

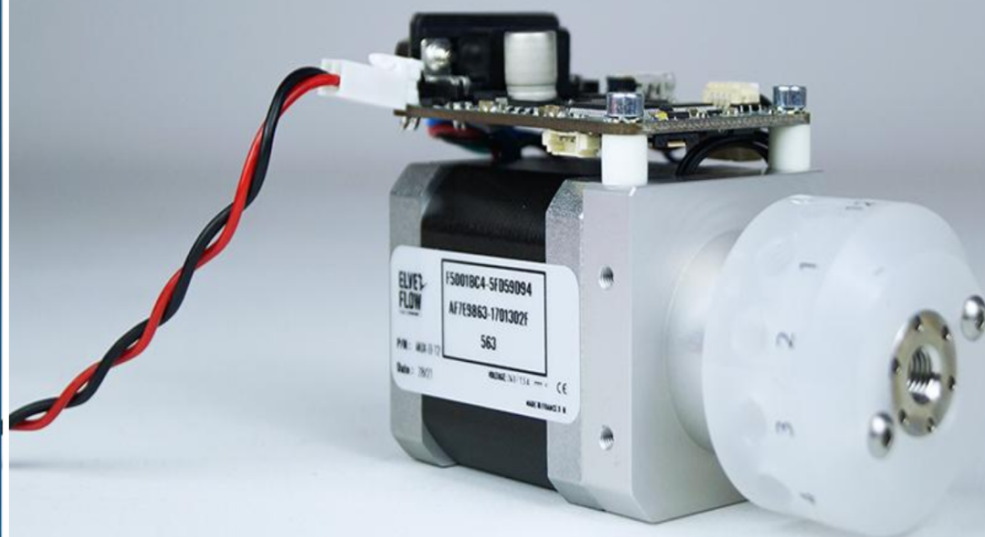
**ELVE  
FLOW**  an **ELVESYS** brand

# OEM MUX DISTRIBUTION

13-ports/12-positions

DOCUMENT REF: UGOMD-150721

## USER GUIDE



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## Introduction

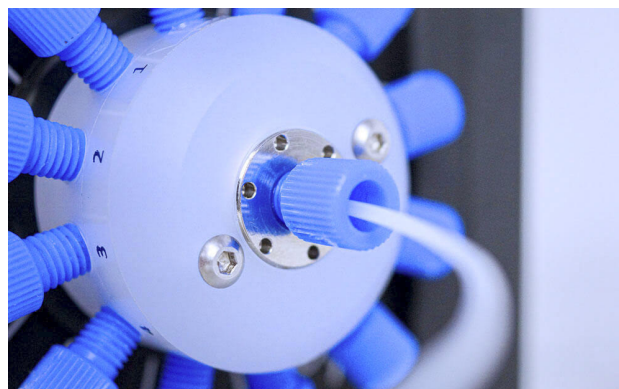
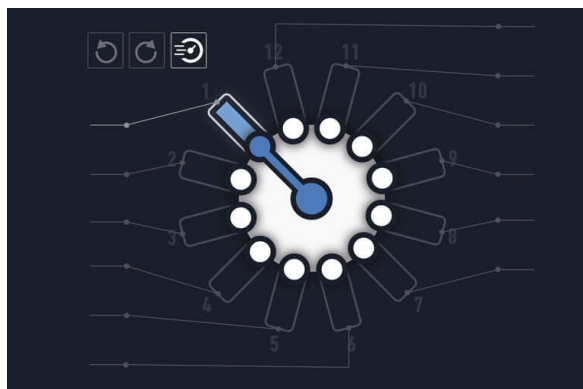
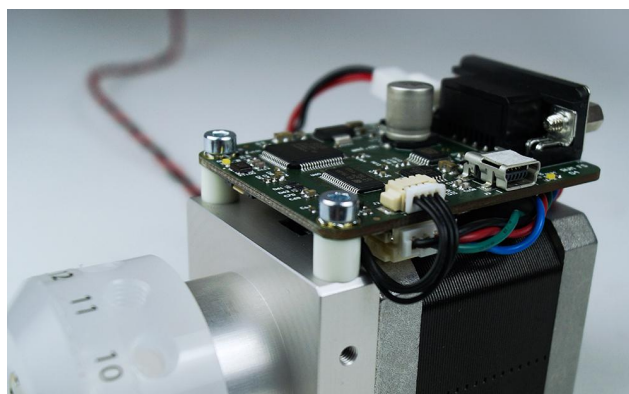
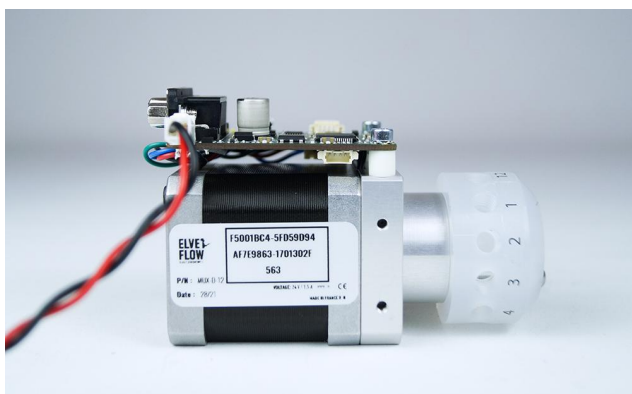
The MUX DISTRIBUTION is a rotary valve which can be used to sequentially inject or select up to 12 different fluids:

- 1 liquid sample into 12 different microfluidic lines
- 12 different liquid samples into 1 microfluidic line

Use this selection valve in combination with the OB1 MK3+ pressure controller to automate injection in microfluidic experiments, program perfusion experiments, sequentially supply different reagents and many more applications. Coupled with the ease of use of the ESI control & automation software, this versatile valve makes long-term experiments easier to automate and run.

