ELVE FLOW

an **ELVESYS** brand

AF1 STANDALONE MICROFLUIDIC PUMP

DOCUMENT REF: UGAF1-210617

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 is available on the internet or from your Elveflow representative.

⚠ READ THIS MANUAL CAREFULLY BEFORE USING THE INSTRUMENT

This manual must be read by any person who is or will be responsible for using, maintaining or repairing the AF1 Pressure Controller.

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 AF1 safety notices:

1. The AF1 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 AF1 requires a 24 V DC input voltage.
3. The AF1 Dual Pressure & Vacuum Controllers must be used exclusively with the AF1 Dual Pressure & Vacuum Generators. Using another pressure source may damage the instrument and void the warranty.
4. Use a particle/humidity filter between the pressure outlet of the AF1 Pressure Generator and the pressure inlet of the AF1 Pressure Controller (both identified with a red ring).
5. Use a particle / anti-backflow filter with a pore size of at least 5 µm on the pressure/vacuum outlet to avoid inserting particles or liquid in the instrument.
6. For the safety of both the user and the instrument, do not use the instrument in connection with substances that could emit toxic or corrosive fumes, such as acids or alkalis.
7. No liquids or solids should enter the AF1.
8. Disconnect your sample reservoir from the instrument after each experiment to prevent backflow from the reservoir to the instrument.
9. Close the pressure outlet with the Luer integral lock when not using the AF1 to prevent any contaminants from entering the instrument.

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 can not guarantee the integrity and strength of the provided reservoirs (for any type: Eppendorf, Falcon, glass ..) beyond atmospheric pressure.

It is the end user's responsibility to take the necessary precautions to prevent damage from any used substance by wearing protective equipment and by taking appropriate precautions to minimize the risks to which the use of such substances gives rise.

Table of contents

Introduction

The Elveflow® pressure control instruments are designed to generate a stable and pulseless flow with a short response time for a wide variety of demanding microfluidic applications.

The Elveflow® AF1 Pressure Controller offers superior fluidic performances compared to microfluidic syringe pumps or peristaltic pumps and delivers the smoothest flow with the highest accuracy, as no moving mechanical part is used in the pressure generation process.

The Elveflow® AF1 instrument is controlled by a computer through a USB connection, using the Elveflow® Smart Interface that allows you to perform real-time creation, monitoring, and modifications on complex pressure or flow rate profiles such as sine, square, triangle, ramp, pulse, or sawtooth.

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.

Main Features & Benefits

- Portable Microfluidic Flow Controller
- Autonomous pressure and vacuum control
- Standalone Unit
- No computer needed
- Customizable: 1 Module, 3 pressure ranges available
- Software automation
- Flow control tuning

Principle

A pressure controller pressurizes a tank, such as Eppendorf, Falcon, or a bottle containing the sample, which is then smoothly and quasi-instantly injected into a microfluidic chip.

Figure: The reservoir is pressurized, the gas pushes on the fluid surface, the fluid will flow through the outlet. Thus, controlling the input gas pressure of the tank will allow controlling the liquid that flows out of the tank. Thanks to piezoelectric pressure regulation, Elveflow's systems are able to regulate flow within 40 ms with a 0.005 % stability. One advantage of pressure-driven flow control lies in the ability to handle fluid volumes of several hundreds of mL. You can thus turn your system into a powerful syringe pump.
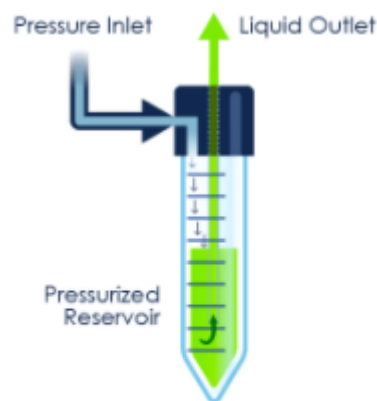
Technical Specifications

