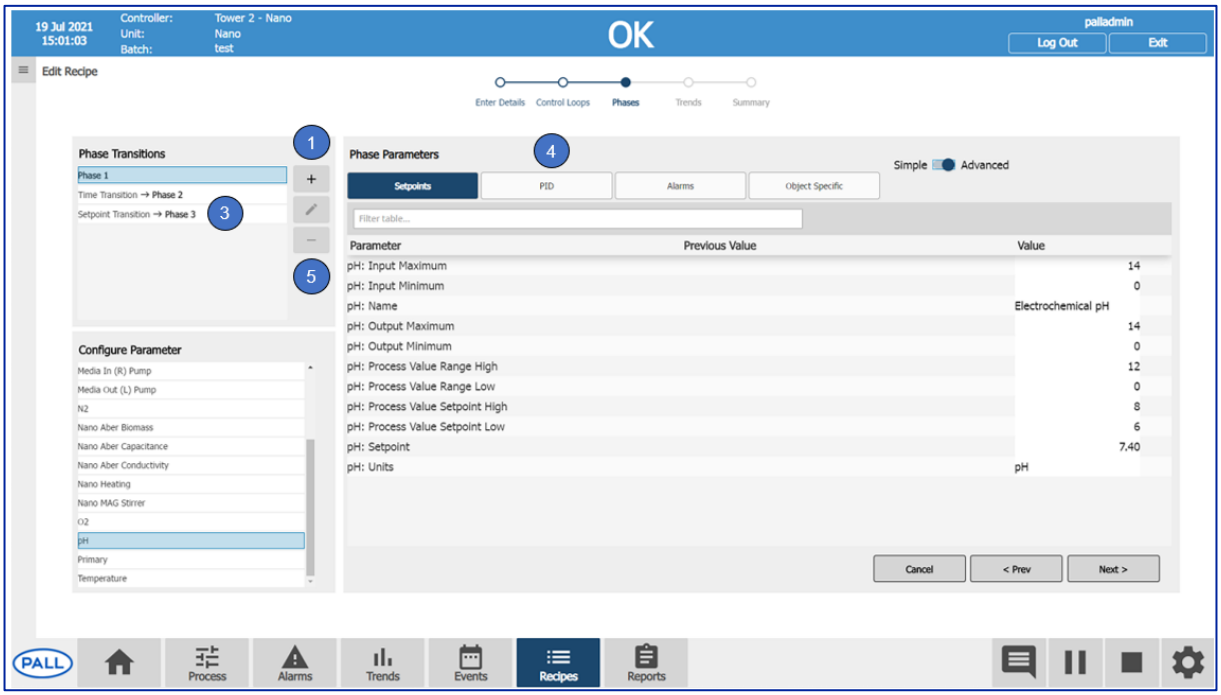
To edit the parameters:

- Select a phase (initially only phase one will exist).
- Once the phase is selected, the desired parameter can be chosen from the configure parameter table.
- A simple view will be shown where the user can edit set points, alarm parameters, and enable or disable an alarm.
- Switching the toggle in the top right to advanced allows the user to edit all variables associated with the parameter.

### 10.2.4 Adding a phase

**Figure 43**

Phase screen – advanced view




1. Select the "+" icon in the phase transitions content box
2. Define the transition type by selecting either duration or process parameter from the drop-down list. Transitions can then be edited using the pencil icon when selecting the desired transition.
3. A new phase will now be added, and all parameters within the second phase will match those in the first.
4. All parameters within the second phase can then be changed if required
5. Up to 10 phases can be added in total by using the "+" icon. The "-"icon can be used to remove any phases.

**Figure 44**

Duration transition selection pop up

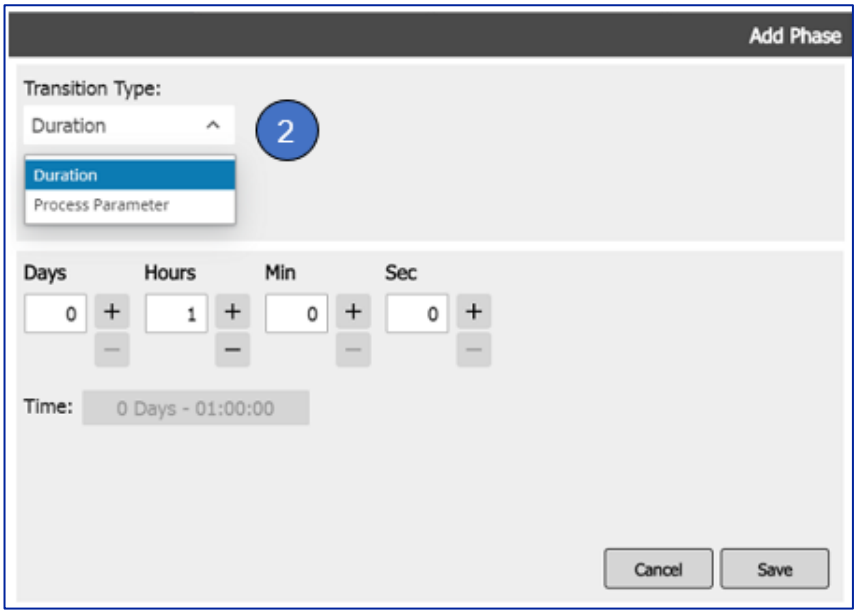
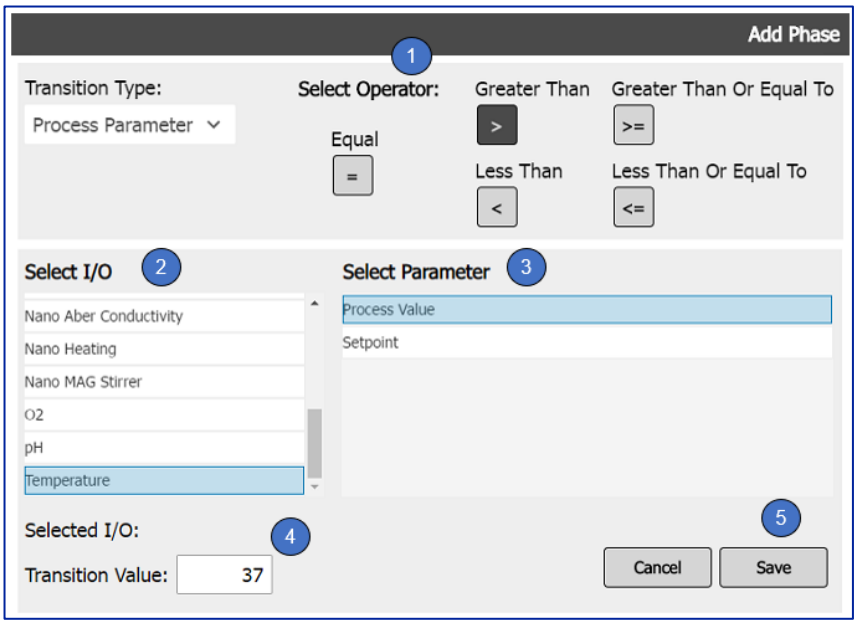



**Figure 45**

Process parameter transition selection pop up




When selecting a process parameter transition:

1. Select a mathematical operator to define the transition to the next phase
2. Select the I/O that the transition will be based on
3. Select the parameter (normally PV or setpoint) for the chosen I/O that the transition will be based on
4. Select a value at which the transition will occur
5. Select save

In the example shown in

Figure 45, the transition to the next phase would occur when the process value for temperature is greater than 37.

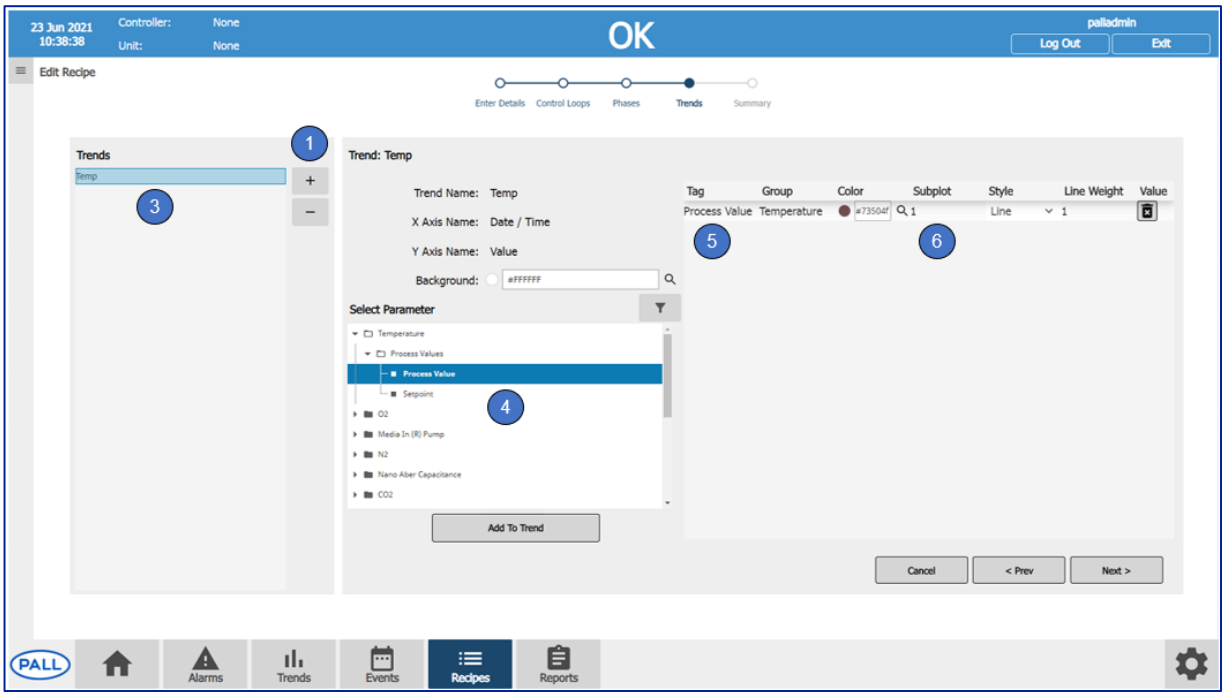
Once completed, navigate to the Trends screen by pressing “Next” or by clicking the trends step.

### 10.2.5 Trend Configuration

Within the recipe set up, a trend can be created which will be plotted every time the recipe is used. If trends are required specific to the recipe they can be created in the following steps. If not proceed to the Summary step.

**Figure 46**

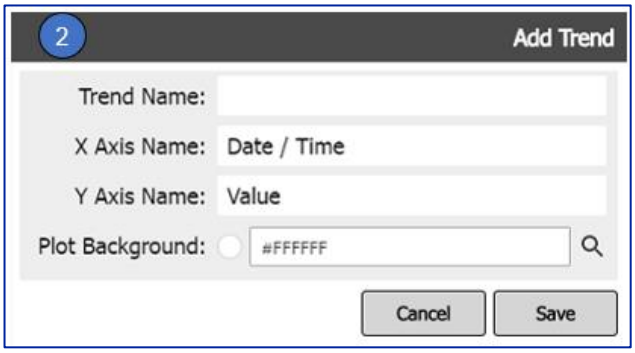
Recipe trends screen.




1. Select the “+” icon on the left of the screen.
2. The trend and X and Y axis can be named and the plot background color defined.
3. Once saved, the trend will be added in the left panel and can be selected to then define the desired parameters.
4. The desired parameter can then be chosen through the select parameter window before selecting “Add to Trend”. Note the filter icon will be set to process values by default although other more advanced parameters can be filtered upon.
5. The color, Sub plot, style and weight can then be changed.
6. Multiple data points can be added from multiple control parameters to the same graph if desired by setting the Subplot number to the same value
7. To create a new trend, select the “+” icon and repeat the steps. Trends can be removed using the “-“ icon.

**Figure 47**

Recipe trend details.




Once completed, navigate to the Summary screen by pressing "Next" or by clicking the Summary step.

### 10.2.6 Summary

The user will be given five options:

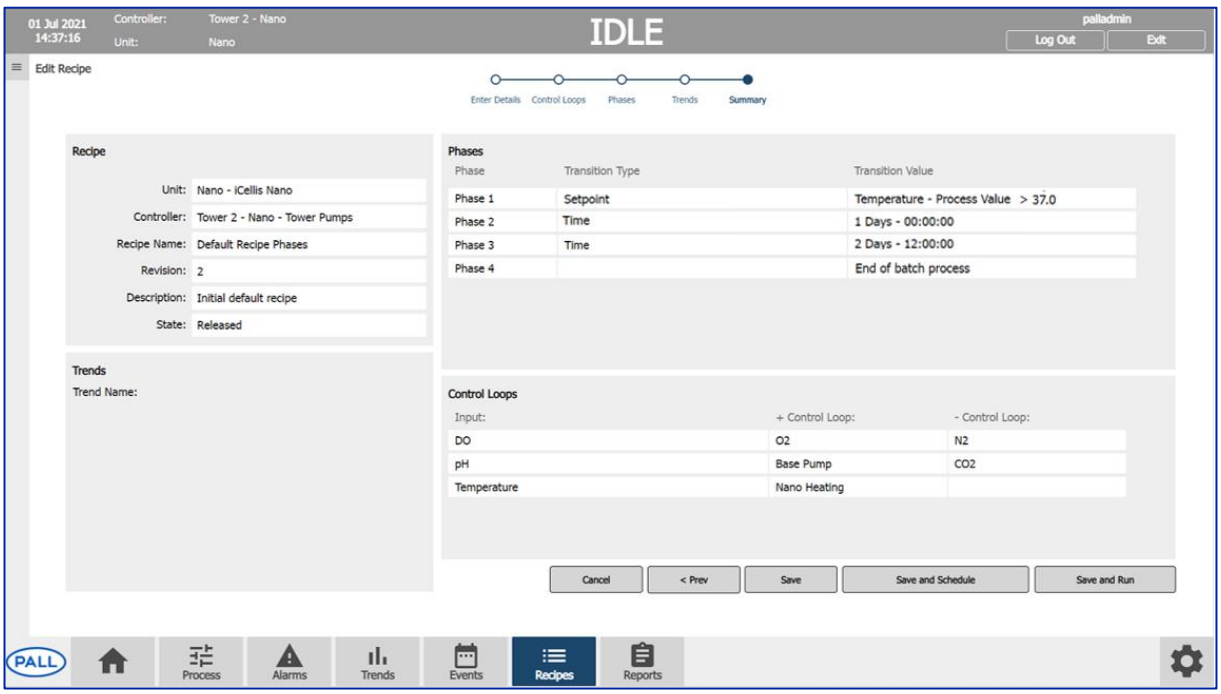
1. Save (The recipe will save and return the user to the recipe manager).
2. Save and schedule* (Scheduling opens a calendar view with a pop up prompting the user to plan a time to run the recipe later).
3. Save and Run (Saves the recipe and opens a check screen before a batch will begin).
4. Prev (Returns the user to the previous step in recipe configuration)
5. Cancel (Returns to recipe manager screen. Recipe is not saved).

An example of a configured recipe is in

Figure 48.

**Figure 48**

Recipe example summary screen




**The phases section of**

Figure 48 can be explained as:

6. Phase 1 – Batch will start and transition to phase 2 once the temperature process value exceeds 37
7. Phase 2 – Phase 2 parameters (as defined in step 3) will be loaded and will transition to phase 3, 1 day from the start of phase 2.
8. Phase 3 – Phase 3 parameters (as defined in step 3) will be loaded and will transition to phase 4, 2 days and 12 hours from the start of phase 3.
9. Phase 4 - Phase 4 parameters (as defined in step 3) will be loaded and batch will run these parameters until manually stopped by the user.

*Note that a batch will not automatically stop and thus will always require manual intervention by the user to stop.*

## 10.3 Editing and Duplicating a Previously Created Recipe

Default recipes can be viewed, and the parameters can be changed to suit user processes. Editing recipes is a rapid method allowing a batch to be run quickly with little configuration.

- Navigate to Recipes > Manage.
- A list of icons is displayed in the Actions column for each recipe
- Edit allows the user to make changes to a current recipe but upon acknowledging those changes the recipe will be saved as the next revision.
- Duplicating a recipe allows the user to make changes but upon acknowledging those changes the recipe must be saved under a different name. The revision will be set at revision 1 for the new recipe. The original recipe will remain unchanged.
- A recipe can be shared to a different unit type, but any IO differences will be highlighted in a pop-up window. These parameters will not be transferred and will remain as default values.

When a unit is selected from the side bar, by default only recipes related to that unit will be displayed. The user can either change the unit filter or select system on the side bar before navigating to recipe management to bring up all recipes in the system.

### 10.3.1 Removing or Retiring a Previously Created Recipe

Recipes can be removed or retired from the listed view by selecting the "Remove" or "Retire" icons listed next to the recipe in the Actions column (Figure 40).

Remove permanently deletes the recipe.

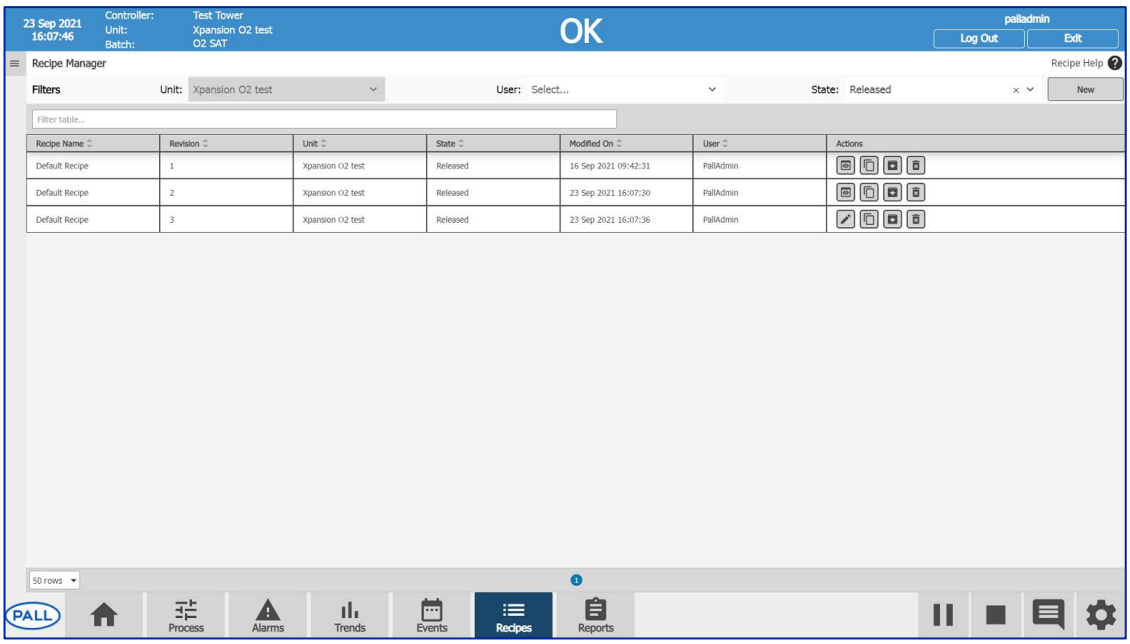
Retire allows the user to hide the desired recipe from the recipe list. The recipe is not deleted and can be found by selecting the "Retired" option from the State filter.

### 10.3.2 Search Feature within Recipe Manager

Saved recipes may be searched using the search filter to the at the top of the recipe management screen. By selecting from the filter options detailed below the recipe list will update for a concise view.

**Figure 49**

Recipe search feature




There are three search options:

1. **Unit** – This option allows the user to search for recipes created for a desired unit. Select the unit from the drop-down box. Note that when the recipe management screen is entered when a unit is selected on the side bar, the filter will default to show only recipes related to the selected unit.
2. **User** – This allows the user to display recipes created by a given user
3. **State** – The user can search for released, retired or unreleased recipes.

## 10.4 Starting a Batch

Batches may be scheduled for the future or started immediately. The options to do a quick start based on a default recipe or after new recipe creation was already described. Here is described how to schedule and start a default recipe, a recipe which has been saved or that has been saved and scheduled during the recipe creation process.

### 10.4.1 Scheduling a Batch Linked to a Recipe

Navigating to recipes > schedule allows users to create batches linked to previously created recipes which can be scheduled from the current time or scheduled for use in the future.

The batch will not automatically start on its scheduled time. The user must select and start the batch.

The schedule view allows users to plan batches, view usage on units and schedule resources.

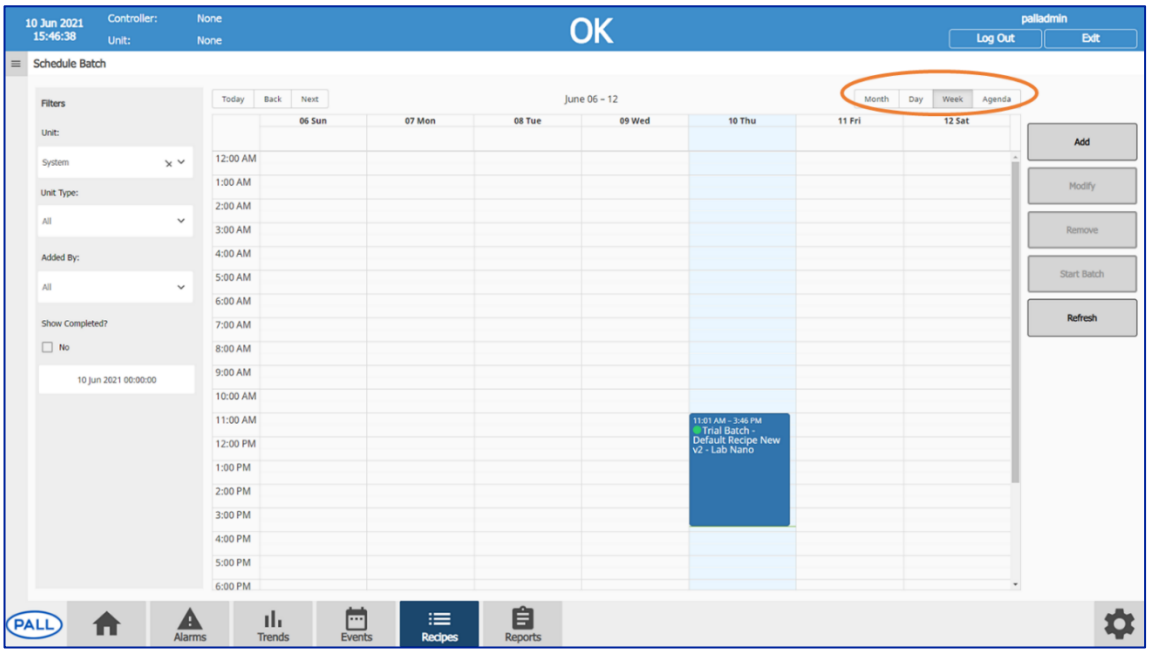
- Click on Recipes > Schedule. (Not required if save and schedule was chosen when creating a recipe)
- The schedule screen has 4 views:

1. Day – Current selected day view.
2. Week – Current selected week view.
3. Month – Current selected month view.
4. Agenda – Tabular view of created batches

The date selector boxes on the left-hand side of the screen allow the user to navigate to a defined region of time. Filters also exist on the left side to filter the view by unit, unit type or user.

**Figure 50**

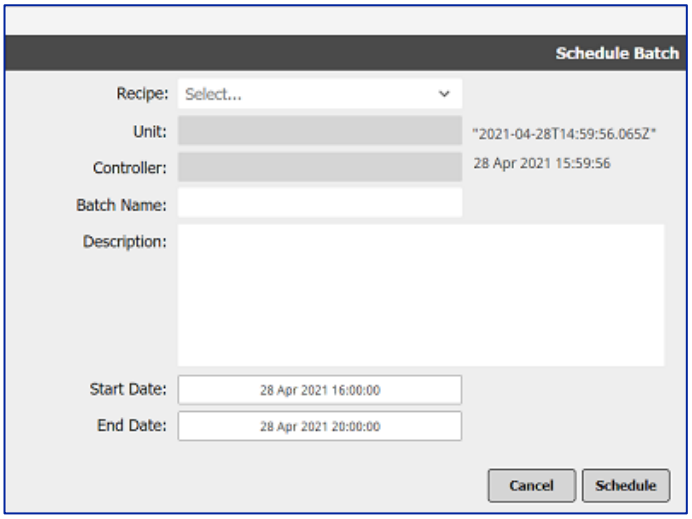
Schedule view




After selecting "Add". A pop up will appear. This is not required if save and schedule was chosen when creating a recipe.

**Figure 51**

Schedule new batch pop up.




- Select a recipe from the drop-down list. If a unit is selected on the left side bar, only recipes available for that unit will be selected. For all available recipes "System" should be selected from the left side bar.
- After selecting a recipe, the unit and control tower will be automatically populated.
- Enter a batch name in the batch name field.
- A description is not required to run the batch but may be used to add extra information.
- Schedule a start and end date and time for the batch from the pop out calendar.
- Press "Schedule".
- Multiple batches can be scheduled by repeating the steps above.

### 10.4.2 Editing a Scheduled Experiment / Batch

- If changes are required to the scheduled time, click the scheduled batch, and then press the "Modify" button on the right side of the screen. The pop-up box from Figure 51 will appear allowing changes to be made.
- The batch cannot be edited once it has started.

The batch will not automatically start on the times chosen. The batch will also not end on the time stated. The user is required to start and end the batch. Scheduling a batch will place an entry into the calendar allowing users to observe the duration of scheduled batch as well as the unit that the batch is run on.

### 10.4.3 Deleting a Scheduled Batch

- To delete a scheduled entry, click on the batch and click "Remove".
- A confirmation pop up will appear asking to confirm deletion.
- A batch cannot be deleted once it has been started.

