# FLOW-RATE PLATFORM


User Manual

FLOW-RATE PLATFORM

FLUIGENT
SMART MICROFLUIDICS™

Version 7A

# GUARANTEE TERMS :

**What This Warranty Covers**

This warranty is granted by Fluigent and applies in all countries.
Your Fluigent product is guaranteed for one year from the date of delivery at your laboratory against defects in materials and workmanship.
If found to be defective within the warranty period, your Fluigent product will be repaired or replaced free of charge.

**What This Warranty Does Not Cover**

This warranty does not cover routine maintenance, or damage resulting from the failure to maintain the product in accordance with instructions provided by Fluigent. This warranty also does not cover damage that arises from accidental or intentional misuse or abuse, alteration or customization, or repaired by unauthorized persons.

**How to Get Service**

If something goes wrong, contact the Fluigent dealer from whom you purchased your product. Arrange a mutually convenient time for Fluigent service representative to discuss over the problem and find a solution to fix the issue. Will be favored any remote repairs, but in case more actions need to be taken, the system will come back to Fluigent offices (for no additional cost, only if it is under warranty).

**The warranty conditions are:**

- Do never open the FLOWBOARD and the FLOW UNIT devices
- Do not use other cables than cables provided by Fluigent
- Prevent foreign objects or liquids from entering the FLOWBOARD
- Prevent foreign objects from entering the FLOW UNIT
- Do not place the product in an unstable location, place the unit in a location with a level surface and a strong and stable support
- Respect the temperature compatibility (from 5°C to 50 °C)
- Filter your solution, if possible add a filter in the fluidic path (§ 10) and clean your FLOW UNIT after each use, especially the FLOW UNIT XS (cf § 4.3). The diameter of the FLOW UNIT XS capillary is small: 25 µm. Fluigent rejects any liability in the event of clogging or surface modifications.
- Do not allow the FLOW UNIT to dry with media in the capillary tube without flushing clean first.
- Fluigent advises to realise a cleaning procedure after use.
- The FLOW UNIT yellow plugs must be installed for storage
- Check the fluid compatibility with the FLOW UNIT wetted materials before using it or ask Fluigent customer support.
- The customer is responsible for fluid used with the FLOW UNIT. Before use, the customer has to check the compatibility of the fluid with the FLOW UNIT .

For specific use, please contact our Support team at **support@fluigent.com**

## WARNINGS:

- Do never open FLOWBOARD and FLOW UNIT devices. Refer all servicing to after-sales service department (support@fluigent.com).

- Prevent foreign objects or liquids from entering the FLOWBOARD, this may cause a short-circuit failure or other malfunction. Failing to respect this advice would:
  - Expose you to direct current/voltage in case the device is under voltage which may lead to severe damages
  - Void device's warranty
  - Discharge our company from any liability regarding physical or device damages

- Do not place the product in an unstable location, place the device in a location with a level surface and a strong and stable support.

- **The diameter of the Flow Unit XS capillary is small: 25 µm. Filter your solution, if possible add a filter in the fluidic path (§ 10) and clean the Flow Unit XS after each use (cf § 4.3).**

# 1. Introduction

The new Flow-Rate Platform provides a solution for measuring and/or controlling[1] flow-rates for any fluidic applications. Combining the FLOW UNIT models and the FLOWBOARD will give you the opportunity to check at all times flow-rate and volume of liquids flowing through your fluidic system. The five (5) different FLOW UNIT models offer an extensive choice of flow-rate ranges to best match your required precision, from 8 nL/min to 5 mL/min. Beside water based solutions, a second calibration for hydrocarbons is available on three (3) different FLOW UNIT models (S, M and L), see §8.

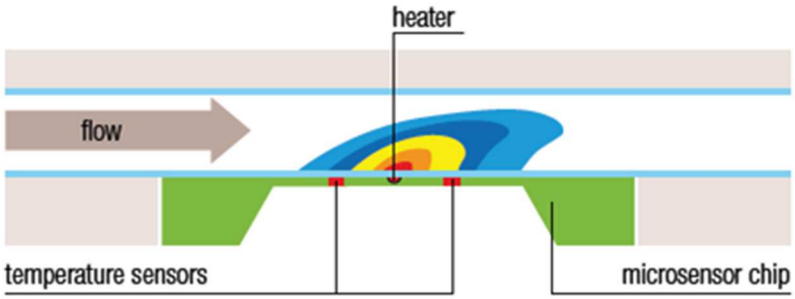
This user manual will show you how to install and use the Flow-Rate Platform for your daily work. It will describe all the Flow-Rate Platform functionalities and will help you to connect all the different FLOW UNIT models and the FLOWBOARD, and to use it with all the equipment.

[1] with Fluigent MFCS™-EZ (and MFCS™), the Flow-Rate Control Module and a specific dongle.

## 2. General information

The Flow-Rate Platform enables flow-rate measurements, in a wide range of flow-rates thanks to the five (5) models: XS, S, M, L and XL.

The flow-rate acquisition is based on a thermal technology. A heating element on the microchip adds a minimal amount of heat to the medium for the thermal flow measurement. Two temperature sensors, symmetrically located above and below the source of the heat, detect even the slightest temperature differences, thus providing the basic information about the spread of the heat, which itself is directly related to the flow-rate.




It is possible to use the Flow-Rate Platform with any flow control systems, from pressure controllers to other types of flow controllers, provided that the flow-rate applied to a FLOW UNIT does not go beyond its range. The Flow-Rate Platform enables you to measure the flow-rate and the volume of fluid introduced during your experiment.

Five (5) different FLOW UNIT models are available. They depend on flow-rate ranges and calibration.

Here is a picture of the five (5) FLOW UNIT models with different ranges, among which three (3) models with a dual calibration (S, M and L models). All the fluidic specifications are diplayed in the table below .


