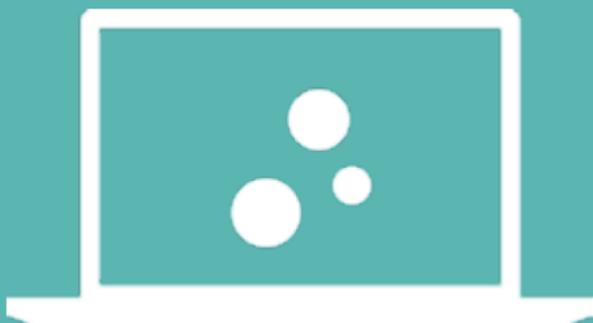


USER'S
MANUAL

OXYGEN



VERSION 2.3.2.0



PRECAUTIONS

Fluigent's software solutions are dedicated to Fluigent instruments.

Do not open any devices. Please refer all service issues to our Support department (support@fluigent.com)

Prevent any objects or liquid from entering the instruments. This may cause a short-circuit or other malfunctions. Failing to follow these instructions may:

- Expose the user to direct current/voltage if the device is powered. This may lead to personal injury.
- Void device's warranty
- Discharge our company from any liability regarding physical or device damage.

If using the software along with hardware devices, please place the products in a stable location with a level surface and good support.

Do not use any other power supply or connection cables than the ones provided by Fluigent. Provided power and USB cables have been carefully selected to meet the power and connection requirements of the devices in all configurations and to comply with all safety standards.



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WHAT IS NEW

OxyGEN latest available version is: **v2.3.2**

Download your operating system corresponding software below:

<https://www.fluigent.com/resources-support/support-tools/software/>

Additions

- Metadata file for CSV recordings..
- Smooth brushes transition when changing theme with visual updates/bugfixes.
- Possibility to turn on or off a controller in device view, available for Link and some MFCS devices.
- Inlet pressure indicator for newer versions of FlowEz and F-OEM
- App logs can now optionally log low-level instrument data for troubleshooting.
- Reordering manual control channel list and saving their order across the sessions.
- Support the OEM Electrovalve Module (P-Switch OEM)

Fixed

- Possible application crash on linux when closing a protocol.
- Dialogs always appear in the front of other windows now.
- Adding multiple simulated MFCS devices no longer causes the application to hang .
- F-OEM no longer returns brief connection errors when using Flow Unit M+ or L+.
- LineUP and F-OEM modules no longer report that they are in sleep mode when a sensor or valve is connected or disconnected.
- Sensor regulation no longer stops on its own when started with the Flow EZ in local control mode.
- Flow rate measurement now has the correct sign when using Flow Unit M with calibrations HFE, FC40 and OIL.
- Instrument replacement popup in protocol editor displays a scrollbar when there are too many instruments to fit the window.

Changed

- Each P-Switch channel has its own column now in CSV recordings.
- Add setpoint column for continuous channels in CSV recordings.
- Reinitialize simulation devices window on + button click to avoid previous setup references.

INTRODUCTION

Fluigent's OxyGEN software is a complete interface allowing one to control, monitor and automate Fluigent product line. This dedicated dashboard can be used as a tool for real-time control of pressures, flow rates and valve actuation in microfluidic experiments. Its modular interface is designed for independent and simultaneous monitoring of all instruments and channels. The software is also dedicated for developing and running time based microfluidic protocols. Easily edit protocols for complete automated experiments, including a wide range of operations and function loops as well as TTL input/output. Live control data can be exported and protocol runs recorded for further use.



This user's manual will guide one over the general instructions to properly install and use Fluigent's OxyGEN software solution. Detailed parts explain in depth each feature, interface and user cases over the preset workspaces such as Live control and Protocol editor.

INSTALLATION

SYSTEM REQUIREMENTS

OxyGEN is supported on Windows, MacOS and Linus. See the following table for complete compatibility:

Windows 32/64-bits	7 SP2, 8, 10 et 11
Linux 32/64-bits	Debian 10 (Buster)+ Ubuntu 16.04+ Fedora 33+
MacOS 64-bits*	Catalina 10.15+

**OxyGEN shows some instabilities when the auto-initialization of instruments is turned ON (see Settings section for more details).*

HARDWARE REQUIREMENTS

OxyGEN software requires:

- A minimum of 512 of RAM (2GB recommended)
- Minimum processor Intel or AMD with 64-bit support 1.6+GHz
- Minimum screen resolution 1024 x 768 (1920 x 1080 recommended)
- Minimum of 100MB of space available (Does not account for experiment and live control records storage)

INSTRUCTIONS

Fluigent OxyGEN is available on Windows, Linux and Mac OS.
Note that any installation of the software requires the Administrator privileges.



Windows

You can download the application installer here:
<https://www.fluigent.com/resources-support/support-tools/software/>

Once downloaded, you can extract the archive content in any folder for which you have execution rights. Then, enter the directory and run the executable by double-clicking on it. Follow the installation instructions until the end. When finished, you can search for OxyGEN from the Windows search bar or double-click on the shortcut added to your Desktop.

Linux

You can download the application executable here:
<https://www.fluigent.com/resources-support/support-tools/software/>

Once downloaded, you can extract the archive content in any folder for which you have execution rights. Then, enter the directory and run the executable either by double-clicking on it from a file explorer or via a Terminal:

```
$> ./OxyGEN
```

NOTE: To use the post-processing module (v2.3+) it is necessary to install **libgdiplus** package.
On Debian-based distributions:

```
$> sudo apt install libgdiplus
```

Via an RPM manager (Red Hat Enterprise Linux):

```
$> sudo yum/dnf install libgdiplus
```

MacOS

You can download the application executable here:
<https://www.fluigent.com/resources-support/support-tools/software/>

Once downloaded, extract the archive content to your "Applications" folder. Then, enter the directory and run the executable either by double-clicking on it from a file explorer or via a Terminal:

```
$> ./OxyGEN.app
```

UPDATES

OxyGEN new versions will be communicated via our usual communication channels, including the landing page news item.



Note that all your settings, records and protocols will be preserved. To update your software, follow the instructions corresponding to your operating system:

Downloading and executing the application executable are the only steps necessary to update and use the newest version of OxyGEN.

Find your version here :

<https://www.fluigent.com/resources-support/support-tools/software/>

List of updates

1	15/10/2021	OxyGEN v1.0.0
2	17/12/2021	OxyGEN v1.1.1
3	11/04/2022	OxyGEN v2.0.0
4	02/08/2022	OxyGEN v2.1.0
5	08/11/2022	OxyGEN v2.2.0
6	04/09/2023	OxyGEN v2.3.0 and 2.3.1
7	08/01/2024	OxyGEN v2.3.2

GETTING STARTED

LAUNCHING OXYGEN



Material

OxyGEN software can be launched without any instruments connected. Any instrument connected after launching OxyGEN will be added automatically to the list of available devices, be monitored right away and be used in an automation protocol.

The supported products are listed below:

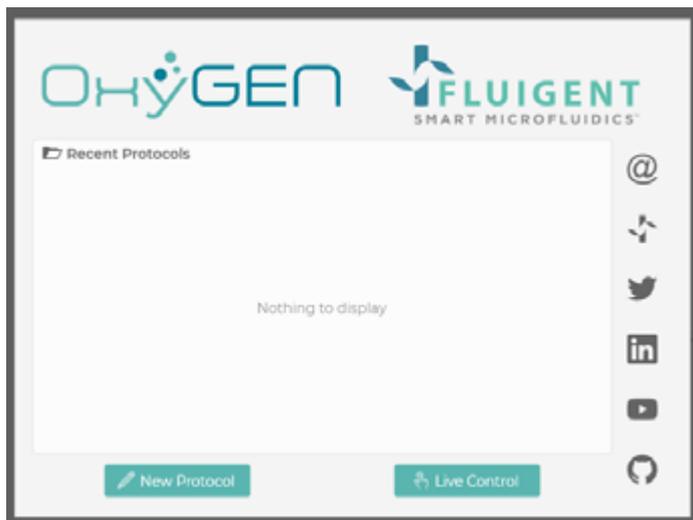
- **LineUp™ series** (Push-Pull, Flow EZ™, SWITCH EZ, P-SWITCH, LINK)
- **MFCs™ series** (MFCs™-EZ, MFCs™-EX)
- **Valves** (2-SWITCH™, L-SWITCH™, M-SWITCH™, SWITCHBOARD)
- **Sensors** (Flowboard, FLOW UNITS, M_{new}⁺, L_{new}⁺ PRESSURE UNITS)
- **Industrial pressure controller** (PX series)
- **Industrial F-OEM** (INT-FOEM, PRM-FOEM, SWM-FOEM, MEV-FOEM)

Instructions

Depending on your Operating System and as explained in the previous section, either double-click the software icon or execute it via command-line. The software should open and the landing page should appear.