## Main Features & Benefits

- Switch between 12 ports in less than 156ms, thanks to a fast & precise valve motor.
- Increase the possibilities with 2 extra ports available (compared to other MUX distribution versions).
- Work in total confidence thanks to the robust and biocompatible materials used (PTFE, PCTFE).
- Use less reagent or sample thanks to the low internal volume (down to 3.5µL).
- ¼-28 connection enables for a leak-free operation and quick connection using standard fittings.



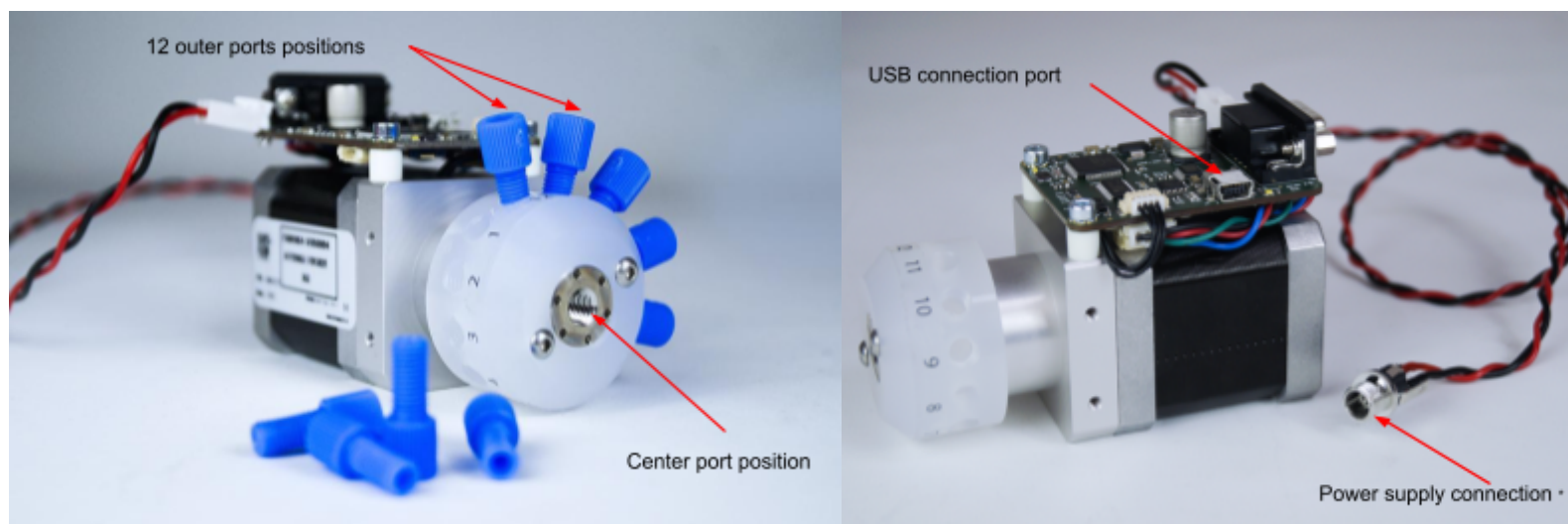
## Applications example

- Cell culture on chip
- Cell response to medium change
- Drug screening
- Toxicity tests
- Stem cells assays
- Reagent switch for flow chemistry
- SPR or TIR imaging coupled with microfluidics
- Any other medium switching experiment you can imagine !

## Instrument description

### Description

front and side view on the instrument



**Figure 1. Front view of the MUX distribution 12.** The manifold outer ports positions are marked from 1 to 12. This bidirectional 12 position/13-port valve which can be used to sequentially inject or select up to 12 different fluids (1 liquid sample into 12 different microfluidic lines, or 12 liquid samples into 1 microfluidic line).

**Figure 2. Side view of the MUX distribution 12.** The USB and power supply connection ports.

## Technical Specifications

<b>Performances</b>	<b>Port to port switching time (ms)</b>	156 ms
	<b>Max recommended pressure</b>	7 bar
	<b>Internal diameter</b>	0.5 mm
	<b>Internal volume <sup>1</sup></b>	3.5 µL
	<b>Carryover volume <sup>2</sup></b>	1.7 µL
	<b>Dead volume <sup>3</sup></b>	None
	<b>Wetted materials</b>	PCTFE, PTFE
	<b>Number of ports</b>	13
	<b>Number of positions</b>	12
<b>Electrical</b>	<b>Power supply voltage</b>	18-24V DC
	<b>Max current consumption</b>	2A peak
	<b>Power consumption (max)</b>	36W
	<b>Connection type</b>	USB
<b>Mechanical specifications</b>	<b>Fluidic connectors</b>	Standard 1/4-28 UNF, flat-bottom
	<b>Operating temperature</b>	5-40°C
	<b>Operating Humidity</b>	20-70% non condensing
	<b>Dimensions (without connectors)</b>	42.3x60x95.9 mm
	<b>Weight</b>	0.514 kg
<b>Software</b>	<b>Computer specifications</b>	USB 2.0 port, Intel Pentium II 500 MHz, 1 Go Hard Disk space, 2 Go RAM Windows XP and newer, 32/64 bit. - LabVIEW® 2011 is required when using LabVIEW® libraries. - ESI installation is required to use SDK.
	<b>Provided software</b>	Elveflow Software Interface
	<b>Software development kit</b>	C++, Python, MATLAB® and LabVIEW® libraries
<b>Part number</b>	<ul style="list-style-type: none"> <li>• <b>Mux distribution v2 - OEM:</b> OEM MUX-D-12-DEM</li> <li>• <b>Mux distribution Valve Head:</b> MUX-D-12-VALV</li> </ul>	

<sup>1</sup> Volume inside the system from entrance to exit

<sup>2</sup> Volume of liquid that will be mixed with the next liquid. It is not stuck, but will be swept next time a liquid passes.