Note: The Flow-Rate Platform can work at its best performances with FLUIGENT pressure flow control solutions (MFCS™ and MFCS™-EZ). More details on www.fluigent.com.

| FLOW UNIT | XS | S | M | L | XL |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **Sensor inner diameter** | 25 µm | 150 µm | 430 µm | 1.0 mm | 1.8 mm |
| **Maximum pressure** | 200 bar | 200 bar | 100 bar | 12 bar | 5 bar |
| **Wetted materials** | PEEK and Quartz Glass | PEEK and Quartz Glass | PEEK and Borosilicate Glass | PEEK and Borosilicate Glass | PEEK and Borosilicate Glass |
| **Calibrated Media** | Water | Water<br>Isopropyl Alcohol | Water<br>Isopropyl Alcohol | Water<br>Isopropyl Alcohol | Water |
| **Range** | 0±1.5 µL/min | 0±7 µL/min<br>0±70 µL/min | 0±80 µL/min<br>0±500 µL/min | 0±1 mL/min<br>0±10 mL/min | 0±5mL/min |
| **Accuracy** (m.v = measured value) | 10% m.v. above 75 nL/min | 5% m.v.above 0.42 µL/min<br>20% m.v. above 4.2 µL/min | 5% m.v. above 2.4 µL/min<br>20% m.v above 25 µL/min | 5% m.v. above 0.04 mL/min<br>20% m.v above 0.5 mL/min | 5% m.v.above 0.2 mL/min |
| | 7.5 nL/min below 75 nL/min | 21 nL/min below 0.42 µL/min<br>210 nL/min below 4.2 µL/min | 0.12 µL/min below 2.4 µL/min<br>5 µL/min below 25 µL/min | 1.5 µL/min below 0.04 mL/min<br>100 µL /min below 0.5 mL/min | 10 µL/min below 0.2 mL/min |
| **Lowest detectable flow increment** | 3.7 nL/min | 10 nL/min | 0.06 µL/min | 0.7 µL/min | 3 µL/min |

**Warning: Please note that the maximum pressure depends on the FLOW UNIT model. Ensure that the pressure applied to a FLOW UNIT does not go beyond this value at all times.**

**The Flow-Rate Platform suits your own fluid controller. If you use a pressure regulator you may have to enter a maximum pressure below this value. If you use other flow controller, be aware that pressure may go higher than 100 bar very easily and may cause damage to your FLOW UNIT.**

# 3. Package content

The Flow-Rate Platform package contains the following items:

- One FLOWBOARD
- At least one FLOW UNIT and its yellow plugs for storage
- A USB cable
- A connection kit:

-With the XS, S and M FLOW UNIT models, the Flow-Rate Platform package can contain *(not always included)* one kit **CTQ_KIT_LQ** : Two LQ flow unit connector for 1/32''OD tubing, one meter of PEEK Tubing Blue 1/32'' OD x0.010'' ID*, 1 green sleeve 1/16'' OD * 0.033''*1.6, 1 adapter PEEK 1/16'' to 1/32'' OD tubing (cf §9.2, ).*

-With the L and XL FLOW UNIT models, the Flow-Rate Platform package can contain *(not always included)* one kit **CTQ_KIT_HQ**: Two Flow Unit HQ connector ¼-28 Flat Bottom for 1/16'' OD tubing, 4 ferrules for HQ flow unit, 1 m FEP tubing 1/16'' OD * 0.020''ID.

NB : With the XL Flow Unit model, 15 cm of 1/16'' OD PEEK tubing with 1.4 mm ID is added (cf §8).

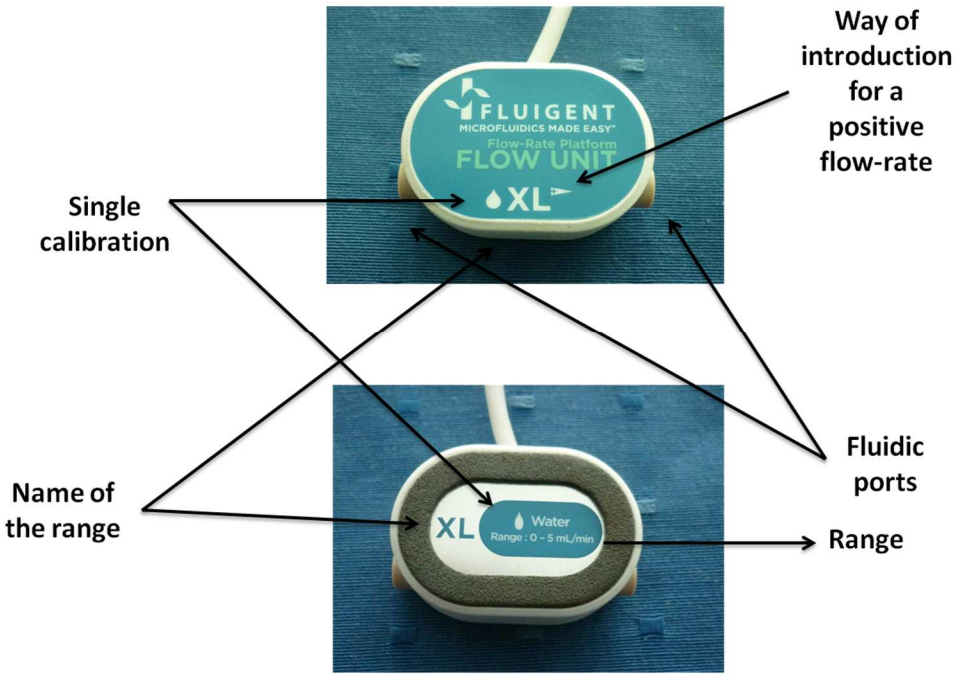
- FLUIGENT Software Platform in a USB stick
- This user manual


If any part is missing or damaged, please contact your local dealer or FLUIGENT immediately (support@fluigent.com).