LANDING PAGE

The landing page allows you to quickly open recent protocols created with OxyGEN. You also have access to the latest Fluigent news and its main communication channels.



Main interactions

- Recent protocols: Overview and quick access to the latest protocols
- Latest news: Quick access to the latest Fluigent news as individual items
- Social networks links: Main communication channels and social networks
- Quick access to Live Control and Protocol Editor

LAYOUT SYSTEM

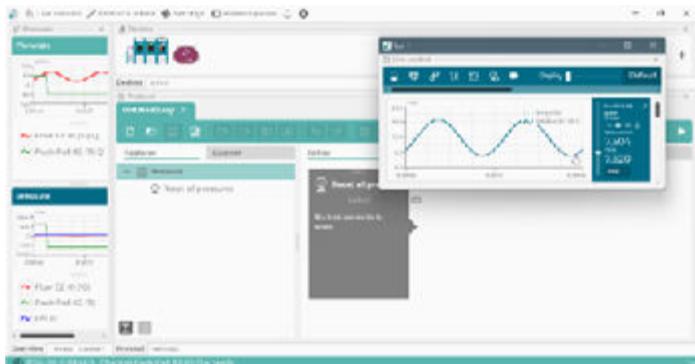
OxyGEN introduces a new way to modify the windows layout via a “docking” system. In this system, any pane can be dragged to a particular area of any other pane to be integrated at its top, bottom, left or right. Finally, the dragged pane can also be integrated within the same space as another tab.



Panes can be dragged either via their title bar when visible (on top) or via their tab (bottom). When the title bar is dragged, all tabs within the current pane will be moved. When dragging the tab, only the corresponding pane will be impacted.

Dragging won't have any effect until you reach the space of another pane. Once reached, an arrow will be displayed, releasing the mouse on one of the 5 possible areas to trigger the pane integration in the new space.

If you release the mouse outside the arrow but in another space, the dragged pane(s) will be opened in a new window, as illustrated here:



When you close a window or a pane, the pane can be re-integrated to the application by clicking on “Hidden panes” at the top of the OxyGEN window. The pane will be re-integrated in pre-defined spaces automatically.

If at some point you want to reset the windows layout to the default one (fixed and predefined workspaces) you can click on the reset button at the right of the “Hidden panes” one. Note that it will automatically close all opened windows.

LIVE CONTROL

The Live Control workspace is dedicated to the direct control of any Fluigent instrument connected to your computer. It also reports live the status of the different sensors embedded by Fluigent instruments and allows you to change a pressure source, switch a valve or even send a TTL signal in a couple of clicks.

INTERFACE



- 1 Device panel (see *Device Section*) see the instruments that have been detected, hover to get basic information (name + SN)
- 2 Overview panel (see *Overview*) graphs of all pressure and flow rate sensors in real time
- 3 Live Control panel (see *Live Control Panel*) graphical list of instruments widgets that allow controlling instruments in the simplest way possible.

DEVICE SECTION



Connecting instruments

Any instrument connected to your computer, either directly or via a controller (LINK, SWITCH EZ, Flowboard, etc.) will appear in here.

If linked to a SWITCH EZ, a SWITCHBOARD or a Flowboard, a sensor or a valve will be indicated by a colored marker at the controller port it is connected to. You can hover the marker to get some details, as a tooltip, on the instrument like its type and serial number for instance. When hovering, if an instrument is linked to several controls in the Live Control pane, then those controls (graphs, switches, etc.) will be highlighted.

Plug & Play feature

OxyGEN is able to detect new instruments connected on the fly. In the same way, any instrument that gets disconnected will be reported. Whereas new instruments will be added to the device overview, disconnected ones will be indicated by a question mark or a greyed out marker.

Simulated instruments

It is possible to add up to 32 simulated instruments. Those simulated instruments can be useful to test some features and combinations and can be mixed with real instruments. They won't be saved between sessions and will need to be recreated at each application restart.

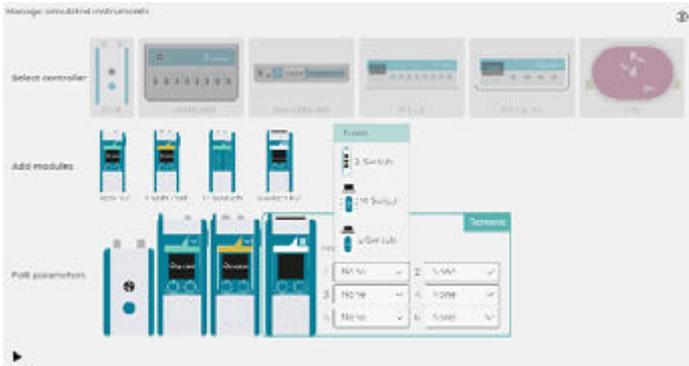
To add a new instrument, click on the "+" button at the right. A new pop-up will open with all controllers that can be simulated:



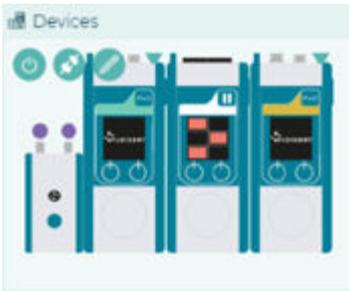
Click on a controller to add it. When done, a new line will appear that will ask you to define the controller parameters. For the Link, a list of modules will be also displayed, see below:



You can add up to 10 modules to a Link, each of them can be customized.



From v2.1.0 on, it is possible to save the current simulated instruments into a file that can be loaded in future sessions without going through the creation process.



To record the current setup, click on the “Save simulated instruments” button  and choose a file name. Note that only simulated instruments will be saved to the file.

To load a previously saved setup, click on “Load simulated instruments” button and choose the file (*.oxysim) that you want to load. You can load several files in one session as long as the total number of simulated instruments does not exceed 32 instruments.

Main interactions & features

The device pane has a limited set of features since its main utility is to report the instruments connected (or simulated) for the current session. Aside from the possibility to highlight controls in the Live Control pane when hovering an instrument and add new simulated instruments, you can turn on/off a controller  (when the function is supported by the controller), disconnect a controller  (when the function is supported by the controller) or edit the controller and its connected instruments .

OVERVIEW

The Overview pane is a quick way to visualize all pressure and flowrate channels variations over time.



The graphs group by type (pressure or flowrate) and the channels are displayed in the Device pane. You can filter out channels to focus on the ones you want. Graphs can be zoomed in and out by scrolling down and up respectively. When scrolling with your mouse or trackpad, both x and y axes are impacted.

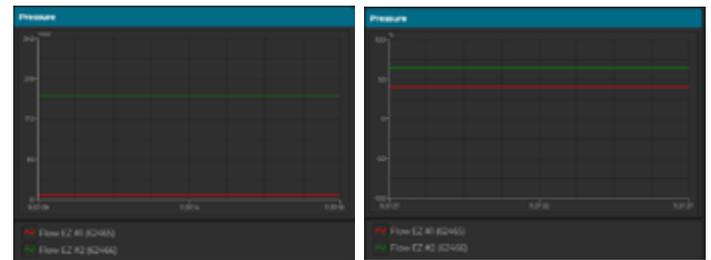
If you want to zoom in/out along a single axis, press "x" or "y", respectively for x and y axis, while scrolling up/down.

It is also possible to move the view area by clicking the plotting area and dragging it in any direction. At any moment you can come back to the default view settings by either clicking on the reset button in the bottom right corner or by right-clicking and choosing "Reset view".

By default, the view auto scrolls to the right when the plotted line reaches the right-end side of the view area. You can disable this feature by right-clicking and unchecking "Auto scroll". Whenever you want, you can save a snapshot of the current graph by right-clicking and choosing "Save image...". A prompt will appear and ask you where you want to save the snapshot.

It is possible to change the current unit used in either of the graph by right-clicking on the graph and go to "Change unit". Then you can choose one of the supported unit for the current graph

Finally, it is possible to switch between absolute and proportional scale for the y axis via the same context menu. In proportional scale mode, the y axis represents the percentage of the channel range a current pressure or flow rate reaches.



As illustrated above, this allows, in some situations, a clearer view of 2 lines when the two channels visualised come from channels with significant differences of range.

LIVE CONTROL PANEL

The Live Control Panel groups control panels associated to all instrument channels that can be manually controlled. It provides you with a direct and friendly interface to monitor the current status of an instrument channel and to control its actions.



- 1 Pressure channel panel displays in real time the applied and ordered pressure, possibility to set the parameters, monitor with slider or enter a value (panel type displayed in blue)
- 2 Flow rate panel displays in real time the flow rate and order, possibility to set the parameters, monitor with slider or enter a value (panel type displayed in green)
- 3 Valve position panel displays the current position of the valve, possibility to change position by clicking (panel type displayed in orange)
- 4 TTL panel to detect and trigger signals via TTL
- 5 Toolbar with a set of features to interact with the connected or simulated instruments, several filters allow for panel sorting

Toolbar



1. Control locked/unlocked: When locked, all commands requested are put on hold and not sent to the instruments. When unlocked, all command orders are sent at once immediately. This allows, for example, to prepare a set of commands that must be executed at the same time by a group of instruments.