<sup>3</sup> Volume that is stuck in the system (dead end), which is not clearly swept and relies on diffusion to clear out



## Product package contents

Before setting up your MUX Distribution valve , please check the package contents to verify that you have received the items below:

1. The instrument
2. a USB cable (mini B to A)
3. a power cable

In addition to the above items. The user should have the necessary fluidic accessories, tubings and fittings to connect the inlets/outlets to the rest of the setup.

## Installation & use

In order to use the MUX Distribution, the device must be connected to the fluidic setup and to the computer.

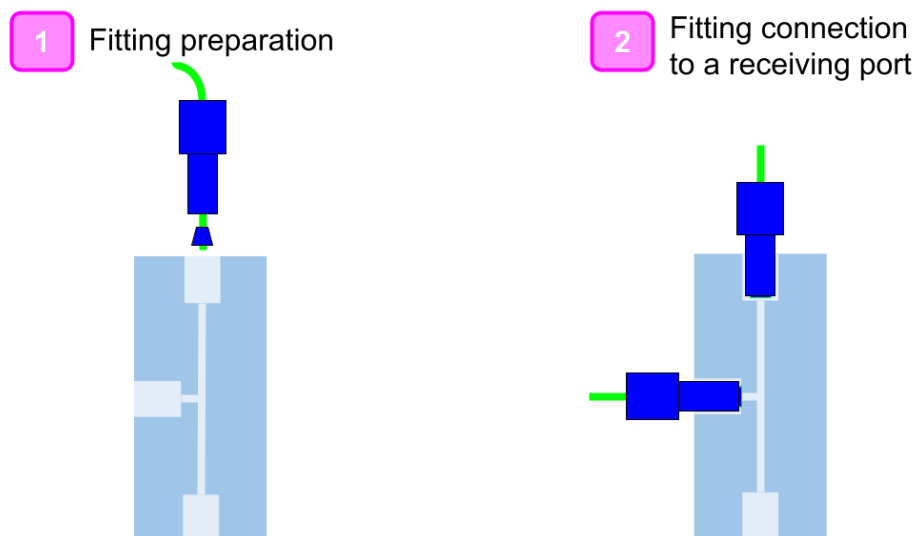
### Fluidic connections

For connecting each port, you need these necessary accessories:

- ¼ -28 connectors for 1/16 inch tubing
- 1/16 inch OD tubing
- Flat bottom ferrules

Connect each port as described in the following illustrations:

1. Cut the tubing to the appropriate length. Ensure a straight section.
2. Slide the ¼ 28 connectors into the tubing.
3. Put the ferrules into the tubing. The flat side facing the instrument ports. Leave only a few mm between the ferrules and one end of the tubing.
4. Connect the tubing to the instrument ports and tighten the connector to prevent any leaks. Be careful not to tighten too much the connector to prevent any damage on long term use.



**Figure 3. Fittings connection principle:** this device uses standard 1/4-28 fittings for quick and easy connection, and leak-free operation.

## Electrical connections

1. Connect the power cable to your 18-24V power line (Red: 18-24V, Black: GND).
2. Connect the USB cable to the computer running the ESI software.

## Software installation

You are now ready to use your Instrument. It can be either controlled by the Elveflow® Smart Interface software (version ESI V3.05.02 and above) or by our Software Development Kit (C++, Python, MATLAB® and LabVIEW® libraries). The Elveflow® Smart Interface's and the SDK main features and options are covered by specific guides.

Please refer to the ESI user guide for a detailed description of the software controls.

