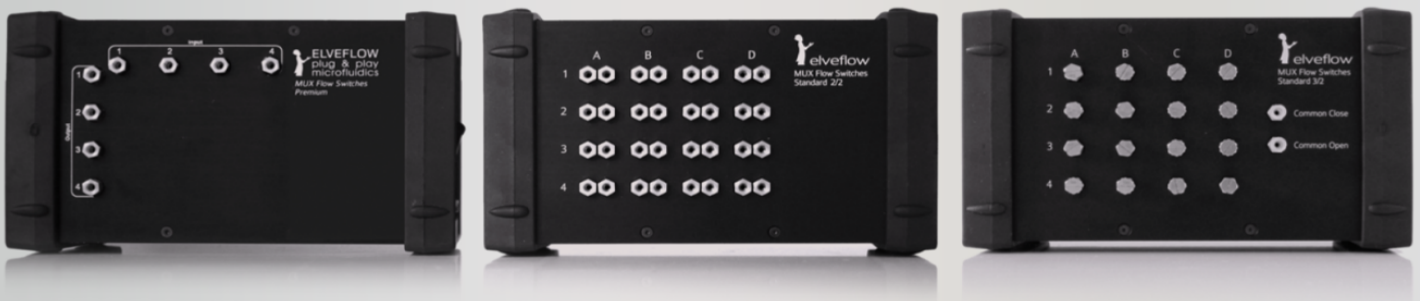
ELVEFLOW an ELVESYS brand

MUX Series

MUX Flow Switch
MUX Quake Valve
MUX Cross Chip
MUX Wire

DOCUMENT REF: UGMUXS-210519

USER GUIDE



Symbols used in this document

Important information. Disregarding this information could increase the risk of damage to the equipment, or the risk of personal injuries.

Helpful information. This information will facilitate the use of the instrument and/or contribute to its optimal performance.

Additional information available on the internet or from your Elveflow representative.

Table of Contents

Please read this document carefully before doing any experiment.

This manual must be read by any person who is or will be responsible for using the MUX.

Due to the continual development of the products, the content of this manual may not correspond to the new product. Therefore, we retain the right to make alterations without prior notification.

Important MUX safety notices:

1. The MUX must be used in a clean and dry environment, with up to 60% relative humidity.
2. Use a power cord of the correct voltage. The MUX requires a 24 V DC input voltage.
3. The pressure applied to the valves must not exceed 2 bar.
4. Fluids used with the instrument must be chemically compatible with PEEK, FKM (Viton), POM (Delrin), and stainless steel (316). The latter is not applicable to the MUX Flow Switch Matrix. Never use acetone with the MUX.
5. No solid should enter the MUX.
6. If possible, filter the media.
7. The MUX Quake Valve must be used exclusively with neutral, dry, dust-free and, oil-free, and particle-filtered gases, at a minimum of 5 µm particle size. Please refer to ISO 8573-1, cl. 3 for detailed information.
8. Clean the MUX before storing it.
9. Do not allow any liquid to dry inside the valves of the instrument.
10. Do not store the instrument with liquid inside it.

IF THESE CONDITIONS ARE NOT MET, THE USER IS EXPOSED TO DANGEROUS SITUATIONS AND THE INSTRUMENT CAN UNDERGO PERMANENT DAMAGE. ELVESYS AND ITS PARTNERS CANNOT BE HELD RESPONSIBLE FOR ANY DAMAGE RELATED TO THE INCORRECT USE OF THE INSTRUMENTS.

Working with systems or equipment containing liquids or gases under pressure can entail risks, especially with pressurized reservoirs containing corrosive, toxic, or explosive liquids and even with water.

Due to the nature of the materials used, transport, and handling of reservoirs by the end-user, Elvesys cannot guarantee the integrity and strength of the provided reservoirs (for any type: Eppendorf, Falcon, glass...) beyond atmospheric pressure.

Presentation

The Elveflow® MUXs are designed for fast fluid injection into microchannels, but also an instantaneous flow stop and low volume sample injection into microchannels.