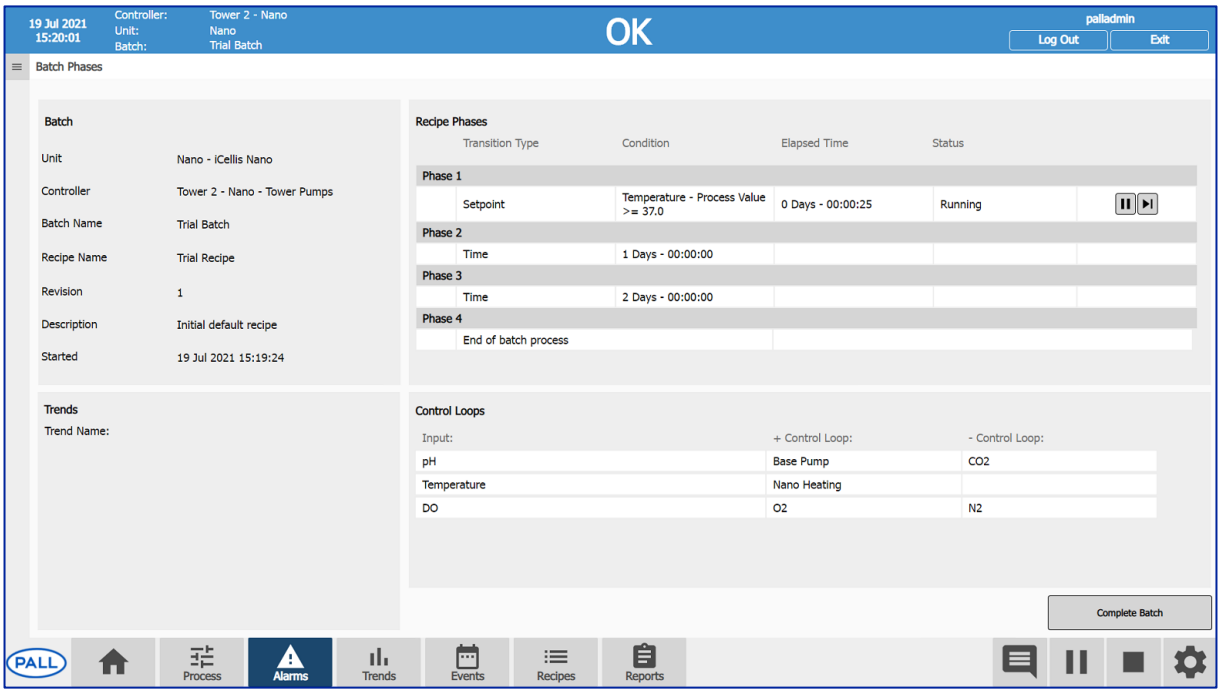
### 10.4.4 Starting a Batch

After the steps above, select the batch to be started by clicking on it from Recipes > Schedule.

- Click on "Start Batch". A confirmation pop-up will appear asking to confirm the batch start. Pressing "No" will return the user to the schedule. "Yes" will take the user to the batch screen. (User can navigate to this screen through Process > Batch)
- The batch screen displays as overview of the batch details, phases, trends, and control loops.
- Selecting the "Begin Phase 1" button will start the batch after the pop-up is confirmed.
- The elapsed time in phase will start counting and the user will have the option of navigating to Process > Overview to view configured parameters

**Figure 52**

Batch screen




## 10.5 Calibration

Sensors, pumps, and internal load cells may all be calibrated. For specific calibration guidance linked to a particular unit, please consult the corresponding unit IFU.

After selecting the desired unit from the side bar, the calibration menu can be navigated to by selecting the settings tab > Calibration. A list of all configured parameters available to calibrate will be displayed.

Calibrations can also be completed by selecting the calibration tab from the faceplate for a specific parameter

Calibration parameters will only be present for the I/O that was added when creating the unit.

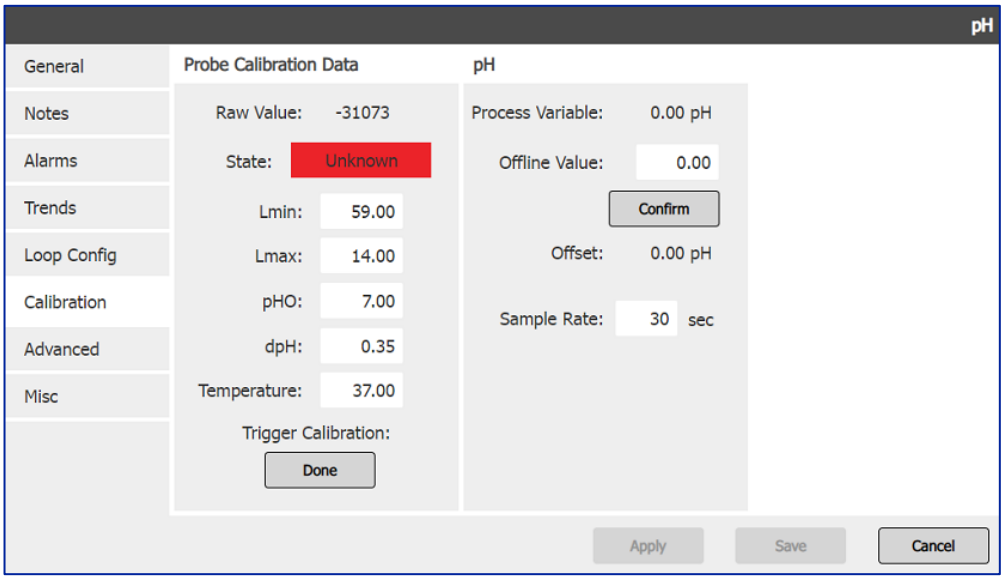
### 10.5.1 Calibrating Pre Sens pH and DO Sensors

The pH fiber optic cable provided with the Allegro XRS 25 and Xpansion multiplate bioreactors is a reusable cable, which works in conjunction with a disposable optical pH sensor. To ensure proper calibration of the sensor and to compensate for any discrepancy, a calibrated offline benchtop pH meter will be required.

1. Prior to calibration, ensure the fiber optic cables are connected to the sensor location points on the bioreactor and ensure the sensor spots within the bioreactor are hydrated.
2. Enter the values for Lmin, Lmax, pH0, dpH and Temperature in their respective edit boxes, as marked on the label on the top of biocontainer or on the biocontainer box.
3. When all values have been entered, press the Trigger Calibration "Done" button. The screen will display "Calibrate" and the probe status will change to Calibrating. Note: Calibration can take up to 30 seconds to complete.
4. Take a sample of growth medium from the unit and measure the pH using the external meter.
5. Enter the offline value into the pH offline value box and press confirm.
6. The offset is calculated automatically, and calibration is complete.

**Figure 53**

Presens pH Calibration

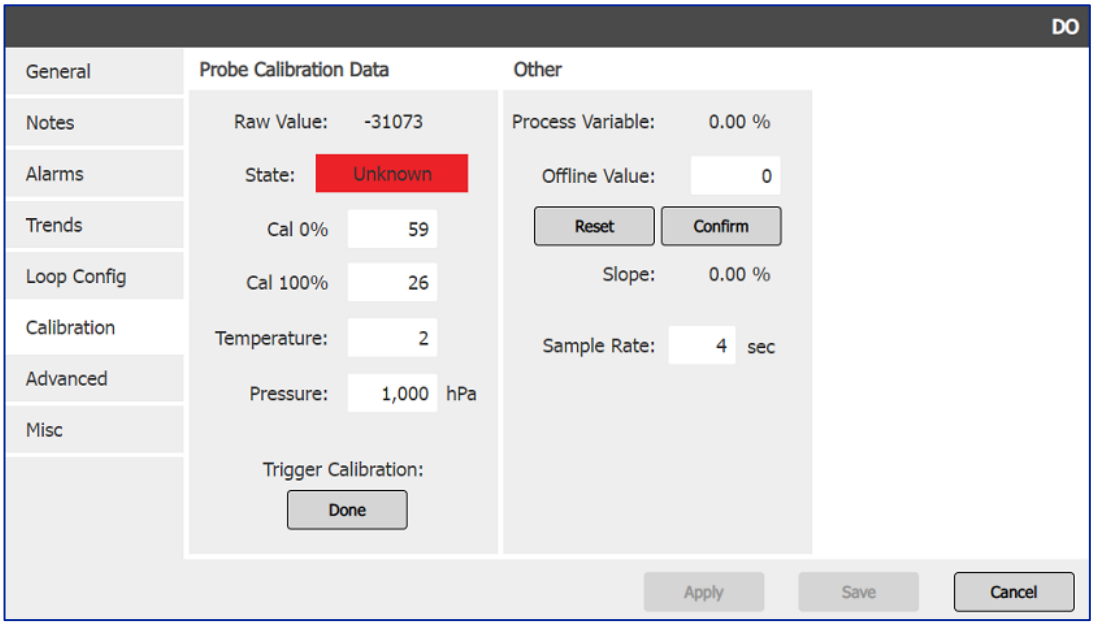



The DO fiber optic cable provided with Allegro XRS 25 and Xpansion multiplate bioreactors is a reusable cable, which works in conjunction with a disposable optical DO sensor.

1. In their respective edit boxes, enter the DO Calibration Factors that are marked on the biocontainers label (and its box): Cal 0%, Cal 100%, Temp (degC) and Pressure (hPa).
2. When all values have been entered, press the Trigger calibration "Done" button. Calibration can take up to 30 seconds to complete.
3. Enter the offline value into the pH offline value box and press confirm.
4. The offset is calculated automatically, and calibration is complete.

**Figure 54**

Presens DO calibration.



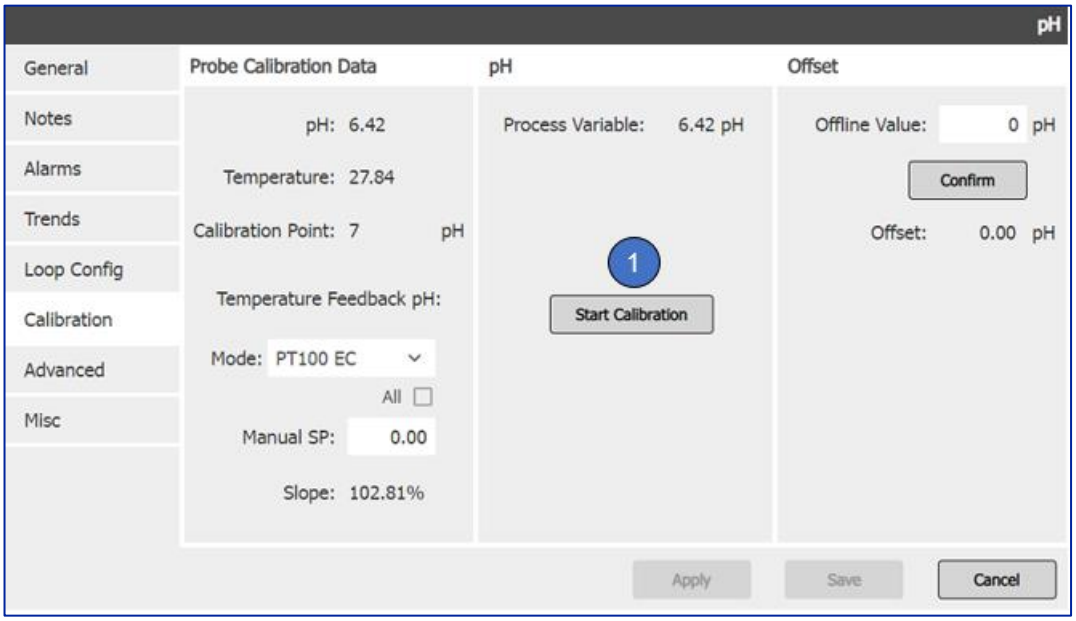

### 10.5.2 Calibrating Electrochemical pH and DO Sensors

Electrochemical pH is a two-point calibration:

1. Select Electrochemical pH from the list on the left-hand side of the screen and select the "Start Calibration" option.

**Figure 55**

Electrochemical pH Calibration Step 1

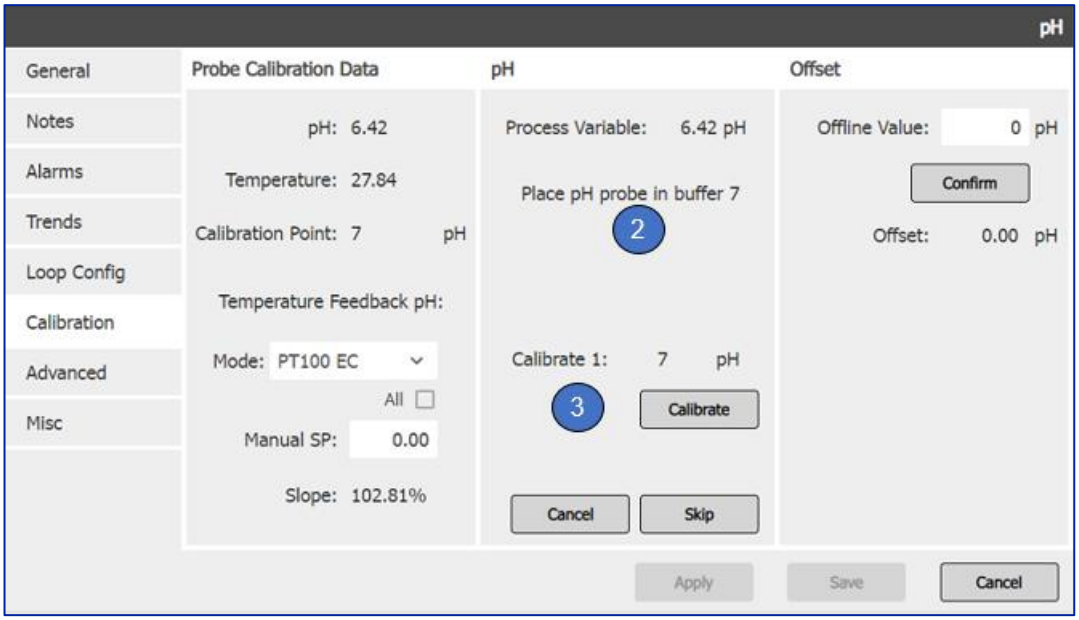



2. Selecting "Calibrate" will then prompt the user to place the pH probe in a pH 7 solution.

3. Once this has been done, ensure the value has stabilised before selecting the "Calibrate" button.

**Figure 56**

Electrochemical pH Calibration Steps 2,3



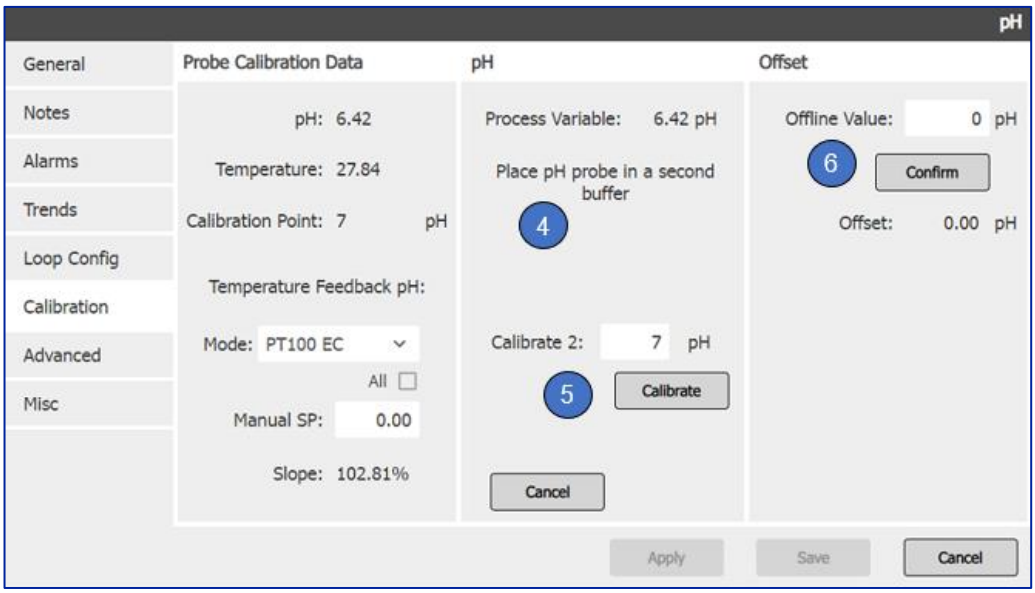

4. A prompt to place the pH probe in a second buffer will appear and the value can be entered in to the "Calibrate 2" box. This can be skipped if only completing a one-point calibration.

5. Place the probe in the second buffer and once the value has stabilised, select the "Calibrate" button once complete to finalise calibration.

6. When performing an offset for either the first or second calibration step, type the correct pH reading into the "Offline Value" box on the right side of the screen.

**Figure 57**

Electrochemical pH Calibration Steps 4, 5, 6

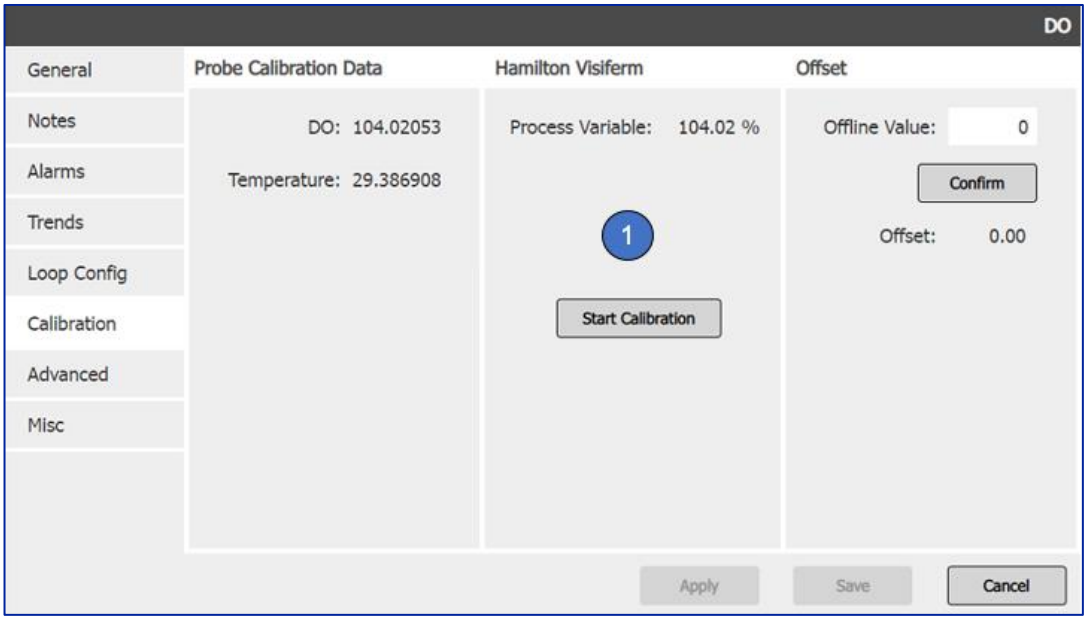


Electrochemical DO and Hamilton Digital DO is also a two-point calibration:

1. Select Electrochemical DO from the list on the left-hand side of the screen and select "Start Calibration"

**Figure 58**

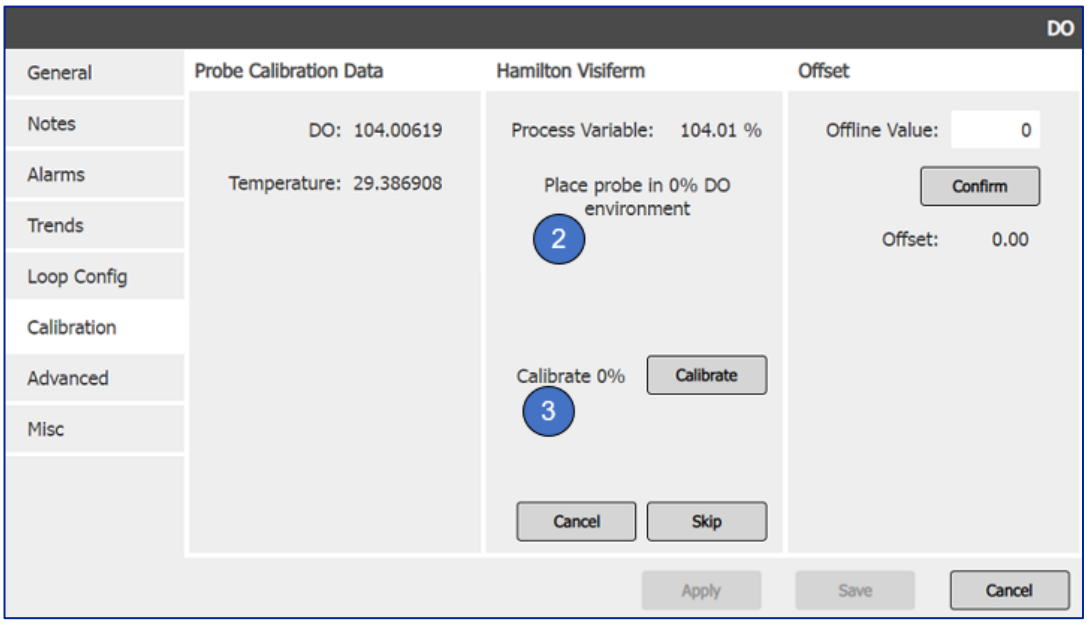
Electrochemical DO calibration step 1.




2. The user will be prompted to place the probe in a 0% DO environment.
3. Press "Calibrate" button.

**Figure 59**

Electrochemical DO calibration steps 2, 3.



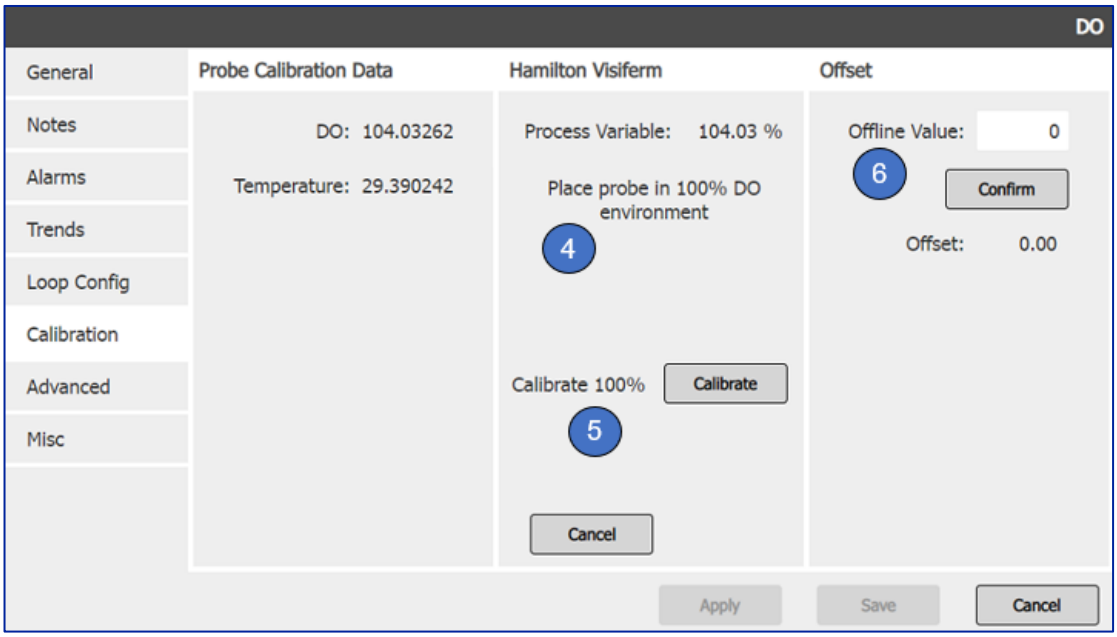

4. The user will be prompted to place the probe in a 100% DO environment.
5. Ensure the value is stable before selecting "Calibrate" to complete.

- When using Hamilton Digital the calibration status is displayed as a numerical value.

6. When performing an offset for the one point or two-point calibration, type the offline DO reading into the "Offline Value" box on the right side of the screen.

**Figure 60**

Electrochemical DO calibration steps 4, 5, 6



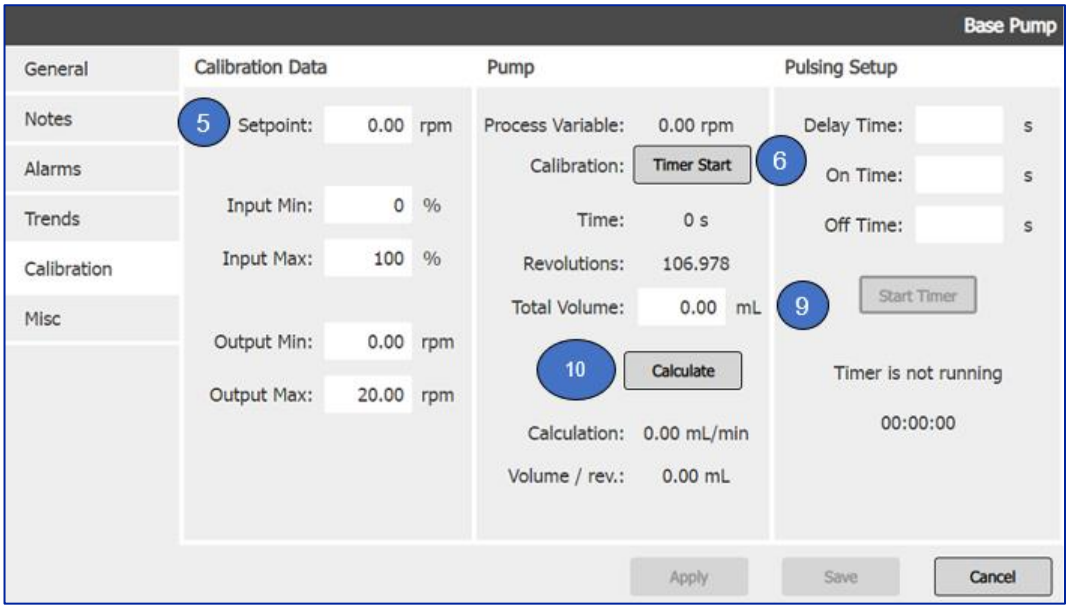

### 10.5.3 Calibrating Pumps

Single point calibration. To calibrate pump flow additional equipment is required. Please source a measurement container which can hold liquid. E.g. measuring cylinder.

1. Connect a section of tubing, equivalent to that being used under sterile conditions to the pump of choice.
2. Ensure one end is in fluid of similar viscosity to fluid used during cell culture.
3. Ensure the opposite end of the tubing is in the measuring container.
4. Prime pump by ensuring tube is full of liquid before calibrating.
5. Set a value in the "Setpoint" field.
6. Click the "Time Start" button.
7. A timer will begin on screen.
8. Press the "Time Stop" button and observe what volume of the measuring container has been reached.
9. Enter this value into the total volume box. (Units are mL).
10. Press "Calculate" to complete calibration.
11. Perform for additional pumps if required.