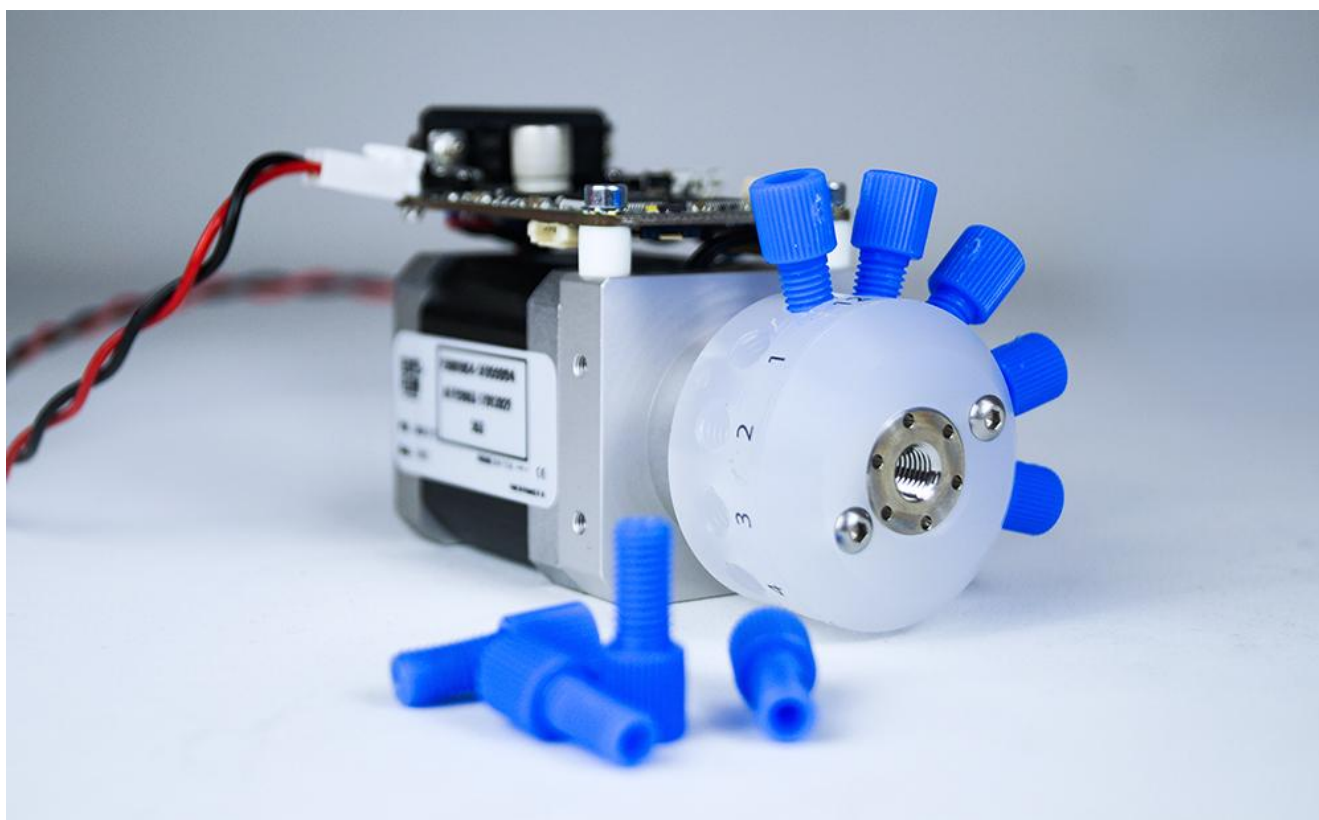
1. Download the [latest ESI version from the Elveflow website](https://support.elveflow.com/support/home).
2. Open the Elveflow folder.
3. Run Install.exe.
4. Follow the instructions presented by the installation assistant.
5. Restart your computer when prompted to finish the installation process.

**Note:** The MUX 12 is supported from version V3.05.02 up. Please update your software if you're using an older version.

## Getting started: learning with an example

The section below “Getting Started” describes a typical application of the MUX distribution 12 so you can learn how to use it with an example.

### How to control the flow while changing flow line with a Mux Distributor 12?



This application note aims to help you maintain a controlled flow rate during microfluidic valve switching thanks to the Mux Distributor. This valve allows you to switch between up to 12 lines to inject several fluids sequentially in your system. It has many applications such as sequential sample injection for biochemistry and flow chemistry, or medium switch for cell biology on chip.

Because the flow switch introduces temporary flow rate diminution, it is important to tune the parameters of the PID flow rate control to have the optimal performances for your set-up. The following sections will walk you through the steps to easily perform this optimal regulation.

We will here focus on how to regulate the flow after a sample switch. Indeed, although the switch occurs in a few hundred ms, it induces a flow rate fall during microfluidic valve switching.

One can use any method to generate the flow. In order to get to a quick and precise flow control we will use the OB1® pressure controller. One advantage of using this instrument is the integrated flow control system provided in the software.



In this set-up, the flow settled by an OB1 is measured thanks to a microfluidic flow sensor. A PID algorithm determines the OB1 pressure output value according to the flow measurement. This algorithm has two parameters – the gain parameter and the integration time parameter – that can be tuned by the user (the D parameter is preset). According to your setup behavior, you may change these parameters to find the best combination to have both a good response time and stability.

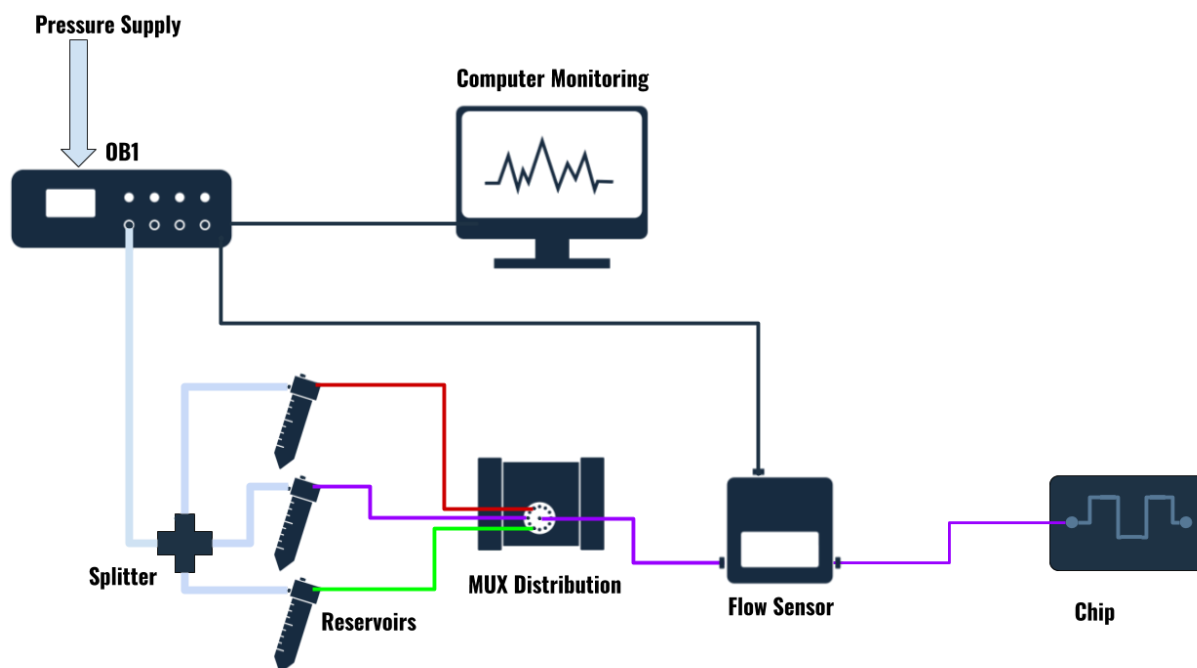
If you want to go further in the understanding of this algorithm, check out our dedicated tutorial: [Set a Flow Control Feedback Loop \(Resistance and PID tuning\)](#).