# 4. FLOW UNIT Description

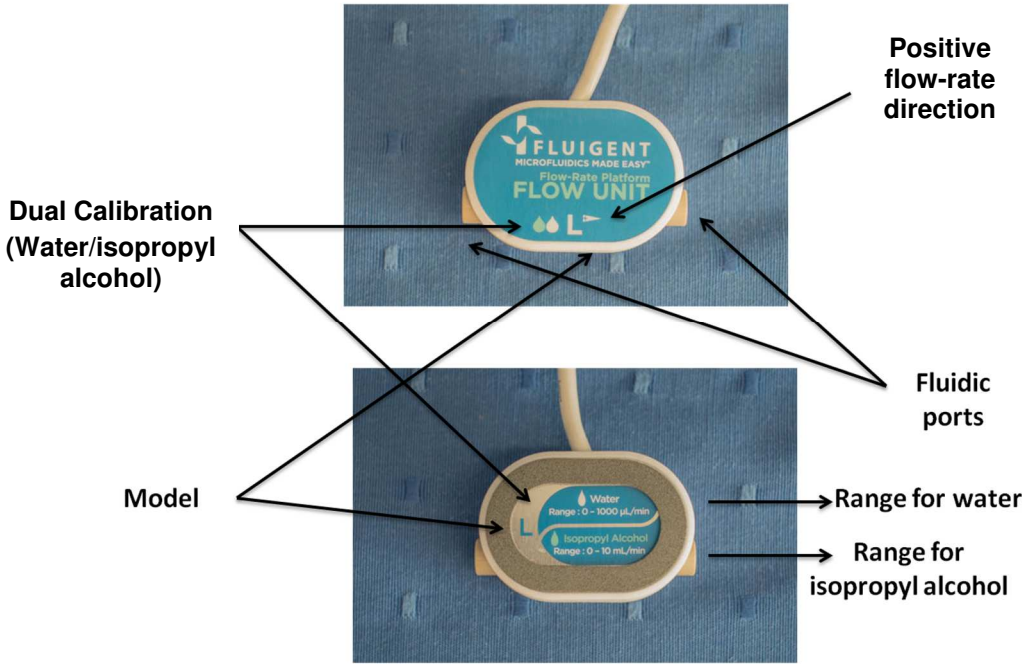
## 4.1 FLOW UNIT Front and Back

XS, XL FLOW UNIT models




- The two (2) fluidic ports are on the sides of the device.
- The front of the FLOW UNIT displays information about the range and the calibration:
  - The letter indicates the "model"; Here it's XL.
  - The droplet indicates the calibration. Here there is a single white droplet. It indicates that the sensor is calibrated for water (cf §2).
- The back of the FLOW UNIT also displays information about the range and the calibration:
  - The letter indicates the "model"; Here it's XL.
  - The droplet indicates the calibration. Here there is a single white droplet: it indicates that the sensor is calibrated for water.
  - The range is displayed clearly: 0 ± 5.0 mL/min.

S, M, L FLOW UNIT models



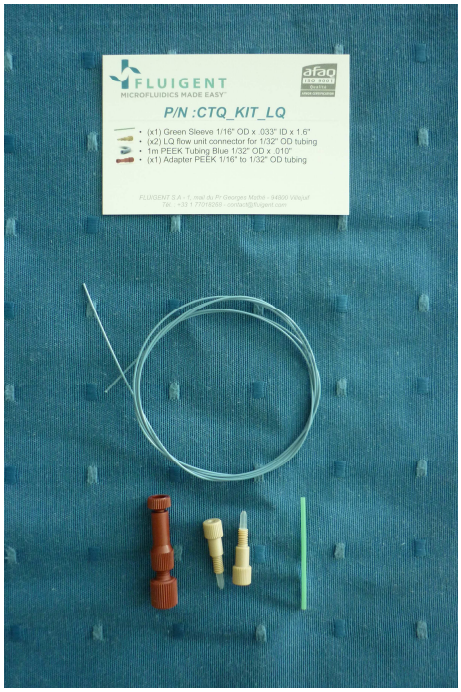

- The two (2) fluidic ports are on the sides of the device.

- The front of the FLOW UNIT displays information about the range and the calibration:
  - The letter indicates the "model"; here it's L.
  - The droplets indicate the calibration. Here there are two droplets: a blue one and a white one. It indicates that the sensor has dual calibration, one for water and the other one for isopropyl alcohol (cf § 2).

- The back of the FLOW UNIT also displays information about the range and the calibration:
  - The letter indicates the name of the model; here it's L.
  - The droplets indicate the calibration. Here there are two (2) droplets: a blue one and a white one.. It indicates that the sensor is calibrated for water and isopropyl alcohol.
  - The range is displayed clearly:
    - 0 ± 1000µL/min for water
    - 0 ± 10mL/min for isopropyl alcohol

## 4.2 Connection

### 4.2.1 Fluidic connection for XS, S and M FLOW UNIT models



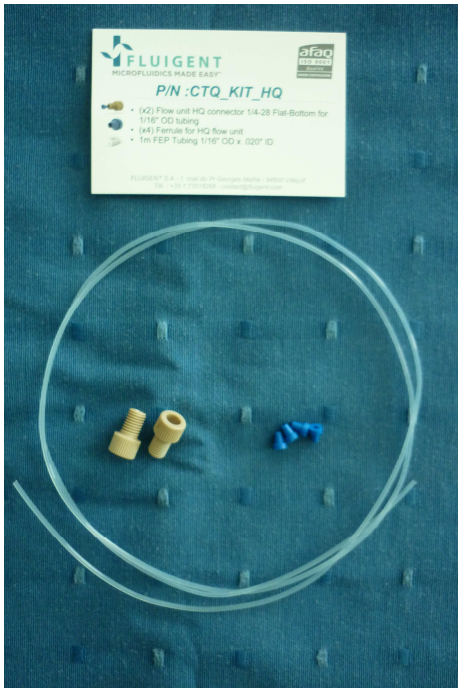

The XS, S and M FLOW UNIT models have two (2) fluidic ports.

- The characteristics of those two (2) ports are:
  - Thread-size: UNF 6-40.
  - Compatible with tubings of 1/32'' external diameter (1/32'' OD).

- To get started, FLUIGENT can provide you a "CTQ_KIT_LQ" kit including:
  - One (1) green sleeve 1/16'' OD x 0.033''x1.6"
  - Two (2) LQ flow unit connector for 1/32''OD tubing,
  - One (1) meter of PEEK Tubing Blue 1/32'' OD x0.010'' ID
  - One (1) adapter PEEK 1/16'' to 1/32'' OD tubing

**NB:** As there is a wide variety of tubings and fittings for the different applications that you may use, FLUIGENT advises you to make sure that your fluidic connection system fits with the two (2) fluidic ports of the FLOW UNIT. If not, please note that there is a large panel of adapters and unions to connect your tubings to ours. Visit www.fluigent.com to learn more about materials and ID available with 1/32'' or 1/16" OD tubing, nuts and ferrules from fittings suppliers to suit your application.

### 4.2.2 Fluidic connection for L and XL FLOW UNIT models




The L and XL FLOW UNIT models have two fluidic ports.

- The characteristics of those two (2) ports are:
  - Thread-size: ¼-28.
  - Flat-bottom type (FB).
  - Compatible with tubings of 1/16'' external diameter (1/16'' OD).

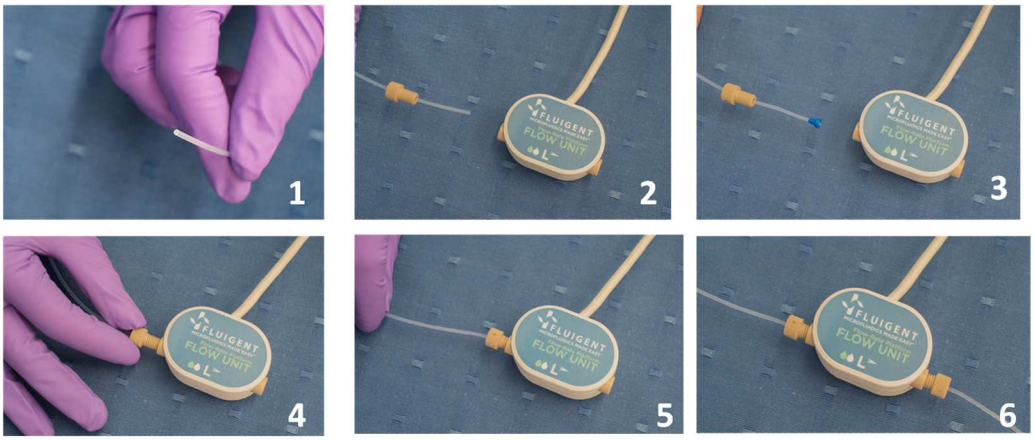
- To get started, FLUIGENT can provide you the "CTQ_KIT_HQ" kit including:
  - Two (2) Flow Unit HQ connector ¼-28 Flat Bottom for 1/16'' OD tubing
  - Four (4) ferrules for HQ flow unit
  - 1 m FEP tubing 1/16'' OD * 0.020''ID.