2. Direct Flow Control window: Open the DFC window where flow rate channels can be associated to a pressure channel that will drive them.



Each flow rate channel can only be coupled to one pressure channel at a time. Once chosen, the Direct Flow Control will only start when the “Play” icon is pressed. Another way to start a DFC is to activate it via the corresponding flow rate control panel.

3. Channel coupling window: Open the channel coupling window where pressure or flow rate channels can be coupled to be controlled simultaneously.



Channels are coupled by pairs but it is possible to couple 3 or more channels by coupling 2 or more pairs with a common channel.

You can limit the source channel setpoint if the target channel limits have been reached. This option avoids a change of the coupling factor if the two channels have different ranges and/or starting values.



4. Volume counter window: Open the volume counter window where each flow rate channel is associated with a volume counter that keeps track of the volume of product that passed by the sensor. Each volume counter can be paused, resumed, reset or inverted. Inversion of a volume counter will invert the sign of the volume that is measured.



5. Snapshots: Open the snapshot window where one can record and save a set of commands to be applied at the same time when a shortcut key is pressed. Commands can be sent to multiple instruments but concerns ONLY pressure and/or flowrate setpoints.



6. Reset all pressures to 0: This button allows resetting all pressure channels to 0 and stops all running protocols at once. This action can also be performed by pressing “Shift+Esc” anywhere in the software or by pressing the cross icon in the top bar of the application.

7. Start/stop recording: This button will start (or stop) the recording of all channels connected, including hidden ones. The name of the file where data is stored is displayed when the recording starts. The base file name and other parameters can be edited in the settings.



8. Channel size: Adjust the size of the channel controls. By default, size is at the maximum but can be reduced to show more channels at the same time. Note that the more channels you have, the smaller the controls can be.

9. Channel display mode: You can choose how the channel controls look like. You can either keep the “Default” mode, both Preview and Parameters panels are shown, “Flexible” will display the Preview panel by default but will show the Parameter panel when you hover the control with your mouse. “Parameters” and “Preview” modes will respectively show only the Parameter or Preview panel for each control.

10. Category filters: Allows to quickly show/hide a whole category of control panels (pressure, flow rate, valves and TTL signals)

11. Unique channel filter: Allows to focus on a unique channel control panel to be displayed, all the others will be hidden.

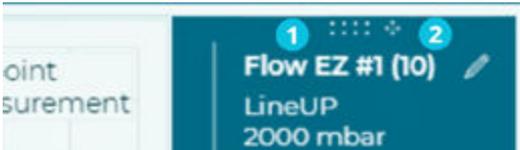
12. Multi-channel filter: Allows to select a precise set of channels to be shown/hidden

13. Reset all filters: Reset all filters (category, unique channel, multi-channel and disconnected channels).

14. Show/hide disconnected channels: Hide all control panels of disconnected channels

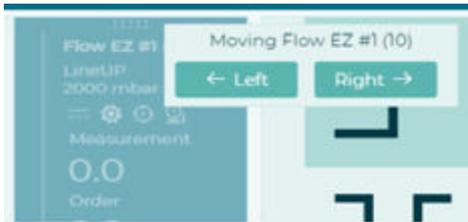
Tiles ordering

Since v2.3.0, it is possible to re-order the tiles displayed in the Live Control pane. To do so, on Windows and Linux, simply drag the dotted area on top of a pane (see 1) wherever you want within the windows section.



A preview of the future tile position will be displayed while the tile is dragged.

On MacOS the re-ordering must be done through the use of the cross button (see 2). When pressed, the tile enters a re-ordering mode where it can move via pressing the left and right arrow keys or pressing the left/right buttons.



Note that, as explained in Session settings persistence, the tiles order is saved across OxyGEN sessions.

Control panels

Seven types of control panels exist, shared between 4 categories.

Pressure graphs

Reports the current pressure sensor measurement and allows to set a new order. The new order can be either given via the vertical cursor or as a number in the dedicated "order" text field. Clicking on the up and down arrows allows to increment/decrement the value by a certain amount defined in the channel options



One can change the unit of reference via the select box under the "Order" field. The name of the channel (which can be modified) and its characteristics can be seen in the top right corner.

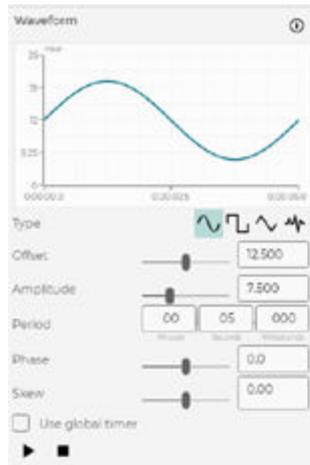
1 Define a custom waveform as pressure order

In this window several types of waveforms can be defined via typical waveform parameters: Type, Offset, Amplitude, Period, Phase and Skew.

By default, waveform's first value takes the value of the Offset parameter.

However, it is possible to base the waveforms values based on a global timer. This allows for a synchronisation between several waveforms of the same phase on different channels.

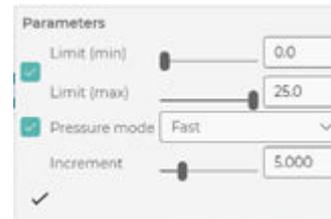
Under those parameters, two buttons allow you to send the waveform order or to stop it.



2 Define the channel options

Here both the lower and upper limits of the pressure orders can be redefined within the range of the pressure sensor capabilities.

For the Flow EZ™, it is possible to switch the pressure mode between Fast and Smooth. This mode will impact the pressure channel behavior when large variations of orders are given. Basically, the Smooth mode deactivates the ON/OFF valves of a Flow EZ™ resulting in a slower but smoother variation of the pressure when a new order is given.



The pressure mode is replaced by an Alpha value for the MFCS™ channels. This value acts as a feedback coefficient whose default value is 5. Decreasing the factor will result in a faster response but more instability and potential overshoots. The range is 1-255. Finally, the Increment option allows to change the amount that will be added or subtracted to the pressure order when changed via the dedicated arrows in the input field.

3 Calibrate the channel

For MFCS™, Push-Pull and Flow EZ™ instruments, this sets the pressure to 0 and then sets the measured atmospheric pressure as the zero of the pressure channel.

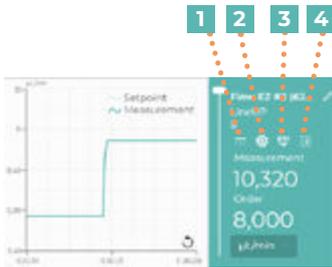
4 Reset pressure to 0 (of the current channel)

Finally, in the bottom area of the pressure channel illustration, the inlet pressure value is reported (> v2.3.0) for the most recent versions of the FlowEZ and F-OEM.

Control panels

1 Flow rate graphs

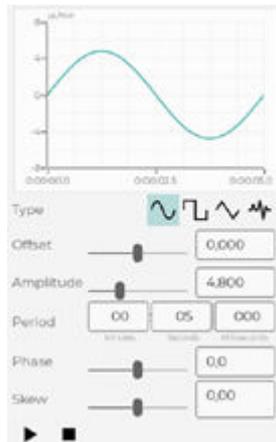
Reports the current flow-rate sensor measurements and allows setting a new order. The new order can be either given via the vertical cursor or if a DFC has been set up (press the hand icon to activate it and make the cursor appear) or as a number in the dedicated text field. One can change the unit of reference via the select box under the "Order" field. The name of the channel (that can be modified) and its characteristics can be seen in the top right corner.



1 Define a custom waveform as flow rate order

In this window several types of waveforms can be defined via typical waveform parameters: Type, Offset, Amplitude, Period, Phase and Skew.

Under those parameters, two buttons allow you to start the waveform order or to stop it.



2 Define the channel options

The parameters that can be changed: Lower and upper limits of the channel orders, within the range of the flow-rate sensor capabilities. Which calibration table to be used, Water or IPA. (Note: depending on the calibration table used, the sensor range will be impacted)

The response time can also be modified (it is 2s by default).

When working with liquids that have different properties from water and isopropyl alcohol such as some Fluorinated oils (HFE 7500, FC40, etc.), one can use a polynomial function to adjust the flow rate measurements. In the Custom factor control, you can choose the factors of the polynomial as well as its maximum value.



3 Set regulation parameters



Here a pressure channel can be associated with the current flow-rate channel. Once the association is made, the DFC can be used to reach a flow-rate order thanks to its associated pressure channel. By default each FLOW UNIT connected to a Flow EZ™ will be associated with it.