## Setup example and elements required

This section explains how to inject sequentially several fluids at a controlled flow rate in the device of your choice (microfluidic device, perfusion chamber etc...) using the following equipment:

- Elveflow® pressure & flow control instrument (OB1)
- MUX Distributor
- Microfluidic Flow sensor (BFS)
- Sample reservoirs, one for each medium sample
- Microfluidic Tubing for the fluidic connection of the setup elements
- Microfluidic device (chip)

We here use the Flow Sensor with the [OB1 MK3](#) in pressure control mode and a MUX Distributor.



**Figure 4.**Example of a setup used for switching solutions at a controlled flow rate, using an Elveflow MUX Distribution 12 valve.

**Tips :** For a faster switch, place your microfluidic chips as close as possible to the Mux Distributor. It also allows a more accurate volume control with less liquid in the tubing.

## Flow Regulation Parameters Tuning

Once the circuit is mounted, the next step is to optimize flow regulation. The algorithm can be tuned in accordance to your needs in order to find the right balance between responsiveness and accuracy.

The optimal parameters can be different from one line to another (depending on the properties of your fluids). The Elveflow® software allows you to save different configurations and to load them easily : you can create configurations for all your lines, the algorithm parameters will also be saved.

Tips : To minimize the perturbations caused by the mechanical switch, plug your samples as much as possible in neighbor lines of the Mux distributor. It will reduce the switch time.

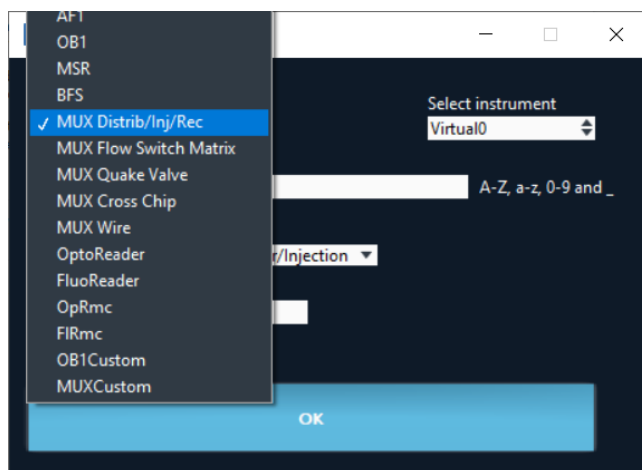
Make sure that all the cables and tubing are well connected to your Elveflow® instruments (USB cable, 24V DC, Flow sensor data cable, etc). Perform leakage tests and remove any air bubbles before starting your experiment.

The flow sensor is very sensitive to vibrations and movement perturbations so it is recommended to tighten it to a stable surface as often as possible.

## Programming a Flow Switch Sequence

### Startup and preparation

- 1) Launch Elveflow® smart interface and add the OB1® pressure controller and the Mux Distributor ("Add instrument").<sup>4</sup>



- 2) Connect the flow sensor<sup>5</sup> ("Add sensor") on the used pressure channel of your OB1.

<sup>4</sup> Important! For MUX Distribution/Distributor/Recirculation/Injection and BFS, driver installation may be required. Drivers are embedded into the ESI installation folder (Default folder: C:\...\Elvesys\driver\Driver\_MUX\_Distributor.exe).

<sup>5</sup> BFS sensors have to be installed as an instrument due to the nature of their electronics ("Add Instrument").

Sensor type

Flow sensor    Digital

Name

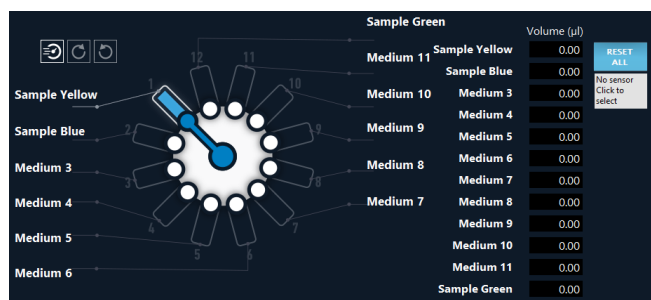
MyFS

Connected to    Channel

OB1 MyOB1    1

OK

3) Launch the OB1® and the MUX Distribution. To switch manually the line connected to the output, simply click on the line you want to select. It is also possible to rename the lines like in this screenshot.



4) Go to the sensor controlled mode and set the parameters as explained in the previous section. You may have to do several tests to find the best parameters. The optimal parameters can be different from one line to another.

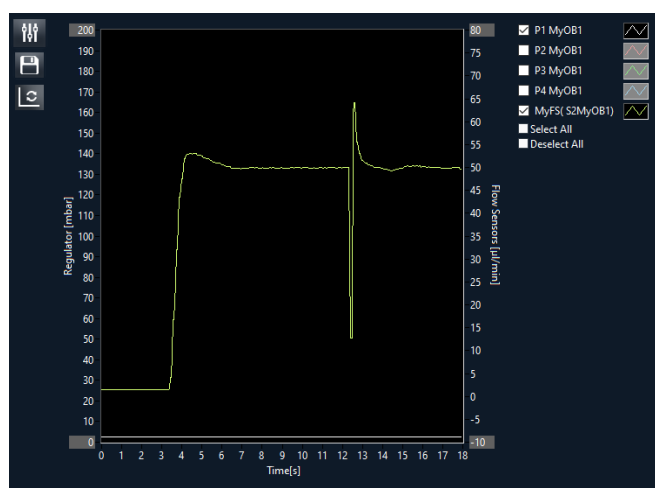
**Note:** using a MFS sensor usually requires to tune the resistance of your setup. Additional information about how to proceed can be found in a specific tutorial: [Set a Flow Control Feedback Loop \(Resistance and PID tuning\)](#).