The MUX is the first professional solution that enables intuitive programming of complex fluidic sequences in a microfluidic device. When used with Elveflow® pressure controllers and liquid tanks, the MUX enables instantaneous flow in either microfluidic devices or capillaries.

The Elveflow® MUX instrument is controlled by a computer through a USB connection, using the Elveflow® Smart Interface that allows you to configure and perform programmable flow switch sequences in your device.

Last but not least, the Elveflow® Smart Interface allows recording and exporting the data generated by all the Elveflow® instruments connected and involved in your experiment.

Product package contents

Before setting up your OB1, please check the package contents to verify that you have received the items below:

1. The instrument (example on the right here)
2. One USB cable;
3. One power supply unit;
4. Specific gas and liquid-tight fittings.

Optional Accessories

You may have ordered some additional elements (e.g. flow sensor units, reservoirs, tubing) so please check that you have received all the corresponding items.

If any parts are missing or damaged, please get in touch with Elveflow support immediately: rcustomer@elveflow.com

Description and typical use

Overview

Four models of MUXs are presented here: MUX Flow Switch Matrix, MUX Quake Valve, MUX Cross-Chip, and MUX Wire. These instruments use electromechanically operated solenoid valves that can be actuated through the Elveflow® Smart Interface. With these instruments, you will be able to perform various tasks such as fast sample injection, medium perfusion and switching, and sample analysis in zero-flow conditions.

You will find below a short description of each instrument's features, as well as three examples of the experimental setup. These simple examples can be used in a real experiment, but the applications of the MUXs extend far beyond them.

Specifications

MUX Type		**Cross Chip**	**Flow Switch**	**Quake Valve**	**Wire**
Performances	Valves actuation time	20ms			
Power Supply	Max. supported pressure	2 bar (29 psi)			2 bar (low-pressure valves) 4 bar (high-pressure valves)
	Input voltage range, AC	100V to 240V			5V USB A type
	AC supply frequency	50Hz to 60Hz			Not applicable
	Input current, AC	1A			0.5A
	Power consumption	35W			Depends on the number of connected valves
	Shutting down	disconnect AC/DC adapter			Switch Off Button
Mechanical specifications	Valve type	2/2-way solenoid valve		3/2-way solenoid valve	2/2-way solenoid valve and 3/2-way solenoid valve
	Input/output connectors	10-32 UNF	1/4-28 UNF	10-32 UNF	1/4-28 UNF
	Wetted materials	POM, Viton, PEEK, FKM			
	Operating temperature	10 °C to 40 °C			
	Operating humidity	20 to 80 %			
Software	Computer specifications	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.			
	Connection type	USB A type			USB A type(controller) Micro USB (valves)
	Provided elements	C++, Python, MATLAB© and LabVIEW© libraries			