4 Open volume counter



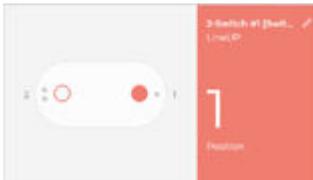
Open the volume counter of the current flow-rate channel. The volume counter can be paused, resumed, reset or inverted. Inversion of a volume counter will invert the sign of the volume that is measured.

Control panels

Valves

1 2-SWITCH™

Allows to quickly change the position of a 2-SWITCH™. The current position is reported by an orange dot and indicated in the right part of the control panel. A requested position is represented by an empty circle with a dashed border. As for all channels, the name can be edited and the type is indicated right below it.



2 L-SWITCH™

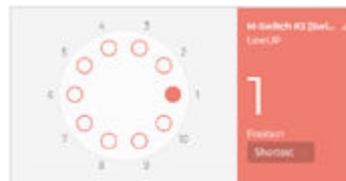
Allows to quickly change the position of a L-SWITCH™. The colored line connecting the colored circles represents the L-SWITCH™ positions that are connected and the current position. This can also be read in the right part of the control panel. When dotted lines are displayed in the control, it means that a position switch has been requested.



3 M-SWITCH™

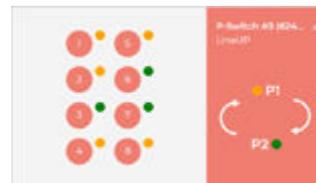
Allows to quickly change the position of an M-SWITCH™. As for the 2-SWITCH™, the current position is reported by an orange dot and indicated in the right part of the control panel. A requested position is represented by an empty circle with a dashed border.

It is also possible to choose the direction of the valve rotation upon switching. The three options are: Shortest (shortest distance between actual and requested positions), Clockwise and Anticlockwise.



4 P-SWITCH

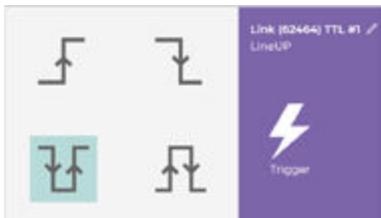
This control panel allows you to quickly switch the P-SWITCH pressure channels between close and open positions. You can either switch the pressure channels individually in the left part of the panel. Or, invert all positions at once by pressing the button in the right part of the panel. A green circle indicates a channel that is opened whereas an orange circle indicates a closed channel.



Control panels

TTL signals

Allows to easily configure a TTL detecting mode or to quickly send a TTL signal. The first two buttons (1st row) change the detection mode of the current TTL channel.



It can either be set to detect rising edges or to detect falling ones.

The last two buttons (2nd row) can be used to configure how a TTL pulse signal will be sent, either as a low one or as a high one. Finally, to trigger the signal, press the Trigger button in the right part of the control.

When a signal is received, an icon shows up on the right side of the Trigger button (see on the screenshot) and stays visible for a couple of seconds.

SESSION SETTING PERSISTENCE

From version 2.0 on, the parameters and channel names defined in the Live Control pane are saved between OxyGEN sessions. So, whenever a channel name is changed, a pressure range is modified or some custom factors are changed, those new parameters are saved and, upon closing and re-opening OxyGEN, are loaded to the same channel, if present. Note that the set of parameters saved is bound to the channel type and serial number.

From version 2.3 on, the order of the channel tiles is also saved between sessions.

SHORTCUTS AND NAVIGATION

Shortcut	Key bindings
Lock/Unlock	Alt+L
Regulation window	Alt+D
Coupling window	Alt+C
Volume counter window	Alt+V
Reset pressures	Alt+P
Record	Alt+R
Filters window	Alt+F
Hide missing	Alt+H
Reset filters	Alt+Shift+F
Emergency stop	Shift+Esc

PROTOCOL EDITOR

The protocol Editor workspace is dedicated to the setup and execution of automated protocols. In those protocols, actions can be triggered and/or monitored to set up complex processes depending on the microfluidics system behavior. It allows for a long and reproducible set of actions while allowing for some degrees of manual control when this is needed.

INTERFACE



- 1 Device panel (see *Device Section*) see the instruments that have been detected, hover to get basic information (name + SN)
- 2 Library panel (see *Library*) Exhaustive list of all channels connected or simulated + all functions available to build a protocol.
- 3 Editor panel (see *Protocol Editor*) Main interface to create and monitor protocols.

DEVICE SECTION

Connecting instruments

Any instrument connected to your computer, either directly or via a controller (LINK, SWITCH EZ, Flowboard, etc.) will appear in here.

If linked to a SWITCH EZ, a SWITCHBOARD or a Flowboard, a sensor or a valve will be indicated by a colored marker at the controller port it is connected to. You can hover the marker to get some details, as a tooltip, on the instrument like its type and serial number for instance.



Plug & Play feature

OxyGEN is able to detect new instruments connected on the fly. In the same way, any instrument that gets disconnected will be reported. Whereas new instruments will be added to the device overview, disconnected ones will be indicated by an question mark or a greyed out marker.

Simulated instruments

It is possible to add up to 32 simulated instruments. Those simulated instruments can be useful to test some features and combinations and can be mixed with real instruments. They won't be saved between sessions and will need to be recreated at each application restart.

Main interactions and features

The device panel has a limited set of features since its main utility is to report the instruments connected (or simulated) for the current session. Aside from the possibility to highlight controls in the Live Control panel when hovering an instrument and add new simulated instruments.

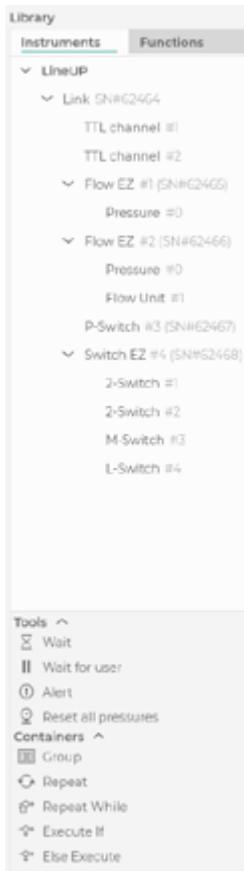
LIBRARY

The Library lists all instruments, either connected or simulated. Each channel of the list can be selected and a set of the functions and conditions attached to this channel is displayed at the bottom of the list.

From the library pane, two actions are possible to add a function (instrument or tool) or a condition:

Double-click the function/condition name to add it to the protocol. (Note: a condition can only be added via this method to a selected function that requires a condition.) The new condition will replace any condition that might have already been assigned to the selection function. If a container is selected the function/tool will be added to the container list of steps.

Drag-and-drop the function to the editor section where you want to insert it within the list of steps displayed. For conditions, it is only possible to drop them on a function that requires a condition. As for the previous method, the new condition will replace any condition that might have already been assigned to the selection function.

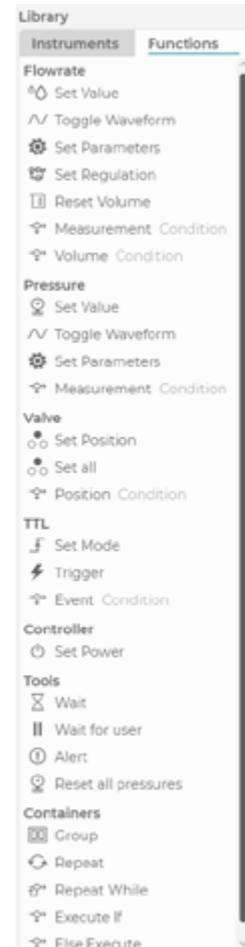


It is also possible to switch to the Functions view where all available functions for the added instruments are listed and splitted by category.

The same actions possible via the Instruments view are available in this view as well.



Any successful or unsuccessful action triggers a visual feedback in the Editor panel (see screenshot above).

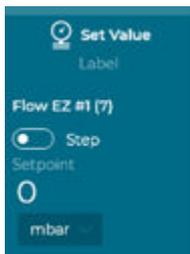


FUNCTIONS

Here is the different type of instrument functions that can be used in a protocol:

Set Value

Set a pressure order as a precise value or as a step (increment/decrement).



Toggle Waveform

Start or stop a waveform for the pressure channel selected. Parameters that can be changed to define the waveform are the same as the ones presented in Live Control section



Set Parameters

Set the parameters of the pressure channel. Parameters that can be changed are in Live Control section.



Set Regulation

Associate a flow-rate sensor with a pressure channel.



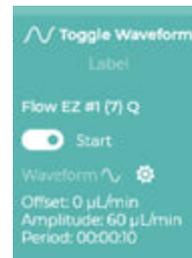
Set Value

Set a flow-rate order as a precise value or as a step (increment/decrement).



Toggle Waveform

Start or stop a waveform for the flow-rate channel selected. Parameters that can be changed to define the waveform are the same as the ones presented in Live Control section.