5) Launch the regulation. You can follow the flow rate evolution on a graph. In this example at time  $t=27s$ , a line switch was performed.

When switching the flow rate first decreases when the flow is blocked. To compensate this stop, the pressure increases and makes the flow rate overshoot the set value before going back to this value in less than 1s.

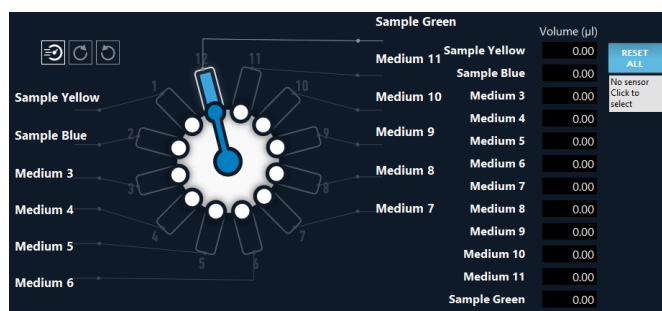
This example shows how to switch between samples when a specific volume of liquid is reached. It is not the most precise way to control experiment because even if the computer gives the volume of liquid, the switch has to be done manually.



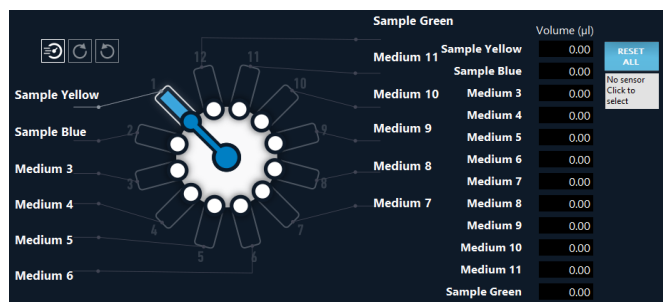
However, it can be very useful if you want to use the Mux Distributor to perform injections in your microfluidic device and this process is particularly easy to follow.

Launch the flow regulation with the OB1® pressure controller and open the Mux Distributor 12 control panel.

You may change the name of the Mux Distributor 12 lines.



Connect the flow sensor to the Mux Distributor, using the panel on the right of the screen. You will now see, for each line, the volume of liquid which went through the line.

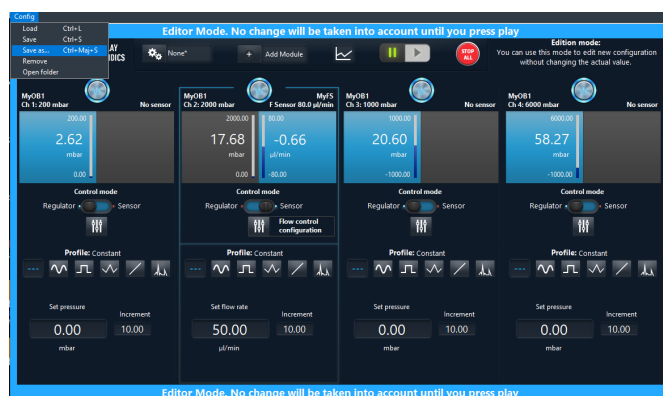


If you don't need too much precision, you can switch manually between the lines when the volume of a sample reached the one you wanted to inject. Connect the flow sensor with the Mux Distributor using the panel on the right of the screen. You will now see for each line, the volume of liquid which went through the line.

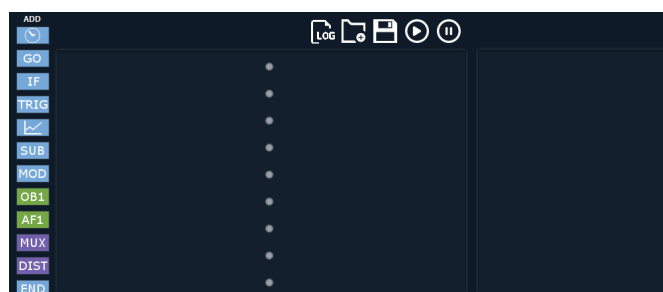
## Automate your solution switch

1) First, for each line create a configuration with the adapted flow rate and flow control parameters. Save these configurations.

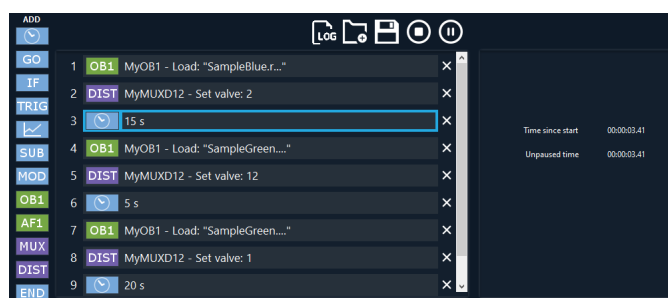
**Tips :** You can also create a “finish” configuration to stop the flow rate at the end of the experiment.