Main specifications

The table summarizes the main specifications of the Elveflow® OB1 MK3+ pressure controller. To provide quality & performance, all of our instruments are tested and calibrated independently (response time, stability, repeatability…) after being assembled and all test results are kept.
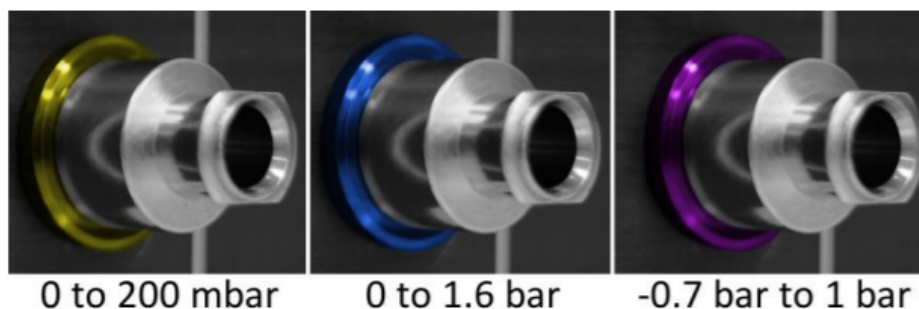
AF1 PREMIUM	AF1 200	AF1 1600	AF1 DUAL
Pressure range	0 to 200 mbar (1) (0 to 2.9 psi)	0 to 1600 mbar (1) (0 to 23 psi)	-700 to 1000 mbar (1) (-10 to 14 psi)
Type of pressure	positive	positive	positive & negative
Minimum pressure increment	0.006 % FS 12.2 µbar (0.0007 psi)	0.006 % FS 122 µbar (0.007 psi)	0.006 % FS 122 µbar (0.007 psi)
Pressure stability (2)	100 µbar 0.05 % FS (0.0014 psi)	1 mbar 0.05 % FS (0.014 psi)	1 mbar 0.05 % FS (0.014 psi)
Response time (3)	50 ms		
Settling time (4)	down to 100 ms		
Supply pressure (min-max)	integrated pressure pump no pressure source needed		integrated pressure & vacuum source no pressure & vacuum source needed
Liquid compatibility	any aqueous or organic solvent, oil, or biological sample solution can be propelled		
Output connectors	stainless steel female Luer lock		

Non-contractual information may be changed without notice

POWER CONSUMPTION: 15 W (100 V to 240 V - 50 Hz to 60 Hz) CASE DIMENSIONS (length x width x height): 220 x 130 x 130 mm WEIGHT: 1.7 kg WEIGHT: input/output 5 V

(1) Maximum pressure might vary by +/- 2.5% (2) Output stability measured at 150 mbar with an external high accuracy pressure sensor (Druck DPI150) (3) Depending on user computer operating system (4) Volume dependent - Measurement done on 12 mL tank for a setpoint from 0 to 200 mbar
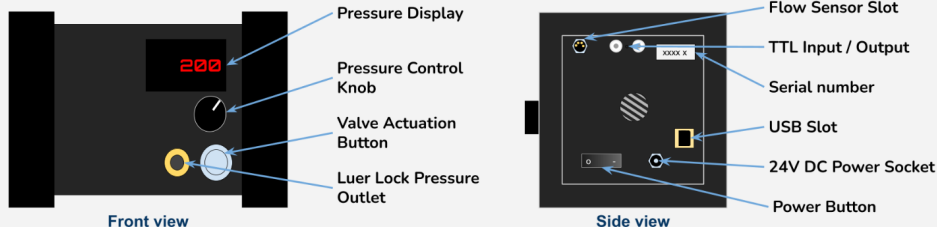
Pressure ranges: color code

0 to 200 mbar   0 to 1.6 bar   -0.7 bar to 1 bar

Instrument description (and pressure ranges)

AF1 200

Working Pressure Range: 0 to 200mbar

Front view
- Pressure Display — 200
- Pressure Control Knob
- Valve Actuation Button
- Luer Lock Pressure Outlet

Side view
- Flow Sensor Slot
- TTL Input / Output
- Serial number — XXXX X
- USB Slot
- 24V DC Power Socket
- Power Button

AF1 1600

Working Pressure Range: 0 to 1600mbar

Front view
- Pressure Display — 1600
- Pressure Control Knob
- Valve Actuation Button
- Luer Lock Pressure Outlet