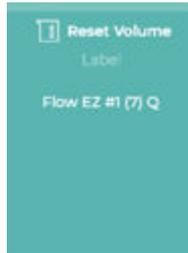
Set Parameters

Set the parameters of the pressure channel. Parameters that can be changed are in Live Control section.



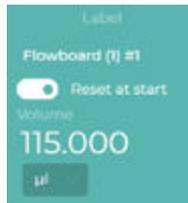
Reset Volume

Reset the volume counter of the selected flow-rate channel.



Wait for Volume

Wait for a certain volume to be reached. It is possible to reset the volume counter of the flowrate channel selected when this block is executed or to use the current volume accumulated previously.

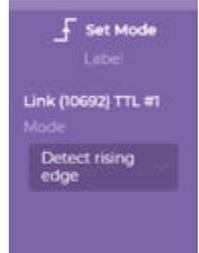


Set Mode

Set the mode of the TTL channel selected.

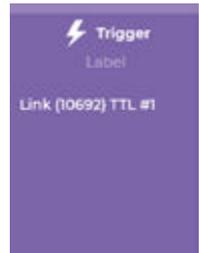
Four modes are possible:

1. Detect rising edge
2. Detect falling edge
3. Output pulse low
4. Output pulse high



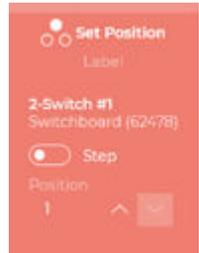
Trigger

Trigger a TTL pulse signal if the TTL channel mode has been set to either "Output pulse low" or "Output pulse high".



Set Position

Set the position of a valve as a precise value or as a step (increment/decrement).



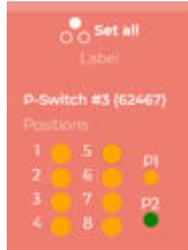
Set Purge

For MFCS-only, activate or deactivate a purge.



Set all

Set the state (open/close) of the P-Switch pressure outlets.



Here is the different type of instrument conditions that can be used in a protocol:

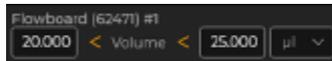
Measurement

If the pressure or flow-rate value is within the limit(s) defined then enter the step, otherwise skip.



Volume

If the volume value is within the limit(s) defined then enter the step, otherwise skip.



Position

If the valve position is equal to the condition then enter the step, otherwise skip.

Event

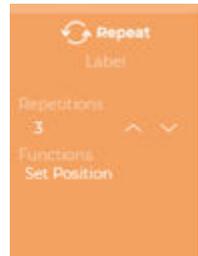
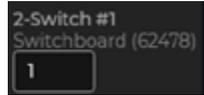
If the TTL channel receives a TTL signal when the condition is evaluated then enter the step, otherwise skip.

Positions

P-switch ONLY: Set a position pattern that will be evaluated when reaching this condition. If the pattern matches the current states of the P-switch valves then the condition is evaluated to True. States possible are "x", "1" or "2". "x" allows to skip the evaluation of this particular valve.

Repeat

Repeat the steps within this container N time(s).





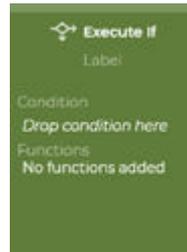
Container

Create a group container that can contain 1 or more step(s)



Container

Create a container whose step(s) will only be executed if the condition defined is evaluated to True



Container

Can ONLY be positioned AFTER an "Execute If" block. It creates a container whose steps will only be executed if the condition of the previous "Execute If" block has been evaluated to False.

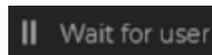


Wait for a certain duration before proceeding to the next protocol steps.



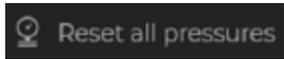
Container

Create a container whose steps will be repeated as long as the condition defined is evaluated to True.



Wait for a user confirmation before proceeding to the next protocol steps.





Reset pressure of all pressure sources to 0 used in the current protocol.



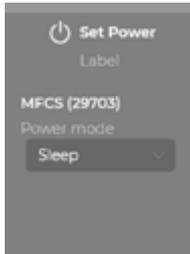
Alert

Triggers a message, a warning, an error or a fatal error. Can be used to force a protocol to stop or to simply log a particular message in the protocol records.



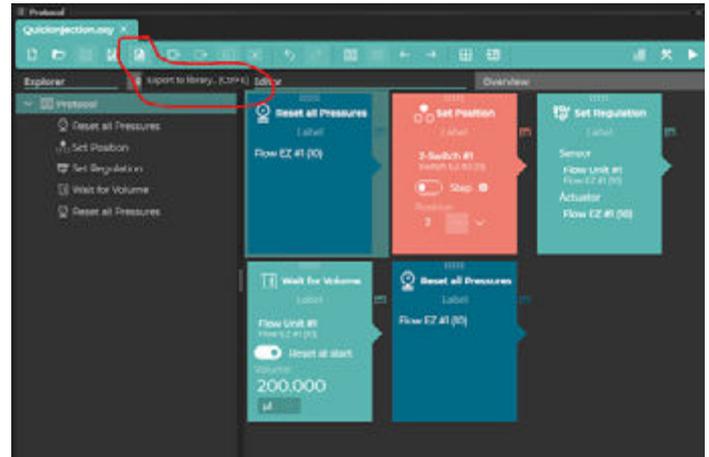
Change the power mode of a Link or an MFCS. Three possible modes:

- Power ON
- Power OFF
- Sleep

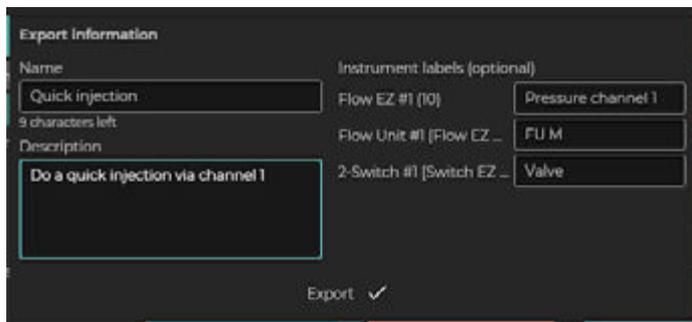


CUSTOM PROTOCOLS

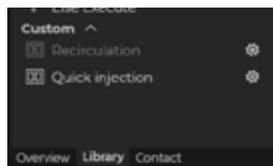
Implemented in v2.1.0, the custom protocols feature allows you to create and import pre-made protocols that can be accessible via a single click in all your future sessions.



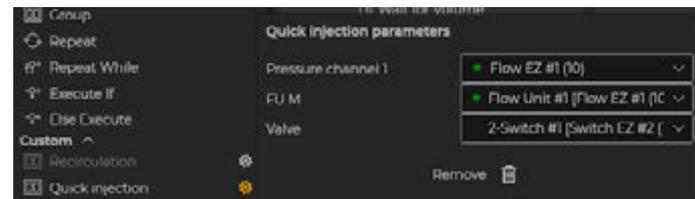
To create a pre-made protocol, first create the protocol thanks to the protocol editor (see T2 : Protocol Editor Pane for more details about a protocol creation). Once your protocol is created, click on the "Export to library" button  and a pop up window will appear.



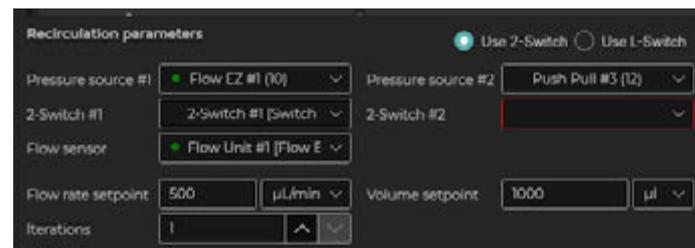
From this window, you can set a name for your custom protocol, optionally a description and finally a label for all the instruments involved in the newly created protocol. Once done, click “Export”. When done, your new protocol should appear at the bottom of the “Instruments” and “Functions” panels.



All your custom protocols will be displayed here. To add a protocol to the current editor, either double-click it or drag and drop it to the editor. A group entitled with the protocol name will be automatically created and will contain all the steps defined when you have created the protocol. It is possible to change the instruments referenced by the protocol by clicking on the settings icon . There, all the instruments involved are listed and a drop down menu allows you to assign a connected instrument to each of them. This is also from this window that you can delete a custom protocol.

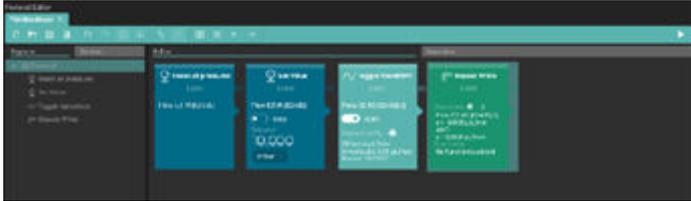


We also embed, by default in OxyGEN, two recirculation protocols (one based on two 2-switch valves and one based on a L-switch valve). For those protocols, not only the instruments can be modified but also the recirculation parameters (Flow rate setpoint, Volume setpoint and Number of iterations/cycles).