**Figure 61**

Pump calibration steps



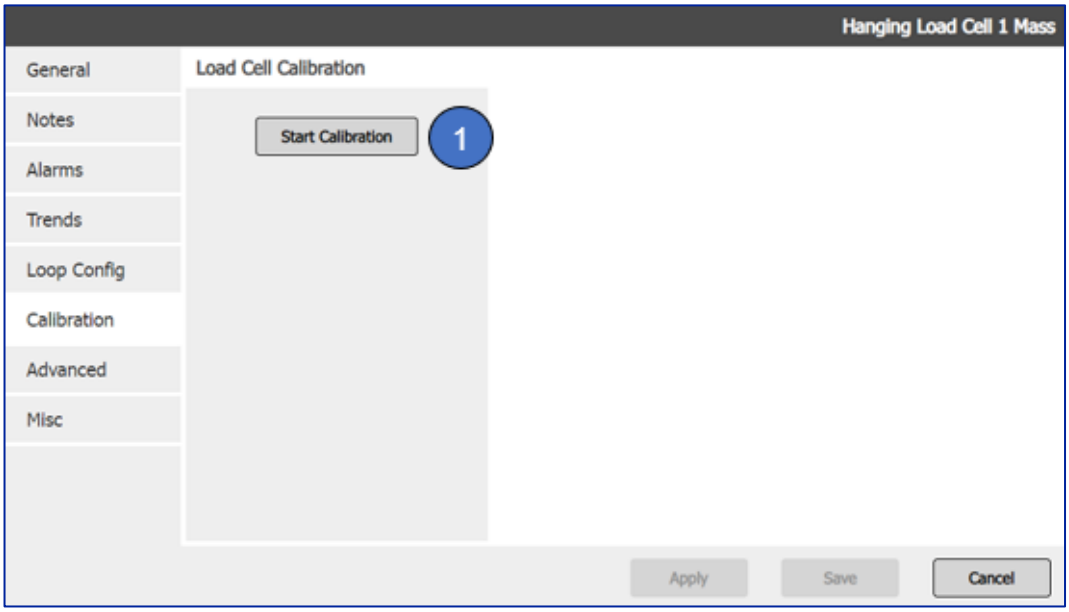

### 10.5.4 Calibrating Hanging Load Cells

Ensure an offline balance is available to weigh the hanging biocontainer. Follow the onscreen instructions to perform calibration of the hanging load cells. All parameters are in grams.

1. Select “Start Calibration” and type in an empty weight value in step one, press enter. Select “Next Step”.

**Figure 62**

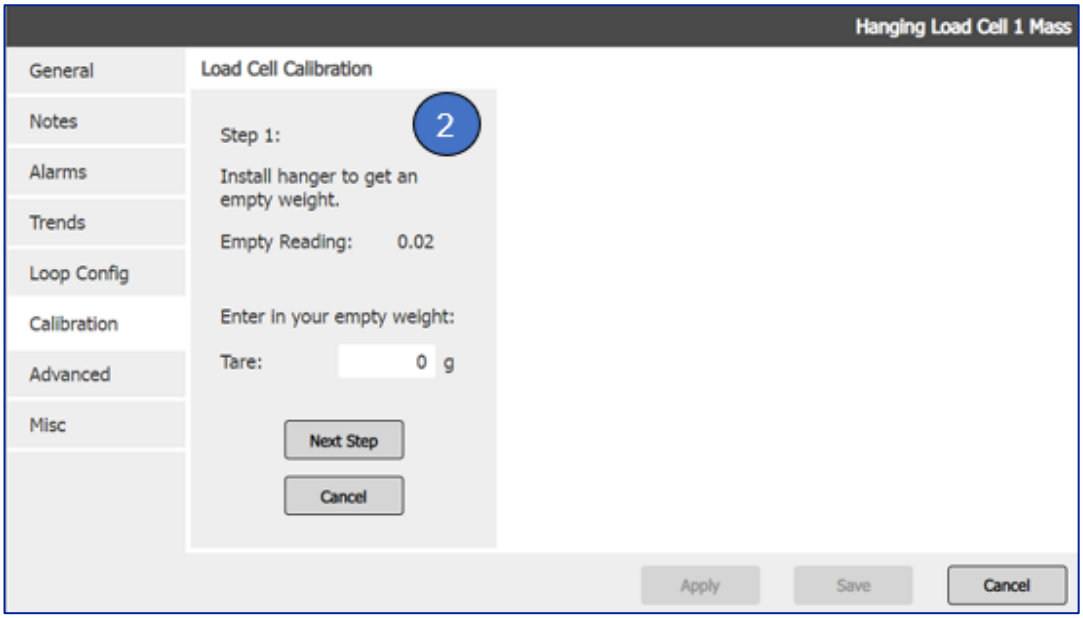
Hanging load cell calibration step 1




2. Place the hanger in position and type in an empty weight value in the tare box. Wait for the empty weight value to stabilize and press next step.

**Figure 63**

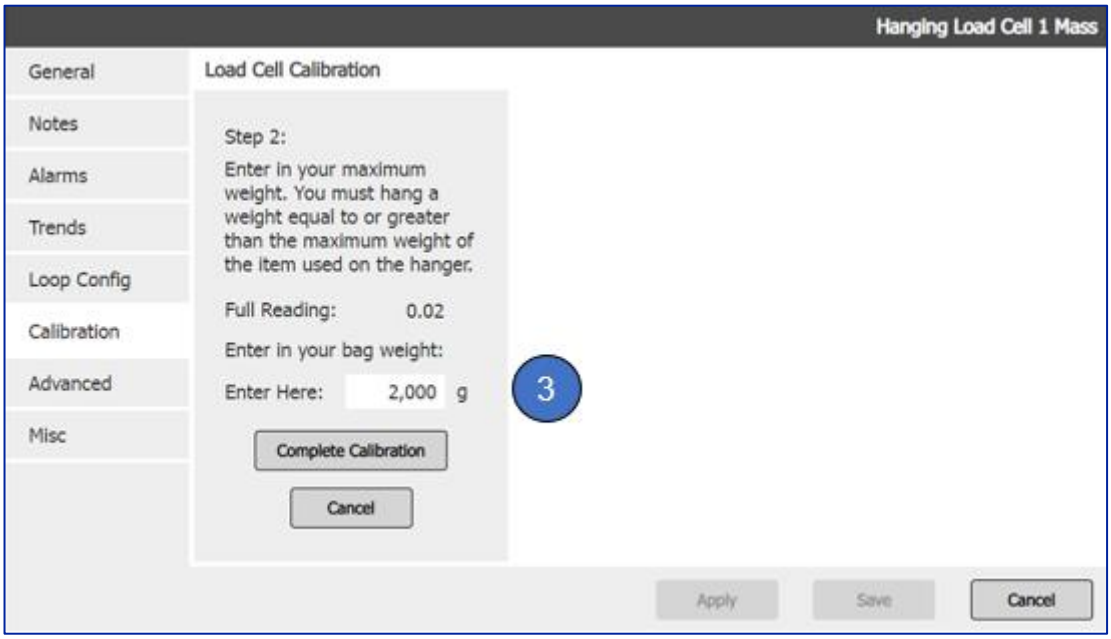
Hanging load cell calibration step 2




3. Hang the heaviest weight (up to a maximum of 2kg) from the load cell and type in its value in grams. Select "Complete Calibration".

**Figure 64**

Hanging load cell calibration step 3



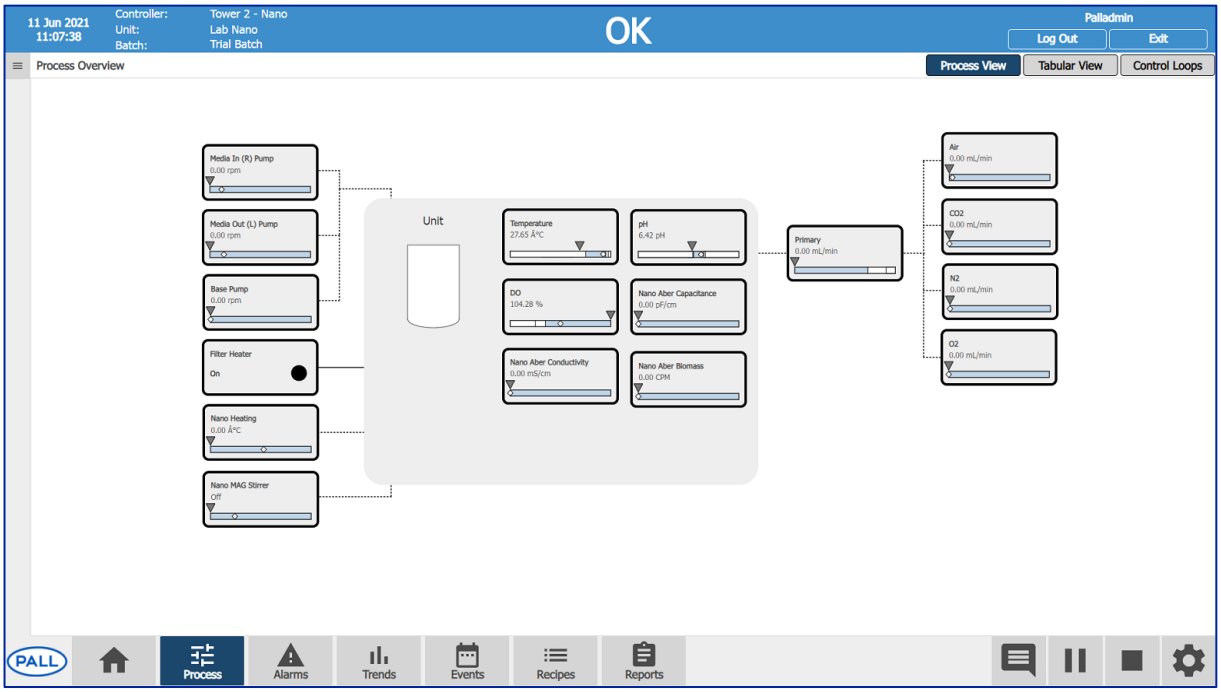
## 10.6 Monitoring a Running Batch

When a unit is selected from the side navigation bar, The Process icon can be selected from the bottom bar with links to the “Overview” and “Batch” screens. Note that the batch screen will only be visible when a batch is running for the selected unit.

### 10.6.1 Overview Screen – Process View

**Figure 65**

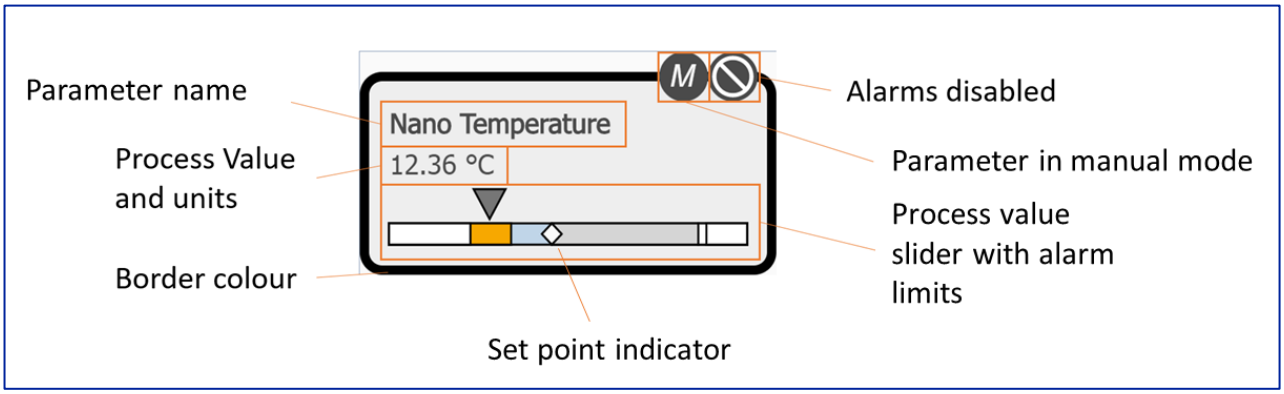
Example process overview screen




A graphical representation of the configured parameters is displayed with the key elements of the standard process overview symbol below. Figure 26.

**Figure 26**

Process overview screen



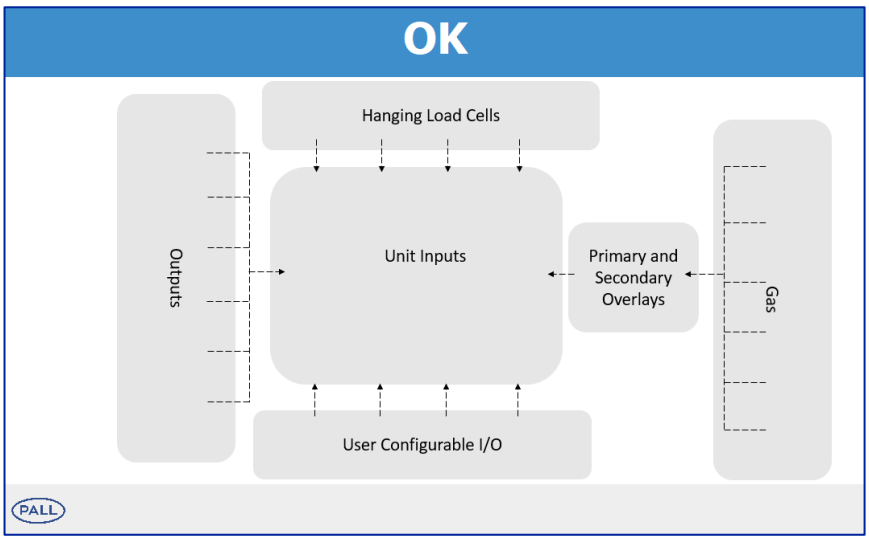

| Item | Description |
|---|---|
| Parameter Name | Name of the parameter which can be configured when setting up a new unit. |
| Process value and units | Current value of the parameter also graphically displayed with the upside-down triangle |
| Border colour | Border colour will change depending on whether the parameter is in alarm. It will show red for critical alarms and orange for warning alarms (unless alarm is disabled). |
| Alarms disabled | This icon will only be displayed if the parameter has 1 or more alarms disabled. |
| Parameter in manual | This icon will only be displayed if the control mode of the IO is in manual. |
| Slider with alarm units | Shows the process value and setpoint on a slider, with alarm limits configured and the diamond representing the set point |

The process overview screen is designed to accommodate any hardware that may be added or removed during the unit setup. If additional hardware is added during unit setup, then the corresponding process symbol will be displayed in a space on the process overview screen once the unit is created. Due to space constraints in the process view, certain parameters will be visible only on tabular view.

The layout of the process screen is designed to map the physical process as closely as possible and will follow the general layout below. The connectors will show as a dotted line when a piece of hardware is not active or turned off and solid lines when the hardware is in use.

**Figure 66**

Process overview screen layout.



Selecting the grey unit inputs section in the middle of the screen brings up a pop-up displaying unit specific information.

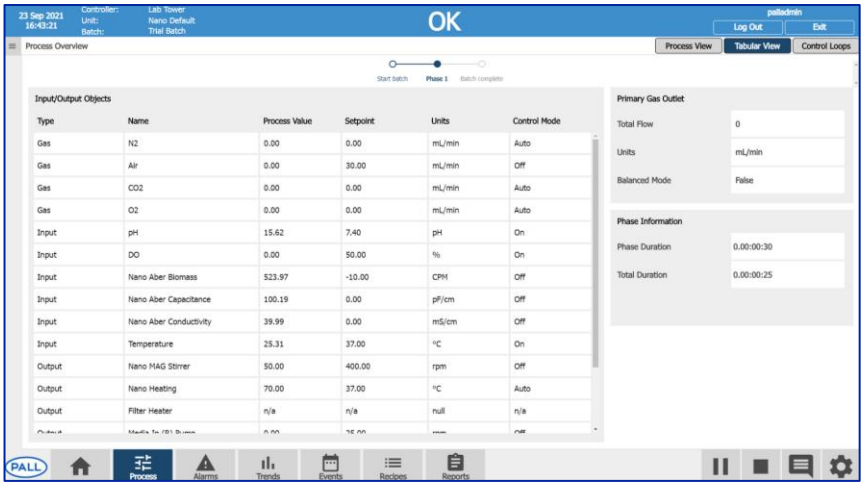
### 10.6.2 Overview Screen – Tabular View

Using the buttons at the top right of the process screen, the user can switch the view to a tabular layout. The information within the table matches that displayed in Figure 65 and will be the default view if using a tablet.

Scrolling to the bottom of the tabular view will show a "Unit Details" item which has the same functionality as selecting the grey unit input box in the middle of the "Process View" layout.

**Figure 67**

Process overview tabular view

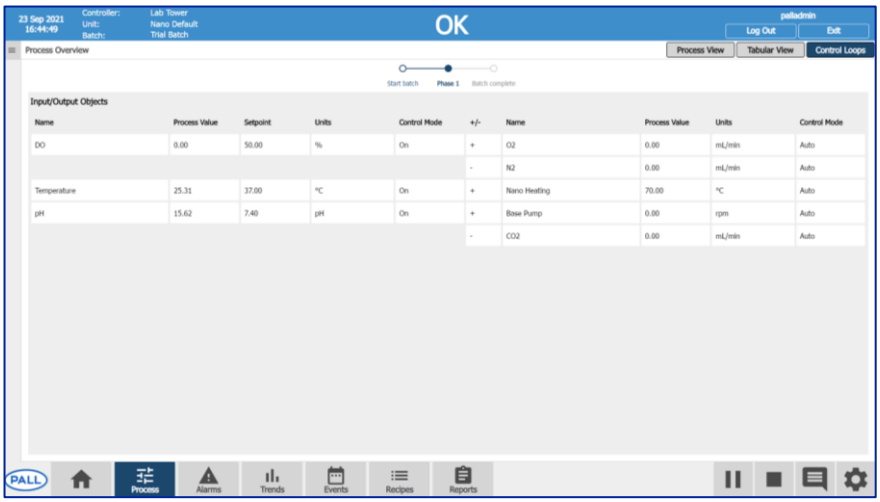



### 10.6.3 Overview Screen – Control Loop View

A control loop view can also be selected from the top right of the process screen. This gives the user a table of all control loops configured for the current batch. It will detail the control loop state and parent child relationship of the configured parameters.

**Figure 68**

Process overview control loop view



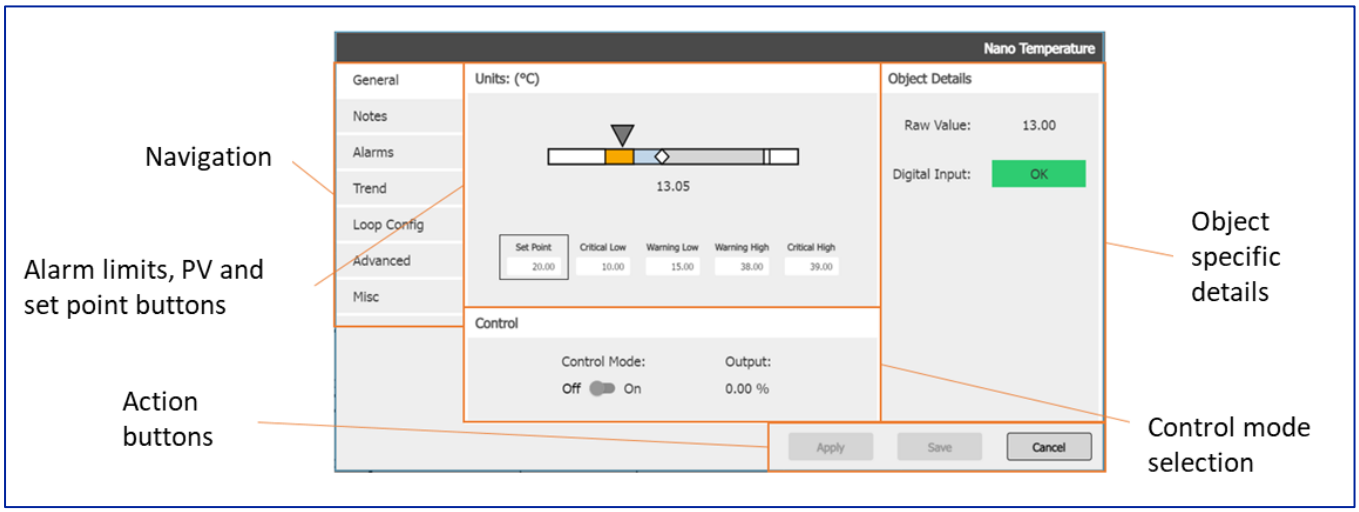
### 10.6.4 Faceplates

Configuration of setpoints, alarms, trends, and other settings for each parameter is carried out by first selecting the desired parameter from the process overview screen. This opens a faceplate as shown below:

### 10.6.5 Typical Parameters

**Figure 28**

Typical parameter faceplate.

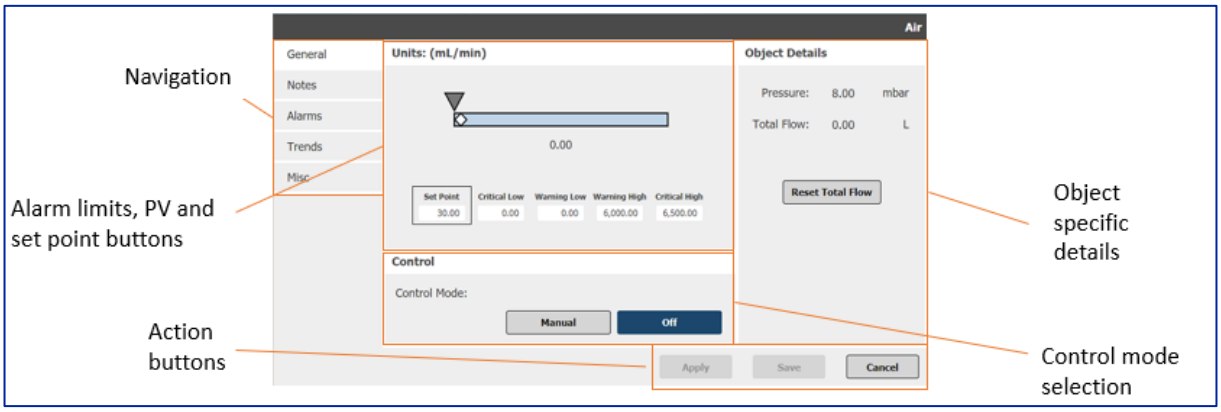



| Tab | Description |
|---|---|
| General | Process Value – This is the value that is being read by the sensor.<br>Setpoint – User editable<br>Alarm Limits – Critical/warning, high/low, critical, alarm configuration<br>Control Mode – Either off or on can be selected<br>Object details – Object specific details such as raw sensor value<br>Output – Percentage power used when attached to a control loop<br>Action buttons – Apply to confirm value, save to confirm value and exit faceplate, cancel to exit faceplate without saving any edits not already applied |
| Notes | Allows the user to add notes to each parameter faceplate. |
| Alarms | - Critical/warning, high/low, critical, alarm configuration<br>- Disable/enable tick box<br>- Deadband |
| Trends | Mini trend to view either process value or setpoint. Date range also configurable |
| Loop Config (visible for input parameters only) | Displays status of control loop and outputs linked to the control loop. Control mode will have three options:<br>- Name (e.g., temperature) – output will control temperature in this case<br>- Manual – Output will operate based on defined set point and not control input<br>- Off – Output will be turned off |
| Calibration | If applicable calibration for the selected parameter can be conducted following the same steps as detailed in section 10.5. |
| Advanced | - PID parameters can be set<br>- Split mode (only visible for certain parameters) Allows user to set different parameters to control the positive and negative sides of the control loop<br>- Outputs for positive and negative sides of the control loop are displayed (only applicable for split mode, if not only one value will be displayed) |
| Misc | - Set point Limits defines the minimum and maximum values that can be entered as a set point<br>- Range Limits defines the total length of the visualisation bar<br>- Scalar limits: Input Min and Max is the % of the control loop that this parameter operates within. Output Min and Max is a limit on the output of that control action. |

### 10.6.6 Gas Handing Faceplate

**Figure 29**

Gas handling faceplate.



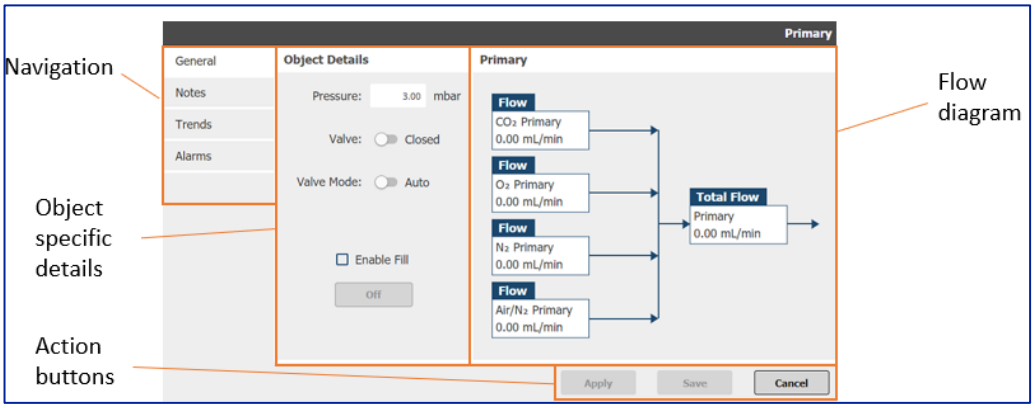

| Tab | Description |
|---|---|
| General | Process Value – This is the value that is being read by the sensor.<br>Setpoint – User editable<br>Alarm Limits – Critical/warning, high/low, critical, alarm configuration<br>Control Mode – Either off or manual can be selected<br>Object details – Object specific details such as flow totaliser<br>Action buttons – Apply to confirm value, save to confirm value, and exit faceplate, cancel to exit faceplate without saving any edits not already applied |
| Notes | Allows the user to add notes to each parameter faceplate. |
| Alarms | - Critical/warning, high/low, critical, alarm configuration<br>- Disable/enable tick box<br>- Deadband |
| Trends | Mini trend to view either process value or setpoint. Date range also configurable |
| Misc | - Set point Limits defines the minimum and maximum values that can be entered as a set point<br>- Range Limits defines the total length of the visualisation bar<br>- Scalar limits: Input Min and Max is the % of the control loop that this parameter operates within. Output Min and Max is a limit on the output of that control action. |

### 10.6.6.1 Primary Gas Faceplate

The Primary gas faceplate shows a visual representation of the gas mixes flowing out of the primary gas port.