**NB 1** : Fifteen (15) centimeters of 1/16'' OD PEEK tubing with 1.40 mm ID is including with the XL Flow Unit model (cf §8).

**NB 2 :** As there is a wide variety of tubings and fittings for the different applications that you may use, FLUIGENT advises you to make sure that your fluidic connection system fits with the two (2) fluidic ports of the FLOW UNIT. If not, please note that there is a large panel of adapters and unions to connect your tubings to ours. Visit www.fluigent.com to learn more about materials and ID available with 1/32'' or 1/16" OD tubing, nuts and ferrules from fittings suppliers to suit your application.

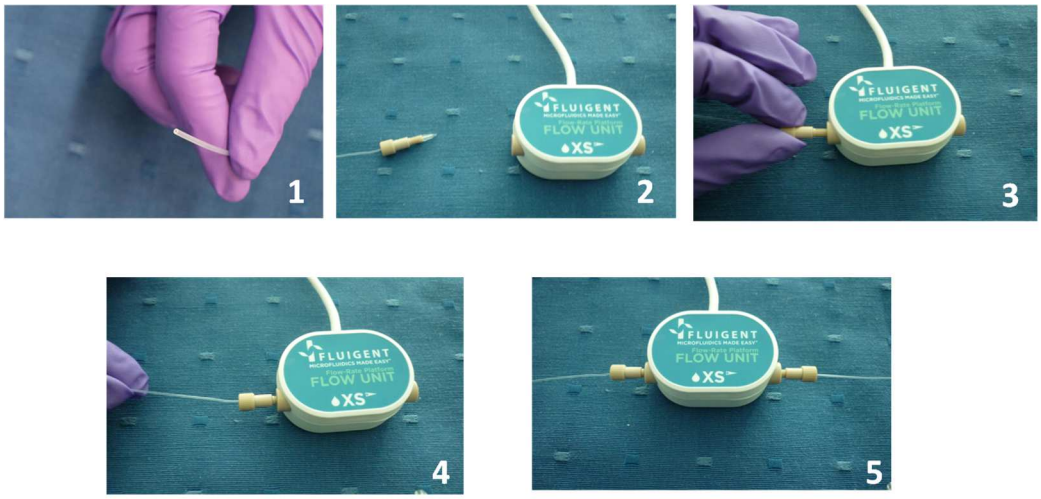
### 4.2.3 How to connect tubing to the FLOW UNIT models

The pictures below illustrate how to connect OD 1/16'' tubing to L and XL FLOW UNIT models.




1. Cut the 1/16'' OD tubing to the desired length, leaving a square-cut face.
2. Slide the nut over the tubing with the nut thread facing the tubing end being connected.
3. Slip the ferrule over the tubing, with the tapered portion of the ferrule facing the nut. NB: the nuts and ferrules are specifically designed to work together. FLUIGENT advises you to only associate the provided ferrules with the provided nuts and vice-versa.
4. Insert the assembly into the receiving port, and while holding the tubing firmly against the bottom of the port, tighten the nut finger tight.
5. To check the tightness of your connection, you may pull gently on the tubing: it must stay fitted in the ferrule and nut.
6. Do the same thing on the 2$^{nd}$ port.

The pictures below show how to connect OD 1/32'' tubing to XS, S and M FLOW UNIT models.



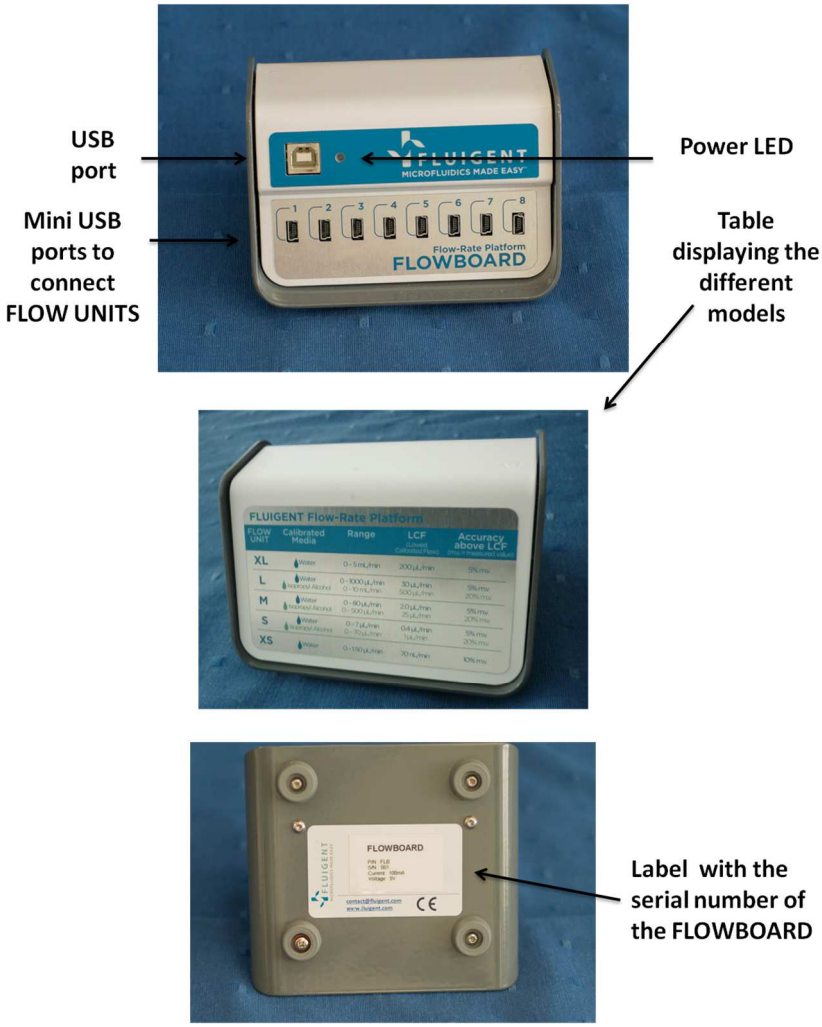

1. Cut the 1/32'' OD tubing to the desired length, leaving a square-cut face.
2. Slide the fitting over the tubing.
3. Insert the assembly into the receiving port, and while holding the tubing firmly against the bottom of the port, tighten the fitting finger tight.
4. To check the tightness of your connection, you may pull gently on the tubing: it must stay fitted in the ferrule and nut.
5. Do the same thing on the 2nd port.