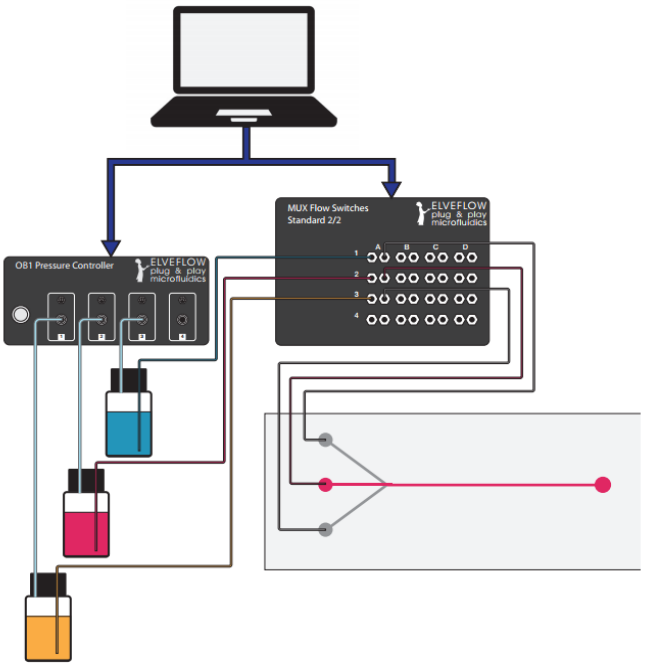
MUX Flow Switch Matrix

The MUX Flow Switch Matrix consists of an array of solenoid valves (i.e. valves with one inlet and one outlet) and is designed to permit and shut off fluid flow. When actuated, these valves allow fluid to pass through, but at rest (default state) the flow is interrupted.

This instrument is typically used with a pressure controller (such as an AF1 or an OB1) that pressurizes samples inside reservoirs. These pressurized reservoirs are connected to the MUX Flow Switch Matrix to selectively inject the pressurized samples into a microfluidic chip in accordance with a valve pattern set via the Elveflow Smart Interface.

MUX Flow Switch Matrix setup example

In this example, a MUX Flow Switch Matrix is used with an OB1 pressure controller as the pressure source, but we could just as easily have used an AF1 pressure generator per reservoir. Both MUX Flow Switch Matrix and OB1 communicate with the computer via the Elveflow Smart Interface. The OB1 is used to apply a stable pressure to the liquids stored in the reservoirs. Each fluidic outlet of these reservoirs is connected to a valve of the MUX Flow Switch Matrix, which is then connected to the microfluidic chip. When actuated using the Elveflow Smart Interface, these valves allow fluid to pass through (see red liquid flowing into the chip), but at rest (default state) the flow is interrupted.



MUX Quake Valve

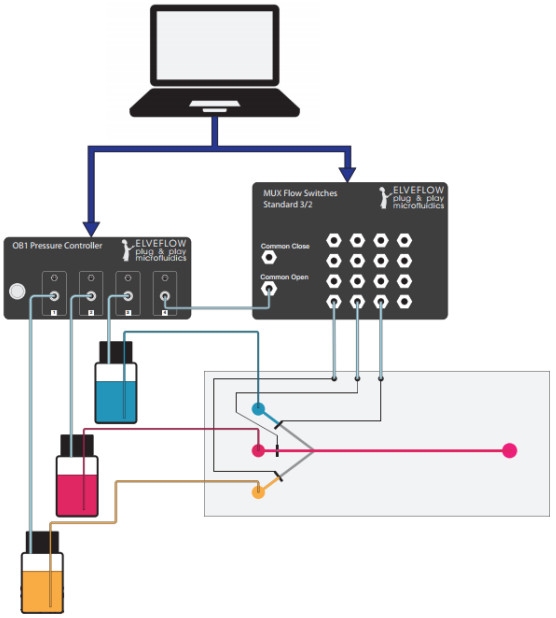
The MUX Quake Valve uses 3-Way solenoid valves, i.e. valves with three ports (NC: Normally Closed, C: Common, and NO: Normally Open), and two positions: **Normally Closed** port linked to Common port, and **Normally Open** port linked to Common port. When the NC port is open, the NO is closed and vice versa.

The MUX Quake Valve offers 16 valves of which a common port is accessible at the front side of the instrument, together with 2 additional connectors ("Common Close" and "Common Open"). A specific manifold connects all NC ports to the Common Close connector and all NO ports to the Common Open connector. The MUX Quake Valve is generally used to alternately apply the pressures set at the Common Close and Common Open inlets to microfluidic channels, in accordance with a valve pattern controlled with the Elveflow Smart Interface.

MUX Quake Valve setup example

In this example, a MUX Quake Valve is used with an OB1 pressure controller as the pressure source, but an AF1 pressure generator can also be used. Both MUX Quake Valve and OB1 communicate with the computer via the Elveflow Smart Interface. The OB1 is used to apply a stable pressure to the liquids stored in the reservoirs, which are then connected to a multilayer microchip that uses pneumatic PDMS microvalves. The OB1 is also used to apply specific pressure to a pressure inlet of the MUX Quake Valve. The second MUX Quake Valve pressure inlet is at atmospheric pressure.