**Figure 30**

Primary Gas Faceplate.




| Tab | Description |
|---|---|
| General | Object Details – Shows pressure through the primary port<br>Object Details - Valve allows the user to close the outlet value preventing gas flow through the primary port.<br>Object Details - Valve mode allows the user to place the valve action into manual or auto. For optimum use leave in auto mode is recommended<br>Object Details –The enable fill button is a press and hold button which allows air only to flow through the primary port. Once the button is released air will stop flowing. This function is not flow controlled so care should be taken when using. This feature is designed to inflate units with air or top up with air. As a safety feature the user must select the enable fill tick box, a pop-up message will appear saying 'Are you sure you want to enable fill?' When yes is pressed the "Off" button is selectable. If the button is not pressed within 30 seconds it will return to an un-selectable state.<br>Primary - Flow diagram is a visual indication to show exactly which gas and flow rate is supplied through the primary port. |
| Notes | Allows the user to add notes to each parameter faceplate. |
| Trends | Mini trend to view either process value or setpoint. Date range also configurable |
| Alarms | - Critical/warning, high/low, critical, alarm configuration for pressure alarms<br>- Disable/enable tick box<br>- Deadband |

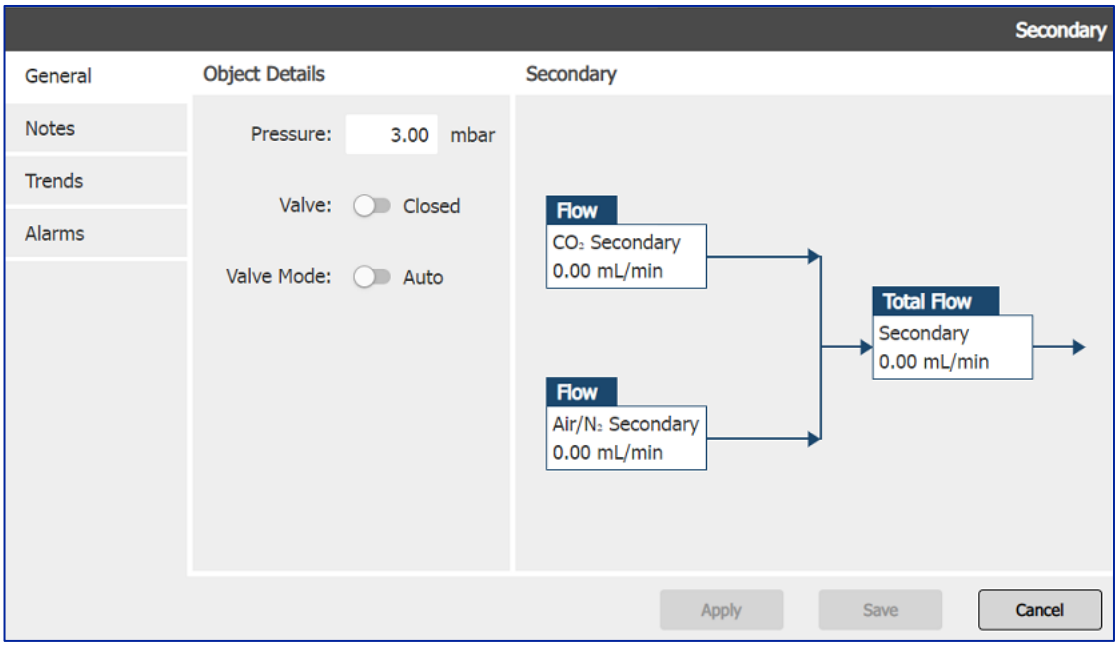
*Fill Feature: As explained in the table above this button allows for rapid flow of air only, to aid in filling units. The button must be held down to allow air to flow. Once released the air flow will stop.*

### 10.6.6.2 Secondary Faceplate

The Secondary gas pop up screen shows a visual representation of gas mixes flowing out of the secondary gas port.

**Figure 69**

Secondary Gas Faceplate.




The Secondary gas pop up screen shows a visual representation of gas mixes flowing out of the secondary gas port.

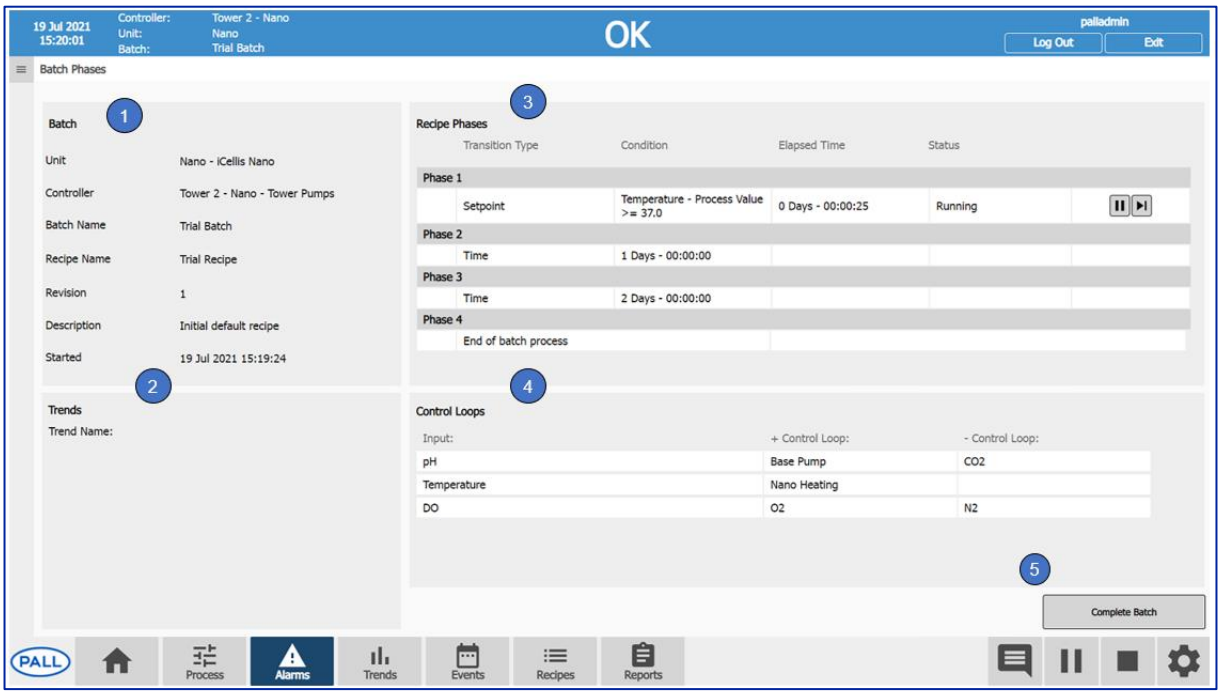
| Tab | Description |
|---|---|
| General | Gas Outlet – Shows pressure and total flow being passed through the primary port.<br><br>Gas Outlet – Valve allows the user to close the outlet value preventing gas flow through the primary port.<br><br>Gas Outlet – Valve mode allows the user to place the valve action into manual or auto. For optimum use leave in auto as shown above.<br><br>Flow diagram is a visual indication for the user to show exactly what gas and how much flow is leaving the primary port. |
| Notes | Allows the user to add notes to each parameter faceplate. |
| Trends | Mini trend to view either process value or setpoint. Date range also configurable |
| Alarms | - Critical/warning, high/low, critical, alarm configuration for pressure alarms<br>- Disable/enable tick box<br>- Deadband |

10.6.6.3 Batch Screen

When a batch is running and a unit is selected from the left side bar, the user can navigate to Process > Batch for a summary of the running process.

**Figure 70**

Batch screen.




| Tab | Description |
|---|---|
| 1. Batch | Provides the control tower, unit, recipe, and batch details for the current batch. |
| 2. Trends | Specifies any trends set up as part of the running recipe |
| 3. Recipe Phases | Shows the currently running phase, duration of the phase and the transition details required to be met to move into the next phase. Two action icons are available:<br><br>Pause icon: Will stop the batch moving to the next phase even if the transition criteria have been met. Note that the batch will continue running the current phase as defined in the recipe whilst the transition is paused. When un-paused, the batch will move to the next phase if the transition criteria have been met.<br><br>Skip icon: Will move to the next phase regardless of if the transition criteria has been met. The batch will start running the parameters from the new phase it enters as defined in the recipe. If a phase is skipped it is not possible to return to the previous phase |
| 4. Control Loops | Defines the control loops as set up in the recipe |

The status column in the recipe phases section (area 3 in Figure 70) will display the status of all previous phase and the currently running phase which may be:

- Running – Successfully running parameters for current phase. Will evaluate criteria in condition column and transition to the next phase once met
- Running (On Hold) – Successfully running parameters for current phase. Batch will not transition to the next phase until the play button is selected.
- Skipped – Indicates a previous phase was manually skipped
- Completed – Indicates a previous phase was successfully completed and transition occurred as planned.

- Failed – Indicates a failed transition (occurs only in the event of the mPath Link server being powered off when a transition was planned). Batch will continue running using parameters from the previous phase.

# 11. Detailed Configuration and Batch Management

## 11.1 Control Loop Configuration

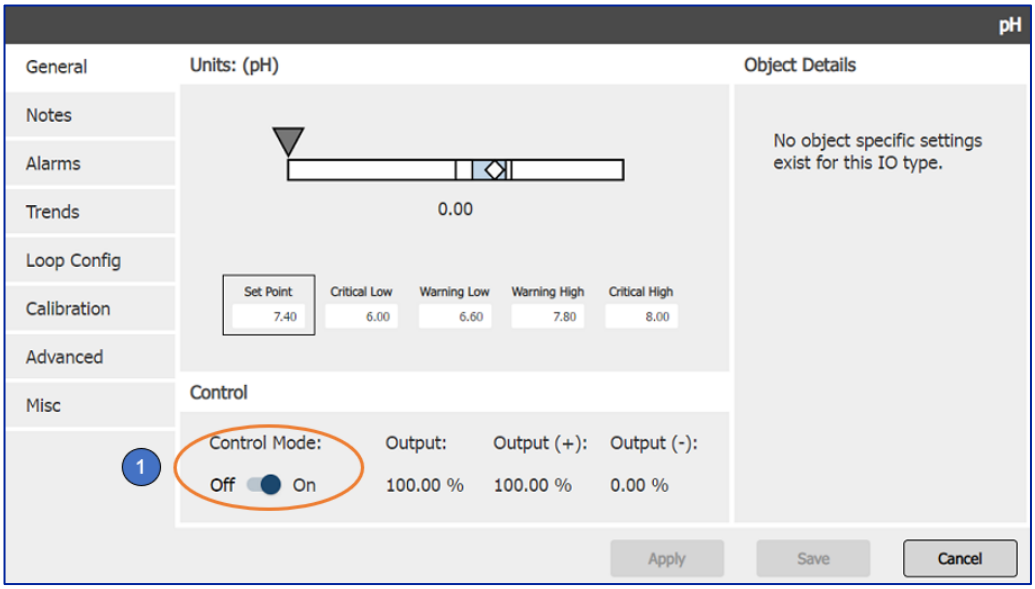
The control loop is created within a recipe. The control of pH, dissolved oxygen and temperature are achieved using a proportional, integral, and derivative (PID) control tower.

Default control parameters have been set by Pall using Pall standard operating procedures and representative cell lines. If your cell line has consumption and production dynamics which vary significantly from the cell lines used in tuning, then custom tuning may be required. Further details are available on request from your Pall applications specialist. When a loop is created, the maximum and minimum input values relate to how much of the loop in percent is used to control to the desired setpoint.

Each output parameter connected to a loop is shown on the control loop tab of the corresponding input.

**Figure 71**

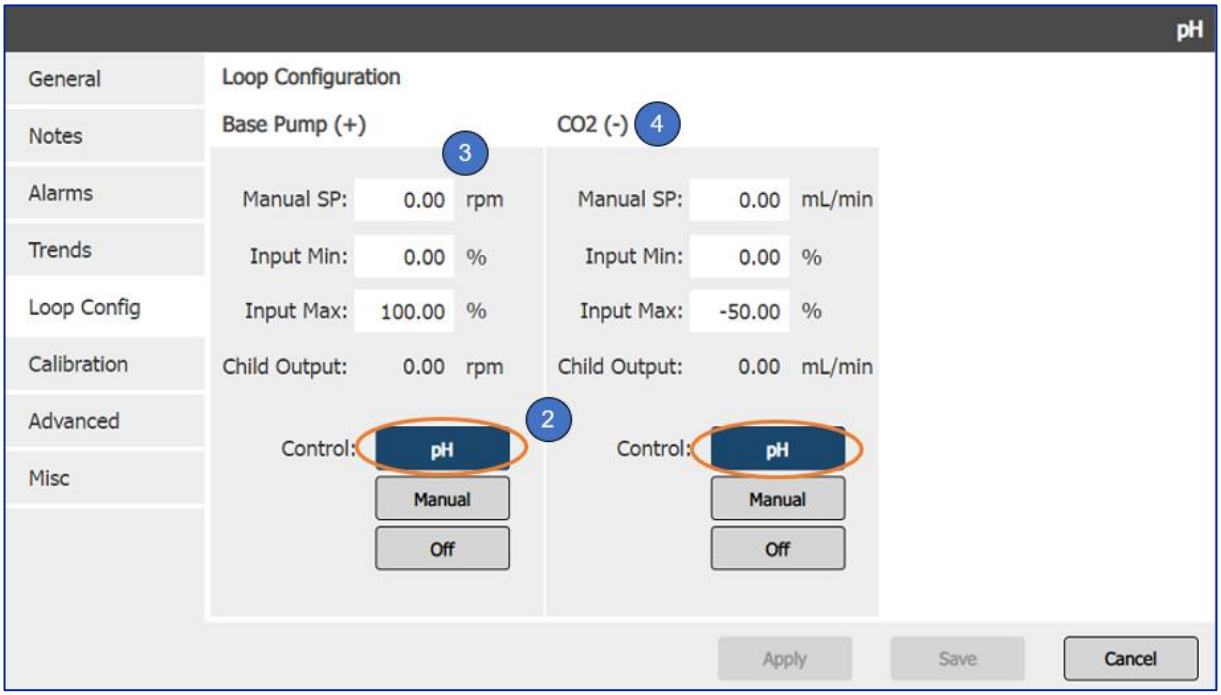
pH Loop config tab step 1




1. To activate the loop, ensure that the control mode is set to “On” from the general tab of an input parameter (for example Nano Temperature).
2. On the “Loop Config” tab of an input, ensure the control mode for the actuator is set to the desired input. Note: The available input displayed in the control loop column is configured during recipe set up.
3. If set to manual, the actuator will not control the input but will instead run at a manually entered set point. If set to off the output will turn off.
4. In the example above, “Nano Heating” can be linked to Nano Temperature by clicking the “Nano Temperature” control box. To activate temperature control, the control mode on the general tab of the Nano Temperature face plate should be set to “On”.

**Figure 72**

pH Loop config tab step 2, 3 and 4




### 11.1.1 Single Parameter Control

If a loop has been created with only one positive control parameter, the minimum input is 0% and the maximum input is 100%. This means that the control parameter is used the entire time the loop is active to control to the desired setpoint.

For negative control, the maximum and minimum values range from 0% to -100%.

*When creating negative control loops ensure a negative value is written to the input minimum and maximum parameters.*

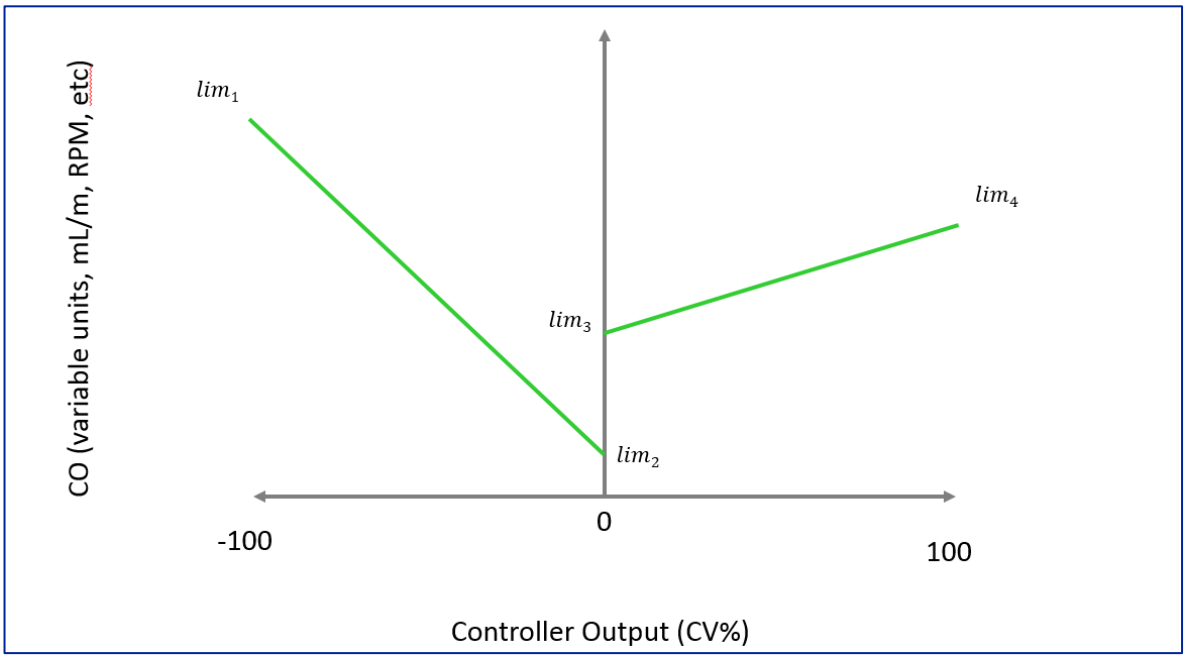
These parameters can be set by the user in the recipe to suit the needs of the batch. A single parameter control loop does not need to be 0 - 100% if the user does not require full use of that output.

*If an output minimum and maximum is not set for a control parameter, the parameter will run at 100% power/speed or flow rate.*

In the example below, temperature is being controlled by using a heating element as one positive child. The example shows that if the temperature loop output is at 100%, due to the present value being far below the desired setpoint, the heating element will be outputting its maximum power of 65°C to raise the temperature present value. As the temperature rises the output loop percentage will decrease which will in turn reduce the output power of the heating element allowing smooth control around the desired setpoint.

**Figure 73**

Single parameter control graph.

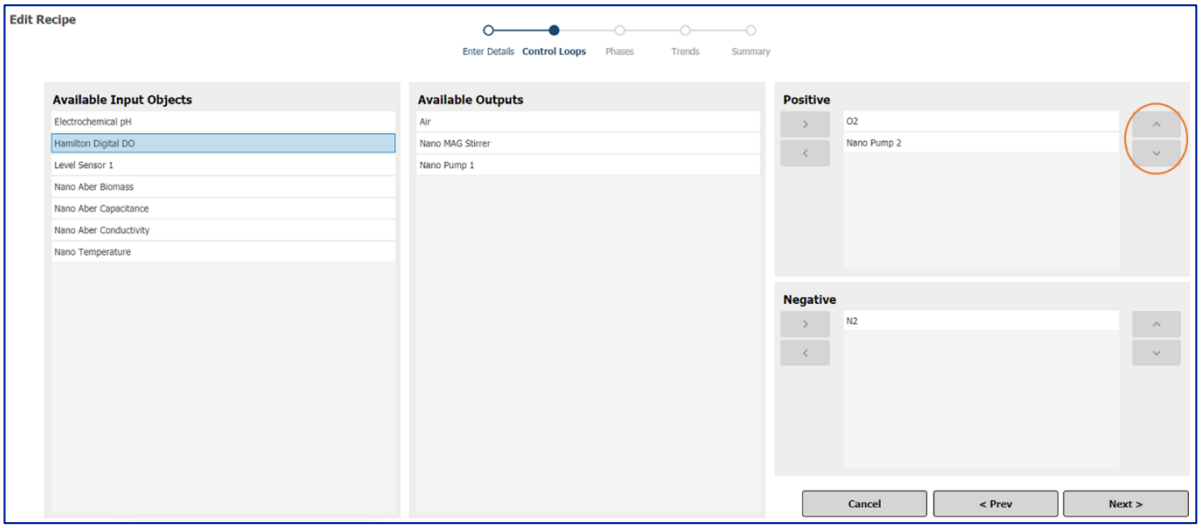



### 11.1.2 Multiple Parameter Control

If two or three control parameters have been selected, the minimum and maximum inputs depend on the order of the desired control. The up and down buttons in the control loops section of the recipe edit screen are used to set a priority of which control parameter is used before the next, to control to the desired setpoint.

**Figure 74**

Child priority buttons.




The explanations below are examples only; all settings are user editable in recipe set up. The percentages allow the control tower to switch control parameters if the desired setpoint cannot be reached using the initial control parameter.

Two actuators (children) – 1/2 split

1. **Positive control** – The control parameter selected first should have a minimum input range of 0% and a maximum input of 50%. The second control parameter should have a minimum input of 50% and a maximum input of 100%.

2. **Negative control** – First control parameter 0% minimum and -50% maximum. Second control parameter -50% minimum and -100% maximum.

- Three control parameters

1. **Positive control** – The control parameter selected first should have a minimum input range of 0% and a maximum input of 33%. The second control parameter should have a minimum input of 33% and a maximum input of 66%. The third control parameter should have a minimum input of 66% and a maximum input of 100%.

2. **Negative control** – First control parameter 0% minimum and -33% maximum. Second control parameter -33% minimum and -66% maximum. Third control parameter -66% minimum and -100% maximum.

The percentages allow the control tower to switch children if the desired setpoint cannot be reached using the initial child.

The example below shows the switching point at 65% DO output where agitation will increase in speed whilst oxygen is still be added at a fixed flow rate. When below 65%, agitation will run at whatever value the output minimum is set to.

**Figure 75**

Two child DO control using Oxygen and Agitation.

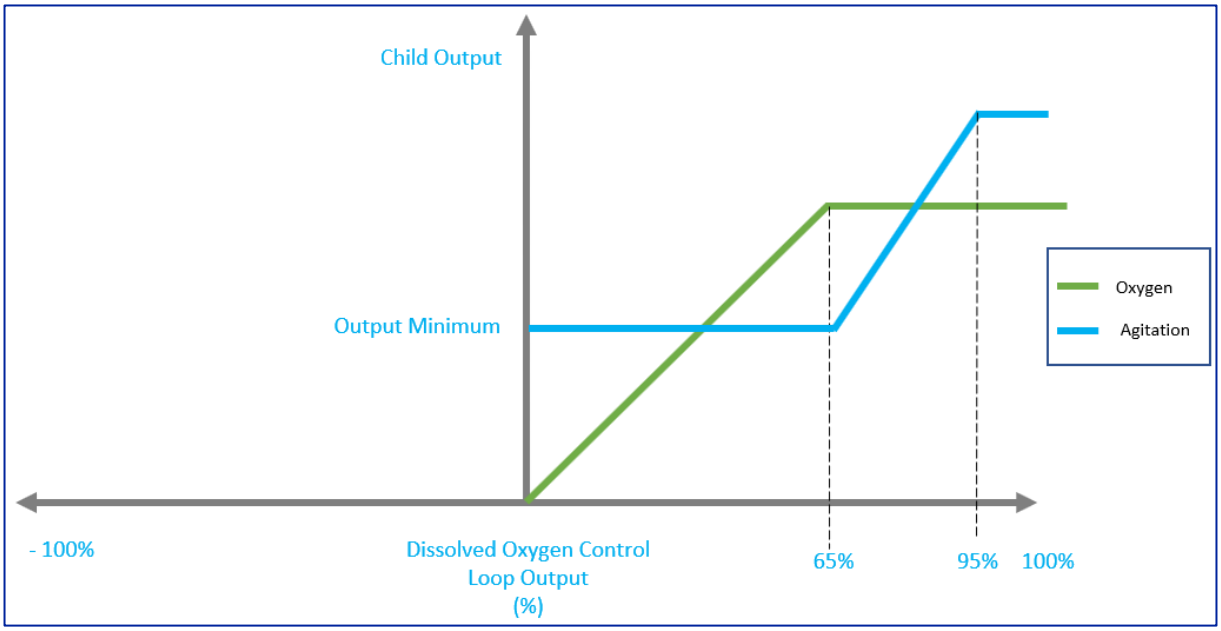
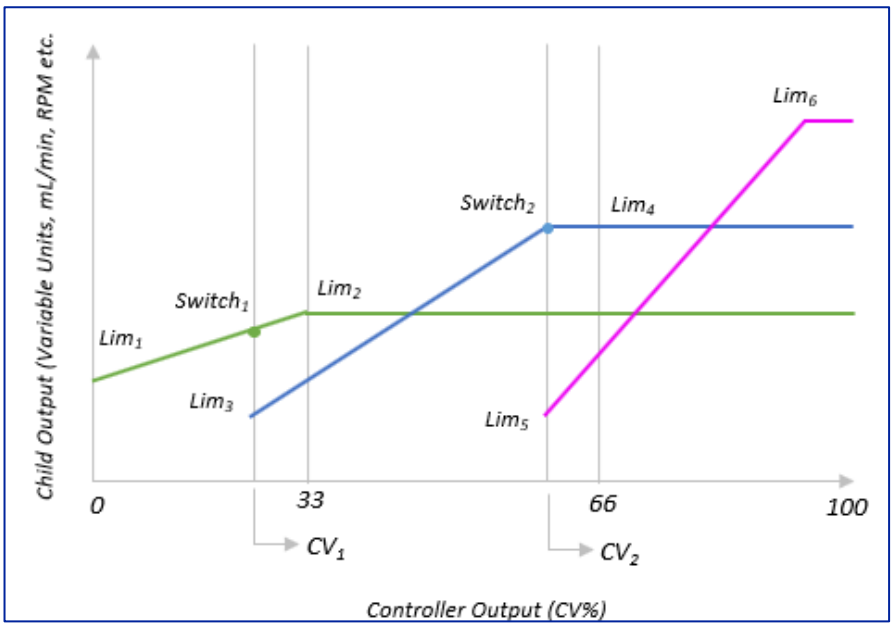


**Figure 76**

Multiple parameter control graph.