To be able to add one of those two recirculation protocols, you must have the required instruments connected (be for real or simulated).

PROTOCOL EDITOR PANEL



Toolbar



1. **New protocol:** Create a new protocol that will be opened in a new tab
2. **Open protocol:** Open an existing protocol (*.oxy)
3. **Save protocol:** Save the current protocol, open a prompt if the protocol has never been saved before
4. **Save protocol as:** Open a prompt to save the current protocol
5. **Export to library:** Export the current protocol to the library of custom protocols that can be accessed via the “Instruments” or “Functions” panel in a single click (see Custom protocols).
6. **Copy step(s):** Copy selected step(s)
7. **Cut step(s):** Cut selected step(s)
8. **Paste step(s):** Paste step(s) that have been copied or cut
9. **Delete step(s):** Delete selected step(s)
10. **Undo last action:** Undo last action
11. **Redo last action:** Redo last action
12. **Group step(s):** Gather selected step(s) into a group container



13. **Ungroup:** Ungroup step(s) previously gathered in a group container
14. **Move step(s) left:** Move the selected step(s) to the left
15. **Move step(s) right:** Move the selected step(s) to the right
16. **Change display mode:** Switch between full and minimized views



17. **Toggle container settings visibility:** Open a side panel on the right in the editor window with the settings used for the current active container. It allows editing its parameters directly instead of navigating backwards in the protocol hierarchy.



18. Replace instruments: Open a window where one can quickly change a channel used in the current protocol by another one. Useful when a protocol has been designed with simulated instruments replaced later by real instruments.



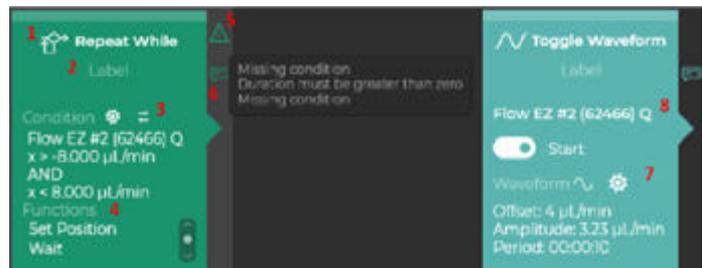
19. Set run configuration: Open a window where one can specify actions to take when an event (warning, error, fatal error) is encountered during a protocol execution



20. Stop protocol: If running, stop the current protocol
21. Play/pause protocol: Execute (or continue if paused) the current protocol / Pause* the current protocol (Pause only stop the execution of the protocol steps, it does not change any of the pressure orders given previously)

Protocol Edition

The editor section will display all steps that have been added to your protocol for the selected container in the explorer section. Each step is displayed as a block:



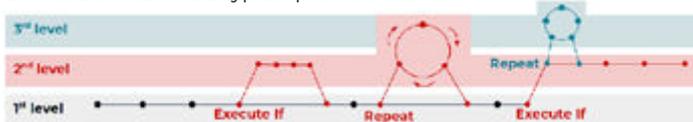
A typical block is made of:

1. The function name
2. An editable label (opt.)
3. When relevant, a condition field with the condition displayed and a button to edit it. Another button allows to quickly invert the condition
4. When relevant, a "Functions" field where all functions present in a container are displayed
5. If any error exists for the current function, a warning icon is displayed. Hovering it will give more details on the existing errors
6. All function blocks can contain a user comment. This comment will be saved within the protocol file and retrieved automatically upon each protocol opening
7. When relevant, the different parameters that define a function are displayed
8. The instrument channel on which the action will be performed, it is possible to see - and switch to - all compatible channels with the current function by clicking on this button

A list of all possible blocks is available in the Functions section

By default, when a new protocol is created, only one container (level) exists, this is the protocol level, this is the entry point of any protocol and the lowest level. Each time a container (see Functions section) is added to the protocol, it can be seen as creating a new branch containing a set of steps to be executed either several times (for a “Repeat” container) or if certain conditions are met (for a “Executive If” container). This can be seen as an ordered file explorer paradigm where folders (containers in OxyGEN) can be added at any level of the file system and can contain any number of files (functions in OxyGEN) or containers. Steps are played sequentially and when a container is reached, the steps it contains are played (except if the container has an entry condition that is not met).

One could illustrate a typical protocol like this:



When a new step is added to a protocol, two situations can occur:

- 1) Nothing or a non-container step is selected : the new step is added at the end of the visible set of steps.
- 2) A container step is selected : the new step is added in at the end of the set of steps present in the selected container.

Once a step is added, its parameters can be edited by accessing its block representation (see BLOCK column of Instruments section). Blocks summarizes the set of parameters defined but for some advanced features it is necessary to interact with the block (often via the gear icon) to get the full list of the editable parameters.

Every block can be selected, allowing to perform uniformized tasks like cutting/copying/pasting, grouping or moving.

Explorer section

The explorer section displays the exhaustive list of all steps/containers that a protocol is made of. The steps are displayed sequentially, in the order they will be played, from top to bottom. Each line displays a unique step or container name.

If a step is not properly defined and/or the instrument it is linked with is not available and/or its condition is wrongly or not defined, then its name will be displayed in red. Hovering it provides details on what is problematic as a tooltip. In the case of a container, all errors of the steps it contains will be displayed in the tooltip below its own potential error(s).

Containers are indicated with an arrow on the left of their names, oriented towards the right when the container is collapsed (no internal steps visible) or towards the bottom when it is expanded.

Interactions

[Editor panel] Double-clicking on a container block allows to enter it

[Editor panel] All blocks can be dragged by clicking on their top area and moving them around

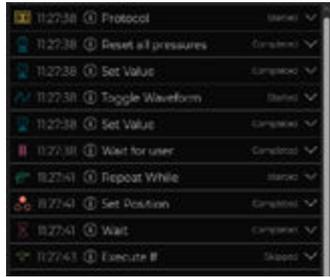
[Explorer panel] Clicking on a block will either display its content (containers) or display its container content (functions).

[Explorer panel] The two buttons on the bottom of the pane allows to:

- Expand/collapse all containers
- Reach the parent container of the selected block (if any)

Protocol Running

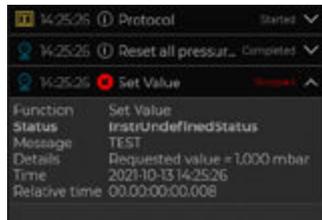
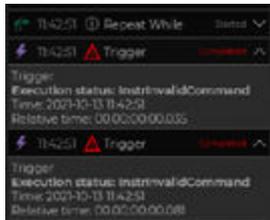
The runner section is displayed as soon as a protocol is played. It replaces the Explorer section but this one can always be accessed via the tab header. In the runner section, all actions performed by the protocol are displayed as a vertical list of items. By default, any item that is not the current function is collapsed.



The current function is expanded to show its details, updated while it is executed (95% of the functions will be executed instantaneously so this detail section won't be shown).



If an error occurs, the execution status and the icon on the left of the name change. Depending on the error level, the protocol might either continue (left screenshot), or stop right away (right screenshot).

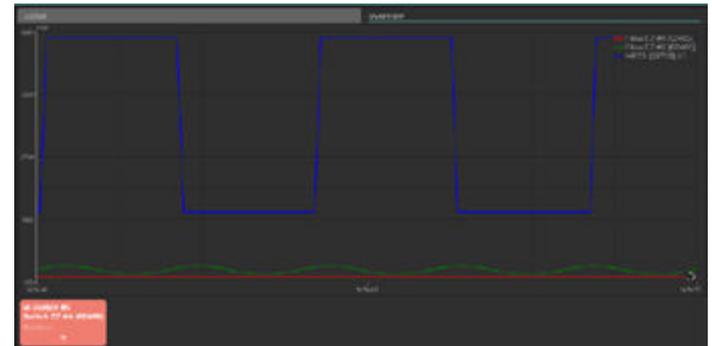


At the end of a protocol, all steps that encountered an error are expanded to spot the nature of the errors in a glance. A summary of the number and nature of the errors can also be found at the bottom of the Runner section:



Two buttons, on the borrow left of the section allow to:

1. Expand and collapse all items at once
2. Activate/deactivate the auto-scrolling when a protocol is running and new items are added