Microfluidic pneumatic microvalves use the deflection of a PDMS membrane to interrupt the flow and can be actuated by alternately applying the OB1 set pressure and the atmospheric pressure. This principle is used to block (blue and yellow liquids) or let flow (red) the liquids connected to the chip, using the Elveflow Smart Interface to open or close the selected solenoid valves.



MUX Cross-Chip

The MUX Cross-Chip uses a 4 x 4 matrix of 2-Way solenoid valves (i.e. valves with one inlet and one outlet) and is designed to permit and shut off fluid flow. When actuated, these valves allow fluid to pass through, but in default, state flow is interrupted.

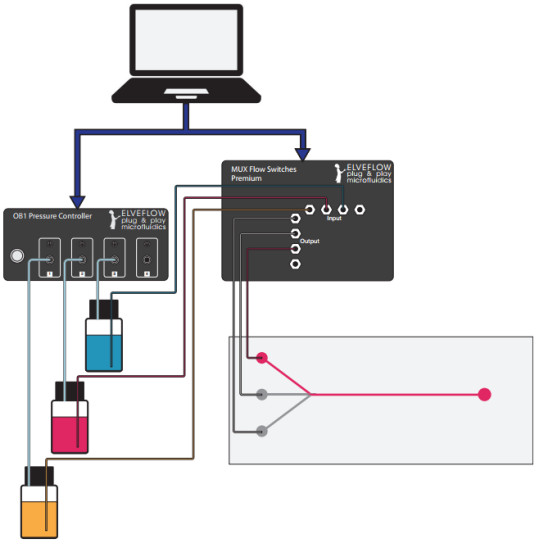
The front side of this instrument shows 8 connectors: 4 inputs and 4 outputs.

The major difference between the MUX Flow Switch Matrix and the MUX Cross-Chip is that the latter has a specific 4x4 matrix-shaped manifold that connects any inlet to any outlet. Therefore, the MUX Cross-Chip can be used to direct the flow coming from a pressurized reservoir connected to any of the four inlets towards any of the four outlets, according to a valve pattern set with the Elveflow Smart Interface.

MUX Cross-Chip setup example

In this example, a MUX Cross-Chip is used with an OB1 pressure controller as the pressure source, (an AF1 pressure generator can also be used). Both MUX Cross-Chip and OB1 communicate with the computer via the Elveflow Smart Interface. The OB1 is used to apply a stable pressure to the liquids stored in the reservoirs, which are then connected to the MUX Cross-Chip inlets.

The MUX Cross-Chip has an internal 4 x 4 matrix-shaped manifold that connects any inlet to any outlet, thus it can be used to direct any fluid coming from one of the inlets to any outlet. In this example, the red fluid connected to the second inlet is injected into the microchip using outlet #3. Subsequently, another pressurized fluid (e.g. blue or yellow) can be injected into the same microchannel, using the same outlet #3, to perform sequential injection experiments.



MUX Wire

The MUX Wire consists of an array of switches that are designed for versatile uses.

We do provide three types of valves that can be connected to the MUX Wire:

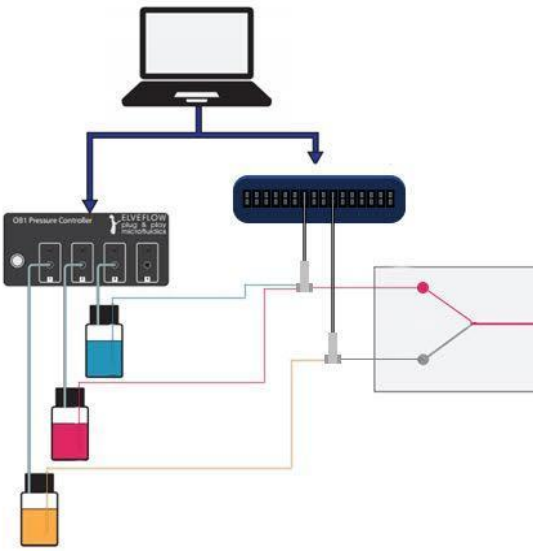
- **2.2 Normally Closed**: one inlet and one outlet, stop the fluid when it is not powered
- **2.2 Normally Opened**: one inlet and one outlet that blocks the fluid when it is powered
- **3.2: Two inlets one outlet**, switch between the two inlets when powered