Side view
- Flow Sensor Slot
- TTL Input / Output
- Serial number — XXXX X
- USB Slot
- 24V DC Power Socket
- Power Button
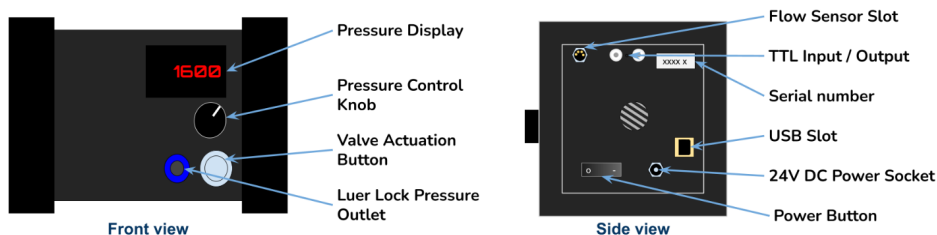
AF1 Dual VAN (generator)

Working Pressure Range: -700 mbar to 1000 mbar

Front view

Side view
- Vacuum line (blue)
- Pressure line (red)
- Pump Control Knob
- Serial number — XXXX X
- 24V DC Power Socket
- Power Button

AF1 Dual VAC (controller)

Front view
- Pressure Display — - 600
- Pressure Control Knob
- Valve Actuation Button
- Luer Lock Pressure Outlet

Side view
- Flow Sensor Slot
- TTL Input / Output
- Serial number — XXXX X
- USB Slot
- 24V DC Power Socket
- Power Button

Side view 2
- Pressure line (red)
- Vacuum line (blue)
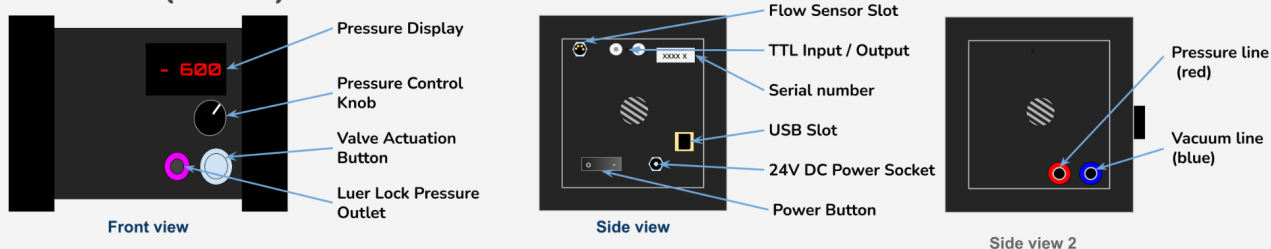
The AF1 Dual VAN (generator) can't be used as a pressure source for the OB1 flow controller.

Product package contents

Before setting up your AF1, please check the package contents to verify that you have received the items below:

For the pressure only version (AF1 200, AF1 1600)

1. The instrument;
2. a USB cable;
3. a power supply unit;
4. a USB flash drive containing the Elveflow® Smart Interface software and the user guides;
5. male Luer integral lock ring plugs (for calibration);
6. male Luer lock to 3/32" OD barbs;
7. particle/humidity filter.

Extra components of the vacuum version (AF1 Dual)

1. The pressure & vacuum generation unit;
2. a power supply unit;
3. male Luer lock to 3/32" OD barbs;
4. paired 4 mm OD tubing;

In addition to the above items. The user should have the necessary fluidic accessories (tubing, additional fittings) to connect the inlets/outlets to the rest of the setup.

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.