# 5. FLOWBOARD Description

The FLOWBOARD is absolutely necessary to operate the Flow-Rate Platform. This device hosts up to eight (8) FLOW UNIT models and provides them power supply. The FLOWBOARD is also the link between the connected FLOW UNIT models and the software (cf. Flow-Rate Platform Soft Front Panel User Manual or Maesflo™ User Manual).

When using the Flow-Rate Platform alone, one must use the Flow-Rate Platform Soft Front Panel (FRP-SFP). When combining the Flow-Rate Platform with the MFCS™-EZ, one must use the Maesflo™.

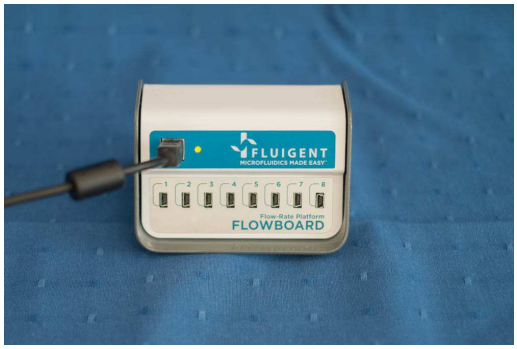
## 5.1 Description




- A green indicator (power LED) lights up when the FLOWBOARD is connected.
- A USB port (type B) links the FLOWBOARD to a computer for software control.
- There are eight (8) mini USB ports (to connect up to eight (8) FLOW UNIT devices).
- On the back of the FLOWBOARD a table summarizes all the FLOW UNIT models available and their characteristics.
- On the bottom of the FLOWBOARD a label indicates the product number, the serial number, the current and the voltage.

## 5.2 Connection

### 5.2.1 USB connection




- Connect the type B plug of the USB cable provided with the Flow-Rate Platform into the type B USB port on the front of the FLOWBOARD.
- Connect the other end of the USB cable (type A standard plug) to the computer where the corresponding software is installed (cf. User Manual).

### 5.2.2 FLOW UNIT connection


- To connect a FLOW UNIT to the FLOWBOARD, plug the end of the mini-USB plug fixed with the FLOW UNIT to one of the eight (8) mini-USB ports on the FLOWBOARD.

# 6. Start working with the Flow-Rate Platform

## 6.1 Quick start procedure

Here is a quick setup guide to remind you the main steps to get your Flow-Rate Platform up and running.

1. First, you may want to integrate the different FLOW UNIT to your microfluidic system, with the right fittings. See §4.2 how to do it.
2. Then, connect the FLOW UNIT models to the FLOWBOARD. See §5.2 how to do it.
3. Then connect the FLOWBOARD and the computer with the USB cable. See §5.2 how to do it.
4. To finish start the software (FRP SFP or MAESFLO) installed on your computer (user manual)

You can now use your Flow-Rate Platform for your application.

**DO NOT FORGET TO CLEAN AND RINSE YOUR FLOW UNIT AFTER USE** (See §7 how to do it.)

## 6.2 Use at high temperature and high flow-rate

The Flow Units can be used in a large range of temperature, but some elements need to be taken into account:

- The Flow Units include temperature compensation between 10°C and 50°C. However, as the temperature deviates from 20°C, the absolute accuracy may acquire an additional error of typically 0.1% of the measured flow rate per °C.
  For example the L Flow Unit model at 50°C has a specified error of 5% + 30*0.1% = 8% of the measured value.
- Between 50°C and 80°C the Flow Unit will still be operational and the repeatability will still be excellent. However, we give no more guarantee for the absolute accuracy of the calibration.

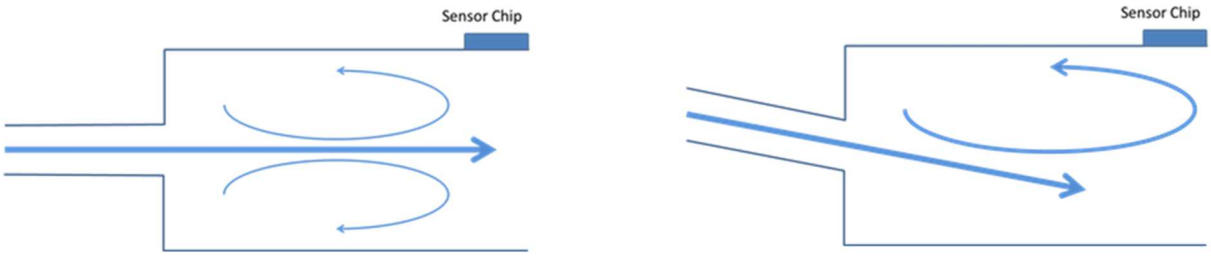
In order to get a correct reading from the sensor, it is crucial to have the liquid temperature and ambient temperature the same (within ± 3°C). At low flow rates this won't be a problem, because the liquid adapts to the ambient temperature very quickly. At higher flow rates (for L and XL Flow Unit models) this is important.

## 6.3 Use a XL Flow Unit

The combination of different parameters can lead to unwanted behaviors and surprising measurements. It's related to the formation of localized vortex and arise from a combination of the following facts:

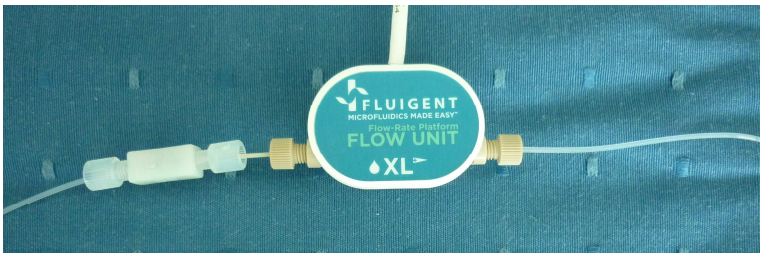
- The decreased viscosity of liquid at elevated temperatures (for example for water at 40°C the viscosity is about half the one at 20°C)
- The combination of small ID tubing (for example 500 µm ID tubing) with the 1.8 mm ID sensor.