In the example above each limit (lim) represents the child's input minimum and input maximum values in percentage.

As the control loop output percentage increases towards 33% the green child will be delivering is output. As the control loop passes 33%, the green child's input maximum limit has been reached. This means that the green child will continue to deliver its output but at a constant rate. The blue child will begin to deliver its output alongside the green child. If the control loop cannot maintain its setpoint even though both children are supplying their output, the loop percentage will further increase. As the loop percentage increases past 66% the purple child will start to deliver its output alongside the green and blue children.

If the control loop reduces below any of the input minimum limits the children will reduce their output delivery or turn off altogether. Once control has been gained and the present value is closely matching the setpoint, the loop output percentage will stabilize.

### 11.1.3 DO and pH Control Philosophy

- Dissolved Oxygen- Can be controlled via positive and negative control parameters enabled during recipe setup. The P, I and D terms represent one control loop controlling to a user defined setpoint. The positive and negative control parameters are activated when the present value is either higher or lower than the desired setpoint:

1. Positive control is active when process value is lower than the setpoint
2. Negative control is active when the process value is higher than the setpoint.

The accuracy range for dissolved oxygen is +/- 5% of the setpoint.

- pH- Like DO, pH can be controlled by positive and negative control parameters to a setpoint with a common dead band. The dead band is equidistant to the setpoint. pH will be controlled by 2 sets of P, I and D parameters. One set for the acidic setpoint (positive side of the dead band from the setpoint) and one set for the basic setpoint (negative side of the dead band from the setpoint). The user interface will display both sets of P, I and D values which are editable.

# 12. Alarms

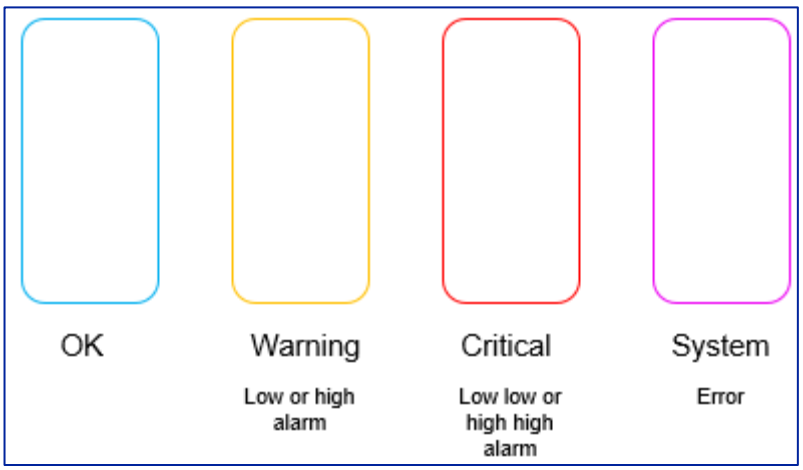
## 12.1 LED Light Ring

During a batch, the status ring encircling the face of the control tower will change color depending on the status of the batch. If there is an alarm detected:

If there is an alarm detected:

- The status ring will be amber or red depending on criticality
- Or pink if a system alarm is detected.

**Figure 77**
LED light ring colors.




## 12.2 Status Bar

The top status bar will reflect the state of the unit selected from the left side bar. If "System > Dashboard" is selected on the left side bar, then the status bar will display the highest priority of any connected unit. Priority from highest to lowest. Table 9.

**Table 9**
Priority level.

| Text | Color | Description |
|---|---|---|
| Critical | Red | Low low or high high alarm |
| System | Pink | System error |
| Warning | Amber | Low or high alarm |
| OK | Blue | Running batch with no alarms |
| Paused | Blue | Paused batch with no alarms |
| Idle | Grey | No running batch with no alarms |

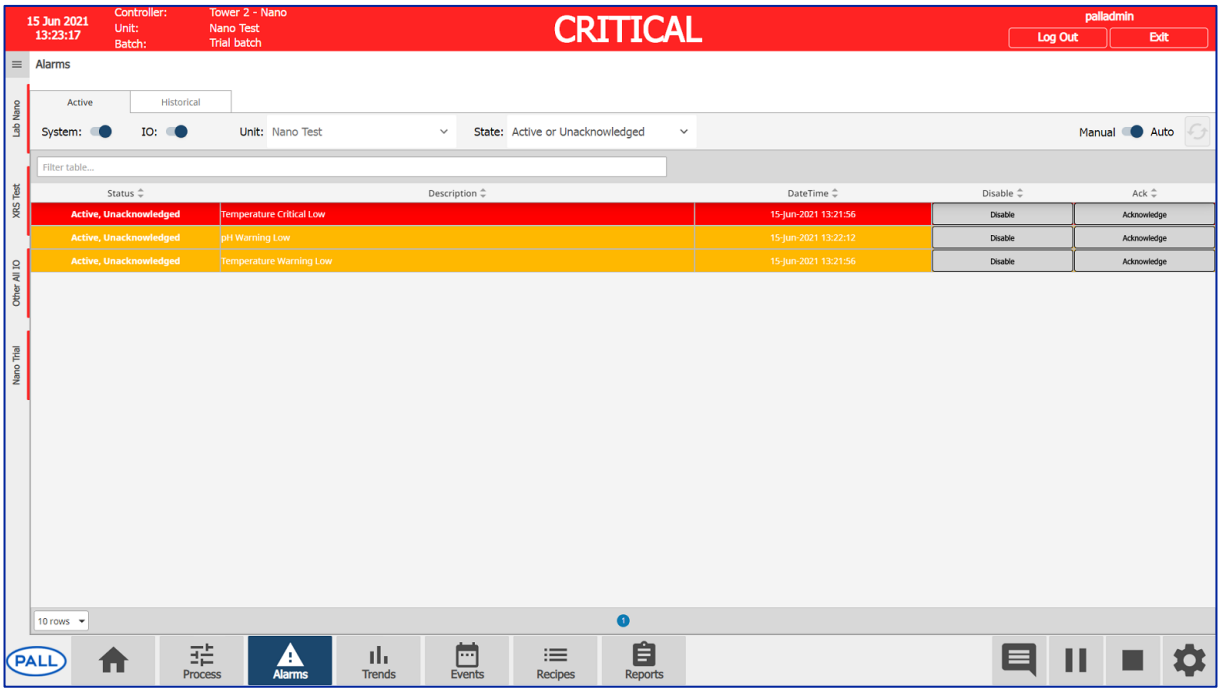
If the status bar is selected, then the user will be navigated to the alarms screen. If system, is selected from the left side bar, the alarms screen will show all alarms from all connected units. If a unit is selected from the left side bar, the alarms screen will be filtered on the specific unit and the filter will not be configurable.

## 12.3 Alarm Screen Description

The alarms screen can be accessed through either the status bar or the main navigation.

**Figure 78**

Active alarms screen.




The alarms screen has two tabs for active and historical alarms. The active screen is set out in a tabular format showing the alarm status, description, date/time stamp and buttons to disable and/or acknowledge. This will display alarms that have not been cleared (still triggered) or alarms that have not been acknowledged.

Prior to an alarm being acknowledged, the light ring will flash and the row in the active alarms screen will be amber, red or pink dependent on the alarm type. Once an alarm is acknowledged, the light ring will stop flashing. The alarm status will show as acknowledged but it will remain in the active alarms table. The background color will change to white for the row that has been acknowledged.

The status bar will remain the color of the alarm until the alarm is acknowledged and cleared. If the alarm criteria are no longer triggered (e.g. temperature recovers above low alarm) or it is disabled, the status in the active alarms table will show as cleared and the status bar will no longer display the alarm color once acknowledged. If an alarm has been cleared but not acknowledged, the status bar will remain the color of the alarm until it has been acknowledged. The user can filter the alarm view by selecting system or I/O alarms, unit, state or by use of the free text filter.

The historical tab displays past alarms and can be filtered as per the active alarms screen with the addition of being filtered by batch.

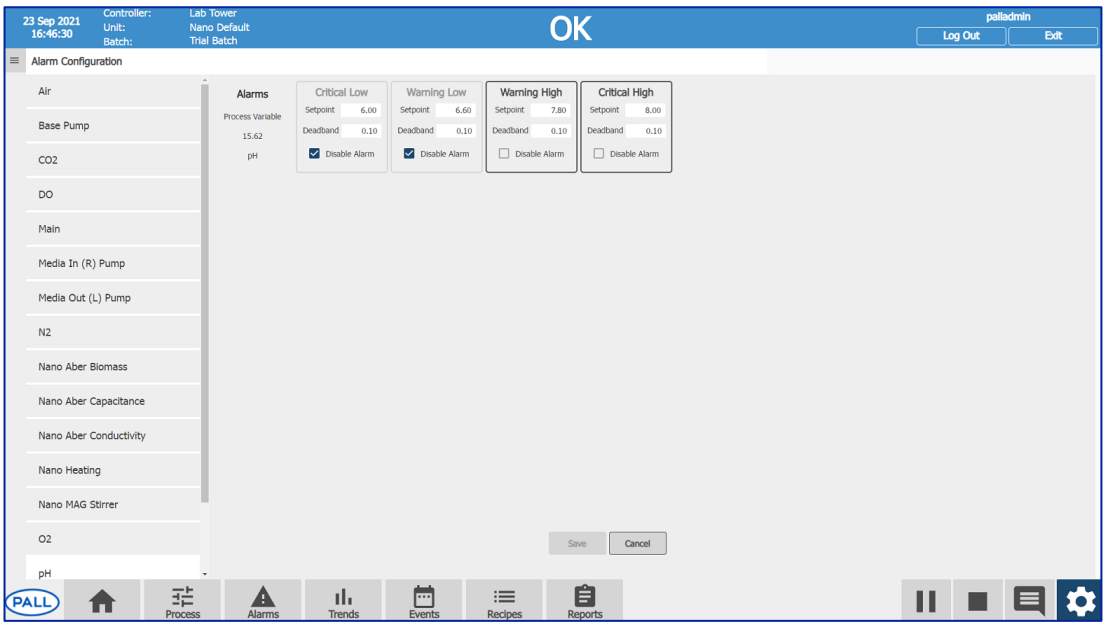
## 12.4 Alarm Configuration

### 12.4.1 Settings Tab

When a unit is selected from the side bar, the user can navigate to the alarm configuration screen using the settings icon.

**Figure 79**

Alarm configuration screen.




Through this screen, the user can configure critical and warning set points for each parameter relating to the selected unit. in addition, the user can change the dead band or use a tick box to enable or disable the alarm. The "Main" option relates to hardware alarms, which have no setpoints, so can only be enabled or disabled.

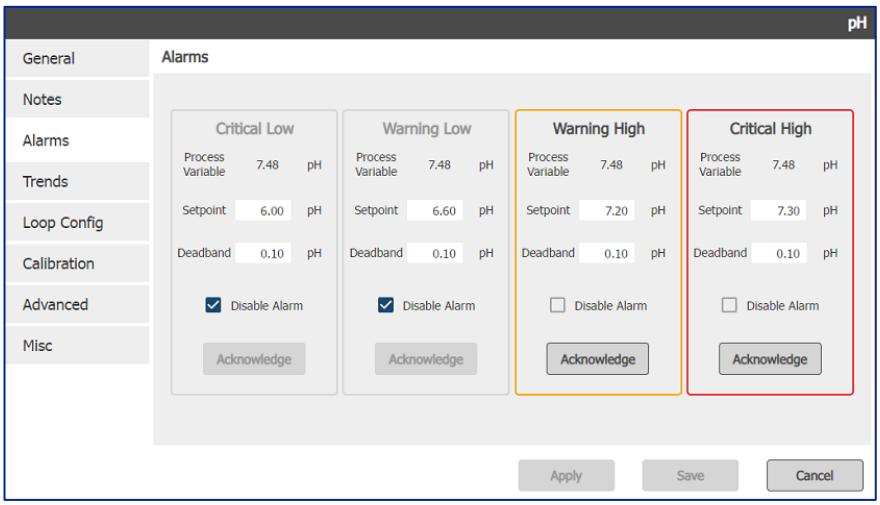
### 12.4.2 Faceplate

Alarm setpoints can also be viewed and edited during a batch by selecting the desired parameter from the process screen.

- From the process screen, first select the desired parameter and select the Alarms tab.
- When an alarm is present, the border of the triggered alarm will show in color on the faceplate in addition to the status bar.
- The alarm can be acknowledged if it is safe to do whilst the issue is investigated. The color will remain around the alarm border and on the navigation bar until the alarm is acknowledged and cleared

**Figure 80**

Alarms tab with high alarms triggered



- Once acknowledged and cleared (either by being disabled or the process value coming back within limits, the status bar will show as idle or OK if no other alarms are present.

### 12.5 System Alarms

System alarms will present when issues occur which are not related to user set alarms in a recipe, for example, loss of communication between control tower and mPath Link server. System alarms will display a flashing pink color status ring on the control tower and status bar on screen.

System alarms will be displayed in the active alarm screen with the row highlighted pink:

- Many system alarms can be cleared by ensuring all connections are connected securely and communications between tower and unit are active.
- If all connections are properly connected the alarm should self-clear. Alarm will only self-clear if acknowledge button has also been selected.
- If the alarm does not clear, and it is safe to do so, disabling the alarm will allow continuation of the batch and the LED light ring will return to blue.
- If the system alarm is not removed, please refer to troubleshooting.

If an alarm is present and the unit is deleted from the mPath Link software, the alarm will remain on the control tower. To remove this alarm, a new unit will need to be created to clear the alarm. To avoid this, remove or acknowledge all alarms before deleting a unit.

A list of alarms that are not present in faceplates are included in Appendix E for troubleshooting purposes.

### 12.6 Disabling Alarms on Batch Start

When a batch is running, all alarms are active. The control tower will display warning and critical alarms due to the high and low setpoints as well as system alarms. During preparation of a batch, present values of many parameters will be either above or below the setpoint. In this case the control tower will display alert and critical alarms on the mPath Link server and via the LED light ring. Alarms at this stage in a batch may be bothersome to the user due to the duration of the preparation stage.

To disable alarms for this stage of the batch the user can acknowledge and disable where required either through the faceplate or the alarm configuration screen. Acknowledging and disabling alarms should only be undertaken by experienced users and will not be available to those with operator user privileges.

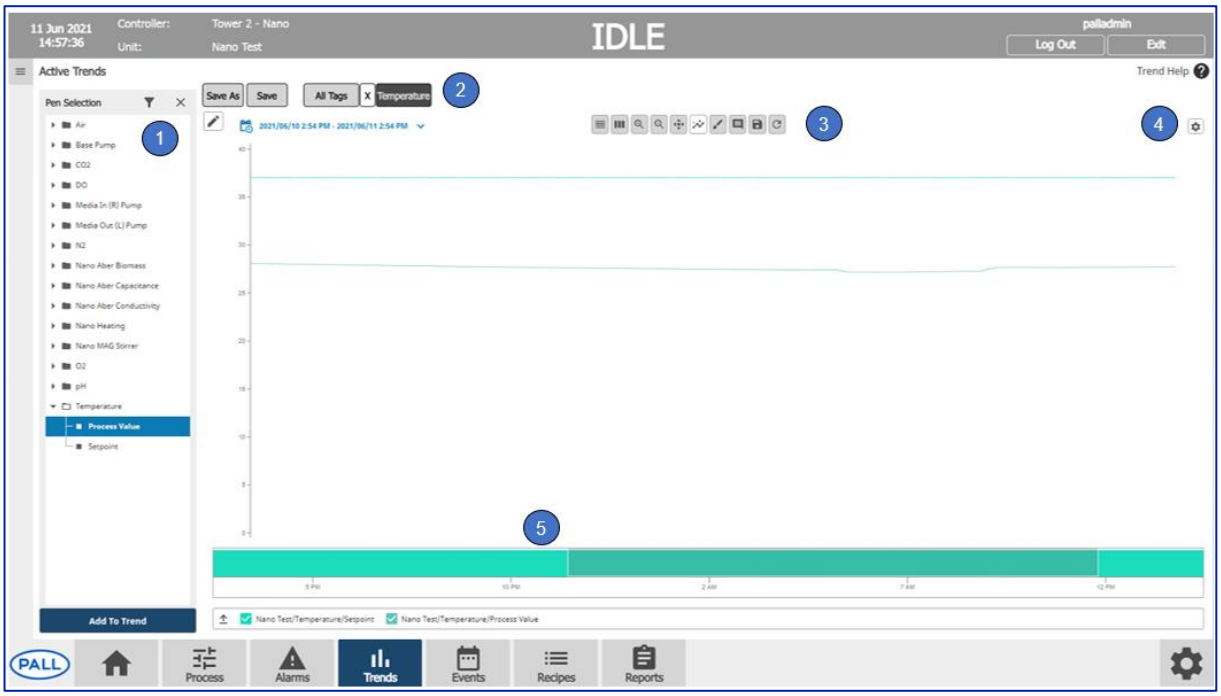
## 13. Trends

### 13.1 Active and Batch

With a unit selected from the side bar, selecting the trends icon will navigate the user to the active trends screen. From here, the user can create and save trends specific to the selected unit and view any trends created as part of a running batch.

**Figure 81**

Active trend screen.

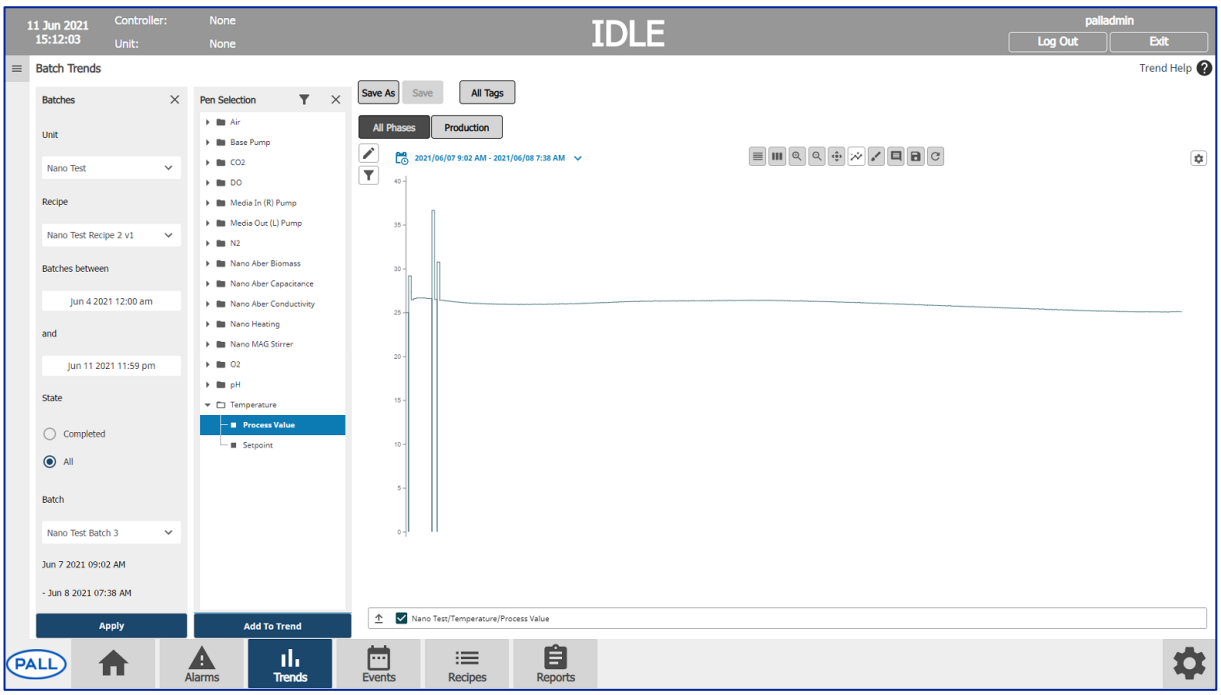



| Area of Screen | Description |
|---|---|
| 1 – Pen Selection | Choose the parameters to trend before selecting "Add to Trend". By default, the view will be filtered to process values, but the filter icon can be used to trend more advanced parameters. |
| 2 – Saved Trends | Trend configurations can be saved and edited |
| 3 – Trend | Trend controls. |
| 4 – Trend Settings | Brings up chart control settings for detailed configuration to axes, pens, and plots. |
| 5 – Range Selector | Can drag regions on the range selector to change the time on the x axis. |

With system selected from the side bar, selecting the trends icon will navigate the user to the batch trends screen. This has the same functionality as the active trends screen with the addition of the batch filters which allows historical trends to be configured based on unit, recipe, date, or batch.

**Figure 73**

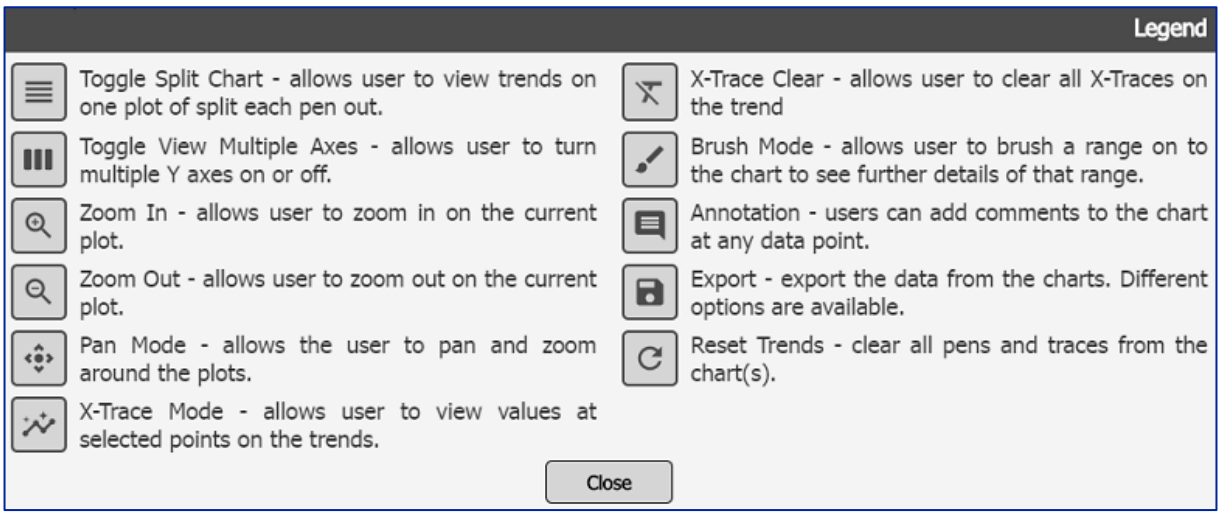
Batch trend screen




A range of different actions can be conducted to alter the current trend which are explained using the on-screen help button.

**Figure 74**

Trends help button overview



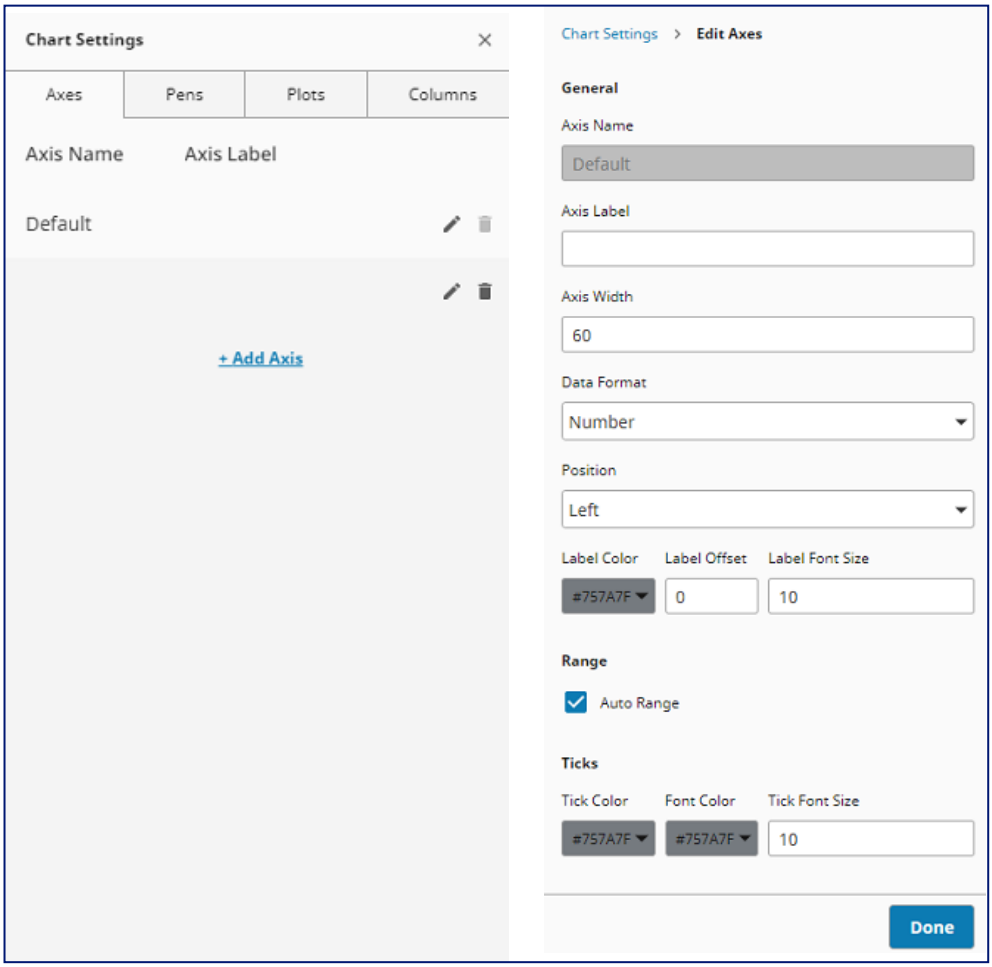
## 13.2 Trend settings

Selecting the trend settings icon allows for a range of detailed configuration.