Helpful information. If any parts are missing or damaged, please get in touch with Elveflow support immediately: customer@elveflow.com
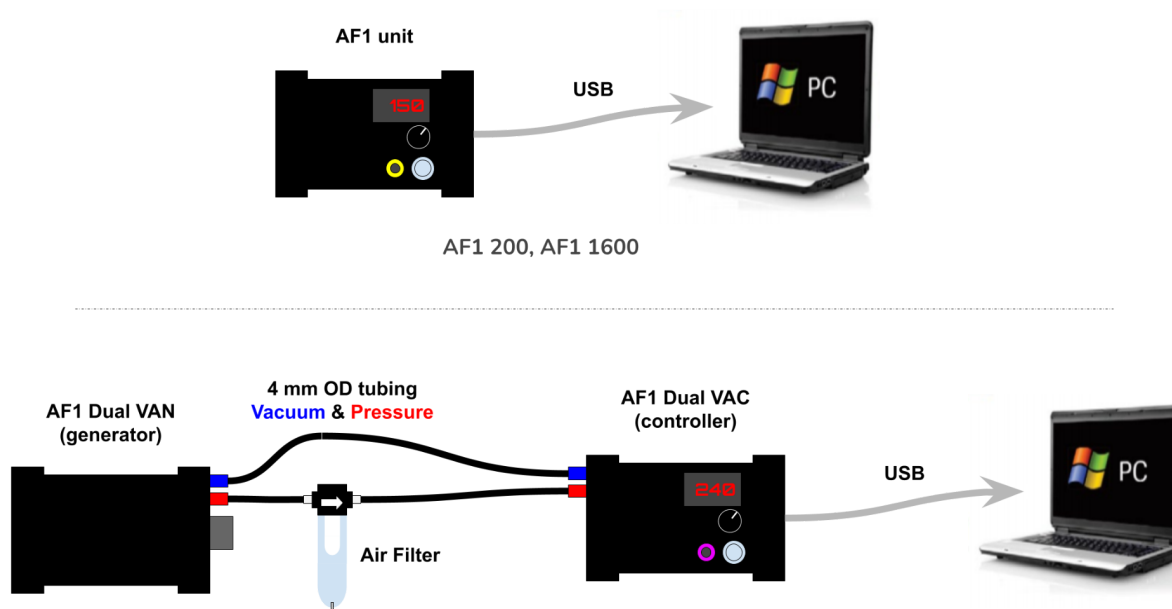
Installation & use

Setting up of the AF1

Pneumatic and Electrical Connections

For AF1 Dual Pressure and Vacuum Controllers, connect the pressure/vacuum sources outlets and inlets to the corresponding Luer-lock connectors at the side of each unit.
The AF1 Dual Pressure and Vacuum Controllers need to be connected to each other (blue vacuum line and red pressure line) for the instrument to perform correctly.

A humidity filter should be connected to the pressure line of the AF1 dual at all times, and water should be drained from the filter by pressing the button at the bottom when water condensates at the bottom.

Preventing Backflows

1. Connect the pressure outlets to sample reservoirs using a male Luer lock 3/32 OD barbs and flexible tubing, as shown in the figures below. Use a filter on any pressure/vacuum outlets.
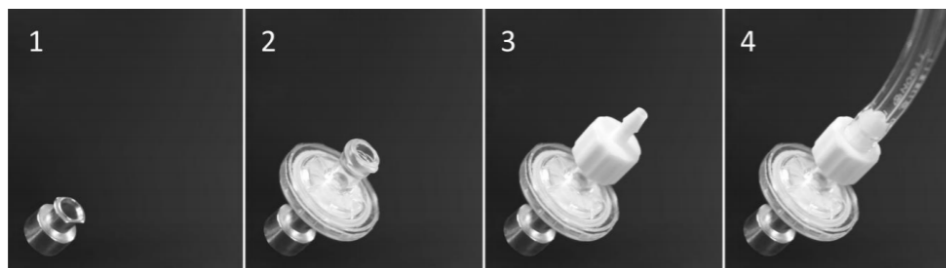
2. Note: the use of filters is highly recommended in order to prevent accidental insertion of liquids in the instrument due to backflow and generally does not affect performance. In some cases, however, it may increase settling time, especially when using large reservoirs (~100 ml). The removal of the filter – although not recommended - will render the instrument more responsive in this case.
3. Connect your microfluidic chip to the reservoirs. Please refer to the dedicated user guide for details on setting up microfluidic accessories.
4. You are now ready to start your first experiment.
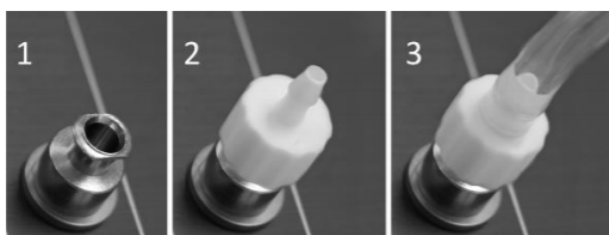
1. Note that the supplied particle/humidity filter must be placed between the pressure outlet of the AF1 Pressure Generator and the pressure inlet of the AF1 Pressure Controller. The arrow on the filter indicates the direction of airflow: from the Generator to the Controller. Note: the stand is not available for purchase.