The response time of our valve is about 10 ms. Any valves powered by 24 VDC can also be used with the MUX Wire (remember that the MUX Wire cannot deliver more than 1,5 A).

The valve is connected as shown in the left picture. This instrument is typically used with a pressure controller (such as an AF1 or an OB1) that pressurizes samples inside reservoirs. Those pressurized reservoirs are connected to the valves that can be controlled by the Elveflow Smart Interface.

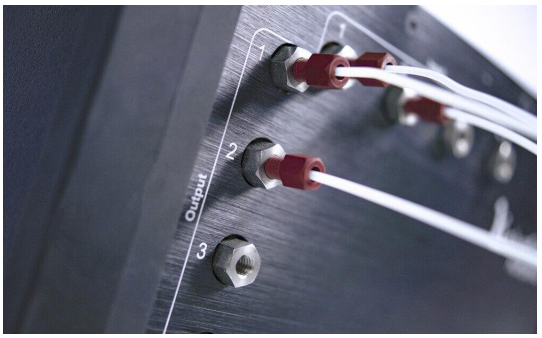
MUX wire setup example

In this example, a MUX Wire is used with an OB1 pressure controller as the pressure source, but we could just as easily have used an AF1 pressure generator per reservoir. Both MUX Wire and OB1 communicate with the computer via the Elveflow Smart Interface. The OB1 is used to apply a stable pressure to the liquids stored in the reservoirs. Two reservoirs are connected to a 3.2 valve in order to switch between the two fluids. In this example, the red liquid is selected. The last reservoir is connected to a 2.2 valve. In this example, the flow is blocked.

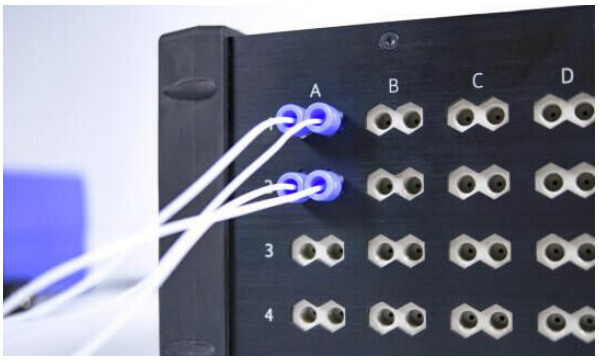


Microfluidic connection

There are two different types of female connectors on the façade of the MUXs. Observe these connectors and use the corresponding flangeless nut and ferrule. Both models accept the standard tubing.



MUX Quake Valve and MUX Cross-Chip



MUX Flow Switch Matrix

ESI Installation

1. Plug the Elveflow® USB flash drive into the computer, or download the latest version from Elveflow website.
2. Open the Elveflow® folder
3. Locate the ESI software zip file (e.g. ESI_V3_04_01.zip)
4. Copy the installation zip file to a location of your choice (e.g. desktop), and unzip the file
5. Run setup.exe and follow the instructions displayed by the installation assistant
6. When prompted, restart your computer to finish the installation process

The instructions displayed in this guide are based on features proposed by ESI V3.04.00 and later releases. **Be sure your ESI version is recent enough before implementing the solutions displayed in this guide.**
Do not install ESI directly from the Zip file, and do not install directly from the USB key, this is likely to cause issues. Always copy the ESI.zip source to your computer, then unzip it before launching the installation process.