### 13.2.1 Axes

**Figure 75**

Trend's axis configuration

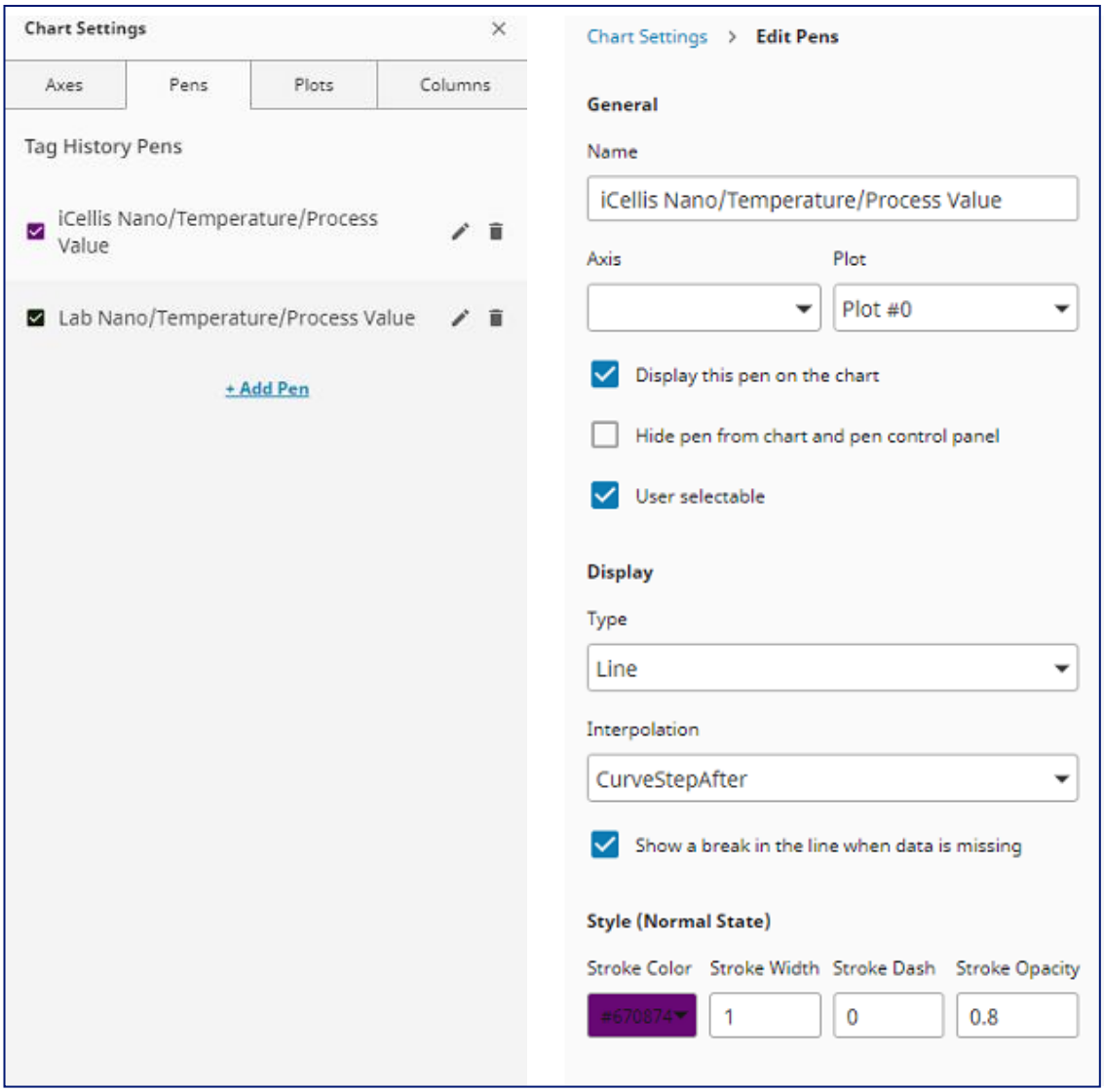



A list of all available axes on current plots will initially be displayed. Selecting the pencil icon next to an axis will bring up the settings allowing for customization to labels, colors, text, and general formatting.

### 13.2.2 Pens

**Figure 76**

Trends pen configuration.



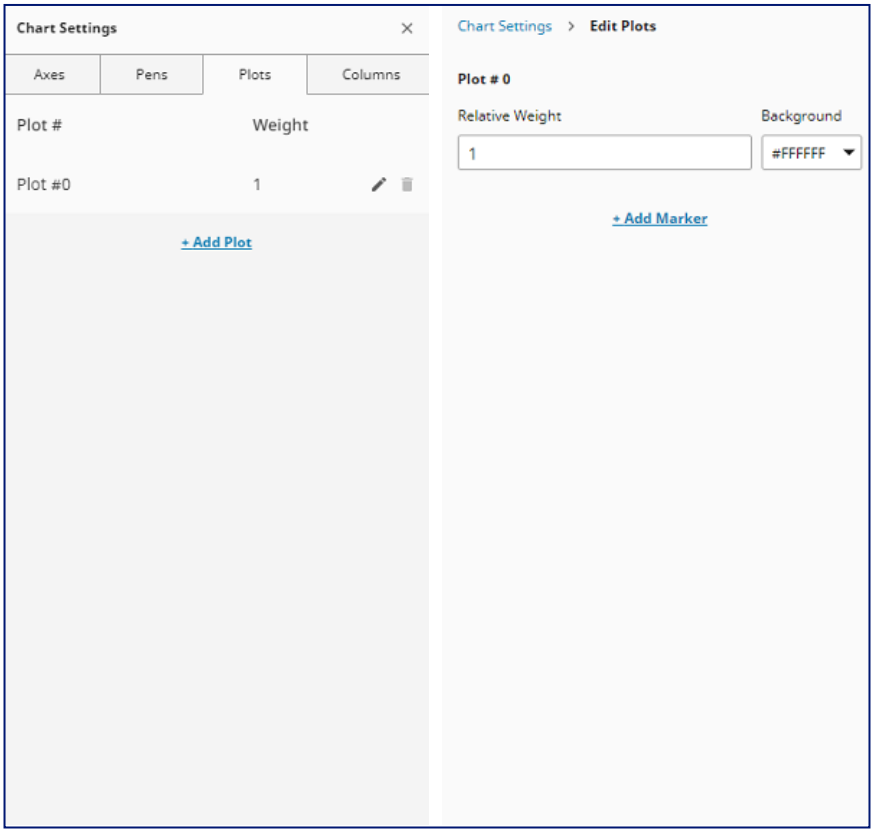

Any parameters that have been added to a trend will be displayed as a "Pen". They can be removed by pressing the bin icon or edited with the pencil icon. By default, any added pens will be plotted on the same plot initially. By selecting the drop-down icon for plot, the pens can be moved onto separate plots if required. If multiple axes have been added, it is possible to move the pen to a different axis using the axis dropdown.

A range of different formatting options can be changed on the pen and scrolling to the bottom of the edit pens window will show a preview of the current configuration.

### 13.2.3 Plots

**Figure 77**

Trends plot configuration.

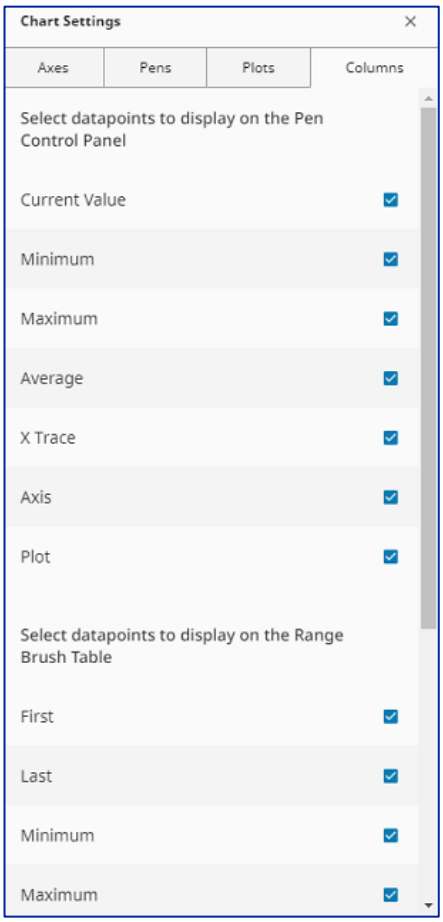



Initially pens will be added to the same plot. Selecting the "Add Plot" option will add an additional plot which pens can be added to. Plots can then be removed using the bin icon or re-formatted using the pencil icon.

### 13.2.4 Columns

**Figure 78**

Trends column configuration

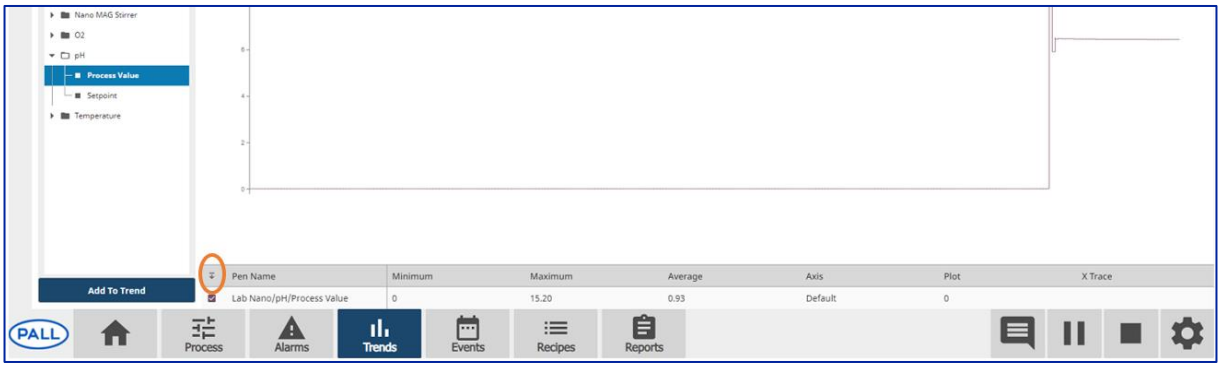



Selecting the columns option defines the parameters that can be displayed when using the "Brush Mode" and the Pen Control Panel.

The pen control panel can be accessed by selecting the icon highlighted in Figure 79 beneath the x axis. This then brings up a collapsible row detailing additional information about the trend area on screen

**Figure 79**

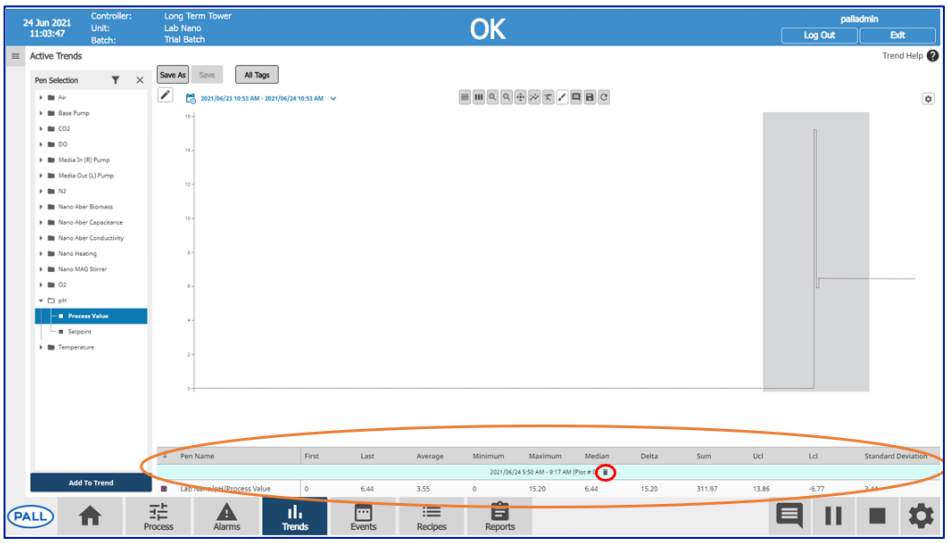
Trends pen control panel




When the brush icon is chosen, dragging on a region of the cart will "brush" that area for further details.

**Figure 80**

Trends brush feature



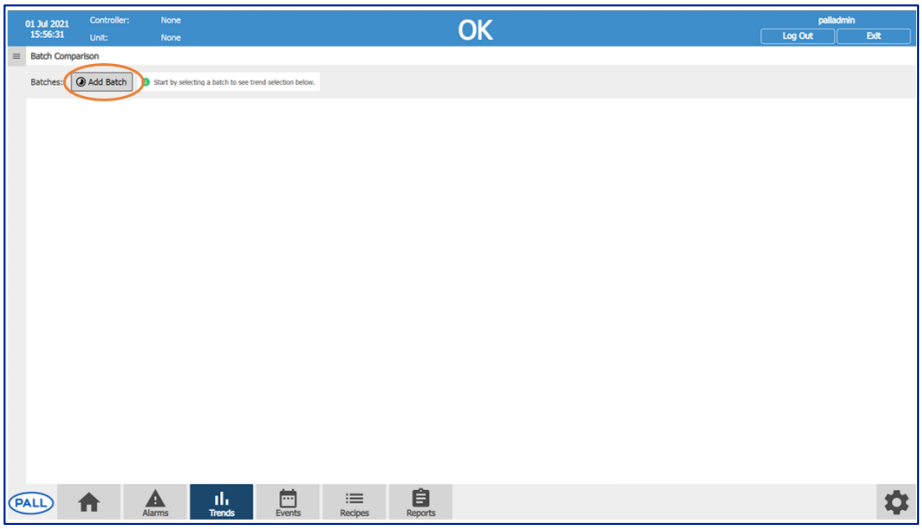

The brushed region will be greyed out on the trend and the details as defined in Figure 74 will be displayed beneath the x axis. To remove the brushed region from the screen the bin icon (highlighted in red Figure 80 can be selected).

## 13.3 Batch Compare

Selecting Trends > Batch Compare allows the user to compare trends of historical or running batches through the batch compare screen.

**Figure 81**

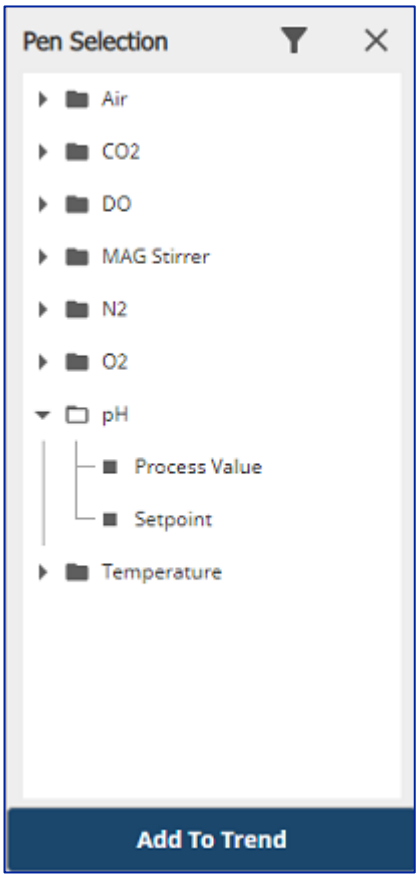
Batch compare screen




- Select a batch using the Add Batch icon. Multiple different batches can be added.
- Once added, select the “Add Parameter Trend” button in the middle of the screen
- This will show a list of available parameters to trend initially filtered to process value and setpoint.
- Selecting the filter icon allows the user to trend advanced parameters including alarms, engineering setpoints, object specific details and PID settings.

**Figure 82**

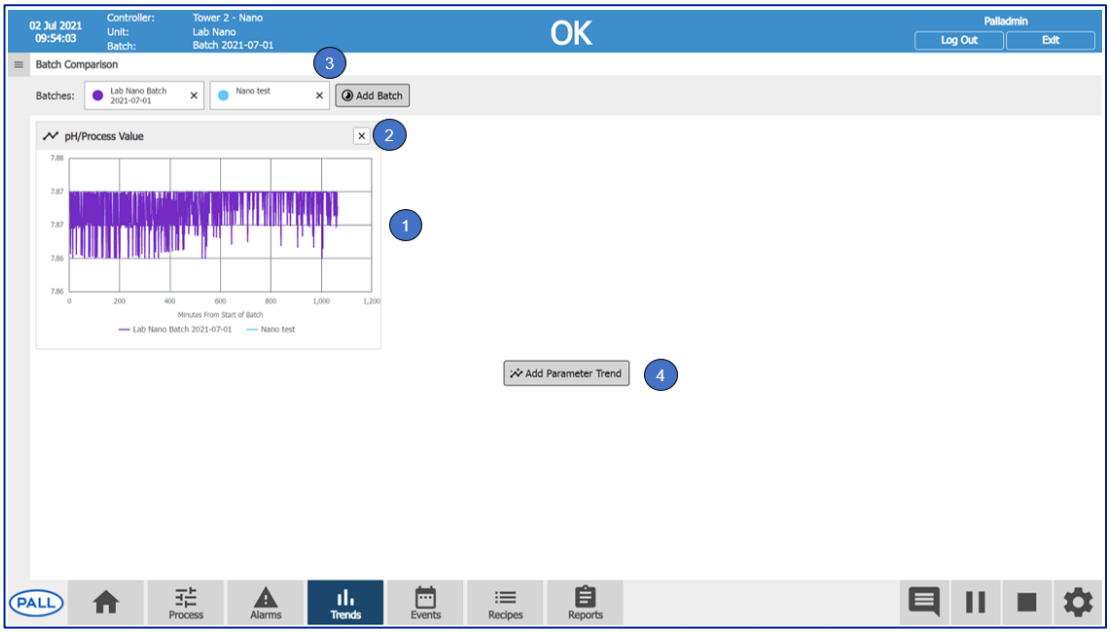
Batch compare. Add parameter trend button




1. Once batches and parameters have been added, the trend will appear in the content area. A separate plot will be displayed for each parameter and each plot will have a trend line with a different color for each batch. All trends will be plotted from the start of the batch with the x axis displaying "minutes from start of batch".
2. Plots can be removed using the x in the top right.
3. Batches can also be removed using the x next to the batch. The plots will remain and display the configured trends for the remaining batches.
4. Additional trend parameters can be added using the "Add parameter Trend" button.

**Figure 83**

Batch compare screen example

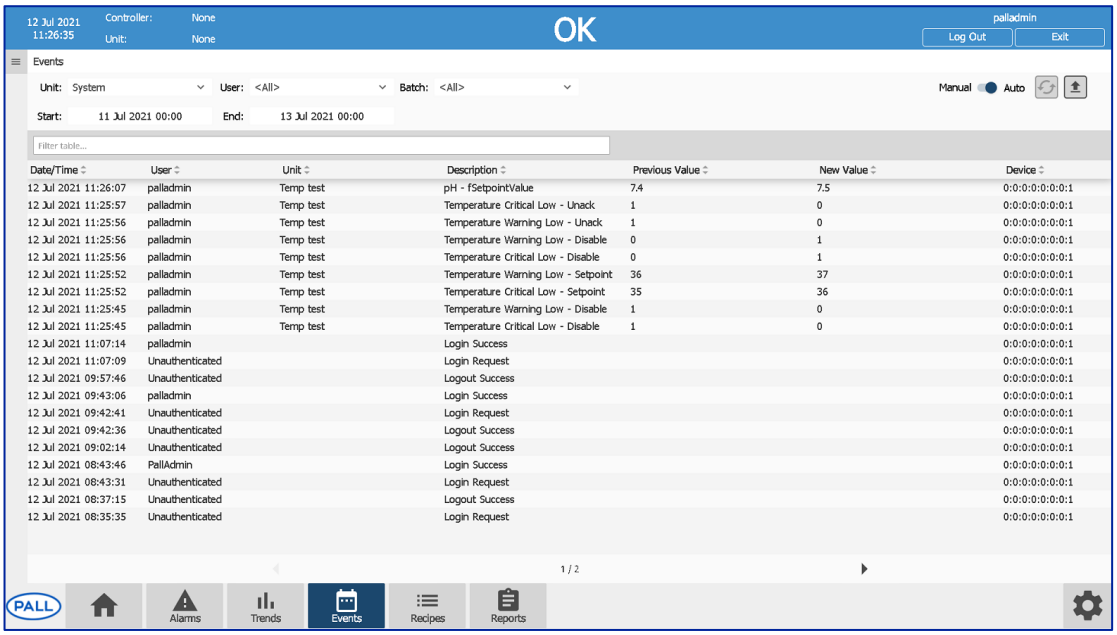



## 14. Events

The Events screen displays in a tabular format, all actions made by the user when commands are written to the programmable logic control tower. When system is selected from the side bar, the table will display entries from all connected units with the option to filter on unit, user, or batch. When a unit is selected from the side bar, the filter will be set to view only events related to the selected unit.

**Figure 84**

Event log screen



The event log displays the event date/time, user, unit, description, previous value, new value, and device in a tabular format. In addition to the standard filters listed above, the screen also has search filters based on text or date range.

### 14.1 Export

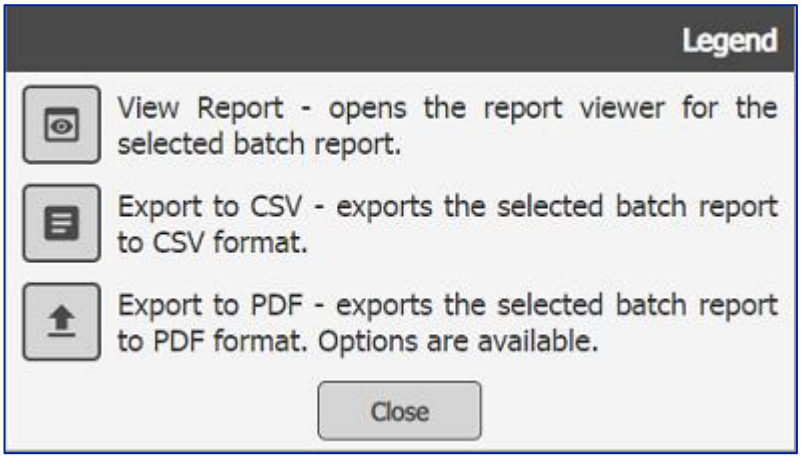
Selecting the export button brings up a preview pdf view of the current screen. Note that the preview will include any filters that have been set. Selecting the export icon will allow the user to export a pdf of the events table to a location of their choice.

## 15. Reports

Reports are automatically generated upon completion of a batch. Navigating to the reports tab when system is selected from the side bar shows reports that have been generated across all units. The user will be able to filter by unit, user, or state (released, retired or unreleased)

If a unit is selected from the side bar, only reports related to that specific unit will be displayed. The unit filter will be fixed to the unit and the user will be able to filter by user or state. Three actions are available for each report.

**Figure 85**
Report actions




### 15.1 View

Selecting the view icon allows the user to view different aspects of the batch. From the details tab, the user also has the option to export the report.

**Table 11**
Available batch aspects.

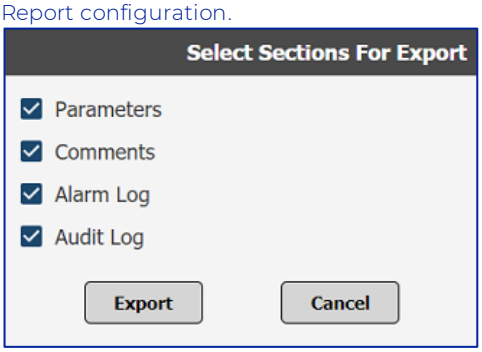
| Tab | Description |
|---|---|
| Details | Gives the unit and recipe details in addition to the batch start and finish times |
| Phases | Details the phases conducted during the batch and the status of each phase. Selecting a phase allows the user to view all parameters and values configured during the phase. |
| Trends | Trends can be configured to view process data during the batch |
| Comments | Any comments recorded against the batch whilst running will be visible |
| Alarm Log | Lists any alarms triggered whilst the batch was running |
| Audit Log | Lists all audited actions that were carried out during running of the batch |

## 15.2 Export

Selecting the export icon allows the user to configure which aspects are included in the report. Once the export button is selected, a preview of the report will be displayed which can then be exported in pdf format to a location defined by the user.

**Figure 86**

Report configuration.




| Selection | Description |
|---|---|
| All unticked | The most basic report that can be exported, which exports a report with a mini trend of the process value for each parameter in addition to any alarms or comments linked to each parameter. This information will be included on all reports exported regardless of the selection. |
| Parameters | Adds into the report the values set for all parameters in each phase of the batch. Will include set points, alarms, and advanced settings. |
| Comments | Adds into the report any comments linked to the batch. |
| Alarm Log | Adds into the report a table of any alarms triggered during the batch. |
| Audit Log | Adds into the report a table of all audited actions during the batch. |

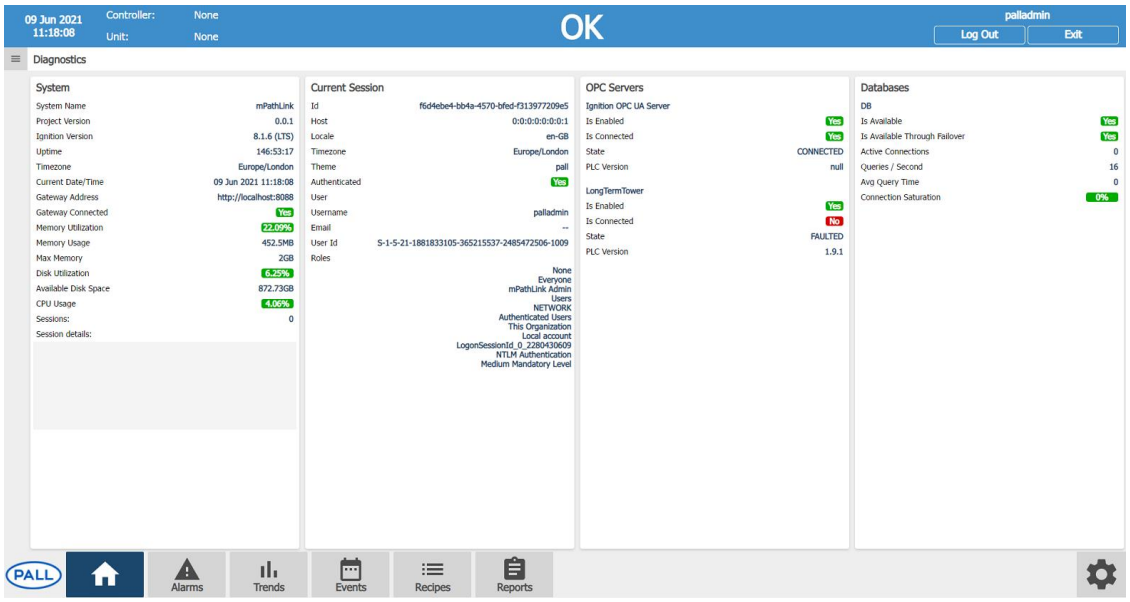
# 16. Diagnostics and Troubleshooting

## 16.1 Diagnostics

The performance and diagnostics of the mPath Link system can be observed and monitored during use from the diagnostics screen located through the settings tab. This information is likely only to be used by Pall representatives when performing system checks.