2. Connect the controller to the computer using the USB cable ("USB" marking).
3. Plug the power adapter into the instrument ("24 V DC" marking), then plug the adapter into an electric plug (both units, for AF1 Dual model)
4. Turn the power switch on at the rear side of the instrument (both units, for the AF1 Dual model)
5. Close the pressure outlet using the Luer integral lock plug.

Using the Elveflow Smart Interface (ESI)

Minimum computer requirements

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 up to date before implementing the solutions displayed in this guide. See ESI download link below. Using the ESI requires complying with the following minimum computer configuration requirements.

ESI V3_04_00 or later versions:

- Window 7 SP1 or later
- USB 2.0 port or faster
- 1 GB RAM
- 3.0 GHz Pentium 4
- 1 GB of free hard disk space.

Software 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 up to date 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 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.
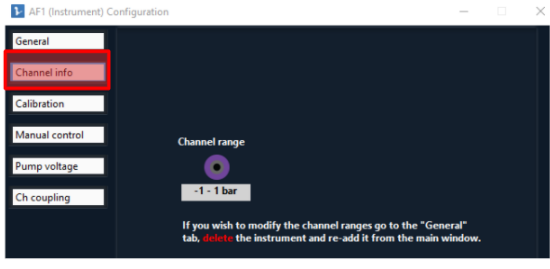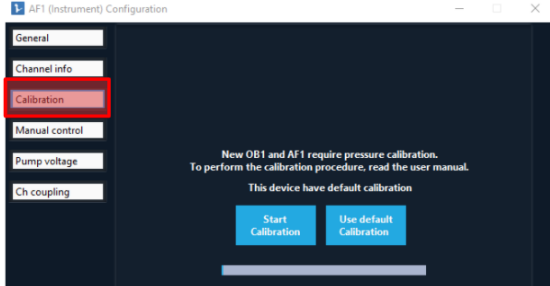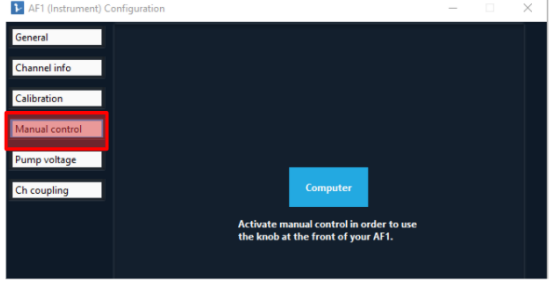
AF1 addition in ESI

Launch the Elveflow Smart Interface, add a new instrument and start the calibration (see ESI User guide for step by step instruction):

1. Add instrument,
2. Select AF1,
3. Enter an instrument name
4. Then set the pressure channels according to the pressure range (it should match the AF1 pressure outlet ring color, e.g. set purple color for an AF1 Dual).
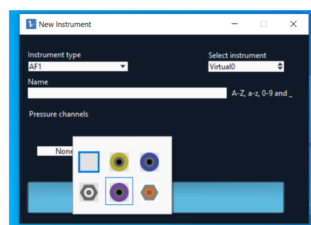
Useful features in ESI

The instrument Settings button in the ESI main window opens a control panel where many features are available.

		The Channel info tab displays all pressure channels present in the instrument and their ranges.
		In the Calibration tab the user can start a calibration and see its progress on the status bar (remember to close all pressure outlets with the dedicated cap before calibrating). A Default calibration can also be used if needed. The used calibration is shown in the second line.
		AF1s can be controlled both with the ESI and manually at the pressure dial. In the Manual control tab the user can select which mode is active. Note that the manual mode is also activated if the USB cable is disconnected from the computer.

For additional details about how to use the AF1 in ESI, please refer to the ESI User guide.

Sensor installation in ESI software (optional)

An MFS sensor can be either controlled by the Elveflow® Smart Interface software or by software development Kit (C++, Python, MATLAB®, and LabVIEW® libraries).

Using an MFS flow sensor in ESI in a flow control experiment requires the following:

1. adding your sensor
2. tuning your sensor to your setup specifications.

Contact Elveflow Support (customer@elveflow.com) to get the Flow Control Guidelines if you don't have them.

The Elveflow® Smart Interface's and the SDK main features and options are covered by specific guides, available through the Elveflow Knowledge Base.
Please refer to those guides for a detailed description.