The transition from the small ID tube to the larger ID sensor may lead to a jet at high flow speeds and low viscosity, see the following sketch. Such a jet is inherently unstable, which can lead to strong fluctuations at high flow-rates and temperatures. The phenomenon is also strongly dependent on the exact geometry of the arrangement. A bending of the tube on the inlet side may generate a stationary vortex and the fluid in proximity to the sensor chip may actually be flowing backward, see the next sketch:




This can lead to a negative flow reading.

To solve this observed behavior, Fluigent advises you to use **15 cm of 1/16''OD 1mm ID tubing**, before the sensor, provided with the Flow-Rate Platform package that contains XL flow unit model. Pay attention when you cut the tube to leave a square-cut face.



# 7. Cleaning procedure

Flow Unit models are highly sensitive and should be properly cleaned to always maintain high performance. With proper care and maintenance, the Flow Units can last many years. No cleaning or improper cleaning may leave deposits on the internal capillary wall which could result in measurement deviations and even clogging. Cleaning the sensor after use and before storing the device for a long period of time should prevent the sensors from any damage.

### 7.1.1 Explanation

Inside the liquid flow sensors, the sensor chip measures the flow through the wall of a thin walled glass capillary. Because the measurement uses the heat propagation through the glass wall and the heat exchange with the medium, it is critical that the coupling of the chip with the medium is not altered. Formation of deposits on the glass wall inside the capillary may block the heat transfer.

### 7.1.2 General Handling

Do not allow the sensor to dry with media in the capillary tube without flushing clean first. Also try to avoid letting the filled sensor sit for extended periods (depending on your liquid).
Before storing the sensor, always drain of fluid, flush with cleaning agent, blow out, and dry the capillary.

**For the XS FLOW UNIT model, filter your solution through a 5µm (or lower) membrane filter.**

### 7.1.3 Cleaning Procedure

Cleaning and flushing of the Flow Units should consider the nature of the materials that were being pumped through them. Typically, one should select a cleaning solution that is safe for the Flow Unit (the inside surface) and the rest of the set up yet will dissolve the type of samples that were in contact with the surface.

For Flow Unit XS, S and M, fluids have to be compatible with PEEK & Quartz glass.
For Flow Unit L and XL, fluids have to be compatible with PEEK & Borosilicate glass.

<u>The following steps are recommended for water-based solutions, in the right order:</u>

- Rinse all your system with water
- Clean the Flow Unit with a non-foaming detergent.
  The detergent needs to be compatible with Flow Unit, the rest of your set-up (microfluidic chip, especially) and fluids used before during your experiment.
- Remove all the contaminant thanks to a disinfectant (for example, Javel bleach).
- Rinse the Javel bleach (or the selected disinfectant) with water.
- Rinse all you system with isopropanol. Thanks to this final step, you won't leave any trace on your Flow Unit**.**
- Then, sensor yellow plugs must be installed for storage.

### 7.1.4 Recommendations for fluids

**Working with Multiple Liquids**

Switching between multiple liquids can leave transient deposits in the form of liquid layers inside the glass capillary. This is especially common for insoluble liquids, but can happen even with miscible liquid combinations. For example, when IPA is followed by water in a sensor without drying in between, large offsets can be observed for hours after switching to water.

If possible, dedicate a separate sensor for each different liquid to be measured. If not possible, use caution when switching media and clean properly.

**Working with Water**

When working with water it is recommended **not to** let the sensor dry out. All salts and minerals in the water will deposit on the glass and are difficult to remove. Although salt solutions are particularly prone to problems, even clean water can still contain enough dissolved minerals to form a deposition layer. Flush with DI water on a regular basis to prevent build-up. If you still encounter problems, occasionally flush the sensor with slightly acidic cleaning agents.

When working with water containing organic materials (sugars, etc.) microorganisms often grow on the walls of the glass capillary and form an organic film that can be difficult to remove. Flush on a regular basis with solvents such as ethanol, methanol or IPA, or with cleaning detergents to remove organic films.

**Working with Silicone Oils**

When working with silicone oil it is recommended **not** to let the sensor dry out. Silicone oils can be cleaned out using special cleaners. Check with your silicone oil supplier for cleaning agents compatible with glass surfaces.

**Working with Paints or Glues**

When working with paints or glues it is critical **not** to let the sensor dry out. Often, depositions of paints and glues cannot be removed anymore after they have dried. Flush the sensor with cleaning agents recommended by your paint or glue manufacturer that are compatible with glass. Ensure that you have found a good cleaning procedure before performing the first tests, and always clean shortly after emptying the sensor.

**Working with Alcohols or Solvents**

Unlike most other fluids, alcohols and solvents are not critical and a short flush of isopropanol (IPA) is sufficient to clean the capillary walls.

**Other Liquids or Applications**

If uncertain about your application and how to clean the flow sensor, please contact FLUIGENT for additional support at support@fluigent.com .

**Identified cleaning solutions**

| Sample liquid | Cleaning solution | Supplier |
|---|---|---|
| Biofilm/cells | • Biofilm remover<br>• Sodium dichloroisocyanurate (1 ppm HClO; ref : 218928) | • Umweltanalytik<br>• Sigma Aldrich |
| 1% micro-beads of polystyrene in DI Water | Toluene 99.8% (ref : 244511) | Sigma Aldrich |
| Mineral oil (Sigma cat no. 5904) | RBS 25 (ref : 83460) | Sigma Aldrich |
| Blood | • BD FACS Clean<br>• RBS 25 (ref : 83460) | • BD<br>• Sigma Aldrich |

### 7.1.5 Cleaning Methods that are not recommended

In general, **any cleaning by mechanical means should be avoided**. Never enter the sensor's flow path with sharp objects that could scratch the glass surface.

Furthermore, no abrasives or liquids containing solids that can grind the surface clean should be used. Anything that affects the glass wall will cause deviations in the measurement performance or permanently damage the sensor.
**Strong acids and bases should also not be used to clean the sensor**. Acids can sometimes be used in low concentration and at low temperatures. Before using the acid check how compatible it is with borosilicate 3.3 glass (Pyrex® or Duran®).

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# 8. Dual calibration

## 8.1 Principle of single and dual calibration

The different FLOW UNIT models are calibrated to provide an accurate reading when used with the corresponding fluid, water or isopropyl alcohol.

For the FLOW UNIT models XS/XL, only one single calibration for water is available. For the FLOW UNIT models S/M/L, two calibrations are available: Water and Isopropyl alcohol.

The FLOW UNIT can be used to handle different fluids not originally calibrated for. When possible, select a standard calibration field that most closely matches your fluid. For example, water calibration can be used for water based solution and isopropyl alcohol calibration for hydrocarbons or oil. The calibration can be selected and switched in the software (see the corresponding user manual).