**Figure 87**

Diagnostics screen




## 16.2 Trouble Shooting

Table 12

| Issue / Error | Troubleshooting |
|---|---|
| Status ring is not static after 40 seconds | Issue – Control tower not booting properly.<br>Turn off power to control tower and leave powered off for 2 minutes due to retentive memory. Re-connect power and switch on control tower. If status ring does not remain static after 40 seconds, there may be an issue with the PLC license. Please contact Pall. |
| Pink light right upon start up | System error present from uncontrolled shut down.<br>Navigate to "Alarms" tab and scroll to find shutdown alarms. Press Acknowledge button. |
| Control tower connection faulted | Check network connections.<br>Check IP address and port configuration entered mPath Link is correct for the control tower.<br>Check that the CX number is entered correctly.<br>Press "Save" after editing or confirming IP addresses, port configuration and CX number in control tower setup.<br>If the connection remains faulted contact your IT department to check the IP address of the control tower and mPath Link server computer. |
| Loss of communication to unit | Check the status of the OPC UA server. If communications are still lost to the unit check all connections are correct between the control tower and unit.<br>Repeat steps in 'Control tower connection faulted' step. |
| Loss of communication to Allegro XRS 25 unit | System alarm will be present.<br>If there is a "Comms Fault" ensure the Allegro XRS 25 unit is turned on and the communications cable is connected between control tower and Allegro XRS 25 unit. |

| | |
|---|---|
| | Navigate to the “Alarms” screen, scroll through the list, and acknowledge all Allegro XRS 25-unit status alarms.<br>If communication status does not resume, shut down the control tower and Allegro XRS 25 unit. After 30 seconds power up the control tower followed by the Allegro XRS 25 unit. Clear the system error due to uncontrolled shut down as described above. |
| Input and output connections not sending readings to user interface | Ensure all input and output connections are connected securely to the control tower and are in the correct ports. |
| Input and output connections not reading correctly | Ensure all input and output connections are connected securely to the control tower in the correct ports. Perform calibration. |
| Loss of on-screen functionality | If the on-screen view displays control parameters shown with red X’s and greyed out text, check the status of the OPC server and that all connections are correct. Ensure the control tower is showing as connected on the diagnostics page.<br>Ensure the mPath Link Server is powered on and the software is operating. |

| | |
|---|---|
| Low pressure | There is insufficient inlet pressure to the gas mixing block. Pressure supplied should be 2 bar (29 psi) minimum. |
| Incorrect gas mixing | Ensure the correct gas lines are connected to the inlet and outlet ports on the control tower.<br>Ensure that the gas supply to control tower is the correct gas from the regulator.<br>Re-calibration of the gas block may be required. Contact Pall. |
| Control tower will not power on | Ensure all electrical connections to the electrical supply are completed and that the appropriate provided power cables are used.<br>For further support please contact units@pall.com. |
| Alarm present but unit deleted | If a unit was deleted before its alarms were acknowledged or cleared. A unit of the same type can be created to then clear any alarms through the Alarms tab. |
| Freezing of alarm screen | If the alarm screen freezes the server may not be able to handle the read/write requests to update a large number of alarms as well as log data.<br>Reduce the number of alarms displayed per page. |
| On screen keyboard does not appear on HMI or Windows devices | Through the Windows menu, navigate to Settings > Typing. Ensure the option “Show the touch keyboard when not in tablet mode and there’s no keyboard attached” is set to on. |

# 17. mPath Link Mobile Application

The mPath Link application is designed to be compatible across IOS and Android mobiles and tablets. If opened on a tablet, the mPath Link application will provide the exact same functionality as when opened on a desktop monitor. The mobile application, however, provides a reduced functionality set more relevant to the needs of a mobile user.

## 17.1 Install

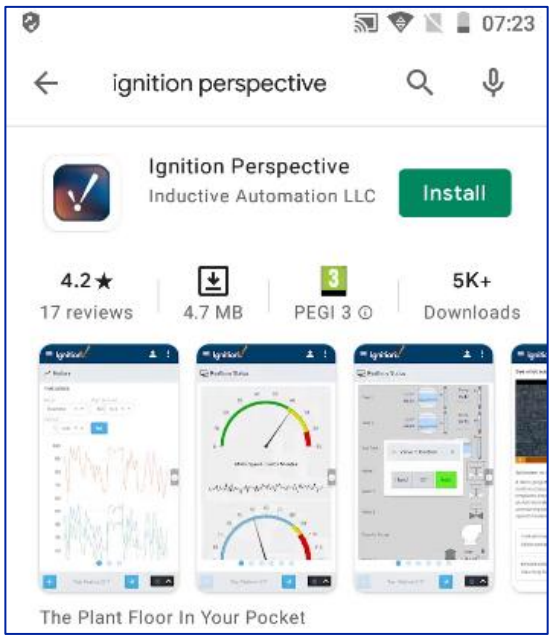
The following installation instructions are based on an Android phone but are applicable to other IOS and Android devices.

### 17.1.1 Application Installation

With the mobile device, go to Play Store or App store and search for Ignition Perspective to install the Ignition Perspective App.

**Figure 88**

Ignition Perspective play store




Once installed, the application should appear on the mobile desktop.

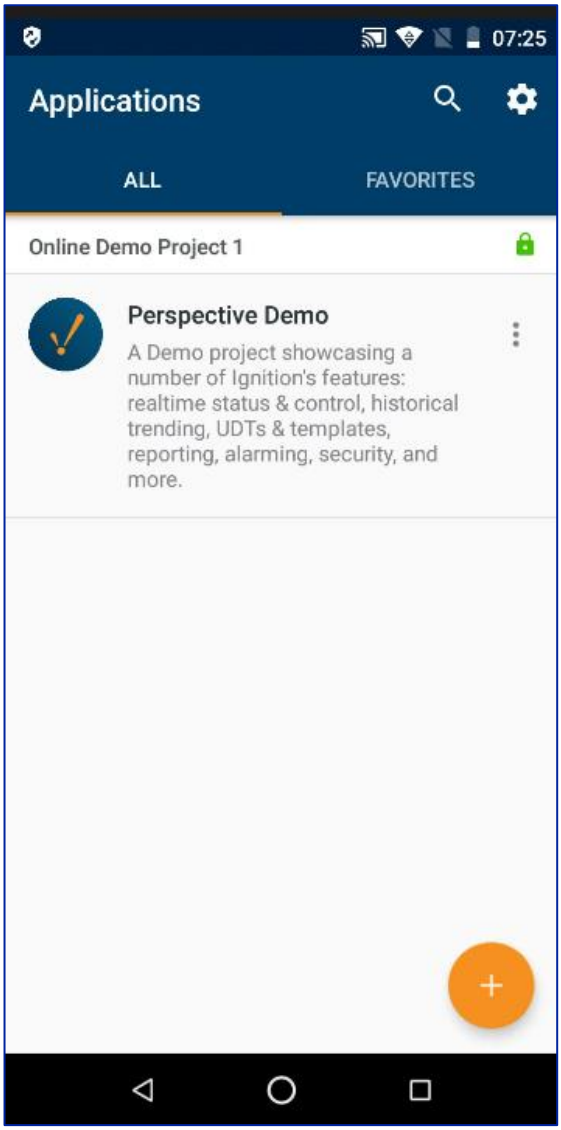
**Figure 89**

Ignition Perspective installed


Open the application and tap "+" button to add the mPath Link application to the mobile. It is also recommended to remove the Perspective Demo by taping on three dots next to it and selecting "Remove Application (swipe right to remove on IOS)"

**Figure 90**

Adding mPath Link

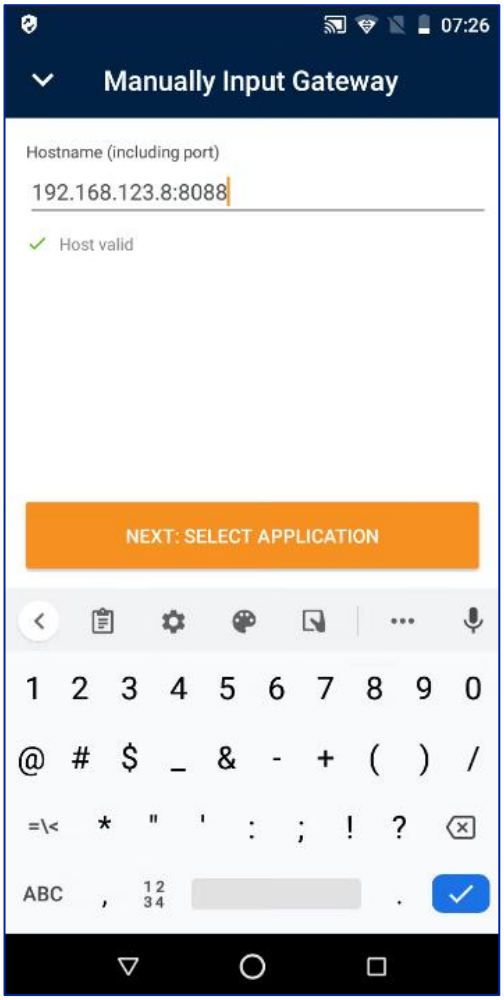



Select Manually Input Gateway and type in Hostname including port. In this example, configuration has been made to connect to the mPath Link server located under 192.168.123.8 IP address and port 8088 (standard port used), although this may differ dependent on the server installation. Once the host is validated, the application can be selected.

The mPath Link server (Pall PC as standard) must be connected to a network accessible by the mobile device to connect.

**Figure 91**

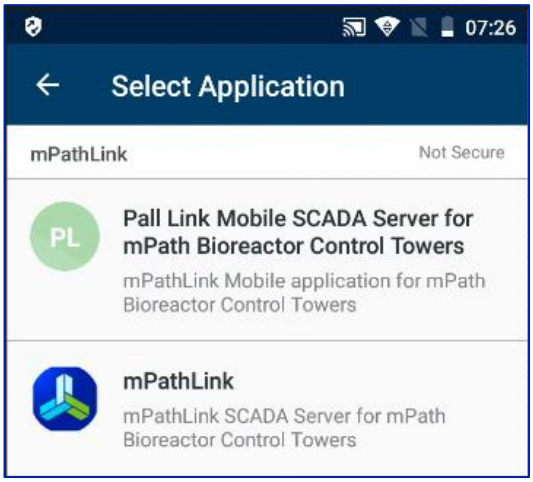
Manual gateway input




Select mPath Link Mobile application from the list of available applications.

**Figure 92**

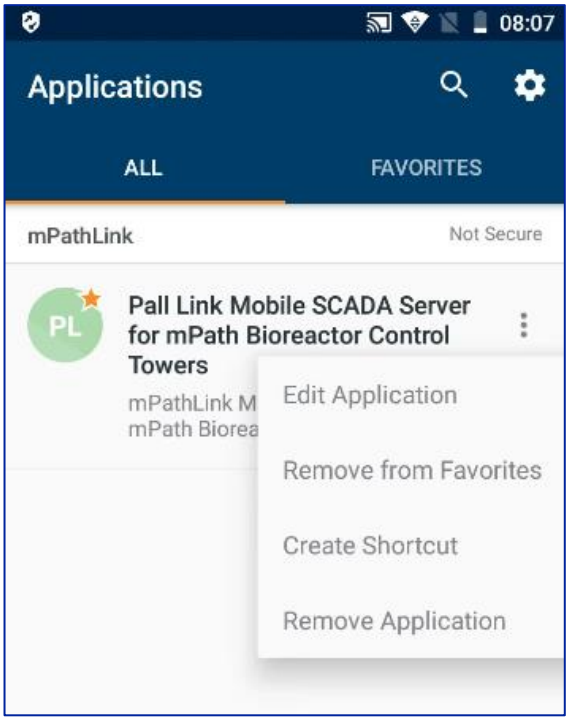
mPath Link mobile application selection



Once the application is selected, it can be further configured by taping on three dots next to it.

**Figure 93**

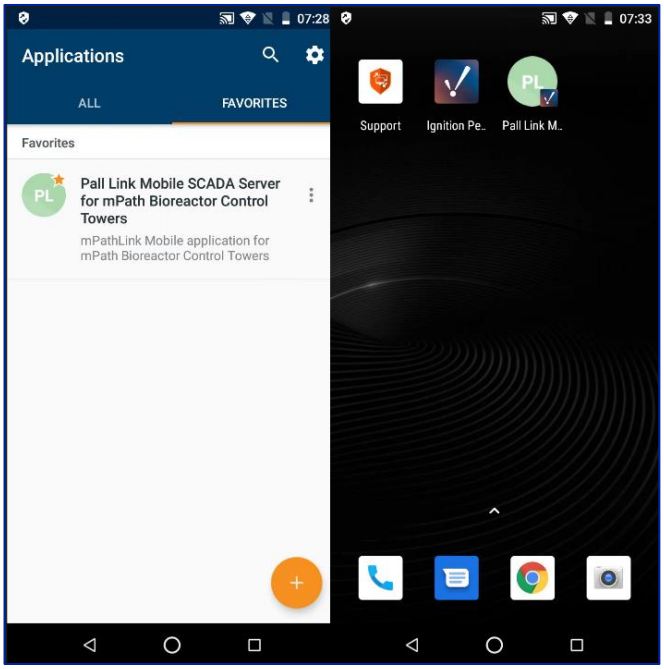
Mobile application configuration




For ease of use, and accessibility, it is recommended to add the mPath Link Mobile application to Favorites or create Shortcut.

**Figure 94**

Mobile Favourites and Shortcut



Once configured, the application is ready to run on mobile device. Note that this process can be used to connect multiple mPath Link servers to the same mobile device by entering the IP addresses specific to the additional servers.

## 17.2 User Interface

As with desktop or tablet devices, the mobile application will display a status bar with the highest priority state displayed in addition to the login/logout function.

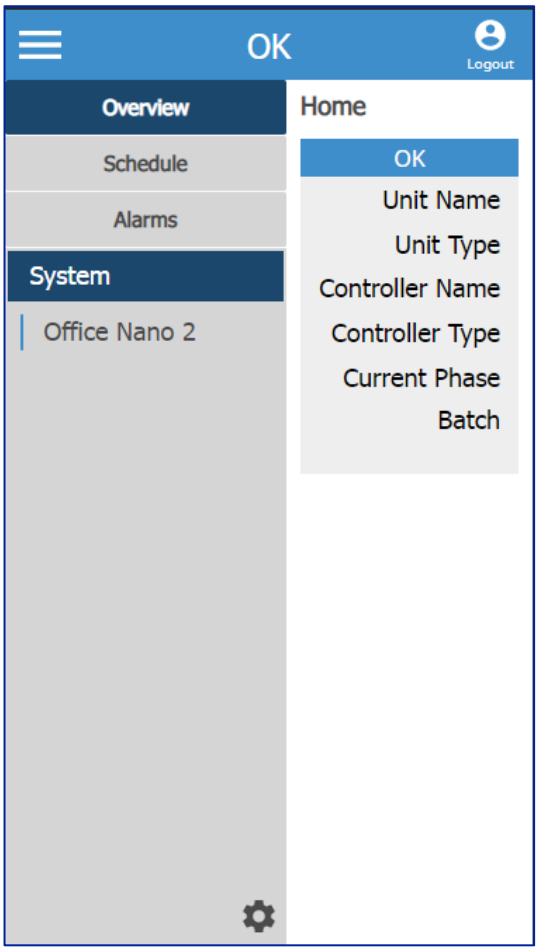
**Figure 95**

Mobile status bar.


Selecting the menu icon on the left of the status bar allows the user to view the connected units and navigate to different areas of the application. The side navigation bar displays the status of the connected units through the vertical-colored strip. With system selected, the user will be able to view an overview of the connected units, schedule, and alarms and with a unit selected, there will be the additional options of the process overview screen and calibration.

**Figure 96**

Mobile menu selected.

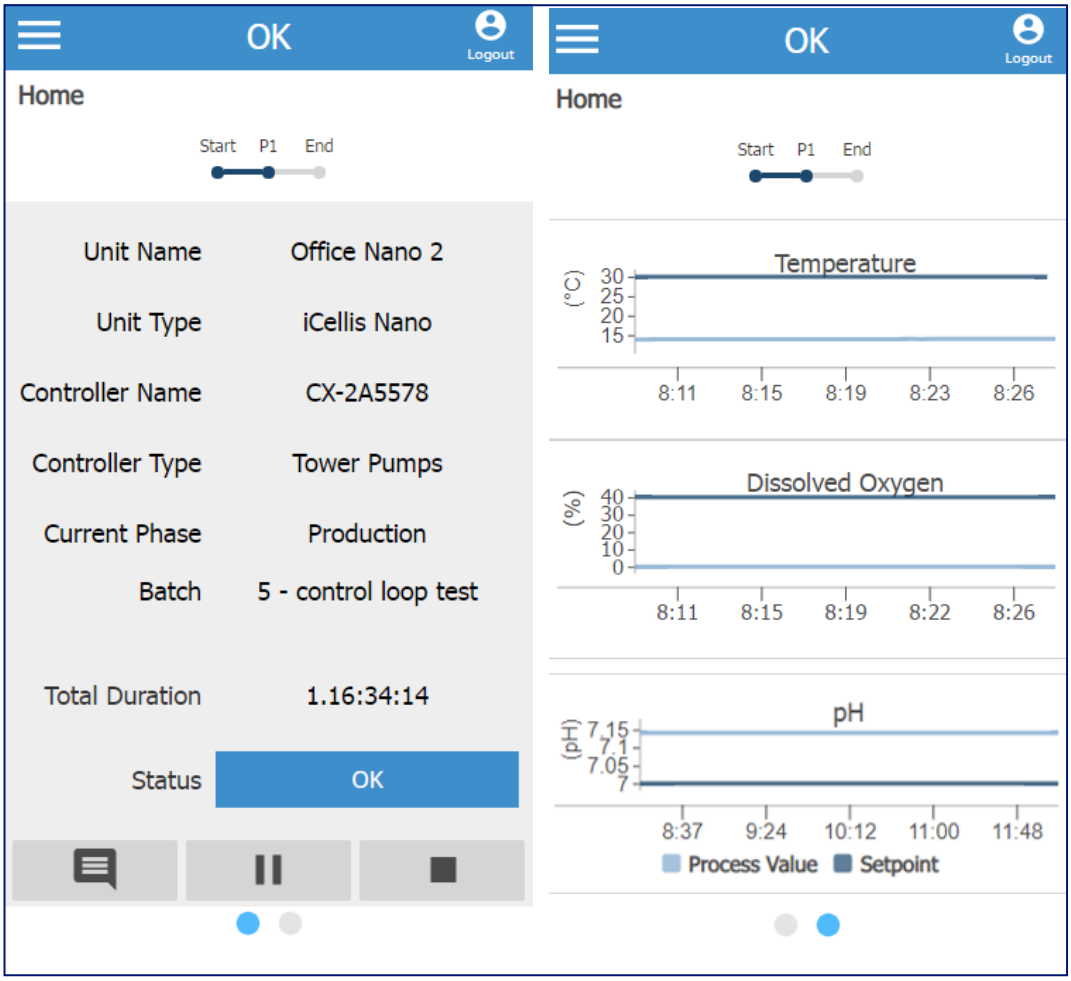


### 17.2.1 Overview

When system is selected from the side bar and the user navigates to the overview screen, a list of the connected units will be displayed along with the specific details. Upon selecting the unit, the user is navigated to an overview screen for that specific unit this can also be achieved by selecting the desired unit from the left side bar before selecting overview.

**Figure 97**

Mobile unit level overview screen.




The initial screen shows the breakdown of the unit detail and by using the buttons at the bottom of the screen, the user can comment on the batch in addition to pausing or stopping. The batch tracker bar at the top of the screen indicates the phase that is currently running.

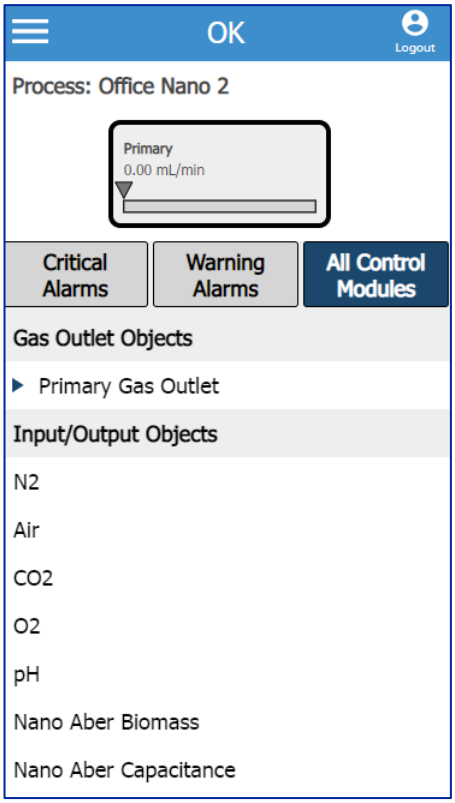
Swiping to the right will brings the user to the mini trends which display process value and setpoint for temperature, dissolved oxygen, and pH.

### 17.2.2 Process

For a detailed view of unit specific parameters, the user can navigate to the process screen through the “hamburger menu” when a unit is selected from the side bar.

**Figure 98**

Mobile tabular process screen.

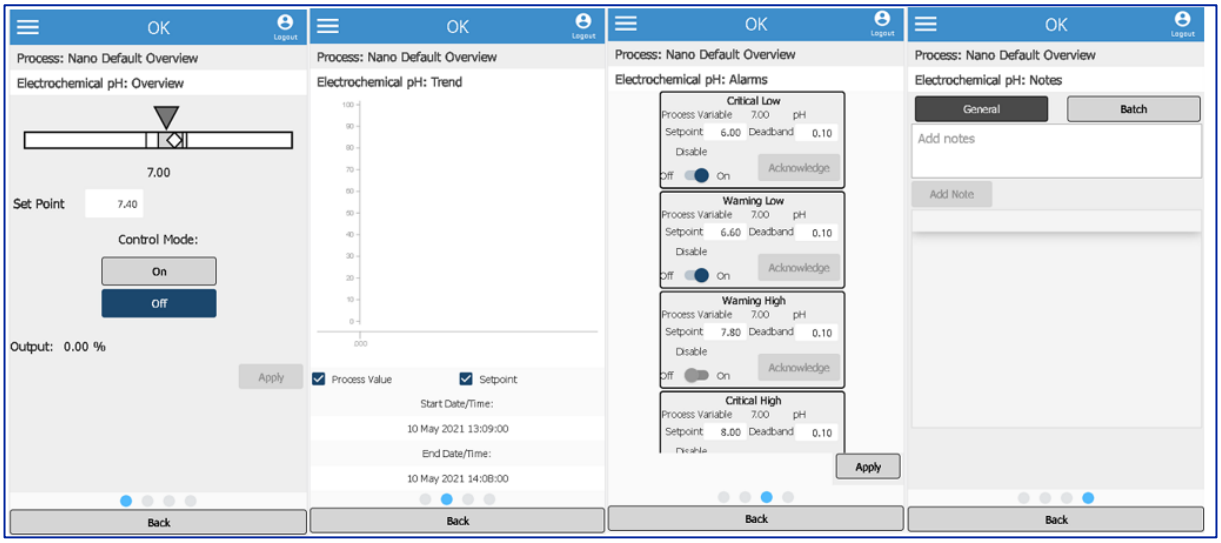



The default view will show all control modules although the user can filter to show alarming parameters by selecting either critical or warning alarm buttons. Parameters can be selected from the list which will then display the process overview symbol which functions the same as the desktop application.

Selecting the process overview symbol allows the user view and configure the selected parameter where the back button returns the user to the process screen view.

**Figure 99**

Mobile process overview screens.




| Tab | Description |
|---|---|
| 1 - Overview | Slider bar shows setpoint and PV. User can edit the set point and the control mode. |
| 2 - Trends | A mini trend with tick boxes to select between process value and set point. Output, and gases will have the additional options output, total and feedback to select from. |
| 3 – Alarms | Critical/warning low and high alarm set points can be configured in addition to disabling or acknowledging an alarm. |
| 4 - Notes | Notes can be added to parameters either relating to general or the batch. |

**Primary or secondary gas objects will also have a tab for a graphical depiction of the gas flow path.*

### 17.2.3 Batch Schedule

Using the menu, the user can navigate to the schedule tab to view any scheduled batches. Note that this is a view only feature.

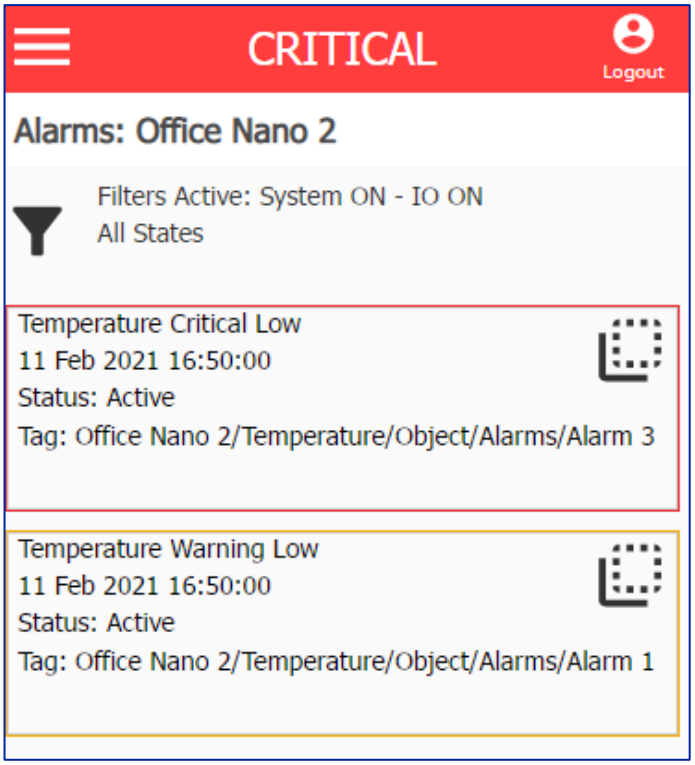
The user will be able to view batch details including, batch name, recipe name, start/end date, and status. Selecting the filter icon allows the user to filter the view for ease of use based on unit, user, and start/end date.