SHORTCUTS

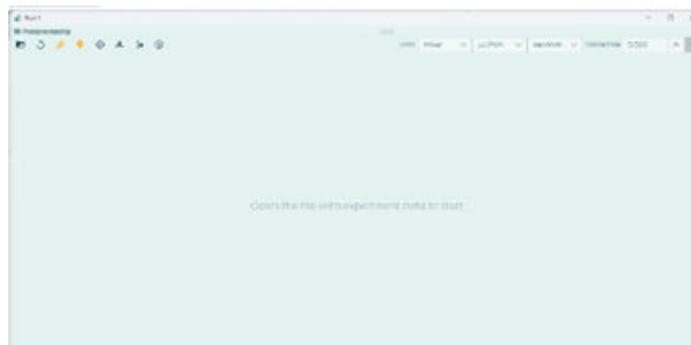
Shortcut	Key bindings (Windows/Linux)	Key bindings (MacOS)
Create new protocol	Ctrl+N	⌘+N
Open protocol...	Ctrl+O	⌘+O
Save protocol...	Ctrl+S	⌘+S
Save protocol as...	Ctrl+Shift+S	⌘+Shift+S
Copy	Ctrl+C	⌘+C
Cut	Ctrl+X	⌘+X
Paste	Ctrl+V	⌘+V
Remove	Delete	Delete
Undo	Ctrl+Z	⌘+Z
Redo	Ctrl+Shift+Z	⌘+Shift+Z
Group	Ctrl+G	⌘+G
Ungroup	Ctrl+Shift+G	⌘+Shift+G
Move left	Ctrl+LeftArrow	⌘+LeftArrow
Move right	Ctrl+RightArrow	⌘+RightArrow
Play/Pause execution	Ctrl+R	⌘+R
Stop execution	Ctrl+Shift+R	⌘+Shift+R
Emergency stop	Shift+Esc	Shift+Esc

POST-PROCESSING MODULE

The post-processing module provides visual tools that aim to help users analysing OxyGEN log data. It is based on the records (CSV file) saved during a protocol or when using the “Record” feature of the Live Control. Currently, this module is ONLY available on Windows and Linux because of some library incompatibility with MacOS.

Interface

This module is opened in a dedicated window, somewhat independent from OxyGEN live control and protocol editor. It can be opened at any moment by clicking on the Post-processing button located in the top bar.



Nothing will be displayed until a record file is opened.

NOTE: Only records saved with OxyGEN v2.3+ are supported since a .csv.metadata is generated together with the usual .csv file.

To open a file, click on the top left icon and choose a .csv file. The module will automatically search for the metadata file associated based on the file names. If not found, an error will be displayed. If both files are found and are properly formatted, several graphs will be automatically displayed:



Most of the analytics provided in the post-processing module are displayed as graphs. Graphs are grouped by channel types: **Pressure**, **Flow-rate**, **Valve position** and **TTL**. It is possible to show/hide a group by clicking on the bottom left icons representing each type available in the current records.

Units for most of the channel types can be changed in the top right drop-down lists. It is also possible to change the time unit common to all graphs. Finally, the **visible time** window displayed in the graphs at once can be increased or decreased. This impacts the number of points displayed at the same time in all graphs. You can tune this value to optimize the performance when analyzing a long experiment. Currently, the maximum is 900 seconds (or 15 min) but it is possible to zoom out the graphs to see more!* data (see Graphs interaction section for more details).

Graphs interaction

Each graph can be manipulated individually. Depending on the option chosen, the other graphs may or may not react synchronously.

Manipulation

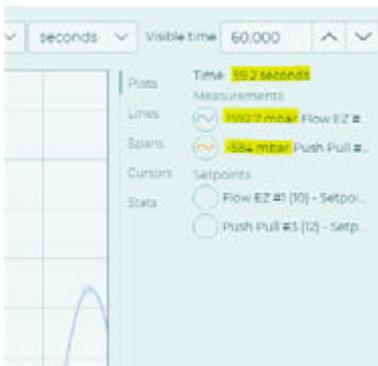
Here are the mouse actions allowed when exploring a graph data:

- Scroll down/up: Zoom in/out
- Drag & drop left-click: Pan in 4 directions (up/down/left/right)
- Drag & drop middle-click: Restrict view to selected area
- Drag & drop right-click: Zoom in/out along x axis (drag&drop right/left respectively) or zoom in/out along y axis (drag&drop up/down respectively)
- Right-click: Open context menu:
 - Show plot in new window: Open the graph in a new window (with independent control)
 - Save plot to the file: Export graph as PNG image

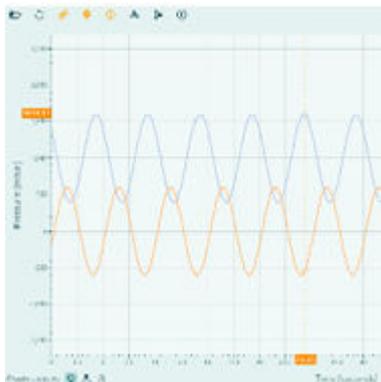
Options



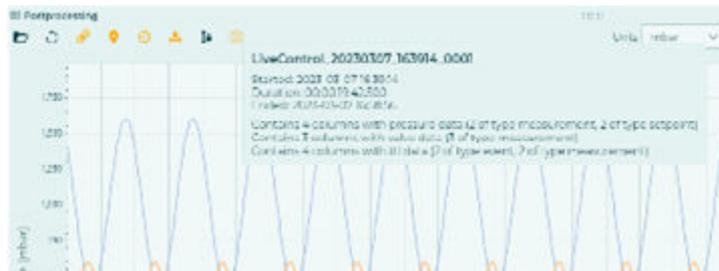
1. **Open recording**: Open a dialog window to choose another CSV file to load.
2. **Reload**: Reset all graphs to their default state
3. **Link plots**: When active, all changes made to a graph zoom level or panning and any selection is reflected on all other graphs.
4. **Enable markers**: When active, display a circle on any point overflown by the mouse pointer. The point coordinates (or associated values) are also displayed at the right of the graph.



5. Enable crosshair: When active, two perpendicular dashed lines crossing on the graph point currently highlighted are drawn and follow the mouse position. They also display, on their extremities, the value of the current highlighted point.



6. Lock horizontal axis: When active, the time axis is fixed and any zoom or pan actions will only be applied to the vertical axis.
7. Lock vertical axis: When active, the ordinate axis is fixed and any zoom or pan action will only be applied to the horizontal (time) axis.
8. Info: Open a pop-up with the current experiment info (file name, start time, duration, end time, number of data lines for each type)

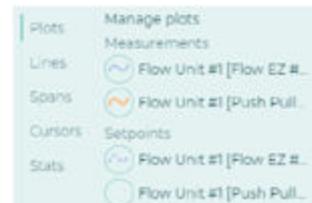


Tools

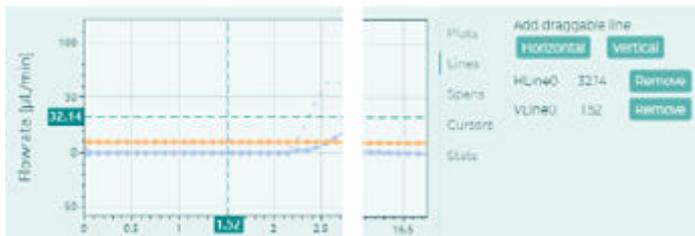
On top of the measurement graphs shown by default, it is possible to tune the information displayed on the graphs. Here are the different tools at your disposal to enrich the view:

- Plots

Any graph line can be hidden or shown by simply clicking on the corresponding representation circle.

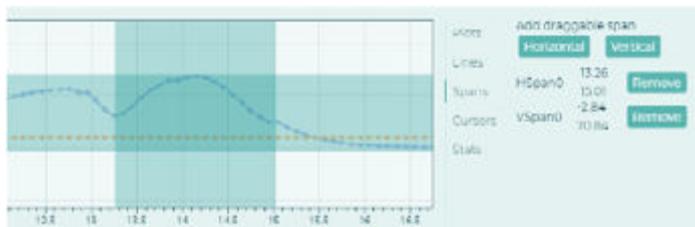


• Lines



It is possible to add as many horizontal or vertical lines as you want. Each line can then be dragged and dropped anywhere in the graph and its corresponding value is displayed on one end. Any added line can be removed as well.

• Spans



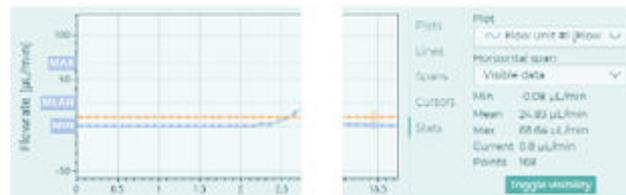
It is possible to add spans, vertical or horizontal, to highlight a certain area. As for the lines, any added span can be removed.

• Cursors



It is possible to add cursors, as pair of highlighted points, to indicate some delta values between 2 points. Those points can either be on the same plot line or a different one. This must be chosen via the draggable cursor drop-down lists. The highlighted points (in pink) can be moved by a drag & drop action as well as the delta labels. The latter are automatically calculated and are not editable.