The Elveflow® Smart Interface's latest stable version can be downloaded anytime from the Elveflow website.
To alleviate bandwidth and access issues, two links for the same file are provided. The mirror link is the same file hosted on another server. So that you always have an accessible version to work with, 24/7.

Using the Elveflow Smart Interface

The Elveflow® Smart Interface's main features and options are covered by a specific guide.

Please refer to this guide for a detailed description.

You will also find dedicated user guides for:

- The other instruments of the Elveflow product line;
- Sensors;
- Accessories for microfluidics (reservoirs, flow restrictors, etc.).

Electrical connection

The MUX devices are connected to the computer using a USB port. Make sure that you are using a computer with enough USB ports available. Not all USB hubs are equal, and some may cause disconnection issues.

We advise using a direct computer USB connection, as USB hubs may cause disconnections issues.

Cleaning and storing

General recommendations

It is recommended to clean the devices after each use according to the procedure detailed in the dedicated user guides. If possible, dedicate a discrete Flow sensor for each different liquid to be measured. If this is not possible, plan a proper change of the media and include a cleaning step in-between.

It is important to not let the MUX dry out, and clean your MUX after each use so that there is no residue building in the channels over time. Residue buildup will typically happen if the MUX is only drained after use but not properly cleaned. The residue inside the flow channel wall will become a constant deposit and will be more difficult to clean over time. Particles and other matter can clog a valve, make flow connections more prone to leaking, and quickly make a valve inoperable. MUX clogging is a serious problem that often requires a replacement of the MUX (not covered by the Elveflow guarantee).

The following strategies are just general guidelines that any user should adopt, taking into account the specificities of each experiment performed. Ensure that you have found a good cleaning procedure before performing the first tests, and always clean immediately after emptying the device. Routine cleaning after each use is the key to ensure a long life for your equipment.

Serious Warnings and Precautions
Any cleaning by mechanical means should be avoided. Never enter the sensor's flow channel with rigid or sharp objects that could scratch the flow channel surface. Furthermore, no abrasives or liquids containing solids that can grind the flow channel surface should be used. Anything that

affects the flow channel wall will cause deviations in the measurement performance, or permanently damage the flow meter.
Abrasive liquids are not to be used for cleaning! Strong acids and bases should also not be used to clean the flow meter.

Material compatibility
Remember to always check your fluids for compatibility with the Elveflow equipment's wetted materials. Exposing Elveflow equipment to multiple chemicals and compounding application factors like temperature, pressure, concentration, etc... can result in significantly different performance. Specific material compound formulations can significantly alter generalized performance ratings. Elveflow makes no warranty, expressed or implied actual performance in specific end-user applications. It's the user's responsibility to evaluate the specific chemical compatibility of parts prior to use.

Choose a washing step based on your experiment.
One of the fundamentals that will help you early on is that you have to choose the washing solution based on the solubility of the compounds used. This is critical if the goal is to remove material that may foul the sensor over time. Please always take some time to think about how to adapt a generic cleaning protocol to your specific situation.

Storing conditions

Always dry the MUX valves with clean, dry air before storing it.

Linked products

Live Cell Perfusion Pack
A liquid handling platform for cell-based experimentations

OB1 MK3+ Flow Controller
The most responsive and stable flow controller on the market

Microfluidic Reservoirs
microfluidic adapters for Eppendorf © , falcon © tubes, or gl45 threaded glassware

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're looking for are already here.

In case there are still some questions and you'd like further clarification, please don't hesitate to let us know by email at customer@elveflow.com.

With critical context information readily at hand, Elveflow Support employees will be better prepared to help you.

The elements usually required are:

- the serial number of the Elveflow device(s) used (Sensors, Instrument)
- the ESI software initialization file located in C:\Users\Public\Documents\Elvesys\ESI\data. It is called either "ConfigESI.ini" or "ESI.ini", depending on your ESI version.
- the screenshots of the error messages received, if applicable.
- Some pictures, or movies of your setup and your issue. WeTransfer is perfect for easily sending us large files.

We are always happy to help ❤️