In order to obtain accurate flow-rates for alternative fluids, it is necessary to use correction factors (scale factor), to convert the displayed value into the actual value. The scale factor can be added in the software (see Custom scale factor in the corresponding user manual). Adding the scale factor ensures that the flow sensor reading is now accurate for the target fluid.

The following section explains how you can calculate this scale factor and shows an example with a fluorinated oil: FC-40.

## 8.2 Example of calibration: FC-40

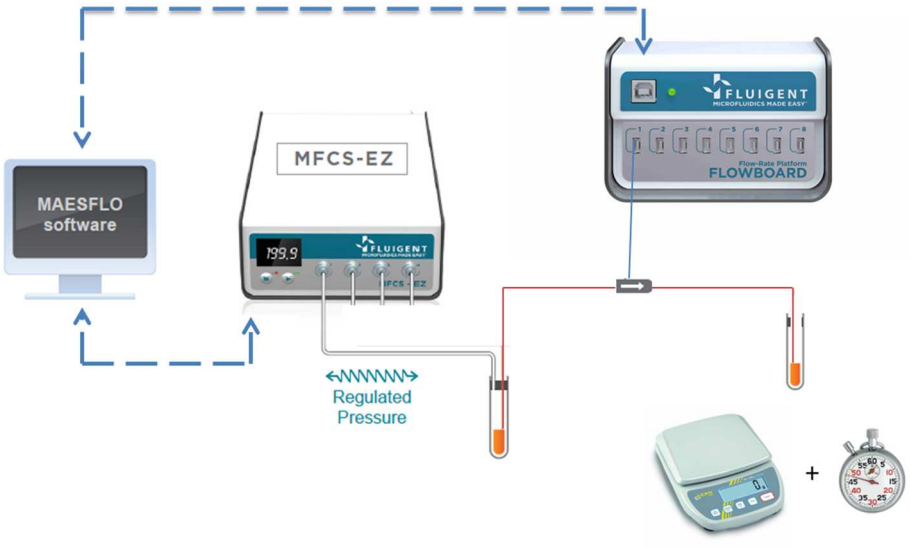
A method for providing a known flow-rate is required to work out the scale factor for the selected fluid. This could be a syringe pump, a peristaltic pump or a pressure regulator delivering fluid onto a precision balance with volume calculated from known density.

Here is an example using MFCS™-EZ, a fast and stable pressure-based flow controller delivered by FLUIGENT. The aim of this FASTAB™ technology is to pressurize a reservoir containing the fluid of interest to be injected through the microfluidic system. For more information about the MFCS™-EZ, please visit us at www.fluigent.com.

Make a table that contains the time for each measurement, the flow-rate of the pump and the data measured by the FLOW UNIT. A minimum of 3 measurements is recommended for each flow-rate.

The principle of the experiment is to inject the FC-40 through the desired FLOW UNIT model connected to the FLOWBOARD. Then simultaneously you record the flow-rate given by the software and you measure the weight of fluid you have collected over a chosen period of time. Knowing the density of the fluid, you are able to define the actual flow-rate.

Note that if a peristaltic or a syringe pump is used, one has to wait until the target flow-rate is reached (settling times can be long) and to calculate an average flow-rate due to the pulsations.




The list of materials needed to reproduce the experiment is given below:

- One (1) FLOWBOARD

- One (1) FLOW UNIT model

- One (1) MFCS™-EZ or with the appropriate pressure range (1 bar for FC-40) and Maesflo™3.2 software (or later versions)

- One (1) precision weighing scale

The table below displays the information recorded during the experiment: the pressure imposed by the MFCS™-EZ, Qs the flow-rate recorded by the FLOW UNIT through the Flow-Rate Platform software, Qw the flow-rate measured with the precision weighing scale, and Qw/Qs the calculated scale factor for a single point calibration.

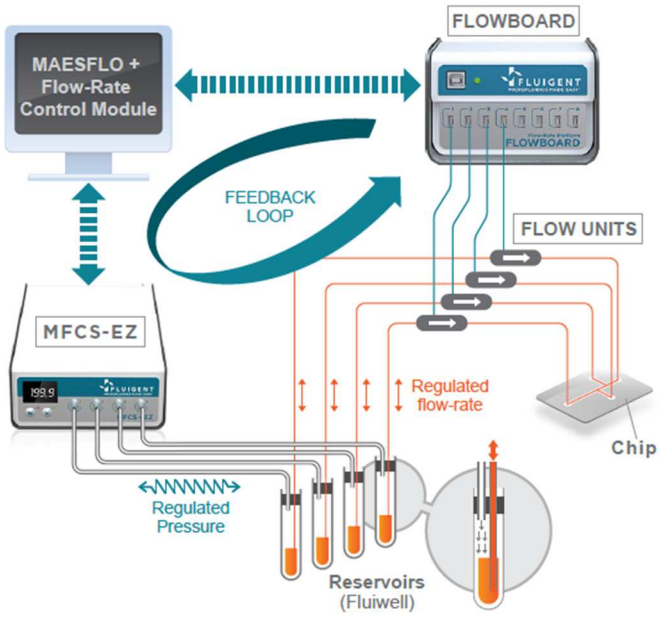
| Pressure (mbar) | $Q_S$ (µl/min) | $Q_W$ (µl/min) | $Q_W/Q_S$ |
|---|---|---|---|
| 596.3 | 91.6 | 317.8 | 3.5 |

Consequently, when working around 317 µl/min (target flow-rate), you have to add the scale factor of 3.5 so that the measurement of the sensor corresponds to the actual flow-rate for FC-40.

# 9. Association with other Fluigent products

## 9.1 Principle

The association of the MFCS™ (MFCS™ and MFCS™-EZ) and the Flow-Rate Platform controlled by the Maesflo™ software enables you to measure the flow-rate and the volume of fluid introduced during your experiment.




In association with the Flow-Rate Control Module[1] (FRCM) you can even control your flows either with pressure and/or flow-rate set points. The FRCM first performs an automated characterization of your fluidic system to work out the relationships between the MFCS™ pressure channels and the flow-rate channels. This pressure/flow-rate relation is then used to automatically compute the best sets of pressure orders to apply in order to reach the target flow-rate set points (See Maesflo™ user manual).