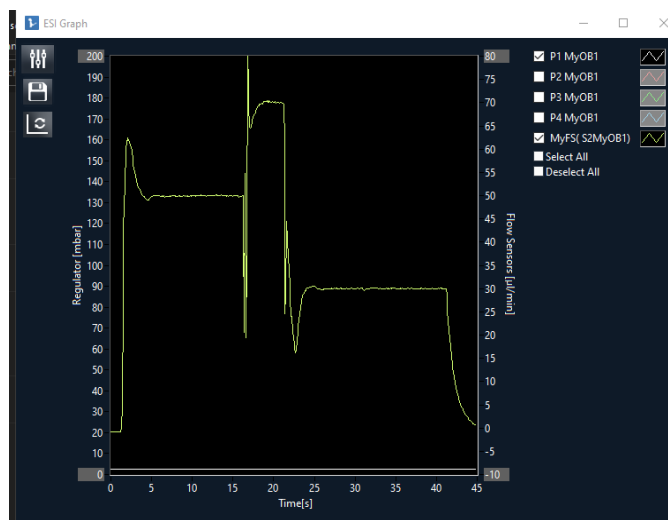
2) Go back to the main panel and launch the sequence planner.



3) Add to the sequence planner the event corresponding to the line switches and the load of the different configurations in the OB1 ®. Then set the time you want to stay in each configuration using the “wait” command.



4) Congratulations! You can now play the sequence ! If the response of one of the channels does not match your needs, go back to the configuration and adapt the flow control parameters.



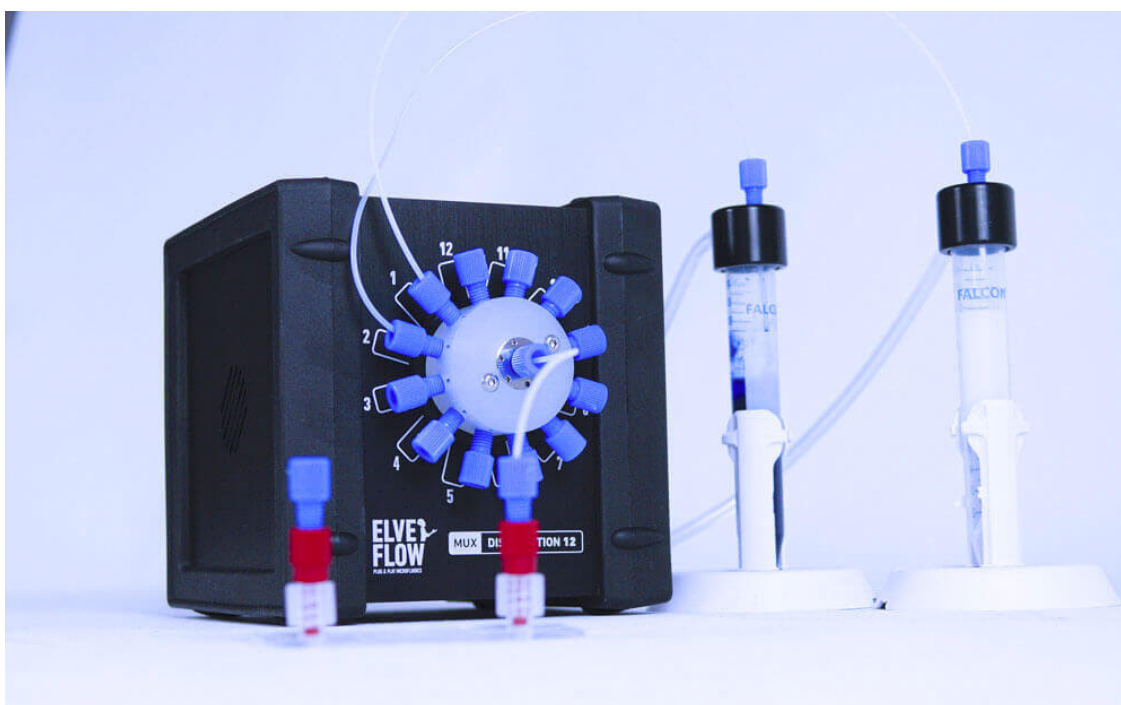
Do not forget that, even if you can't avoid a little bit of disturbance during a line switch because of the flow rate brief stop, you can minimize it with microfluidic valve switching between neighboring lines. Congratulations, you can now run your experiment and control up to 12 lines with a low switch time, and an accurate flow regulation!



## A dedicated product: the sequential fluid injection pack

Elveflow developed a full system for fluid injection experiment called the sequential fluid injection pack, that has the following feature and benefits:

- multiple fluids injection: quickly swap between up to 12 (or more) fluids (gas or liquids)
- high stability and precision: switch fluids while maintaining highly stable and accurate flow rate
- microfluidic workflow automation: no more time consuming experiments
- high versatility: use it with any fluidic system



**[Discover it on elveflow.com !](https://www.elveflow.com)**

## Tips & tricks - Recommendations

### Cleaning Procedure

A cleaning procedure should be performed at the end of each day or in between two different experiments. For an effective cleaning, pass one of the solutions below (depending on your application) at least twice in each tube connected:

- **Bleach solution** to kill microorganisms : 1% chlorine bleach and deionized water.
- **Detergent solution** to remove debris: 1% detergent (Mucosol for example) and deionized water.

**Note:** 2% RBS 25 can also be used. For blood or plasma manipulation, you may use 1% Alconox. For the valve, you can make this washing step into an ultrasonic bath after a long period of using it.

- **Rinsing water** to prepare the valve for your next experiment: deionized water.

**Note:** Before the rinsing step with the deionized water, you can add a washing step with a solvent such as IPA or 70% ethanol (same manipulations as for the rinsing step). Thanks to the small internal volume, each cleaning cycle is extremely efficient. These solutions can be directly added to your system for automatic cleaning between experiments.