• Stats



The last section of each graph provides some basic statistics on either all or only the visible data. The minimum, mean, maximum and number of points are shown as well as the current point if any is selected. The Toggle visibility button allows to hide and show horizontal bars that correspond to the minimum, mean, maximum just mentioned. It is of course possible to show the stats for any of the plot lines available in the current graph via the Plot drop-down list. Any manipulation of the graph that would change the visible area while computing statistics for the visible data will trigger an automatic re-calculation of the different values.

SETTINGS & HISTORY

Settings allow you to tune your OxyGEN experience.



General

- Initialize new instruments automatically (default: OFF): Allows to detect, without restarting the app, to detect any new instrument connected to the computer. WARNING: On MacOS this feature creates some instabilities, we strongly advise to leave it unchecked.
- Display landing page on startup (default: ON): Shows the landing page with the recent protocols and the latest news upon each application startup
- Display notifications: Allows to display a pop-up when a new version of OxyGEN is available (v2.2+).
- Use dark theme (default: OFF): Render the application with a dark theme, useful for environments with low luminosity.
- Use system culture (default: OFF): By default, the numerical and date/time formats are set to the Invariant culture (based itself on the “en-US” one) where formats are uniform across all regions, operating systems, etc. You can override this Invariant culture to apply the culture of your system. This will convert all decimal and date/time format to the one you use on your computer.
- Automatically open saved recordings in post-processing module: Open the post-processing module and load the log file automatically when an experiment that just ended or a live-control monitoring that has been stopped.

SETTINGS & HISTORY

Live Control

- Sampling period: Change the time between two updates of the channel values. Value must be set between 10ms and 1s.



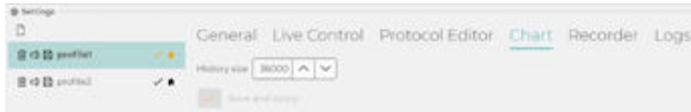
Protocol Editor

- Record all instruments: By default, only channels involved in a given protocol have their values recorded in the log files. It is possible to check this option to extend the recording to all connected channels, be used in a running protocol or not.
- Set pressure channels to zero when paused: When a protocol is paused, do the pressure channels switch to 0 automatically?
- Stop counting volume while paused: When a protocol is paused, do the volume counter(s) stop counting the flow?
- Stop detecting TTL events while paused: When a protocol is paused, does the TTL signal detection stop?
- Step pressure channels to zero when canceled: When a protocol is stopped/canceled, do the pressure channels switch to 0 automatically?



Chart

- History size: How many points are saved in the graph.



Recorder

- Base path: Directory in which the live control and protocol records will be saved.
- Base file name: For live control records, choose what prefix will be used to name any new record. NOTE: Protocol records replace the base file name defined here by the protocol name.
- Sampling period: Choose what is the sampling time of the values recorded for the live control and protocol records. NOTE: It does NOT affect the refresh rate of the data presented in the Live control workspace.
- Maximum file size: When a file reaches this size and a record is still ongoing, new values are written to a new file.
- Maximum file time: When a file reaches this record time and a record is still ongoing, new values are written to a new file.
- Column separator (default: Semicolon): Values are recorded as column-separated values (or CSV). Define the separator symbol to be used in the *.csv files. Choices are: Comma, Semicolon, Tab and Space.

- Decimal separator (default: Dot): Define the decimal separator symbol to be used in the *.csv files. Choices are: Dot and Comma. (NOTE: If Comma has been selected as Column separator then only Dot can be selected as decimal separator)
- Time format (first row): Choose how to format the first line of a record file. Date and time will put the absolute date and time at which the protocol started. Time from start of recording will use relative time (e.g. 00:00:0) instead and Time from start of recording (in seconds) will use number of seconds (e.g. 0.002 corresponding of the time it took to create the file).
- Time format (other rows): Choose how to format all lines but the first of a record file. Date and time will put the absolute date and time at which the log was written. Time from start of recording will use relative time (e.g. 00:05:8) instead and Time from start of recording (in seconds) will use number of seconds (e.g. 5.804).
- Apply first row format to each file: If several files are created to record a unique protocol, you can choose to apply the format defined in Time format (first row) to each new file first row or to use the Time format (other rows) instead.



Logs

- Log to UI: What levels of information are logged to the UI (see Operation History section)
- Log to file: What levels of information are logged to the log file.

NOTE: A log file is created for each session and stored within C:\Users\%USERNAME%\AppData\Local\Fluigent\OxyGEN\AppLogs

Possible levels are: Debug / Info / Warning / Error / Fatal



Fluigent SDK verbosity: Low-level instrument data for troubleshooting. This adds on top of the application log file, the logs provided by the communication layer (SDK) used by OxyGEN to interact with the instruments. By default, leave this value to 0. A level of 5 will log any USB frame exchanged between OxyGEN and the instruments every few milliseconds. Therefore, this level of verbosity can result in very large files. As a rule of thumb, you can consider about 1MB/min for each instrument connected (simulated included).

Operation History

The Operation History reports all the events that occurred within a session. Depending on the levels of information selected in the Settings, the list of operations will be more or less verbose. By default, all events except the Debug ones are recorded and displayed in the section.



TECHNICAL SUPPORT

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<http://www.fluigent.com/faqs/>

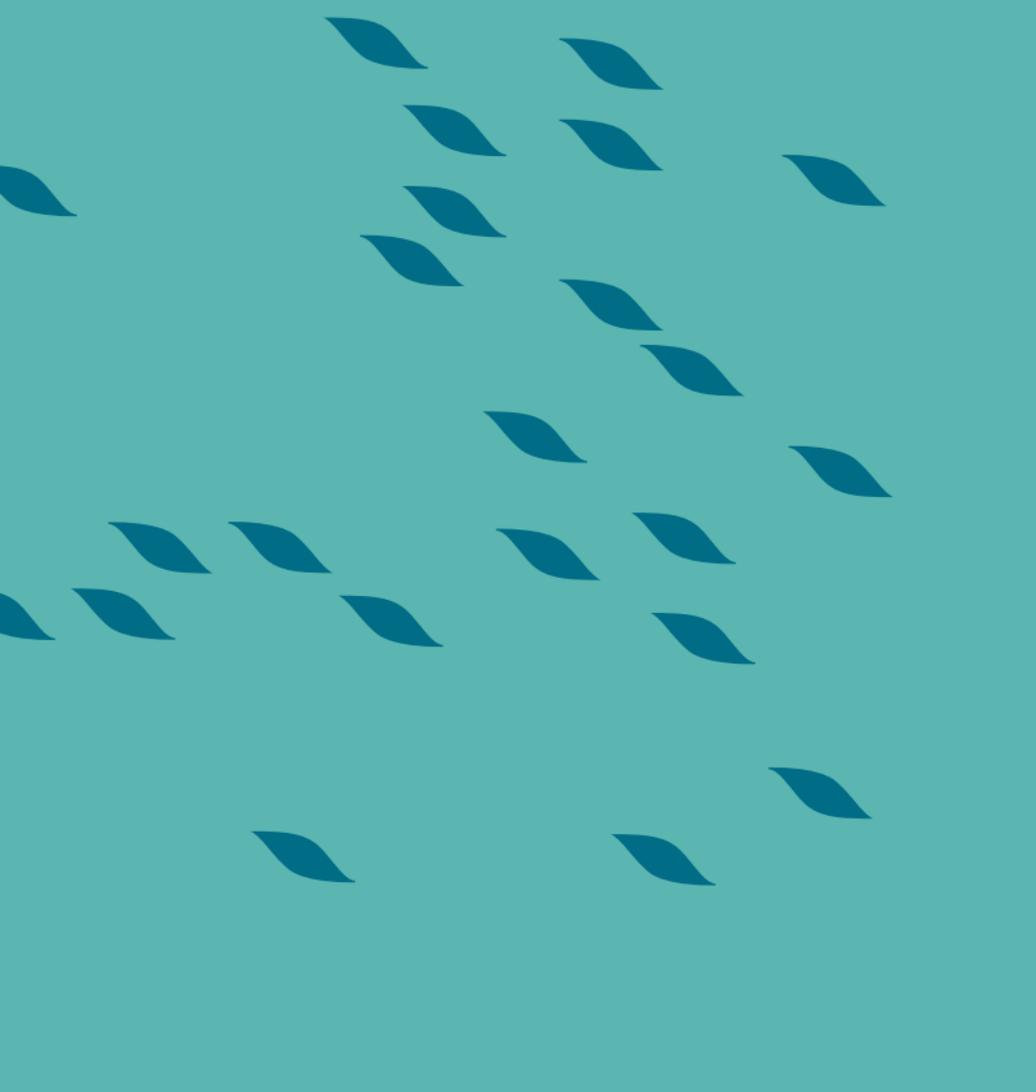
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