### 17.2.4 Alarms

Navigating to the alarms tab will display all alarms that are present in the system displayed in chronological order, with the alarm border indicating the severity of the alarm. When the alarm window button (in the top right of each alarm box) is touched, the available alarm controls for that parameter are shown. The user will then be able to disable and/or acknowledge the selected alarm. Selecting the filter icon allows the user to filter the display by IO or system alarm, state, unit and by free text. Selecting the window button in the top right then hides the additional parameters to return to the original view.

**Figure 100**

Mobile alarms screen.




# 18. Cleaning and Maintenance

## 18.1 Cleaning

The ingress protection rating of the mPath control tower is IP 54. To clean the mPath unit control tower wipe down the instrument externally with a non-fiber releasing IPA wipe or IPA spray.

## 18.2 Preventive Maintenance

Pall provides maintenance and repairs for all unit systems, including preventive maintenance services. Please consult datasheet USD 3078: Pall Single-Use Unit Systems Support and Maintenance Services on www.pall.com or contact your Pall sales representative. To keep the unit system up and running a minimum of one preventive maintenance a year is recommended.

### 18.3 Critical Spare Parts

**Table 13**
Critical spare parts

| Part Number | Description |
|---|---|
| KMPATHLOAD | mPath unit control tower loadcell hanger |
| KMPATHCLIP | mPath unit control clip for screen |
| KMPATHCBLXRS | Communication cable kit Allegro XRS 25 unit |
| KMPATHCBLICLN | Communication cable kit for iCELLis Nano unit |

## 19. End of Life Disposal

To dispose of the mPath unit control tower, the relevant local legal regulations must be observed. Within the European Community, the disposal of electrical devices is regulated by national regulations based on EU directive 2002/96/EC pertaining to waste electrical and electronic equipment (WEEE). According to these regulations, any device supplied after August 13, 2005, in the business-to-business sphere (to which this product is assigned), may no longer be disposed of in municipal or domestic waste. To document this, they have been marked with the following symbol:

Please visit our website for more information and local instructions on disposing of the product at https://www.pall.com/en/about-pall/corporate-sustainability/weee-compliance.html.

# 20. Technical Specifications Summary

## 20.1 mPath Control Tower

**Table 14**
mPath control tower technical specifications.

| | | |
|---|---|---|
| Models | KMPATHBRXPS2P3<br>KMPATHBRXPS2P0<br>KMPATHBRXPS0P3<br>KMPATHBRXPS0P0 - | mPath control tower, PreSens pH/DO, pumps x 3<br>mPath control tower, PreSens pH/DO, pumps x 0<br>mPath control tower, PreSens x 0, pumps x 3<br>mPath control tower, PreSens x 0, pumps x 0 |
| Facility | Dimensions (W x D x H) | 230 x 600 X 450 mm (590 mm with hangers attached) |
| | Weight kg | 20 kg |
| | Materials of construction | Polymer, stainless steel, aluminum |
| | Electrical supply | Voltage: Automatically adjusted between 100 – 240 V AC<br>Input Frequency: 50 Hz/60Hz |
| | Electrical connection | Supplied with US, EU and UK cables |
| | Power consumption | 360 W maximum |
| | Gas supply | 2.0 – 6.0 bar / 29 – 87 psi |
| Utilities | Control architecture | Beckhoff◆ PLC, SBC<br>MPath Link SCADA |
| | Operating system | Pall Corporation SCADA<br>mPath Link server: Microsoft◆ Windows 10 Pro<br>Control Tower: Microsoft Windows Embedded Compact<br>Oracle◆: MSSQL◆ and Java◆ |
| Control System | Automation design | Developed and tested in accordance with GAMP 5 |
| | Electronic records and electronic signatures | Compatible with FDA 21 CFR Part 11 & EudraLex Annex 11 |
| | Network compatibility | Integrated OPC-UA server |
| | Data export / communication | USB, OPC-UA over Ethernet |
| | Remote operation | Yes, support for remote desktop and mobile clients through mPath Link SCADA software |
| | Standalone operation | No, requires mPath Link SCADA software for operation |
| Gas | Gas connections | 6 mm push to connect fittings<br>6 mm OD pneumatic tubing |
| | Gas flow control | 6 TMFCs |
| | Input gases supported | $N_2$, $O_2$, air and $CO_2$ |
| | Pressure regulation | Onboard preset regulators, inputs from 2.5 bar (36.3 psi) – 6.0 bar (87 psi) accepted |

| | | |
|---|---|---|
| Pumps | Pumps (on selected models) | 3 variable speed pumps (14 - 211 rpm), control requiring speeds less than 14 rpm achieved through pulse width modulation (PWM) |
| | Compatible tubing | Up to ID 8 mm and 1.6 mm wall thickness |
| | Maximal flow rate | Up to 844 mL/min<br>(tubing with ID 8 mm and OD 11.2 mm) |
| | Flow rate with standard SUS | 1 line up to 844 mL/min<br>(tubing with ID 8 mm and OD 11.2 mm)<br>2 lines up to 633 mL/min<br>(tubing with ID 6.4 mm and OD 9.6 mm) |
| | External pump support | Up to 4 via user configurable I/O |
| Sensors | Single use sensors (on selected models) | Integrated PreSens – 1 pH / 1 DO |
| | Temperature | Pt100 |
| | Pressure | Gas input, 4 input lines<br>Gas output / biocontainer pressure, 2 output lines |
| | Weight | 3 biocontainer load cells; each hanging load cell can hold a max weight of 2 kg. A combined max total weight of 4.5 kg can be hung from the mPath control tower |
| Auxiliary | User configurable I/O | 4 ports, M12 A coded 8-way female |
| | Power output | 1 USB, power only, 2.1A |
| | Data I/O | 3 USB 2.0 |
| | Display output | 1 HDMI |
| Safety | E-stop & interlocks | Hard emergency stop on both platform and tower, soft stops on all user interfaces, programmable and preconfigured safety interlocks |
| | CE marked | WEEE Directive – 2012/19/EU<br>UL and CSA optional available |
| | EMC Directive 2014/30/EU | BS EN 61326-1: 2013 |
| | Low Voltage Directive (LVD) 2014/35/EU | BS EN 61010-1: 2010 |
| | Machinery Directive 2006/42/EC | BS EN ISO 12100:2010 |
| | RoHS Directive | 2011/65/EU |
| | IP rating | IP54, IEC 60529 Ed 2.2 b 2013 |
| | Operating conditions | Laboratory environment<br>The ambient temperatures must be between 5 °C (41 °F) and 40 °C (104 °F).<br>Maximum relative humidity of 80% for temperatures up to 31 °C decreasing linearly to 50% relative humidity at 40 °C. |

## 20.2 mPath Link Server

| Item | Specification |
|---|---|
| Memory (RAM) | 16 GB |
| CPU | 1 x INTEL i3-8100 3.60Ghz |
| Storage | 1TB |
| Software | Ignition, Windows 10 LTSC, MSSQL Standard |

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

## 21. Technical Assistance and Important Contact Details

The mPath control tower is manufactured by:

Pall Portsmouth for Pall international SARL, Avenue de Tivoli 3, 1700 Fribourg Switzerland.

For technical assistance, please contact:

Pall Equipment Support Hotline

1-855-920-PALL (1-855-920-7255) USA & Canada

00800 Pall TECH (008007255 8324) EMEA

Or

- Contact your local Pall representative
- Visit the support section on www.pall.com
- E-mail your enquiry to lapplsupport@pall.com

## 22. Appendix A: Abbreviations

| Term | Meaning |
|---|---|
| DO | Dissolved Oxygen |
| I/O | Inputs and Outputs |
| IFU | Instructions for use |
| IPA | Isopropyl alcohol |
| MSDS | Material safety data sheet |
| pH | Potential of Hydrogen |
| SCADA | Supervisory Control and Data Acquisition |
| UI | User Interface |
| CSA | Canadian Standards Association |
| HMI | Human-Machine Interface |
| Hz | Hertz |
| ID | Inner Diameter |
| OD | Outer Diameter |
| PID | Proportional Integral Derivative |
| PV | Process Variable |
| rpm | Revolutions per minute |
| RTD | Resistance Temperature Detector |
| SCADA | Supervisory Control and Data Acquisition Software |
| slpm | Standard Litres per Minute |
| SP | Set point |
| TMFC | Thermal Mass Flow Control tower |
| V | Volts |
| W x D x H | Width x Depth x Height |

# 23. Appendix B: Connecting to Additional Networked Computers and Tablets

To connect to additional networked devices, the mPath Link system must be connected to a local area network. If the air-gapped approach has been used, no additional viewing platforms can be used other than the mPath Link server supplied.

If the mPath Link server supplied is connected to a local area network or a wider area network which allows traffic, enter the IP address of the mPath Link server into the browser of your networked device.

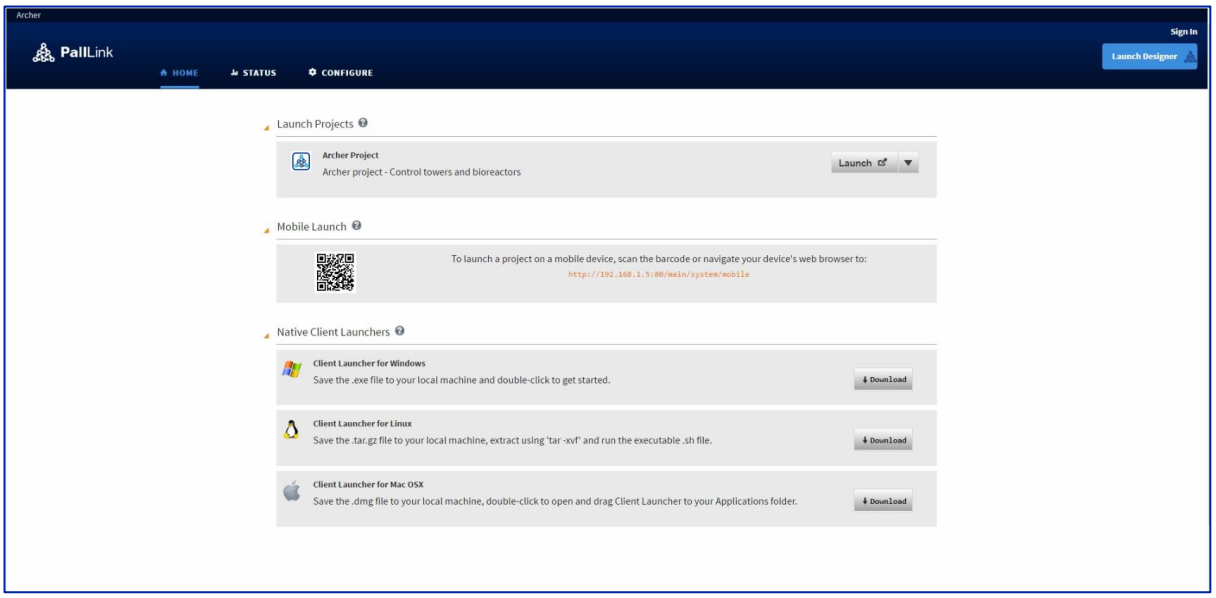
## 23.1 Computers

The mPath Link page will open giving the user the options on how to download the SCADA screens.

- Press launch to download the SCADA screens.
- Log in using the details created within user management.

**Figure 48**

Mobile link page.




## 23.2 Tablets

- The login page of the SCADA screen will open.
- Log in using the details created within user management.

## 24. Appendix C: I/O List

Full I/O list and the default I/O (ticked) in mPath Link as per unit.

| I/O | Description | Allegro XRS 25 | Xpansion Multiplate | iCELLis Nano |
|---|---|---|---|---|
| Air | 6 mm gas supply to primary outlet. | ✓ | ✓ | ✓ |
| Air Secondary | 6 mm gas supply to secondary outlet. | | | |
| Balance Load Cell | M12, A-coded, 5-way, female connector, 24 V supply, 0-20 mA input. Units: grams | | | |
| Balance Load Cell Feed | M12, A-coded, 5-way, female connector, 24 V supply, 0-20 mA input. Units: grams/second | | | |
| Biomass | M12, A-coded, 5-way, female connector, 0-20 mA. | | | ✓ |
| Biomass Growth Rate | M12, A-coded, 5-way, female connector, 0-20 mA. | | | |
| Aber Biomass | | | | ✓ |
| $CO_2$ | 6 mm gas supply to primary outlet. | ✓ | ✓ | ✓ |
| $CO_2$ Secondary | 6 mm gas supply to secondary outlet. | | | |
| DO | Dissolved oxygen fibre optic | ✓ | ✓ | |
| Electrochemical $CO_2$ | Electrochemical $CO_2$ | | | |
| Electrochemical DO | Electrochemical DO | | | |
| Hamilton Digital DO | Digital DO | | | ✓ |
| Electrochemical pH | Electrochemical pH | | | ✓ |
| Filter Heater | M12, A-coded, 5-way, female connector. 0-24 V | | | |
| Hanging Load Cell 1 Feed | Hanging load cell feed measured in g/s | | | |
| Hanging Load Cell 1 Mass | Hanging load cell mass measured in g. | ✓ | ✓ | |
| Hanging Load Cell 2 Feed | Hanging load cell feed measured in g/s | | | |
| Hanging Load Cell 2 Mass | Hanging load cell mass measured in g. | ✓ | ✓ | |
| Hanging Load Cell 3 Feed | Hanging load cell feed measured in g/s | | | |
| Hanging Load Cell 3 Mass | Hanging load cell mass measured in g. | ✓ | ✓ | |
| Level Sensor 1 | M12, A-coded, 5-way, female connector. 1 x 0-20 mA input; 1 x 24 V digital input | | | |
| Level Sensor 2 | M12, A-coded, 5-way, female connector. 1 x 0-20 mA input; 1 x 24 V digital input 1 x 24 V digital input | | | |

| | | | | |
|---|---|---|---|---|
| MAG Stirrer | 2Mag stirrer plate. | | ✓ | |
| $N_2$ | 6 mm Gas supply to primary outlet. | ✓ | ✓ | ✓ |
| Nano Filter Heater | 0-24 V | | | ✓ |
| Nano MAG Stirrer | Internal connection. Measured in rpm | | | ✓ |
| Nano Peltier | Internal connection. Measured in %. | | | ✓ |
| Nano Pump 1 | Pump speed measured in rpm. | | | ✓ |
| Nano Pump 2 | Pump speed measured in rpm. | | | ✓ |
| Nano Pump 3 | Pump speed measured in rpm. | | | ✓ |
| Nano Resistor | Internal connection. Degrees C. | | | ✓ |
| Nano Temperature | PT 100 measured in Degrees C. | | | ✓ |
| $O_2$ | 6 mm Gas supply to primary outlet. | ✓ | ✓ | ✓ |
| Peltier | M12, T-coded, 4-way, female. | | | |
| pH | pH fibre optic | ✓ | ✓ | |
| Pressure Sensor Current | M12, A-coded, 5-way, female. 0-20 mA | | | |
| Pressure Sensor Voltage | M12, A-coded, 5-way, female. 0-10 V | | | |
| Primary | Outlet gas flow of all primary gas flows. 6 mm | ✓ | ✓ | ✓ |
| Pump 1 | Pump on mPath control tower. Measured in rpm | ✓ | | |
| Pump 2 | Pump on mPath control tower. Measured in rpm | ✓ | | |
| Pump 3 | Pump on mPath control tower. Measured in rpm | ✓ | | |
| Secondary | Outlet gas flow of both secondary gas flows. 6mm | | | |
| Stirrer | PadReactor Mini unit paddle stirrer. Measured in rpm. | | | |
| Temperature | PT 100 measured in Degrees C. | ✓ | ✓ | |
| Allegro XRS Agitation | Agitation to Allegro XRS 25 unit measured in CPM. | ✓ | | |
| User configurable I/O x3 | M12, A-coded, 8-way, female. DO(24V); DI(24V); 0V; 0-10V In; 0-20mA In; 0-10V Out; 0-20mA Out | | | |

# 25. Appendix D: User Management (Default List)

## Operator

| | | | |
|---|---|---|---|
| Alarm Edit ☐ | Configuration View ☑ | Recipe Create ☐ | Settings Edit ☐ |
| Alarm View ☑ | Event Log ☑ | Recipe Modify Existing ☐ | Settings View ☐ |
| Batch Modify Schedule ☐ | Export ☑ | Recipe Modify New ☐ | Simulation ☐ |
| Batch View ☑ | Notes ☑ | Recipe View ☑ | System Settings View Edit ☐ |
| Calibration ☑ | Process Edit ☐ | Reports ☑ | Trends ☑ |
| Configuration Edit ☐ | Process View ☑ | Setpoint ☐ | User ☐ |

## Supervisor

| | | | |
|---|---|---|---|
| Alarm Edit ☑ | Configuration View ☑ | Recipe Create ☑ | Settings Edit ☑ |
| Alarm View ☑ | Event Log ☑ | Recipe Modify Existing ☑ | Settings View ☑ |
| Batch Modify Schedule ☑ | Export ☑ | Recipe Modify New ☑ | Simulation ☑ |
| Batch View ☐ | Notes ☑ | Recipe View ☑ | System Settings View Edit ☑ |
| Calibration ☑ | Process Edit ☐ | Reports ☑ | Trends ☑ |
| Configuration Edit ☑ | Process View ☑ | Setpoint ☑ | User ☑ |

## Administrator

| | | | |
|---|---|---|---|
| Alarm Edit ☑ | Configuration View ☑ | Recipe Create ☑ | Settings Edit ☑ |
| Alarm View ☑ | Event Log ☑ | Recipe Modify Existing ☑ | Settings View ☑ |
| Batch Modify Schedule ☑ | Export ☑ | Recipe Modify New ☑ | Simulation ☐ |
| Batch View ☑ | Notes ☑ | Recipe View ☑ | System Settings View Edit ☑ |
| Calibration ☑ | Process Edit ☑ | Reports ☑ | Trends ☑ |
| Configuration Edit ☑ | Process View ☑ | Setpoint ☑ | User ☑ |

# 26. Appendix E: Alarms

| Alarm | Description |
|---|---|
| Gas handling module (GHM) Status Alarm | Power Failure – Gas Handling Module |
| GHM Status Alarm | Comms Failure – Gas Handling Module |
| GHM Status Alarm | CO2 Valve PV1 Failed to Open – Gas Handling Module Primary |
| GHM Status Alarm | CO2 Valve PV1 Failed to Close – Gas Handling Module Primary |
| GHM Status Alarm | O2 Valve PV2 Failed to Open – Gas Handling Module |
| GHM Status Alarm | O2 Valve PV2 Failed to Close – Gas Handling Module |
| GHM Status Alarm | Air / N2 Valve PV3 Failed to Open – Gas Handling Module Primary |
| GHM Status Alarm | Air / N2 Valve PV3 Failed to Close – Gas Handling Module Primary |
| GHM Status Alarm | Rapid Inflation Valve SV1 Failed to Open – Gas Handling Module |
| GHM Status Alarm | Rapid Inflation Valve SV1 Failed to Close – Gas Handling Module |
| GHM Status Alarm | CO2 Valve PV4 Failed to Open – Gas Handling Module Secondary |
| GHM Status Alarm | CO2 Valve PV4 Failed to Close – Gas Handling Module Secondary |
| GHM Status Alarm | Air / N2 Valve PV5 Failed to Open – Gas Handling Module Secondary |
| GHM Status Alarm | Air / N2 Valve PV5 Failed to Close – Gas Handling Module Secondary |
| GHM Status Alarm | N2 Valve PV6 Failed to Open - Gas Handling Module Primary |
| GHM Status Alarm | N2 Valve PV6 Failed to Close – Gas Handling Module Primary |
| GHM Status Alarm | Primary Outlet Shutoff Valve SV2 Failed to Open – Gas Handling Module |
| GHM Status Alarm | Primary Outlet Shutoff Valve SV2 Failed to Close - Gas Handling Module |
| GHM Status Alarm | Secondary Outlet Shutoff Valve SV3 Failed to Open – Gas Handling Module |
| GHM Status Alarm | Secondary Outlet Shutoff Valve SV3 Failed to Close – Gas Handling Module |
| GHM Air Inlet Pressure Alarm Critical low (Units are mBar) | Air Inlet Pressure Critical – Gas Handling Module |
| GHM Air Inlet Pressure Alarm Warning Low | Air Inlet Pressure Low – Gas Handling Module |
| GHM Air Inlet Pressure Alarm Warning high | Air Inlet Pressure High – Gas Handling Module |
| GHM Air Inlet Pressure Alarm Critical high | Air Inlet Pressure Critical – Gas Handling Module |
| GHM O2 Inlet Pressure Alarm Critical low | O2 Inlet Pressure Critical – Gas Handling Module |
| GHM O2 Inlet Pressure Alarm Warning Low | O2 Inlet Pressure Low – Gas Handling Module |
| GHM O2 Inlet Pressure Alarm Warning High | O2 Inlet Pressure High – Gas Handling Module |
| GHM O2 Inlet Pressure Alarm Critical high | O2 Inlet Pressure Critical – Gas Handling Module |
| GHM CO2 Inlet Pressure Alarm Critical low | CO2 Inlet Pressure Critical – Gas Handling Module |
| GHM CO2 Inlet Pressure Alarm Warning Low | CO2 Inlet Pressure Low – Gas Handling Module |
| GHM CO2 Inlet Pressure Alarm Warning High | CO2 Inlet Pressure High – Gas Handling Module |

| | |
|---|---|
| GHM CO2 Inlet Pressure Alarm Critical high | CO2 Inlet Pressure Critical – Gas Handling Module |
| GHM N2 Inlet Pressure Alarm Critical low | N2 Inlet Pressure Critical – Gas Handling Module |
| GHM N2 Inlet Pressure Alarm Warning Low | N2 Inlet Pressure Low – Gas Handling Module |
| GHM N2 Inlet Pressure Alarm Warning High | N2 Inlet Pressure High – Gas Handling Module |
| GHM N2 Inlet Pressure Alarm Critical high | N2 Inlet Pressure Critical – Gas Handling Module |
| GHM Outlet Pressure Alarm Critical low | Primary Outlet Pressure Critical – Gas Handling Module |
| GHM Outlet Pressure Alarm Warning Low | Primary Outlet Pressure Low – Gas Handling Module |
| GHM Outlet Pressure Alarm Warning High | Primary Outlet Pressure High – Gas Handling Module |
| GHM Outlet Pressure Alarm Critical high | Primary Outlet Pressure Critical – Gas Handling Module |
| GHM Outlet Pressure Alarm Warning High | Secondary Outlet Pressure Critical – Gas Handling Module |
| GHM Outlet Pressure Alarm Warning Low | Secondary Outlet Pressure Low – Gas Handling Module |
| GHM Outlet Pressure Alarm Critical high | Secondary Outlet Pressure High – Gas Handling Module |
| GHM Outlet Pressure Alarm Warning High | Secondary Outlet Pressure Critical – Gas Handling Module |
| GHM Outlet Pressure Alarm Warning Low | Secondary Outlet Pressure Low – Gas Handling Module |
| GHM Outlet Pressure Alarm Critical high | Secondary Outlet Pressure High – Gas Handling Module |
| GHM Outlet Pressure Alarm Critical low | Secondary Outlet Pressure Critical – Gas Handling Module |
| GHM Outlet TotalFlow Alarm Warning High | Primary Outlet Total Flow High |
| GHM Outlet TotalFlow Alarm Warning Low | Primary Outlet Total critical |
| GHM Outlet TotalFlow Alarm Critical high | Primary Outlet Total Flow Critical |
| GHM Outlet TotalFlow Alarm Critical low | Primary Outlet Total critical Low |
| GHM Outlet TotalFlow Alarm Warning High | Secondary Outlet Total Flow High |
| GHM Outlet TotalFlow Alarm Warning Low | Secondary Outlet Total critical |
| GHM Outlet TotalFlow Alarm Critical high | Secondary Outlet Total Flow Critical |
| GHM Outlet TotalFlow Alarm Critical low | Secondary Outlet Total critical Low |
| Allegro XRS 25 unit status alarm | Allegro XRS 25 unit Power Failure |
| Allegro XRS 25 unit status alarm | Allegro XRS 25 unit Comms Failure |
| Allegro XRS 25 unit status alarm | X Axis Servo Failure |
| Allegro XRS 25 unit status alarm | Y Axis Servo Failure |
| Allegro XRS 25 unit status alarm | Lid Open |
| PT100 Status Alarm (out of bounds) | PT100 Sensor Open Circuit - Failed Sensor or Broken Wire / Connector |
| PT100 Status Alarm (out of bounds) | PT100 Sensor Overrange |
| PT100 Status Alarm (out of bounds) | PT100 Sensor Overrange |
| Presens Module 1 status alarm | Presens Module 1 – Power Failure |
| Presens Module 1 status alarm | Presens Module 1 – Comms Failure |
| Presens Module 1 status alarm | Presens Module 1 – Open Circuit |
| Presens Module 1 status alarm | Presens Module 1 – Overrange |
| Presens Module 2 status alarm | Presens Module 2 – Power Failure |

| | |
|---|---|
| Presens Module 2 status alarm | Presens Module 2 – Comms Failure |
| Presens Module 2 status alarm | Presens Module 2 – Open Circuit |
| Presens Module 2 status alarm | Presens Module 2 – Overrange |

PALL CORPORATION

**Corporate Headquarters**
Port Washington, NY, USA
+1-800-717-7255 toll free (USA)
+1-516-484-5400 phone

**European Headquarters**
Fribourg, Switzerland
+41 (0)26 350 53 00 phone

**Asia-Pacific Headquarters**
Singapore
+65 6389 6500 phone

**Visit us on the Web at www.pall.com/Biotech**
**Contact us at www.pall.com/contact**

Pall Corporation has offices and plants throughout the world. To locate the Pall office or distributor nearest you, visit www.pall.com/contact.

The information provided in this literature was reviewed for accuracy at the time of publication. Product data may be subject to change without notice. For current information consult your local Pall distributor or contact Pall directly.

*IF APPLICABLE* Please contact Pall Corporation to verify that the product conforms to your national legislation and/or regional regulatory requirements for water and food contact use.



USD3238 / October2021