[1]*With a specific dongle*

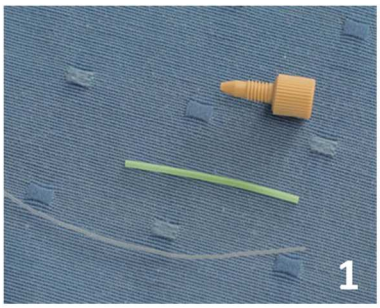
## 9.2 How to connect FLOW UNIT models to Fluiwell

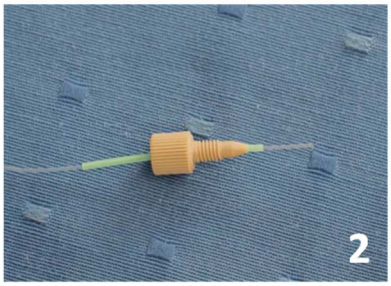
The Fluiwell is a microfluidic accessory enabling a precise pressurization of the samples into disposable vials (different volumes are available to be injected in your microfluidic system through FLOW UNIT models. It's an interface between the MFCS™ or MFCS™-EZ, and your FLOW UNIT or your microfluidic system.

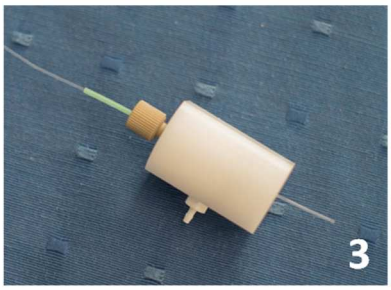
Here is a series of pictures explaining how to connect FLOW UNIT models to a Fluiwell 15 mL.

NB: There are 2 other types of Fluiwell (0.5-2 mL , 50 mL) that you can order to suit your application.
Other volumes are available upon request.

For OD 1/32" tubing

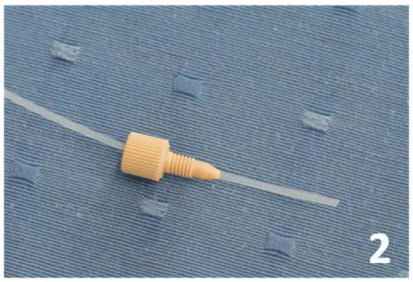


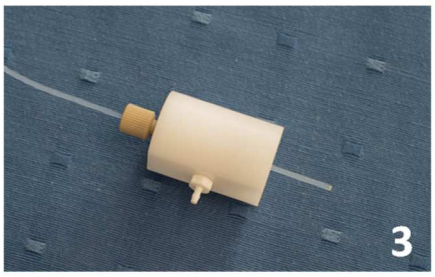




To connect your OD 1/32” tubing you need one nut (F-120) and one green sleeve.
Slide the sleeve over the nut and slide the nut and sleeve over the tubing with the nut thread facing the tubing end being connected.
Insert the assembly into the Fluiwell.

For OD 1/16” tubing


To connect your OD 1/16” tubing you need one nut (F-120).
Slide the nut over the tubing with the nut thread facing the tubing end being connected.
Insert the assembly into the Fluiwell.

# 10. Frequently Asked Questions

How can I clean the Flow Unit after use ?

See §7 how to do it.

In which range of temperature the values given by the sensors stay accurate?

The FLOW UNIT sensors are already temperature compensated, so they work in a range of 10°C to 50 °C. This can be useful if your device needs to be contained within an incubation chamber.

Will the size of the capillary of the XS FLOW UNIT model have an influence on my system?

Yes the diameter of the capillary is small: 25 µm, so depending on the size of your system, you may need to push your fluids harder to obtain a given flow-rate. Then the maximum pressure drop between the sides of the XS FLOW UNIT model at maximum flow-rate is 0.8 bar.

Is there a specific way of washing the XS FLOW UNIT?

You can find cleaning procedures in §4.3. Concerning specifically the XS FLOW UNIT, it may withstand pressures up to 200 bar, so is it possible to use high pressure or flow-rate pumps in case of clogging.

Is there a specific way to prevent clogging in XS FLOW UNIT?

It is possible to add a filter in the fluidic path. As an example, you can find among Idex products, biocompatible precolumn filters (references A-355, A-356). These filters are designed for use with 1/16'' OD tubing. You can choose either 0.5 µm (A-700) or 2 µm (A-701) frit version to filter particles from you flow path.

Why is the flow-rate measured by the FLOW UNIT not stable?

Some fluid controllers are unable to limit the fluctuations of the flow-rates around a mean ordered value because of the mechanical actuation they use. How to connect tubing to the FLOW UNIT models Therefore, the flow-rate within your system can be an imprecise response to the fluid controller. *Visit us on www.fluigent.com for further information.*

Why will the measured flow-rate not reach a steady state?

For some fluid controllers, the settling-time may be long. For this reason, the transition phase after an order change in the fluid controller takes much longer, depending on the nature of the fluid controller. *Visit us on www.fluigent.com for further information.*

Why does the flow-rate measured by the FLOW UNIT not match the ordered flow-rate on my fluid controller?

- The flow-rate calculated by the FLOW UNIT is based on a temperature diffusion-advection measurement with the glass capillary. If your fluid is not pure water (or isopropanol) you first need to add a scale factor to calibrate your FLOW UNIT. *See section 8 for more details on the calibration of the FLOW UNIT.*
- There might be a leak within your system. Please check if your system is completely tight before going any further. *See §4.2 how to connect your FLOW UNIT.*
- The settling time may be long. *Check your fluid controller supplier for more information.*
- Your fluid controller may not be as precise as the FLOW UNIT sensor.

Is it possible to plug the FLOW UNITS directly to the computer ?

No the FLOW UNITS have to be plugged to the FLOWBOARD, which allows the communication between the FLOW UNITS and the computer.

# 11. Specifications

| **FLOW UNITS** | XS | S | M | L | XL | |
|---|---|---|---|---|---|---|
| Over pressure resistance between the FLOW UNIT sides (bar) | 200 | | 100 | 12 | 5 | |
| Wetted materials : | | | | | | |
| Internal Sensor Capillary Material | Quartz Glass (Fused silica) | | Borosilicate Glass 3.3 (Duran®) | | | |
| Fitting material | 100% PEEK ™ (polyetheretherketone) | | | | | |
| Additional sealing material | None | | Teflon® | | ETFE (Tefzel®) | |
| Total internal volume | 1 µL | 1.5 µL | 5.1 µL | < 30µL | < 90 µL | |
| Internal Sensor Capillary, Inner Diameter | 25 µm | 150 µm | 430 µm | 1 mm | 1.8 mm | |
| Size | 80 x 35 x 22 mm | | | | | Length x width x height |
| Length of the cable | 1.5 m | | | | | |
| Weight | 97 g | | | | | |
| **FLOWBOARD** | | | | | | |
| Input | 5V ⎓ 100 mA | | | | | |
| Size | 114 x 102 x 70 mm | | | | | Length x width x height |
| Weight | 478 g | | | | | |

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