#### **Note — Additional cleaning :**

If your experiment creates precipitates, a more extensive cleaning cycle may require Elveflow to manually remove and clean the valve head. Please contact us for further details.

### Get Faster Flow Switches

For a faster switch, place your microfluidic chips as close as possible to the Mux Distributor. It also allows a more accurate volume control with less liquid in the tubing.

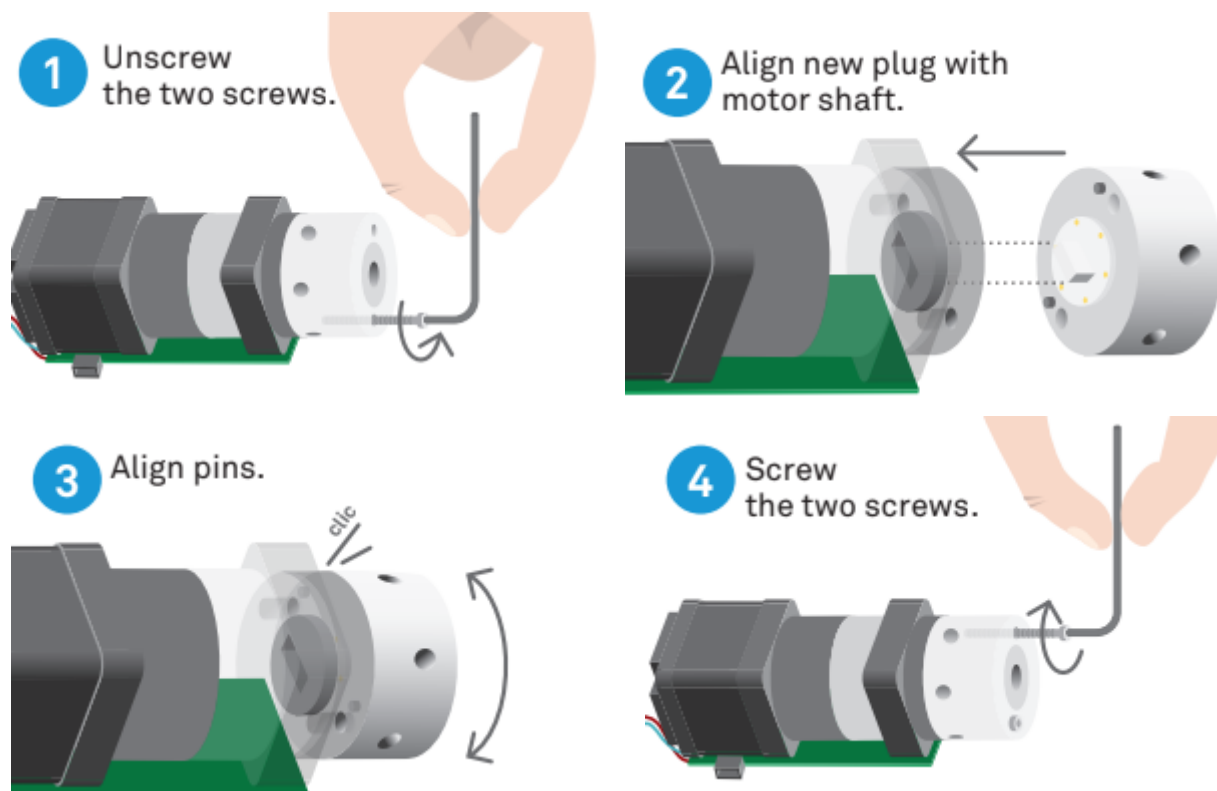
### Do not use Elveflow equipment in a humid environment

Damages caused by humidity, either due to an improper fluidic connection causing leakage, or by the use in a humid environment (e.g. cell culture incubator) can cause damage to this equipment, that would not be covered by warranty.

### How to change the valve head

Please follow the instructions in order to change the valve head:

1. Disconnect the valve from USB and power supply
2. Disconnect all the tubings.
3. Proceed to removing the old valve head and placing the new one according to the steps below:



## Troubleshooting

Below are the most common events that can happen during an experiment.

### The valve head is leaking?

If the valve is leaking, it is most likely due to improper fluidic connection. Please check the following:

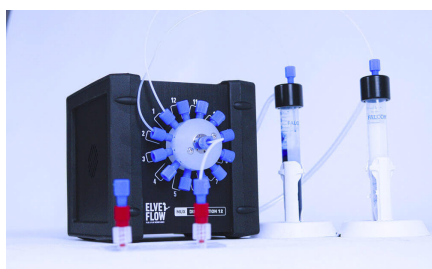
- The ferrules are put in the right direction (follow the fluidic connection section)
- The 1/4-28 connectors are tightened properly
- Unused outputs are not sealed

### I cannot add or detect the instrument in the ESI software?

Please check that you added the instrument properly. Reminder: the instrument falls under the category "rotative valve".

Your instrument might be already added to the software. Launch the ESI software again and click on the refresh button.

## Linked products



#### Perfusion & Sequential injection Pack

An all-in-one solution to quickly swap between up to 12 (or more) fluids (gas or liquids)



#### OB1 MK3+ Flow Controller

The most responsive and stable flow controller on the market



#### MUX series: MUX Distribution, MUX Wire, Individual valves...

## Customer Support

You are welcome to browse through the Elveflow Support Portal accessible online anytime (<https://support.elveflow.com/support/solutions>). You can find lots of guidance on how to use our product line. It is most likely that the answers you are looking for are already there.

In case there are still some questions and you would like further clarification, please don't hesitate to let us know by email at [customer@elveflow.com](mailto:customer@elveflow.com).

We are always happy to help.