Calibration

You can calibrate your device following its addition in ESI, or anytime you feel this is necessary. Put the caps (plugs) on the pressure outlets, reach the device settings, open the calibration tab and start the calibration.

The calibration tab can be reached from your device calibration settings
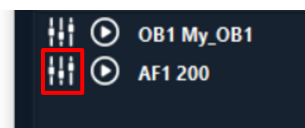
Calibration is recommended:
When the instrument is connected to a computer for the first time, and any time a difference between the requested value and the measured value is observed. A few mbar difference is considered acceptable depending on the Technical specifications of the AF1 used.

Specific information about the AF1 Dual pressure & vacuum controller/generator

The AF1 dual pressure and vacuum controller is designed to regulate pressure from – 700 mbar to 1000 mbar on the same channel, and generate a stable and pulseless flow with a short response time for a wide variety of microfluidic applications. This controller can be used with an external unit, the Dual vacuum & pressure generator which includes a micropump to supply both vacuum and pressure.

AF1 Dual pressure & vacuum controller/generator connection. The AF1 Dual pressure & vacuum controller and generator have specific pressure inlets and outlets for positive (red ring) and negative (blue ring) pressure. Please connect these devices properly (red on red, blue on blue) using the provided tubing and connectors before starting an experiment.

Safety Humidity filter

A safety particle/humidity filter must be placed between the red positive pressure outlet of the AF1 Pressure Generator and the pressure inlet of the AF1 Pressure Controller. The arrow on the filter indicates the direction of airflow: from the Generator to the Controller. Note: the stand is not available for purchase.

AF1 Dual Quickstart

The AF1 DUAL system consists of 2 devices:

The generator (VAN): the button on the side determines the importance of the activation of the pump. The higher the potentiometer is open, the greater the air and vacuum flow. This can be verified by disconnecting the tubes on the side and placing the finger near the vacuum and pressure outlets to feel the airflow from each outlet.

The controller (VAC): we set it generally so as to have the display vertical and facing the user. The knob on the front panel allows you to adjust the outlet pressure (vacuum or pressure, according to your needs). It is important to note that the front panel button must be pressed (ON position) to activate the controller and to manually change the output values by playing with the wheel.

Procedure:

1. Plug the power supply for each part.
2. Check the generator alone if at full power (side knob open fully) there is pressure coming out and vacuum that is created.
3. Then connect the generator (VAN) to the controller (VAC), connect both the pressure (red) and the vacuum (blue) lines.
4. Plug the VAC front outlet with a Luer plug (cap) otherwise you will have an open and unstable system
5. Switch ON the VAC front button (round aluminum button),
6. connect to ESI using a computer (USB connection)
7. open the VAN pump knob to the maximum.
8. start a calibration

Sensors compatibility chart with Elveflow instruments

The AF1 can only read analog MFS flow rate sensors.
Digital MFS flow rate sensors, MPS pressure sensors, MFP pressure sensors can't be used with the AF1.

|		MFS		MPS	MFP	Bubble Detector	Custom
		Analog	Digital				
OB1	Mk2	✔	✘	✘	✘	✔	
	Mk3	✔	✘	✘	✘	✔	✔
	Mk3+	✔	✔	✔	✔	✔	✔
	Essential	✔	✔	✔	✔	✔	✔
AF1	Pressure	✔	✘	✘	✘	✘	✔
	Dual	✔	✘	✘	✘	✘	✔
MSR	V1	✔	✘	✔	✔ (1)	✔	✔
	V2	✔	✔	✔	✔ (1)	✔	✔
	Flow Reader	✔	✔	✔	✔	✔	✔

✔ compatible
✘ not compatible

(1) USB 3.0 is recommended if more than 3 sensors are connected.

> [!] Always check the compatibility of your sensor with your equipment before ordering, so as not to buy a sensor you won't be able to use with your device.

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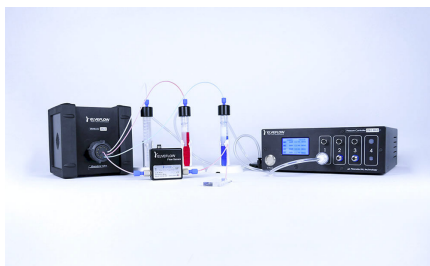
Live Cell Perfusion Pack
A liquid handling platform for cell-based experimentations

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 ❤️